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PROJECT PROPOSAL – HAMLET OF ARVIAT: EMERGENCY WATER-SUPPLY PROJECT

Project Description and Environmental Assessment to Support Review and Decision-Making by:

- **Nunavut Impact Review Board**
- **Nunavut Water Board**
- **Department of Fisheries and Oceans**
- **Environment Canada**

Submitted by:

Nunami-Stantec Ltd.

On behalf of:

The Hamlet of Arviat and Government of Nunavut, Department of Community and Government Services

Project No. 1492-39001

April 19, 2011

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1.0 Background Information

1.1 THE HAMLET OF ARVIAT

Arviat (pronounced “arq-viat”), from the Inuktitut name for bowhead whale, was formerly named Eskimo Point. Ancient *qajaq* stands found at traditional summer camp sites in the area provide evidence that in the past hundreds of Inuit gathered in the area to hunt whales, seals, and walrus. There are Thule culture sites near Arviat dating back to AD 1100. Two of these sites, Arvia’juaq and Qikiqtaarjuk, were designated National Historic Sites in 1995 (PWGSC 2002).

The Hudson’s Bay Co. established a post at Arviat in 1921. A Roman Catholic mission was established in 1924 and an Anglican Mission was founded in Arviat in 1926. Many groups of Inuit suffered as the demand for furs eventually decreased. The Ahiarmiut were one of the groups of Inuit hardest hit, and in 1957 the federal government relocated the Ahiarmiut to Arviat and a Federal Day School was opened, marking the beginning of permanent settlement in Arviat (PWGSC 2002). The physical evolution of the community has been significant, as evidenced in Figures 1-1, 1-2 and 1-3.

Arviat receives potable water from Wolf Creek, which is located approximately 11 km south of the community. Water is piped from Wolf Creek and held in a two-celled reservoir located approximately 500 m west of Arviat (Figures 1-4 and 1-5).

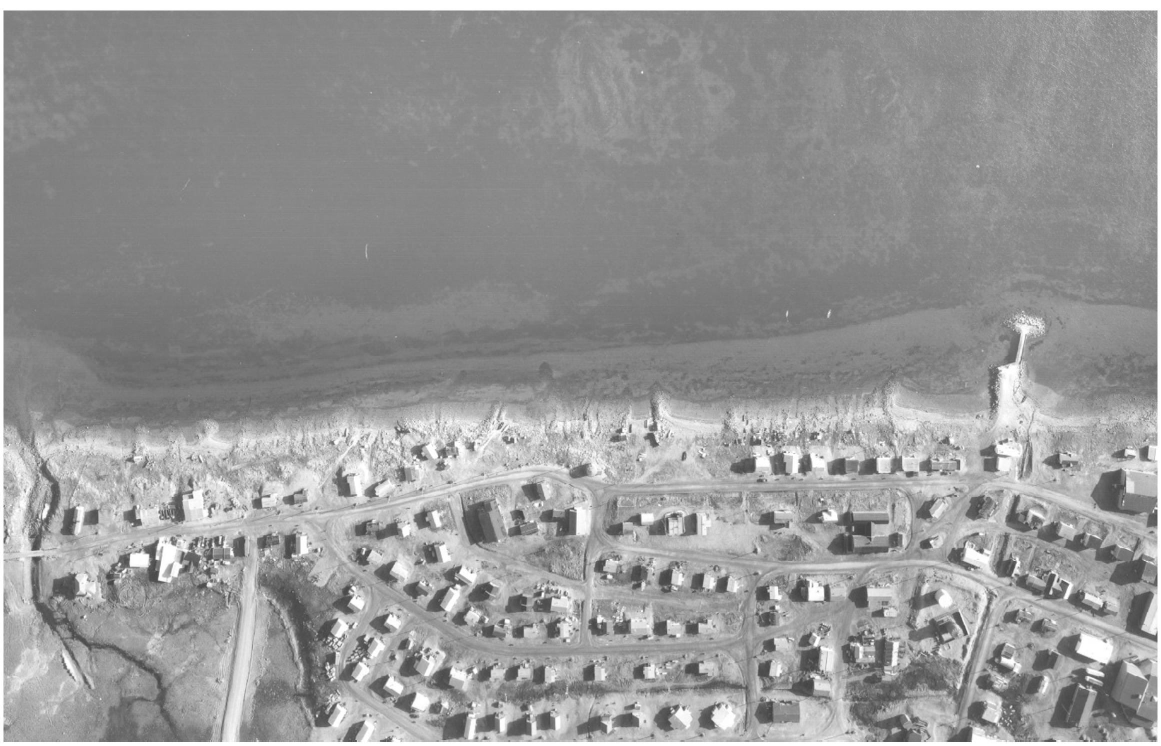
1.2 NEED FOR PROJECT

The Project is needed to remedy an emergency. It was discovered last fall that the liner in the larger of the two water-supply reservoirs (Figures 1-4 and 1-5) had failed. The liner failure resulted in the seepage loss of the majority of the Hamlet’s stored water for the population of approximately 2,800 people. The remaining water is being supplied from the smaller reservoir. The remaining water supply as of the date of filing of this Project Proposal is approximately four weeks.

The Hamlet secured the services of professional engineering consultants, scientists and regulatory advisors in Nunami Stantec Ltd. (Nunami) in early January to assist it to respond to this emergency. The Hamlet, and the Government of Nunavut, through its Department of Community and Government services (C&GS), then initiated emergency planning activities with Nunami to review options for securing the fastest possible means for provision of a safe and reliable emergency water-supply system. After review of the practical foreseeable options, the decision was made on March 29, 2011, to design, procure, import and construct a nominal 720 m^3/d (500 L/min) modular water-supply and treatment system utilizing Reverse Osmosis (RO) to treat sea water. The design of the system and its operations must and will be attentive to the realities that Arviat, insofar as the timeline for this Project is concerned, is an air-access community.

Source: PWGSC, 2002

Arviat in 1969
Figure 1-1



Source: PWGSC, 2002

Arviat in 1992
Figure 1-2

Source: PWGSC, 2002

Arviat in 1998
Figure 1-3

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Figure 1-4

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Figure 1-5

The system is needed to operate from approximately mid-May until the Hamlet's water-supply reservoirs can be thoroughly inspected and repaired. Upon completion of the necessary engineering design and construction work to restore the integrity of the Hamlet's permanent water-supply system, the modular emergency system will be decommissioned and removed.

1.3 PROJECT PROPONENT

The Proponent is the Hamlet of Arviat
P.O. Box 150
Arviat, NU X0C 0E0

The Hamlet's Contact Person for purposes of this review by the various parties is:

Senior Administrative Officer:	Ed Murphy
Phone:	(867) 857-2841
email:	arviatsao@qiniq.com

The Hamlet's Field Supervisor for purposes of this review by the NIRB is:

Director of Public Works:	Joe Savikataaq, Jr.
Water/Sewage Request:	(867) 857-2598
Public Works email:	hamlet_of_arv@qiniq.com

1.4 AUTHORIZING AGENCIES AND APPROVALS, PERMITS AND LICENCES REQUIRED

1.4.1 Nunavut Impact Review Board

The NIRB may have jurisdiction over the Project pursuant to its responsibilities under Article 12 of the Nunavut Land Claim Agreement (NLCA), although Nunami-Stantec is advised (Wall *pers. comm.* 2011) that traditionally it has not regulated projects having to do with the marine environment. Nunami-Stantec is also advised (Granchino *pers. comm.* 2011) that the NIRB could exempt the NLCA Schedule 12-1 exempting "*…construction, operation and maintenance of all buildings and services within an established municipality…*"

In the event that it may assert its jurisdiction, and to otherwise assist its review, this submission has been prepared in consideration of the NIRB's "Operational Procedures for Project Proposals" Guidance Document and the NIRB's Guide 1, Guide 3 and Guide 4 documents. It is hoped that this format will be sufficient for the reviews and decision-making necessary or required of the Nunavut Water Board, Department of Fisheries and Oceans and/or Environment Canada.

The Proponent is requesting that:

- NIRB issues a Project Certificate consistent with its responsibilities and the procedures set out in Section 12.4.1 of the NLCA or, alternatively, that
- NIRB determines that the project is exempt from screening (pursuant to its discretion under NCLA sections 12.1, 12.2 and 12.3).

The Proponent respectfully requests that any terms or conditions that the NIRB may include in a Project Certificate that it may issue be mindful of the emergency character and timelines of the Project.

1.4.2 Nunavut Water Board

The dependence of the Preferred Option on a seawater source means that either a new Type B Water Licence (for "Municipal Undertakings" at rates <2,000 m^3/day) be required for the emergency-supply RO system or that Arviat's existing Type A Water Licence (issued pursuant to the *Northwest Territories Water Regulations*) be amended to account for the emergency RO system. Nunami-Stantec understands as of April 11, 2011, that the Water Board may not have jurisdiction over a project using seawater, and is altering the Type A licence in respect of current temporary use of freshwater from a nearby lake (Goose Lake; Hohnstein *pers. comm.* 2011). The Board is expressing interest in reviewing this Project Proposal.

The Proponent is requesting that the Nunavut Water Board (NWB) either:

- Determine it has no jurisdiction and no decision to make in respect of the project; or
- Grant any such new (or amended) licence after a review process sensitive to the emergency character of the Project (i.e., without the formal public-hearing process normally a mandatory requirement for Type A licencing decisions).

1.4.3 Department of Fisheries and Oceans and Environment Canada

Satisfaction of s.30(1) of the federal *Fisheries Act* with regard to an acceptable "*…fish guard or screen to exclude fish…*" will be required. Nunami-Stantec is advised (Schwartz *pers. comm.* 2011) that DFO will require to review the Project Proposal, especially details on the water-intake design and placement in the water column, and its screen. Acknowledgement of satisfaction of s.35(2) by the Department of Fisheries and Oceans (DFO) is solicited following DFO's review of the relevant contents in Attachment A and consideration of Section 5 herein.

A federal authorization of a harmful alteration, disturbance or destruction (HADD) of marine habitat, pursuant to s.35(2) of the federal *Fisheries Act*, could be required if the DFO is not reassured by the engineering design and operations plan that impacts to marine habitats and biota can be fully prevented or mitigated. Nunami-Stantec is advised (Schwartz *pers. comm.*

2011; Williston *pers. comm.* 2011) that the correct person for conducting the review on behalf of the Iqaluit office of DFO's Central and Arctic Region (Eastern Arctic Area) is in the Prescott, Ontario office. Conversations with this scientist (Williston *pers. comm.* 2011) indicated that DFO will review the Project Proposal viz. requirements set out in Sections 30(1), 35(1) and 37(1) of the *Fisheries Act*. She further advised of the need for Environment Canada to require review of the Proposal in respect of Section 36(3) of the *Fisheries Act*.

Again, the most timely of decisions is respectfully requested in such a scenario.

This submission is therefore also being provided to Environment Canada (the Yellowknife office). The proponent is requesting that:

- DFO determine the acceptability of the proposed design intended to satisfy s.30(1) of the *Fisheries Act*.
- DFO determine whether the Project is expected to cause a HADD and, if so, that the HADD is authorized pursuant to s.35 of the *Fisheries Act*.
- Environment Canada determine whether the volume and chemistry of the RO reject water (the "concentrate") constitutes the deposit of a "deleterious substance" as defined by the *Act*.

1.5 PREVIOUS ENVIRONMENTAL ASSESSMENTS

As this Project arises out of a site-specific emergency in Arviat, there are no directly and strictly relevant "previous environmental assessments." There are, however, various sources of environmental information relevant to consideration of the environmental impacts of the proposed Project and the means by which these potential effects can be prevented or mitigated. Such relevant information includes those documents listed in Section 11 herein.

2.0 Project Description

2.1 TITLE OF PROJECT

The title of the Project is: "Arviat Emergency Water-Supply Project"

2.2 TYPE OF ACTIVITY

The Project is a Water-Supply Project. The activities involved in its development and delivery include the following:

- Review of all relevant information describing the character of the emergency.
- Review of practical and foreseeable options for temporary and immediate restoration of a safe and secure water supply to the Hamlet.
- Selection of a Preferred Option for emergency supply of 220,000 L/d (4.7 L/s nominal during 14 hr/day operations) of potable water by treatment of seawater to produce a water quality which satisfies Canadian Drinking Water Guidelines.
- Design of all elements of the system comprising the Preferred Option.
- Tendering and procurement of all elements of the system comprising the Preferred Option.
- Delivery of all elements of the system comprising the Preferred Option to the selected Project Location.
- Construction of the modular emergency water-supply system at the selected Project Location, including installation of the raw water intake and brine-reject lines.
- Commissioning of the system to ensure operational conformance with design and operating specifications.
- Monitoring of system performance, including water-supply capacity, water quality, and apparent environmental effects of system operations.
- System operations during engineering investigations of the Hamlet's existing water-supply reservoirs, engineering design of repair and/or upgrading works, and construction of such repairs and works.
- Testing of the Hamlet's repaired/upgraded permanent water-supply and storage system and verification of system integrity and performance.
- Decision that emergency water-supply system is redundant and can be decommissioned.

- Decommissioning and removal of the emergency water-supply system.

2.3 SUMMARY OF OPERATION

The emergency water-supply system will access a secure supply of sea water in an environmentally acceptable manner from the Project Location. It will treat the sea water to remove the majority of the dissolved constituents (various salts) in the sea water to render it potable at a rate of 220 L/day. It will return the concentrated dissolved salt ("brine") to the sea in an environmentally acceptable manner. It will store sufficient quantity of the drinking water in tankage at the Project Location to allow water-supply trucks (tankers) to fill their tanks so water can be delivered from the Project Location to the community.

2.4 PREFERRED OPTION

Nunami reviewed various options that appeared practical and achievable for creating either:

- Immediate restoration of the integrity of the Hamlet's permanent water-supply system; or
- Provision of a temporary, safe and secure treatment and supply system to serve on an emergency basis until the permanent system could be repaired this summer and its integrity assured.

The option of immediate inspection, engineering design and repair of the permanent system was rejected on grounds of:

- Seasonal impracticality.
- Lengthy time required before system integrity could be assured.
- Doubt that any repairs or system upgrades undertaken under current winter conditions would be found to be sustainable and reliable after the spring thaw.

Accordingly, the option of securing a temporary water-treatment and -supply system was retained for further investigation. The two options considered for an emergency system were:

- Accessing moderately contaminated and variable-quality freshwater at a nearby lake (either Landing, Michalak or Goose Lakes) and treating the water with Reverse Osmosis (RO) technology using a modular system capable of airlift delivery.
- Accessing uncontaminated and consistent-quality seawater from the existing permanent causeway and treating the water with Reverse Osmosis (RO) technology using a modular air-lift system.

The different lake sources have different attributes favouring or constraining their candidacy. Michalak Lake is shallow and, as such, remains frozen to the bottom, with vulnerability of water quality to wind-induced mixing and sediment resuspension. Goose Lake has high-quality water but only two to three weeks of supply capacity, and no current road access. Once road access is complete (nominally within days) reliability of access is by no means assured, especially during spring thaw, and the distance for water conveyance is greatest for this option. The water quality in Landing Lake, the closest source, is not ideal. Salinity values indicate a hydraulic connection to Hudson's Bay, with associated implications for choice of treatment to address elevated concentrations of dissolved salts.

Irrespective of the relative merits or demerits of the individual lake sources, the lake-water option was rejected as the Preferred Solution (although it is currently serving as a short-term, interim, 'stop-gap' measure, using water from Goose Lake) on grounds of:

- Insufficient data available within the necessary timeframe to the system-design team describing the water quality and its spatial and temporal variability in quality:
    - Such a data deficiency would require an extreme 'worst case' approach to design, causing 'over-engineering' of the system to be able to accommodate an excessive possible variability in water chemistry, causing component over-sizing, excessive system operating redundancy, greater transportation challenges and costs due to over-sizing and excess system redundancy, and excessive cost.
    - By contrast, seawater chemistry is extremely well known and almost unvariable, simplifying system-design and operations considerations.
- Insufficient water supply (in the case of Goose Lake).
- Likely inability to find an environmentally acceptable way to dispose of the brine reject stream created by the treatment process to either a surface-water body or to land, in the case of Landing Lake.
- Probable regulatory process complexity and duration of decision-making related to securing any form of formal approval for disposition of the brine reject stream to either surface water or land, in the case of Landing Lake.

Accordingly, the seawater option was selected for attention by the system-design team.

2.5 PROJECT LOCATION

Figures 1-4 and 1-5 indicate the general and specific locations of the Project. The Preferred Location of the emergency water-treatment and –supply system (Figure 2-1) is at the end of the existing rock wharf/breakwater projecting from the Hamlet in a northeasterly direction into Hudson's Bay (Figure 2-1; Photo 2-1). This structure has an elaboration of its western face (Photo 2-2) to create a truck-turning and boat-launching capacity.

