PHASE 2
DRAFT ENVIRONMENTAL IMPACT STATEMENT

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Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

AEMP	Aquatic Effects Monitoring Program
AWR	All weather road
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRA	Commercial, Recreational, or Aboriginal
DFO	Fisheries and Oceans Canada
Doris Project	Existing Doris North Project
EEM	Environmental Effects Monitoring
EIS	Environmental Impact Statement
ERM	Environ mental Resource Management
FOP	Fisheries Offsetting Plan
HBML	Hope Bay Mining Ltd.
Hope Bay Project	Comprises all aspects of Doris, Phase 2 and advance exploration projects associated with the Hope Bay Project
HTO	Hunters and Trappers Organization
HWM	High Water Mark
IIBA	Inuit Impacts and Benefits Agreement
IQ	Inuit Qaujimajatuqangit
KIA	Kitikmeot Inuit Association
LSA	Local Study Area
Miramar	Miramar Hope Bay Ltd./Hope Bay Joint Venture
MMER	Metal Mining Effluent Regulations
MOMB	Marine outfall mixing box
NIRB	Nunavut Impact Review Board
NLCA	Nunavut Land Claims Agreement
NTKP	Naonaiyaotit Traditional Knowledge Project

NWB	Nunavut Water Board
PAD	Permanent Alteration or Destruction of Fish Habitat
Phase 2	Phase 2 Project
PDA	Project Development Area
PoE	Pathway of Effect
QA/QC	Quality Assurance/Quality Control
RSA	Regional Study Area
SARA	Species at Risk Act
t	tonne
TK	Traditional Knowledge
TMA	Dry-stack tailings management area at Boston
tpd	tonnes per day
VEC	Valued Ecosystem Component
WRR	Doris to Boston Winter Road Route

10. Marine Fish

The Project may interact with marine fish (inclusive of marine biological resources, fish habitat, and fish) through the development of Phase 2 infrastructure such as the cargo dock and the discharge pipe and diffuser in Roberts Bay. This section summarizes the sources of data, the methods of data collection, and the results from the sampling of marine biological resources, fish habitat, and fish community.

Fish habitat is defined in the federal *Fisheries Act* as "spawning grounds and any other areas, including nursery, rearing, food supply, and migration areas, on which fish depend directly or indirectly in order to carry out their life processes." In this section of the Environmental Impact Statement (EIS) it is divided into two components: biological resources and physical habitat. Biological resources include the abundance and taxonomy of lower trophic levels such as primary producers (phytoplankton) and secondary producers (zooplankton and benthic invertebrates). Physical habitat includes bathymetry, substrate size, gradients, and other physical characteristics.

The term "fish" in the *Fisheries Act* includes "parts of fish; shellfish, crustaceans, marine animals, and any parts of shellfish, crustaceans, or marine animals; and the eggs, sperm, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals". In this section, fish includes fish species richness and the relative abundance of fish species.

Data on marine fish were collected in a nested series of areas. The Project Development Area (PDA) is the area which has the potential for infrastructure to be developed as part of the Phase 2 Project. It includes engineering buffers around the footprints of structures The Local Study Area (LSA) is the area surrounding the PDA in which there is a reasonable potential for immediate effects on a Valued Environmental Component (VEC) due to an interaction with a Phase 2 Project component or physical activity. The marine fish LSA encloses Roberts Bay. The Regional Study Area (RSA) is the maximum extent of the area surrounding the LSA that may be directly or indirectly affected by Phase 2 development. It encloses Melville Sound, the western part of Elu Inlet, the northern part of Bathurst Inlet, and part of Coronation Sound.

10.1 INCORPORATION OF TRADITIONAL KNOWLEDGE

Traditional Knowledge (TK) information was gathered by the Kitikmeot Inuit Association (KIA) in a report titled *Inuit Traditional Knowledge for TMAC Resources Inc., Hope Bay Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (Banci and Spicker 2016) (hereafter referred to as the TK report). This report provides recorded and georeferenced TK pertaining to the Project by means of interviews conducted between 1997 and 2000, regional and site-specific studies, the *Inuit Land Use Occupancy Study* (Freeman 1976), focused workshops in Kugluktuk and Cambridge Bay in 2013, and studies of anadromous lake trout from Roberts Lake by Dr. Heidi Swanson of the University of Waterloo.

A second source of TK is information on traditional land use presented in the baseline of the land use chapter of this EIS (Volume 6; Section 4). This information was obtained through a land use focus group conducted in November 2011 for the Project and interviews with representatives of local Hunter and Trappers Organizations (HTOs) (Land Use Focus Group 2011). The focus group was attended by five elders and one younger hunter active in areas near to the Project, specifically Omingmaktok. Interviews included both structured and semi-structured questions, as well as resource mapping, to gather additional information on current use of land and resources to supplement the information collected from the focus group.

10.1.1 Incorporation of Traditional Knowledge for Existing Environment and Baseline Information

10.1.1.1 TK Report

The TK report was reviewed for existing environment and baseline information on marine fish and fish habitat. Fish were, and continue to be, an important component of the Inuit seasonal diet. They were essential during times of food shortage, particularly when caribou did not arrive because of a change in migration route or calving area. They were also important for feeding dog teams during winter trapping.

Inuit fished the ocean adjacent to the mainland and island coastlines, and at the mouths of major rivers. Fishing was conducted in the regions of Bathurst Inlet, Melville Sound, Elu Inlet, Roberts Bay, Ida Bay, Daniel Moore Bay, and scattered areas within the Coronation Gulf. Figure 21 of the TK report shows that most individual fishing places in the Project area were located along the coastline of Roberts Bay and the southern coastline of Melville Sound.

In the past, Inuit fished the ocean during the open-water season by jigging and sometimes with nets. In the spring they fished through the ice cracks. Fishing is now most commonly conducted using nets.

> *Inuit mostly fish inlets and bays. Sometimes we go out on the open ocean, deep water, too.*
>
> *You go out into the ocean to catch cod. Deep, deep water. They live right on the bottom of the ocean, more of bottom feeding fish. They are seldom seen on top, like charr. Charr always go on top. It will be up on top, feed on top of the water.*
>
> *They are all over this whole area, all of Bathurst Inlet. Kanayuk (sculpins), and natanik, turbot, flounders, they are all over. And eels, also eels. There are all types of ocean species, but we don't know what they all are.*
>
> *People fished the ocean by jigging mostly. Now they use a lot of gillnets. They ice fish today with fishing rods. There are Arctic charr and some trout close to the ocean. Some trout are really close to the ocean… In the ocean, there are whitefish, what they call the broad whitefish, lots of broad whitefish, and those flat fish called flounders, tomcod, Thompson eel, and sculpins ...*

Fish caught in the ocean included both anadromous and exclusively marine species. Section 6.1 of the TK report describes the results for the freshwater life stages of four major anadromous species: Arctic Char, Lake Trout, Arctic Cisco, and Broad Whitefish. Inuit caught all four species at the mouths of rivers and in shallow, coastline habitats with weirs, spears, and fish traps.

<u>Hiugyoktuk (Saffron Cod and Arctic Cod)</u>

Arctic Cod (*Arctogadus glacialis*) and Saffron Cod (*Eleginus gracilis*) are the main target species for Inuit marine fisheries. Saffron Cod are fished primarily in shallow inlets and bays and Arctic cod are fished primarily in deep ocean habitats. Both species are prized as food fish.

> *You pretty well find cod everywhere. There are two types of cod here (Arctic cod and saffron cod). They are all over the inlet (Bathurst Inlet) … They are all good eating. What we have*

noticed is that they are mostly the same, in abundance. This one (saffron cod) is found in inlets and bays, in more shallow waters … and this one (Arctic cod) is in deeper waters.

Arctic cod can grow really, really large … I remember catching one in the really deep part. And they said you're going to get tired trying to take that fish out. (I was fishing) by jigging … where it was really deep.

Capelin

Capelin (*Mallotus villosus*) was caught with baskets when they spawned on beaches. Spawning usually took place once or twice a year during the summer. Inuit ate capelin and also fed it to their dogs. No Inuit name for capelin was reported in the TK report.

Capelin always stay in the ocean, in the deep ocean. They only come to the shallows to lay their eggs.

There are lots in the middle of July. They arrive maybe twice. Early July, and then again about two weeks later. Then they come back.

Capelin … These are ocean fish. They are always in the ocean. Summertime they come to shore to lay their eggs. Millions and millions of eggs on the shoreline. They have to have a certain type of place to lay their eggs, mostly sandy beaches. But sometimes they find rocky parts to lay their eggs.

Etok (Rainbow Smelt and Pacific Herring)

Rainbow smelt (*Osmerus mordax*) and Pacific herring (*Clupea pallasii*) are also summer shore spawners. Smelt spawn on sandy beaches and herring spawn on aquatic vegetation or bare rock if vegetation is not present. Inuit harvest them during the spawning period using traps and nets.

… The shiny little fish are called rainbow smelt. They are different from the capelin, really shiny.

They are a little smaller than the capelin.

Herring are different. They are bigger. There are herring in here too. Herring, etok. They are all over this ocean too. They tend to stay out in the ocean. They don't come ashore, they are mostly in the deep ocean.

Other traditionally harvested marine species include sculpins, flounders, wolfish, eels, crabs, oysters, and starfish.

10.1.1.2 Land Use Study

This section reports relevant TK shown in Section 4 (Land Use) of Volume 6 of this EIS.

Fish are harvested in winter, spring and summer. Fishing methods includes the use of weirs and nets (Land Use Focus Group 2011). While fishing occurs throughout the land use RSA, there are two prominent fishing areas located within the RSA and one within the LSA. The first frequented fishing area within the RSA is located approximately 25 km northwest of the Project on Kent Peninsula near a small lake at the edge of Melville Sound. The NTKP report indicates this lake is known as Naoyak or Tahikyoaknahik (Banci and Spicker 2016). Many people come to this lake from Cambridge Bay, especially to ice fish in the spring. There are two cabins near this fishing area (Land Use Focus Group 2011; J. Avalak, pers. comm.). This location is used for fishing Arctic Char in the fall and fishermen set nets through the ice. Grizzlies frequent the area because of the Arctic Char (Land Use Focus Group 2011).

The second frequented area is Roberts Lake, which was also highlighted by Omingmaktok residents as having abundant fish (e.g., Whitefish, Char, Cod, Sculpins, and Flatfish). However, it is minimally used because of its proximity to the Doris area. Generally, Omingmaktok harvesters focus on Whitefish, Trout and Cod (Land Use Focus Group 2011). Larger lakes and rivers that connect to the ocean are important as they usually have an abundance of fish such as Arctic Char, Whitefish, and Trout. Local land users pile rocks in a particular formation to mark good fishing spots. When travelling the land, people follow big lakes and rivers and look for fish markers (Land Use Focus Group 2011). Currently, harvesters hunting and fishing in the area use the camp for short-term stays. One seasonal camp is located adjacent to Roberts Lake.

