From: jamesmeaney@nalcorenergy.com
Sent: Friday, November 1, 2013 5:53 PM
To: georgechehab@lowerchurchillproject.ca
Cc: Jason Kean; Lance Clarke
Subject: Re: FFC analysis (Sept)
Attachments: LCP-Underwriting Submission-FINAL.pdf

George/Jason

The cost component groupings I referred to in the meeting can be seen on page 24-25 of the attached AON insurance report. Would presenting it next Weds by project component (MF, LTA and LIL) is this manner make sense? We would then want to contract package level detail ready as support to go into the data room if required.

Jim

1 attachment

LCP-Underwriting Submission-FINAL.pdf

nalcor energy
LOWER CHURCHILL PROJECT

James Meaney, CFA
General Manager Finance
Nalcor Energy - Lower Churchill Project
t. 709 737-4860 c. 709 727-5283 f. 709 737-1901
e. JamesMeaney@nalcorenergy.com
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1.888.576.5454

George Chehab---11/01/2013 05:06:19 PM---Jason/ Jim further to our meeting today and Jason's request to prepare few slides about the latest F

From: George Chehab/LCP/NLHydro

To: Jason Kean/NLHydro@NLHydro, James Meaney/NLHydro@NLHYDRO

Date: 11/01/2013 05:06 PM

Subject: FFC analysis (Sept)

Jason/ Jim

further to our meeting today and Jason's request to prepare few slides about the latest FFC (September) and the variance and the way we produce our Forecast, i have identified these some 20 cost categories which variance i will analyze

let me know if you are ok with this breakdown

- MF civil works

- MF concrete works

- MF electromechanical works

- MF site operations

- MF site infrastructure

- North Spur

- MF Miscellaneous

- Switchyards

- Converter and transition compounds

- Synchronous Condenser

- Overland AC construction

- Overland AC equipment

- Overland DC construction

- Overland DC equipment

- HVdc Specialties Miscellaneous

- General services

- SOBI works

- Owner's cost

- Environmental

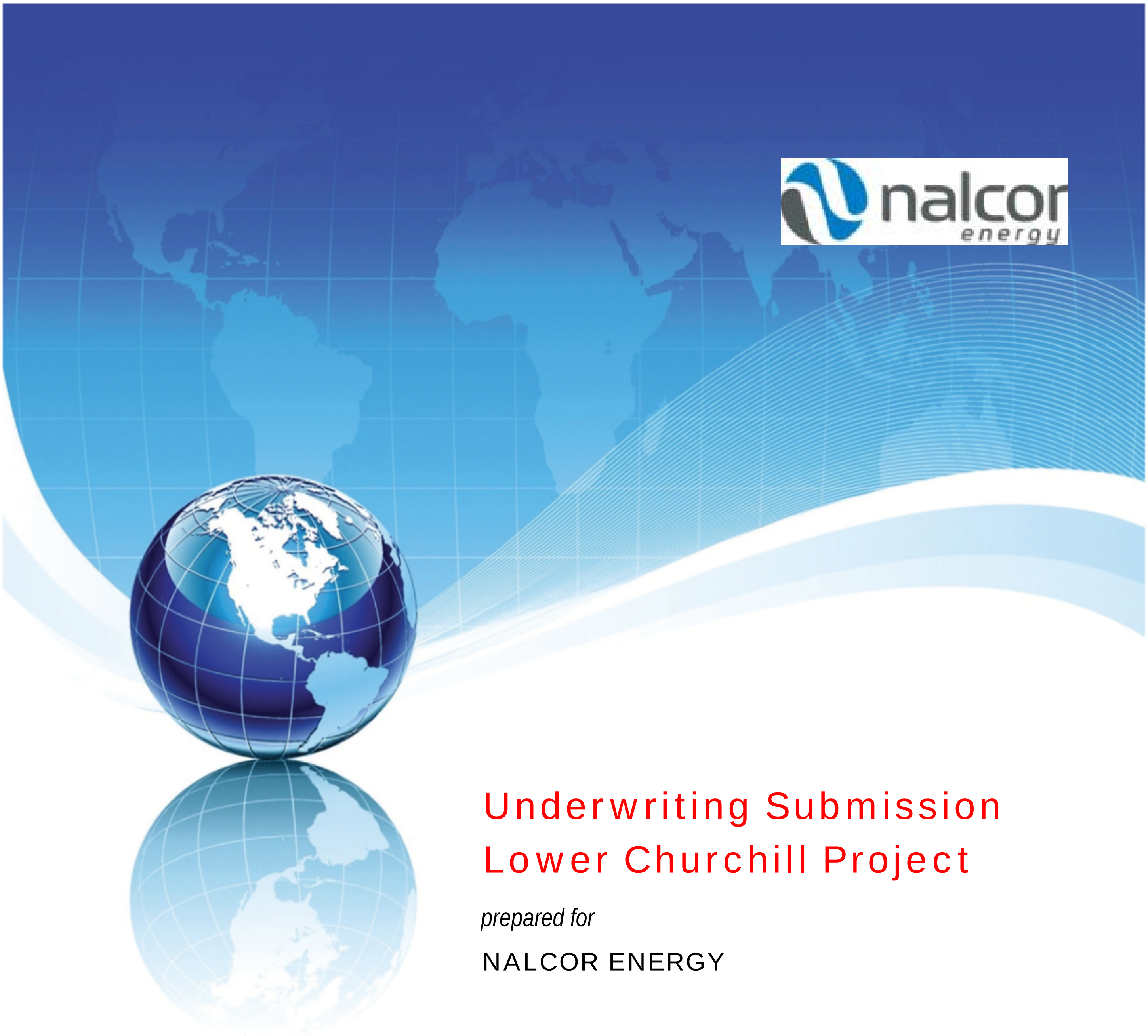
- Historical costs

cheers

George

George Chehab
Lead Cost Controller
PROJECT DELIVERY TEAM
Lower Churchill Project
t. **709-752-3461 x55147**
e. **GeorgeChehab@lowerchurchillproject.ca**
w. **muskratfalls.nalcorenergy.com**

You owe it to yourself, and your family, to make it home safely every day. What have you done today so that nobody gets hurt?



Underwriting Submission
Lower Churchill Project

prepared for

NALCOR ENERGY

Hydroelectric Generation & Transmission Project

date

July 2013

prepared by

Darren Marsh, P.Eng.
Aon Risk Solutions

Contents

Introduction

Aon Risk Solutions has been appointed as broker to handle the insurance program for Nalcor Energy's interests in Phase 1 of the Lower Churchill Project (the "Project") and we are pleased to provide you with the opportunity to provide quotations on this account.

Our mandate is to provide the Project with comprehensive construction, delay in start-up (DSU) and wrap-up liability covers in a format that will meet the needs of this world class hydroelectric power generation project. Our program will insure the Lower Churchill Project, the Owner (Nalcor Energy and its subsidiaries), and all contractors, subcontractors and suppliers (on site) under an owner controlled Insurance Program.

Our timetable is designed to expediently accommodate any additional questions you may wish to raise within the phases of this placement. Our mandate is to have the insurance program in place for 1 October 2013 for a term of approximately 5 years.

To achieve this, our timetable is as follows:

Phase I: May/June 2013
This includes technical presentations to Insurers with time allotted for questions and answers.

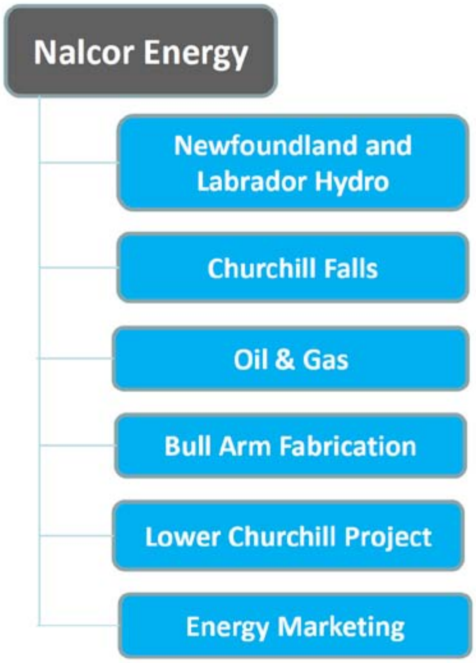
Phase II: June/July 2013
Completion of underwriting information, follow-up technical information, final contract values and proposed coverage specification.

Phase III: July/August 2013
Please note our commitment to our client is to present a formal proposal no later than 1 September 2013 to reflect all the terms, conditions and options available.

We hope you will find this submission of interest and we look forward to working with you on this Project. If you have any questions or concerns, please direct them to the Aon Account Team as follows:

Account Director	John Bate john.bate@aon.ca (1) 416.868.5828
Account Executive Technical Questions	Darren Marsh darren.marsh@aon.ca (1) 709.758.5525
Broking Team Lead – London Coverage Questions	Darren Marshall darren.marshall2@aon.co.uk (44) 20.7086.4731
Broking Team Lead – Toronto Coverage Questions	Jim Cardwell jim.cardwell@aon.ca (1) 416.868.5604

Nalcor Energy Corporate Profile



Who is Nalcor?

- Diversified growth focused energy company
- World class energy assets
- Partner with other leading energy companies
- Demonstrated history of building and operating hydro-electric and transmission assets
- Key player in executing NL Energy Plan

2012 Assets/Operational Statistics	
Hydro-electric generation (MW)	6,386
Other Generation (MW)	688
Transmission Lines (km)	4,821
Labrador-NY Transmission (MW)	265
Oil Reserves (Mbbls)	56.2
Oil Production (000 bbls per year)	595
Domestic Electricity Sales (TWh)	8.7
Export Sales (TWh)	32.4

Nalcor Energy is a crown corporation of the Government of Newfoundland and Labrador ("NL"). Its business includes the development, generation, transmission and sale of electricity; the exploration, development, production and sale of oil and gas; industrial fabrication; and energy marketing.

Focused on sustainable growth, the company is leading the development of NL's energy resources and has a corporate-wide framework which facilitates the prudent management of its assets while continuing an unwavering focus on the safety of its workers and the public.

Nalcor has six lines of business: *Newfoundland and Labrador Hydro, Churchill Falls, Lower Churchill Project, Oil and Gas and Bull Arm Fabrication*.

Newfoundland and Labrador Hydro

As the province's main electricity provider, Hydro is focused on providing a safe, reliable and cost-effective electricity supply to meet current electricity needs and accommodate future growth. Hydro's primary business is to generate and deliver electricity in Newfoundland and Labrador to utility, industrial, residential and commercial customers in over 200 communities across the province.

Churchill Falls

Nalcor's flagship operation in Churchill Falls is one of the largest underground hydroelectric powerhouses in the world with a rated capacity of 5,428 megawatts. The Churchill Falls generating station provides clean, renewable electricity to millions of consumers throughout North America. A significant portion of that electricity is being sold to Hydro-Québec through a long-term power purchase agreement with additional sales to Hydro and Twin Falls Power Corporation to meet the needs of residential and industrial customers on the Labrador Interconnected electricity system.

Churchill Falls focuses on safety excellence, delivering reliable electricity to customers and ensuring future generations benefit from this world-class resource through long-term asset management.

Oil and Gas

Nalcor is currently a partner in three developments in the Newfoundland and Labrador offshore oil and gas industry: the Hebron oil field, the province's fourth offshore oil project; the White Rose Growth Project; and the Hibernia Southern Extension. Nalcor is also the majority owner and operator of an onshore exploration program on the province's west coast.

Bull Arm Fabrication

The Bull Arm Fabrication site is Atlantic Canada's largest fabrication site. Close to international shipping lanes and Europe, this site has unobstructed, deep water access to the Atlantic Ocean. This world-class facility spans over 2,560 hectares and has integrated and comprehensive infrastructure to support fabrication and assembly in three project areas simultaneously, in three separate theatres: Topsides Fabrication and Assembly; Dry dock Fabrication and Construction; and the Deepwater Site.

Lower Churchill Project

The Churchill River in Labrador is a source of renewable, clean electrical energy; however, the potential of this river has yet to be fully developed. The existing 5,428 MW Churchill Falls generating station, which began producing power in 1971, harnesses about 65 per cent of the potential generating capacity of the river. The remaining 35 per cent is located at two sites on the lower Churchill River, known as the Lower Churchill Project (LCP).

This project comprises the most attractive undeveloped hydroelectric project in North America and is a key component of the province's energy warehouse. The Project's two proposed installations at Muskrat Falls (824 MW) and Gull Island (2,250 MW) will have a combined capacity of over 3,000 megawatts and can provide 16.7 terawatt hours of electricity per year. The clean, stable, renewable electricity provides the opportunity for the province to meet its own domestic and industrial needs in an environmentally sustainable way, and also export electricity to other jurisdictions where the demand for clean, renewable energy continues to grow.