5-3 - *orientation of numbered photograph*

Arviat marine bulk fuel-resupply facility on west face of breakwater / wharf structure
Figure 2-1

arviat_pics
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Source: Nunami Stantec, 2008

Southwest Aspect of Breakwater / Wharf
Arviat NU, August 2007
Photo 2-1

Source: PWGSC, 2002

View of Arviat marine bulk-fuel resupply facility
(~ 13 meters width x 100 m length)
on west face of Breakwater / Wharf.
Photo 2-2

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The shorelines near the wharf/breakwater are typically free of infrastructure (Photo 2-3), except for a marine sealift facility (Photo 3-1) used by larger barges and vessels.

The northing and easting of the approximate centroid of the Preferred Location for the emergency system (i.e., the Project Site) is:

Northing	6775623 m
Easting	442930 m

There are no other ancillary facilities at any other locations.

2.6 SCHEDULE

The Project is being expedited on an emergency basis. As set out in the Nunavut C&GS Request for Tenders (Tender No. 142874, dated April 1, 2011), the project-delivery schedule is shown below:

- The RO System must be in place in Arviat, NU, on or before April 29, 2011, ready for set up.
- The RO System must be in Winnipeg, MB, on or before April 27, 2011, where Nunami will arrange shipping to Arviat.
- The RO System supplier must be in Arviat fully prepared to assist the Nunavut C&GS and Hamlet forces to uncrate and set up the RO System on or before April 27, 2011.
- The System must be commissioned and fully operational with the volume of water produced meeting specified quality requirements by May 6, 2011.

This schedule assumes optimum timelines for design, procurement, transportation and construction (detailed further in Appendix A to Attachment A).

2.7 SYSTEM DESIGN

As further detailed in Attachment A, the design details for the Project are now sufficient to allow review and consideration by the NIRB, the Nunavut Water Board and the DFO. Attachment A contains:

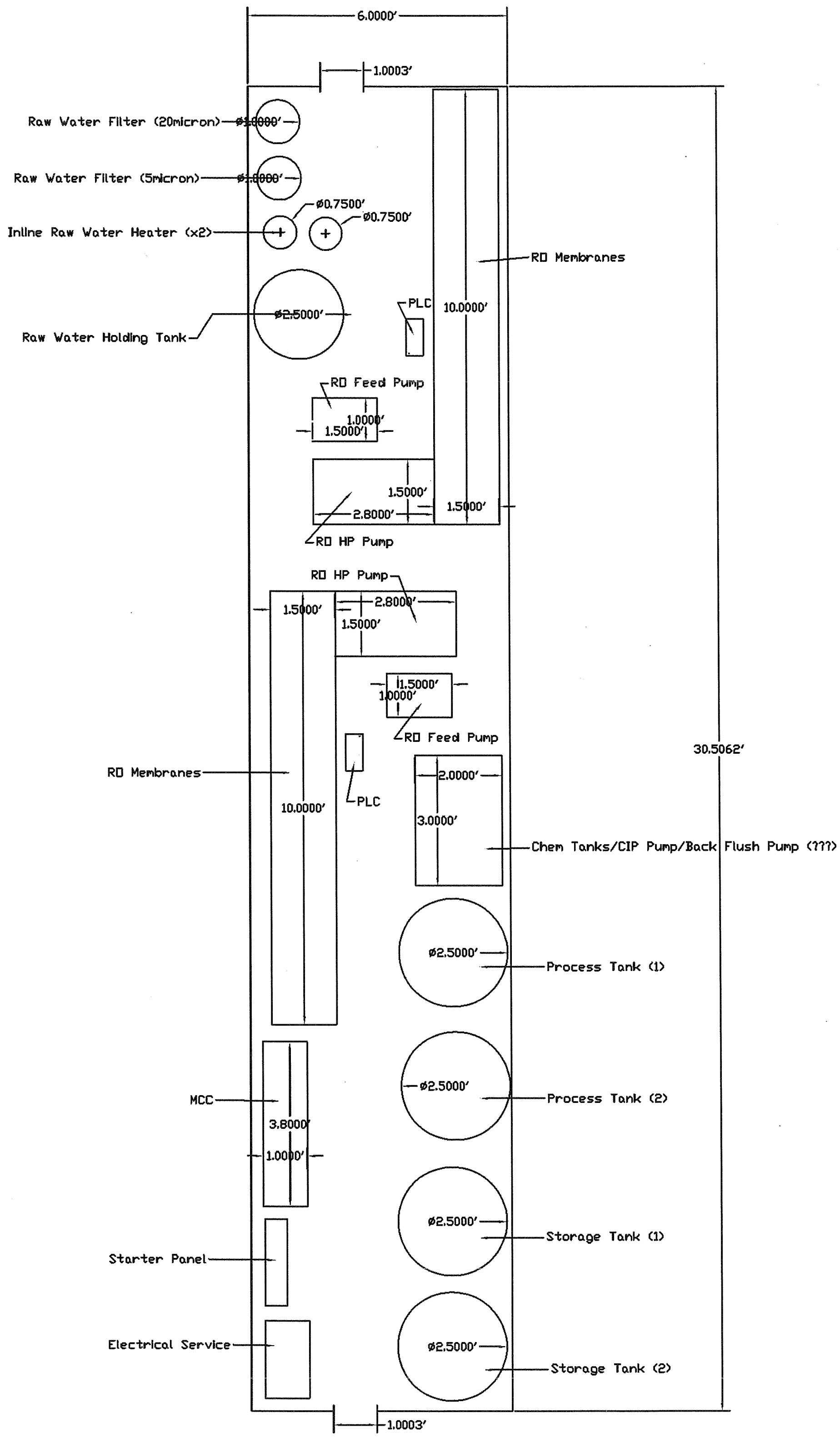
- A narrative description of the water supply and treatment (RO) technology and the elements of the RO and Clean-in-Place (CIP) systems (Section 1) which will include:
  - RO System:
    - RO membranes (specified able to achieve approximately 45% recovery efficiency)
    - RO feed pump c/w starter control panel

Source: Nunami Stantec, 2008

Typical shoreline near the beach outside Arviat.
Photo 2-3

    - Programmable Logic Control (PLC) c/w Human Machine Interface (HMI)
    - Pre-filtration system
    - Instrumentation (including meters, pressure gauges, conductivity, etc.)
    - System shall be skid mounted or containerized
    - Anti-scaling injection system c/w sufficient anti-scaling for three months of operation
  - Clean-in-Place (CIP) System:
    - Chemical tanks c/w injection pumps
    - System to be automated through RO PLC
    - Sufficient CIP chemicals for three months of operation
    - Ancillary equipment
    - Five 6,000-L holding, process or storage tanks, auxiliary tanks, pumps, 40-kW water-heater units, interconnecting piping and electrical cabling, etc.

- A narrative description of the all-weather enclosure for the system (Section 2) needed to ensure optimum operating temperatures and system security (i.e., temporary 20’ x 100’ fabric-covered, steel-framed building that will house and protect the treatment system (Figure 2-2), including the system to anchor the structure to the granular materials comprising the wharf/ breakwater).
- A narrative description of the mechanical (Section 3) and electrical (Section 4) systems.
- Process Flow Diagram of the new water-treatment and –supply system (designated as Drawing P001 in Appendix C to Attachment A).
- Plan View of the Hamlet’s existing wharf/breakwater and Project Location shown in Figure 2-1 (designated as drawing S001 in Appendix D to Attachment A).
- Design details of the raw-water intake (Figures 2-3 and 2-4) and the brine-outlet structures.
- A narrative description of the energy requirements of the emergency system and how these needs will be met (likely with a new 1-MW 14’ x 6’ x 8’ diesel generator or by a new ~75-kW genset once coupled to a ~400-kW generator owned by C&GS and available at the site).



Building Dimensions and System Layout
Figure 2-2

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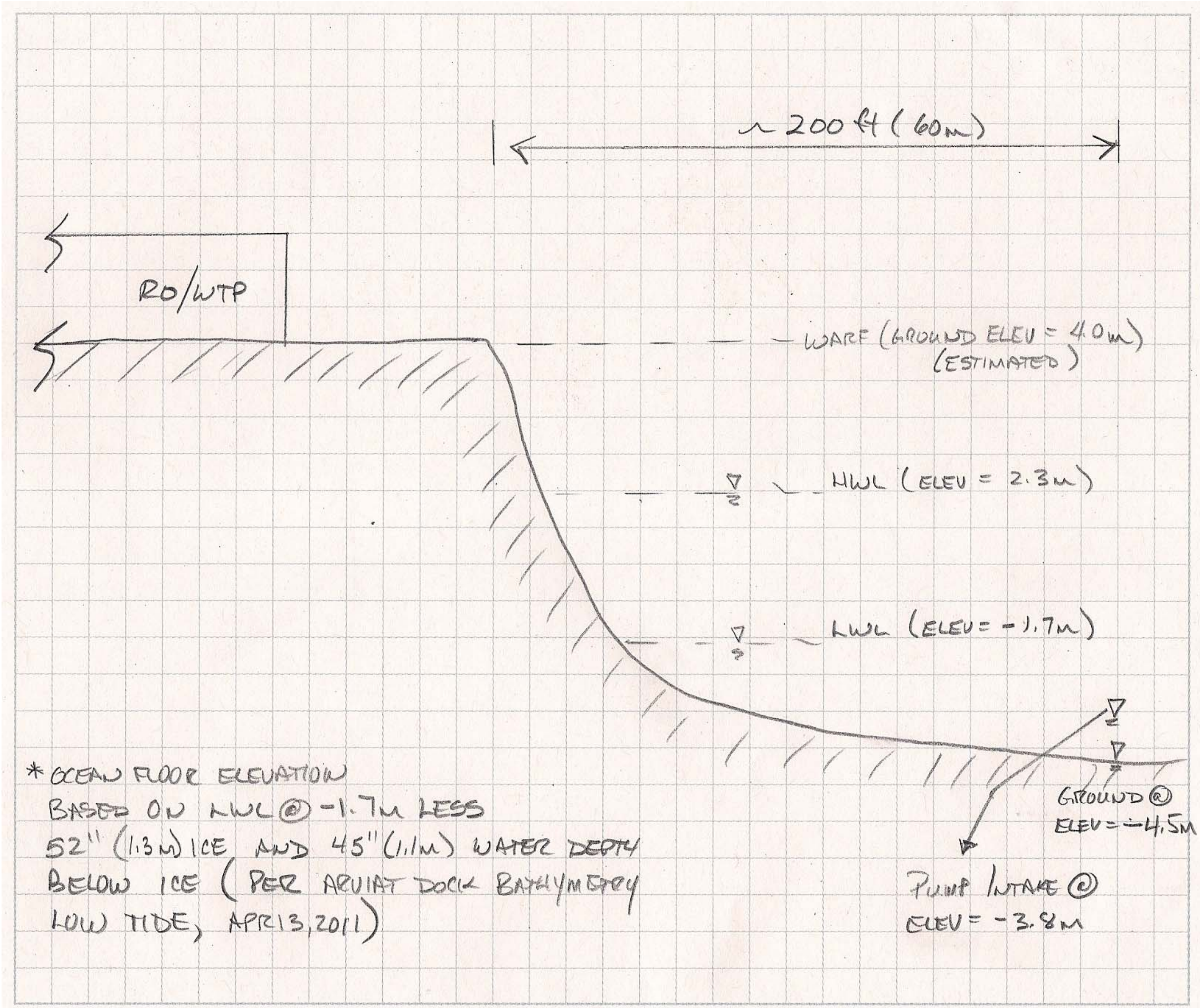

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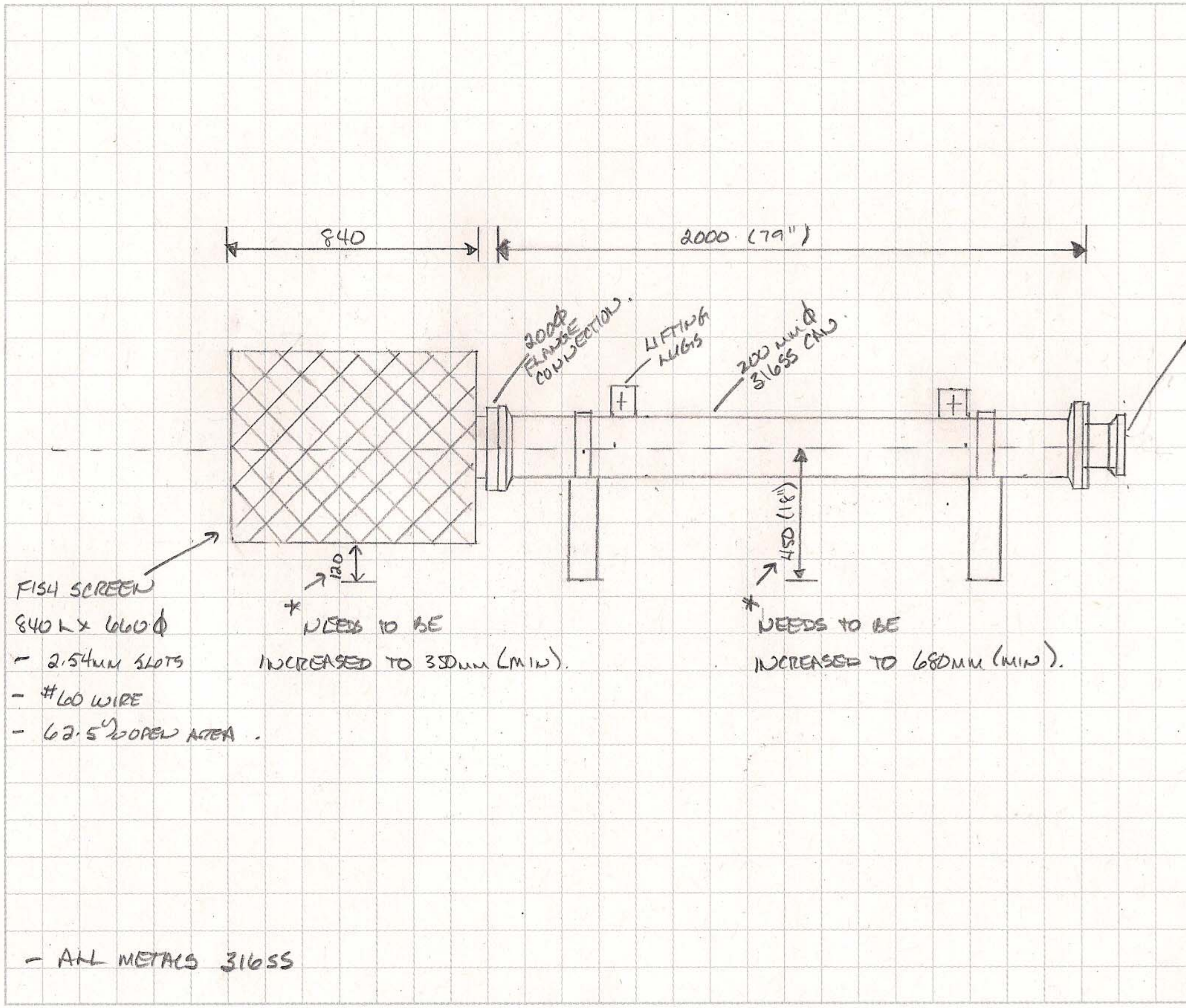
Arviat Pump Intake
Figure 2-3



Arviat Raw Water Pump and Fish Intake Screen

Figure 2-4

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The General Contractor will be supported during the construction process by an Environmental Inspector to prevent spills and to document actions to preclude or minimize effects of construction on the sea.

2.8 SITE ACCESS AND TRANSPORTATION METHODS

All deliveries to Arviat will be via Hercules aircraft on a flight scheduled for April 27, 2011.

To the maximum extent possible, the modular components of the new system will be palletized to facilitate rapid delivery to the site. On-site vehicles needed will include existing on-site scissor-lift, Sky Jack, Michigan excavator and other construction-oriented heavy equipment.

Staging areas in the Hamlet near the wharf may be needed to accommodate the project needs, including lay-down area, turnaround area, vehicle-fueling area, etc.

2.9 ENVIRONMENTAL PROTECTION PLAN

Key elements of the Environmental Protection Plan (EPP) include the impact-prevention and -management measures listed in Sections 5.1.4 and 6.0 herein.

Other key elements of the EPP include:

- Vigilant environmental inspection of the construction location during construction to inspect activities having potential for environmental impacts (e.g., hazardous material handling) and to ensure prevention of spills, leaks or accidental discharges.
- On-site use of spill-capture or –sorption media suited for the types of hazardous fluids to be handled or stored on-site.
- Monitoring of the seabed and water column in the areas around the water intake and brine-discharge lines to seek early detection of any unexpected impacts on local marine biota.
- Reliance on electrical generators instead of diesel-powered units where possible for meeting the power needs of the system.