10.1.2 Incorporation of Traditional Knowledge for VEC Selection

The TK report and the land use information were reviewed to refine the potential Valued Ecosystem Component (VEC) list for marine fish. The marine and anadromous fish species identified in the TK report and other commercial and recreational fish and their habitats were considered as potential VECs for the effects assessment. In addition, Inuit traditional fishing places and known fish distribution/locations identified in the TK report were considered as potential VECs for the effects assessment. Traditional knowledge was combined with data from public consultation and baseline surveys to determine which valued components would potentially interact with the proposed Project, and should therefore be evaluated for inclusion in the candidate VEC list.

Saffron cod was chosen as the only exclusively marine fish VEC because of its importance of food fish for Inuit, in addition to being the single most common species of marine fish in inlets and shallow habitat near Phase 2 infrastructure in Roberts Bay (50.85% of all fish caught in Roberts Bay from 2000 to 2010) (See Section 10.2; Table 10.2-11).

Although identified as being fished, Capelin was not chosen as a VEC because it is not common in Roberts Bay, although when it is present it is present in large numbers. Capelin was caught in only 3 of the 8 years that Roberts Bay was sampled from 2002 to 2010, and 98.5% of its total number (2,668) was caught in 2003 (See Section 10.2; Table 10.2-11). This suggests that Capelin uses habitat in Roberts Bay for only part of the year. Since Capelin has not been observed spawning on beaches in Roberts Bay, they were probably passing through Roberts Bay in 2003 on the way to beach spawning sites elsewhere in Melville Sound. A Capelin spawning event is highly visible because it attracts marine mammals such as seals and large flocks of noisy birds.

Arctic cod were not chosen as a VEC because they have not been caught in Roberts Bay, no doubt because of their preference for deep water habitat.

Rainbow smelt were not chosen as a marine fish VEC because they were rarely caught in Roberts Bay. Only a single specimen was captured in 2004 (See Section 10.2; Table 10.2-11).

Pacific herring were caught but in relatively small numbers (3.55% of all fish) compared to other species such as Saffron Cod (50.85%) (See Section 10.2; Table 10.2-11), indicating they are not a dominant member of the marine fish community. They are also not a popular food fish for Inuit. Hence they were not chosen as a marine fish VEC.

Flounders and sculpins were caught in Roberts Bay, but not wolfish or eels. Numbers of flounders and sculpins were too low, and their value as food fish was too low, to justify selection as VECs.

The anadromous life stage of Arctic Char was chosen as the second marine VEC because the species was frequently caught in Roberts Bay (7 of 8 sampling years) (See Section 10.2; Table 10.2-11), and TK shows that it is a prized food fish. The results of baseline studies for this EIS confirmed that Arctic Char are present in the LSA and RSA of freshwater fish (See Section 10.2; Section 6.2.5.2) and that anadromous Arctic Char are present in the LSA of marine fish (See Section 10.2; Section 10.2.6.3).

In addition, Inuit traditional fishing places and known fish distribution/locations identified in the TK report and the land use chapter were considered as potential VECs for the effects assessment.

10.1.3 Incorporation of Traditional Knowledge for Spatial and Temporal Boundaries

The results of the TK report and land use study were considered when developing the spatial and temporal boundaries for the Project. The TK report showed that specific and general fishing locations extend along both shores of Melville Sound, but are concentrated along the southern shore extending both east and west of Roberts Bay. The land use study showed fishing for anadromous fish species such as Arctic Char in the Roberts Lake drainage. As a result, Roberts Bay was included within the boundaries of the LSA. The temporal boundaries of the assessment must extend into the indefinite future, as in the post-closure phase, because preservation of the productive capacity of the marine aquatic ecosystem, particularly the capacity to produce food fish and fishing opportunities, is a key value of Inuit culture.

10.1.4 Incorporation of Traditional Knowledge for Project Effects Assessment

The results of the TK report were considered when developing the effects assessment for marine fish. It is clear that Inuit value a suite of marine fish species, mainly the two species of cod plus the anadromous life stage of Arctic Char, as food fish and as key attributes of marine aquatic systems. Therefore, mitigation and adaptive management measures must focus on preserving the productive capacity of marine systems in the Project area so that these fish populations can continue to provide food and fishing opportunities into the indefinite future.

10.1.5 Incorporation of Traditional Knowledge for Mitigation and Adaptive Management

The TK report and land use study were considered when developing mitigation and adaptive management plans for freshwater fish and fish habitat. The Phase 2 Project has been designed such that infrastructure will not be located on important marine fishing habitat. Additional mitigation of Project-related effects may be achieved by the development of a Fish Offsetting Plan, which considers TK. Ongoing consultation with Fisheries and Oceans Canada (DFO), and future engagement with the KIA and other stakeholders, regarding the further development of the Fish Offsetting Plan, including the development of additional or alternative options that could provide value to the local communities, is intended through the life of the EIS.

The two fish VECs considered in the marine fish assessment – Saffron Cod and the anadromous life stage of Arctic Char – use estuarine and coastal habitat within Roberts Bay and the RSA, hence conservation of that habitat is essential for preservation of productive populations. Productive marine ecosystems plus continued access to important feeding areas and spawning grounds are key requirements for both species.

10.2 EXISTING ENVIRONMENT AND BASELINE INFORMATION

10.2.1 Regional Overview and Past Activities

The Hope Bay Project development is comprised of Approved Projects and the Phase 2 Project. The Phase 2 Project is situated within the Queen Maud Gulf Lowlands, approximately 125 km southwest of Cambridge Bay on the southern shore of Melville Sound in the West Kitikmeot region of Nunavut. The Phase 2 Project is located within the Hope Bay Property, which runs 80 km in a north-south direction with a width of approximately 20 km and a total area of 1,101 km^2. The Property encloses a greenstone belt with gold mineralization. The Property is located approximately 700 km northeast of Yellowknife and 150 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet. The nearest settlements are Umingmatok, located approximately 60 km to the west, and Kingaok (Bathurst Inlet), located 130 km southwest. The centre of the Property lies approximately 143 km above the Arctic Circle at 67º50' N latitude and 106 °30' W longitude.

The Hope Bay Project consists of three developments, with Doris being the northernmost, followed by Madrid in the north-central area, and Boston at the southern end (Figure 10.2-1). Marine infrastructure associated with the Hope Bay Project is located along the southern (68° 18' N, 106° 64' W) and western shoreline (68° 19' N, 106° 65' W) of Roberts Bay (Figure 10.2-2), a small inlet that empties into Melville Sound. Roberts Bay is bordered on the west by Hope Bay and on the east by Ida Bay (formerly known as Reference Bay) (Figure 10.2-1). Current infrastructure in Roberts Bay includes a jetty, associated laydown areas, and an access road along it southern shoreline. A marine outfall berm and associated discharge pipeline has also been authorized to be constructed through the Doris Project Type A Water Licence 2AM-DOH1323 (the Type A Water Licence).

Shipping access to the Phase 2 Project is via the Arctic Ocean terminating at the dock/jetty sites in Roberts Bay (Volume 3 Project Description, Section 1). Shipping occurs along existing shipping route through the Northwest Passage. The common Northwest Passage shipping route starts in Nunavut at Lancaster Sound, and passes through Barrow Strait, Peel Sound, Victoria Strait, and the Queen Maud Gulf. Incoming ships would travel south into northern Bathurst Inlet, and enter from the west into Melville Sound terminating in Roberts Bay.

The marine fish RSA encloses Melville Sound, the western part of Elu Inlet, the northern part of Bathurst Inlet, and part of Coronation Sound (Figure 10.2-1). The marine fish LSA encloses Roberts Bay, consistent with the Doris Project. Roberts Bay has a maximum north-south length of 5 km, and an east-west width of 4 km, giving a total surface area of 14.3 km^2 (Figure 10.2-2). The total volume of the bay is approximately 5.1×10^8 m^3 with a mean depth of 36 m and maximum depth of 88 m at its mouth. The southernmost section of the inlet is shallow (<20 m), and deepens to between 40 m and 90 m towards Melville Sound.

Ida Bay is a true fjord that is long (10 km), narrow (1 km at entrance), deep (>65 m), with a shallow sill (20 m deep) at its mouth that impedes deep-water exchange with Melville Sound (Figure 10.2-1). Hope Bay is a broad inlet dotted with many small islands and islets with free connection to Melville Sound.

The physiography of the surrounding area is represented by broad, sloping uplands (primarily igneous outcrops) that reach approximately 300 m in elevation in the south, and subdued undulating plains near the coast. The region’s vegetation is characterized by shrub tundra vegetation such as dwarf birch (*Betula nana*), willow (*Salix* sp.), Labrador tea (*Ledum decumbens*), avens (*Dryas* sp.), and blueberries (*Vaccinium* sp.) (Rescan 2011d).