Phase 1 of the Project, which includes Muskrat Falls, the Labrador Transmission Assets, the Labrador Island Transmission Link and the Maritime Transmission Link were sanctioned by Nalcor Energy and its partner Emera Inc. in December 2012.

With both the Muskrat Falls and (later) Gull Island fully complete, the LCP would have a combined capacity of 3,074 MW with annual output of 16.7 Terawatt hours of electricity per year. That is enough to supply hundreds of thousands of households annually and contribute significantly to the reduction of air emissions from fossil fuel-fired power generation.

This would provide the capability to displace the Newfoundland Hydro's oil fired Holyrood plant and meet the growth in provincial power requirements for years to come. In addition, this would interconnect the Island with the regional North American power grid.

Further details can be found at **www.muskratfalls.nalcorenergy.com**

Energy Marketing

Nalcor is involved in energy marketing and other energy activities, including non-regulated electricity generation, wind energy, and research and development. Nalcor's energy marketing portfolio will grow over the coming years and currently includes recall power not required by Hydro.

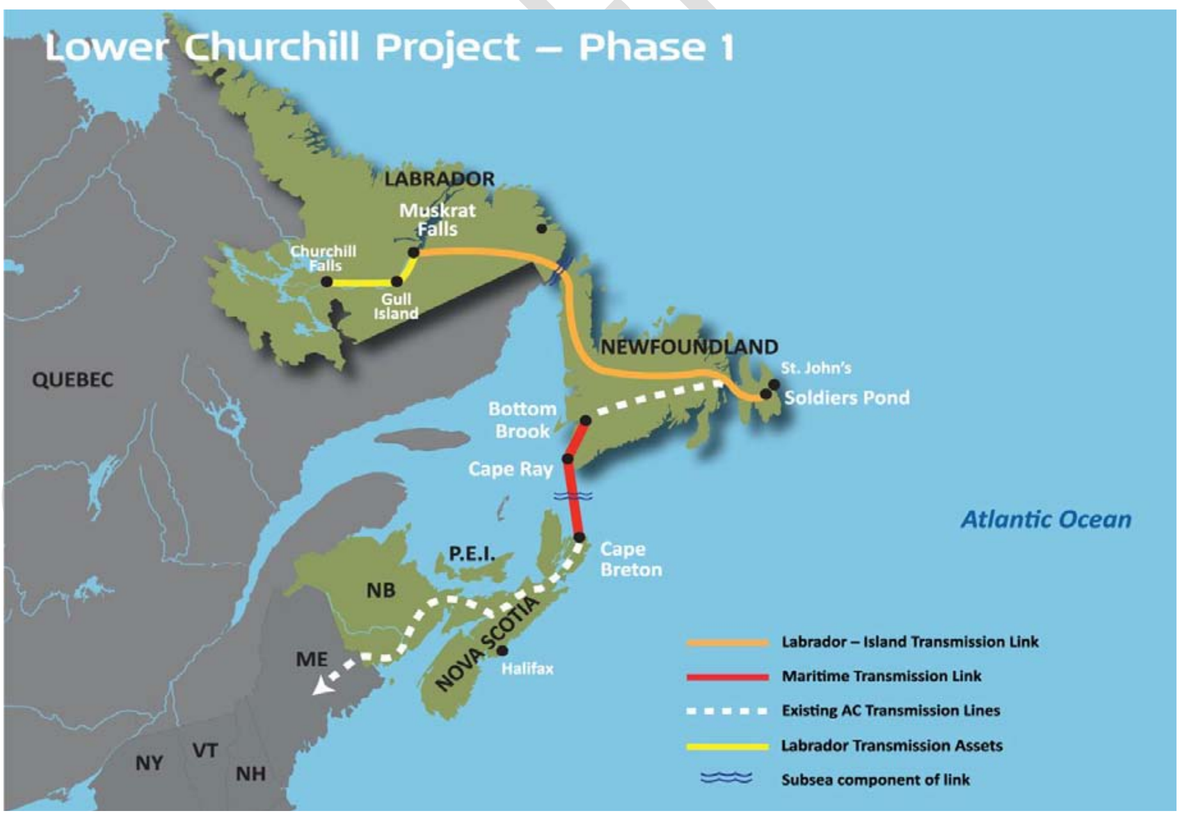
More details On Nalcor Energy can be obtained at www.nalcorenergy.com.

Project Overview

Phase 1 of the project is made up of four distinct components named:

- Muskrat Falls Generation Project (MF)
    - An 824 MW hydroelectric dam & generating station
- Labrador Transmission Assets Project (LTA)
    - Two 263 km 315 kV HVac transmission lines from a new Muskrat Falls switchyard to the existing as well as a new 315kV/735 kV Upper Churchill Falls switchyard
- Labrador-Island Transmission Link Project (LIL)
    - A 1,100 km 350 kV HVdc transmission line from Muskrat Falls to Soldiers Pond, near St. John's, NL, including an approximate 30 km subsea section crossing the Strait of Belle Isle (SOBI)
- Maritime Link Transmission Project (ML)
    - Primarily consists of a 180km 350 kV HVdc subsea transmission line from the island of Newfoundland to Nova Scotia which will be executed by Emera concurrently with the above three components.

Only the MF, LTA and LIL components form the basis of this Underwriting Submission, insurance coverage for the ML will be secured separately by Emera.



Muskrat Falls

Muskrat Falls Generation includes the following sub-components:

- 22 km of access roads, including upgrading and new construction, and temporary bridges;
- A 1,500 person accommodations complex (for the construction period);
- A north Roller Compacted Concrete (RCC) overflow dam;
- A south rock fill dam;
- River diversion during construction via the spillway;
- 5 vertical gate spillway;
- Reservoir preparation and reservoir clearing;
- Replacement fish and/or terrestrial habitat;
- North Spur stabilization works;
- A close coupled intake and powerhouse, including:
  - 4 intakes with gates and trash racks
  - 4 Kaplan-type turbine/generator units at approximately 206 MW each with associated ancillary
  - electrical/mechanical and protection/control equipment
  - 5 power transformers (includes 1 spare), located on the draft tube deck of the powerhouse
  - 2 Overhead cranes each rated at 450 Tonnes
- Salient Features of the MF site are summarized in Appendix A

Labrador Transmission Asset (LTA)

LTA consists of an AC transmission line system from the existing Upper Churchill Falls site to Muskrat Falls, specifically:

- Churchill Falls (CF) switchyard extension;
- New Churchill Falls 315kV/735kV switchyard including a 735kV line interconnecting the existing and the new CF Switchyards
- Transmission lines from Churchill Falls to Muskrat Falls: double-circuit 315 kV ac, 3 phase lines, double bundle conductor, single circuit galvanized lattice steel guyed suspension and rigid angle towers; 247 km long.
- Muskrat Falls switchyard;
- Salient Features of the LTA site are summarized in Appendix B

Labrador Island Transmission Link (LIL)

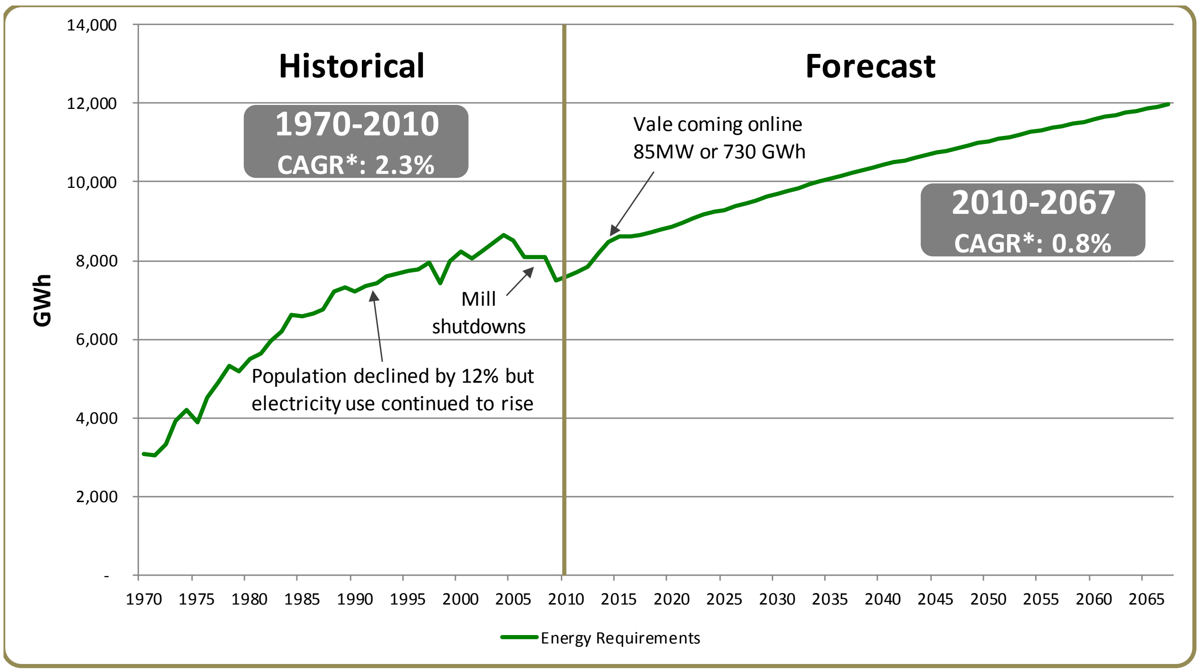
The LIL consists of the overland high voltage direct current (HVdc) Transmission system and associated HVdc converter station systems, the Strait of Belle Isle (SOBI) crossing and a new synchronous condenser facility. Specifically it includes:

- Muskrat Falls HVdc converter stations: HVdc bipolar converter station; 315 kV ac, converted to ±350 kV dc; Pole capacity of 450 MW;
- Overhead transmission line from the Muskrat Falls converter station to Soldiers Pond converter station: 900 MW, ±350 kV dc, bipolar line, single conductor per pole; Galvanized lattice steel guyed suspension and rigid angle towers; 1100 km long.
- 3 Mass Impregnated 450MW capacity each submarine cables crossing the SOBI protected using HDD boreholes and seabed rock protection
- One transition compound for each side of the Strait of Belle Isle submarine cable crossing, with associated switch works to manage the junction of multiple submarine cables and the overhead transmission line.

- Shoreline pond electrode located on the Labrador side of the Strait of Belle Isle. The Lanseau-Diable shoreline pond electrode will be connected to the converter station at Muskrat Falls with dual overhead conductors supported on a wood pole line from the pond electrode site to the HVdc transmission line Right of Way and from there on will be supported on the HVdc Line structures.
- Soldier's Pond HVdc converter station: HVdc bipolar converter station; 230 kV ac, converted from ±350 kV dc; Pole capacity of 450 MW; and Shoreline pond electrode located on the east shore of Conception Bay
- AC Switchyard at Soldier's Pond on the Avalon Peninsula.
- Dowden's Point shoreline pond electrode connected to the converter station at Soldiers Pond with dual overhead conductors supported on a wood pole line.
- New synchronous condenser at Soldier's Pond – 3 x 175 MVar units
- Breaker upgrades / replacements at the existing Sunnyside Terminal Station
- ECC Upgrades and fiber communication connections to Soldier's Pond
- Operations Telecommunication system
- Salient Features of the LIL site are summarized in Appendix C

Economic/Business Case

Newfoundland and Labrador requires new sources of power to meet the province's future electricity needs. The economy is growing and demand for residential and business electricity continues to rise steadily. Forecasts prepared by Newfoundland and Labrador Hydro show that without a new source of power for the island by 2015, demand will begin to exceed firm supply.



***CAGR** - Compound Annual Growth Rate

Demand is being driven by:

- A strong economy and new business development
- Growth in the number of residential customers
- Higher than average new home construction
- Growing electricity use in homes
- Increased use of electric heat (86% of all new homes use electric heat)
- Increased industrial demand, primarily driven by the nickel processing facility in Long Harbour

Overall, the island's electricity demand is expected to rise an average of 1.4% per year between 2011 and 2030. This assumes no new large energy intensive industrial customers in the province over this period.

The Province has developed an Energy Plan to ensure that the people of NL take pride and ownership in energy resources and strategically develop them in such a way that returns maximum benefits to the province for generations to come. To support the plan, they have established principles, goals and policy actions. The *principles* are the anchors for all future decision-making on energy issues. They will hold true even in changing times throughout the province, the country and the world. The principles include sustainability (Energy developments must be environmentally and economically sustainable), control (exercise appropriate control over the development of our resources) and cooperation & coordination (effective cooperation and coordination with key stakeholders and partners).