2.10 CONTINGENCY PLANS

The Hamlet's and the Nunavut government's Emergency Response Plans (ERPs) will apply to the Project on a site-specific basis. So too will the RO-supplier's ERP.

3.0 Description of the Environment

3.1 BIOPHYSICAL ATTRIBUTES

Arviat is located in a small bay on the west coast of Hudson Bay (Figure 1-4) and is largely sheltered from the prevailing north winds. The existing wharf/breakwater in Arviat (Figure 2-1) provides additional protection from easterly winds from Hudson Bay (Nunami 2008).

Arviat borders the Southern Arctic Ecozone and the Taiga Shield Ecozone. Within the Southern Arctic Egozone, Arviat is part of the Maguse River Upland Ecoregion. This ecoregion includes much of the northwest coast of Hudson Bay, covering the uplands south of Chesterfield Inlet and extending as far south as Churchill. Most of the human population and land use is along the coast. Arviat is one of the main settlements in the sparsely populated ecoregion. The population of the ecoregion is approximately 3,600 (ESWG 2005). The vegetation in the area is historically influenced by the shallow soils and the very poor drainage. Referred to as the "barren lands," the area is largely treeless, consisting of broad expanses of lichen and moss-covered boulders and grassy meadows, interspersed with frequent graveled eskers (Smith *et al.* 1998).

Some forest stands (shrubs, willow and stunted conifers) can be found in sheltered river valleys, or in small stands on the leeward sides of hills.

3.1.1 Site Topography and Soils

The broadly rolling terrain is underlain by Precambrian granite bedrock covered with interspersed glacial till overburden. The topography ranges from exposed bedrock to thin organic soil cover, with many glacial features such as moraines, eskers and kames (Smith *et al.* 1998).

The soils are cryosolic and may have their horizons disturbed by frost movement. Where the active layer (above the permafrost) is deep, and the surface well drained, there may be brunisolic soils. Regosolic soils occur along the coast on newly emerged land where permafrost has yet to develop in areas such as the Hamlet of Arviat (Smith *et al.* 1998).

3.1.2 Freshwater Ponds and Estuaries

The area is characterized my numerous small shallow lakes owing to the poor drainage caused by the bedrock and well developed permafrost just below the surface (<5 to 100 cm). The land is flat and consists of sandy low marshes, muskeg and tidal flats (Manitoba Hydro 1999). Even though the climate is quite arid, the local soils are usually perpetually wet due to the continuous supply of moisture from melting frost (Smith *et al.* 1998). Several such shallow ponds and estuaries are adjacent to the Hamlet, as evidenced in Figures 1-4 and 1-5 and in Photos 1-1 and 1-3.

3.1.3 Coastal Bathymetry and Tidal Seabed Attributes

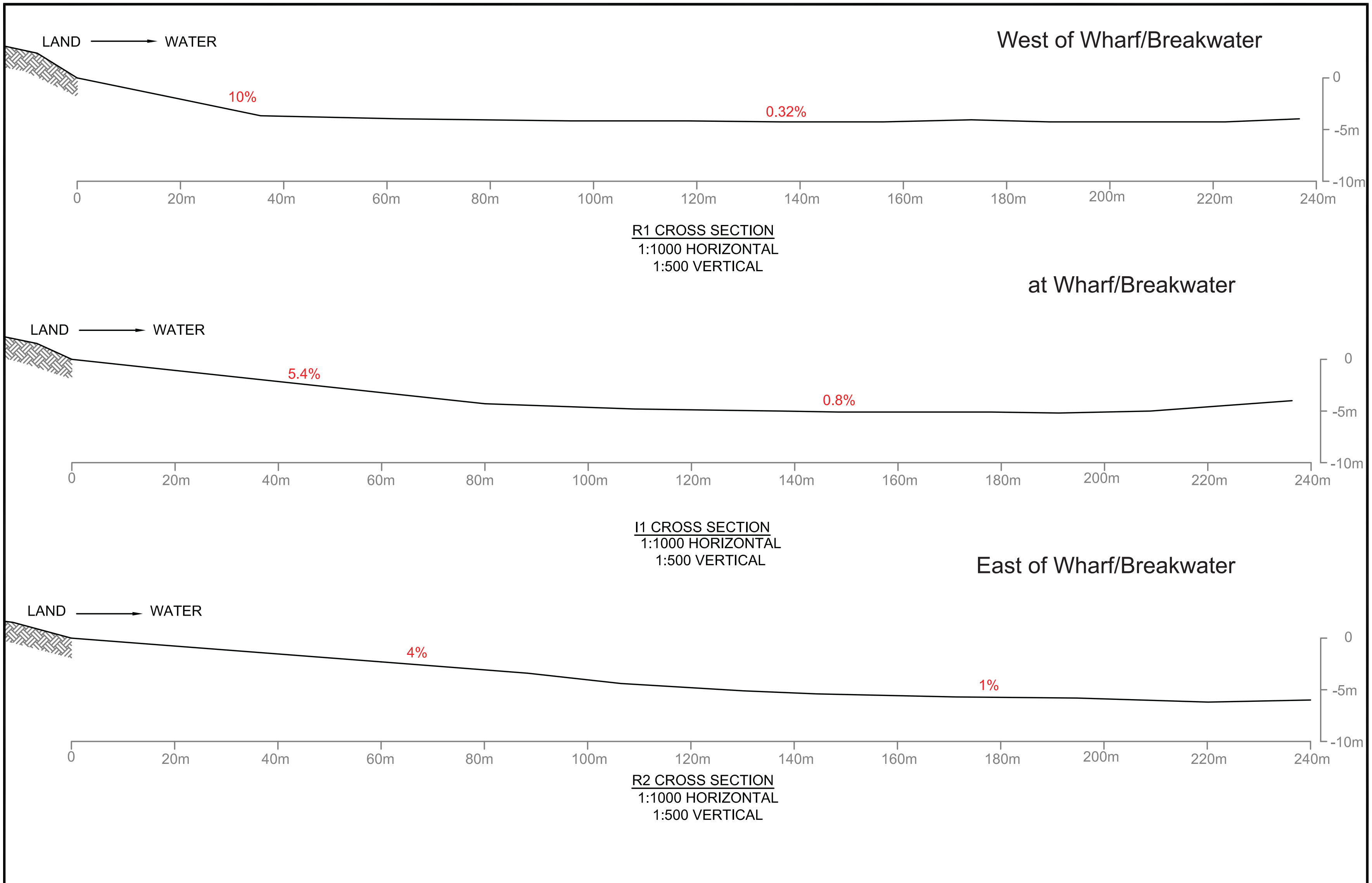
The shoreline and high to mid intertidal areas of Arviat are dominated by a gently sloping intertidal and subtidal area (Figure 3-1) comprised predominantly of fines with an intermittent veneer of gravel, cobble and boulders (Table 3-1). Over the years, Arviat residents have altered much of the shoreline within the hamlet by moving aside larger cobbles and boulders to form breakwaters and boat ramps. Arviq Hunters and Trappers Organization (HTO) members believe the existing array of boulders is a result of breakwater erosion during ice-out in spring (Section 3.2.1).

In a 2007 nearshore fish and fish habitat study by Nunami-Jacques Whitford (now Nunami Stantec), the intertidal and subtidal habitats near the existing wharf/breakwater were found to be very similar (see Table 3-1 and Figure 3-2). However, because of reasons discussed above, there appears to be more large boulders near the wharf in the intertidal area (Nunami 2008). Nunami also examined the intertidal and subtidal habitat on either side (east and west) of the wharf/breakwater during the 2007 study (see Table 3-1 and Figure 3-2).

In the area beyond the end of the existing wharf/breakwater, where a water intake or an RO-reject outfall could be located (highlighted in Table 3-1), the data suggest only a modest (10-20%) extent of boulder armouring of the marine sediments. Here, substrates are in great majority (80-90%) comprised of soft sediments (“fines”). This type of bottom substrate can be vulnerable to hydrodynamic disturbance.

Table 3-1: Nearshore Physical Habitat Characteristics at Arviat (August 2007)

Site[1]	Average Distance from Shore (m)	Mean Sample Site Water Depth (m)	Boulder (>256 mm)	Cobble (64-256 mm)	Gravels (2-64 mm)	Fines (<2 mm)	Approx. Submergent Vegetative (attached algae) Cover (%)
I.1.1	113	5	30	10		60	10
I.1.2	160	5	10			90	20
I.1.2	93	6	10			90	20
I.2.1	113	5	30	10		60	20
R.1.1	68	5	20			80	20
R.1.1	68	2	20			80	20
R.1.2	188	4	20			80	30
R.1.2	75	5	30			70	30
R.2.1	75	4	20			80	20
R.2.2	188	7	20			80	30
R.3.1	78	7	20			80	10



Job No.:	1024457	**Dwg. No.:**	Jacques Whitford AXYS
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Date:	20-Nov-07		
Dwn. By:	NP		
App'd By:			

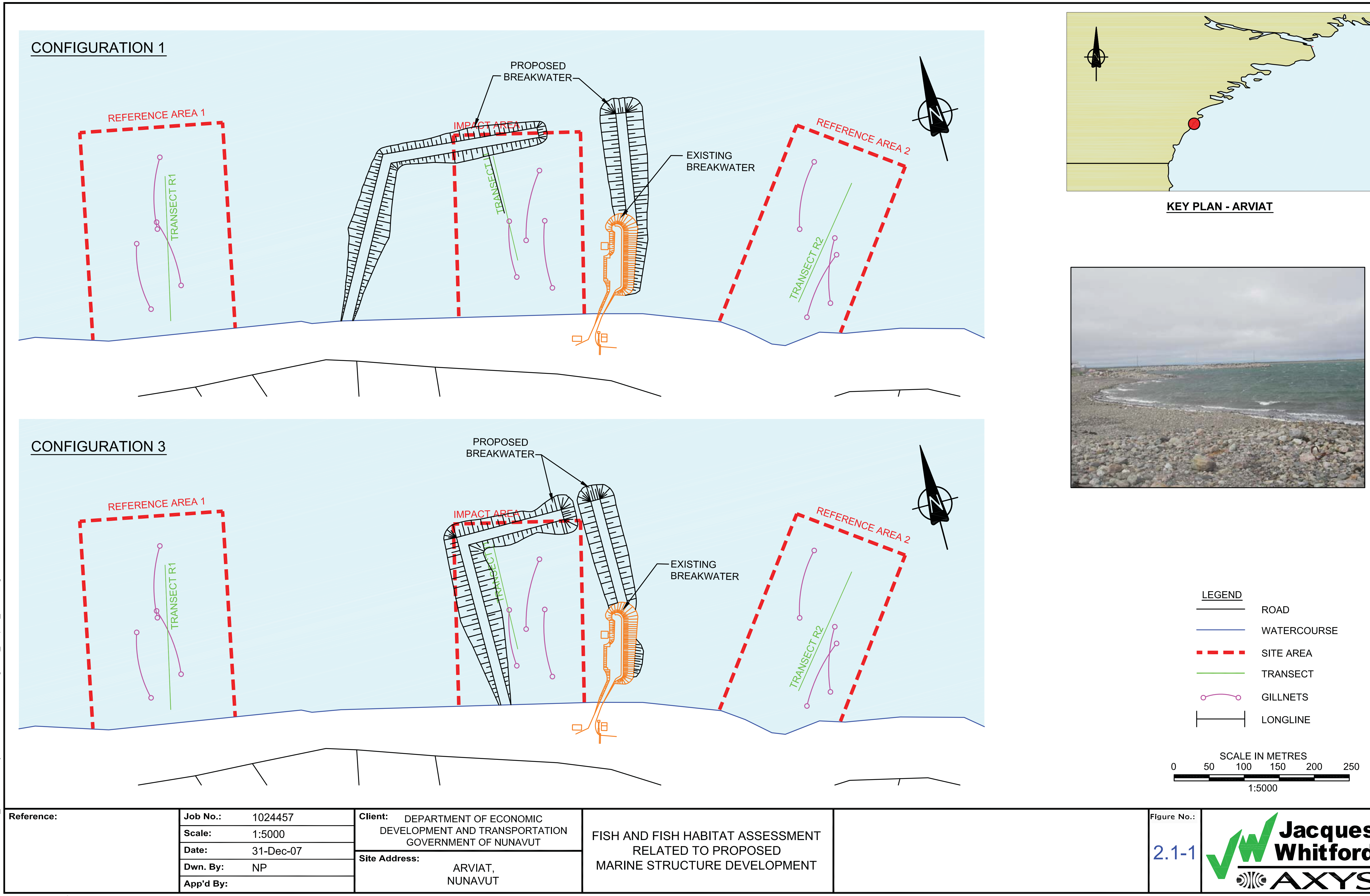
Client: DEPARTMENT OF ECONOMIC DEVELOPMENT AND TRANSPORTATION GOVERNMENT OF NUNAVUT

Note: See Figure 3-2 for Transect Locations

Source: Nunami-Jacques Whitford, 2008

Cross Sections of Depth Transects - Fish and Fish Habitat Assessment Related to Proposed Marine Structure Development

Figure 3-1



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Source: Nunami-Jacques Whitford, 2008

Sample Site Locations - Arviat Breakwater and Marine Fuel Re-Supply Facility

Figure 3-2

arv_bkwatr_spls; V:\1114\actv\grfx\01\misc

Table 3-1: Nearshore Physical Habitat Characteristics at Arviat (August 2007)

Site[1]	Average Distance from Shore (m)	Mean Sample Site Water Depth (m)	Boulder (>256 mm)	Cobble (64-256 mm)	Gravels (2-64 mm)	Fines (<2 mm)	Approx. Submergent Vegetative (attached algae) Cover (%)
R.4.1	93	7	20			80	10

[1] I: Wharf/Breakwater area; R.1 and R.3: Area West of Wharf/Breakwater; R.2 and R.4: Area East of Wharf/Breakwater (Figure 3-1)

Shaded area: area beyond end of wharf/breakwater where water intake and/or RO-reject discharge could be located

3.1.4 Wharf/Breakwater Construction

The existing wharf/breakwater at Arviat was constructed between 1989 and 1992 of a boulder base, wood and steel reinforcement, and a gravel top. The wharf and associated breakwater facilities are presently used as a community wharf and for bulk fuel re-supply. The existing wharf/breakwater is too small to be used for annual sealift off-loading or boat landing; a semi-natural "push out" located east of the hamlet is currently used by large vessels for off-loading sea containers (Photo 3-1). The wharf/breakwater has been the subject of various studies and attempts to secure funding for improvements and upgrades since the 1990s (Attachment B; Figure 3-2).

The granular character of the construction materials means that it cannot contain spilled fluids, which therefore will migrate into the sea.

The breakwater is believed to be eroding (Section 3.2.1). Upgrades to the wharf and breakwater were proposed in 2007 but have not yet been constructed.

While adjacent coastal areas are characterized by large boulders and cobbles, the shoreline near the community of Arviat has been cleared of large rocks to facilitate boat landing. Some boulders do get pushed ashore during spring break-up; these are believed to be part of the eroding breakwater structure (Nunami 2008).

3.1.5 Seawater Chemistry and Temperature

During Nunami's 2007 study, general seawater chemistry was determined (Table 3-2). The seawater had a salinity ranging from 28.5% to 29.8% (i.e., 28,500-29,800 ppm). Conductivity fluctuated negligibly from 3.15 to 3.29 S/m across the study area, and also fluctuated little with depth. The water temperature at depth of 0.1 to 2.0 m ranged from 8.3 to 11.4°C. Dissolved oxygen levels (mg/L) were above accepted minimum level (i.e., CCME Marine Aquatic Life guideline) at all sites, and ranged from 8.16 to 9.61 mg/L across the area. Dissolved oxygen level also changed little with depth.