Figure 10.2-1
Local and Regional Areas for Marine Fish

TMAC RESOURCES

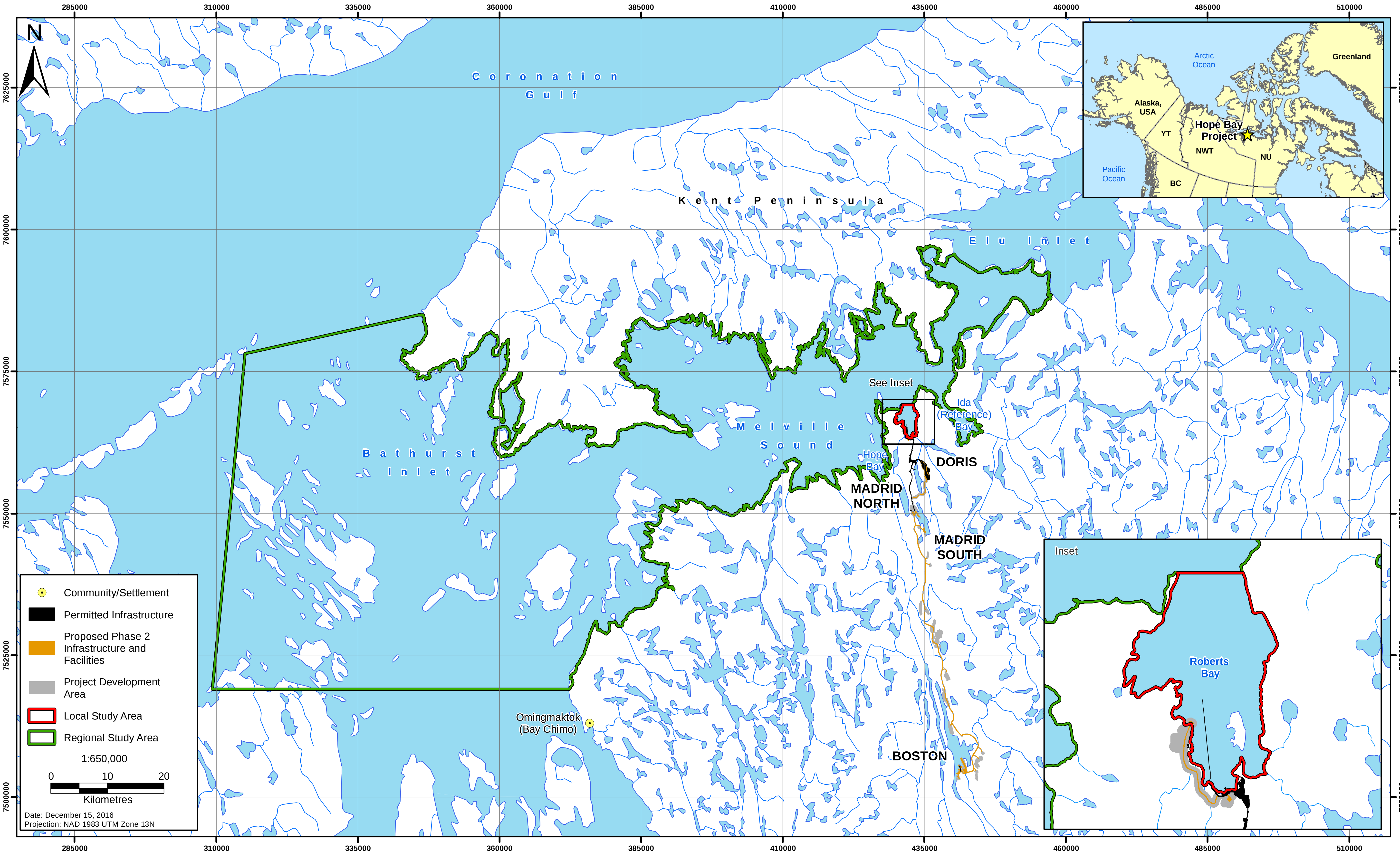
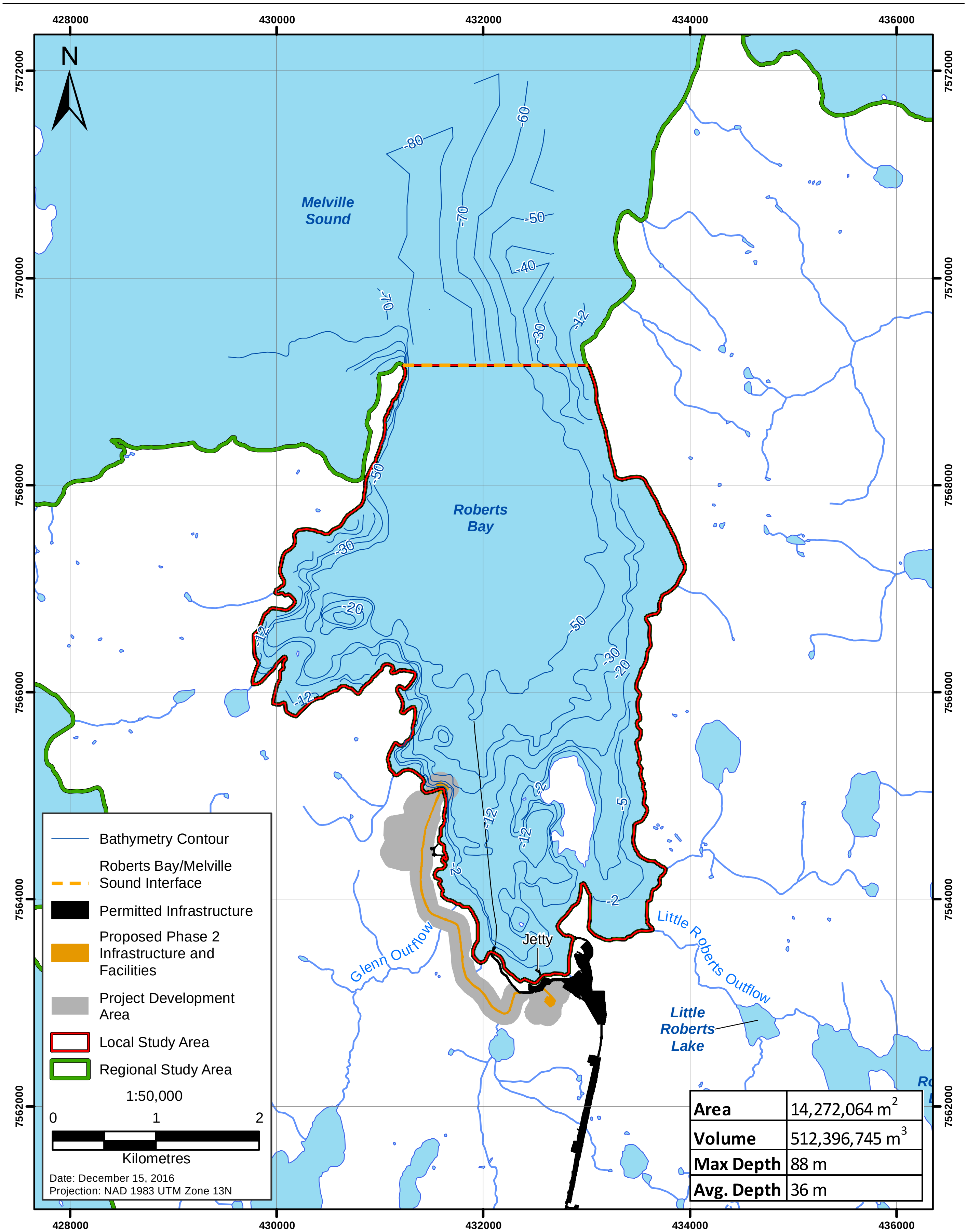


Figure 10.2-2
Roberts Bay



Area	14,272,064 m^2
Volume	512,396,745 m^3
Max Depth	88 m
Avg. Depth	36 m

Water in Roberts Bay has free exchange with Melville Sound because there is no sill present in the inlet. Water exchange between the two waterbodies occurs primarily during the summer months when winds drive the upper freshwater layer towards the shoreline of Roberts Bay, and deeper waters move into Melville Sound (Rescan 2012b). The bay is typically ice covered from October to June, most of that time with land-fast ice that is about 1.5 m thick. During ice cover, the waters of the bay are isolated from wind stress and the exchange of waters between Roberts Bay and Melville Sound is minimal.

Freshwater enters Roberts Bay from Little Roberts Outflow, Glenn Outflow, and smaller tributaries (Figure 10.2-2), with Little Roberts Outflow being the dominant source. The Koignuk River and the Angimajuq River supply the vast majority of freshwater into Hope Bay and Ida Bay, respectively. These inputs contribute to vertical stratification found in the inlets by forming a two-layer system with less dense water overlaying denser bottom water, which can reduce vertical mixing due to wind stress.

Roberts Bay and the surrounding embayments are generally well oxygenated, low in metals and nutrients, and have very low phytoplankton biomass levels. A total of 23 fish species have been found in Roberts Bay to date (see Table 10.2-11).

This section provides a summary of the methods and results from the marine fish habitat, inclusive of biological resources, and fish community sampling carried out in Roberts Bay and the surrounding region for the proposed Project.

10.2.2 Proximity to Designated Environmental Areas

There are currently no existing or proposed parks or conservation areas near the proposed Project. The nearest conservation area is the Queen Maud Gulf Migratory Bird Sanctuary approximately 50 km east of Roberts Bay by air and over 300 km by water (as Melville Sound is isolated from the Queen Maud Gulf by the Kent Peninsula). The Draft Nunavut Land Use Plan (Nunavut Planning Commission 2014) has designated northern Bathurst Inlet, Melville Sound, and Elu Inlet as a key bird habitat site, and thus the marine LSA and RSA are contained within this area. The land use plan also designated the Project area as a High Mineral Potential area. The proposed Hiukitak River Cultural Area is on the eastern shore of northern Bathurst Inlet and is outside of the marine RSA, approximately 120 km northeast of Roberts Bay (by water).

10.2.3 Regulatory Framework

Several federal regulations guide development where it pertains to fish and fish habitat protection. These include the:

- Canada *Fisheries Act* (1985a);
- Metal Mining Effluent Regulations (SOR/2002-222); and
- *Canada Species at Risk Act (SARA; 2002).*

The following sections describe these acts, regulations, and guidelines and how they apply to the protection of fish and fish habitat. Other federal and territorial acts and regulations relevant to Marine Water Quality and Marine Sediment Quality such as the *Arctic Waters Pollution Prevention Act* (1985b), *Canada Water Act* (1985c), and *Nunavut Waters and Nunavut Surface Rights Tribunal Act (2002a)* are discussed in Volume 5, Sections 8 and 9.

10.2.3.1 Canada Fisheries Act

Fish and fish habitat are protected under the *Fisheries Act* (1985a), as well as other federal regulatory acts and principles. In 2012, the *Fisheries Act* was amended to establish (into legislation) the federal government's direction to focus efforts on protecting the productivity of commercial, recreational, and Aboriginal (CRA) fisheries; to institute enhanced compliance and protection tools that are more easily enforceable; to provide clarity, certainty, and consistency of regulatory requirements; and to enable enhanced partnerships with stakeholders.

The *Fisheries Act* includes a prohibition against causing "serious harm to fish" that are part of, or support a, CRA fishery (Section 35), provisions for flow and passage (Sections 20 and 21), and a framework for regulatory decision-making (Sections 6 and 6.1).

The fisheries protection provisions of the *Fisheries Act* aim to provide for the sustainability and ongoing productivity of CRA fisheries (DFO 2013a).

The four factors in Section 6 and 6.1 to be taken into account by the Minister of DFO in decision-making (e.g., issuing authorizations) or making regulations are:

- the contribution of the relevant fish to the ongoing productivity of commercial, recreational, or Aboriginal fisheries;
- fisheries management objectives;
- whether there are measures and standards to avoid, mitigate, or offset serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery; and
- public interest.

For the purposes of the *Fisheries Act*, "serious harm to fish" includes the death of fish or any permanent alteration to, or destruction (PAD) of fish habitat. The *Fisheries Act* defines fish habitat as "spawning grounds and any other areas, including nursery, rearing, food supply, and migration areas, on which fish depend directly or indirectly in order to carry out their life processes." The term "fish" includes parts of fish; shellfish, crustaceans, marine animals, and any parts of shellfish, crustaceans, or marine animals; and the eggs, sperm, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals. An alteration of fish habitat is considered a permanent alteration if it is "of a spatial scale, duration or intensity that limits or diminishes the ability of fish to use such habitats… in order to carry out one or more of their life processes". An alteration of fish habitat is considered the destruction of fish habitat if it is "of a spatial scale, duration, or intensity that fish can no longer rely upon such habitats…in order to carry out one or more of their life processes".

The Marine Mammal Regulations (SOR/93-56) apply to the management and control of fishing for marine mammals and related activities in Canada or Canadian fisheries waters. Prohibitions under the Regulation include no disturbance of a marine mammal except when fishing under the authority of the Regulations. Going forward, for the purposes of this assessment, marine mammals will be addressed in the Marine Wildlife Section 11 in Volume 5.