The *goals* describe what they want to achieve in the long term. They consider the realities and the challenges they face. The goals are flexible, so they can evolve with their energy industry and society. The goals include Environmental Leadership, Energy Security and Sustainable Economic Development.

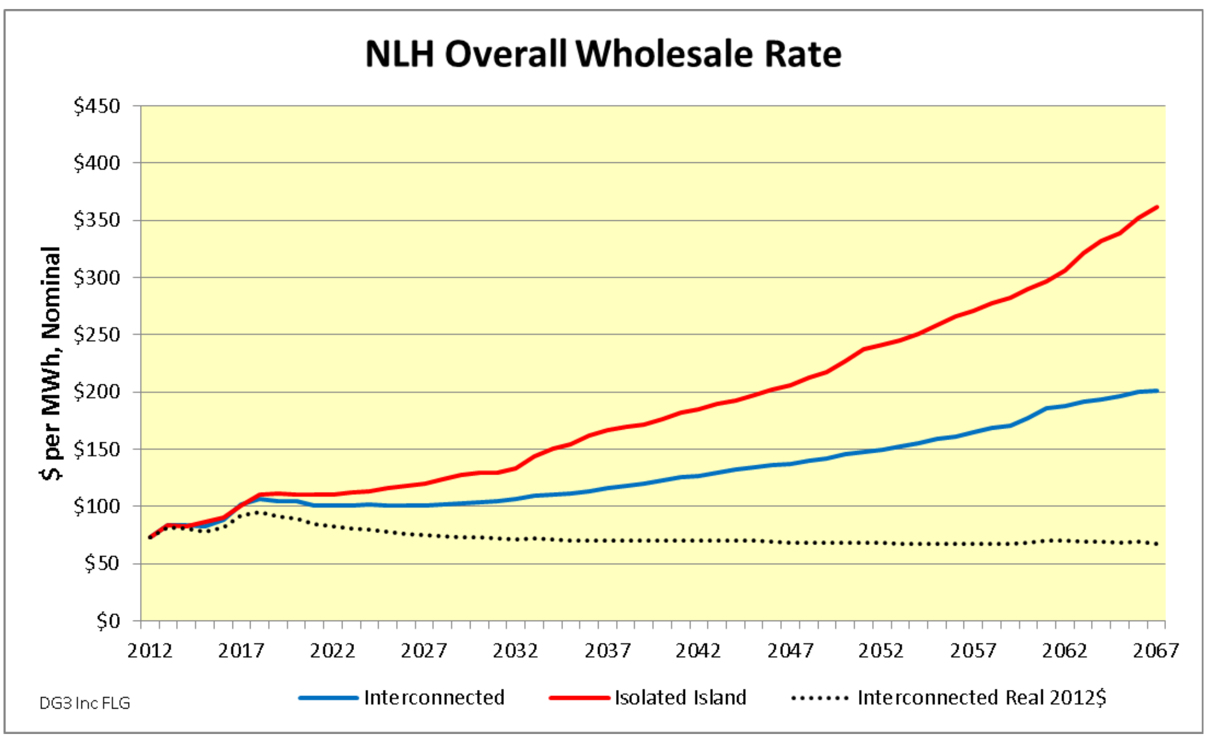
The *policy actions* are the detailed, measurable steps they will take to achieve the goals.

Nalcor evaluated a number of potentially feasible generation expansion alternatives for the growing and long-term supply of electricity to the Island of Newfoundland including natural gas, small hydro, wind power, biomass, solar, enhanced conservation efforts, continued oil-fired generation at the Holyrood Plant and other thermal-based options.

After examining all available options to determine which ones were viable, the final two alternatives were:

- an oil-dependent alternative with continued use of the Holyrood thermal plant and the addition of more thermal generation, wind power and small hydro (Isolated Island); and
- Muskrat Falls with a transmission link to the island (Interconnected Island).

Remaining isolated would mean a future that is dependent on thermal generation, burning millions of barrels of oil at the aging Holyrood plant. It would also include development of a series of smaller hydro, thermal and wind generating facilities around the island. The combined cost of building and operating the Isolated Island option exceeds the cost of building and operating the Interconnected Island option by more than $2.4 billion in 2012 (present day) dollars.



Building Muskrat Falls is the lowest-cost option for meeting the province's growing electricity needs. The development of Muskrat Falls would also mean the island would no longer operate as an isolated system, and would have increased reliability through the ability to import or export power. With Muskrat Falls, the province will own a revenue-generating asset and have an interconnected system, with transmission links from the island to Labrador and to the mainland.

Strategic De-Risking

The LCP management team utilized a disciplined management process to ensure the entire project was de-risked to an acceptable level.

A formal Risk Register was utilized early on in the project to address commercial risks, financial risks, regulatory & stakeholder risks, technical risks and execution risks.

In addition, specific risk registers were developed for different areas of the project to develop the overall Project Risk Register. The areas were:

- General Risk Register – includes Labor Relations, Financing, Regulatory & Sales, Aboriginal and Environmental Assessment Risks
- SOBI Risk Register – includes SOBI crossing risks
- EPCM Consultant's Risk Registers – includes MF, Overland Transmission, HVdc Specialties as well as General Execution & Project Management risks
- Emera's Maritime Link Risk Registers – Cable Strait Crossing, Overland Transmission and HVdc Specialties

Specific areas achieved were:

- Design philosophies based upon over 40 years of hydroelectric and transmission engineering, construction and operations
- Secured SNC Lavalin, a world class EPCM services contractor
- Selection of robust HVdc technology with overload capacity which has been utilized in Canada for over 40 years
- Turbine efficiency model testing program completed to guarantee turbine efficiency and power output utilizing Kaplan turbines which are well within turbine flow and head capabilities
- SOBI crossing consisting of 3 cables (2 plus an installed spare)
- Mass impregnated submarine cables
- SOBI cable protection proven offshore on the east coast of Canada
- Extensive geotechnical baseline of sites
- Resolved land claims by Innu
- Pilot program for HDD to confirm production rates
- Project labour agreements in place
- Utilization of up to 735 kV which is core to existing Nalcor system
- Low head and no penstocks with concrete powerhouse founded on Canadian Shield

In addition, the project has undergone various independent reviews by various parties to ensure that project is both financially viable but also technically achievable with the parties involved. Specific reviews include the following:

- Independent Project Review by the team at each stage
- Independent Project Analysis (IPA) evaluation at Decision Gate 2
- Navigant checked the business model
- Manitoba Hydro International did an overall project assessment report for the Public Utilities Board (PUB) of Newfoundland and Labrador at DG2 and again at DG3
- PUB conducted a open public review
- MWH was engaged as the independent engineer in 2012 to perform technical review on behalf of the Federal Government for the loan guarantee

From a fire insurance standpoint, the protection/suppression systems are to be designed utilizing NFPA and FM Global standards.

Project Capital Cost Estimate

Nalcor has adopted the recommended estimating practices of the Association for Advancement to Cost Engineering (AACE) International for use in planning the development of the LCP. AACE International is recognized within the engineering, procurement and construction industry as the leading authority in total cost management, including cost estimating standards, practices and methods. While AACE International is yet to publish a cost estimate classification system, Nalcor has built upon the general guidance contained within Recommended Practice No. 17R-97 to map the level of estimate maturity required for each of the gate decisions within Nalcor's Gateway Process, as shown below.

Estimate Classes required for Decision Gates

Required for	Decision Gate 1	Decision Gate 2	Decision Gate 3	Financial Close	Mid-Point Check
Class	AACEI Class 5	AACEI Class 4	AACEI Class 3	AACEI Class 2	AACEI Class 1
Estimate Purpose	Opportunity Screening	Alternative Selection	Sanction/Control	Financing	Check Estimate
Project Definition	0% to 2%	1% to 15%	10% to 40%	30% to 70%	50% to 70%
Estimating Accuracy	-50% to +90%	-30% to +50%	-20% to +30%	-15% to +20%	-10% to +15%

The following table provides the latest (Q4-2012) breakdown of the DG3 Capital Cost Estimate by Project and Estimate Component.

	Muskrat Falls	LTA	LIL	Total
Base Estimate	$2,511,923,504	$601,311,778	$2,359,610,970	$5,472,846,252
Growth Allowance	$389,234,769	$90,270,587	$250,137,947	$729,643,303
Total	**$2,901,158,273**	**$691,582,365**	**$2,609,748,917**	**$6,202,489,555**

Note: Growth Allowance = Estimate Contingency + Escalation Allowance

The costs quoted here are inclusive of all development costs (including pre-development costs, soft costs, contingencies and escalation). Values for insurance purposes are presented later in this document.

Shareholder Support & Commitment

The key LCP players are:

1. *Government of Newfoundland and Labrador* - The Government of Newfoundland and Labrador, as sole shareholder of Nalcor and NLH, is the primary equity provider of the LCP. The Government is committed to supporting the development of the LCP as a matter of Government policy of the highest importance, consistent with its 2007 Energy Plan. They have committed to provide the base level and contingent equity support required by Nalcor to ensure successful achievement of in-service for MF/LTA/LIL and ensure all project costs are recovered from NL ratepayers through legislative and regulatory framework.
2. *Nalcor Energy* – Nalcor is a provincial Crown corporation. Nalcor has several roles and responsibilities in the development of the LCP, including: project sponsor; development manager; equity holder of the SPVs that will be created to own, finance and operate the Projects; and provider of support, services and resources to SPVs, either pursuant to its role as development manager or pursuant to written service contracts with SPVs.
3. *Newfoundland and Labrador Hydro (NLH)* – NLH is a provincial Crown corporation and a subsidiary of Nalcor. NLH generates, transmits and distributes electrical power and energy to industrial, utility and residential customers in Newfoundland and Labrador.

   NLH has several roles and responsibilities in relation to the development of the LCP, including:
   - Purchaser of a portion of the power generated by the Muskrat Fall Generation Project for subsequent distribution to its customers;
   - Ultimate funder of the Labrador Transmission Assets Project and the Labrador-Island Link Project;
   - Remote monitoring and operation of the completed Muskrat Falls Generation Project, Labrador-Island Link Project, and Labrador Transmission Assets Project;
   - Provision of technical, support, administrative and other services as may be requested from time to time by Nalcor to support Nalcor in its role as development manager of LCP;
   - Upgrade its facilities in Newfoundland and Labrador as required to receive, transmit and distribute the power from Muskrat Falls Generation Project, including for purposes of transmitting power to Emera (and/or its subsidiaries) and other export market customers via the Maritime Transmission Link Project;
   - Arrange and ensure recovery of appropriate costs and earning of revenue through the approved tariffs.
4. *Emera Inc.* – Emera is a public company that operates throughout north-eastern North America, including Nova Scotia and New Brunswick. Emera's role in relation to the LCP includes:
   - Minority equity investor in the Labrador-Island Link Project;
   - For a period of 35 years, recipient of approximately 1 TWh per year of power from the Muskrat Falls Generation Project (the "NS Block");
   - Project sponsor responsible for construction of the Maritime Transmission Link;
   - Provider of transmission rights to Nalcor on the Nova Scotia, New Brunswick and Maine transmission systems to deliver power that is not required by NLH or the NS Block, to export markets.
5. Federal Government of Canada – The Federal Government of Canada has provided a Federal Loan Guarantee for the Lower Churchill Projects that will result in the project debt achieving Canada's AAA credit rating.

Ownership & Financial Structure

Each of the project components will be owned by a corporation, limited partnership or other special purpose entity ("SPV") created for that purpose. Maintenance, service and operation of each project will also be the responsibility of one or more newly created SPVs, who may perform those services themselves or contract them to NLH or others. Further, two separate project development SPVs will be created. One will be responsible for the Labrador-Island Link Project, acting in the capacity of Project integrator, and the second will be responsible for execution of both the Muskrat Falls Generation Project and the Labrador Transmission Assets Project, acting in the capacity of Project integrator.

Under the current project implementation strategy, each of the projects will be owned, operated and maintained by the following SPVs or existing entities:

Muskrat Falls Generation Project

Owner: Muskrat Falls Generation Co, a wholly owned subsidiary of Nalcor which will become the owner of the Muskrat Falls Generation Project.

