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Qulliq Energy Corporation
Société d'énergie Qulliq
Qulliq Alruyaktuqtunik Ikumatjutiit

IQALUIT HYDROELECTRIC PROJECT
PROJECT PROPOSAL

Knight Piésold
CONSULTING

February 12, 2013

www.knightpiesold.com

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ABBREVIATIONS

AANDC .... Aboriginal Affairs and Northern Development Canada
ACRD .... Asphalt Core Rockfill Dam
Armshow South Project .... Armshow South Hydroelectric Project
CCME .... Canadian Council of Ministers of the Environment
CEA .... Cumulative Effects Assessment
CLARC .... Community Lands and Resources Committee
DFO .... Department of Fisheries and Oceans
DIO .... Designated Inuit Organization
EIS .... Environmental Impact Statement
ELC .... Ecological Land Classification
ELU .... Ecological Land Units
EPC .... Engineer, Procure and Construct (‘turnkey contract”)
EPCM .... Engineering, Procurement and Construction Management
GN .... Government of Nunavut
GWh .... Giga Watt hours (1,000,000,000 Watt hours)
HTA .... Hunter and Trapper Association
IFR .... In-stream Flow Requirement
IIBA .... Inuit Impact and Benefit Agreement
IOL .... Inuit Owned Land
Jaynes Inlet Project .... Jaynes Inlet Hydroelectric Project
kV .... Kilo Volt (1,000 Volts)
kW .... Kilo Watts (1,000 Watts)
kWh .... Kilo Watt hour (1,000 Watt hours)
MAD .... Mean Annual Discharge
masl .... Metres Above Sea Level
MW .... Mega Watts (1,000,000 Watts)
MWh .... Mega Watt hours (1,000,000 Watt hours)
NIRB .... Nunavut Impact Review Board
NLCA .... Nunavut Land Claims Agreement
NPC .... Nunavut Planning Commission
NPPAA .... Nunavut Planning and Project Assessment Act (proposed)
PGA .... Peak Ground Acceleration
PPD .... Petroleum Products Division, Government of Nunavut
QEC .... Qulliq Energy Corporation
QIA .... Qikiqtani Inuit Association
RCC .... Roller Compacted Concrete
RDAG .... Response Development Advisory Group
SI .... International System of Units
URRC .... Utility Rate Review Council
VC .... Valued Component
VEC .... Valued Ecosystem Component
VSEC .... Valued Socio-economic Component

1 – INTRODUCTION

1.1 BACKGROUND

Qulliq Energy Corporation (QEC) is pursuing the development of hydroelectric facilities to supply electricity to the City of Iqaluit, Nunavut with the following objectives:

- Meet Iqaluit's energy requirements with a cost-effective renewable energy source
- Stabilize and potentially reduce overall energy costs for QEC and ratepayers
- Reduce reliance on fossil fuel (diesel generated power), which will reduce the city's carbon footprint and reduce QEC's exposure to fuel price risks / market volatility

Currently all electricity in Iqaluit is supplied from diesel-electric generation. QEC has identified the staged development of the Jaynes Inlet site followed by the Armshow South site as the preferred development plan. Collectively, this Project is the subject of a feasibility study, and is expected to undergo an environmental review by the Nunavut Impact Review Board (NIRB). Figure 1.1 shows the location of the two development sites in relation to the City of Iqaluit.

Iqaluit currently requires about 60 gigawatt hours (GWh) of electrical energy per year, with a peak load requirement of approximately 10 to 11 MW. This demand is met from two diesel powered generating stations in Iqaluit, currently being upgraded to a total installed capacity of 23 MW and a firm capacity of 17.8 MW (calculated with the largest unit out of service). This generating capacity is summarized in Table 1.1.

Table 1.1 Current Generating Capacity of Iqaluit's Diesel Power Plants

Generator Set	Continuous Rating (MW)	Year Installed
G1	3.0	1993
G2	4.3	2000
G3	2.0	1996
G4	3.3	1992
G5 (New Unit)	5.2	2013
G6 (New - Largest Unit)	-5.2	2013
Total Firm Capacity	17.8	-

NOTES:

1. FROM "APPLICATION FOR MAJOR PROJECT PERMIT: IQALUIT MAIN PLANT UPGRADE AND CAPACITY INCREASE" (QEC, 2010).

With an increasing population and a growing economy in Iqaluit, electricity demand is forecasted to increase in the coming decades. Also, the majority of homes are heated with heating oil. It is envisioned that hydroelectric generation could supplant the need for diesel-electric generation for all but backup purposes. In time, an additional opportunity may be for hydroelectric generation to also offset electrical home heating to reduce the consumption of heating oil.

The existing diesel-electric power plants will remain important in the overall energy strategy for Iqaluit. Once the Jaynes Inlet facility is commissioned, the power plants will be used to meet peak energy requirements at certain times of the day and year, and will provide full back-up to the hydroelectric facility during planned and unplanned outages. The power plants may play a role in providing voltage and frequency stability to the electrical system.

1.2 REPORT OBJECTIVES

Qulliq Energy Corporation has prepared this Project Proposal to fulfill the information requirements of the NIRB`s Part 2 Form, which is required to initiate the environmental review of the Iqaluit Hydroelectric Project (the Project). The document also provides supplemental information requirements in support of the core permit applications QEC is submitting for land and water use. It is these core permit applications that will trigger an environmental screening by NIRB. The following applications and supporting information are contained in the appendices of this report:

- **Appendix A -** Photographs of the two project sites
- **Appendix B -** Application for Access to Inuit Owned Land, for submission to the Qikiqtani Inuit Association (QIA)
- **Appendix C -** Nunavut Territorial Parks Use Permit Application, for submission to Nunavut Parks, Government of Nunavut
- **Appendix D -** Application for a Land Use Permit for Crown Land, for submission to the Department of Aboriginal Affairs and Northern Development Canada (AANDC)
- **Appendix E -** General Water Licence Application, for submission to the Nunavut Water Board (NWB)

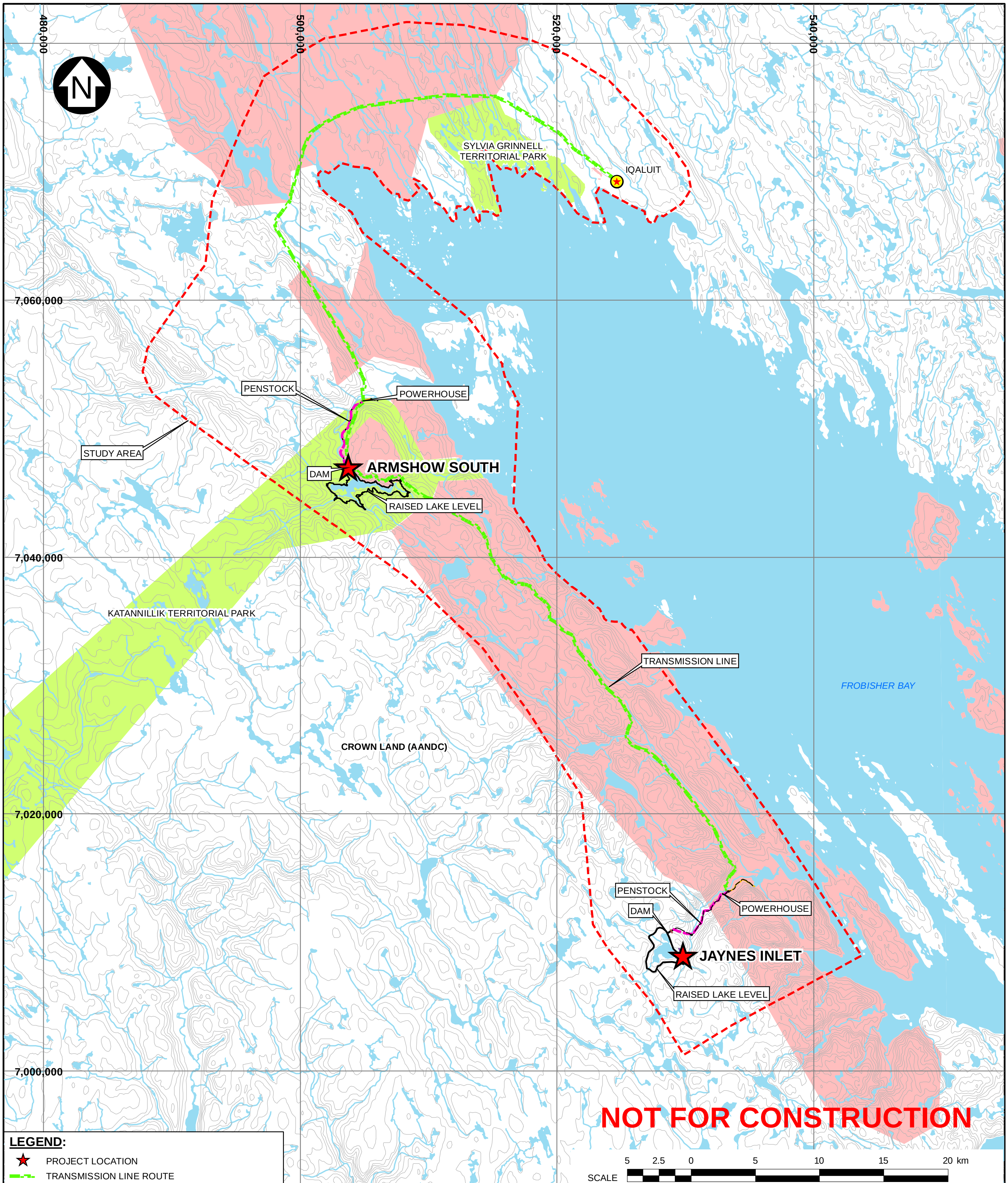
This document will also be a key resource in the engagement of QEC`s stakeholders on the Project, as the Corporation looks to advance its feasibility study and move through the NIRB-coordinated environmental review process.

1.3 GENERAL DESCRIPTION OF FACILITIES

1.3.1 Jaynes Inlet Site

The Jaynes Inlet site will be a proposed 10 to 14.6 MW storage hydroelectric facility, consisting of the following:

- A 30 m high main dam at the outlet of an upper lake with a current elevation of 450 m above sea level (masl). The main dam crest will be at 484 masl with a spillway at 480 masl, raising the current lake level by a maximum of approximately 30 m.
- A separate concrete gravity buttress (same crest elevation as the main dam), and an intake structure at 448 masl
- A surface penstock approximately 5.7 km in length and 1.3 m in diameter (inside diameter), which connects the intake to a powerhouse located at an elevation of 75 m
- A powerhouse equipped with two Pelton turbines rated at 5 to 7.5 MW each. The powerhouse will have a gate that opens during the open water season to discharge water to the stream.



LEGEND:

- PROJECT LOCATION
- TRANSMISSION LINE ROUTE
- PENSTOCK ROUTE
- CATCHMENT BOUNDARY
- TAILRACE ROUTE
- RIVER/STREAM/DRAINAGE
- WATER
- INUIT OWNED LAND - SURFACE ONLY EXCLUDING MINERALS (QIKIQTANI INUIT ASSOCIATION)
- PARK LAND (GOVERNMENT OF NUNAVUT)
- CROWN LAND (AANDC)
- STUDY AREA

NOTES:

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3. CONTOUR INTERVAL IS 60 METRES.
4. BOUNDARIES OF INUIT OWNED LAND PROVIDED BY NUNAVUT TUNNGAVIK INCORPORATED (2012). HTTP://WWW.NTILANDS.COM/DATA.HTML

QULLIQ ENERGY CORPORATION

IQALUIT HYDROELECTRIC PROJECT

PROJECT LOCATION

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P/A NO.	REF NO.
NB103-137/8	1

FIGURE 1.1 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	12FEB'13	ISSUED WITH REPORT	RAC	SWK	RAC	SRM

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- A tailrace approximately 3.2 km in length and 1.2 m in diameter will discharge water from the powerhouse to the lower lake during the winter months. The tailrace pipeline may be buried over its entire length, or may be surface mounted. In either case, the pipeline will discharge into a lower lake through the tailrace outfall structure that will include an energy diffuser. During the summer months, the water discharging from the powerhouse will exit the tailrace box directly adjacent to the powerhouse via an open channel and be returned to the river directly downstream of the fish barrier waterfall.
- An operator's accommodation and workshop, with additional temporary accommodation facilities for small maintenance crews
- An access road from the powerhouse to a barge landing area

Figures 1.2 and 1.3 present the Jaynes Inlet site layout for the construction and operation phases, respectively.

Electricity generated at the Jaynes Inlet site will be transmitted via a 69 kV transmission line to Iqaluit. The transmission line is described in Section 1.3.3.