On November 1, 2013, The *Fisheries Protection Policy Statement* (DFO 2013a) was issued and replaced the earlier *Policy for the Management of Fish Habitat* (DFO 1986). Although the new policy statement does not include the "no net loss" principle, as outlined in the earlier policy, application of this "no net loss" principle has been used to provide useful guidance when considering "serious harm to fish".

Any project or activity that causes serious harm to fish that are part of, or support, a CRA fishery requires an authorization from DFO. Regulations have been developed to guide the application for this authorization under Paragraph 35(2)(b) of the *Fisheries Act* Regulations. DFO has issued additional guidance in *The Fisheries Protection Program Operational Approach* (DFO 2013b). As indicated above, any issues associated with marine mammals will be addressed in the Marine Wildlife Section 11 in Volume 5.

10.2.3.2 Metal Mining Effluent Regulations

In 1996, Environment Canada undertook an assessment of the aquatic effects of mining in Canada. This assessment provided recommendations regarding the review and amendment of the Metal Mining Liquid Effluent Regulations, currently titled the Metal Mining Effluent Regulations (MMER; SOR/2002-222), and the design of a national Environmental Effects Monitoring (EEM) program for metal mining. The MMER, under the *Fisheries Act*, instruct metal mines to conduct EEM as a condition governing the authority to deposit effluent (MMER, Part 2, section 7).

The MMER (SOR/2002-222) permit the deposition of mine effluent into sea water containing fish if the effluent pH is within a defined range, the concentrations of the MMER deleterious substances in the effluent do not exceed authorized limits, and the effluent is demonstrated to be non-acutely lethal to a marine test species such as echinoids (sea urchins and sand dollars) (Environment Canada 1992). These discharge limits were established as minimum national standards based on best available technology economically achievable at the time that the MMER were promulgated. To assess the adequacy of the effluent regulations for protecting the aquatic environment, the MMER include EEM requirements to evaluate the potential effects of effluents on fish, fish habitat, and the use of fisheries resources.

Regulations Amending the MMER were published in the Canada Gazette, Part II, in October 2006 (Canada Gazette 2006). The purpose of these amendments was to clarify the regulatory requirements by addressing matters related to the interpretation and clarity of the regulatory text that had emerged from the implementation of the Regulations.

Additional amendments to the MMER were published in the Canada Gazette, Part II, in March 2012 (Canada Gazette 2012). The following changes were made in 2012 to expand EEM provisions of the MMER:

- modifications to the definition of an “effect on fish tissue” in order to be consistent with the Health Canada fish consumption guidelines and to clarify that the concentration of total mercury in tissue of fish from the exposure area must be statistically different from and higher than its concentration in fish tissue from the reference area;
- addition of selenium and electrical conductivity to the list of parameters required for effluent characterization and water quality monitoring;
- exemption for mines, other than uranium mines, from monitoring radium 226 as part of the water quality monitoring, if 10 consecutive test results showed that radium 226 levels are less than 10% of the authorized monthly mean concentration (subsection 13(2) of the Regulations; SOR/2002-222);
- change to the time frame for the submission of interpretative reports for mines with effects on the fish population, fish tissue, and benthic invertebrate community from 24 to 36 months;

- change to the time frame for the submission of interpretative reports for magnitude and geographic extent of effects, and for investigation of cause of effects, from 24 to 36 months; and
- minor changes to the wording for consistency within Schedule 5.

10.2.3.3 Canada Species at Risk Act

The federal *Species at Risk Act* (SARA; 2002b) is designed to prevent Canadian indigenous species, subspecies, and distinct populations from becoming extirpated or extinct. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses and identifies species at risk. COSEWIC is designated under *SARA* to assess species according to their level of conservation concern: *extinct*, *extirpated*, *endangered*, *threatened*, *special concern*, *not at risk* or *data deficient*. Only those species listed in Schedule 1 of the *Act* qualify for legal protection and recovery under *SARA*. The Act prohibits the killing, harming, harassing, capturing or taking of an individual of a wildlife species that is listed in Schedule 1 as *extirpated*, *endangered* or *threatened* by SARA (section 32(1)). *SARA* also protects the residence of species listed as *extirpated*, *endangered* or *threatened* from being damaged and destroyed as specified in Section 33. No *SARA*-listed species were captured in marine habitats in baseline studies.

10.2.4 Data Sources

This section provides a brief chronological history of surveys of marine fish habitat and fish communities in the LSA and RSA. Marine fish habitat comprises two components: (1) biological resources such as phytoplankton, zooplankton and benthic invertebrates; and (2) physical fish habitat.

Although environmental studies of the Hope Bay Belt began in 1993 with surveys of the freshwater aquatic environment of the Boston area (Rescan 1993), sampling of the marine environment did not begin until 1997. Sampling of benthic invertebrates was conducted in Roberts Bay for BHP Minerals Canada Ltd. in 1997 and for BHP Diamonds Inc. in 1998. No studies of physical fish habitat or marine fish were conducted during the 1990s.

Miramar Hope Bay Ltd./Hope Bay Joint Venture (Miramar) acquired the property in 1999, and initiated studies in Roberts Bay of physical marine habitat (in 2000, 2003, and 2004), biological resources (phytoplankton biomass in 2006 and 2007, phytoplankton taxonomy in 2007, and zooplankton taxonomy in 2007), and marine fish communities (2002 to 2007).

Miramar also took the Doris property through the environmental permitting process in Nunavut, and was issued a Project Certificate by the Nunavut Impact Review Board (NIRB), a Type A water licence by the Nunavut Water Board (NWB), and a Schedule 2 amendment to the Metal Mining Effluent Regulations (MMER) for Tail Lake. Other regulatory approvals were also obtained including a Fisheries Authorization and Fish Habitat Compensation Agreement for habitat lost by construction of the Roberts Bay Jetty, a Navigable Waters Authorization, a Water Compensation Agreement with the Kitikmeot Inuit Association (KIA), and an Inuit Impacts and Benefits Agreement (IIBA) with the KIA.

Newmont Mining Corporation acquired the property in March 2008, and formed Hope Bay Mining Ltd. (HBML) to continue exploration activities, and evaluate various options for long-term development of the belt. That work included preparing a review of baseline studies and a data gap analysis (Rescan 2009). HBML continued sampling of Roberts Bay for marine habitat (2009 and 2010), biological resources (phytoplankton biomass from 2009 to 2012, phytoplankton taxonomy in 2009 and 2010, zooplankton taxonomy in 2009, and benthic invertebrates form 2009 to 2011), and marine fish communities (2007, 2009, and 2010).

In 2012, TMAC acquired the property and continued freshwater aquatic studies including baseline studies, annual compliance reports, and reports of the Aquatic Effects Monitoring Program (AEMP) of the Doris Project.

In summary, surveys of the marine aquatic environment of Roberts Bay began in 1997 and have continued to 2015 under three proponents and under both baseline sampling and compliance monitoring programs.

10.2.4.1 Marine Fish Habitat - Marine Biological Resources

Biological resources data were compiled from site-specific surveys in the LSA and RSA conducted from 1997 to 2015). The primary sources of biological resource information used in the EIS were collected between 2009 and 2014 in Roberts Bay and Ida Bay, including baseline studies (Rescan 2010a, 2011e) and Aquatic Effects Monitoring Program (AEMP) sampling for the Doris North Project (Rescan 2011c, 2011b, 2012a, 2013; ERM Rescan 2014; ERM 2015, 2016). Data collected historically (1997 to 2007) in Roberts Bay and Hope Bay are included where applicable, however, due to the inter-annual variability in the field and laboratory methods some data were not used for comparisons (e.g., phytoplankton density). All reports can be found in appendices as indicated below, except the Doris North Project Aquatic Effects Monitoring Program reports, which are available on the Nunavut Impact Review Board (NIRB) FTP (http://ftp.nirb.ca) and Nunavut Water Board FTP (ftp://ftp.nwb-oen.ca) sites.

- Hope Bay Belt Project - 1997 Environmental Data Report (Rescan 1998);
- Hope Bay Belt Project - 1998 Environmental Data Report (Rescan 1999);
- Boston and Madrid Project Areas: 2006 - 2007 Aquatic Studies (Golder Associates Ltd. 2008);
- 2009 Marine Baseline Report, Hope Bay Belt Project (Rescan 2010a);
- Hope Bay Belt Project: 2010 Marine Baseline Report (Rescan 2011e);
- Hope Bay Belt Project: 2010 Regional Marine Baseline Report (Rescan 2011f);
- Doris North Gold Mine Project: 2010 Aquatic Effects Monitoring Program Report (Rescan 2011b);
- Doris North Gold Mine Project: 2010 Aquatic Effects Monitoring Program (AEMP) Marine Expansion Base Report (Rescan 2011c);
- Doris North Gold Mine Project: 2011 Aquatic Effects Monitoring Program Report (Rescan 2012a);
- Doris North Gold Mine Project: 2012 Aquatic Effects Monitoring Program Report (Rescan 2013);
- Doris North Project: 2013 Aquatic Effects Monitoring Program (ERM Rescan 2014);
- Doris North Project: 2014 Aquatic Effects Monitoring Program (ERM 2015); and
- Doris North Project: 2015 Aquatic Effects Monitoring Program Report (ERM 2016).

10.2.4.2 Marine Fish Habitat – Physical Characteristics and Fish Community

Baseline surveys of marine physical habitat in Roberts Bay were conducted in 2000, 2003, 2004, 2009 and 2010 as part of studies of marine fish communities (Rescan 2001; RL&L/Golder 2003b; Golder 2005; Rescan 2010a, 2011f). Ten years of marine fish community and fish habitat information (2000 to 2007, 2009, and 2010) is available for Roberts Bay, and 2 years of marine fish community information (2009 and 2010) is available for Ida Bay.

Most of the sampling effort from 2000 to 2007 focused on collecting fish community and habitat information from the mouth of Little Roberts Outflow and from the existing jetty location. In 2009 and

2010, sampling effort in Roberts Bay focused on potential marine infrastructure sites (two sites in 2009 and five sites in 2010), and the jetty and compensation shoals for the Doris North Fisheries Authorization Monitoring Program. The proposed cargo dock infrastructure is positioned adjacent and between two of the five sites sampled in 2010. Full details of the baseline and compensation programs used to collect information are described in reports listed below.

Reports publically available on the Nunavut Impact Review Board (NIRB) FTP site (http://ftp.nirb.ca) and/or Nunavut Water Board (NWB) FTP site (ftp://ftp.nwb-oen.ca) are the following:

- Doris North Project Aquatic Studies 2004 (Golder 2005; Appendix V5-4G);
- Doris North Project Aquatic Studies 2006 (Golder 2007a; Appendix V5-4I);
- Doris North Project “No Net Loss” Plan – Revision 6 Final Report (Golder 2007b; Appendix V5-6B);
- Doris North Project Aquatic Studies 2007 (Golder 2008a; Appendix V5-4J); and
- Doris North Gold Mine Project: 2010 Roberts Bay Jetty Fisheries Authorization Monitoring Report (Rescan 2010b; Appendix V5-10A).