Operator: Muskrat Falls Generation Co. The plant will be remotely operated from NLH's control center in St. John's. This will involve the starting and stopping of units, loading and unloading of power output, reactive control of the units, and the monitoring and reporting of plant alarms and events.
Although the organizational structure has not been yet been settled, the Operator through a center of expertise in hydro plant operation will be able to draw on the experience of NLH and CF(L) Co, the operator of the Churchill Falls generating facility. This could include contracting the operation to NLH, which will result in a center of asset management expertise with broad experience that will oversee the Muskrat Falls Plant. There will be staff present at Muskrat Falls who will be responsible for the local operation and troubleshooting. They will be supported by centralized engineering staff that will provide the operations engineering support for the plant.

Routine Maintenance: Muskrat Falls Generation Co. Routine maintenance will be done by local technical staff that are trained in the maintenance requirements of the Muskrat Falls Plant. They will follow Nalcor's asset management practices implemented for Churchill Falls and NLH's numerous hydroelectric assets, adjusted as necessary for the unique assets in use at Muskrat Falls.

Non-Routine Maintenance, Upgrades and other Work and Services: Third party specialty contractors.

Labrador Transmission Assets Project

Owner: Labrador Transmission Co. ("Labrador Transco"), a wholly owned subsidiary of Nalcor which will become the owner of the Labrador Transmission Assets Project.

Operator: The Project owner will have capacity operating control and responsibility for maintenance. The owner will be providing operating control through a Transmission Operator Agreement to the Newfoundland and Labrador system operator ("Sys Op") who is responsible for the reliable operation of the NL bulk electric system and providing transmission service to transmission customers.

Routine Maintenance: Labrador Transco, which will be responsible for the routine maintenance of the Labrador Transmission Asset. It will contract the routine maintenance to NLH who has transmission asset management expertise in all areas of transmission operation and maintenance.

Non-Routine Maintenance, Upgrades and other Work and Services: Third party specialty contractors under contracts with Labrador Transco or through NLH as appropriate and when required.

Labrador-Island Link Project

Owner: Labrador-Island Link Limited Partnership ("LIL LP"), the partners of which include:

- Nalcor Labrador-Island Link Holding Co. ("LIL Holdco"), which will be a wholly owned subsidiary of Nalcor, which will have a 65% interest; and
- Emera Newfoundland and Labrador Inc. ("Emera NL"), an existing wholly owned subsidiary of Emera, either directly or through a wholly-owned Newfoundland and Labrador subsidiary, which will have a 35% interest.

In addition, Nalcor Labrador-Island Link General Partner Co. ("LIL GPCo"), a wholly owned subsidiary of Nalcor will be the general partner of LIL LP.

Operator: Nalcor Labrador-Island Link Operations Co. ("LIL Opco"), a wholly owned subsidiary of Nalcor, pursuant to a long term lease arrangement with LIL LP under which it assumes capacity operating control and responsibility for maintenance. LIL Opco will provide operating control to Sys Op through a Transmission Operator Agreement. The system operator will be responsible for the operational control of the transmission asset as part of its responsibility for the reliable operation of the NL bulk electric system. It will also provide transmission service using these transmission assets to transmission customers.

Routine Maintenance: LIL Opco, who is responsible for routine maintenance, will contract the maintenance to NLH.

Non-Routine Maintenance, Upgrades and other Work and Services: Third party specialty contractors under contracts with LIL Opco as and when required.

Financial Structure

The Project will be funded through a combination of an equity commitment from NL and debt financing that will be guaranteed by the Government of Canada per the Federal Loan Guarantee Agreement executed on November 30, 2012. The Province has committed to provide the base level and contingent equity, if required, to ensure the Projects achieve in-service. The debt guarantee constitutes a direct, absolute, unconditional and irrevocable obligation of Canada and thereby carries the full faith and credit of Canada (i.e. AAA ratings or equivalent from each of Standard & Poor's, Moody's, DBRS and Fitch Ratings).

Nalcor approached the financial markets in May 2013 with a Request for Financing to select a lead arranger (or co-leads) to provide a fully underwritten financing of up to $2.6 billion for the Muskrat Falls/Labrador Transmissions Assets Funding Trust and up to $2.4 billion for the Labrador Island Link Funding Trust. Each of these funding vehicles will be a special purpose NL trust, the purpose of which is to borrow funds pursuant to its financing arrangements with third party lenders and on-lend those funds to the respective Nalcor subsidiaries responsible for the development, construction, commissioning and operation of the Project. Under these arrangements, lenders will be entirely insulated from project risks. Further details on these funding vehicles, the Canada guarantee and the related financing structure can be found in a press release from Moody's Investor Services dated April 18, 2013.

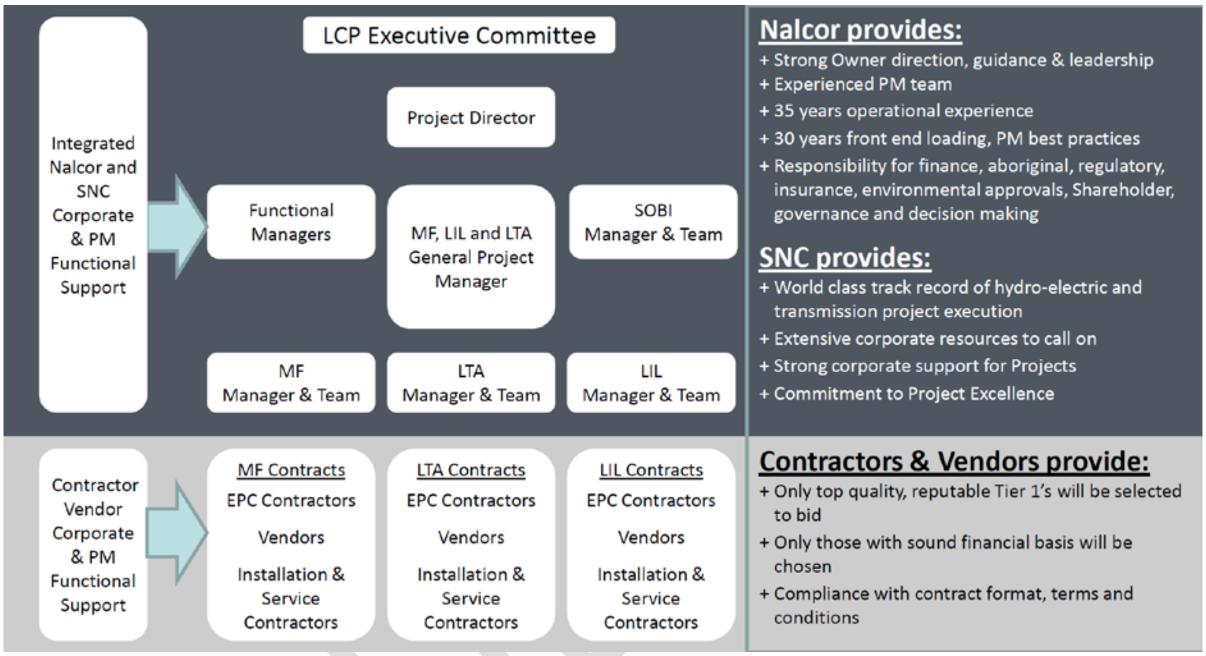
Financial Close is targeted for Q4 2013. In the meantime, Early Works construction is being funding 100% via equity contributions from the Province.

Project Execution & Contracting Strategy

A detailed Project Execution Plan describes the Decision Gateway process used for the LCP and the division of the LCP into the three projects and various sub-projects for ease of execution, cost effectiveness and risk mitigation.

Project Management

Organizational Structure



Under the Project Execution Plan, Nalcor, with SNC-Lavalin Inc. as its integrated Engineering, Procurement and Construction Management (EPCM) consultant, operate as a single integrated team and is responsible for:

- the Muskrat Falls Generation Project
- the Labrador Transmission Assets Project, and
- the Labrador-Island Link Project, other than the marine crossing at the Strait of Belle Isle (SOBI) which will be managed directly by Nalcor

Nalcor, as Owner and Development Manager, is responsible for obtaining environmental and regulatory approvals, aboriginal negotiations and consultations, power sales, financing, industrial relations and an owner-controlled insurance program, and general management and coordination of the three projects.

The Nalcor Strait of Belle Isle scope of work is excluded from the SNC-Lavalin services. There is a dedicated Nalcor team responsible for the project management of the SOBI scope of work, including:

- an EPC contract for the supply and installation of the sub-marine cable
- one or more Horizontal Directional Drilling (HDD) contracts for drilling holes from land to a water depth of approximately 80 meters through which the cables will be installed, and
- contract for the supply and installation of a rock berm to cover the exposed portions of the cable at water depths in excess of 80 meters.

The fundamental planning strategy for the Project is as follows:

- Divide the Project into manageable sub-Projects, each with their own execution plans that efficiently represent the work and minimize interface conflicts. The next figure indicates the breakdown of the Project into phases, sub-projects and sections, as configured at DG3.
- Identify Project Key Dates and Project Milestones which will be universally accepted as significant.
- Establish a baseline for gauging delivery of Project Key Dates and Project Milestones that is consistent across the Project.
- Establish a benchmark for gauging efficiency of delivery.
- Establish an analysis and reporting mechanism of actual performance against the baseline that serves to align the PMT and is forward looking enough to permit timely intervention to avoid or correct undesirable events.

The central strategy for achieving the planning and scheduling objectives noted above is to develop project schedules that support the achievement of key planning dates established for the Project and endorsed by Executive Management. The Target Milestone Schedule has been developed to define and establish these key planning dates for the Project upon which the Project Execution Plan and detailed work programs endeavor to facilitate. All project schedules must work to structured to facilitate the achievement of these Project Milestones.

Appendix G of the Target Milestone Schedule provides the planning basis as understood at Decision Gate 3, with key dates noted in Table below. All detailed project schedules align in support of these target dates.

The milestones and logic in this Target Milestone Schedule have been developed using the results of engineering and project planning completed up to Decision Gate 3 (DG3). At the time it was prepared Muskrat Falls Generation, Labrador Transmission Asset, and Labrador-Island Transmission Link sub-projects were all in Gateway Phase 3, in preparation for DG3 approval. The level of detail in this document for the four projects is commensurate with the stage of the applicable sub-project.

Milestone	Target Milestone Date
Project Sanction	Q4 2012 (achieved)
LIL – LTA Ready for Energy Transfer	June 2017
First Power to Island via LIL	December 2017
MF Full Power	December 2018

The development of this Target Milestone Schedule for DG3 is predicated on a number of assumptions. These assumptions will change over time and this Target Milestone Schedule will need to be revised accordingly. They include:

- The environmental assessment process for the Labrador-Island Transmission Link project will be completed no later than the end of the first or second quarter of 2013.
- Project Sanction will occur at DG3 and is a pre-requisite for financial commitment required to proceed with major construction works, other than Early Works underway pre-DG3.
- The SOBI subsea cables can be installed in a single construction season.
- The supply and installation works for subsea cables on both the LIL and ML projects can proceed independently without affecting each other.
- Sufficient construction contractors and construction labour is available to execute the overland transmission works on the three separate projects (LTA, LIL and ML) within the required timeframes.

- Either the Labrador Transmission Assets or the Labrador-Island Transmission Link is required to commission the Muskrat Falls generating facility.
- Full Power from Muskrat Falls can only be delivered to the Island of Newfoundland after completion of the Labrador-Island Transmission Link as well as commissioning of the four (4) generating units at Muskrat Falls.

Contracting Approach

As part of its development strategy for the LCP, Nalcor considered various contracting strategies for the LCP. These included requests for proposals for development of the entire LCP, which resulted in no acceptable proposals due to the magnitude and scope of the LCP, a single and/or multiple EPC contracts for the entire LCP, an owner-integrated team approach and many others.

The current contracting strategy for LCP, and for each of the main projects within the LCP, is fully described in the Overarching Contracting Strategy Document. In summary, Nalcor concluded that the optimal project contracting strategy was not through one or more EPC contracts to the exclusion of all other types of contracts. Given the limited availability and competitiveness of contractors with sufficient financial capacity, resources and experience to execute an EPC contract of the size and scope required for any one of the three projects, let alone all of the LCP, a default or insolvency of such a contractor during construction creates unacceptable risks to Nalcor and the lenders.