Source: Nunami Stantec, 2007

"Push-Out" Wharf ~670m East of Main
Wharf / Breakwater Used for Off-loading Barges
Photo 3-1

arviat_wharf
v\1114\actv\grfx\01\misc

Table 3-2: Water-Quality Characteristics at Arviat (August 2007)					
Site	Depth (m)	Water Temp-erature (°C)	Conduct-ivity (S/m)	Dissolved Oxygen (mg/L)	Salinity (%)
I.1.1 at wharf/ breakwater	0.1	11.4	3.28	9.32	28.6
	1.0	11.2	3.27	9.20	28.6
	2.0	11.2	3.28	9.18	28.7
I.1.2 at wharf/ breakwater	0.1	10.7	3.24	8.41	28.7
	1.0	10.6	3.23	8.26	28.7
	2.0	10.6	3.24	8.16	28.7
I.2.1 at wharf/ breakwater	0.1	9.7	3.22	8.80	29.3
	1.0	9.6	3.21	8.70	29.4
	2.0	8.4	3.15	8.88	29.7
R.1.1 west of wharf	0.1	10.7	3.23	8.49	28.5
	1.0	10.7	3.23	8.40	28.6
	2.0	10.6	3.24	8.47	28.7
R.1.2 west of wharf	0.1	9.2	3.18	9.45	29.3
	1.0	9.3	3.18	9.61	29.3
	2.0	8.7	3.16	9.59	29.6
R.2.1 east of wharf	0.1	10.1	3.22	8.75	28.9
	1.0	10.1	3.22	8.93	28.9
	2.0	9.5	3.19	8.85	29.2
R.2.2 east of wharf	0.1	9.9	3.24	8.60	29.2
	1.0	8.8	3.17	8.60	29.6
	2.0	8.3	3.15	8.85	29.7
R.3.1 west of wharf	0.1	10.2	3.29	9.01	29.5
	1.0	10.1	3.29	9.27	29.7
	2.0	10.0	3.29	9.38	29.8
R.4.1 east of wharf	0.1	10.0	3.29	9.18	29.8
	1.0	9.7	3.27	9.28	29.8
	2.0	9.5	3.26	9.57	29.9

[1] I: Wharf/Breakwater area; R.1 and R.3: Area West of Wharf/Breakwater; R.2 and R.4: Area East of Wharf/Breakwater (Figure 3-2).

3.1.6 Marine Habitats

3.1.6.1 Submersed Marine Vegetation

Very limited amounts of seaweeds are present on the boulders in the subtidal habitat. Some drift kelp (*Laminaria longicruris* and *Alaria esculenta*) is present near the wharf/breakwater (Nunami 2008).

Submergent vegetative cover ranges from 10 to 30% in the nearshore shallows. Aquatic vegetation consists of rockweed (*Fucus* spp.) and small amounts of drift kelp. These three species provide marginal fish habitat along Arviat's shoreline (Nunami 2008), supporting the fisheries and marine mammal food chains.

3.1.6.2 Marine Mammals

The western coast of Hudson Bay, including Arviat's small bay, is home to a variety of seal species such as ringed seals (*Pusa hispida*), the most important source of food for Polar Bears (*Ursus maritimus*). Harp seals (*Pagophilus groenlandicus*), and Harbor seals (*Phoca vitulina*) are also common residents.

Beluga whales (*Delphiniapterus leucas*) migrate past Arviat when moving between breeding and wintering habitats, and polar bears are also common seasonal residents (Nowak 1991). Walruses are only seen occasionally (Nunami 2008).

3.1.7 Fisheries

Although there are no commercial fisheries in Arviat, some community members travel to Whale Cove or Rankin Inlet to work in commercial fishing in those communities. Recreational fishing is common however and limited recreational fishing can occur off the wharf/breakwater (Arnalak *pers. comm.* 2011). Arctic char (*Salvelinus alpinus*) is one of the most important species caught recreationally. Other locally important fish species include Arctic cod (*Boreogadus saida*) and sculpins (fourhorn and Arctic), with fishing derbies being popular local pastimes (Nunami 2008). Clams and scallops are also harvested (e.g., from Sentry Island to the northeast of the Hamlet of Arviat; Nunami 2008).

Arviat fisheries attributes near the wharf/breakwater were studied in 2007 by Nunami in relation to two configurations proposed for marine-structure development within the harbour (Figure 3-2).

Gill netting was the fish-capture method used during this study at locations (Table 3-3) adjacent to the existing wharf/breakwater and on either side (east and west) of the wharf/breakwater (Figure 3-2).

Table 3-3: Fish-Capture Methods Used at Sample Locations, Arviat (UTM Zone 15V) (August 2007)[1]

Sample Site[2]	Fish-Capture Method[3]	Easting	Northing
I.1.1 at wharf/breakwater	GN	442805	6775729
I.1.2 at wharf/breakwater	GN	442822	6775697
I.2.1 at wharf/breakwater	GN	442841	6775622
R.1.1 west of wharf/breakwater	GN	442279	6775739
R.1.2 west of wharf/breakwater	GN	442317	6775847
R.2.1 east of wharf/breakwater	GN	443181	6775488
R.2.2 east of wharf/breakwater	GN	443204	6775612
R.3.1	GN	442329	6775760
R.4.1	GN	443219	6775499

[1] Data from Nunami (2008)
[2] I.1 and I.2: Wharf/Breakwater area; R.1 and R.3: Area West of Wharf/Breakwater; R.2 and R.4: Area East of Wharf/Breakwater (Figure 3-2)
[3] GN: gillnet (6 panel, multiple mesh size research gillnet, unless stated otherwise)

3.1.7.1 Fish Species Catch Rates (CPUE) and Relative Abundance

A total of 120 fish was captured during 83.75 hours of gillnet soak time (Table 3-4). Species caught were Arctic char, Arctic cod, Arctic sculpin (*Myoxocephalus scorpoides*), fourhorn sculpin (*Triglopsis quadricornis*), Arctic cisco (*Coregonus autumnalis*), slender eelblenny (*Lumpenus fabricii*) and Pacific herring (*Clupea pallasii pallasii*). Only one Arctic char was caught; this was captured at site R.4.1, a reference site east of the existing wharf/breakwater (Figure 3-2).

Total catch rates at the different sites varied from 0.44 to 2.33 fish/hour, and were greatest in the subtidal zone adjacent to the wharf/breakwater over two separate sets (2.33 and 2.22 fish/hr) (Table 3-5, Figure 3-3). In general, there were no significant differences in species-specific catch rates between any of the sites near the existing wharf/breakwater, with the exception of Arctic cisco, which presented a higher CPUE near the wharf (Kruskal-Wallis, $p < 0.05$; (Figure 3-4).

The total mean catch rate at the wharf/breakwater was significantly greater ($P < 0.05$; ±2SE) than at the reference sites to the west and east (Table 3-5, Figures 3-3 and 3-4).

Table 3-4: Fish Species Relative Abundance at Arviat (August 2007)[1]

Date	Site No.[2]	Location	Soak Time (hr)	Arctic Char	Arctic Cod	Arctic Sculpin	Fourhorn Sculpin	Arctic Cisco	Slender Eelblenny	Pacific Herring	Total
7-Aug	I.1.1	Nearshore @	19	0	15	1	6	1	12	0	35
9-Aug	I.1.2	Offshore @	3	0	4	2	1	0	0	0	7
9-Aug	I.1.2	Offshore @	2.25	0	1	0	2	2	0	0	5
10-Aug	I.2.1	Nearshore @	7.5	0	1	0	3	6	0	0	10
9-Aug	R.1.1	Nearshore W	4.5	0	2	0	0	0	0	0	2
9-Aug	R.1.1	Nearshore W	5.5	0	2	0	2	0	0	0	4
10-Aug	R.1.2	Offshore W	7	0	6	0	4	0	0	0	10
10-Aug	R.1.2	Offshore W	4	0	3	1	1	0	0	0	5
9-Aug	R.2.1	Nearshore E	6.75	0	2	0	3	1	0	0	6
10-Aug	R.2.2	Offshore E	7.5	0	7	1	1	0	0	1	10
11-Aug	R.3.1	Nearshore	8.5	0	6	0	5	0	0	0	11
11-Aug	R.4.1	Nearshore	8.25	1	1	1	6	6	0	0	15
Total			**83.75**	**1**	**50**	**6**	**34**	**16**	**12**	**1**	**120**

[1] Data from Nunami (2008)
[2] I.1 and I.2: Wharf/Breakwater area; R.1 and R.3: Area West of Wharf/Breakwater; R.2 and R.4: Area East of Wharf/Breakwater (Figure 3-2)
@ = at wharf/breakwater; W = west of wharf; E = east of wharf

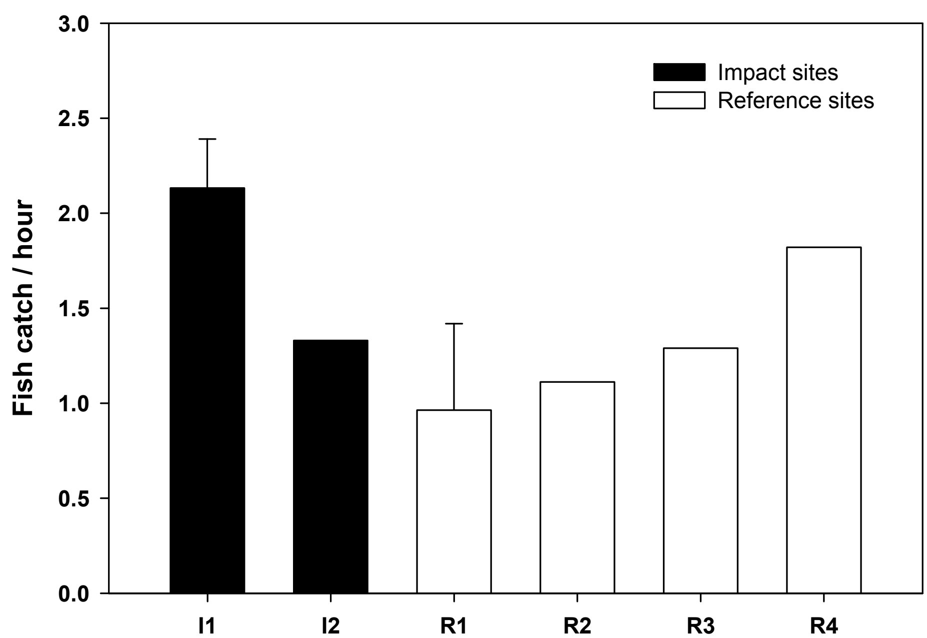
Table 3-5: Species-Specific Mean Catch Rates at Arviat (August 2007)[1]

Date	Site No.[2]	Location	Soak Time (hr)	CPUE							
				Arctic Char	Arctic Cod	Arctic Sculpin	Fourhorn Sculpin	Arctic Cisco	Slender Eelblenny	Pacific Herring	Total CPUE (fish/hr)
7-Aug	I.1.1	Nearshore @	19	0.00	0.79	0.05	0.32	0.05	0.63	0.00	1.84
9-Aug	I.1.2	Offshore @	3	0.00	1.33	0.67	0.33	0.00	0.00	0.00	2.33
9-Aug	I.1.2	Offshore @	2.25	0.00	0.44	0.00	0.89	0.89	0.00	0.00	2.22
10-Aug	I.2.1	Nearshore @	7.5	0.00	0.13	0.00	0.40	0.80	0.00	0.00	1.33
9-Aug	R.1.1	Nearshore W	4.5	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.44
9-Aug	R.1.1	Nearshore W	5.5	0.00	0.36	0.00	0.36	0.00	0.00	0.00	0.73
10-Aug	R.1.2	Offshore W	7	0.00	0.86	0.00	0.57	0.00	0.00	0.00	1.43
10-Aug	R.1.2	Offshore W	4	0.00	0.75	0.25	0.25	0.00	0.00	0.00	1.25
9-Aug	R.2.1	Nearshore E	6.75	0.00	0.30	0.00	0.44	0.15	0.00	0.00	0.89
10-Aug	R.2.2	Offshore E	7.5	0.00	0.93	0.13	0.13	0.00	0.00	0.13	1.33
11-Aug	R.3.1	Nearshore	8.5	0.00	0.71	0.00	0.59	0.00	0.00	0.00	1.29
11-Aug	R.4.1	Nearshore	8.25	0.12	0.12	0.12	0.73	0.73	0.00	0.00	1.82

[1] Data from Nunami (2008)
[2] I.1 and I.2: Wharf/Breakwater area; R.1 and R.3: Area West of Wharf/Breakwater; R.2 and R.4: Area East of Wharf/Breakwater (Figure 3-2)
@ = at wharf/breakwater; W = west of wharf; E = east of wharf

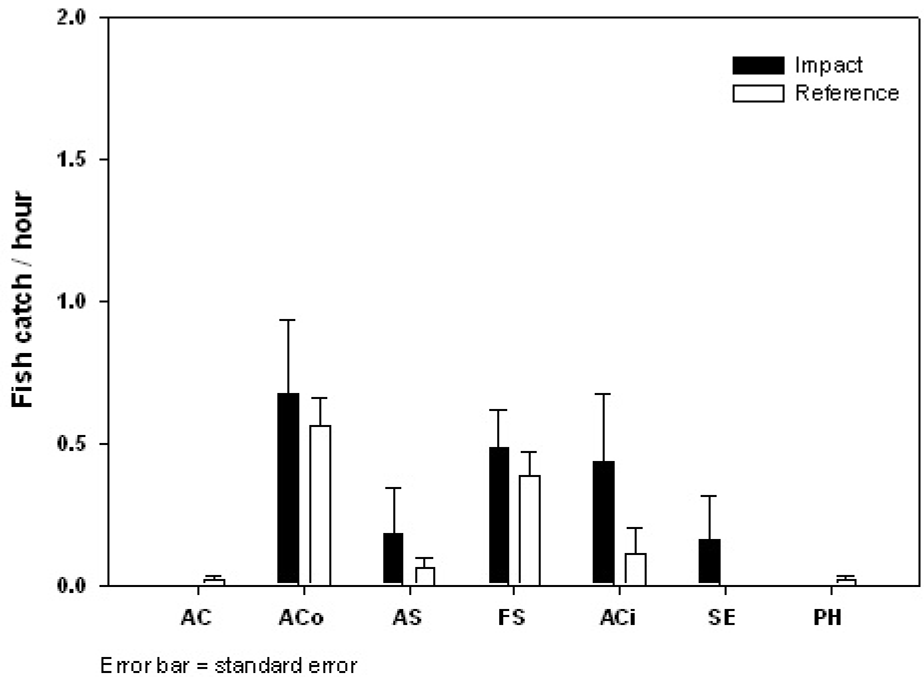
Table 3-6: Total Fish Relative Abundance and Mean at Arviat (August 2007)[1]		
Site/Location	**No. Fish Caught**	**Mean Catch Rates (fish/hr ± SE)**
Site:		
Impact (at wharf/breakwater)	57	1.93 + 0.23
Reference (east and west)	63	1.15 + 0.15
Total	120	1.41 + 0.16
Location:		
Nearshore	83	1.19 + 0.20
Offshore	37	1.71 + 0.23

[1] Data from Nunami (2008)



Error bar = standard error

Figure 3-3: Mean Catch Rates at Arviat (August 2007; Nunami [2008])



AC: Arctic char; ACo: Arctic cod; AS: Arctic sculpin; ACi: Arctic cisco;
SE: slender eelblenny; FS: fourhorn sculpin; PH: Pacific herring

Figure 3-4: Species-Specific Mean Catch Rates at Arviat (August 2007; Nunami [2008])

3.1.7.2 Fish Species Richness and Diversity

Five fish species were captured near the existing wharf/breakwater (i.e., the 'impact' site in Figure 3-2) (Arctic cod, Arctic sculpin, fourhorn sculpin, Arctic cisco and slender eelblenny) compared to six at the 'reference' sites to the east or west (Arctic char, Arctic cod, Arctic sculpin, fourhorn sculpin, Arctic cisco and Pacific herring). The species diversity index was slightly higher near the existing wharf/breakwater than on either side of the structure (Table 3-7).

Table 3-7: Species Richness and Diversity at Arviat (August 2007)		
Sites[1]	**Species Richness**	**Species Diversity (Shannon Index)**
I.1 at wharf	5	1.38
I.2 at wharf	4	0.9
Total	**5**	**1.47**
R.1 west of wharf	3	0.81
R.2 east of wharf	5	1.19
R.3 west of wharf	2	0.69
R.4 east of wharf	5	1.27
Total	**6**	**1.25**

[1] Data from Nunami (2008)
[2] I.1 and I.2: Wharf/Breakwater area; R.1 and R.3: Area West of Wharf/Breakwater; R.2 and R.4: Area East of Wharf/Breakwater

The higher diversity index and catch rates at the wharf/breakwater is likely an artifact of capturing more slender eelblenny, likely in relationship to the habitat that the structure has created over the past decades. The higher abundance of these species at the existing wharf/breakwater is likely associated with the presence of boulders/riprap, cryptic hiding places and increased prey populations, as suggested by HTO members (Section 3.1.4). In comparison, the ‘reference’ sites on either side of the structure have relatively homogenous, smaller substrates, and lack of habitat diversity. Winter fishing derbies for Arctic cod and sculpins are typically more productive in areas adjacent to the existing wharf/breakwater than in other areas of the harbour. Accordingly, the data suggest that fish species in Arviat prefer the habitat diversity provided by the larger breakwater substrates to the homogenous smaller substrates and lack of structure in the intertidal ‘reference’ areas.

Only one Arctic char was captured (length = 465 mm; weight = 1300 g; condition factor [k] = 1.3), from a reference area east of the existing wharf/breakwater. The lack of Arctic char within the harbour limits is consistent with observations of HTO members and other local residents. Observations of numerous boats and gill nets fishing for Arctic char indicated that the primary fishery occurs outside the harbour (Nunami 2008).