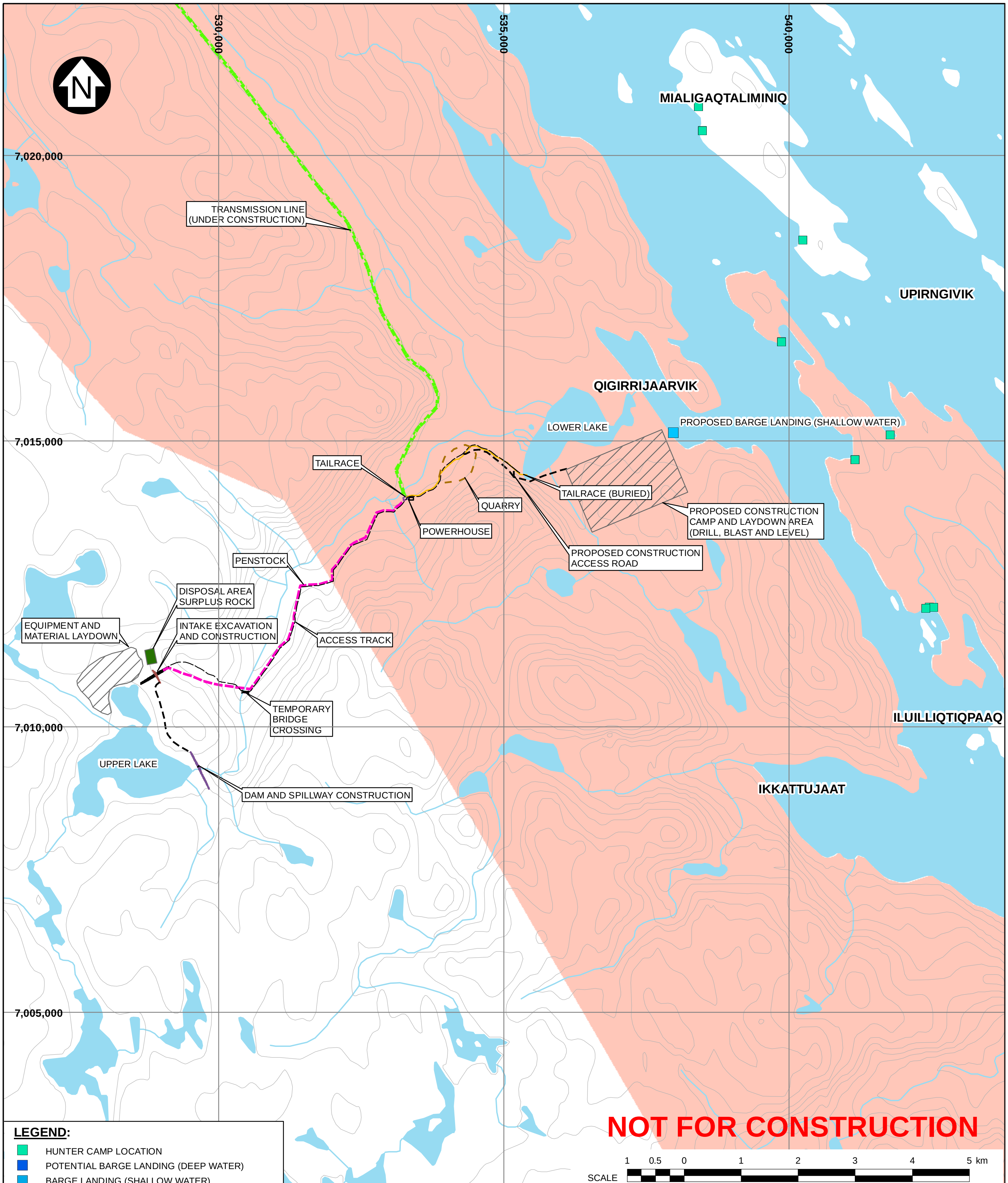
During construction, it will be necessary to establish a construction camp and laydown area near the coast. Equipment and materials will be delivered to the site by barges, which will beach in Jaynes Inlet at low tide. It will be necessary to construct a ramp at the coast to facilitate barge offloading.

Consideration is being given to establishing a small airstrip at the Jaynes Inlet project site to facilitate site access by fixed wing aircraft during the construction phase and operating life of the Project. This aspect will be studied further in 2013.

1.3.2 Armshow South Site

The Armshow South site will be a proposed 6 to 8.8 MW storage hydroelectric facility, consisting of the following:

- A 25 m high dam equipped with an intake at the outlet of an upper lake. The current elevation of the lake is about 229 masl. The dam will be equipped with a spillway at 250 masl, and an intake structure at the current lake level of 229 masl. The dam will raise the current lake level by a maximum of approximately 21 m.
- A surface penstock approximately 5.96 km in length and 1.4 m in diameter (inside diameter), connecting the intake to a powerhouse located at an elevation of 50 masl
- A powerhouse equipped with two Pelton turbines rated at 3 to 4.4 MW each
- A tailrace pipeline, approximately 0.6 km in length and 1.2 m in diameter, will be buried over its entire length and will discharge the flow through the tailrace outfall structure that includes an energy diffuser. The selected discharge location is an over-winter pool and it is expected that discharge of water will enlarge the overwintering pool in the lower reach of the river.
- An operator's accommodation and workshop, with additional temporary accommodation facilities for small maintenance crews
- An access road from the powerhouse to a barge landing area



LEGEND:

- HUNTER CAMP LOCATION
- POTENTIAL BARGE LANDING (DEEP WATER)
- BARGE LANDING (SHALLOW WATER)
- TRANSMISSION LINE ROUTE
- PENSTOCK ROUTE
- ACCESS TRACK
- ROAD
- TAILRACE
- TAILRACE (BURIED)
- RIVER/STREAM/DRAINAGE
- DISPOSAL AREA SURPLUS ROCK
- WATER
- INUIT OWNED LAND - SURFACE ONLY EXCLUDING MINERALS (QIKIQTANI INUIT ASSOCIATION)
- CROWN LAND (AANDC)

NOTES:

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QULLIQ ENERGY CORPORATION

IQALUIT HYDROELECTRIC PROJECT

JAYNES INLET SITE LAYOUT
CONSTRUCTION PHASE

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P/A NO.	REF NO.
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FIGURE 1.2 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
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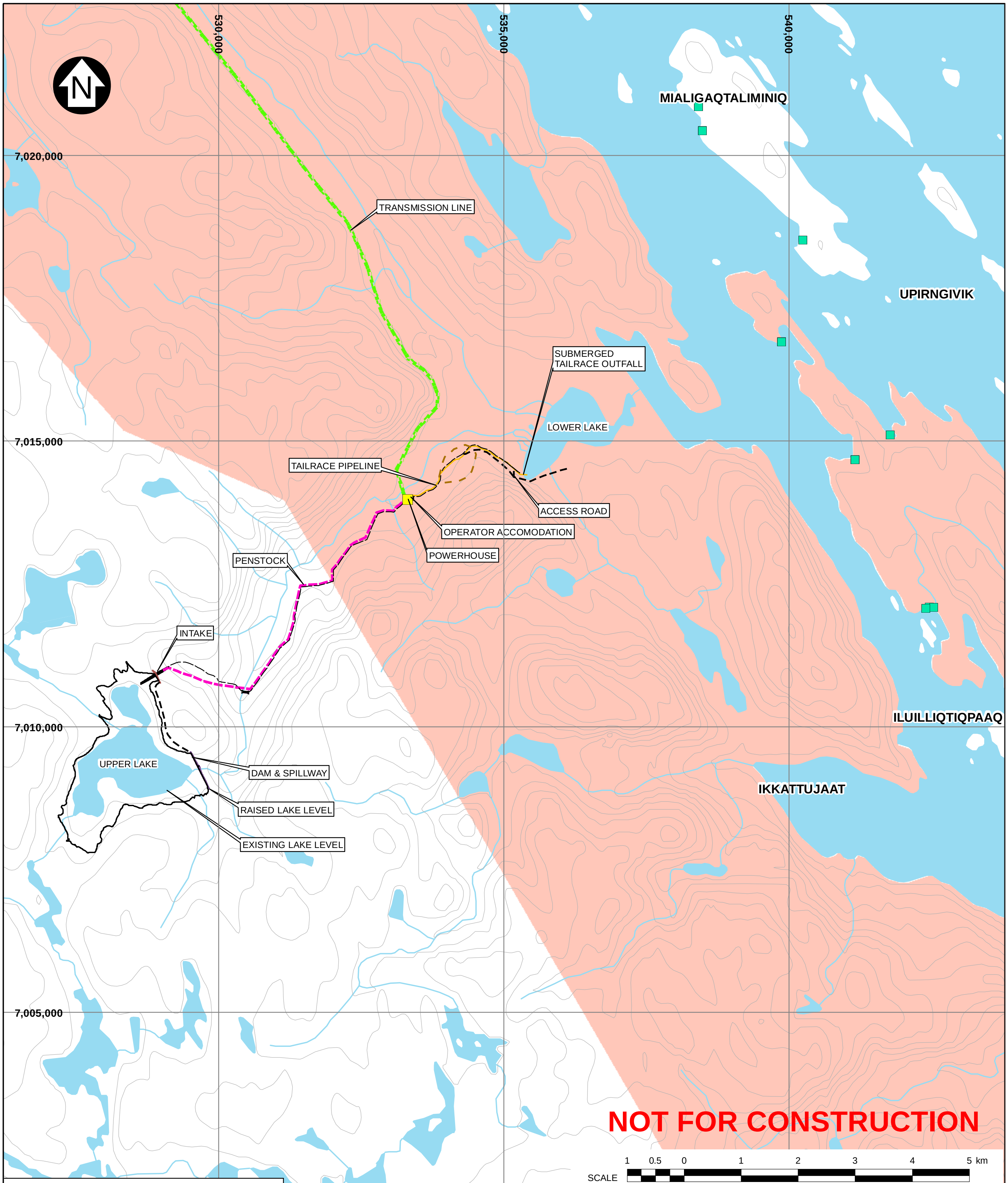

LEGEND:

- HUNTER CAMP LOCATION
- TRANSMISSION LINE ROUTE
- PENSTOCK ROUTE
- ACCESS TRACK
- ROAD
- TAILRACE
- RIVER/STREAM/DRAINAGE
- WATER
- INUIT OWNED LAND - SURFACE ONLY EXCLUDING MINERALS (QIKIQTANI INUIT ASSOCIATION)
- CROWN LAND (AANDC)

NOTES:

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4. BOUNDARIES OF INUIT OWNED LAND PROVIDED BY NUNAVUT TUNNGAVIK INCORPORATED (2012). HTTP://WWW.NTILANDS.COM/DATA.HTML

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QULLIQ ENERGY CORPORATION

IQALUIT HYDROELECTRIC PROJECT

JAYNES INLET SITE LAYOUT
OPERATION PHASE

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P/A NO. NB103-137/8

REF NO. 1

FIGURE 1.3

REV 0

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Figures 1.4 and 1.5 present the Armshow South site layout for the construction and operation phases, respectively.

Similar to Jaynes Inlet, during construction it will be necessary to establish a construction camp and laydown area at the Bay of Two Rivers near the coast. Equipment and materials will be delivered to the site by barges, which will beach on the tidal flats at low tide. It will be necessary to construct a ramp at the coast to facilitate barge offloading.

Consideration is being given to establishing a small airstrip at the Armshow South project site to facilitate site access by fixed wing aircraft during the construction phase and operating life of the Project. This aspect will be studied further in 2013 and discussed with stakeholders.

The powerhouse at the Armshow South site will be connected into what will be an existing 69 kV transmission line connecting the Jaynes Inlet facility to Iqaluit. The transmission line is described further in Section 1.3.3.

1.3.3 Transmission Line and Substation Tie-In

A 69 kV transmission line will be constructed to transmit energy from the Jaynes Inlet powerhouse to a substation adjacent to QEC's main diesel generating plant in Iqaluit. The estimated length of the line is 84 km, and the line will predominantly be single wooden pole construction. Where larger spans are necessary, double H-Frame wood pole structures will be utilized, and some steel structures may also be required.

A preliminary alignment has been identified based on positioning poles on bedrock where possible (Figure 1.1). For much of the north-south section from Jaynes Inlet, the poles will be positioned at the base of a bedrock ridge that trends north-south. Bedrock installations will consist of steel anchor mounts bolted into the bedrock. Where poles cannot be positioned on bedrock, backfilled culverts will be used to found the poles.

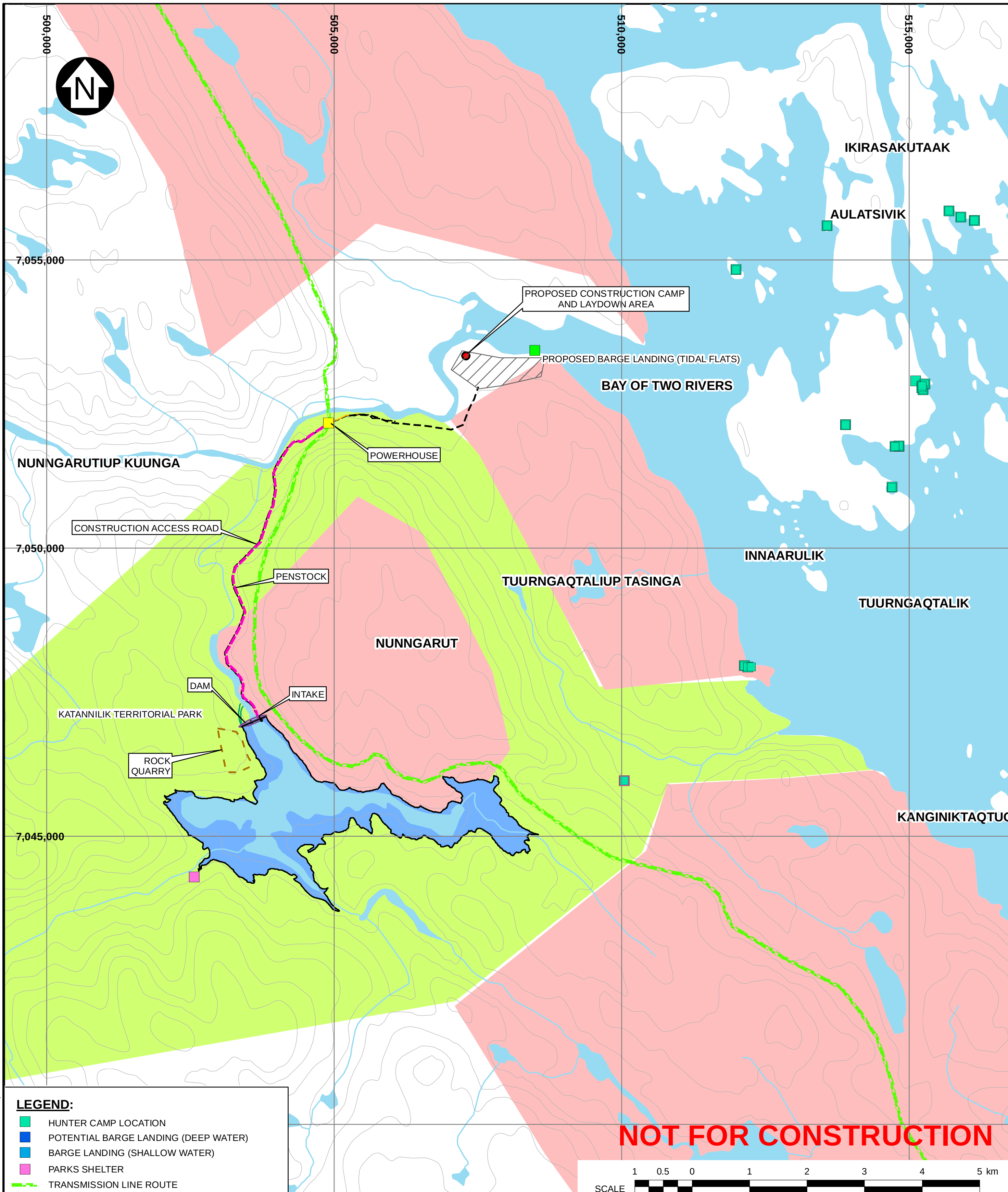
The transmission line crossing of the Armshow River will be located near to the proposed Armshow South powerhouse location.