As part of its contracting strategy for the LCP, Nalcor identified the major work elements for the LCP, which are:

Major Work Elements

Power Generation

Large civil and concrete works

- Powerhouse
- Gated Spillways
- RCC and Earth-filled Dams
- Access Roads
- Temporary River Diversion Works
- Turbine and Generators
- Balance of Plant (E&M)
- Construction Temporaries
- Accommodations Complex
- Reservoir Clearing
- Catering and Site Mgmt

HVdc Specialties

Specialty works with "proprietary" technology

Group 1
- Converter Stations
- Synchronous Condensers
- Switchyards
- Electrodes
- Transition Compounds (submarine to overhead)

Group 2
- Submarine Cable Supply
- Submarine Cable Installation
- Seabed Protection
- Shoreline Protection

Overland Transmission

Large scale HVac and HVdc transmission works with "standard" hardware

- Hardware Design & Spec
- Hardware Purchase
  - Towers, Foundations, etc.
  - Conductor
  - Insulators
- Installation
  - Right of way clearing
  - Access roads
  - Camps
  - Foundations
  - Anchors
  - Tower erection
  - Conductor stringing

As readily evident from the major work elements, many elements are unrelated to each other and require different types of contractors and resources than others. For example, reservoir clearing work has little in common with the supply and installation of turbines and generators both of which require different types of skill sets, resources and experience and have clear, separately defined limits, distinct from each other.

From the major work elements, contract packages were identified for work that was considered largely independent of other work or that had clear battery limits and defined but limited interfaces with other work. This allowed for discrete contract packages that would create more competition and, more importantly, in the event of delay, default or insolvency of any one contractor, would not put the project at risk because that contractor could be replaced with a new, potentially existing site contractor. This contractor package breakdown did not exclude EPC contracts entirely. In a number of cases, and where deemed most appropriate, an EPC contract was considered the optimal contract for most effectively managing risk, examples of which include the design, supply and installation of the turbine and generators, the HVac to HVdc converter stations, and the submarine cable. Appropriate work breakdowns would also allow early tendering, award and construction of work to mitigate schedule risk, thereby providing more assurance that full power will be delivered when scheduled. It also facilitates using different pricing strategies with different contract packages to further mitigate again cost over-runs and delay and impact claims which could increase the total cost of the LCP.

Major Contracts

The major contract values are in a limited number of large contract packages, which are identified and described in the Overarching Contracting Strategy document and can be summarized below.

Package Ref. No.	Contract Package Title	Scope	Notional Contract Form
CH0002	Accommodations Complex Buildings	Supply and installation of construction accommodations complex (1500 persons)	Combination – Lump Sum and Unit Prices
CH0003	Administration Buildings	Supply and installation of construction administration buildings (medical clinic/ security, gate house, fire station, admin. Building, Owner's warehouse)	Combination – Lump Sum and Unit Prices
CH0004	Main Site Access Road - South Side	19 km long access road on the south side of the Churchill River from Muskrat Falls to near Blackroad Bridge on Trans Labrador Highway	Combination – Lump Sum and Unit Prices
CH0005	Accommodations Complex Site Utilities	Includes: - Site Prep - Camp Area - Water Supply / Distribution & Fire Protection - Sewage Treatment Plant & Sewer Mains - Site Prep - Owner's Warehouse & Laydown - Site Prep. - Contractor's Laydown Area - Electrical Supply and Distribution for Camp - Emergency Generator c/w Tank - On Site Communications infrastructure - Electrical Infrastructure - Distribution switchgears	Combination – Lump Sum and Unit Prices
CH0006	Bulk Excavation Works	Includes: - Powerhouse / Intake Excavation - Tailrace Excavation - Spillway Excavation - South dam overburden excavation	Unit Price

		- Muskrat Falls Switchyard and Converter station grading and leveling	
CH0007	Intake, Powerhouse & Spillway Construction	Concrete Structures including: - Formwork & Concrete for Intake, Spillway, Powerhouse including Draft Tube, Service & Erection Bay, & Transition Dams Includes: - Reinforcing Steel - Embedded parts and grounding, - Powerhouse Building including the supply and installation of Structural Steel, Cladding and lighting, - Grounding of guide guides - Formwork and Concrete - Secondary Concrete - Gate Guides - Reinforcing Steel - Grounding of Gate guides	Unit Price
CH0008	North Spur Stabilization	Including: - Upstream Berm - Downstream Stabilization - Pumpwells - Crest Unloading - North End of Spur	Unit Price
CH0009	RCC Dams - North & South Construction	RCC Dam Works including: - Upstream and downstream cofferdams - Foundation Preparation - RCC Dam Construction - Concrete Downstream Face - Concrete Cap and Retaining Walls - Drainage Gallery - Instrumentation - Cofferdam Installation and Removal - Downstream Toe Wall	Unit Price
CH0023/ CH0024	Reservoir Clearing	Reservoir Clearing including surveying & clearing, harvesting, collection of materials and disposal of waste, including debris and slash management.	Lump Sum
CH0030	Turbine & Generators	Turbine units & generators, including exciters, controls and monitoring systems elec. and mech. protection systems, governors – Supply, Install, testing and commissioning.	EPC Lump Sum
CH0031	Balance of Plant (BOP)	Supply of installation materials and erection of electromechanical equipment incl. DG set, utilities and architectural work	EPC Lump Sum
CH0032	Spillway, Intake & Powerhouse Gates	Draft Tube Gates (2 sets), complete with storage and retrieval system and guides/ concrete embedments, and follower beam and gantry crane. Spillway Gates (3), including stop logs (1 set) complete with storage and retrieval system, hoists and heating system, guides/concrete embedments, hoist structure, and emergency diesel generator set, fuel storage and	Lump sum

		accessories	
CT0319	HVac Transmission Line Construction & Installation	132.5 km of double circuit 315kV Transmission Line construction (lines 1 and 2) – Muskrat Falls to Kilometer 132.5.	Combination Lump Sum & Unit prices
CT0341	HVac ROW Clearing	263 km of Right of Way Clearing (100m wide) for 315kV Transmission Line parallel to the existing 138kV ROW.	Combination Lump Sum & Unit prices
CH0033	Powerhouse Crane	Supply and install powerhouse crane	Lump Sum
PH0014	Transformers	Supply and supervise installation of the generator step-up Unit transformers, autotransformers at tap station 315-138kV, and autotransformers at Churchill Falls 735-315kV.	Lump Sum
CD0501	Converter Stations @ Muskrat Falls and Soldiers Pond	Turnkey electromechanical design, supply, erection and commissioning, including civil works and buildings	EPC Lump Sum
CD0502	AC Substations & Synchronous Condensers	Turnkey electromechanical design, supply, erection and commissioning, including civil works and buildings	EPC Lump Sum
CD0535	Synchronous Condensers	Turnkey electromechanical design, supply, erection and commissioning, including civil works and buildings	EPC Lump Sum
CT0327	HVdc Transmission Line Construction and Installation	Transmission Line construction including access roars, foundations, tower erection, conductor stringing, materials handling	Combination Lump Sum & Unit Prices
CT0319	Transmission Corridor ROW Clearing	Right of Way clearing including access roads	Combination Lump Sum & Unit Prices
CD0508	Switchyard, Electrodes & Transition Compound Construction	Civil works including final grading, concrete foundations, supply and erection of control buildings, access roads, fencing, and grounding mat and electro-mechanical installation and commissioning.	Combination Lump Sum & Unit Prices
LC-SB-003	SOBI Cable Supply and Install	Supply and install SOBI cable	Lump Sum
LC-SB-022	HDD Rig	Supply HDD Risk and Surface Spread	Lump Sum
LC-SB-024	HDD for SOBI Cable	Civil works for the horizontal directional drilling of the cable holes	Lump Sum
LC-SB-011	Rock Berm for SOBI Cable Protection	Placement of rock protection via vessel	Lump Sum

Quality Assurance Strategies

The Quality Assurance Department for the Lower Churchill Project has been established as a functional quality department to focus on the delivery of the four projects; Strait of Belle Isle cable crossing, Muskrat Falls Generation, Overland Transmission and HVdc Specialties & Switchyards projects. Each functional department includes quality managers, quality coordinators, inspectors, inspection coordinators, and auditors.

Specific areas where QA has/will been applied are:

1. Rigorous supplier/contractor qualification process which involves:
   - Defined pass/fail quality criteria for all supply and contract packages. (i.e. Suppliers/ Contractors must work in compliance with ISO 9001 Quality Management Systems; Higher score given to those who are actually certified to this standard)
   - Pre-award audit assessments for high-risk critical contract packages. (i.e. For turbines and generators package, in depth quality assessments were made in China and India for a periods on 4 weeks in 2012)
2. Ensuring strong linkage between suppliers and sub supplier's in terms of surveillance oversight and management for quality. This is confirmed during assessments and through weekly meetings with the suppliers/contractors.
3. Implementation of project quality schedule.
4. Detailed review of quality plans, procedures and records from all suppliers and contractors during execution of the work.
5. Owner managed independent testing laboratories have been engaged during construction. Contract is in place with AMEC to perform this.
6. Owner retained independent testing laboratories will be engaged during manufacture in Asia to validate material properties.
7. Engaging other Owner's to get lessons learned from working in Asia. (i.e. The LCP team went to Manitoba Hydro for two days to discuss their lessons learned from working in China with Andritz).
8. Development and implementation of quality surveillance plans and strategies for packages.
9. Use of four globally recognized third-party inspection service contractors to provide quality surveillance. Contracts are in place with:
   - SGS
   - Moody
   - Killick group
   - GL Noble Denton
10. Controlled process for release of equipment and materials inbound to the project.

Logistics

Within the Supply Chain Functions, a Logistics Manager supported by a 3rd party Freight Forwarding Specialist will coordinate the domestic and international transport and import process including supervision and receipt of equipment and material at site. A freight forwarder will be chosen to manage all logistics aspects of the project. The full team will include but not be limited expeditor, freight forwarder, customs broker and warehouse/marshalling manager.

The Logistics Manager will address the following, but not limited to, strategic points:

- Transportation routes into Newfoundland and Labrador;
- Infrastructure upgrades required to move heavy load equipment;
- Weather constraints in a northern climate;
- Worldwide sourcing of materials;
- Material critically;
- The general experience of Suppliers in shipping;
- Consideration of strategic marshalling/consolidation points;
- The number of “heavy lift” and “out of gauge” shipments to be transported;
- The importance of correct procedures and documentation for Canadian import.

Mammoet, a heavy haul specialist, conducted a route survey in Labrador and the island of Newfoundland for the transportation of heavy equipment and identified various routes that could be used to move heavy load equipment, identified decisions that are required plus next steps which will be addressed in the near term.

Logistics Studies

In 2008 and 2009 Nalcor engaged technical consultants to review access to the Project site and to identify any required modifications to infrastructure in the area. The studies provided assistance in identifying gaps in the transportation strategies and assist in determining what infrastructure upgrades are required.

In January 2012 SLI prepared an issued a logistics study which outlined the various transportation methods, identified challenges for the project and potential strategies to mitigate them. It also confirmed some of the previous gaps identified from the Nalcor studies conducted in 2008 and 2009.

As a result, Nalcor engaged Mammoet Hunt’s Atlantic Ltd., a worldwide specialist in heavy haul movements, to conduct a detailed route study for transportation of heavy equipment to the Project sites.

The route study involved the large cargo movements of the auto and converter transformers, turbine and generator components and synchronous condenser components to the noted areas of Churchill Falls, Muskrat Falls and Soldier’s Pond.

Several options were provided as solutions. A complete review of the details and decisions made as to which options are almost complete. The DG3 Estimate includes provisional allowances for upgrades to be completed.

Schedule & Cost Breakdown

The project commenced with Early Works (Q3 -2012 at Muskrat Falls) and DG3 and Nalcor/Provincial authorization. Early Works are described later in this document. Financial Close and the main construction activity would commence throughout 2013. The Projects are planned to produce first power by the end of 2017 with full commercial operation by in 2018.

Base Estimate

The Base Estimate was developed using four key inputs: (i) scope, (ii) construction methodology and schedule, (iii) price factors, and (iv) performance factors. The following table shows a breakdown of the final DG3 Base Estimate. From these figures, we deduct historical costs and various soft costs to arrive at the Project Value for insurance purposes.

The calculated Base Estimate for each of MF, LTA and LIL by major scopes of work are shown in the tables below. Detailed values are provided in an attachment (DG3 Capital Cost Estimate Tables).