Reports not publically available on NIRB and/or NWB FTP sites are the following:

- Hope Bay Belt Project: 2000 Supplemental Environmental Baseline Data Report (Rescan 2001; V5-3C);
- Doris North Project Aquatic Studies 2002 (RL&L/Golder 2003a; Appendix V5-5A);
- Doris North Project Aquatic Studies 2003 (RL&L/Golder 2003b; Appendix V5-3E);
- Doris North Project Aquatic Studies 2005 (Golder 2006; V5-4H);
- Doris North Gold Mine Project: 2008 Roberts Bay Authorization Monitoring Report (Golder 2008; Appendix V5-10B).
- Doris North Gold Mine Project: 2009 Roberts Bay Jetty Fisheries Authorization Monitoring Report (Rescan 2009; Appendix V5-10C);
- 2009 Marine Fish and Fish Habitat Baseline Report, Hope Bay Belt Project (Rescan 2010a; Appendix V5-10D); and
- 2010 Marine Fish and Fish Habitat Baseline Report, Hope Bay Belt Project (Rescan 2011f; Appendix V5-10E).

Supplementary information for the RSA was obtained from the Back River Draft EIS (Rescan 2013a), which sampled the marine fish community in southern Bathurst Inlet, and DFO’s *Annotated List of the Arctic Marine Fishes of Canada* (DFO 2004).

10.2.5 Methods

10.2.5.1 Marine Fish Habitat – Biological Resources

Marine biological resource (phytoplankton, zooplankton, and benthic invertebrates) information has been collected in Roberts Bay (LSA), Ida Bay (RSA), and Hope Bay (RSA) since 1997, and has included baseline surveys (Rescan 1998, 1999; Golder Associates Ltd. 2008; Rescan 2010a, 2011e, 2011c, 2012b) and AEMP sampling (Rescan 2011b, 2012a, 2013; ERM Rescan 2014; ERM 2015, 2016). The most intensive sampling has occurred in Roberts Bay where Project activities have been focussed, with sampling being conducted along the perimeter of the bay as well as within the deep pelagic waters. The biological components that have been surveyed and the methods with which they have been collected are described below.

Phytoplankton

Phytoplankton is a group of free-floating photosynthetic microorganisms that use inorganic nutrients and sunlight to produce organic matter. They play an important ecological role in many aquatic systems as primary producers and food for higher trophic levels. In the marine environment, phytoplankton is the main source of food for zooplankton, which is consumed directly by planktivorous fish. Zooplankton is also consumed by certain pelagic and benthic invertebrates, which constitute important food resources for insectivorous and omnivorous species of fish.

Baseline phytoplankton samples were collected for biomass (as indexed by the concentration of chlorophyll *a*) during the under-ice (April) and open-water (July, August, September/October) seasons and for taxonomy (community composition) during the open-water season. Baseline samples were collected locally from 12 different sites in Roberts Bay from 2006 to 2011, and at the near-shore sites RBW and RBE from 2010 to 2015 as part of the Doris North AEMP program (biomass only; Table 10.2-1 and Figure 10.2-3). Regionally, samples were collected from several sites in Ida Bay between 2009 and 2015 and at one site in Hope Bay during the summer of 2007 (Table 10.2-2).

Table 10.2-1. Marine Phytoplankton Biomass (as Chlorophyll *a*) Sampling Sites, 2006 to 2015

	2006	2007	2009	2010	2011	2012	2013	2014	2015
Roberts Bay	**Sep**	**Jul, Aug, Sep**	**Aug**	**Apr, Jul, Aug, Sep/Oct**	**Apr, Jul, Aug, Sep**	**Apr, Jul, Aug, Sep**	**Apr, Jul, Aug, Sep**	**Apr, Jul, Aug, Sep**	**Apr, Jul, Aug, Sep**
RBW	-	-	-	X	X	X	X	X	X
RBE	X[a]	X[a]	-	X	X	X	X	X	X
ST0	-	-	X	-	-	-	-	-	-
ST1	-	-	X	-	-	-	-	-	-
ST2	-	-	X	-	-	-	-	-	-
ST3	-	-	X	-	-	-	-	-	-
ST4	-	-	X	X	-	-	-	-	-
ST5	-	-	X	-	-	-	-	-	-
ST6	-	-	X	-	-	-	-	-	-
DWP	-	-	-	X	-	-	-	-	-
RB1	-	-	-	-	X	-	-	-	-
RB2	-	-	-	-	X	-	-	-	-
Ida Bay									
REF-Marine 1	-	-	-	X[b]	X	X	X	X	X
REF-Marine 2	-	-	-	-	X	-	-	-	-
RP3	-	-	X	-	-	-	-	-	-
REF4	-	-	X	X	-	-	-	-	-
Hope Bay									
Stn1-HB	-	X	-	-	-	-	-	-	-

Notes:
Dashes indicate no samples were collected.
Three replicates collected at each sampling site unless otherwise indicated.
[a] Single replicate collected at each site .
[b] July and August sampling only.

Figure 10.2-3
Marine Phytoplankton Sampling Sites, 2006 to 2015

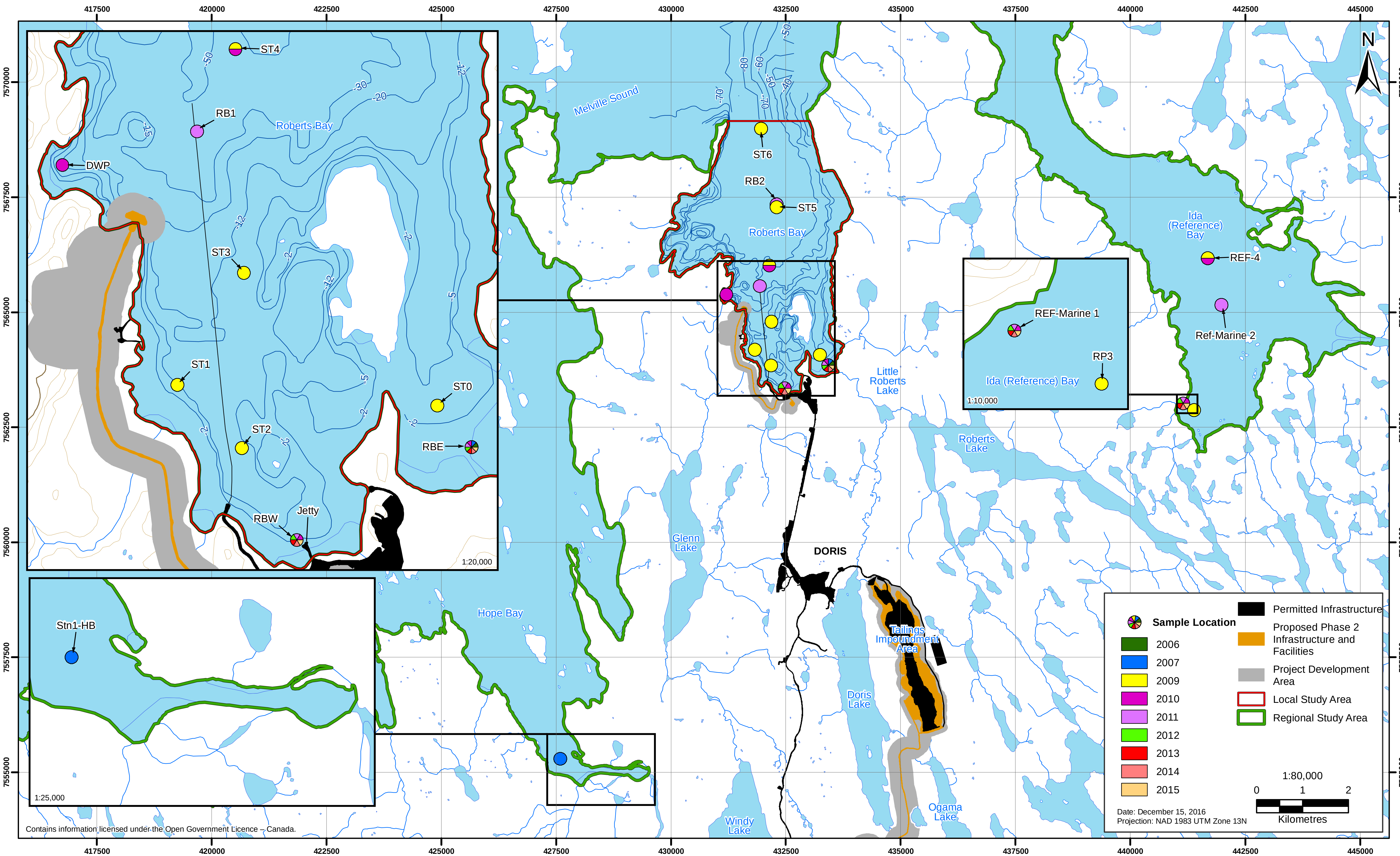


Table 10.2-2. Marine Phytoplankton Taxonomy Sampling Sites, 2007 to 2010

	2007	2009	2010
Roberts Bay	**Jul, Aug, Sep**	**Aug**	**Aug, Sep**
ST0	-	X	-
ST1	-	X	-
ST2	-	X	-
ST3	-	X	-
ST4	-	X	X[b]
ST5	-	X	-
ST6	-	X	-
Ida Bay			
RP3	-	X	-
REF4	-	X	X
Hope Bay			
Stn1-HB	X[a]	-	-

Notes:
Dashes indicate no samples were collected.
Three replicates collected at each sampling site unless otherwise indicated.
[a] *Single replicate collected at each site.*
[b] *August sampling only.*

Phytoplankton biomass (as chlorophyll *a*) and taxonomy samples were collected in triplicate from 1 m depth using Niskin (ice-covered sampling) or GO-FLO sampling bottles (open-water sampling). In 2006 and 2007, single samples were collected from 3-m depth using a Kemmerer bottle sampler and depth-integrated water sampler, respectively. Biomass samples were transferred into 1 L plastic bottles and stored in coolers (i.e., cool, dark environment). The biomass samples were filtered onto 0.45 µm filters, which were then wrapped in aluminum foil, and stored frozen. Chlorophyll samples were hand carried to Vancouver (BC) to ensure they remained frozen, and then sent to ALS Environmental (Burnaby, BC) for analyses. Taxonomy samples were preserved with Lugol's iodine solution and were sent to a qualified taxonomist for enumeration and identification.

Phytoplankton communities were described using abundance (cells/L), richness (number of taxa per sample), and diversity (Simpson's Diversity Index). The Simpson's Diversity Index is considered a dominance index because it weights towards the most abundant species (represents the probability that two individuals selected at random from the population are different species or genera) and is defined as:

$$D = 1 - \Sigma(p_i)^2$$

where p_i is the proportion of the i^{th} taxa at a sampling station and Σ indicates that the $(p_i)^2$ is summed over all taxa.