Additional discussion will be required with key stakeholders regarding the position of the transmission line at specific locations. Nunavut Parks is interested in minimizing the visual effects of the transmission line at the entrance to the Katannilik Territorial Park near the Armshow South site, and the City of Iqaluit is interested in the transmission line location entering the City boundaries as it relates to the crossing of the Sylvia Grinnell River and users of the park, as well as minimizing activities within the Lake Geraldine watershed from which the City derives its municipal water supply.

1.3.4 Overview of Construction Execution

Each of the two sites will be constructed during separate periods, the timing of which is described in Section 2.7. The construction strategy for both sites, however, will be similar.

Each site will be constructed over three years, or possibly over two years if opportunities can be identified during the feasibility study to reduce the construction time.



LEGEND:

- HUNTER CAMP LOCATION
- POTENTIAL BARGE LANDING (DEEP WATER)
- BARGE LANDING (SHALLOW WATER)
- PARKS SHELTER
- TRANSMISSION LINE ROUTE
- PENSTOCK ROUTE
- ACCESS TRACK
- RIVER/STREAM/DRAINAGE
- WATER
- PROPOSED QUARRY
- INUIT OWNED LAND - SURFACE ONLY EXCLUDING MINERALS (QIKIQTANI INUIT ASSOCIATION)
- COMMISSIONER'S LAND (GOVERNMENT OF NUNAVUT)
- CROWN LAND (AANDC)
- LAYDOWN AREA

NOTES:

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QULLIQ ENERGY CORPORATION

IQALUIT HYDROELECTRIC PROJECT

ARMSHOW SOUTH LAYOUT CONSTRUCTION PHASE

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P/A NO.	REF NO.
NB103-137/8	1

FIGURE 1.4 REV 0

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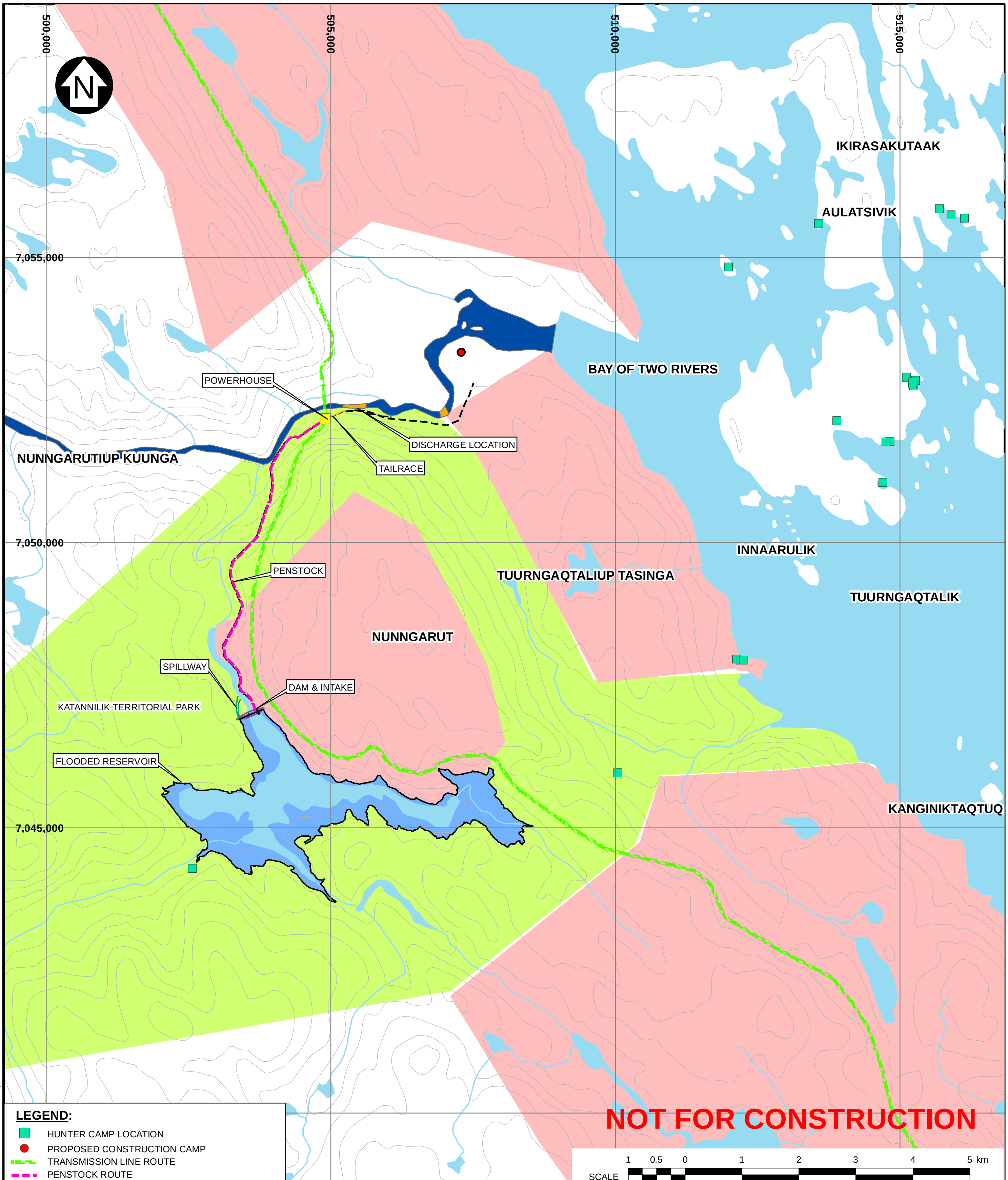

LEGEND:

- HUNTER CAMP LOCATION
- PROPOSED CONSTRUCTION CAMP
- TRANSMISSION LINE ROUTE
- PENSTOCK ROUTE
- TAILRACE
- ACCESS ROAD
- RIVER/STREAM/DRAINAGE
- WATER
- INUIT OWNED LAND - SURFACE ONLY EXCLUDING MINERALS (QIKIQTANI INUIT ASSOCIATION)
- COMMISSIONER'S LAND (GOVERNMENT OF NUNAVUT)
- CROWN LAND (AANDC)
- WINTER POOLS
- RIVER FROZEN TO SUBSTRATE

NOTES:

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REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	12FEB'13	ISSUED WITH REPORT	RAC	SWK	RAC	SRM

QULLIQ ENERGY CORPORATION

IQALUIT HYDROELECTRIC PROJECT

ARMSHOW SOUTH LAYOUT
OPERATIONS PHASE

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FIGURE 1.5 | REV 0

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It will be necessary to bring equipment and materials to each project location by barge. Barge landings have been identified at both project sites that will allow barges to be brought in during high tide and beached (see the construction phase layouts presented as Figures 1.2 and 1.4 for the Jaynes Inlet and Armshow South sites, respectively).

A temporary construction camp will be established at each location. Construction laydown areas will be established as well as access roads and trails to support construction and operation.

Construction crews will likely work either 4-week on / 2-week off or 6-week on / 2-week off work rotations, and all crew changes from Iqaluit will be by helicopter. Most of the civil works will be concentrated during the brief summer period. As such, the timing of civil and concrete works drives the overall construction schedule.

To the maximum extent possible, the transmission line will be constructed using winter trails. Where this is not possible, helicopters will be utilized.

1.4 QULLIQ ENERGY CORPORATION

1.4.1 Background

QEC is a Crown Corporation wholly owned by the Government of Nunavut (GN). The Corporation was originally established in 2001 as the Nunavut Power Corporation under the *Nunavut Power Utilities Act*. It was renamed Qulliq Energy Corporation in 2003. The *Nunavut Power Utilities Act* was also renamed the *Qulliq Energy Corporation Act* as the result of legislation passed in March of 2003. This legislation also broadened the Corporation's mandate to address a range of energy use and conservation issues within Nunavut.

QEC generates and distributes electrical energy to Nunavummiut through the operation of twenty-six diesel generation plants in twenty-five communities. QEC also provides mechanical, electrical and line maintenance from three regional centres. Billings and the Corporation's Human Resource and Financial activities are based out of offices in Baker Lake.

Qulliq Energy attends to the overall objectives provided by legislation, supports the Minister responsible for the Qulliq Energy Corporation on intergovernmental issues, has the mandate to manage the capital projects of the Corporation, and respond to issues of alternative generation sources. Through the Nunavut Energy Secretariat, the Corporation also supports the mandate of the Minister of Energy.

The Corporation's vision is to provide to the communities of Nunavut safe, reliable, sustainable and economical energy supply and service. QEC's plan to achieve this vision is based on an empowered and accountable workforce, which is representative of Nunavut's population and reflective of Inuit societal values, Inuit Qaujimajatuqangit and Tamapta.

1.4.2 Mission Statement

The Corporation's Mission Statement is as follows:

QEC provides safe, reliable and efficient electricity and plans long term affordable energy for Nunavummiut.

The Values included within the Mission Statement are:

- *Safety* is and will continue to be the Corporation's first priority. This fact is communicated to the Corporation's employees clearly and consistently.
- *Reliability* is second only to safety. The focus of the Corporation's day to day operations is the provision of safe and reliable service to customers.
- *Efficiency* is applicable to all of the Corporation's operational and administrative activities. Efficiency indicates the Corporation's intention to respect the investment in the Corporation made by the people of Nunavut, and to use resources with clear attention to reasonableness and value.

1.4.3 Corporate Structure and Mandate

The GN is the Corporation's sole shareholder, its largest customer, its largest supplier, its ultimate regulator and the source of consumer subsidy regimes. The GN and the Minister responsible for the Qulliq Energy Corporation (the Minister) play a significant role in the Corporation's activities.

The Corporation's Board of Directors is appointed by the Minister and QEC must submit applications for rate changes to the Minister, who may then seek the advice of the Utility Rate Review Council (URRC).

The URRC is created by an act of the same name. Its purpose is to make rate recommendations to the Minister. The Minister determines whether to implement the regulator's recommendation, the Corporation's request, or may instruct that the process begin again.

Since 2005-2006 the Minister has provided to the Corporation an annual Letter of Expectation. The purpose of this letter is to help provide the Board of Directors and the President of QEC direction in defining the priorities and desired outcomes of the Corporation, while reinforcing the importance of the Corporation's relationship with the GN. In the 2011-2012 Letter of Expectation, the Minister outlined his expectation that QEC will pursue renewable energy initiatives, including the development of a hydroelectric facility at Jaynes Inlet.

In 2007, the GN released Ikummatiit: An Energy Strategy for Nunavut (GN, 2007). This strategy focuses on reducing Nunavut's reliance on fossil fuels, finding alternative energy sources, and promoting the efficient use of energy in the territory.

The same mandate has continued into the current government. The most recent mandate from the GN is stated in the aforementioned Tamapta document, and covers the period from 2009 to 2013. The Tamapta Action Plan states that

With our vision set on the future, Nunavut, with its federal and land claims partners, will look at alternative forms of energy to reduce our reliance on fossil fuels.

Therefore, QEC must promote efficient energy use and continue to seek alternatives to diesel fuel for electricity generation, concentrating on renewable energy sources in Nunavut such as hydro, wind and solar power.

1.4.4 Commitment to Tamapta

As a Crown Corporation of the GN, QEC is committed to working with the GN to meet the requirements of its mandate, Tamapta/ᑕᒪᑉᑕ : Building our future together (Tamapta).

Tamapta is based in large part on what Nunavummiut had to say about the Government of Nunavut through the “Qanukkanniq Report Card”, which was conducted in the spring and summer of 2009 and made public on October 1, 2009. The vision of Tamapta looks towards where Nunavummiut and the Territory will be in the next twenty years, and provides the vision of Nunavut in the year 2030.

QEC has developed a multi-year Corporate Plan for the years 2011 to 2016. By stating operational and departmental priorities for the years 2011 and beyond, the Corporate Plan provides operational details for the implementation of Tamapta for the stated six years and beyond.

The Guiding Principles that will bring QEC and the GN to meeting their visions are the same Inuit societal values that have led Nunavummiut and will continue to guide the GN and QEC into the future:

- **Inuuqatigiitsiarniq**: respecting others, relationships and caring for people.
- **Tunnganarniq**: fostering good spirit by being open, welcoming and inclusive.
- **Pijitsirniq**: serving and providing for family and/or community.
- **Aajiiqatigiinniq**: decision making through discussion and consensus.
- **Pilimmaksarniq/Pijariuqsarniq**: development of skills through observation, mentoring, practice, and effort.
- **Piliriqatigiinniq/Ikajuqtigiinniq**: working together for a common cause.
- **Qanuqtuurniq**: being innovative and resourceful.
- **Avatittinnik Kamatsiarniq**: respect and care for the land, animals and the environment.