Muskrat Falls Base Estimate by Major Scopes of Work

A - Muskrat Falls Generation	**$2,077,401,708**
A.1 - Accommodation Complex/Admin/Utilities Access Roads/Construction Power	$166,608,338
A.2 - Bulk Excavation and Main Civil works for Intake and Powerhouse, Spillway and Transition Dams	$823,064,224
A.3 - North Spur/ North and South Dams/Reservoir Clearing/Habitat Compensation works	$336,605,489
A.4 - T&G's/Powerhouse Mech and Elect Auxiliaries/Hydro Mech Equipment/GSU's/ Collector Lines	$484,012,733
A.5 - Telecommunications	$17,298,550
A.6 - Site Services	$248,312,374
A.7 – Spares	$1,500,000
D – General	**$337,218,632**
D.1 - Project Management	$292,987,287
D.2 - Integrated Commissioning Services	$1,950,000
D.3 - Project Vehicles / Helicopter Support	$5,691,750
D.4 - Insurance/Commercial	$14,531,242
D.5 - Land Acquisitions and Permits	$1,115,004
D.6 - Quality Surveillance & Inspection/Freight Forwarding Services	$4,700,000
D.7 - Environmental & Aboriginal Affairs	$16,243,349
E – Historical	**$97,303,164**
D.8 - Historical Cost	$97,303,164
Grand Total	**$2,511,923,504**

Labrador Transmission Assets Base Estimate by Major Scopes of Work

C - Labrador Transmission Asset	**$498,769,539**
C.1 - OL Transmission CF-MF	$288,254,205
C.2 - Switchyards	$192,087,214
C.3 - Telecommunications	$15,467,507
C.4 - Spares	$2,960,613
D - General	**$98,346,146**
D.1 - Project Management	$82,891,340
D.2 - Integrated Commissioning Services	$9,372,938
D.3 - Project Vehicles / Helicopter Support	$842,250
D.4 - Insurance/Commercial	$2,519,988
D.5 - Land Acquisitions and Permits	$1,119,630
D.6 - Quality Surveillance & Inspection/Freight Forwarding Services	$1,600,000
E - Historical	**$4,196,093**
D.8 - Historical Cost	$4,196,093
Grand Total	**$601,311,778**

Labrador-Island Transmission Link Base Estimate by Major Scopes of Work

B - Labrador - Island Transmission Link	**$2,012,062,855**
B.1 - Converters/Transition Compounds/Synch Condensers/SP Switchyard	$639,805,781
B.2 - Electrode Sites/Island Upgrades	$77,613,063
B.3 - OL Transmission MF-SP	$929,045,619
B.4 - SOBI Marine Crossing	$337,440,262
B.5 - Telecommunications	$21,433,995
B.6 - Spares	$6,724,135
D - General	**$262,240,951**
D.1 - Project Management	$194,893,751
D.2 - Integrated Commissioning Services	$3,053,762
D.3 - Project Vehicles / Helicopter Support	$10,311,000
D.4 - Insurance/Commercial	$15,674,421
D.5 - Land Acquisitions and Permits	$18,472,787
D.6 - Quality Surveillance & Inspection/Freight Forwarding Services	$8,100,000
D.7 - Environmental & Aboriginal Affairs	$11,735,229
E - Historical	**$85,307,165**
D.8 - Historical Cost	$85,307,165
Grand Total	**$2,359,610,970**

Estimated Contract Values for Insurance

	Base Estimates	Est. Insured Value Liability Insurance	Est. Insured Value COC Insurance
Total – MF	**$2,511,923,504**	**$2,397,261,987**	**$2,397,261,987**
Total – LTA	**$601,311,778**	**$595,996,055**	**$307,741,850**
Total – LIL	**$2,359,610,970**	**$2,244,095,790**	**$977,609,908**
Master Total – all components other than SOBI Marine COC	**$5,472,846,252**	**$5,237,353,832**	**$3,682,613,746**
SOBI Marine Crossing	**Included in LIL**	**Included in LIL**	**$337,440,262**

Notes: 1) for both Liability & COC, soft costs, land costs, historical costs have been removed.

2) for COC, overhead transmission has also been removed from values

LCP Risk Assessment and Contingencies

Nalcor, with the support of its Risk Management Consultant – Westney Consultants, undertook a detailed risk analysis of the three LCP projects. The analysis entailed the development of a Tactical Risk Assessment a Time Risk Assessment, and a Strategic Risk Assessment. This analysis also informed Nalcor's estimate of project contingencies.

The probabilistic Tactical Risk Assessment considered the impact of such factors as schedule, performance factors and price risks on the Base Estimate. High and low ranges were developed for each major cost item predicated on the uncertainties associated with each of the four key inputs.

The primary project Timing Risk factors were:

- the Generation Project release from EA;
- Powerhouse Excavation and Primary Powerhouse Concreting; and
- The awarding of the Engineering, Procurement and Construction Services Management (EPCM) contract.

Nalcor has placed significant effort in its Time Risk Assessment on developing and implementing a de-risking strategy for the delivery schedule. Mitigation activities have included preparing to issue a Bulk Excavation Contract Package to facilitate an early commencement of Powerhouse Excavation, and award of three separate contracts for Turbine Model Testing to de-risk the overall turbine component delivery schedule, which is critical to maintain the planned Powerhouse concrete schedule.

Developing a cost and schedule for long term construction projects such as Muskrat Falls Generation and the Labrador ‐ Island Link is an extremely complicated process. The process becomes substantially more complex when the project involves three completely separate and different facilities that require two of the three projects need to commence commercial service at the same time. If two of the three projects is completed on schedule, while the other is delayed, cost recovery for the completed project could begin.

Nalcor has taken steps to mitigate this risk by

1) Incorporating uncertainties associated with major excavations and structures in the contingency allowance;
2) Scheduling installation of the undersea HVdc cable one year before it would be required; and
3) Engaging the same EPCM Consultant for Muskrat Falls and the Labrador ‐ Island Link.

4) In addition, the overall plan entails a 315 KV transmission interconnection between Muskrat Falls and Churchill Falls which would accommodate more flexible water storage arrangements, i.e., the Muskrat Falls project could potentially be used and useful even if completion of the Labrador ‐ Island Link is delayed.

Nalcor will continue to assess, and if necessary mitigate, potential project-on-project risks as the overall project continues.

The Strategic Risk Assessment primarily focuses on financial exposure. Strategic risks were apportioned among organizational risks, financial risks, interface risks, commercial risks, health, safety and environmental risks, engineering/technical risks, environmental approvals and permitting risks, stakeholder risks, construction risks, turbine supplier risks, de-escalation/inflation risks, transmission risks, environmental assessment risks, enterprise risks and technology risks. For each of the strategic risks, the assessment includes recommendations for mitigating the related risk. For example, with respect to the risks associated with the limited number of HVdc specialty suppliers and installers, the recommendations include: (i) optimizing packaging strategy of HVdc specialties equipment and services to entice key players; and (ii) select and engage early to ensure availability. Since the assessment has been completed, Nalcor has already taken actions to mitigate certain identified risks, e.g., reverting back to traditional LCC HVdc technology to alleviate the risk of failure of application of VSC HVdc technology for the Island Link.

The foregoing risk assessments were used by Nalcor to determine that a contingency of 15 percent of the Base Estimate was considered appropriate and has been incorporated in the capital estimates.

LCP ESCALATION

While inflation is typically treated in a simplistic manner, e.g., an overall rate applied across the project, Nalcor recognized that because of changes in the economic climate, a more sophisticated approach to developing the Escalation Component was warranted. Based on the identified best practices, a methodology for estimating cost escalation linking estimated capital costs with project scheduling was developed. This methodology provides escalation estimates on commodity, project component and aggregate levels that ultimately produced escalation index categories for each line item. Indices provided from forecasting services were applied to the escalation index categories resulting in cumulative escalation factors for the LCP projects.

General Timelines

As the project has evolved and project optimization has progressed, target dates have also been amended. The current project implementation schedule is summarized briefly below.

	Activity	Target Date	Comments
Lower Churchill Falls Project			
	EA Release for Generation Project (MF and LTA)	Q1-2012 &Q2-2013	
(a)	DG3 / Project Sanction	Q4-2012	
(b)	Finalize and award all major construction contracts	Q4-2012 & Q1-2013	Some early site preparation work will commence prior to this date, including access roads. Turbine & Generator, SOBI and T&D contracts were awarded January 2013. Bulk excavation at Muskrat Falls forecast to commence Jan 2013.
(c)	Financial Close	Q4-2013	
(d)	Labrador Transmission Assets Project 315 kV HVac transmission line complete and ready for service	Q3-2016	
(e)	Strait of Belle Isle Subsea Cable Installed	Q3-2016	Cable Agreement signed December 2012, with manufacturing and installation slot obtained. Cable manufacture to start in 2014.
(f)	Ready for Reservoir Impoundment	Q4-2017	
(g)	Labrador-Island Link HVdc Converter Stations complete	Q4-2016	
(h)	Labrador-Island Link system commissioned and ready for service	Q2- 2017	
(i)	Start-up and commence production of Commissioning Power:		Between Q4-2017 and Q4-2018
(j)	First Unit:	Q4-2017	Current Estimate
(k)	Second Unit	Q1/Q2-2018	Current Estimate
(l)	Third Unit	Q2/Q3-2018	Current Estimate
(m)	Fourth Unit	Q3/Q4-2018	Current Estimate

Early Works Overview

Early Works activity commenced following EA release and started in Q4-2012.

With respect to All-Risk Course of Construction (COC) insurance, a small Early Works COC was placed in Q3-2012 with the full placement to follow in 2013 to coincide with Financial Close.

With respect to Liability insurance, full placements covering the full Project scope and term was effected in 2013 concurrent with the Early Works.

Accordingly, in this section we describe the Early Works activity for the information of COC underwriters.

The project site is located along the Churchill River approximately 35 km west of the Town of Happy Valley-Goose Bay. Permanent access to the site will be from the south shore, via a road extension from the existing Trans Labrador Highway. The main components of the development will be:

- Main access road, including new construction of over 22 km of roads on the south side of the site;
- A 1,500 person accommodation complex;
- Contractor Laydown Areas;
- Reservoir preparation including some access roads, forest harvesting, and bank stabilization;
- Powerhouse and intake structure including north and south RCC dams, diversion channel, and gated spillway;
- High voltage overhead transmission lines and associated infrastructure; and
- Environmental habitat protection, remediation and replacement.

Early works construction is progressing with approximately 250-300 people onsite. The south side road to the main site has been completed, construction power has been brought to site and bulk excavation has begun.

A Starter/Phase 1 campsite has been constructed and consists of six individual dormitories with a 300 person capacity and a separate starter camp kitchen/dining/recreation facility and dedicated parking areas. The early works campsite is mainly for the Bulk Excavation Works contract. The main camp is currently under construction offsite and will be brought in this year.

Collective agreements with labour unions have been executed and special project orders with "No Strike - No Lockout" provisions have been enacted by the Newfoundland and Labrador Legislature.

A total of approximately 500,000 hours worked at the site without a lost time accident. In addition, a total of over 3,000,000 hours have been accumulated on the overall project without a lost time accident.

A new telecommunications fiber installation was completed across Labrador in conjunction with Nalcor, the Provincial Government, the Federal Government and Bell Canada recently as well. This new fiber installation will allow much better communications with the construction site and working conditions for all employees.

Site Drawing for Early Works

A full site drawing which includes the Starter Camp is located in an attachment (LCP Camp Arrangement)

Cash Flow Estimates

Cash Flow Estimates including the Early Works are included in an attachment (Financial Model-Schedule Overview).

Financial Information

Total contract values estimated for the Early Works site are the following:

Contract	Description
CH0006	Bulk Excavation Works
SH0019	Security Services (MF)
SH0020	Medical Services (MF)
PH0053-007	Temp. Camp Water Treatment Plant Transport
SH0056	Transportation of Temporary Camp
CH0055	Temporary Construction Camp Installation
PH0036	Supply of Auxiliary Transformers
PH0038	Supply of Emergency Diesel Generators
PH0053	Purchase of Temporary Construction Camp & Kitchen (300 person)
PH0053-005	Purchase of Temporary Sewage Treatment Plant
PH0053-006	Purchase of Temporary Water Treatment Plant
PH0053-008	Purchase of Fuel Tanks
PH0053-009	Purchase of Teck Cable
PH0053-010	Purchase of Lift Station
PH0057	Purchase of Office Trailers and Washcars
PH0059	Purchase of Step Down Transformers for Temporary Dorms
CD0512	Construction of Power Line to Muskrat Falls Site
PD0513	Supply of Transformer
PD0513	Supply of Transformer
PD0514	Supply of Circuit Breakers
PD0515	Supply of Disconnect Switches
PD0518	Supply of Capacitor Voltage Transformer
PD0519	Supply of Vacuum Interrupter
PD0520	Supply of Capacitor Banks
PD0522	Supply of Pre-Fabricated Control Room Building
PD0523	Supply of Substation Service Transformers
PD0529	Supply of Reclosers
PD0530	Supply of Surge Arrestors
PD0531	Supply of MV Instrument Transformers
PD0561	Supply of D20 RTU and Cabinets
PD0562	Supply of Protection Front Panels and Protection Relays
PD0563	Supply of Circuit Switcher, MV Switches & Fuse Cut-outs

PT0336-001	Supply of Distribution Line Hardware
PT0336-002	Supply of Distribution Line Hardware
PT0336-003	Supply of Distribution Line Hardware
PT0337	Supply of Distribution Line Fiber Optic Cable
PT0338	Supply of Distribution Line Conductors
PT0339	Supply of Distribution Line Insulators
PT0340	Supply of Wood Poles for Distribution Line
Total	$181,291,000

Technical Information

Geotechnical

The material balance at the Muskrat Falls construction site is very favorable with the amount removed for the powerhouse and spillway and the construction of the cofferdams and South Rockfill dam.