Zooplankton

Marine zooplankton communities are key sources of food for planktivorous fish species, and they are an important trophic linkage between primary producers and higher trophic levels in marine food webs. Baseline zooplankton samples were collected for abundance and taxonomy at six sites in Roberts Bay in August 2009, at two sites in Ida Bay in August 2009, and one site in Hope Bay in July, August, and September 2007 (Table 10.2-3; Figure 10.2-4).

Table 10.2-3. Marine Zooplankton Taxonomy Sampling Sites, 2007 and 2009

Roberts Bay	2007 Jul, Aug, Sep	2009 Aug
ST0	-	X
ST1	-	X
ST2	-	X
ST3	-	X
ST4	-	X
ST5	-	X
ST6	-	X
Ida (Reference) Bay		
RP3	-	X
REF4	-	X
Hope Bay		
Stn1-HB	X[a]	-

Notes:
Dashes indicate no samples were collected.
Three replicates collected at each sampling site unless otherwise indicated.
[a] Single replicate collected at each site.

In 2009, zooplankton samples were collected in triplicate at each site using a Birge-style zooplankton net with a mesh size of 202 µm fitted with a flow meter. Vertical tows were conducted at deep sites (>20 m; ST4-ST6 and REF4), oblique tows at shallower depths (5-20 m; ST1-ST3 and RP3), and horizontal tows at the shallowest site (3 m; ST0). Vertical tows were conducted by lowering the net to 1 m above the sediment and brought to the surface at a speed of 0.5 m/s. Oblique and horizontal tows were conducted by slowly dragging the net behind a moving aluminum boat. Flow meter readings were taken before and after net deployment to determine the volume of water that passed through the net. Similar volumes were sampled for each replicate haul so that species-volume relationships were maintained and diversity relationships were comparable. In 2007, a single zooplankton sample was collected in July, August, and September using a Wisconsin net with a mesh size of 153 µm. Samples were collected by performing a vertical tow from 1m above the sediment to the water surface. A flow meter was not used for these tows.

Zooplankton samples were preserved with 10% buffered formalin and sent to a qualified taxonomist for enumeration and identification. In 2009, zooplankton communities were described using abundance (organisms/m^3), richness (number of genera per sample) and diversity (Simpson's Diversity Index at a genera level). In 2007, zooplankton communities were described using biomass (µg/m^3).

Benthic Invertebrates

Marine benthic invertebrates (also known as benthos) are both an important source of food for benthic-feeding fishes and are an important linkage for energy transfer between lower (e.g., primary producers) and higher trophic levels of marine food webs, including those ultimately occupied by piscivorous fishes, birds, and mammals (Hobson and Welch 1992; DFO 2008; McMeans et al. 2013). In the shallow waters of coastal environments (<40 m depth), like the nearshore sites of Roberts Bay, benthic organisms can be responsible for 80% of the total ecosystem primary production (Rysgaard and Nielsen 2006).

Baseline benthos samples were collected locally from 20 different sites in Roberts Bay from 1997 to 2011, and at the near-shore sites RBW and RBE as part of the Doris North AEMP from 2010 to 2015 (Table 10.2-4; Figure 10.2-5). In the RSA, benthic invertebrates were collected at five sites in Ida Bay from 2009 to 2015, and at three sites in Hope Bay in 1998 (Figure 10.2-5). All benthic invertebrate samples were collected in August, except in 1998 when samples were collected in July.