The priorities set out within Tamapta, which the GN and QEC are committed to supporting are as follows:

- Improve education and training outcomes
- Reduce poverty
- Connect our community
- Increase housing options
- Increase support for culture and the arts
- Help those at risk in our communities
- Support community-based, sustainable economies
- Address social concerns at their roots
- Improve health through prevention
- Enhance our recognition in Canada and the world
- Strengthen the public service

1.4.5 Corporate Contact Information

The corporation's head office is located in Baker Lake. In addition, the corporation operates a corporate and engineering office in Iqaluit. The primary contact for the Project is:

Stephen Kerr, B.Sc.
Director of Engineering
PO Box 250 Iqaluit, Nunavut X0A 0H0
Main Telephone: (867) 979-7540
Hydro Inquiries: hydro@npc.nu.ca

1.5 PROJECT HISTORY

QEC initiated its hydro initiative in the Iqaluit area in 2005. In addition to contracting an engineering firm to undertake a site identification and ranking process, the corporation actively engaged its stakeholders. This stakeholder engagement process included bringing community representatives from Kimmirut, Iqaluit and Pangnirtung to visit an operating hydroelectric facility in Greenland.

A Site Identification and Ranking engineering study was generated in January 2006, which identified a short-list of five projects from a total of 14 projects on 13 rivers located within about a 100 km radius of Iqaluit (Knight Piésold, 2006a). Sites include the Sylvia Grinnell River next to Iqaluit, the McKeand River system towards Pangnirtung, several sites in Cantley Bay and several sites to the southwest of Iqaluit including the Armshow River and Jaynes Inlet. In January 2006, a Phase II pre-feasibility study was generated, which included additional engineering and environmental review of the short-listed five project sites (Knight Piésold, 2006b). In early 2006, QEC also contracted the Water Survey of Canada to install hydrometric stations in most of the identified river systems to collect site-specific streamflow data.

Over the period of 2006 through 2008, QEC undertook a comprehensive review of the short-listed sites. Preliminary environmental baseline and Inuit knowledge studies were undertaken with the objective of identifying key environmental considerations that may influence QEC`s site selection process. This included identifying the potential presence of migrating anadromous (sea run) arctic char and/or intensive land use. The corporation established a hydro committee from local stakeholder groups (see Section 7.2). An owner`s engineer (Manitoba Hydro International) was retained to peer review the pre-feasibility study work and advise QEC on engineering and financial analysis matters. The corporation also actively pursued outside funding for a feasibility study, which is the next step in project development.

In the last quarter of 2008, QEC contracted to have the three years of site-specific streamflow data analyzed at four main river systems (Knight Piésold, 2008a-d). These studies determined that there was considerably more runoff at the Jaynes Inlet and Armshow River systems than was suggested by the long-term streamflow record at the Sylvia Grinnell River.

By late 2008, the QEC had not identified outside funding and, with the global financial crisis, the hydro initiative entered a stage of dormancy. The Minister of Energy`s Letter of Expectation for 2011-12 (Section 1.4.3) restarted the initiative and QEC resumed its activity on the Project. The first step was to update the financial analyses for the Jaynes Inlet and Armshow South projects based on the 2008 hydrological analyses. Updates to the pre-feasibility engineering and financial analyses were completed early in 2011, with independent costing completed by two EPC Contractors: Peter Kiewit Infrastructure of Canada and ISTAK of Iceland (Knight Piésold, 2011). Following this, the corporation made plans to `self-fund` the feasibility study by deferring planned capital expenditures. The feasibility study was initiated in the last quarter of 2012.

1.6 PROJECT NEED AND PURPOSE

The largest item in QEC's current budget is fuel. All fuel is purchased through the Petroleum Products Division (PPD) of the GN Department of Community and Government Services. About half of this is purchased and stored by the corporation using PPD as the agent, paying "off the boat" prices. The other half is purchased from PPD throughout the year at GN-set prices. The combination of these purchasing methods in each community depends on the existence or locations of pipelines and the storage capacity of tanks.

Fuel prices in Nunavut are dependent on the price of crude oil on world markets and the American versus Canadian foreign exchange rate. Fuel prices spiked in 2007, leading the corporation to pay higher prices for the fuel purchased "off the boat". The Fuel Stabilization Rider was increased to 12.52 cents per kWh in November of 2008 in order to recuperate some of the incurred costs due to the global fuel price spike. The Fuel Stabilization Rider is at 4.13 cents per kWh as of December 2012.

In the longer term, higher or fluctuating fuel prices will make alternatives to diesel generation increasingly viable across Nunavut. Even though this may create a stressful transition, the long term diversity of generation and supply will eventually have a positive impact of fuel pressures, both economic and environmental.

QEC continues to operate in a time of significant load growth. Across Nunavut, government departments and municipalities are mobilizing to provide improved infrastructure to Nunavummiut. The Corporation is working hard to keep up with load growth with limited financial and personnel resources. The economies of scale, a limited revenue stream from a small customer base, and short shipping and construction windows make it difficult to maintain or expand QEC's infrastructure to meet growing customer demand.

Load growth in each of the respective Nunavut Regions has been significant and is forecast to continue into the foreseeable future. Load growth for the 20 year period from 1998/99 to 2019/20 is between 2% and 2.5% per year in each of the Regions. Growth within the Qikiqtaaluk Region is being driven by growth in the population of Iqaluit. The historic and predicted growth in electricity load for the City of Iqaluit is discussed in the following section.

1.7 DEVELOPMENT SCHEDULE

The target dates for key milestones in the development process of the Jaynes Inlet site are presented in Table 1.2. A more detailed development schedule is presented as Figure 1.6.

Table 1.2 Jaynes Inlet High Level Development Schedule

Date	Activity/Milestone
February 2013	Submit Project Description and core permit applications to NIRB
April to September 2013	Carry out supplemental baseline studies
June 2013 to May 2014	Complete feasibility study, including geotechnical investigations in summer 2013
January 2014	Receive final EIS guidelines from NIRB
May 2014	Submit Draft EIS to NIRB
May 2015	Receive Project Certificate from NIRB; sign Inuit Impact and Benefit Agreement (IIBA)
February to July 2015	Detailed Design
September 2015	Receive Type A Water Licence and other permits; award construction contract
January to June 2016	Procurement and mobilization
June to Oct (2016, 2017, 2018)	On-site construction
Fall 2018	Commissioning and commence operation of the Jaynes Inlet hydroelectric facility

The development of the Armshow South site will eventually follow a similar progression, when the energy requirements of Iqaluit grow to the point where most of the power generated by that facility can be sold. This is discussed further in relation to the electricity load forecast in Section 2.7.

1.8 REGULATORY CONTEXT

The regulatory process in Nunavut is established primarily under the Nunavut Land Claims Agreement (NLCA). Table 1.3 lists the federal and territorial legislation and guidelines applicable to the Project.

Figure 1.6 presents the major steps in the regulatory approvals process (environmental assessment and permitting) as well as target timeframes in relation to the Jaynes Inlet development schedule.

Conformance with Land Use Plans

The Nunavut Planning Commission (NPC) was established under Article 11 of the NCLA. The NPC reviews development proposals to ensure conformity with approved land use plans (where plans exist). The Project is located in the South Baffin Planning Region, which has no approved land use plan in place. The NPC has been conducting community consultations on a Draft Nunavut Land Use Plan (NPC, 2012), but the plan has not yet received Ministerial approval.

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FIGURE 1.6
QULLIQ ENERGY CORPORATION
IQALUIT HYDROELECTRIC PROJECT

PROJECT DEVELOPMENT SCHEDULE

ID	Task Name	Duration	Start	Finish	Predecessors
1	**QEC EXECUTIVE DECISIONS**	**648 days**	**5/6/2014**	12/2/2015	
2	Investigate Project Financing Options	30 days	5/6/2014	6/1/2014	28
3	Owner/investor Review of Feasibility Study	60 days	6/1/2014	7/24/2014	2
4	Proceed with Engineering Design and Construction	0 days	12/2/2015	12/2/2015	45,3,56
5	**SUPPLEMENTAL BASELINE STUDIES**	**297 days**	**4/12/2013**	**12/31/2013**	
6	Late Winter Aquatic Program	10 days	4/12/2013	4/20/2013	
7	Summer Aquatic Program	86 days	7/1/2013	9/15/2013	
8	Terrestrial Baseline Studies	74 days	6/3/2013	8/7/2013	
9	Baseline Reporting	164 days	8/8/2013	12/31/2013	
10	**FEASIBILITY STUDY**	**709 days**	**8/14/2012**	**5/6/2014**	
11	Site Visit by Project Team	5 days	9/17/2012	9/21/2012	
12	Phase 1 Geotechnical Investigations	31 days	9/17/2012	10/14/2012	
13	Update Hydrology	60 days	8/15/2012	10/7/2012	
14	Confirm In stream Flow Requirements	45 days	10/7/2012	11/16/2012	13
15	Update Load forecast	9 days	8/14/2012	8/21/2012	
16	Confirm Facility Geometries and Locations	60 days	11/12/2012	1/4/2013	15
17	Project Summary Report	54 days	1/4/2013	2/21/2013	13,14,15,16
18	Geotech Drilling - Late Winter	79 days	4/1/2013	6/10/2013	
19	Geotech Drilling - Summer	69 days	7/1/2013	8/31/2013	
20	Geotechnical Testing and Reporting	102 days	9/1/2013	11/30/2013	18,19
21	Site Visits During Field Program	69 days	7/1/2013	8/31/2013	
22	Hydrology Update (2012+2013 flows)	33 days	11/1/2013	11/30/2013	19,21
23	Engineering Design Updates	68 days	12/1/2013	1/30/2014	22
24	Energy Model Updates	18 days	1/30/2014	2/15/2014	23
25	Cost Estimate Updates	31 days	2/15/2014	3/15/2014	24
26	Financial Analysis	17 days	3/15/2014	3/30/2014	25
27	Draft Feasibility Study Report	34 days	3/31/2014	4/30/2014	26
28	Final Feasibility Study Report	0 days	4/30/2014	4/30/2014	27
29	**ENVIRONMENTAL ASSESSMENT**	**1089 days**	**2/14/2013**	10/10/2015	
30	Submit Project Description and Applications	0 days	2/21/2013	2/21/2013	
31	NPC Conformity Check (no approved land use plan)	20 days	2/27/2013	3/16/2013	30
32	NIRB Screening and Recommendations to Minister	60 days	3/16/2013	5/9/2013	31
33	Minister's Decision on Process (not a fixed timeline)	100 days	5/9/2013	8/5/2013	32
34	Scoping Meetings for NIRB Part 5 Environmental Review	60 days	8/6/2013	9/28/2013	33
35	NIRB/NWB Prepare Draft EIS Guidelines	60 days	9/28/2013	11/20/2013	34
36	Public Review of Draft EIS Guidelines	45 days	11/20/2013	12/30/2013	35