3.1.7.3 Valued Ecosystem Components

The most important species from both sociocultural and ecological views are Arctic Char and Fourhorn Sculpin. Of these, the Sculpin is the most amenable to use in any necessary environmental program (Section 9), in part because Arctic Char are virtually absent.

3.1.8 Rare, Threatened or Endangered Species

A diversity of Rare, Threatened or Endangered (RTE) Species is known for the terrestrial and aquatic, and marine habitats in the region (Table 3-8). Those reported for the Arviat coastal area are highlighted in Table 3-8, as are those NOT reported for this same coastal area.

3.1.9 Local Climate

Arviat has a harsh climate with high wind speeds (DS-Lea Consultants Ltd. 1999) and is part of the Maguse River Upland Ecoregion. The Maguse River Upland Ecoregion is classified as having a low arctic ecoclimate. The region is characteristized by a tundra ecosystem (Tetr*ES* 1995). Arviat has cool summers and very cold winters (DS-Lea Consultants Ltd. 1999). A mean summer temperature of 6°C and mean winter temperature of -24°C occur for the entire ecoregion. The mean annual precipitation ranges 250–400 mm with more than 400 mm occurring south of Arviat. Temperature and precipitation increase to the south of the ecoregion. The coastal climate is moderated by the open waters of Hudson Bay during the late summer and early fall prior to freeze-up when damp foggy weather is common. Blowing snow occurs frequently during the winter months. Ice fog and fog are also common (DS-Lea Consultants Ltd. 1999).

3.1.10 Tides

The tidal variation in Hudson's Bay at Arviat can range from ~4 m at high tide to substantially below 1 m at low tide in September (Nunami 2008; Figure 3-5). The tides in western Hudson Bay are semi-diurnal (Appendix C). The mean tide at Arviat is approximately 2.8 m above chart datum with maximum tide around 3.9 m (DFO 2007). Tidal height at Arviat varied between 0.6 and 3.4 m during the early August study in 2007 (Nunami 2008).

3.1.11 Storms

Tidal amplitude in 2010 was greater than during Nunami's 2007 study, indicating the variability in local tidal movements.

In spring, the cold marine water reduces vertical convection, and thereby wind stress, with a stabilizing effect on the air. Summer surface winds are generally the lightest of the year and can be quite variable in direction, with summer storms tending to pass from west to east across central Hudson Bay. In autumn, the relatively warm waters of the Hudson Bay have a destabilizing effect on the cooler air, producing storms that move predominantly west to east and southward. In the western Hudson Bay, the stormiest months with the highest surface winds occur in late fall (October) and early winter (November). Strong autumn winds can cause tidal storm surges of at least 1.2 m in southern James Bay (Stewart and Lockhart 2005).

Information on wave heights and periods in western Hudson Bay is scant, with the nearest storm wave data source in James Bay. Strong storm surges recorded in James Bay occur most

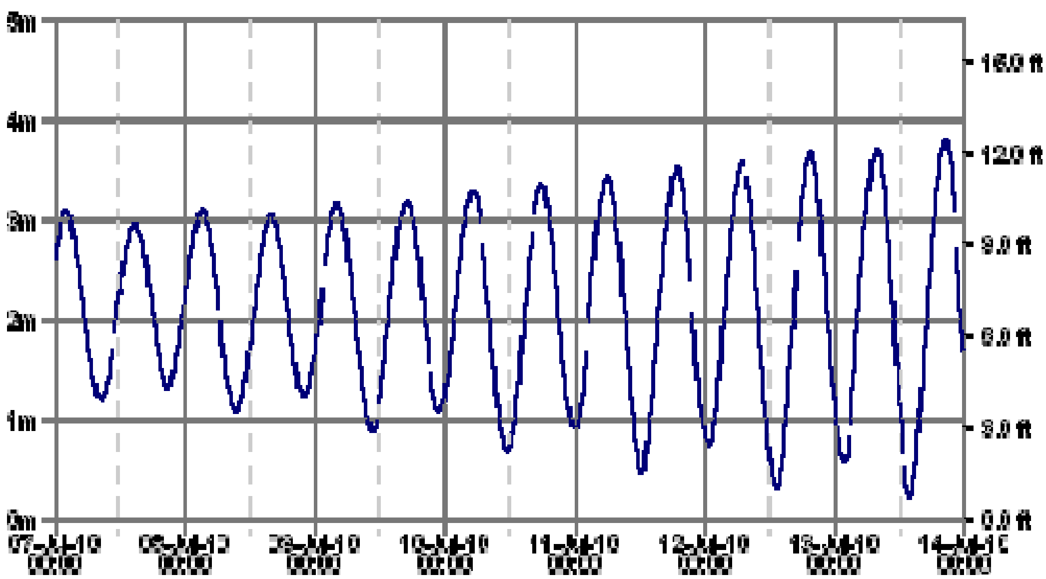
Table 3-8: Rare, Threatened or Endangered Species							
Taxon	**Common Name**	**Scientific Name**	**Population**	**COEWIC Status**	**Schedule**	**SARA Status**	**Reported Occurrence at or Near Arviat (Drawn from Nature Serve, SARA Registry, COSEWIC Status Reports)**
Vascular Plants	Felt-leaf Willow	*Salix silicicola*		Special Concern	Schedule 1	Special Concern	Sand dune obligate; **not known to occur on the coast** – closest know location is Pelly Lake (**far north and west of Arviat**).
Fishes	Atlantic Cod	*Gadus morhua*	Arctic Lakes population	Special Concern	No schedule	No Status	Arctic lake population inhabits three coastal lakes on Baffin Island, **not known to occur near Arviat.**
Fishes	Fourhorn Sculpin	*Myoxocephalus quadricornis*	Freshwater form	Data Deficient	Schedule 3	Special Concern	Some individuals may migrate long distances (up to at least 200 km) upstream from coastal areas. Habitat includes salt, brackish, and fresh shallow, cold coastal waters from 20 m to intertidal zone; estuaries; coastal rivers as far as 200 km from sea; resident "relics" in some lakes (most abundant at depths below 75 m in Great Lakes). Adults are benthic. Eggs are laid in deep water in a depression constructed on the bottom. Larvae are pelagic. Eats mainly various invertebrates (priapulids, mysids, isopods, amphipods, mollusks, chironomid larvae and pupae, etc.); also small fishes and fish eggs. **Should be assumed present in the inter-tidal zone at Arviat**.
Birds	Eskimo Curlew	*Numenius borealis*		Endangered	Schedule 1	Endangered	**No known populations in or near Arviat**.
Birds	Harlequin Duck	*Histrionicus histrionicus*	Eastern population	Special Concern	Schedule 1	Special Concern	**No known populations in or near Arviat**.
Birds	Horned Grebe	*Podiceps auritus*	Western population	Special Concern	No schedule	No Status	**Some birds follow coastlines for part of their migration**. Horned Grebes generally winter in marine habitats, mainly estuaries and bays. They are found in greatest numbers in coastal habitats, particularly in areas that provide some degree of protection.
Birds	Ivory Gull	*Pagophila eburnea*		Endangered	Schedule 1	Endangered	**No known populations in or near Arviat**.
Birds	Peregrine Falcon anatum/tundrius	*Falco peregrinus anatum/tundrius*		Special Concern	No schedule	No Status	
Birds	Peregrine Falcon anatum subspecies	*Falco peregrinus anatum*		Non-active	Schedule 1	Threatened	**Does not breed in Nunavut.**
Birds	Peregrine Falcon tundrius subspecies	*Falco peregrinus tundrius*		Non-active	Schedule 3	Special Concern	No overlap in breeding distribution; **known migration routes along west side of Hudson Bay.**
Birds	Red Knot islandica subspecies	*Calidris canutus islandica*		Special Concern	No schedule	No Status	**Migratory stopovers and wintering grounds are vast coastal zones swept by tides twice a day**, usually sandflats but sometimes mudflats. In these areas, the birds feed on molluscs, crustaceans, and other invertebrates. The species also frequents peat-rich banks, salt marshes, brackish lagoons, mangrove areas, and mussel beds.
Birds	Red Knot rufa subspecies	*Calidris canutus rufa*		Endangered	No schedule	No Status	No known overlap in distribution; **migration routes pass along the east side of Hudson Bay**.
Birds	Ross's Gull	*Rhodostethia rosea*		Threatened	Schedule 1	Threatened	In Canada, only four nesting locations have been found, three of them in Nunavut (Cheyne Islands, Prince Charles Island, Penny Strait) and one in Manitoba (near Churchill). Given the size of the Arctic and its harsh climate, some breeding sites have possibly gone undetected. The breeding sites that were occupied on the Cheyne Islands and in Penny Strait were on low-lying gravel reefs close to polynyas—openings in the sea ice that attract birds in late spring.
Birds	Rusty Blackbird	*Euphagus carolinus*		Special Concern	Schedule 1	Special Concern	No overlap in breeding distribution; **no populations in or near Arviat**.
Birds	Short-eared Owl	*Asio flammeus*		Special Concern	Schedule 3	Special Concern	**Widely distributed in Nunavut** but no population status available.
Mammals	Atlantic Walrus	*Odobenus rosmarus*		Special Concern	No schedule	No Status	The Northern Hudson Bay–Davis Strait population is distributed over an area of about 385,000 km^2, from Arviat on the west coast of Hudson Bay north and east through

Table 3-8: Rare, Threatened or Endangered Species							
Taxon	**Common Name**	**Scientific Name**	**Population**	**COEWIC Status**	**Schedule**	**SARA Status**	**Reported Occurrence at or Near Arviat (Drawn from Nature Serve, SARA Registry, COSEWIC Status Reports)**
		rosmarus					Hudson Strait to Clyde River on the east coast of Baffin Island. Walruses were more common and numerous along the west coast of Hudson Bay between Arviat and Chesterfield Inlet in the past (Loughrey 1959; Born *et al.* 1995). They are now found mostly in the area north of Chesterfield Inlet. No counts are available for this region. They are rarely taken at Arviat and irregularly at Whale Cove, but more commonly further north (Welland 1976; Gamble 1988, Strong 1989; Fleming and Newton 2003).
Mammals	Barren-ground Caribou	*Rangifer tarandus groenlandicus*	Dolphin and Union population	Special Concern	Schedule 1	Special Concern	Dolphin and Union **population range does not encompass Arviat**. Beverly and Qumanirjuaq herds, which are not listed, are known to occur near Arviat.
Mammals	Beluga Whale	*Delphinapterus leucas*	Western Hudson Bay population	Special Concern	No schedule	No Status	RE Threats: This large population, centred on the Seal, Churchill and Nelson Rivers, is the subject of substantial, and rising (see above) catches, and might be subject to disturbance by increased shipping. Future hydroelectric projects could cause changes to river outflow and result in changes in the use of such sites as either moulting or feeding areas. This has not apparently been the case in the developments to date on the Churchill River.
Mammals	Grizzly Bear	*Ursus arctos*	Northwestern population	Special Concern	No schedule	No Status	**Arviat is included in range**; incomplete information on population.
Mammals	Peary Caribou	*Rangifer tarandus pearyi*	High Arctic population	Non-active	Schedule 2	Endangered	Only found on arctic island; **no populations known near Arviat**.
Mammals	Peary Caribou	*Rangifer tarandus pearyi*	Low Arctic population	Non-active	Schedule 2	Threatened	Only found on arctic island; **no populations known near Arviat**.
Mammals	Peary Caribou	*Rangifer tarandus pearyi*		Endangered	Schedule 1	Endangered	**No range overlap; no populations known near Arviat**.
Mammals	Polar Bear	*Ursus maritimus*		Special Concern	No schedule	No Status	Occur along Hudson Bay coastline; **reported occurrence near and in Arviat**.
Mammals	Wolverine	*Gulo gulo*	Western population	Special Concern	No schedule	No Status	**Arviat is included in range**, but population is listed as low density.
Mosses	Porsild's Bryum	*Mielichhoferia macrocarpa*		Threatened	Schedule 1	Threatened	**No known populations in or near Arviat**.
Sources: Tetr*ES* Consultants Inc. 1995; DS-Lea Consultants 1999; Manitoba Hydro 1999; Nunami-Stantec 2008							

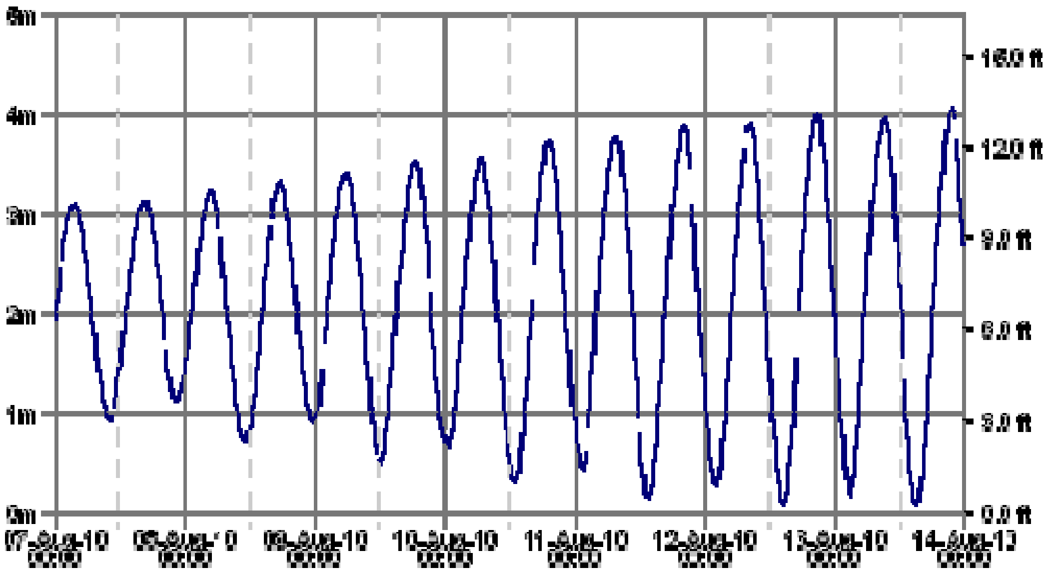
frequently between September to December and April to June. Autumn storm-wave data from James Bay document August and September median wave heights of 1 to 2 m with periods of 5 to 6 seconds. Surges of this intensity may extend kilometers inland beyond the normal high-water mark (Stewart and Lockhart 2005).

The bulk of the emergency plant's operations are thus outside the typical spring/fall window for storms and related storm-surge effects on water levels and tidal oscillations.

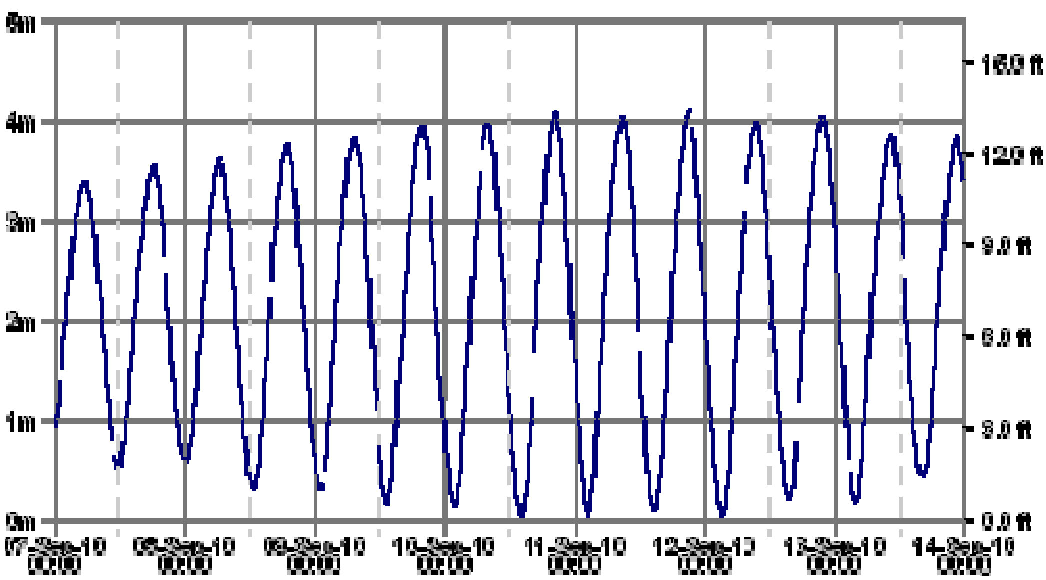
a) July



b) August



a) September



Source: http://www.tides.gc.ca/english/Canada.shtml

Figure 3-5: Heights of High and Low Tides (EDT) at Arviat (July-September 2010)

3.2 SOCIOECONOMIC ATTRIBUTES

The community of Arviat (formerly Eskimo Point) is located at 61° 07’ N latitude and 94° 03’ W longitude and lies on the northern side of a peninsula. Arviat has a population of approximately 1,600 people, which varies with tourism (Manitoba Hydro 1999).