Figure 10.2-4
Marine Zooplankton Sampling Sites, 2007 and 2009

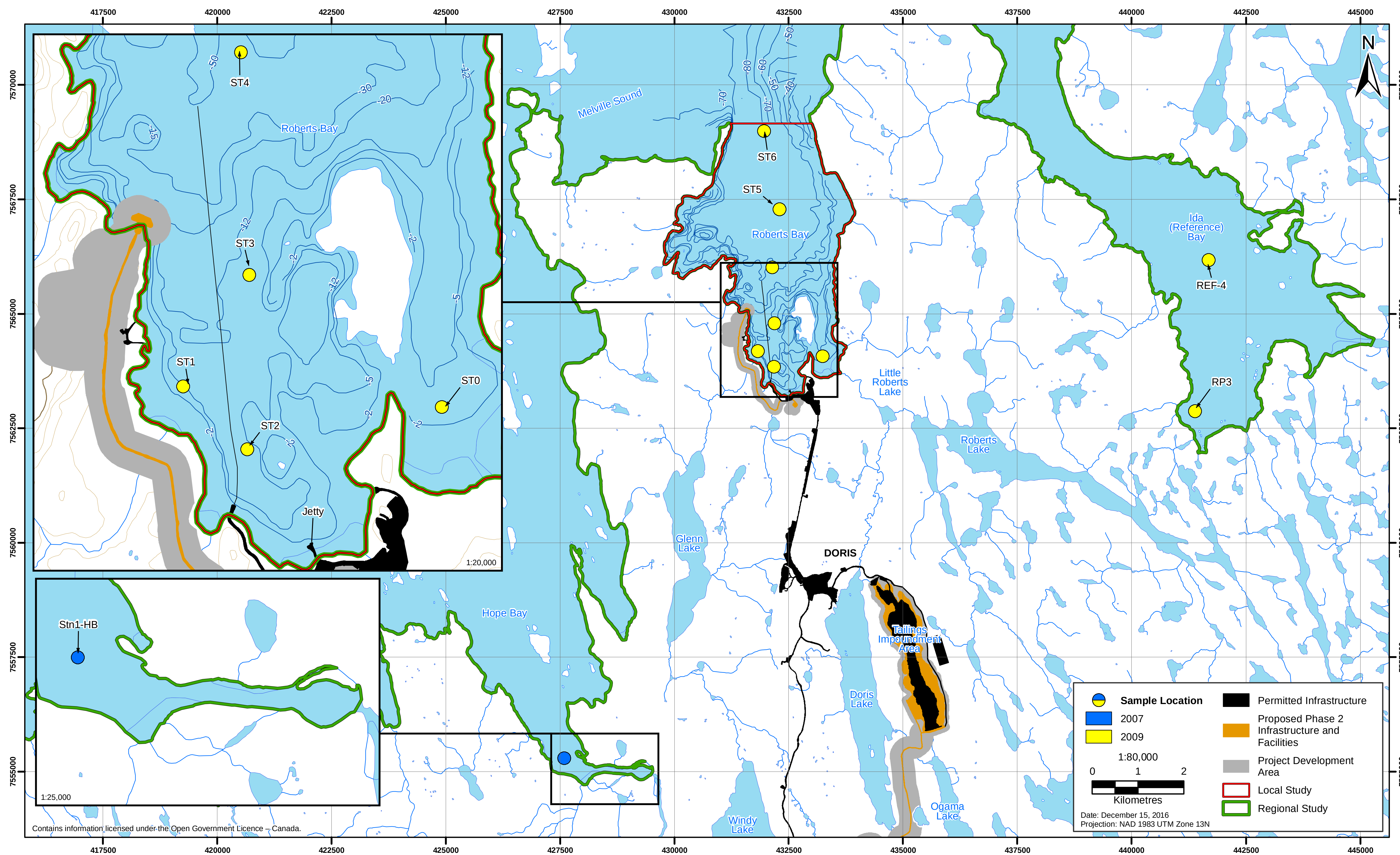


Figure 10.2-5
Marine Benthic Invertebrate Sampling Sites, 1997 to 2015

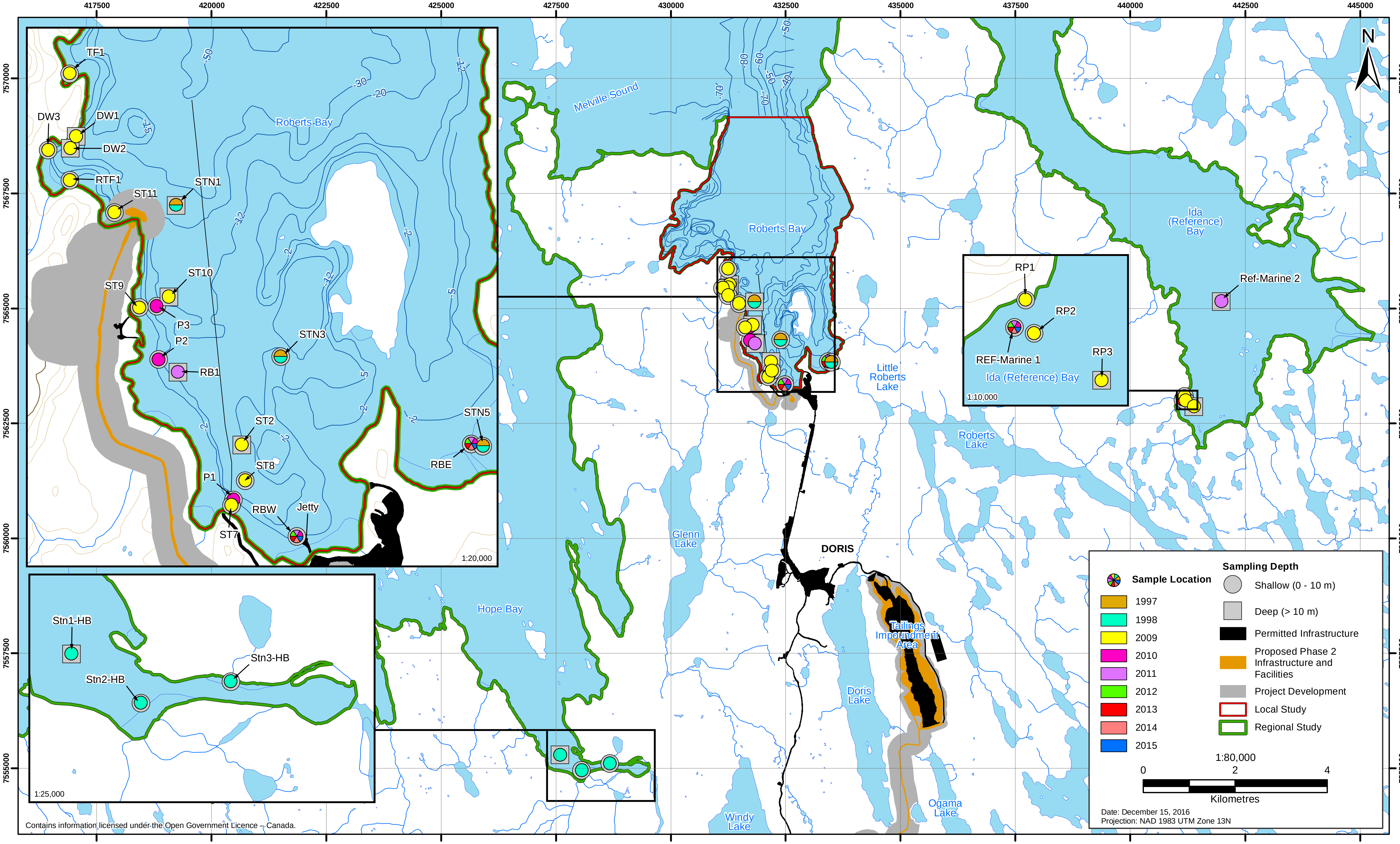


Table 10.2-4. Marine Benthic Invertebrate Sampling Sites, 1997 to 2015

Roberts Bay	Depth (m)	1997 Aug	1998 Jul	2009 Aug	2010 Aug	2011 Aug	2012 Aug	2013 Aug	2014 Aug	2015 Aug
RBW	<5	-	-	-	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]
RBE	<5	-	-	-	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]
STN1	15.5-19	X	X	-	-	-	-	-	-	-
STN3	9.5-10.4	X	X	-	-	-	-	-	-	-
STN5	0.75-1.2	X	X	-	-	-	-	-	-	-
ST2	7	-	-	X	-	-	-	-	-	-
ST7	2	-	-	X	-	-	-	-	-	-
ST8	8	-	-	X	-	-	-	-	-	-
ST9	2	-	-	X	-	-	-	-	-	-
ST10	13	-	-	X	-	-	-	-	-	-
ST11	8	-	-	X	-	-	-	-	-	-
DW1	13	-	-	X	-	-	-	-	-	-
DW2	13	-	-	X	-	-	-	-	-	-
DW3	1	-	-	X	-	-	-	-	-	-
RTF1	3	-	-	X	-	-	-	-	-	-
TF1	2	-	-	X	-	-	-	-	-	-
P1	5.5	-	-	-	X	-	-	-	-	-
P2	3	-	-	-	X	-	-	-	-	-
P3	3.5	-	-	-	X	-	-	-	-	-
P4	5	-	-	-	X	-	-	-	-	-
RB1	42	-	-	-	-	X[a]	-	-	-	-
Ida (Reference) Bay										
REF-Marine 1	<5	-	-	-	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]
REF-Marine 2	40	-	-	-	-	X[a]	-	-	-	-
RP1	5	-	-	X	-	-	-	-		
RP2	9	-	-	X	-	-	-	-	-	-
RP3	14	-	-	X	-	-	-	-	-	-
Hope Bay										
Stn1-HB	3.7	-	X	-	-	-	-	-	-	-
Stn2-HB	3.6	-	X	-	-	-	-	-	-	-
Stn3-HB	8	-	X	-	-	-	-	-	-	-

Notes:
Dashes indicate no samples were collected.
Three replicates collected at each sampling site unless otherwise indicated.
[a] *Each replicate was a composite of three subsamples.*

Benthos samples were collected in triplicate with an Ekman sampler in 1997 and with a Ponar dredge sampler in 1998, 2009, and 2010 (P1-P4). From 2010 to 2015, five composite (three subsamples each) benthos samples were collected using a Petite Ponar dredge sampler at RBW, RBE, and REF-Marine 1 sites as part of the Doris North AEMP program. Replicate samples were collected approximately 5 to 50 m apart. The sampler was carefully set open, lowered gradually onto the sediment floor using a metered cable, and triggered closed. Once recovered, either 1 L of each sample (2009 and 2010 only) or all of each sample was transferred into a 500 µm sieve bucket and rinsed with site water until free of sediment particles smaller than 500 µm. The material retained within the sieve was then transferred to a labelled plastic jar and filled with 10% buffered formalin. All benthos samples were sent to an analytical laboratory for enumeration and identification. Benthos counts were normalized to density as organisms/m^2 based on the total surface area sampled. Benthic invertebrate communities were described using density (organisms/m^2), richness (number of families or taxa per sample), and diversity (Simpson's Diversity Index at a family or taxa level).

Quality Assurance/Quality Control (QA/QC)

Chain of custody forms were used for all biological resources samples. All samples had replication; three samples were collected for chlorophyll *a* (phytoplankton biomass), phytoplankton taxonomic analysis, zooplankton, and benthos (1997, 2009, and 2010), and five composite samples were collected for all AEMP benthos (2010 and 2015). Additional QA/QC measures were used by the benthic invertebrate taxonomists to ensure consistent and accurate sorting of benthos samples. As part of the AEMP QA/QC program, re-sorting of benthic sample residues was conducted on a randomly selected 10% of the samples of benthos to determine the level of sorting efficiency. The criterion for an acceptable sorting was that more than 90% of the cumulative number of organisms found in the initial + QA/QC sorts were recovered during the initial sort, as required by Environment Canada for invertebrate community surveys (Environment Canada 2002). This was calculated by the following equation:

$$\%\,sorting\ efficiency = \left(1 - \frac{\#\ in\ QA/QC\ re\text{-}sort}{\#\ sorted\ originally + \#\ in\ QA/QC\ re\text{-}sort}\right) \times 100$$

Any sample not meeting the 90% removal criterion was re-sorted a third time. The 90% minimum efficiency was attained for all samples of benthos.

10.2.5.2 Marine Fish Habitat – Physical Characteristics

Since 2000, marine fish habitat in Roberts Bay has been assessed using a suite of methods. Table 10.2-5 summarizes fish habitat sampling methods by year. Methods of fish habitat assessment were described in detail in Section 6.2.5.1 (Fish Habitat) of this EIS. Marine fish habitat outside of Roberts Bay has not been assessed, although observations were made of shoreline habitat in Ida Bay while fishing at that site.

Table 10.2-5. Summary of Marine Fish Habitat Surveys Conducted in Roberts Bay, 2000 to 2010

Year	Sampled Environment			Survey Type				
	Shoreline	Intertidal	Subtidal	Bathymetry	Hydroacoustic	Visual	Aerial	Underwater Video
2000	X	X	-	-	-	-	X	-
2003	-	X	X	X	-	-	-	-
2004	-	X	-	-	-	X	-	-
2009	-	X	X	-	-	X	-	-
2010	-	X	X	-	X	X	-	X

Note: X = survey completed, - = survey not done.

Marine fish habitat is characterized as either shoreline, intertidal or subtidal. The shoreline is defined as habitats above the high water elevation. The intertidal zone is defined as all habitats between the high water elevation and 1 m below the low tide elevation. The subtidal zone is defined as all habitats below low tide elevation.

In 2000, aerial surveys of the shoreline and the intertidal zone of Roberts Bay were conducted by helicopter. In 2003, a bathymetric map of Roberts Bay was first prepared. In 2004, 2009, and 2010, visual surveys of the intertidal zone were conducted by walking and/or boating along the shoreline. In 2009, the upper subtidal was also visually surveyed. In 2010, the subtidal was surveyed using hydroacoustic techniques ground-proofed by video cameras. Description of the substrate in the intertidal zone was accomplished by first dividing it into homogenous habitat units. For example, in 2009, habitat surveys of three potential dock sites were conducted by walking along the shoreline and delineating habitat units based on the dominant type of littoral zone substrate. Substrate types were divided into the following size classes: bedrock (>4,000 mm), boulder (256 to 4,000 mm), cobble (64 to 256 mm), gravel (2 to 64 mm), fines (0 to 2 mm). Within each habitat unit, substrate composition was recorded as a percent coverage (e.g., 70% cobble, 20% gravel, and 10% fines) and the length of each unit was measured. Ground and aerial photographs were taken to illustrate various types of habitat units. In the office, a combination of field notes and photographs were used to create habitat maps.

Subtidal zone habitat was characterized using observations collected through hydroacoustics and underwater video sampling. Hydroacoustic surveys characterized dominant substrates based on bottom echo types along the surveyed transect lines. Underwater videos were used to verify the hydroacoustic substrate classifications. Mapping software was then used to interpolate substrate classifications and depth into maps.

10.2.5.3 Marine Fish Community

Since 2002, the marine fish community in Roberts Bay has been assessed using a suite of gear chosen to sample a variety of habitats and species. Sampling gear included gillnets, fyke nets, angling, minnow traps, beach seines, crab traps, and long-lines. Table 10.2-6 summarizes the fish community sampling methods, general sample locations, and sampling dates for each year since 2000.

The sampling methods varied between years depending upon the survey objectives. With two exceptions (crab traps and long lines), all methods of fishing were described in detail in Section 6.2.5.2 (Freshwater Fish) of this EIS.

Crab traps were used to sample large-bodied invertebrates (e.g., crabs, isopods), but they also captured fish (Rescan 2010a, 2010b). Traps were placed overnight in the deeper waters of each site in Roberts Bay and Ida Bay. Long lines were also used to capture actively-feeding fish in Roberts Bay and Ida Bay.

From 2002 to 2007, the objective was to determine fish species composition, relative abundance, movement, and biology of the nearshore subtidal area of Roberts Bay for a proposed marine jetty off-loading facility.

The most intensive marine fish community programs in Roberts Bay and Ida Bay were conducted in 2009 and 2010 (Rescan 2009, 2010a, 2010b, and 2011f). The 2009 fish community survey objectives were to:

- collect baseline nearshore intertidal and subtidal fish community, macrobenthos community (i.e., large-bodied benthos), and fish habitat data at potential marine infrastructure sites in Roberts Bay;
- collect baseline nearshore intertidal and subtidal fish community and macrobenthos community data in Ida Bay as a reference location; and
- determine baseline nearshore intertidal and subtidal fish community and macrobenthos community at the four shoals in Roberts Bay (artificial shoals) and Ida Bay (natural shoals).

Table 10.2-6. Fish Community Sampling Methods, Locations, and Dates in Roberts Bay and Ida Bay from 2002 to 2010

Sample Method	Year							
	2002 August 27 to September 2	2003 July 24 to 28 August 9 to 29	2004 August 20 to 21	2005 August 8 to 12	2006 July 10 to 12	2007 July 12 to 17	2009 August 21 to September 5	2010 July 30 to August 19 August 29 to September 24
Sinking Gillnet	-	• Multiple panels, each panel 15.1 x 1.5 m • Variable mesh, 19 - 109 mm • Throughout Roberts Bay near Little Roberts Outflow, jetty, compensation shoals, proposed marine outfall berm	-	-	-	-	• 6 panels, totalling 91.2 x 2.4 m • Variable mesh, 25 - 89 mm • LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals) • RSA (Ida Bay; including reference site and shoals)	• 6 panels, totalling 91.2 x 2.4 m • Variable mesh, 25 - 89 mm • LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals) • RSA (Ida Bay; including reference site and shoals)
Floating Gillnet	-	-	-	-	-	-	• 6 panels 91.2 x 2.4 m • Variable mesh, 25 - 89 mm • LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals) • RSA (Ida Bay; including reference site and shoals)	• 6 panels 91.2 x 2.4 m • Variable mesh, 25 - 89 mm • LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals) • RSA (Ida Bay; including reference site and shoals)
Beach Seine	-	Roberts Bay at Little Roberts Outflow	Roberts Bay at Little Roberts Outflow	Jetty	-	-	• Marine shoreline • LSA (Roberts Bay) and RSA (Ida Bay)	• Marine shoreline • LSA (Roberts Bay) and RSA (Ida Bay)