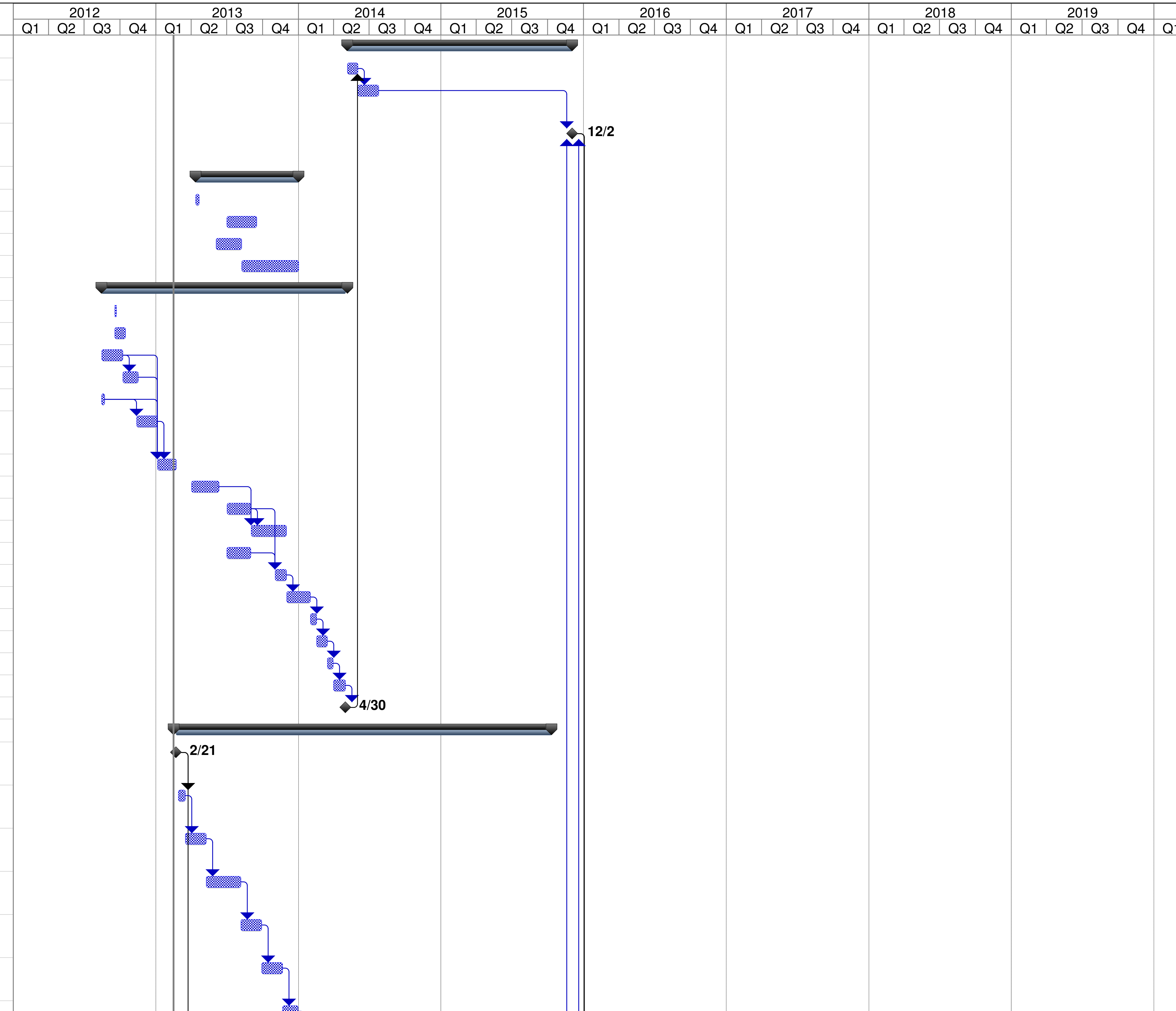

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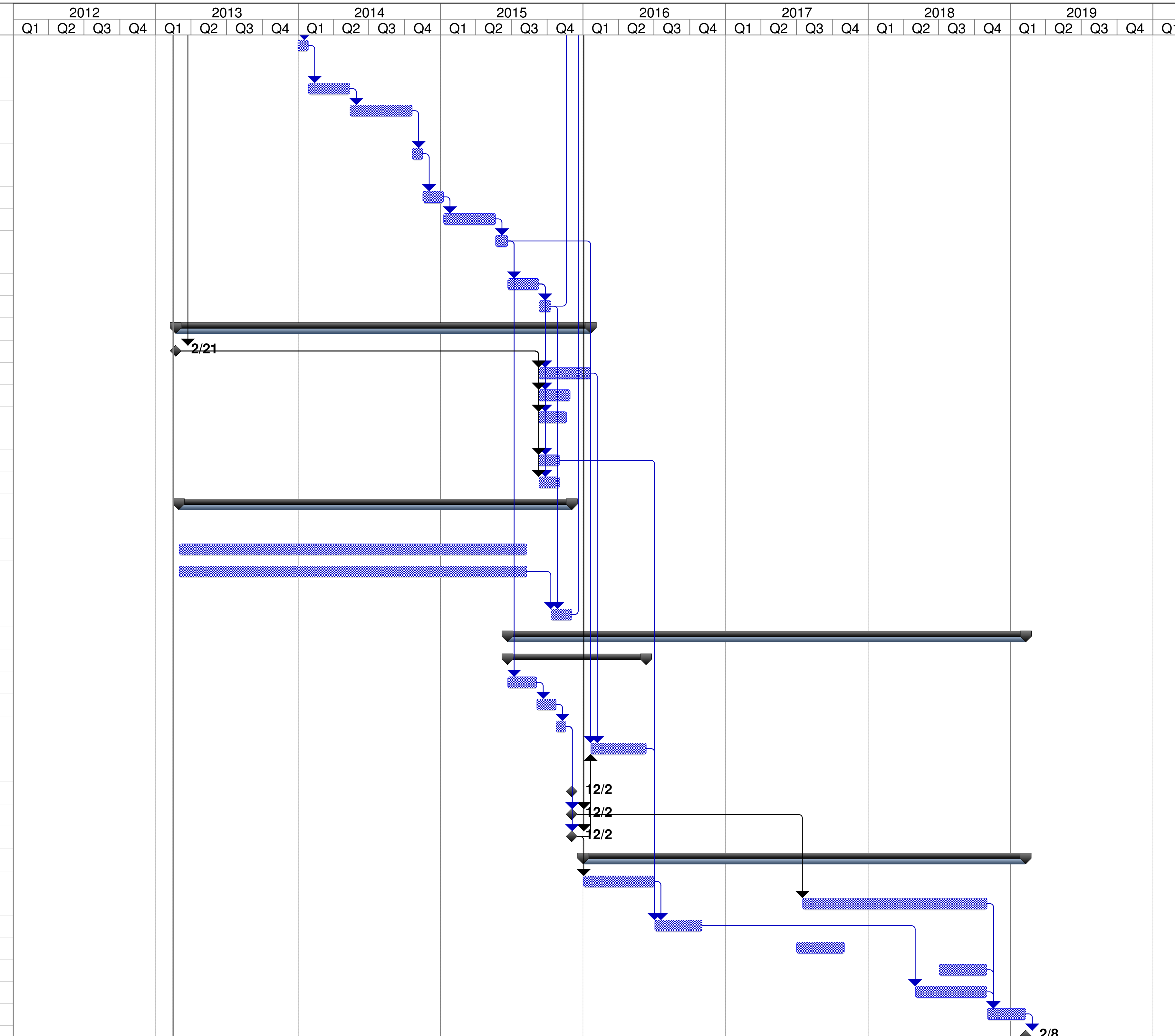
FIGURE 1.6
QULLIQ ENERGY CORPORATION
IQALUIT HYDROELECTRIC PROJECT

PROJECT DEVELOPMENT SCHEDULE

ID	Task Name	Duration	Start	Finish	Predecessors
37	NIRB/NWB Finalize and Issue Final EIS Guidelines	30 days	12/30/2013	1/26/2014	36
38	Prepare and Submit Draft EIS	120 days	1/26/2014	5/12/2014	37
39	Review of Draft EIS (Irs, Tech Review, Meetings, Pre-hearing, Conference)	180 days	5/13/2014	10/19/2014	38
40	NIRB Provides Direction to QEC for Final EIS	30 days	10/20/2014	11/15/2014	39
41	Prepare and Submit Final EIS	60 days	11/15/2014	1/7/2015	40
42	Final EIS Review and Hearings	150 days	1/8/2015	5/21/2015	41
43	NIRB Issues Decision and Recommendation to Minister	35 days	5/21/2015	6/21/2015	42
44	Federal Minister Issues Approval	90 days	6/21/2015	9/9/2015	43
45	NIRB Issues Project Certificate	35 days	9/9/2015	10/10/2015	44
46	**PERMITTING**	**1197 days**	**2/21/2013**	1/20/2016	
47	Submit Core Permit Applications	0 days	2/21/2013	2/21/2013	30
48	Water License Process	150 days	9/9/2015	1/20/2016	47,44
49	Obtain DFO Fisheries Authorizations	90 days	9/9/2015	11/28/2015	47,44
50	Finalize Leases, Right of Way, Order-in-Council	80 days	9/9/2015	11/19/2015	47,44
51	Quarry and Borrow Permits	60 days	9/9/2015	11/1/2015	47,44
52	Navigable Waters Approval	60 days	9/9/2015	11/1/2015	47,44
53	**LAND NEGOTIATIONS AND COMPENSATIONS**	**1133 days**	3/1/2013	12/3/2015	
54	Negotiate IIBA	1003 days	3/1/2013	8/9/2015	
55	Negotiate Water Compensation Agreement	1003 days	3/1/2013	8/9/2015	
56	Finalize IIBA	60 days	10/10/2015	12/2/2015	55,45
57	**ENGINEERING AND CONSTRUCTION**	**1495 days**	**6/21/2015**	**2/9/2019**	
58	**Engineering Design**	**400 days**	**6/21/2015**	**6/10/2016**	
59	Preparation of Tender	84 days	6/21/2015	9/4/2015	43
60	Tender Period	56 days	9/4/2015	10/23/2015	59
61	Evaluation of Tenders	28 days	10/23/2015	11/17/2015	60
62	Detailed Design, including Rebar Drawings	160 days	1/20/2016	6/10/2016	43,65,48
63	**Procurement**	**0 days**	**12/2/2015**	**12/2/2015**	
64	Award Water-to-Wire Contract	0 days	12/2/2015	12/2/2015	61,4
65	Award Civil Contract	0 days	12/2/2015	12/2/2015	61,4
66	**Construction**	**1276 days**	**1/1/2016**	**2/8/2019**	
67	Mobilization	205 days	1/1/2016	7/1/2016	65
68	Water-to-Wire Supply & Installation	532 days	7/16/2017	11/1/2018	64
69	Civil Construction - Season 1	137 days	7/2/2016	10/31/2016	67,51,62
70	Civil Construction - Season 2	138 days	7/1/2017	10/31/2017	
71	Civil Construction - Season 3	138 days	7/1/2018	10/31/2018	
72	Reservoir Filling	206 days	5/1/2018	10/31/2018	69
73	Installation and Commissioning	112 days	11/1/2018	2/8/2019	68,71,72
74	Commercial Operation Date (COD)	0 days	2/8/2019	2/8/2019	73



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Nunavut Environmental Assessment

Under Article 12 of the NLCA, a Project Certificate issued by the Nunavut Impact Review Board (NIRB) is required to allow the Project to proceed. The NIRB was established under Article 12 of the NLCA to:

- Screen project proposals to determine whether a review is required
- Gauge and define the extent of the regional impacts of a project
- Review the ecosystemic and socio-economic impacts of project proposals
- Determine whether project proposals should proceed, specify the terms and conditions and then report its decision to the Minister of AANDC
- Monitor projects in accordance with Part 7 of Article 12 of the NLCA

Bill C-47 contains the proposed Nunavut Planning and Project Assessment Act (NPPAA), which outlines the process for land use planning and environmental assessment in Nunavut. Bill C-47 completed first reading in the House of Commons on November 6, 2012. The content of the proposed NPPAA within Bill C-47 appears to resemble NLCA Article 12.

The steps in the environmental assessment are presented in the detailed development schedule (Figure 1.6), based on QEC's understanding and assumptions about the process. These are summarized as follows:

- Core permit applications and a Project Description/Project Proposal will be submitted to authorizing agencies and to NIRB
- NIRB will consult NPC on land use planning. In the absence of an approved land use plan, the Project will be referred back to NIRB for screening.
- Screening by NIRB - QEC anticipates, based on decisions on projects of a similar scale, that NIRB will recommend to the AANDC Minister that the Project be subject to an environmental review under Part 5 or Part 6 of Article 12 of the NLCA
- Minister refers the Project to a Part 5 review by NIRB (or possibly, a Part 6 review by a federal panel)
- NIRB carries out project scoping, and develops draft and then final EIS guidelines
- The proponent prepares and submits a draft EIS that meets the guideline requirements
- NIRB conducts a conformity review to determine if the draft EIS meets the requirements of the EIS guidelines
- NIRB carries out a step where the public and review agencies submit information requests and the proponent is asked to provide the requested information
- A public technical review period is conducted, followed by a technical meeting between the proponent and review agencies
- A pre-hearing conference is held shortly after the technical meetings where review agencies present the key outstanding issues to the NIRB Board
- A pre-hearing conference report is issued by NIRB summarizing the outcome of the technical review on the Draft EIS, and providing direction to the proponent on issues to be addressed in the Final EIS
- The proponent revises the Draft EIS to meet the requirements of the PHC report and issues its Final EIS

TABLE 1.3

APPLICABLE ACTS, REGULATIONS AND GUIDELINES

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Act	Regulation	Responsible Agency	Guideline
FEDERAL			
Aeronautics Act, [R.S. 1985, c. A-2]	Canadian Aviation Regulations, [SOR/96-433]	TC-Civil Aviation	
Arctic Waters Pollution Prevention Act [R.S.C. 1985, c. A-12]	Arctic Waters Pollution Prevention Regulations [C.R.C., c.345]	TC-Marine Safety	Guidelines for the Operation of Tankers and Barges in Canadian Arctic Waters (Interim)
	Arctic Shipping Pollution Prevention Regulations		Arctic Ice Regime Shipping System Standards; Arctic Waters Oil Transfer Guidelines
Canada Shipping Act 2001 [2001, c.26]	Ballast Water Control and Management Regulations SOR/2006-129	TC-Marine Safety	A Guide to Canada's Ballast Water Control and Management Regulations
	Anchorage Regulations SOR/88-101		
	Oil Pollution Prevention Regulation		
	Response Organization and Oil Handling Facilities Regulation		
Canada Transportation Act [1996, c. 10]	Handling of Carloads of Explosives on Railway Trackage Regulations SOR/79-15	TC	
	Railway Employee Qualification Standards Regulations SOR/87-150		
	Railway Prevention of Electric Sparks Regulations SOR/82-1015		
	Railway Third Party Liability Insurance Coverage Regulations SOR/96-337		
	Railway Traffic Liability Regulations		
	Railway Service Equipment Cars Regulations SOR/86-922		
Canada Marine Act 1998, c. 10	Natural and Man-made Harbour Navigation and Use Regulations SOR/2005-73	TC	
	Port Authorities Management Regulations		
	Port Authorities Operations Regulations SOR/2000-55		
	Seaway Property Regulations SOR/2003-105		
Canada Water Act, [R.S.C. 1985, c. C-11]		EC	
Canada Wildlife Act (R.S., 1985, c. W-9)	Wildlife Area Regulations (C.R.C., c. 1609)	EC	
Canadian Environmental Protection Act 1999, [1999, c.33]	Environmental Emergency Regulations [SOR/2003-307]	EC	CCME Canada Wide Standards for Dioxins and Furans CCME Canada Wide Standards for Mercury Emissions Health Canada Federal Contaminated Sites Guidance on Human Health Risk Assessment in Canada
	Federal Registration of Storage Tank Systems for Petroleum Products and Allied Petroleum Products on Federal Lands or Aboriginal Lands Regulations (SOR/97-10)		
	Fuels Information Regulations, No. 1 (SOR/C.R.C., c. 407)		
	Interprovincial Movement of Hazardous Waste Regulations (SOR/2002-301)		
	Sulphur in Diesel Fuel Regulations (SOR/2002-254)		
	Sulphur in Gasoline Regulations (SOR/99-236)		
	Proposed - Interprovincial Movement of Hazardous Waste and Hazardous Recyclable Material Regulations		
	Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations		
	Proposed - Regulations Amending the Environmental Emergency Regulations		www.ec.gc.ca/CEPARegistry/guidelines