3.2.1 Traditional Knowledge and Traditional Uses

During the 2007 study in Arviat, Nunami biologists met with members of the Arviq HTO to discuss the importance of the local fishery, especially attributes of Arctic char and other important species near the existing wharf/breakwater, for the community, and within the region. Arctic char was reported to be the primary sustenance fish for the community of Arviat. It was communicated that although there are no commercial fisheries in Arviat, some local fishers travel to Rankin Inlet and Whale Cove to participate in commercial fisheries there.

HTO members informed Nunami that Arctic char in the Arviat area typically emigrate to marine habitats at the end of ice-out in mid-to late July, and return to natal rivers in mid-September. Arctic char are believed to originate from one or several rivers including the Ferguson, Wallace, Sandy Point, Copperneedle, Ghost and/or an unnamed river near Ferguson River. Members of the HTO reported they have noted that the flesh color of Arctic char caught in the more southern fishing areas is paler than that of fish caught in the more northern fishing areas. The white-fleshed char seem thinner and have a weaker taste. The difference in flesh color may be associated with different diets of Arctic char between the two areas.

Nunami was advised that Arctic cod and sculpins are also harvested and consumed by local residents. Small fisheries for Arctic cisco, which is used primarily as dog food, also occur in Arviat. There is a sculpin fishing derby in the fall and a cod fishing derby in the winter within the Arviat harbour.

HTO members also communicated that other important marine species for the hamlet include harp seals (*Pagophilus groenlandicus; qairulik*), harbor seals (*Phoca vitulina*), ringed seals (*Pusa hispida; nattiq*) and belugas (*Delphinapterus leucas; qinalugaq*). About once every five years a walrus is seen near the hamlet. Nunami was informed that clams and scallops are harvested outside of the harbour, mostly from Sentry Island.

The HTO reported that it has many concerns regarding the continued erosion of the existing wharf/breakwater. The HTO believes that the annual redistribution of breakwater boulders during ice-out may be adversely affecting fish habitat (Nunami 2008).

3.2.2 Adjacent Land Uses

Homes and commercial buildings are located along the waterfront and further south (Photos 1-2 and 1-3; Figure 2-1).

A semi-natural "push out" is located approximately 670 m east of the existing wharf/breakwater (Photos 3-1). This is currently used for offloading the annual sealifts arriving for the community during the summer months. In 2007, HTO members informed Nunami that sand is added to this push out area annually to build it up for the sea lifts. The HTO suggested that the annual additions of sand may be impacting fish habitat in the area.

3.2.3 Unique Elements and Features

The wharf/breakwater is, itself, a unique and valued feature in the socio-economic and socio-cultural landscape of Arviat. There are no other socio-cultural or socio-economically "unique" features in close proximity to the wharf.

3.2.4 Socioeconomic Conditions

Economic activities in Arviat are centered around hunting, fishing, crafts and tourism (Manitoba Hydro 1999). The wharf/breakwater is important for landing of cargo, mooring of boats, protection of key reach of the community seaside, and for recreational fishing.

3.2.5 Consequences of this Emergency Persisting

The consequences of the emergency situation persisting without remedy include disease outbreaks, community malaise and loss of morale, and impairment of socio-cultural and socio-economic activity. The former impact is of greatest concern. Its remedy is the potential benefit against which all potential impacts must be weighed.

4.0 Regulatory and Public Consultation

4.1 REGULATORY

4.1.1 Organizations Consulted

Individuals spoken to include:

- Ms. Sophia Granchino (NIRB; March 30, 2011) regarding the likely extent of interest that NIRB might have in screening the project, and her perspective on other public-sector agencies who might be contacted.
- Ms. Phyllis Beaulieu (NWB; March 30 and April 11, 2011) regarding the extent of interest that NWB might have in licencing the project, and her perspective on other public-sector agencies who might be contacted.
- Mr. Dave Hohnstein (NWB; March 30, 2011) regarding he NWB's likely process for licencing the project.
- Mr. Emil Arnalak (April 1, 2011) regarding the extent of public recreational use of the wharf/breakwater.
- Mr. Todd Schwartz DFO: April 11, 2011) regarding the DFO's interest in the project and information needs for supporting its decision-making.
- Ms. Georgina Williston (DFO; April 18, 2011) regarding probable interests of DFO and Environment Canada in review of the project.
- Ms. Anne Wilson (Environment Canada; April 18, 2011) regarding specific information needed by Environment Canada for its review of the project.

4.1.2 Public

The community has been fully engaged by its leaders in understanding the problem created by the reservoir-liner failure. Periodic communications explaining actions taken by C&GS and Hamlet leaders have been frequent, clear, and focused on potential solutions (Attachment D). In addition, communication of information through the community and the larger region has been effected through such media as CBC News (Attachment D). In addition, Nunami has been engaged in public consultations for development of the emergency water-supply project, and in assessing its consequences, as noted below.

4.2 CITIZENS CONSULTED

Individuals spoken to include:

- Mr. Don St. John (April 5, 2011) regarding the construction and mass-bearing capacity of the wharf/breakwater, and the typical practices employed by Eskimo Point Lumber for unloading barged shipments of construction materials at the wharf.
- Ms. Olivia Tagalik (April 13, 2011) regarding the possible public perceptions of the project.

4.3 PUBLIC RESPONSE TO PROPOSED PROJECT

We understand that the Hamlet's leadership in securing an interim water supply is receiving strong local support for its efforts.

4.3.1 Expressed Concerns

To Nunami's knowledge, no concerns about project impacts have been expressed to the Hamlet or project regulators. No concerns were communicated to Nunami-Stantec by any individuals contacted.

4.4 PROPONENT'S RESPONSE TO PUBLIC CONCERNS

No changes in the current approach and project design have been needed to address public concerns as no such concerns have been expressed.

5.0 Environmental Effects of the Project

The following outlines the temporal and spatial boundaries of the Project, and examines the potential for adverse effects within those boundaries. The issues and concerns addresses in the assessment are also set out below.

5.1 BIOPHYSICAL EFFECTS

5.1.1 Benefits

Desalination of sea water is increasingly relied upon in semi-arid and arid regions of the world, especially by means of Reverse Osmosis (RO) (Peters and Pinto 2008). It is a proven, if expensive, technology producing 24.5 million m^3/day of potable water around the globe (as of 2006). Benefits are well established:

> *"…desalination of seawater offers a range of human health socio-economic and environmental benefits by providing a seemingly unlimited constant supply of high quality drinking water…"* (Latteman and Hopner 2008)

5.1.2 Potential for Impacts

Potential adverse effects ("impacts") reported (e.g., Latteman and Hopner 2008; Hopner and Latteman 2002) in the technical literature include:

- Loss of aquatic organisms colliding with intake screens ("impingement").
- Loss of aquatic biota ingested with raw feedstock water ("entrainment").
- Disturbance and loss of marine invertebrate and invertebrate-dependent biota from seabed disturbance from construction of the raw water intake.
- Localized impairment of seawater quality from hydrodynamic scouring of the seabed near the intake, and associated suspension of sediments.
- Release of pretreatment, anti-sealant and system cleaning-chemical residues (many of them biocides), reaction byproducts, and heavy metals from system operating, system maintenance and/or system corrosion process.
- Release of brackish water to the sea having concentrations of salinity significantly higher than the original seawater.
- Hydrodynamic impacts of reject streams on seabed scouring, etc.
- Additional and unexpected energy consumption:

5.1.3 Potential Local Ecosystem Sensitivities

The most sensitive attributes of the local marine ecosystem which can create the potential for impacts are:

- The soft-bottom invertebrate community (beyond the intertidal area) where the water intake will be placed (Section 3.1.3).
- The higher biological productivity and species diversity observed in the vicinity of the wharf/breakwater (Sections 3.1.7.1 and 3.1.7.2).
- The presence of a designated RTE species (Fourhorn Sculpin) in the same area (Section 3.1.7.3).

5.1.4 Expected Impact-Prevention and Risk-Management Measures

Best Practices have been developed to mitigate or prevent these potential impacts (Peters and Pinto 2008; Latteman and Hopner 2008). Along with measures designed to satisfy the *Fisheries Act*, they include:

- Designing and locating the water-intake structure such that the intake screen will be ≥300 mm above the marine sediments and invertebrate community (Figure 2-3).
- Finding optimum combinations of intake-mesh sizing, mesh surface area, mesh metal type and intake velocities to reduce risks of both impingement and entrainment utilizing DFO's *Freshwater Intake End-of-Pipe Fish Screen Guideline* (Figure 2-4).
    - The dimensions of the stainless-steel mesh will be greater than the minimum requirement set out in the Guideline because the intake is not self-cleaning and for reasons of greater protection against fish impingement.
- Reducing chemical loads and the thermal impacts of RO-reject streams by dilution before disposal with power-plant cooling (or other surplus) water (e.g., seawater overflow from flow-balancing tank).
- Providing for dechlorination of any overflow of treated water and testing prior to discharge back to the sea.
- Finding optimum locations for subsurface RO-reject outlets using local knowledge for selecting areas of faster heat dissipation and salinity dilution.
- Discharge of CIP waste to sanitary rather than to RO reject stream.
- Use of a diffuser on the RO-reject outlet line, sized for optimum flash-dilution of the reject water (e.g., Castillo, Sanchez, Castillo 2007).

- Ensuring that any chemicals, fuel or wastes associated with the proposed project do not enter the sea.
  - Consistent use of secondary containment or surface liners (drip trays, fold-a-tanks, etc.) under all containers, tank inlet and outlet points, hose connections and hose ends where any hazardous material transfers may occur.
  - Ensuring that secondary containment will be of adequate size and volume to contain and hold fluids for the purpose of preventing spills under the "worst-case" scenario.
- Satisfying the requirement set out in *Section 36(3)* of the *Fisheries Act* that any discharge into sea water will be non-deleterious, by selecting RO technology of such efficiency (e.g., 45% in Pass One) that dissolved salts in the reject water is concentrated by only a factor of about 2, instead of 3, 4 or 5.
  - As noted in Table 5-2 below, chloride will increase by about 2.1 times, while Total Dissolved Solids will increase by about 2 times and sulfate by about 1.8 times.
- Commitment that any spill of fuel or hazards materials, adjacent to or into a water body, regardless of quantity, shall be reported immediately to the 24-hour Spill Line, **(**867) 920-8130.

Table 5-2: Water Quality in Feedwater and Expected from RO Units

Parameter	Feed	Concentrate
NH_4	0.00	0.00
K	349.00	715.34
Na	10100.00	18340.95
Mg	1210.00	2199.68
Ca	411.00	747.17
Sr	0.00	0.00
Ba	0.00	0.00
CO_3	3.43	9.25
HCO_3	160.00	284.34
NO_3	0.04	0.07
Cl	15000.00	32595.59
F	0.91	1.65
SO_4	2900.00	5272.86
SiO_2	0.00	0.00

Table 5-2: Water Quality in Feedwater and Expected from RO Units		
Parameter	**Feed**	**Concentrate**
Boron	0.00	0.00
CO_2	2.89	4.62
TDS	30179.39	60166.91
pH	7.70	7.76

5.1.5 Existing Documented Impacts

5.1.5.1 From Fuel Storage and Transfer Spills

The bulk fuel resupply port (wharf) is constructed of granular and porous fill material, including sand, cobble and boulders (Photo 5-1). The material on the beach, immediately adjacent to the wharf/breakwater, appears to be mainly naturally occurring substrate (Photo 5-2). These facts mean that the sea near the wharf/breakwater is vulnerable to fuel spills which appear to have occurred over the past decades (Photo 5-3).

A search of the GNWT Hazardous Materials Spills Database by PWGSC (2002) was conducted by Nunami-Stantec in 2007 to determine if any fuel spills had occurred at or adjacent to the sealift resupply area, given the evidence of less than optimum local fuel-handling practices in PWGSC's 2002 audit (Photos 5-4 and 5-5). Following receipt of the spills report, the Hamlet Office in Arviat was contacted to determine which, if any, of the spills had occurred within 100 m of the sealift bulk-fuel resupply area (Figure 5-1). The GNWT Hazardous Materials Spills Database (Table 5-1) indicated that the following hazardous materials spills were reported to have occurred within 100 m of the bulk-fuel resupply facility:

- On July 22, 1986, 210 litres of diesel P-50 was spilled by Hanunaik Arts near the craft shop.
- On February 18, 2001, 1,110 litres of diesel fuel was spilled by the Northern Store on the Northern Store property.
- At the beginning of 2002 (i.e., before May 8, 2002) and unknown amount of heating fuel was spilled by an unknown party on the Northern Store property.

The GNWT Hazardous Materials Spills Database records (Table 5-1) indicated eighteen other hazardous materials spills were reported to have occurred within approximately 275 m of the bulk-fuel resupply facility between February 1975 and September 2002 (PWGSC 2002).
Table 5-1 provides detailed information on the spills, indicating that most of the spills occurred in the area of the former tank farm or power plant which is located approximately 100 m south of the bulk-fuel resupply facility. One spill that is reported to have occurred in the bay where the sealift fuel resupply activity is conducted. The spill report indicates that on July 6, 1977,

Table 5-1: Hazardous Materials Spill Database
Environmental Protection Service of RWED
600, 5102-50th Avenue, Yellowknife, NT
Sorted by Spill Number for the Year(s): 1971-2003

Spill No.	Spill Date	Region	Location	Description	Commodity	Quantity (L or kg)	Party	Source	Agency
1974038		KEE	Eskimo Point	Tank Farm	Fuel Oil	0	NCPC	ST>	--
1975051	24-Feb-75	KEE	Eskimo Point	Tank Farm	Fuel Oil	22730	POL	ST>	--
1977031	06-Jul-77	KEE	Eskimo Point	Bay on North Side	Diesel P-50	3410	NTCL	MV	GNWT
1977040	15-Jul-77	KEE	Eskimo Point	Gravel Around Powerhouse	Diesel P-50	22730	NCPC	ST>	--
1979053	23-Oct-79	KEE	Eskimo Point	Tank Farm in Town	Diesel P-50	4546	NCPC	ST>	--
1980072	04-Jul-80	KEE	Eskimo Point	Bay Shore	Water/Oil	227	DPW	PL	--
1983087	30-Dec-83	KEE	Eskimo Point	-	Fuel	350	NTCL	MV	INAC
1985075	25-Jul-85	KEE	Eskimo Point	Southeast Section of Hamlet	Diesel P-50	900	900 Sanajiit Ltd.	ST<	GNWT
1986072	22-Jul-86	KEE	Eskimo Point	Near Craft Shop	Diesel P-50	210	Hanunaik Arts	PL	EPS
1986080	08-Aug-86	KEE	Eskimo Point	8 km South of Airport	Diesel Fuel	303	Schooner – James & Lucy	MV	CCG
1987018	21-Feb-87	KEE	Eskimo Point	NCPC Fuel Tanks	Diesel Fuel	10600	Hamlet of Eskimo Point	PL	GNWT
1987035	29-Mar-87	KEE	Eskimo Point	Inside Building	PCB Oil	5	NCPC	OTH	EPS
1987041	19-May-87	KEE	Eskimo Point	Housing Association Office	Diesel Fuel	450	Eskimo Point Housing Assoc.	PL	GNWT
1987045	26-May-87	KEE	Eskimo Point	Lot 452 House 602	Fuel Oil	1200	Eskimo Point Housing Assoc.	PL	GNWT
1987066	16-Jul-87	KEE	Eskimo Point	Tank Farm	Diesel Fuel	8118	NCPC	PL	EPS
1987069	17-Jul-87	KEE	Eskimo Point	Tank Farm	Diesel P-50	91	NCPC	ST>	EPS
1988070		KEE	Eskimo Point	Housing Office #500	Fuel Oil	100	Eskimo Point Housing Assoc.	PL	GNWT
1988071		KEE	Eskimo Point	Housing Office #397	Fuel Oil	100	Hamlet of Eskimo Point	PL	GNWT
1988092	11-Jul-88	KEE	Eskimo Point	Outside Hamlet Garage	Fuel Oil	3600	Eskimo Point Housing Assoc.	ST>	GNWT
1988155	03-Oct-88	KEE	Eskimo Point	-	Heating Fuel	200	Eskimo Point Housing Assoc.	PL	GNWT
1989012	06-Feb-89	KEE	Eskimo Point	Beside House	Heating Oil	700	Eskimo Point Housing Assoc.	ST<	GNWT
1989116	03-Aug-89	KEE	Arviat (E.Point)	NWTPC Tank Farm	Diesel Fuel	1000	NWTPC	PL	GNWT

Table 5-1: Hazardous Materials Spill Database
Environmental Protection Service of RWED
600, 5102-50th Avenue, Yellowknife, NT
Sorted by Spill Number for the Year(s): 1971-2003