The entire site is built upon what is broadly known as the Canadian Shield is a broad region of Precambrian rock that encircles Hudson Bay. It spans eastern, northeastern and east-central Canada and the northern portion of the upper Midwestern United States. The shield is U-shaped, but almost semi-circular, which yields an appearance of a warrior's shield from where it obtained its name.

Embankment Materials

Embankment materials will be divided up into several categories.

Impervious Fill [Class 1] Well graded glacial till, that will compact into a homogeneous impervious mass with high shear strength and low permeability, to be used for the cofferdams, for the impervious core in the South Rockfill Dam and for impervious blankets on the spur, which will be obtained from the north and south borrow areas or other approved sources, and falls within the following gradation limits.

The Class 1 fill will be compacted to an average of 98% Standard Proctor maximum dry density (ASTM D698) within ±2% of the Standard Proctor optimum moisture content.

Dumped Impervious Fill [Class 1A] Well graded glacial till will be dumped in the wet to construct impervious blankets for cofferdams and compacted in cofferdams above water level to an average of 95% Standard Proctor maximum dry density (ASTM D698).

Granular Fill [Class 2] Well graded, gravely sand, free-draining with less than 5% passing the 0.074 mm (No. 200) sieve having a coefficient of uniformity greater than five (5). This material is to be obtained from the north and south borrow areas or other approved sources and may require selective excavation or processing. Class 2 fill is used as filter-drains in the cofferdams, filter and drainage blankets on the South Rockfill Dam, and stabilizing and drainage blankets for the spur. Class 2 will be compacted to an average of 95% of the maximum vibrated density by ASTM D2045.

Dumped Granular Fill [Class 2A] Well graded gravely sand will be dumped in the wet to construct transition fill for cofferdams and compacted in cofferdams above water level to an average of 95% of maximum vibrated density (ASTM D2045).

Random Fill [Class 2B] Uniform to well graded semi-pervious sand with less than 10% passing the 0.074 mm (No. 200) sieve and having a coefficient of uniformity greater than 3 for use as granular backfill. This material is to be obtained from surficial sands from required excavations and borrow pits in the project vicinity and compacted to an average of 95% of the maximum vibrated density (ASTM D 2045).

Transition Fill [Class 3C] Crushed rock, well graded from 150 mm to sand sizes from selective borrow area excavation or processing of rock from structural excavations and quarries is to be used for transition material in the cofferdams for erosion protection. It is to be placed in 0.3 m lifts and compacted with four passes of a 10 t vibratory roller or equivalent compactive effort with the tracks of a D-8 dozer.

Rockfill [Class 4] Quarry run rockfill from structural excavations and quarries to be used in the cofferdams, the South Rockfill Dam and for north spur stabilization, and elsewhere as required. Graded from 1 m to fine rock, containing less than 15% of particles smaller than 25 mm, placed in 1 m lifts and compacted by four passes of a 10 t vibratory roller.

Dumped Rockfill [Class 4A] Quarry run rockfill from structural excavations and quarries to be used in cofferdam construction, well graded from approximately 1 m diameter (minimum size) or as required to obtain cofferdam closure and for erosion protection elsewhere.

Riprap [Class 5] Broken rock material, clean and well graded within the following gradation limits from required structural excavations or quarries, intended for erosion protection for cofferdams, the South Rockfill Dam, the north spur and other embankments as required.

Foundation Materials

Foundation materials under the embankment structures are:

- Alluvium;
- Surficial stratified deposits - sands, silty sands, silts and clays;
- Glacial till;
- Bedrock.

Cofferdams and the South Rockfill Dam will be constructed with a positive cut-off to bedrock or suitable in-situ material.

Weak, compressible surficial deposits will be stripped as necessary to provide adequate stability. Concrete structures will be founded on bedrock.

Stability analyses for the cofferdams will be done using effective stress methods (Bishop's simplified, Janbu or Morgenstern Price) using manual or computer programs (Stabl, Slope 2) as appropriate with steady state piezometric and uplift pressures calculated from flow nets for the appropriate loading cases.

The factors of safety to be used are:

- End of construction - minimum factor of safety: 1.30
- Long term steady seepage: 1.50
- Rapid drawdown (normal): 1.30
- Rapid drawdown (extreme): 1.10
- Temporary excavated slopes: 1.30

The Muskrat Falls site is located in a zone where PGA = 0.17 g. Seismic effects on the stability of the structures will be evaluated by pseudostatic measures.

Settlement

Foundation settlement is to be determined using oedometer test data for structures founded on overburden. Internal settlement of compacted embankments founded on rock will be taken as 0.5% of the embankment height for summer compaction. The settlement allowance provided for embankments will equal 1.5 times the anticipated post-construction settlement.

Seepage

Design of the structures for controlling seepage will:

- Minimize seepage quantities and exit gradients;
- Limit seepage pressures to ensure stability with respect to shear failure;
- Prevent internal erosion or piping of embankment and foundation soils.

Flow nets will be developed by finite element methods. Seepage control measures will include:

- Shortest seepage path through the impervious core of cofferdams and will be not less than half the water pressure head;
- Seepage through dam foundations will be controlled with a single line grout curtain in bedrock to a minimum depth of 0.50 times the water pressure head (or 8 m) under concrete gravity structures, and pressure relief drains where the head is > 16 m.
- The length of the shortest seepage path through any pervious zone in an abutment shall be at least ten times the water pressure head. The seepage exit will be filtered with a reverse filter to prevent particle migration. Alternatively, the seepage path may be increased to 15 times the water pressure head by blanketing or other means.

North Spur Stabilization

The North Spur Stabilization is required as this natural piece of land will essentially be acting as a partial natural dam for the river, thus the stabilization will ensure that this land conforms to the Canadian Dam Association guidelines.

Stratigraphic sequence of this land mass consists of 12-15 m of terrace sands, ice-contact stratified drift consisting of interbedded sand and silt from El. +50 to 0 m, and marine clay from El. 0 to -60 m which is underlain by proglacial or glaciofluvial sand and gravel which in-fills the pre-glacial bed of the Churchill River, to as deep as El. -250 m. Mass wasting necessitated installation of an interim line of pumped wells, in 1981, to help stabilize the spur.

Additional measures to ensure long term stability under operating conditions include:

- An upstream zoned rockfill stabilizing berm to provide wave protection and prevent drawdown failure under operating conditions;
- Downstream crest unloading, erosion protection and relief wells to augment stability under operating conditions;
- Improved drainage of the kettle lakes north of the spur to reduce ground water recharge.

The hydrogeologic model of the spur will be refined using data on pumping performance and piezometer response. The stability of the spur will be refined using stability analyses combined with detailed seepage analysis. Long term efficiency of the pumping system will be assessed and the need for extension of the pumping system assessed on the basis of Corps of Engineers relief well theory and flow nets. Design of stabilization measures will be finalized at that time.

Grouting and Drainage

Grouting under the dams and civil structures will be designed based on core drilling and geocamera survey results, as well as water pressure test data. Unless upcoming data analysis indicates otherwise, grout curtains will be constructed to a depth of 0.33 to 0.50 times the head at maximum water level (minimum 8 m) under the dams and civil structures. Grout curtain depth will be deepened locally in highly pervious fractured zones as required. Grout curtains will be closed by split-spacing with primary grout hole spacing presently estimated at 12 m. Drain curtain depth and spacing will be compared with precedent hydro developments on the Canadian Shield and Quebec North shore Region.

Batch Plants

- The 3rd party batch plants will consist of two full winterized temporary Concrete Batch Plants at Muskrat Falls for the supply, delivery, inspection and testing of batch-mixed concrete, grout and mortar.
- The Contractor will be required to comply with the rules and provisions of CSA, American Concrete Institute, ASTM and NBC. The Contractor will obtain written approval from the Engineer prior to using other equivalent codes and standards.
- A formal Quality Control Program will be implemented during execution of the work. The program shall include inspection and testing of all materials.
- The concrete batching facility will be of size and capacity sufficient to provide for the concrete placement schedule. Each plant will have a minimum capacity of 60 cubic meters/hour. Both plants will be fully automated, winterized and totally independent of each other.
- Combined storage facility for both plants will be sufficient to produce concrete for at least five days at full hourly rate with Type LH-M cement.
- A water chiller plant and chilled water storage, capable of chilling water to 4 degrees C overnight will be provided.
- An ice plant and storage facility for ice, required for cooling batch mixed concrete for at least two days at full hourly rate will be provided.
- The batch plants will use intelligent scales for automatic batch weight recording (computer controlled and recorded). Each plant will also be equipped with temperature sensors to check temperatures of concrete and raw materials. The batch plants shall also be equipped with moisture sensors for fine and large aggregates.
- All Mobile Mixer trucks will comply with truck manufacturer's bureau TMMB 100 standard except that each truck will be provided with a removable water meter capable of measuring added water to mix within a precision of 2 %.
- The Contractor will keep logs on all concrete activities, including production, placing, supervision and production control, inspection and testing. These logs will be reviewed by an assigned Engineer for examination.

Borrow Pits and Quarries

Geotechnical and geological investigations in 1979, 1998 and 2007 were focused on identifying borrow areas on the north bank of the Churchill River. Due to the final layout chosen for the project, complementary investigations were conducted in 2010 to identify borrow areas on the South bank.

MATERIAL BALANCE

TILL MATERIAL

Estimates of till deposits indicate that the total proven quantities of till material are about 20% less than the total quantities of till required for all the construction works on the south bank, including the river closure; however the potential volume of available till is much higher than the required volume.

There is no deficit of till material for the bulk excavation contract (CH0006); all the required quantities are proven in the short term from designated till borrow areas. During the bulk excavation contract, additional investigations with deep test pits will be performed to prove the quantities of till required for subsequent contracts.

For the North Spur stabilization works, the proven volume of the till material in main borrow area is greater than the required volume for embankments.

GRANULAR MATERIAL
The estimated total proven volume of granular materials in south bank deposits is about 25% less than the estimated granular material required for all construction works. However, the potential volume of exploitable granular material shows a surplus of about 50%.

There is no deficit of granular material for the bulk excavation contract and all the required quantities are proven from designated borrow areas. During the bulk excavation contract, additional investigations will be performed to prove the required quantities of granular material for subsequent contracts.

On the north bank, the proven volume of granular sources meets all needs for the North Spur stabilization works.

CONCRETE FINE AGGREGATES
A material balance summary shows a current deficit in concrete fine aggregates. However, the potential volume of fine aggregates is higher than the required volume. Deep test pits will be performed in the course of the access road contract to prove the quality and additional quantities of concrete fine aggregates. Borrow area GD-1 is considered to be an alternative borrow area for concrete fine aggregates and it will also be investigated during access road construction works.

ROCKFILL MATERIAL
The proven volume of rockfill materials on the north and south banks is larger than the volumes required to construct all structures and related works.

NORTH SPUR
For all construction materials needed for the stabilization works on the North Spur, the proven volumes are larger than the required volumes. Till and granular materials required for the North Spur stabilization works will be sourced from the north bank. Required till materials will be sourced from a nearby borrow area, which is about 7 km from the North Spur, while required granular materials will be supplied from a borrow area located about 12.5 km from the North Spur. The filter material will be sourced from the required excavations on the North Spur. If the 2013 investigation shows sufficient filter material is not available from N/W cut off wall excavation, the deficit will be sourced from another nearby borrow area.

The rockfill materials required for the North Spur stabilization works below elevation 26.0 m to be done prior to diversion of the Churchill River will be sourced from a north bank quarry, which is located about 3.5 km from the site. After diversion of the river and construction of the temporary access road to the North Spur through the crest of the upstream cofferdam, the rockfill materials needed for the North Spur stabilization works will be supplied from the rockfill stockpiles located on the south bank containing rock from required excavations at the spillway and powerhouse.