TABLE 1.3

APPLICABLE ACTS, REGULATIONS AND GUIDELINES

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Act	Regulation	Responsible Agency	Guideline
Dominion Water Power Act (R.S.C., 1985, c. W-4)	Dominion Water Power Regulations (C.R.C., c. 1603)	AANDC	
	Expropriation Fees Regulations (SOR/2000-142)		
Explosives Act [R.S.C. 1985, c. E-17]	Ammonia Nitrate and Fuel Order, [C.R.C., c. 598]	NRCan	
	Explosives Regulations [C.R.C., c. 599]		
Fisheries Act [R.S.C. c. F-14]	Metal Mining Effluent Regulations, [SOR/ 2002-2222]	DFO/EC	DFO Policy for the Management of Fish Habitat; Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters; DFO - Freshwater Intake End-of-Pipe Fish Screen Guideline; DFO-Habitat Conservation and Protection Guidelines, 1998; Various DFO Operational Statements
Marine Transportation Security Act (R.S. 1994, c.40)	Marine Transportation Security Regulations (SOR/2004-144)	TC-Marine Safety	
Migratory Birds Convention Act 1994 [1994, c.22]	Migratory Bird Sanctuary Regulations, [C.R.C., c.1036]	EC	
	Migratory Birds Regulations, [C.R.C., c.1035]		
Navigable Waters Protection Act [R.S. 1985, c. N-22]	Navigable Waters Bridges Regulations (C.R.C., c. 1231)	TC - NWPP	
	Navigable Waters Works Regulations (C.R.C., c. 1232)		
Nunavut Act [1993, c. 28]	Nunavut Archaeological and Paleontological Sites Regulations, [SOR/2001-220]	GN-Culture and Heritage	
Nunavut Land Claims Agreement		NTI	A Guide to Mineral Exploration and Development on Inuit Owned Lands in Nunavut
NLCA Article 12-Development Impact		NIRB	
NLCA Article 13-Water Management		NWB	
NLCA Article 26-Inuit Impact Benefit Agreement		DIO	
NLCA Article 6-Wildlife Compensation			
NLCA Article 20-Inuit Water Rights		NWB/DIO	
NLCA Article 21-Entry and Access Part 4			
Proposed Nunavut Planning and Project Assessment Act	Passed first reading as part of Bill C-47 on November 6, 2012	AANDC	
Nunavut Waters and Nunavut Surface Rights Tribunal Act [2002, c.10]	*Proposed* Nunavut Waters Regulations - Draft Nunavut Waters Regulations issued and reviewed by technical meeting/pre-hearing conference in late 2011. NWB expects the draft regulations to be passed into legislation by the end of 2012.	AANDC	
Species At Risk Act [2002, c.29]		EC	Species at Risk Act: A Guide
Territorial Lands Act [R.S. 1985, c. T-7]	Northwest Territories and Nunavut Mining Regulations, [C.R.C., c. 1516]	AANDC	INAC Mine Site Reclamation Policy for Nunavut (INAC, 2002); Mine Site Reclamation Guidelines for the Northwest Territories (INAC, 2007)
	Territorial Land Use Regulations, [C.R.C., c. 1524]		
	Territorial Quarrying Operations, [C.R.C., c. 1527]		
	Northwest Territories Mining District and Nunavut Mining District Order		
Transportation of Dangerous Goods Act [1992, c.34]	Transportation of Dangerous Goods Regulations	TC	

TABLE 1.3

APPLICABLE ACTS, REGULATIONS AND GUIDELINES

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Act	Regulation	Responsible Agency	Guideline
TERRITORIAL			
Apprenticeship, Trade and Occupations Certification Act [R.S.N.W.T. 1988, c. A-4]	Apprenticeship, Trade and Occupations Certification Regulations, R.R.N.W.T. 1990 c. A-8	ED&T	
	Occupation Designation Order, N.W.T. Reg. 026-96		
	Trade Advisory Committees Order, R.R.N.W.T. 1990 c. A-9		
	Trade Designation Order, R.R.N.W.T. 1990 c. A-10		
Boilers and Pressure Vessels Act, [R.S.N.W.T. 1988, c. B-2]	Boilers and Pressure Vessels Regulations, N.W.T. Reg. 006-93	WSCC	
Child and Family Services Act[R.S.N.W.T. 1997, c. 13]	Child and Family Services Regulations, N.W.T. Reg. 142-98	HSS	
Commissioner's Land Act (Nunavut), [R.S.N.W.T. 1988, c C-11]	Commissioner's Airport Lands Regulations, N.W.T. Reg. 067-97	CG&S	
	Commissioner's Land Regulations, R.R.N.W.T. 1990 c. C-13		
Electrical Protection Act [R.S.N.W.T. 1988, c. E-3]	Electrical Protection Regulations, R.R.N.W.T. 1990 c. E-21	WSCC	
Environmental Protection Act (Nunavut), [R.S.N.W.T. 1988, c. E-7]	Spill Contingency Planning and Reporting Regulations, N.W.T. Reg. 068-93	DOE	Spill Contingency planning and reporting in Nunavut: A Guide to the new regulations
	Asphalt Paving Industry Emission Regulations, R.R.N.W.T. 1990 c. E-23	DOE	Government of Nunavut (GN) Environmental Guidelines for: Site Remediation; Management of Waste Lead and Lead Paint; Air Quality Sulphur Dioxide and Suspended Particulates; Dust Suppression; General Management of Hazardous Waste; Industrial Waste Discharges; Waste Antifreeze; Waste Asbestos; Waste Batteries; Waste Paints; Waste Solvents
Emergency Medical Aid Act, [R.S.N.W.T. 1988, c. E-4]		HSS	
Explosives Use Act, R.S.W.N.T. 1988, c.E-10	Explosives Regulations, R.R.N.W.T. 1990 c. E-27	WSCC	
Fire Prevention Act, R.S.N.W.T. 1988, c. F-6	Fire Prevention Regulations, R.R.N.W.T. 1990 c. F-12	CG&S	
	Propane Cylinder Storage Regulations, N.W.T. Reg. 094-91	WSCC	
Gas Protection Act, [R.S.N.W.T. 1988, c. G-2]	Gas Protection Regulations, R.R.N.W.T. 1990 c. G-1	CG&S	
Hospital Insurance and Health and Social Services Administration Act, [R.S.N.W.T. 1988, c. T-3]	Baffin Regional Health and Social Services Board Order, N.W.T. Reg. 059-98	HSS	
	Hospital Standards Regulations, R.R.N.W.T. 1990 c. T-6	HSS	
	Territorial Hospital Insurance Services Regulations, R.R.N.W.T. 1990 c. T-12	HSS	
Liquor Act, R.S.N.W.T. 1988, c. L-9	***Various general and community specific regulations and orders***	CG&S	
Mine Health and Safety Act, [S.N.W.T 1994, c.25]	Mine Health and Safety Regulations, [R-125-95]	WSCC	
	Mine Health and Safety Regulations, amendment, Nu. Reg. 016-2003	WSCC	

TABLE 1.3

APPLICABLE ACTS, REGULATIONS AND GUIDELINES

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Act	Regulation	Responsible Agency	Guideline
Public Health Act, R.S.N.W.T. 1988, c. P-12	Camp Sanitation Regulations, R.R.N.W.T. 1990 c. P-12	HSS	
	General Sanitation Regulations, R.R.N.W.T. 1990 c. P-16	HSS	
	Public Water Supply Regulations, R.R.N.W.T. 1990 c. P-23	HSS	
	Public Sewerage Systems Regulations, R.R.N.W.T. 1990 c. P-22	HSS	
Safety Act, R.S.N.W.T. 1988, c. S-1	Asbestos Safety Regulations, N.W.T. Reg. 016-92	WSCC	
	General Safety Regulations, R.R.N.W.T. 1990 c. S-1	WSCC	
	General Safety Regulations, amendment, Nu. Reg. 021-2000	WSCC	
	Safety Forms Regulations, N.W.T. Reg. 102-91	WSCC	
	Silica Sandblasting Safety Regulations, N.W.T. Reg. 015-92	WSCC	
	Work Site Hazardous Materials Information System Regulations, R.R.N.W.T. 1990 c. S-2	WSCC	
Scientists Act [R.S.N.W.T. 1988, c. S-4]	Scientists Act Administration Regulations, N.W.T. Reg. 174-96	Nunavut Arctic College	
Transportation of Dangerous Goods Act [R.S.N.W.T. 1988, c. 81 (Supp.)]	Transportation of Dangerous Goods Regulations, 1991, N.W.T. Reg. 095-91	DOE	
Wildlife Act, [R.S.N.W.T. 1988, c. W-4]	Wildlife General Regulations, N.W.T. Reg. 026-92	DOE	
	Critical Wildlife Areas Regulations, R.R.N.W.T. 1990 c. W-3	DOE	
	Polar Bear Defence Kill Regulations, N.W.T. Reg. 037-93	DOE	
	Wildlife Management Barren-Ground Caribou Areas Regulations, N.W.T. Reg. 099-98	DOE	
	Wildlife Management Grizzly Bear Areas Regulations, N.W.T. Reg. 155-96	DOE	
	Wildlife Management Muskox Areas Regulations, R.R.N.W.T. 1990 c. W-11	DOE	
	Wildlife Management Polar Bear Areas Regulations, R.R.N.W.T. 1990 c. W-13	DOE	
	Wildlife Sanctuaries Regulations, R.R.N.W.T. 1990 c. W-20	DOE	
	Wildlife Preserves Regulations, R.R.N.W.T. 1990 c. W-18	DOE	
Workers' Compensation Act, R.S.N.W.T. 1988, c. W-6	Workers' Compensation General Regulations, R.R.N.W.T. 1990 c. W-21	WSCC	

I:\1\03\00137\08\A\Report\Report 1 Rev 0 Project Proposal\Tables\[Table 1.3 Rev 0 - Acts, Regs and Guidelines.xlsx]Acts, Regs and Guides

NOTES:

1. ABBREVIATIONS:

CG&S - DEPARTMENT OF COMMUNITY AND GOVERNMENT SERVICES; DOE - DEPARTMENT OF ENVIRONMENT; ED&T - DEPARTMENT OF ECONOMIC DEVELOPMENT AND TRANSPORTATION; HSS - DEPARTMENT OF HEALTH AND SOCIAL SERVICES; WSCC - WORKER'S SAFETY & COMPENSATION COMMISSION.

- A similar process of IRs, technical review, and technical meeting are carried out on the Final EIS
- Final Hearings are held on the Final EIS
- NIRB issues a Final Hearing Report with a recommendation to the AANDC Minister to approve the Project, subject to various conditions included in the Final Hearing Report
- The AANDC Minister approves the Project
- NIRB holds a Project Certificate meeting with the proponent and review agencies in preparation for issuing a Project Certificate
- The Project Certificate is issued to the proponent

Once the Project Certificate has been issued, the various permits can be obtained.

Inuit Impact and Benefit Agreement

Article 26 of the NLCA requires the finalization of an IIBA before commencement of a Project that is wholly or partially located on Inuit Owned Lands (IOL). The Project is partially located on IOL.

Water Compensation Agreement

Article 20 of the NLCA requires that a compensation agreement be entered into with the designated Inuit organization (DIO, in this instance the QIA), if a project is expected to substantially affect the quality, quantity or flow of water on IOL.

Permits, Approvals and Licences

After completion of the environmental review process and once NIRB has issued a Project Certificate, all other required authorizations can then be issued. The Project Certificate is considered an authorization against which NIRB will monitor the Project for compliance with conditions in the certificate. The following additional authorizations are anticipated to be required:

- Type A Water licence (NWB)
- Land Lease for the hydroelectric facility located on Crown land (AANDC)
- Easement for the transmission line located on Crown Land (AANDC)
- Quarry permits or licences for aggregate sources (AANDC and/or QIA)
- Authorization under the *Fisheries Act* for Harmful Alteration, Disruption or Destruction (HADD) of fish or fish habitat
- Possible approval under the *Navigable Waters Protection Act*

Table 1.4 presents the project activities and estimated project development areas by landowner. The area estimates in this table were the basis for calculating permit application fees.

Research Permits

Regulations require permits and licences to be obtained to carry out scientific research as part of environmental and socio-economic baseline studies. These licences and permits include:

- A Scientific Licence from the Nunavut Research Institute (Nunavut`s *Scientists Act*) to carry out non-biological land and water research, as well as socio-economic and traditional knowledge studies

Table 1.4 Project Activities and Areas by Land Ownership

Land Ownership	Area (ha)	Activities	
		Construction	Operation
Park Land	19.9	Transmission lines between Jaynes Inlet and Iqaluit	Transmission lines between Jaynes Inlet and Iqaluit and maintenance
	47.7	Armshow South facility (powerhouse, penstock and dam)	Armshow South facility (powerhouse, penstock and dam)
	352.8	-	Armshow South storage reservoir operation
Inuit Owned Land (IOL)	70.6	Armshow South construction camp	-
	152.4	Jaynes Inlet construction camp	-
	225.2	Transmission lines between both sites and Iqaluit	Transmission lines between both sites and Iqaluit and maintenance
	29.9	Jaynes Inlet quarry	-
	47.6	Jaynes Inlet facility (powerhouse, penstock and tailrace)	Jaynes Inlet facility (powerhouse, penstock and tailrace)
	17.5	Armshow South facility (penstock)	Armshow South facility (penstock)
Crown Land	67.7	Transmission lines between both sites and Iqaluit	Transmission lines between both sites and Iqaluit and maintenance
	51.0	Jaynes Inlet quarry	-
	28.5	Armshow South quarry	-
	42.5	Jaynes Inlet facility (dam and penstock)	Jaynes Inlet facility (dam and penstock)
	191.4	-	Jaynes Inlet storage reservoir operation

NOTES:

1. ASSUMED 100 m BETWEEN DAM AND POWERHOUSE AND 30 m RIGHT-OF-WAY FOR TRANSMISSION LINES FOR FOOTPRINT CALCULATIONS DURING CONSTRUCTION AND OPERATION.
2. FOOTPRINTS OF CONSTRUCTION CAMPS AND LAYDOWN AREAS APPLIED TO ACTIVITIES DURING THE CONSTRUCTION PHASES ONLY.

- A Licence to Fish for Scientific Purposes from the Department of Fisheries and Oceans Canada (*Fisheries Act*) to conduct fish and fish habitat related studies including the capture of fish and invertebrates
- A Wildlife Research Permit from the Department of Environment, Government of Nunavut (Nunavut`s *Wildlife Act*) to carry out wildlife surveys on the Project
- An Archaeological Permit from the Department of Culture, Government of Nunavut (Archaeological and Paleontological Site Regulations, *Nunavut Act*) to carry out archaeological surveys of the study areas

QEC submitted the above research permits in late 2012 to allow geotechnical investigations and environmental baseline studies to proceed over the period of April through September 2013. These studies are required to support completion of a feasibility study and the preparation of a Draft Environmental Impact Statement.