Sample Method	Year							
	2002 August 27 to September 2	2003 July 24 to 28 August 9 to 29	2004 August 20 to 21	2005 August 8 to 12	2006 July 10 to 12	2007 July 12 to 17	2009 August 21 to September 5	2010 July 30 to August 19 August 29 to September 24
Minnow Trap	-	-	-	-	-	-	• LSA (Roberts Bay; Marine shoreline and rock structures [jetty and shoals]) • LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals) • RSA (Ida Bay; including reference site and shoals)	• LSA (Roberts Bay; Marine shoreline and rock structures [jetty and shoals]) • LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals) • RSA (Ida Bay; including reference site and shoals)
Angling	-	-	-	Throughout LSA (Roberts Bay)	-	-	-	-
Fyke Net	Roberts Bay along western shoreline	Roberts Bay at Little Roberts Outflow	Roberts Bay at Little Roberts Outflow	Jetty	Jetty	Jetty	-	• LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals)
Crab Trap	-	-	-	-	-	-	• Marine fish and benthos • LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals) • RSA (Ida Bay; including reference site and shoals)	• Marine fish and benthos • LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals) • RSA (Ida Bay; including reference site and shoals)
Visual Observation	-	-	-	-	-	-	• Snorkel surveys • LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals) • RSA (Ida Bay; including reference site and shoals)	-

Sample Method	Year							
	2002 **August 27 to September 2**	**2003** **July 24 to 28 August 9 to 29**	**2004** **August 20 to 21**	**2005** **August 8 to 12**	**2006** **July 10 to 12**	**2007** **July 12 to 17**	**2009** **August 21 to September 5**	**2010** **July 30 to August 19 August 29 to September 24**
Long Line	-	-	-	-	-	-	• Floating/sinking combination line • LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals) • RSA (Ida Bay; including reference site and shoals)	• Suspended line, hooks at 2.5 m intervals • LSA (Roberts Bay; including potential marine infrastructure sites; jetty and compensation shoals) • RSA (Ida Bay; including reference site and shoals)

Note: Dash indicates not sampled

The 2010 fish community survey objectives were to:

- collect baseline nearshore intertidal and subtidal fish community, macrobenthos community and fish habitat at five potential marine infrastructure sites in Roberts Bay;
- collect baseline nearshore intertidal and subtidal fish community and macrobenthos community data in Ida Bay; and
- determine baseline nearshore intertidal and subtidal fish community and macrobenthos community at the four shoals in Roberts Bay and Ida Bay.

Figures 10.2-6 to 10.2-10 show the locations of sampling gears installed in the LSA and RSA from 2002 to 2007 and in 2009 and 2010. In 2009, a total of 38 floating gillnet sets, 48 sinking gillnet sets, 25 long line sets, 193 minnow trap sets, 84 crab trap sets, and 31 beach seines were conducted (Rescan 2009, 2010a). In 2010, 56 floating gillnet sets, 59 sinking gillnet sets, 35 fyke net sets, 54 long line sets, 364 minnow trap sets, 177 crab trap sets, and 37 beach seines were conducted (Rescan 2010b, 2011f). Fish community sampling was conducted from the jetty west and northward along the shoreline of Roberts Bay.

Significant fish community sampling effort was conducted along the western shoreline of Ida Bay in 2009 and 2010. In 2009, a total of 17 floating gillnet sets, 21 sinking gillnet sets, 16 long line sets, 116 minnow trap sets, 11 beach seines, and 42 crab trap sets were conducted (Rescan 2009 and 2010a). In 2010, a total of 11 floating gillnets sets, 11 sinking gillnet sets, 10 long line sets, 167 minnow trap sets, 11 beach seines, and 57 crab trap sets were conducted (Rescan 2010b and 2011f).

- For all fish sampling conducted from 2002 to 2010, the following data were collected:
- UTM coordinates and depth of each location at which fishing gear was deployed.
- Date of deployment and times that each gear was installed and retrieved.
- Catch (both total and for each species) for each location, gear type, date, and retrieval time.
- Catch per unit effort (CPUE) (e.g. number of fish caught per hour fishing of a fyke net) for each location, gear type, date, and retrieval time.
- Fate of each fish captured (released live, escaped during handling, or died during capture and handling).
- Biological data for each fish captured. At a minimum, data on species, length, and weight were collected. Fish with clipped fins indicating previous sampling for ageing purpose or fish carrying dorsal tags were noted and tag numbers recorded. For most fish that were released live non-destructive samples of ageing structures (scales and fin rays) were also taken for age reading. Fish that died during capture or were killed for otoliths and stomach content analysis were also examined for sex and maturity, reproductive status, and gonad weight.
- Large fish (>300 mm long) were tagged using tags with unique numbers and released live to learn about migratory routes from their recapture.

A total of 23 fish species from 12 families were captured in marine waters during baseline surveys from 2002 to 2010, including 5 species that could only be identified to the family level. Table 10.2-7 shows their common names and scientific names.

Table 10.2-7. Common and Scientific Names of Fish Species Captured During Marine Surveys, 2002 to 2010

Family	Common Name	Scientific Name
Agonidae	Poacher	Unidentified
Ammodytidae	Sand Lance	Unidentified
Clupeidae	Pacific Herring	*Clupea pallasii*
Cottidae	Shorthorn Sculpin	*Myoxocephalus scorpius*
	Fourhorn Sculpin	*Triglopsis quadricornis*
	Sculpin	Unidentified
Gadidae	Greenland Cod	*Gadus ogac*
	Saffron Cod	*Eleginus gracilis*
Gasterosteidae	Ninespine Stickleback	*Pungitius pungitius*
Liparidae	Snailfish	Unidentified
Osmeridae	Capelin	*Mallotus villosus*
	Rainbow Smelt	*Osmerus mordax*
Pholidae	Banded Gunnel	*Pholis fasciata*
Pleuronectidae	Arctic Flounder	*Liopsetta glacialis*
	Longhead Dab	*Limanda proboscidea*
	Starry Flounder	*Platichthys stellatus*
	Flounder	Unidentified
Salmonidae	Arctic Char	*Salvelinus alpinus*
	Lake Trout	*Salvelinus namaycush*
	Lake Whitefish	*Coregonus clupeaformis*
	Cisco	*Coregonus artedi*
	Least Cicso	*Coregonus sardinella*
Stichaeidae	Arctic Shanny	*Stichaeus punctatus*

Life history information was collected from all captured fish. Live fish were identified to species, measured (fork length or total length to the nearest 1 mm), and weighed to the nearest 0.1 g. Fish larger than 300 mm in fork length were tagged with a uniquely numbered Floy tag to assess their movements through subsequent recaptures. Ageing structures were removed from selected fish. Depending upon the species being examined, ageing structures collected were left pelvic fin and/or scales. Additional data were collected from accidental and euthanized mortalities (i.e., fish collected for diet analysis). These included sex and maturity, reproductive status, gonad weight, stomach contents, and collection of otoliths for ageing. These biological data are not summarized in this EIS, but are available for review in the appended marine fish reports.

Figure 10.2-6
Extent of Marine Fish Community Sampling within the LSA and RSA, 2002 to 2007, 2009 and 2010

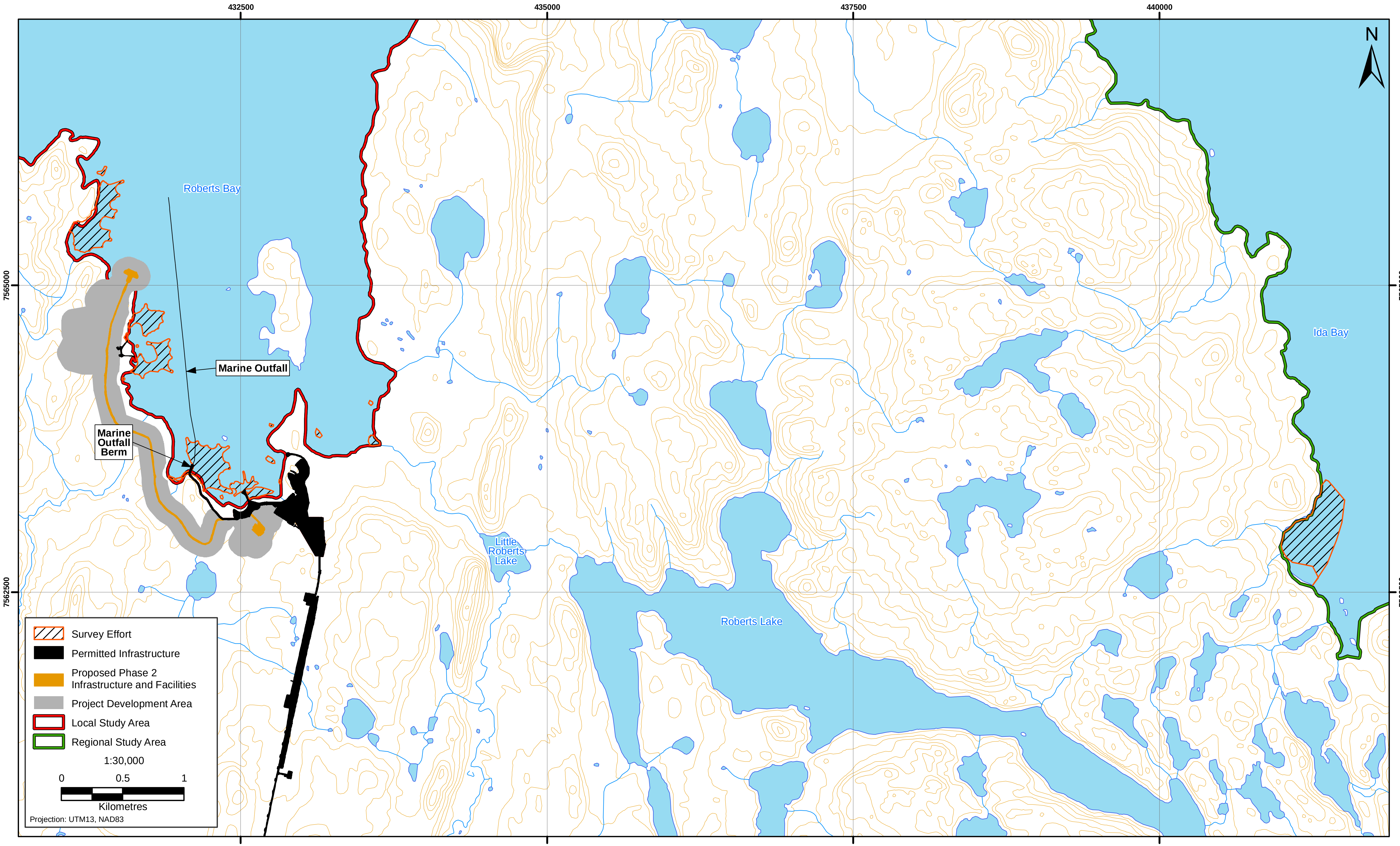


Figure 10.2-7
Marine Fish Community Gillnet, Long Line, and Fyke Net Sample Locations within Roberts Bay, 2002 to 2007, 2009 and 2010