Spill No.	Spill Date	Region	Location	Description	Commodity	Quantity (L or kg)	Party	Source	Agency
1990081	01-Jun-90	KEE	Arviat	-	Fuel Oil	340	DPW	ST<	GNWT
1990164	16-Sep-90	KEE	Arviat	Power Plant	Diesel Fuel	680	NWTPC	ST>	GNWT
1991002	08-Jan-91	KEE	Arviat	Tank Farm	Fuel Oil P-50	1200	Hamlet of Arviat	PL	GNWT
1991041	15-Apr-91	KEE	Arviat	Gas Station/Tank Farm	Gasoline	454	Hamlet of Arviat	PL	GNWT
1991061	13-May-91	KEE	Arviat	Tank Farm	Fuel Oil	521	Unknown	PL	GNWT
1991068	16-May-91	KEE	Arviat	Hamlet Office	Fuel Oil	0	Hamlet of Arviat	PL	GNWT
1991070		KEE	Arviat	Return Line	Fuel Oil	2273	Hamlet of Arviat	PL	GNWT
1991093		KEE	Arviat	Lot #43	Used Oil/Fuel Oil	2100	Hamlet of Arviat & NWTPC	OTH	GNWT
1992187	26-Aug-92	KEE	Arviat	House #367	Fuel Oil P-50	100	DNB Contracting	ST<	GNWT
1992246	09-Dec-92	KEE	Arviat	House #508	Fuel Oil	60	Joe Kanayol	ST<	GNWT
1992251	29-Dec-92	KEE	Arviat	House #700	Heating Oil	1350	POL Contractor	ST<	GNWT
1993015	18-Feb-93	KEE	Arviat	Tank Farm	Heating Fuel P-50	400	Padlei Co-op (POL)	ST>	GNWT
1993114	19-Jul-93	KEE	Arviat	NWTPC Power Facility	Diesel P-50	600	NWTCP	ST>	GNWT
1994122	12-Jul-94	KEE	Arviat	61:05:5N 94:4W	Jet B	16	Dept. Renewable Resources	ST<	GNWT
1994133		KEE	Arviat	POL Tank Farm	Gasoline/Fuel	0	POL	ST>	GNWT
1994177		KEE	Arviat	NWTPC Tank Farm	Diesel P-50	0	NWTPC	ST<	GNWT
1995097		KEE	Arviat	Next to NWTPC P/House	Diesel P-50	455	NWTPC	ST<	GNWT
1995117		KEE	Arviat	DPW/Hamlet Section	Hydraulic Fluid	159	Unknown	ST<	GNWT
1995171	21-Oct-95	KEE	Arviat	House #542D	Diesel P-50	568	Arviat Development Corp.	ST<	GNWT
1996003	10-Jan-96	KEE	Arviat	Arviat	Diesel P-50	1136.5	Padlei Co-op (POL)	ST<	GNWT

Table 5-1: Hazardous Materials Spill Database
Environmental Protection Service of RWED
600, 5102-50th Avenue, Yellowknife, NT
Sorted by Spill Number for the Year(s): 1971-2003

Spill No.	Spill Date	Region	Location	Description	Commodity	Quantity (L or kg)	Party	Source	Agency
1996072		KEE	Arviat	House 340	Heating Fuel	273	Housing Association	ST<	GNWT
1996098		KEE	Arviat	Northern Rental Unit #350	Fuel Oil	0	Arviat Housing Association	ST<	GNWT
1997115		KEE	Arviat	ADC Office Building	Heating Fuel P-50	0	Padlei Co-op (POL)	ST<	GNWT
1998085		KEE	Arviat	ADC Office Building	Diesel P-50	50	ADC & Co-op	ST<	GNWT
1999125		KEE	Arviat	Lot 301 Proposed Health Centre	Hydrocarbons	0	Unknown	UK	GN
1999126		KEE	Arviat	Unit #175A	Heating Fuel	1136	Keewatin Plumbing & Heating	ST<	GN
1999136	07-Oct-99	KEE	Arviat	NWTPC Near Old Garage	Waste Lube Oil	130	NWTPC	DRUM	GN
2000042	01-Oct-99	KEE	Arviat	Domestic Dump	Fuel Oil	455	Hamlet of Arviat	ST<	GN
2000045		KEE	Arviat	School Fuel Tank	Heating Fuel P-50	20	Unknown	ST<	GN
2000101		KEE	Arviat	N.E. End 71.410 Elf School	Diesel P-50	10	Co-op	ST>	GN
2000151	15-May-00	KEE	Arviat	Airport Road Going Towards Town	ATF	20	E.P. Lumber	TRU	GN
2000152	15-Jun-00	KEE	Arviat	House 335 Side of Road	Used Oil	2	Owner	DRUM	GN
2000164		KEE	Arviat	Inside Steel Berm Power Plant	Diesel P-50	205	Nunavut Power Corp.	PL	GN
2001044	18-Feb-01	KEE	Arviat	Northern Store Property	Diesel Fuel	1100	Northern Store	ST<	GN
2001108	31-Mar-01	KEE	Arviat	Apt #174D & 174C NCC Housing Units	Fuel Oil	568	NCC Properties Ltd.	ST<	GN
2001168	30-May-01	KEE	Arviat	Lot 106/118	Heating Fuel	568	Leonard & Assoc. Ltd.	ST<	GN
2001250		KEE	Arviat	In a Ditch	Heating Oil	130	Unknown	DRUM	GN
2001270	19-Aug-01	KEE	Arviat	Unit 32-515, Lot 488	Heating Oil	1136	Unknown	ST<	INAC

Table 5-1: Hazardous Materials Spill Database Environmental Protection Service of RWED 600, 5102-50th Avenue, Yellowknife, NT Sorted by Spill Number for the Year(s): 1971-2003									
Spill No.	**Spill Date**	**Region**	**Location**	**Description**	**Commodity**	**Quantity (L or kg)**	**Party**	**Source**	**Agency**
2001317	05-Oct-01	KEE	Arviat	Lot 357	Fuel Oil P-50	364	Hamlet of Arviat	PL	GN
2001325		KEE	Arviat	Old Historical Society House	Heating Fuel	455	Historical Society of Arviat	PL	GN
2002024		KEE	Arviat	Northern Store Arviat	Heating Fuel	0	Unknown	UK	GN
2002307	08-May-02	KEE	Arviat	Near Intersection of Airport Rd. & North Part of Tank Farm	Heating Oil	0	Hamlet of Arviat	DRUM	GN
2002522	19-Sep-02	KEE	Arviat	Unit 174 A	Diesel Fuel	0	Private Individual	PL	GN

Source: PWGSC, 2002

Materials used in construction of Arviat's marine fuel-resupply facility, (granular fill behind stacked 8 x 8 pressure-treated timbers between steel I-beams).

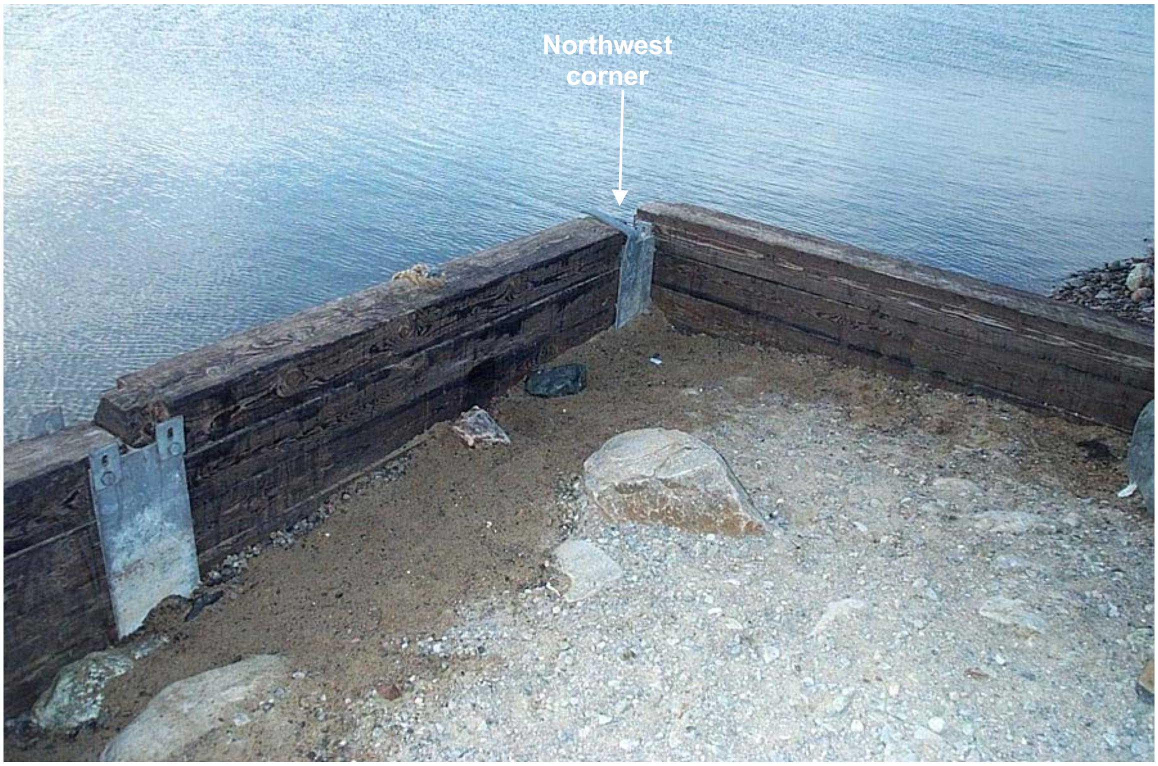
Photo 5-1

Source: PWGSC, 2002

Cobble and boulder shoreline east of marine fuel-resupply facility with rusting metallic waste.

Photo 5-2

arviat_pics
v\1114\active\grfx\01\misc

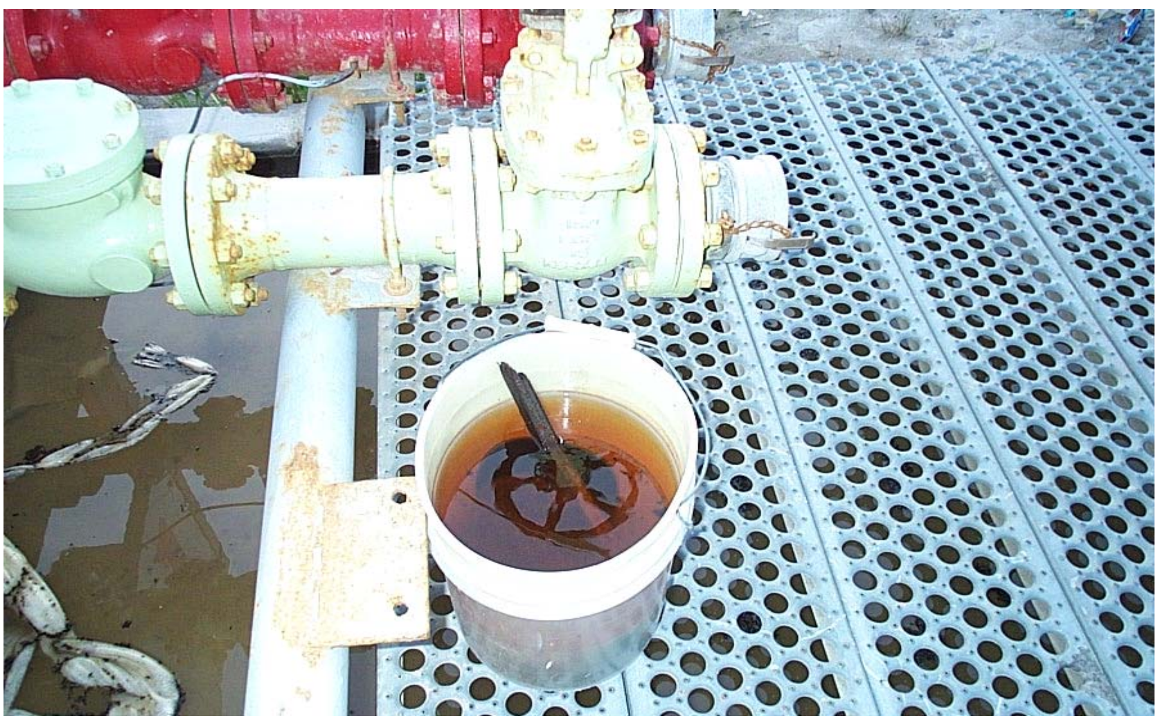


Source: PWGSC, 2002

Evidence (stained sand) of fuel spills visible along west face of marine bulk-fuel resupply facility.
Photo 5-3

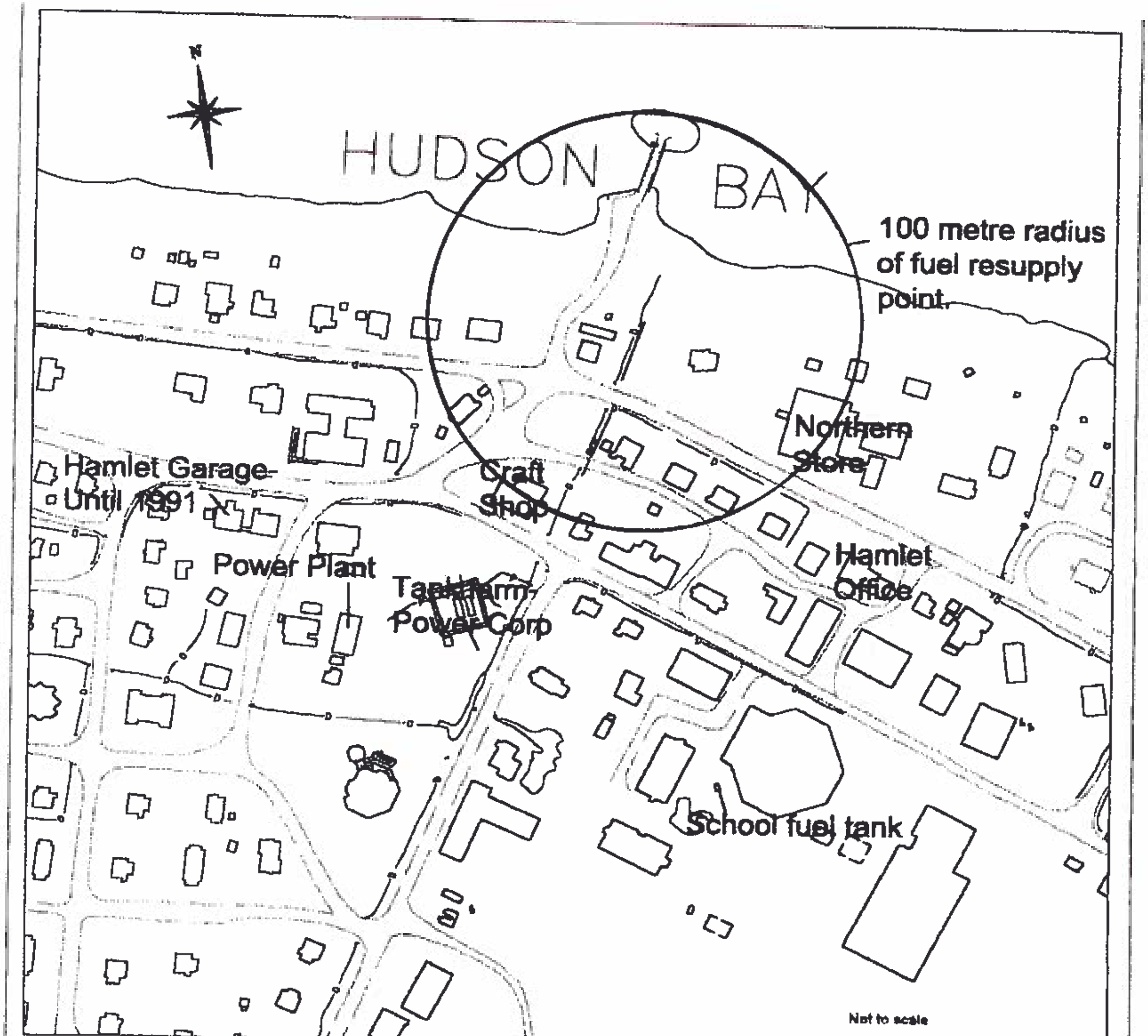
Source: PWGSC, 2002

View of pipe header on east side of access road to marine bulk fuel-resupply facility.
Photo 5-4



Source: PWGSC, 2002

Lack of Best Practices at fuel-resupply facility (20 litre pail with no lid, unknown contents, oily appearance) without drip tray on open-metal grate above bare ground beneath pipe header.
Photo 5-5



For Public Works & Government Services Canada,
Environmental Services

Haardous Material Spills in Arviat, Nunavut

Hamlet of Arviat
Arviat, Nunavut

Overview of the fuel sealift resupply port in Arviat. The large blue circle indicates the 100-meter radius around the fuel resupply pipe header

Figure 5-1

arviat_map
v\1114\actv\grfx\01\0221\29&51

3,410 litres of diesel P-50 was spilled by NTCL at the 'bay on north side.' In 1991 the tank farm was moved to the industrial area of the community, approximately 500 m from the sealift pipe header.