2 – DESIGN BASIS

2.1 GENERAL DESIGN APPROACH

All engineering design will be carried out using the International System of Units (SI), e.g. force expressed in kN, stress in MPa, deflections in mm, etc., and will use a Limit States Design approach considering defined hazard categories. All project components will be designed in accordance with good utility practice and in accordance to Design Codes, where such codes exist.

2.2 FACILITY CLASSIFICATION AND DESIGN LEVEL DEFINITION

The design life of the facility is 40 years. Typically, hydroelectric infrastructure lasts well beyond its design life with adequate maintenance.

For the powerhouse, the building classification per National Building Code of Canada (NBCC; NRCan, 2010) Division B: Part 3 is: Low hazard industrial occupancy, Group F, Division 3.

The following design level definitions have been adopted for the design:

- Operation: All levels below design basis for which facility functions normally whether in operation or not.
- Design Basis: Limit of expected normal function and performance of facility - no major damage to facility but minor interruption may result in the case of seismic and flood event.
- Maximum Credible: Loss of equipment possible and major damage to structures may occur. Structures do not collapse and major components can be repaired or replaced.

The hazard events for the above three levels are defined by the following return periods (Table 2.1):

Table 2.1 Hazard Event Return Periods

Hazard	Return Period (Years)		
	Operation	Design Basis	Maximum Credible
Flood	0 - 499	500	1,000
Earthquake	100	475 or 2,475 (1)	(2)
Snow Avalanche(3)	30	50	100
Wind	30	1.5 x 30 year values	N/A(4)

NOTES:

1. A RETURN PERIOD OF 2475 YEARS WILL BE ASSUMED FOR THE DESIGN OF THE POWERHOUSE SUPERSTRUCTURE' WHILE THE 475 YEAR RETURN PERIOD EVENT WILL BE USED ON ALL OTHER COMPONENTS. BRIDGE SUPERSTRUCTURES WILL BE DESIGNED FOR THE 475 RETURN PERIOD BUT REPAIR OF BRIDGE SUBSTRUCTURE SUPPORTS MIGHT BE REQUIRED FOR SUCH AN EVENT DUE TO GEOTECHNICAL CONDITIONS BEYOND CONTROL. INTAKE STRUCTURES WILL BE DESIGNED TO THE 475 YEAR RETURN PERIOD EVENT, SATISFYING THE RECOMMENDATIONS OF THE CANADIAN DAM ASSOCIATION "DAM SAFETY GUIDELINES" (2007) FOR A LOW DAM CLASSIFICATION.
2. MAXIMUM CREDIBLE HAZARD COVERED BY DUCTILITY REQUIREMENTS.
3. APPLIES TO INTAKE STRUCTURES, PENSTOCKS AND POWERHOUSES WHICH WILL BE UNMANNED: THEREFORE SERVICEABILITY REQUIREMENTS PREVAIL.
4. SEISMIC DUCTILITY REQUIREMENTS GOVERN FOR STRENGTH AND STABILITY; LOSS OF FINISHES IS NOT LIFE-THREATENING.

2.3 SEISMICITY

A preliminary seismicity assessment has been carried out for the Project area. This included a review of the regional seismicity, using historical earthquake records from the United States Geological Service (USGS, 2013) database, and a seismic hazard analysis to provide appropriate seismic design parameters.

The seismicity of southern Baffin Island is typical of an intra-plate region, characterized by low levels of seismic activity. There have been no recorded earthquakes greater than magnitude 5.0 within 300 km of the sites of interest. The large majority of recorded earthquakes in the region of Baffin Island are typically concentrated along the northeastern coastline. Most of these events are small earthquakes with magnitudes of less than 5.0. Some moderate to large earthquakes have occurred in this region, the largest being a magnitude 7.3 earthquake in 1933, located off-shore in Baffin Bay. A potential future event of this magnitude along the northeast coast is not considered a seismic hazard to the project area as it would be too distant.

A seismic hazard calculation for the project area has been provided by Natural Resources Canada (NRC). The results are summarized in Table 2.2. This table includes values of Peak Ground Acceleration (PGA) for a range of earthquake return periods ranging from 100 years to 2,475 years. The PGA values are for "firm ground" (Soil Class C) as defined by the NBCC (NRC, 2010). The PGA for a return period of 2,475 years (corresponding to a probability of exceedance of 2% in 50 years) is 0.04 g. The low PGA values included in Table 2.2 indicate that the seismic hazard is low.

Table 2.2 Summary of Probabilistic Seismic Hazard Analysis

Probability of Exceedance In 50 Years[1] (%)	Return Period[1,3] (years)	Peak Ground Acceleration (g)[2]
2	2,475	0.04
5	1,000	0.03
10	475	0.02
40	100	0.01

NOTES:

1. PROBABILITIES OF EXCEEDANCE AND PGAS PROVIDED BY NATURAL RESOURCES CANADA (NRC, 2013).
2. PGAS ARE FOR FIRM GROUND (NBCC 2010 SOIL CLASS C).
3. RETURN PERIODS ARE CALCULATED BY ROUNDING THE RECIPROCAL OF THE NUMBER PER ANNUM PROVIDED BY NRC (2013).

2.4 HYDROLOGICAL ANALYSES

Knight Piésold previously developed and reported hydrological analyses for both the Jaynes Inlet and Armshow South River Project Sites in 2008 (Knight Piésold, 2008a and 2008b). The hydrological analyses for both sites included two years of data, from August 2006 to December 2007.

In order to develop an updated model of the energy generation potential for both projects, the long-term synthetic streamflow series for both the Jaynes Inlet and Armshow South project intake locations were updated based on five years of data, from August 2006 to December 2011 (Knight Piésold, 2012). In the absence of long-term streamflow records for the subject sites, the long-term regional streamflow dataset for the Sylvia Grinnell River was used to develop the long-term synthetic streamflow series for the Jaynes Inlet and Armshow South sites. The mean annual unit runoff of the Sylvia Grinnell River is 11 $l/s/km^2$, which is much lower than the runoff measured at either of the Jaynes or Armshow South Rivers. This difference is consistent with its lower mean watershed elevation. The Sylvia Grinnell River's hydrograph does have a very similar shape to that of the Jaynes and Armshow South River's hydrographs.

The updated analysis of the long-term synthetic MAD at the Jaynes Inlet intake location is 4.1 m^3/s, which is equivalent to a mean annual unit runoff of 20 $l/s/km^2$. The long-term synthetic MAD at the Armshow South intake location is 4.8 m^3/s (equal to a mean annual unit runoff of 17 $l/s/km^2$).

It should be noted that these updated hydrologic values are approximately 25% greater than the values presented in the previous hydrologic assessment completed by Knight Piésold (2008a and 2008b). At that time, only limited preliminary data were available and the analyses actually produced similar mean annual discharge estimates for both rivers. However, because of the limited data and the observation that these flows suggested unit runoff values that were considerably greater than available regional values, it was decided to reduce the 2008 flow estimates by 25% to avoid overestimating the energy generating potential of these two projects.

2.5 INSTREAM FLOW REQUIREMENTS

2.5.1 Jaynes Inlet Site

The preferred operations alternative for the Jaynes Inlet site is to design and operate the water storage reservoir without a minimum Instream Flow Requirement (IFR) at the dam site. This is the preferred alternative, since an IFR would result in the direct loss of energy.

The Project is located on an unnamed river system that flows into the head of Jaynes Inlet and is inhabited by resident (non-anadromous) Arctic char and to a lesser extent threespine stickleback. Both fish species rely on lakes as critical habitat for overwintering, spawning, and adult rearing. An upper lake exists at the dam site, while a lower lake exists on the same river system below the powerhouse. Inflow tributaries to these lakes are used by Arctic char on a seasonal basis for juvenile rearing during the summer months. Construction and operation of the storage dam will directly affect lake habitat, while the diversion of water from the storage reservoir for power generation will alter the hydrological regime. Both water storage and the diversion of water will dewater the section of river located between the dam site and the powerhouse in the absence of an IFR during the summer months.

To assess the risk to fish by operating the Project without an IFR, a risk evaluation was completed based on DFO's risk management framework (DFO, no date). The residual effect of dewatering the diversion section during the summer months was assigned a low risk category based on the following key points:

- Arctic char utilization of the diversion section is limited to summer use by char emigrating from upstream habitats. Upstream movement to habitat in the diversion route by char from downstream areas is precluded by impassable falls located below the powerhouse.

- Arctic char residing in the diversion section during summer are prevented from returning to upstream habitat by impassable falls located at the lake outlet. Fish in the diversion section are required to move downstream to the lower lake to find suitable overwintering habitat. Fish that attempt to remain in the diversion section through winter do not likely survive because the river is shallow and is expected to freeze to the bottom under near zero flow conditions from November to May
- Invertebrate drift from the diversion section to downstream areas during the summer months will be reduced in the absence of an IFR flow. Habitat downstream of the powerhouse will continue to receive invertebrates from habitat upstream of the diversion section via the penstock. As such, invertebrate production loss will only be related to lost habitat along the diversion section and a reduction in wetted habitat downstream of the powerhouse. The lower lake will continue to receive invertebrate drift from other unaffected tributaries. It is expected that the reduction of invertebrate contribution from the diversion section will have negligible affect to char in downstream areas. Further, the loss of invertebrate production along the diversion section will be partially mitigated by occasional re-watering of the diversion route by excess water spilled at the dam. Flow increases to the lower lake during fall may increase invertebrate drift contributions to the lake during these periods.
- Summer rearing habitat for Arctic char residing in the lower lake occurs in three inflow tributaries. During operation of the project, the extent of habitat and food production for char will remain unchanged in two of the three tributaries. Flow will be reduced along the third tributary due to the Project, which will result in a loss of some summer rearing habitat. The abundance of invertebrates is expected to decrease only modestly in the tributary (see above). The area of accessible summer rearing habitat available to char from the lower lake is extensive. It is expected that the loss of a small portion of available summer rearing habitat and invertebrate production will have a negligible effect on char in the lower lake

The exclusion of an IFR for Jaynes Inlet Project and the subsequent dewatering of the diversion section present a low risk to the resident Arctic char and threespine stickleback that utilize the affected river system. Monitoring of fish and aquatic invertebrates is recommended to confirm the residual effects of the Project. Mitigation, compensation, and enhancement opportunities should be identified as a contingency against unexpected negative effects and to ensure no-net-loss.

In consideration of upcoming changes to the *Fisheries Act,* the residual effect of dewatering the diversion section during the summer months is not considered to constitute serious harm to fish. The resident Arctic char and threespine stickleback that use the affected river system are also not part of an aboriginal, recreational, or commercial fishery.

2.5.2 Armshow South Site

The preferred operations alternative for the Armshow South site is to design and operate the water storage reservoir without a minimum IFR at the dam site. This is the preferred alternative, since an IFR would result in the direct loss of energy.

The Armshow South site is located on a steep unnamed tributary which flows into the Armshow River about 6 km upstream of Frobisher Bay. The Armshow River mainstem supports both resident and migratory anadromous Arctic char. A lake supporting a resident population of

Arctic char exists at the dam site. No other fish species have been documented in this system. The diversion section is steep with a barrier that is thought to prevent upstream movement of fish from the mainstem into the tributary. The powerhouse will discharge diverted flow directly to the Armshow River. Construction and operation of the storage dam will directly affect lake habitat, while the diversion of water from the storage reservoir for power generation will alter the hydrological regime. In the absence of an IFR during the summer months, both water storage and the diversion of water will dewater the diversion section that is located between the dam site and the Armshow River.

As with the Jaynes Inlet site, a risk evaluation was carried out for the Armshow South site on the effect of operating the Project without an IFR. The residual effect of dewatering the diversion section at the Armshow South site during the summer months was also assigned a low risk category based on the following key points:

- Arctic char utilization of the diversion section is limited to summer use by fish emigrating from upstream habitats. Upstream movement to habitat in the diversion route by char from the Armshow River mainstem is precluded by impassable falls located below the powerhouse.
- Arctic char residing in the diversion section during summer must retreat to overwintering habitat either upstream or downstream of the diversion section. Fish that attempt to remain in the diversion section through winter do not likely survive because the tributary is shallow and is expected to freeze to the bottom under near zero flow conditions from November to May.
- The contribution of invertebrate production by the diversion section to the Armshow River mainstem during the summer months will be reduced in the absence of an IFR flow. Habitat and char downstream of the diversion section will continue to receive invertebrates from upstream of the diversion section via the penstock. As such, reduced invertebrate production will only be related to lost habitat along the diversion section. The extent of habitat in the diversion section is small compared to the amount of available habitat in the Armshow River mainstem. It is expected that the loss of a small amount of invertebrate production in the diversion section will have little or no effect on char residing in the lowermost 6 km of the Armshow River.

The exclusion of an IFR for the Armshow South site and the subsequent dewatering of the diversion section present a low risk to the resident Arctic char that utilize the affected river system. Monitoring of fish and aquatic invertebrates is recommended to confirm the residual effects of the Project. Mitigation, compensation, and enhancement opportunities should be identified as a contingency against unexpected negative effects and to ensure no-net-loss.

In consideration of upcoming changes to the *Fisheries Act*, the residual effect of dewatering the diversion section during the summer months is not considered to constitute serious harm to fish. The migratory anadromous Arctic char that use the lower Armshow River are considered part of an aboriginal fishery.

2.6 ENERGY MODEL

2.6.1 General

The following section summarizes the methodology and assumptions that were employed to determine the annual energy potential for the Jaynes Inlet and Armshow South project alternatives.

This methodology and associated assumptions are implemented in a spreadsheet-based energy model created by Knight Piésold.

2.6.2 Input Requirements

The energy model incorporates each of the inputs summarized in Table 2.3 and is determined from values calculated on a daily basis. The corresponding statistics are then compiled on a monthly and annual basis. The power output of the facility is calculated on a daily basis using the following: power is equal to the overall plant efficiency multiplied by the available generation flow, the net head in metres, gravitational acceleration, and the density of water. The model incorporates a daily mass balance of the flows in and out of each reservoir.

Table 2.3 Facility Physical Assumptions

	Jaynes Inlet	Armshow South
Design Flow	Variable	Variable
Maximum Reservoir Operating Level	477.00 masl	250.00 masl
Minimum Reservoir Operating Level	455.00 masl	238.00 masl
Estimated Maximum Operating Volume	86.0×10^6 m^3	102.7×10^6 m^3
Estimated Minimum Operating Volume	12.6×10^6 m^3	33.8×10^6 m^3
Active Storage Volume	73.4×10^6 m^3	68.9×10^6 m^3
Tailwater Elevation	75.00 masl	49.00 masl
Conveyance Losses	10% of Maximum Operating Head = 40.2 m at design flow	10% of Maximum Operating Headloss = 20.1 m at design flow
Turbine Efficiency	Vertical Axis 6-Jet Pelton Generic Efficiency Curve. Peak efficiency of 90.3% (No Hill Chart)	Vertical Axis 6-Jet Pelton Generic Efficiency Curve. Peak efficiency of 90.3% (No Hill Chart)
Generator Efficiency	98%	98%
Transformer Efficiency	99.5%	99.5%
Station Usage	80 kW	80 kW
Unscheduled Outages [1]	3%	3%
Transmission Losses	Not Modelled	Not Modelled

NOTES:
1. MAINTENANCE/SCHEDULED OUTAGES WILL BE REQUIRED BUT CAN BE PLANNED FOR AND ARE NOT TYPICALLY DEDUCTED FROM THE ANNUAL ENERGY ESTIMATES.

Depth Area Capacity Curve

The depth-area-capacity relationship was derived from coarse topographical information for elevations between 450 and 485 masl for the Jaynes Inlet site and between 230 and 255 masl for

Armshow South site. The active storage volumes are expected to be 73 and 69 million cubic meters, respectively.

Hydrology

The synthetic long-term daily flow series developed by Knight Piésold (2012) for each site (described in Section 2.4) was used to determine the reservoir inflows. The Jaynes Inlet reservoir is expected to have a mean annual inflow of 4.1 m^3/s and the Armshow South reservoir is expected to have a mean annual inflow of 4.8 m^3/s.

It should be noted that the prospective inflows during the month of June may have the most effect on the operating decisions associated with the reservoir. The current model aims to have the reservoir at the elevation of the outlet (roughly the current natural lake level) by the end of May in anticipation of the spring flows. If there is little precipitation in June then the facility has limited energy production ability. Alternatively, if water was conserved for the month of June then there would often be water spills at the facility associated with the spring freshet.

Instream Flow Requirements

For the purpose of this assessment, two IFR scenarios were considered: a No IFR Scenario and a Conservative Scenario (IFR of 50% of Mean Annual Discharge (MAD) in June, 80% of MAD in July, 40% of MAD in August and 10% of MAD in September and 5% of MAD in October).

Operational Rules

For the purpose of modeling the energy generation potential the reservoir was operated in the following fashion:

- If the start of day reservoir elevation is above Minimum Reservoir Operating Level then the monthly IFR is released
- If the reservoir elevation is above the Maximum Reservoir Operating Level then the remainder of the water available that day is spilled entirely
- For start of day reservoir levels above the Minimum Reservoir Operating Level, then water is released through the hydroelectric powerhouse according to the following rules:
    - Turbine Flow ($Q_{turbine}$) is equal to:

$$Q_{turbine} = \frac{V}{t} + \widetilde{Q_E} - IFR_E$$

Where: V = Current available storage volume
t = Number of days left until mid-June
$\widetilde{Q}_E$ = Cumulative median expected flow until the end of May
IFR_E = Expected IFR until the end of May

    - In July and August this Rule is over-written to release the Full Design Flow

Turbine and Generator Efficiencies

Turbine and generator efficiencies are usually provided by equipment suppliers. In this case, the generic efficiency curves for facilities with single units with non-variable heads were utilized.

Net Head at Design Flow

The gross head on the system is assumed to be equal to the difference in elevation between the start of day reservoir level and the turbine centerline. The headloss coefficient is an expression of the overall headloss over the square of the flow. It is assumed here that the headloss is 10% of Maximum Operating Head.

Net Power

Net power is described as the power at the turbine less all turbine, generator and transformer losses. Turbine and generator losses are determined as above.

Net Energy

The net energy is calculated on a daily basis as the net power multiplied by 24 hours (expressed in gigawatt-hours, GWh). The annual net energy production is the sum of all daily energy values.

Station service requirements are typically deducted from the gross output of the facility. The station service usage will need to cover the heating system, the HPU, the lighting system as well as any additional systems required due to the isolated nature of the facilities. Although heat tracing will be installed as an additional backup, these loads are not included in the service usage as the heat tracing will not be needed as long as the water is kept moving through the penstock at all times. A station service usage of 80 kW was assumed in this assessment.

Unscheduled outages, assumed to be 3% of the power after the transformer, is then subtracted from the total. For the purposes of this calculation the transmission losses were not included.

2.6.3 Energy Model Results

The results of the energy analysis are summarized below:

Jaynes Inlet Facility

- Base Case (old hydrology) = 10 MW and 73.5 GWh/year
- New Hydrology:
    - 0.80 x MAD plus conservative IFR = 10.0 MW and 78.1 GWh/year
    - 0.80 x MAD no IFR = 10.0 MW and 82.0 GWh/year
    - 1.00 x MAD plus conservative IFR = 12.5 MW and 83.8 GWh/year
    - 1.00 x MAD no IFR = 12.5 MW and 91.1 GWh/year
    - 1.20 x MAD plus conservative IFR = 15.0 MW and 86.9 GWh/year
    - 1.20 x MAD no IFR = 15.0 MW and 95.5 GWh/year

Armshow South Facility

- Base Case (old hydrology) = 6 MW and 45.9 GWh/year
- New Hydrology:
  - 0.82 x MAD plus conservative IFR = 6.0 MW and 43.5 GWh/year
  - 0.82 x MAD no IFR = 6.0 MW and 45.0 GWh/year
  - 1.00 x MAD plus conservative IFR = 7.3 MW and 46.0 GWh/year
  - 1.00 x MAD no IFR = 7.3 MW and 48.4 GWh/year
  - 1.20 x MAD plus conservative IFR = 8.8 MW and 47.7 GWh/year
  - 1.20 x MAD no IFR = 8.8 MW and 51.0 GWh/year

For each project, the base case project sizing for Jaynes Inlet (10 MW) and Armshow South (6.0 MW) are presented for comparison. The updated 2012 hydrological analysis described in Section 2.4, determined that both sites have approximately 25% more water available than an earlier assessment in 2008 (i.e., the MAD was reduced in the 2008 analyses by approximately 25% to avoid overestimating the energy generating potential due to the limited hydrology dataset). Therefore, two additional development scenarios in addition to the base case have been developed based on the revised hydrology. In each of these scenarios, the power and energy outputs have been calculated:

- Assuming 1.00 x MAD, the installed capacity of both projects have been revised upwards to 12.5 MW and 7.3 MW for the Jaynes Inlet and Armshow South projects, respectively
- There is an option to “oversize” the projects (1.20 x MAD) to be able to generate additional power during high flow years

Whether or not an IFR is required for the section of river between the dam and powerhouse is another variable that influences the available energy, as summarized above.

These two additional options are being carried into the feasibility study. Aquatic studies in 2013 will investigate the fish habitat that would be affected if the projects were operated without an IFR. The feasibility study will more closely evaluate the various options for installed capacity and compare them on the basis of economics and long-term reliability in meeting Iqaluit’s energy requirements.

2.7 LOAD FORECAST

The electrical energy demand over the period of 1994 to 2011 is shown on Figure 2.1. Over this period, the average annual increase in electrical demand was 3.8%. Most of the electrical demand in Iqaluit is from residential use with limited commercial and industrial uses. As such, the increase in demand likely tracks population growth. While Iqaluit became the capital of Nunavut in 1999, the rate of increase in electrical demand before and after 1999 appears to be fairly constant.

Also shown on Figure 2.1 is the electricity demand forecast over the period of 2012 through 2040. Three growth scenarios are considered:

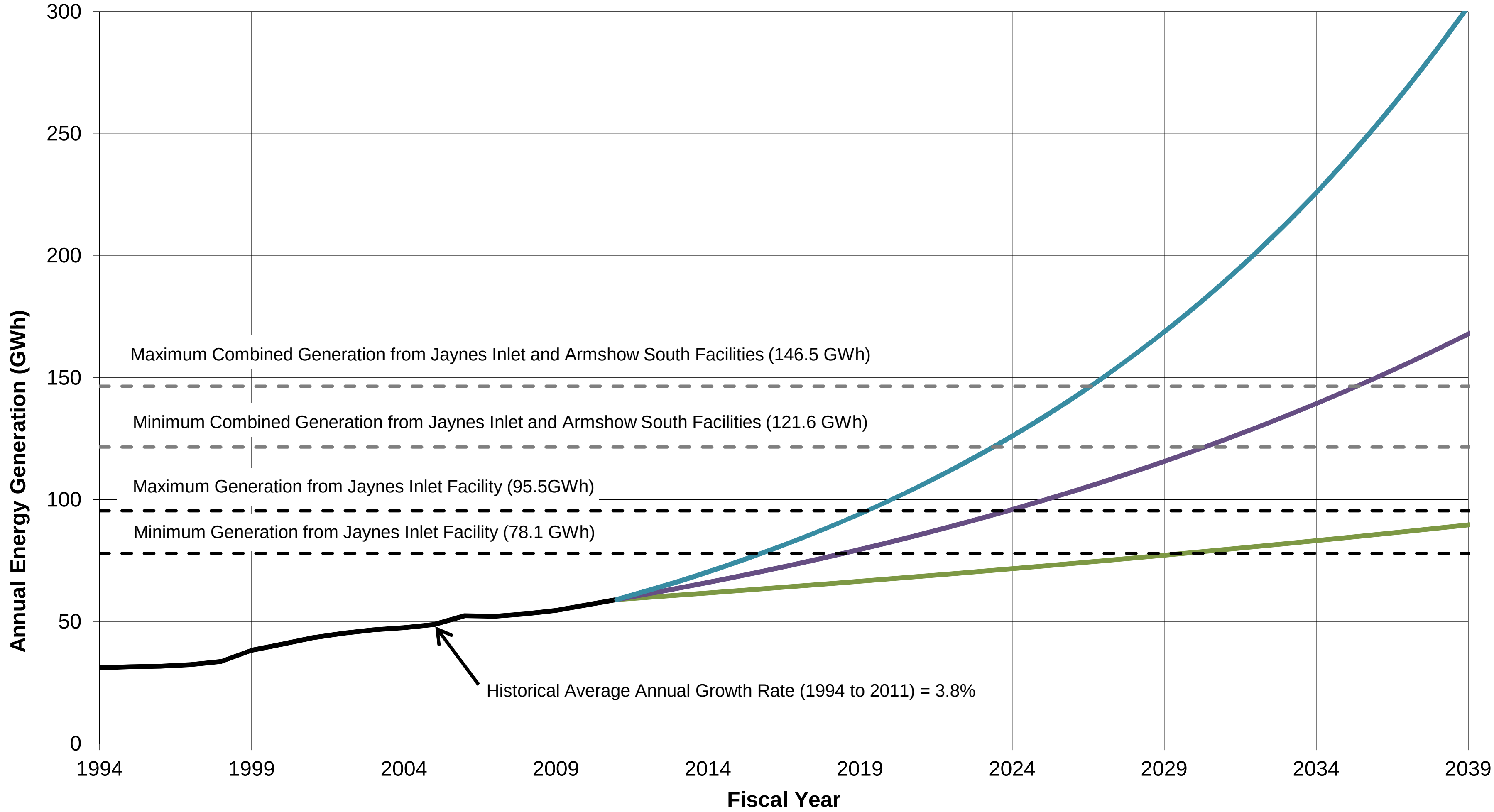
- Low demand growth (1.5% annual increase)
- Average demand growth (3.8% annual increases)
- High demand growth (6.0% annual increases)

The historical annual rate of increase of 3.8% was selected as the most likely or average demand growth scenario over the long term.

Development of the Jaynes Inlet facility and subsequently the Armshow River facility is shown in relation to Iqaluit's load forecast on Figure 2.1. Energy production for the two projects is plotted against the load forecast for the various development scenarios contemplated in the energy model.

The Jaynes Inlet site will produce between 78.1 and 95.5 GWh of energy under the various development scenarios considered. It will meet Iqaluit's energy requirements under the average growth scenario in 2019, shortly after the site is commissioned.

The Armshow River site would be developed in the future when the demand has increased to the point that all the generated energy could be sold. It is expected that the current diesel power plant will satisfy the additional growing demand until the Armshow site can be constructed and brought into operation. The diesel plant will be kept as a back-up and emergency supply. Under the average growth scenario, the Armshow site could be brought into operation between 2030 and 2035.



NOTES:
1. HISTORIC DATA AND QEC FORECAST DATA PROVIDED BY QEC.
2. LOW GROWTH FORECAST BASED ON 1.5% ANNUAL GROWTH.
3. AVERAGE GROWTH FORECAST BASED ON HISTORICAL AVERAGE ANNUAL GROWTH OF 3.8%.
4. HIGH GROWTH FORECAST BASED ON 6.0% ANNUAL GROWTH.
5. DASHED LINES SHOW AVERAGE ANNUAL GENERATION FROM SELECT PROJECTS.

Past Generation
Low Growth Forecast
QEC Average Growth Forecast
High Growth Forecast
Jaynes Inlet
Jaynes Inlet + Armshow South

QULLIQ ENERGY CORPORATION
IQALUIT HYDROELECTRIC PROJECT

IQALUIT ELECTRICAL LOAD FORECAST

Knight Piésold CONSULTING

P/A NO. NB103-137/8 | REF. NO. 1

FIGURE 2.1 REV 0

0	12FEB'13	ISSUED WITH REPORT	EEB	RC	SRM
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D