The 2002 PWGSC report concluded: "*…hazardous material spill records information indicated that many spills occurred at the former tank farm which was located approximately 100 meters south of the bulk fuel resupply area and it is possible that contamination from the tank farm property may have had the potential to impact the bulk fuel resupply port in Arviat*".

This means that the intertidal and deeper-water areas around the existing wharf/breakwater have been consistently affected by discharges of deleterious substances (fuels and oils) for 35 years. This local marine environment is thus not pristine and is already somewhat stressed by hydrocarbon pollution.

5.1.5.2 From Sewage Treatment Lagoon

The sewage lagoon servicing Arviat is located 1 to 1.3 km south of the community (Figure 1-4). It consists of an excavated sewage lagoon with a gravel (i.e., permeable) berm. The contents are not treated and drainage occurs naturally towards the shores of the Hudson Bay, approximately 0.25 km to the southeast.

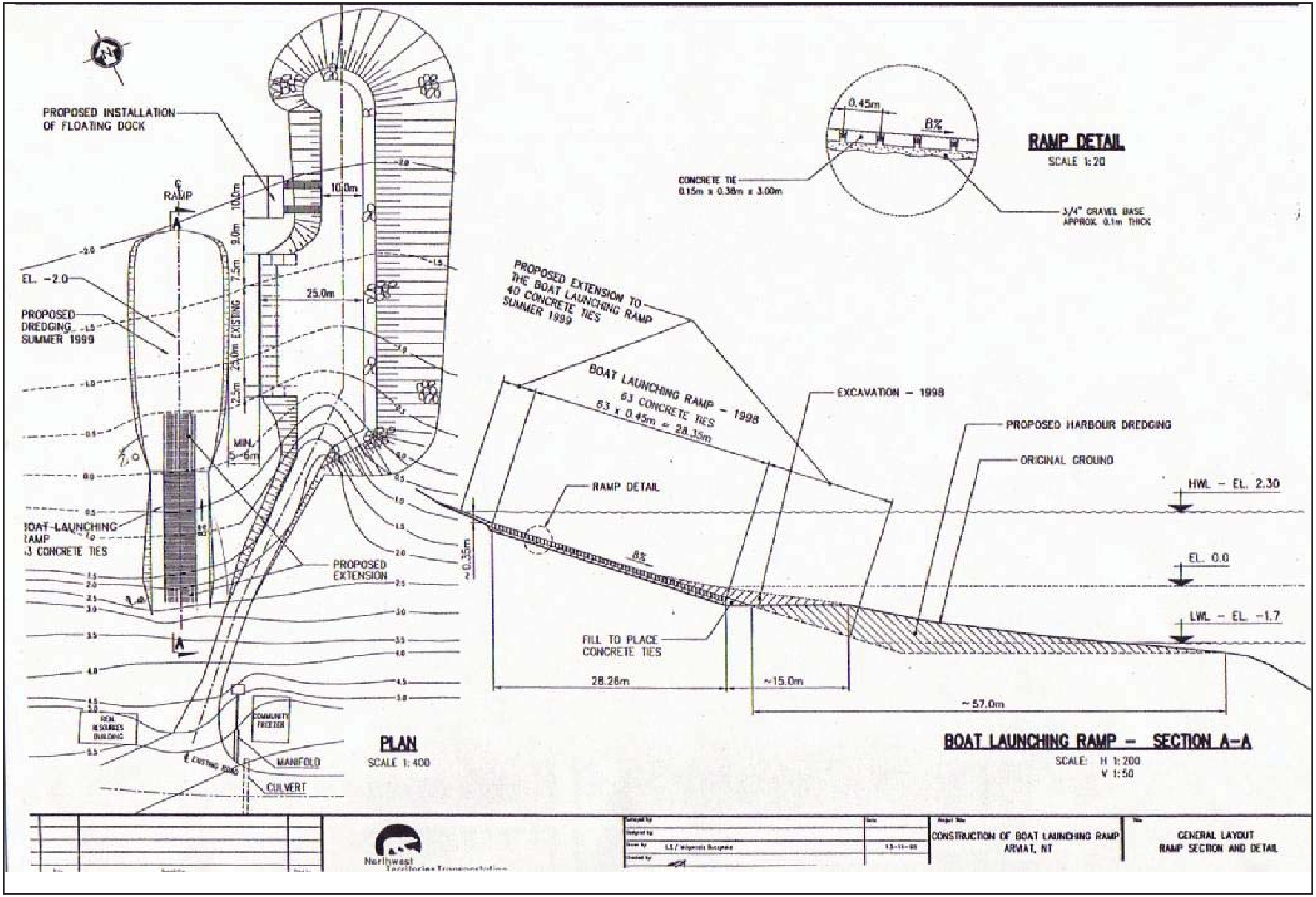
This means that the local region of the bay receives nutrient and microbiological loadings on a sustained basis, adding to the stress on the marine ecosystem that comes from occasional hydrocarbon spills when circulation patterns bring water from the southeast around the point and into the bay north of the Hamlet.

5.1.5.3 From Other Industrial Developments

The studies in Arviat undertaken in 2008 were in support of plans for a major expansion of the wharf/breakwater. As noted in Figure 5-2, that plan called for a significant dredging activity west of the bulk-fuel refueling facility. The new breakwater structure to create an enclosed harbor (Figure 3-2) would have created a very significant impact on existing shallow marine habitats, as would have the proposed dredging, which Figure 5-2 indicates to have a footprint about half the size of the existing breakwater structure (i.e., a very large impact area). Clearly, plans for upgrading the wharf/breakwater structure, although they have not been implemented, imply an acceptability for significant localized effects on the intertidal sediments and biotic communities. This builds upon previous plans for similar breakwater upgrades or improvements which would also have created impacts that the community and territorial government were clearly prepared to accept (Attachment B).

5.1.6 Net Residual Biophysical Impacts

The combination of a highly self-contained treatment-system design; return of salty RO-reject water back to the sea; careful design and siting of the water-intake line and structure; the very



Proposed Construction of Boat-Landing Ramp at Existing Arviat Breakwater and Marine Bulk-Fuel Resupply Facility

Figure 5-2

arv_boat_ramp; V\1114\actv\grfx\01\misc

small areas (<10 m^2 for the intake and <50 m^2 for the outlet) having even the slightest potential for physical or chemical impact; the reliance on secondary containment wherever required; the commitment to construction environmental monitoring to support the General Contractor to prevent spills during construction of the system; the commitment to environmental monitoring of the water column and seabed near the intake and outfall to verify assessment predictions; and a receiving environment already somewhat stressed by dilute nutrient, microbiological and hydrocarbon loadings means that the potential for environmental impacts on the marine environment is not significant.

5.2 SOCIOECONOMIC EFFECTS

Broadly speaking, the Project is necessary to avert a potentially significant humanitarian and socio-economic crisis. Its completion will prevent the crisis and contribute to the existing well-being of the residents of Arviat. As such, the project reflects the priorities and values of the Arviat community and the Government of Nunavut.

More specifically speaking, socioeconomic impacts are few and localized, and relate to:

- Substantial additional power costs and fuel use.
- Some substantial operational constraints on recreational access to and use of the wharf.
    - The community dock has tourism value; the west side landing is increasingly used for tourism purposes as local boat owners and outfitters licenced and capable of running boat tours to the Arvia'juaq National Historic Site and other destinations use that docking structure (Robbins *pers. comm.* 2011).
    - The dock is also used for certain community events (i.e., for fishing derbies [like the Sculpin Derby in early May] and Hamlet Day festivities). In these situations, the community uses the entire dock area, as happens when fishing derbies attract large numbers of people who use "*…every square inch of the shoreline around the dock area*." (Robbins *pers. comm.* 2011).
        - There could be community concerns expressed about constraints on these activities.
        - Public concerns can likely be alleviated by community leaders explaining the need for the project and its unavoidable location on the wharf.
    - There could be concerns with the visual impact of a water purification plant at the end of the dock, given the dock's prominence as a place to walk and view the activities out on the water and over to the point across the bay (Tagalik *pers. comm.* 2011; Robbins *pers. comm.* 2011).
        - Again, public communications by Hamlet leadership should be capable of alleviating this concern.

- A specific constraint on public access to the sea in the immediate vicinity of the seawater intake, and the RO-reject water outlet.
- A small but possibly noticeable noise loading on the local soundscape within ~500 ft of the plant.

5.2.1 Noise Impact

The operation of the RO treatment plant will produce noise that may have modest effects on the small number of marine biota utilizing the immediately adjacent area, but is not expected to cause disturbance to nearby residences or buildings.

Sound-level data indicate that a 1-MW diesel generator produces noise levels at 7-m distance of 94 dBA (ASHRAE undated). Such sound levels are similar to that of a track-driven pavement crusher (75-95 dBA at 15 m; US EPA 1971), a garden tractor (88-94 dBA) or a combine (80-105 dBA) (Murphy *et al.* 2007; US National Safety Council, undated).

The homes and buildings closest to the wharf/breakwater (Figure 2-1) are within a radius of ~450-700 ft from the approximate centroid of the north end of the wharf where the emergency water-treatment plant will be constructed. The sound-intensity levels measured beside the 1-MW generator will not be a nuisance at the closest nearby residences because sound attenuates greatly with distance in the manner described by the "Inverse Square Law," (Anonymous 2009; Murphy *et al.* 2007; Table 5-3). As explained by the Inverse Square Law, sound-pressure levels reduce by 6 decibels for every doubling of the distance from the noise source, in feet, as shown in the examples below:

Table 5-3: Examples of Sound Attenuation with Distance

Distance (feet)	Sound Pressure (decibel)		
	Rifle Shot	1,000-kW Generator	Characterization of Sound Levels
1.25	134	89*	
2.5	128	83	80 "Moderately Loud"
5	122	77	
10	116	71	
20	110	65	
40	104	59	
80	98	53	50 "Quiet"
160	92	47	
320	89	**41**	
640	80	**35**	

Table 5-3: Examples of Sound Attenuation with Distance			
Distance (feet)	Sound Pressure (decibel)		
	Rifle Shot	1,000-kW Generator	Characterization of Sound Levels
1280	72	**29**	30 “Very Quiet”
2560	66	**23**	25 “Whisper”
5120	60	**17**	
Source: ASHRAE TC2.6 undated			

The incremental sound level at the nearest homes related to generation noise of the treatment plant (i.e., the values **bolded** in Table 5-3 above) cannot reasonably be predicted to exceed 40 dB (between “quiet” and “very quiet”). At distances further away, the incremental sound will be in the 20-30 dBA range (i.e., a little more than a “whisper”).

5.3 NET EFFECT OF PROJECT

On the basis of the foregoing information, it can be reasonably predicted that the net effects of the Project will be positive. The widely demonstrated benefits of community access to reliable and safe drinking water can be realized with little to zero impact on the marine environment supplying the raw water feedstock and receiving the rejected brine. The marine environment is not pristine and is already subject to the local fuel-leakage and –spill history related to the seaside fuel-supply activities of past decades. There will be no new substantial prejudice to the local marine ecosystem integrity.

6.0 Mitigation Measures and Residual Impacts

A suite of design and operating details collectively create the capacity to prevent or fully mitigate the potential for adverse effects of the Project. Among the design details creating such impact-prevention and –mitigation are the following:

- Maximum practical sizing of the raw-water-intake line and associated screened intake structure so as to preclude or minimize water velocities near the intake.
- Location of the screened raw-water intake in the water column at such height above the seafloor as to preclude hydrodynamic scouring of the adjacent marine sediments and thereby prevent harmful alteration, disturbance, or destruction of marine seafloor invertebrate communities (Figure 2-3).
- Use of DFO-approved stainless steel screening on the raw-water intake to prevent entrainment of small-bodied fish or other similar-sized marine biota from the adjacent water column, in satisfaction of s.35(1) and 35(2) of the federal *Fisheries Act* (Figure 2-4).
- Return of the reject brine to the sea from whence it came.
- Return of the brine to the sea by means of a multipart diffuser (Stover undated) minimizing localized velocity impacts and salt-concentration impacts on seawater within a volume of seawater estimated to be, at most, 50 m long, 2 m high and 10 m wide, to prevent or minimize hydrodynamic or thermochemical-gradient impacts on marine life. Commitment to environmental inspection during construction and operation of the treatment system to prevent circumstances leading to accidental spills of oils, grease or fuels to the sea.
- Consistent reliance on provision of secondary containment and drip trays/containers wherever materials are used which, if leaking into the sea, could be deemed to be “deleterious.”
- Willingness to consider diversion of RO reject to the Hamlet sewage lagoon if Environment Canada determines that the RO reject is a ‘deleterious’ substance on the basis of toxicity testing or other findings of ecological impact in the marine ecosystem.

A monitoring program (Section 9) will be designed and implemented to validate the findings of this environmental assessment or, in the alternative, to provide early warning of some unexpected defect in system design or operations.

On the basis of these and other impact-prevention and –minimization measures, it is predicted that any residual environmental impacts on marine life will be highly localized, short term in duration, and **NOT SIGNIFICANT**.

7.0 Cumulative Effects

This project is a one-time event being undertaken on an emergency basis. There are no other water-treatment activities known to exist (or be planned for) the area of the Arviat harbour. Because there already are impacts of human activity occurring within the local area, largely related to fuel handling and storage, any loss of hydrocarbons from the treatment plan would create an increment in the local hydrocarbon-contamination situation. The probability of this incremental hydrocarbon loading is considered to be very low. Because of tidal movements and circulation patterns, any incremental hydrocarbon loadings would be subject to the natural volatilization, mixing, photo-oxidation and organic-sorption dynamics that appear to have been effective for recent decades in degradation of spilled hydrocarbons. For these reasons, there is no basis to predict any adverse cumulative effects of the Project. Potential impacts on marine habitats will be highly localized and can be fully mitigated, thereby creating no increment to any current significant constraints on marine life and habitat within the Arviat harbour.

8.0 Project Decommissioning

As previously noted, the project is being executed on an emergency basis until the Hamlet's permanent system can be repaired or upgraded (or both). Upon the Hamlet determining that the containment integrity and the water supply capacity have been restored, the emergency system will be stopped, and the modular system will be de-constructed. Decommissioning will include airlifting of the system components to another location for storage or site-specific repurposing.

9.0 Monitoring

Environmental monitoring is proposed to be undertaken during operation of the emergency water-supply system to confirm the prediction that no significant adverse effects will be measurable within the Project area.

The Environmental Monitoring Plan will:

- Provide information to demonstrate satisfaction of any related terms or conditions of any regulatory approval, permit or licence.
- Test the effectiveness of the measures intended to prevent or minimize environmental impacts from the operation of the emergency water-supply system.
- Assess the accuracy of the impact assessment and the predictions of Project Effects contained in s. 5 above on local water chemistry, local marine-sediment invertebrate communities and (if ecologically appropriate at the time of the year) “sentinel” marine fish:
  - Based on the review of the Valued Ecological Components (Section 3.1.7.3), the Fourhorn Sculpin is the fish species whose sensitivity, small home range, ecological and socio-cultural importance, and relative rarity makes it the “sentinel species” for tracking any impacts of the project on the local marine environment, if this can be feasible.
  - The principal surveillance methods will be water-quality sampling, photography of ‘exposed’ and ‘reference’ stations having a standard size (e.g., 1 m^2 quadrants), and grab sampling of sediments in ‘exposed’ and ‘reference’ locations.
  - Tracking salinity densities downgradient of the outlet-line diffuser will verify the accuracy of impact predictions, while documenting the expected absence of environmental effects.

As appropriate, the monitoring will include opportunistic recording of the locations and dates of any observations of Species at Risk, behavior or actions taken by the animals when project activities were encountered, and any actions taken to avoid contact or disturbance to the species, its habitat, and/or its residence.

Any other specific monitoring requirements that may be prescribed by the NWB, the DFO, the NIRB or Environment Canada will be included in the program.

The Monitoring Plan will be designed and executed so as to coordinate with (and prevent duplication of) any other local marine monitoring undertaken by the Hamlet, the Government of Nunavut, or any other interested party.

At present, it is expected that Nunami will execute the program with support and involvement by the local fishers.

10.0 Conclusion

ON THE BASIS OF THE AVAILABLE INFORMATION, NUNAMI STANTEC CONCLUDES THAT THE PROJECT IS NECESSARY TO AVERT A HUMANITARIAN AND SOCIOECONOMIC CRISIS, AND CAN PROCEED WITHOUT SIGNIFICANT ENVIRONMENTAL IMPACT.

THE NET CONSEQUENCE OF THE PROJECT IS SIGNIFICANTLY POSITIVE.

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