STRUCTURES AND RELATED WORKS ON THE SOUTHBANK
As per the initial material balance, taking into consideration all the structures to be built, a deficit in till, granular and fine aggregate materials existed originally between the proven and required volumes. It should be noted that the proven volumes were estimated based on shallow test pits (maximum of 3.1 m depth) made with heliportable backhoes. It was expected that the thickness of suitable materials in the deposits are in general greater than 3.0 m and the potential quantities of materials will exceed the quantities required for the construction works.

When the south side access road was built, additional deep test pits were dug with larger equipment from the onsite Contractors which increased the proven quantities.

For the construction of structures on the south bank of the river, till material will be sourced from up to five borrow areas, and granular materials will be supplied from three borrow areas. All borrow areas are located at less than 11 km from the site.

For bulk excavation package, there is no deficit of materials. Required till and granular materials are proven in up to 4 borrow areas.

Concrete fine aggregates will be supplied from a single borrow area located about 2.5 km from the site. The deposit was initially investigated by means of shallow test pits, less than 3 m deep. Estimated proven quantities are less than the required quantities. Natural material contains between 0 and about 20% of particles greater than 10 mm, so it will have to be screened to meet the grain size requirements for concrete fine aggregate. Organic impurities are present in the material and exceed the acceptable limit in 2/3 of the 24 tested samples, so it will have to be washed to comply with the requirements.

Additional investigation by means of deep test pits was performed with large equipment belonging to access road Contractor to prove the quality of the material and the required quantities.

A single borrow area, located about 25 km from the site, will be an alternative deposit for concrete fine aggregate. This borrow area was investigated by means of deep test pits performed with large equipment belonging to the access road Contractor.

All rock materials required to construct the structures and related works on the south bank will be sourced from the excavations required for the spillway and powerhouse.

Civil/Structural Design Criteria

Environmental Data

The following climatic data is obtained from the National Building Code of Canada for the Town of Happy Valley – Goose Bay.

Design Temperature	January-31°C to -33°C	
	July	27°C to 19°C
Snow Load (1/50 yrs), kPa	Ss = 5.3	Sr = 0.4
Hourly Wind Pressures, kPa	1/10 yrs	0.29
	1/50 yrs	0.37
Seismic Data for Buildings (2% in 50 yrs)	Sa (0.2)	0.150
	Sa (0.5)	0.092
	Sa (1.0)	0.047
	Sa (2.0)	0.014
	PGA	0.091
Degree Days Below 18°C	6700	
15 Min Rainfall, mm	20	
One Day Rainfall, (1/50 yrs), mm	80	
Annual Rainfall, mm	575	
Annual Total Precipitation, mm	960	
Driving Rain Wind Pressures, Pa (1:5 yrs)	160	

The maximum design earthquake (MDE) for water retaining structures is based on an annual probability of being exceeded of 1/10 000 years. The operating basis earthquake (OBE) is based on an annual probability of being exceeded of 1/200 years.

The site class at the Muskrat Falls site is considered to be hard rock, site class A. The peak ground acceleration value $PGAH^{MDE}$ for a return period of 10,000 years is extrapolated with a logarithmic regression using known median probabilities for return periods corresponding to probability of exceedance in 50 years of 2%, 5%, 10% and 40%. Interpolation is used to determine the $PGAH^{OBE}$ for return period of 200 years.

Site-specific evaluation of the spectral and peak hazard values should be performed during the next phase engineering to confirm those values.

Peak Horizontal Ground Acceleration	$PGAH^{MDE} = 0.170$ g
	$PGAH^{OBE} = 0.012$ g

Codes and Standards

The fabrication and the construction of the structures meet the latest editions of the following codes and standards:

National Building Code (NBC)
ASTM
CAN/CSA
ACI
CSA
CDA
CAN/CGSB
ICCA
SSPC

Design Guidelines

The design follows the following guides:

- Concrete Design Handbook, Cement Association of Canada;
- PTI Post-Tensioning Manual;
- Handbook of Steel Construction, Ninth Edition;
- AISE Technical Report No 13, Guide for the Design and Construction of Mill Buildings, June 1997;
- Formwork for Concrete (M.K. Huro);
- Design of Gravity Dams, US Bureau of Reclamation;
- Dam Safety Guidelines, Canadian Dam Association, 2007;
- FERC, Engineering Guidelines for the Evaluation of Hydropower Projects;
- ASCE 1989, Civil Engineering Guidelines for Planning and Designing Hydroelectric Developments;
- Earthquake Spectra and Design (N.M. Newmark et W.J. Hall/1982);
- Hydrodynamic Pressures on Dams due to Horizontal Earthquakes (Zangar,C.N.; 1953). Proceedings Society on Experimental Stress Analysis, 10, 93-102;
- Hydrodynamic Pressures on Dams during Earthquakes (Zangar, C.N.; 1952). Engineering monograph No 11, U.S. Bureau of Reclamation;
- CIGB, bulletin 27, Considérations sur le calcul sismique de barrages; CIGB, bulletin 72, Choix des paramètres sismiques pour les grands barrages. Recommendations;
- Design of Hydraulic Structures (V.T. Chow);
- Design of Small Dams (U.S. Bureau of Reclamation);
- Reinforced Steel - Manual of Recommended Standards (RSIC);
- Canadian Geotechnical Design Manual (Canadian Geotechnical Institute); Standards for Design Review of Existing Concrete Gravity Dams, Dam Safety(DS-STD-03);
- Water Pressures on Dams during Earthquakes (Westergaard, H.M.; 1933). Transactions ASCE, 98: 413-433;
- Water Power (Jacobsen, 1974). ASCE vol. 2, chapitre D.
- US Army Corps of Engineers, Retaining and Flood Walls, EM-1110-2-2502, 1989

Design Loads

The powerhouse, the spillway and the gravity dams are designed to resist the following loads:

Dead loads	Earthquake
Water pressure	Live loads
Lateral earth pressure	Wind
Lateral sediment pressure	Snow
Uplift	Rain
Ice	

EARTHQUAKE

The superstructure is designed using the pseudo-static method for earthquake, as prescribed by the National Building Code of Canada.

The water retaining structures are designed using the pseudo-static analysis for earthquake, as prescribed by the Canadian Dam Association.

Transmission Line Design Criteria and Meteorological Loading

The CSA Standard C22.3 (Overhead Systems and Design Criteria of Overhead Transmission Lines) was used as a suggested guideline in the design of overhead transmission lines. The standard addresses specific design aspects, including the application of meteorological loads. The standard also provides guidance for minimum design standards, recommends consideration be given to local conditions and operating history, and reminds designers to consider the relative importance of a transmission line.

Nalcor has approached the application of transmission criteria in a manner consistent with the CSA standard and also with its historic approach for planning the Island system. Eleven (11) different combinations of wind and ice load cases were identified for the Labrador-Island Transmission Link with different wind loads over the three dominant ice loading zones.

Overall, meteorological loading for the transmission systems for the Labrador Island Link:

- are based on significant historical assessment and current modeling using data and information collected over a 50-year time frame; include design maximum ice loads that are realistic for the Newfoundland and Labrador environment; yet significantly exceed the loadings published in the CSA standard, usually equating to CSA 500-year loads or more; and
- include design maximum wind loads that meet CSA 50-year wind speeds, and are higher than historical transmission line design levels even though NLH transmission lines have never failed due to extreme wind.

WIND LOADING

NLH has historically designed most of its transmission lines to a maximum wind load case of 175 kilometers per hour (kph) gust wind speed which corresponds to a sustained wind speed of approximately 100 kph. To date, NLH has not had a structural failure of a transmission line due to the maximum wind load case. The CSA standard provides a map of reference wind speeds for a 50-year return period. These wind speeds range from 100 kph in central Labrador to 130 kph on the Avalon Peninsula. This covers the range of the LCP transmission infrastructure. Based on NLH's operating experience over the past 50 years, and the fact that there have been no failures on the transmission system related to the maximum wind load, NLH considers the 1:50 year wind loads as per CSA standard to be appropriate, and determined that no amplification of these wind loads is required. Therefore, Nalcor has adopted the 50-year CSA wind loads for the design of the Labrador-Island Transmission Link for all but the Alpine region of the Long Range Mountains (LRM).

Analysis of wind speeds on the LRM is based on a correlation study between Environment Canada Meteorological Weather Station at Daniel's Harbour on the Northern Peninsula of Newfoundland and a wind speed monitor installed in the LRM. This analysis resulted in a reference wind speed of 180 kph, much higher than any wind load in the province but considered realistic for this area. Given the knowledge that topographical features amplify the wind speed profile in the LRM, Nalcor has selected this reference wind speed of 180 kph as the 1:50 year design wind speed as opposed to the 120 kph wind speed specified in the CSA standard. Nalcor also applied the 180 kph reference wind speed to the other Alpine regions (highlands of St. John's and Labrador coast) along the transmission line. The selection of this elevated reference wind is considered appropriate for those areas.

ICE LOADING

Through decades of experience operating transmission infrastructure in harsh environments, NLH has gained considerable knowledge of the necessary design criteria for its electricity infrastructure. NLH has designed transmission lines in recent years to ice loads higher than those published in the CSA Standard.

CSA C22.3 provides reference icing amounts for a 50-year return period. These values range from 15 millimeters (mm) of radial glaze ice (ice thickness measured from the conductor surface) in central Labrador up to a maximum of 40 mm on the Avalon Peninsula. CSA recommends a factor of 1.5 times the reference amount to account for the spatial nature of transmission systems, and the elevation correction for conductors which are assumed to be 20 m higher than the reference level of 10 m above ground. This would equate to 50-year design loads from 23 mm to 60 mm across the transmission system. CSA also recommended that spatial factors less than 1.5 may be substantiated by local data and experience.

In the case of Newfoundland and Labrador, Nalcor has determined that the design ice loads should be higher than those published in the CSA Standard based on a substantial amount of historical data. Studies completed by Meteorology Research Inc. (MRI), Teshmont and RSW for the complete Labrador-Island Transmission Link produced loads of up to 100 mm of radial glaze ice. These loads are significantly higher than the CSA loads and there is very little evidence of loads coming close to this level in the history of transmission lines in the province. A third party independent study for the entire Labrador-Island Transmission Link route, produced loads that were significantly lower than the CSA Standard loads, loads which have been experienced relatively frequently in the province.
The discrepancy in findings between the various studies led to a dilemma as to what loads should be used consistently in the design criteria. While the MRI and Teshmont studies produced up to 100 mm of radial glaze ice, recent meteorological load studies in the NLH electricity system have produced load cases of 75 mm of radial glaze ice on the Avalon, and 50 mm of radial glaze ice for the Granite Canal line. Both locations are based on an extreme value analysis using 40 years of data and the analyses resulted in what was calculated statistically to be 1:50 year return period load cases.
The alpine regions are areas above 350 m elevation that experience significant levels of rime (in-cloud) ice. Although rime ice can occur at any level, rime ice load cases exceed the glaze ice load cases in alpine areas. Because of this, rime ice load cases are used for line design in alpine regions. Because the CSA standard does not cover this type of ice, a thorough meteorological study including atmospheric modeling and correlation with test spans on the LRM was performed using international experts (EFLA Consulting Engineers from Iceland) in rime ice formation on transmission lines. As a result of this study, Nalcor selected a maximum ice load case of up to 135 mm of radial rime ice for design in all alpine zones.

CSA AMPLIFICATION FACTORS FOR 150 AND 500-YEAR RETURN PERIODS

The CSA standard provides modification factors to increase the 1:50 year loads to various load cases, including 1:150 years and 1:500 years. In terms of radial glaze, 50-year loads are increased to 150-year loads by a factor of 1.15, and 50-year loads are increased to 500-year loads by a factor of 1.30.

According to the CSA standard, the Labrador-Island Transmission Link areas corresponding to the “average regions” should have 50-year loads ranging between 23 to 38 mm, and 500- year loads ranging between 33 and 49 mm. Notwithstanding the standard, Nalcor has established a design load of 50 mm radial ice loading in average regions.

The CSA standard corresponding to the zone identified as the Labrador-Island Transmission Link Eastern region has suggested loads of 60 mm for 50-year loads to 78 mm for 500-year. Nalcor’s analysis has led it to established a design load of 75 mm in the Eastern region.

In summary, the design ice loading for the Labrador-Island Transmission Link approximate or exceed the CSA recommended 500-year maximum ice loads. Nalcor believes that the selection of these higher ice loads is appropriate based on NLH’s operating experience over the last 50 years. In summary, Nalcor has developed maximum design loads through analysis of extensive operating experience, meteorological data and extreme value analyses that have been carried out over the last 40 years. Given the importance of the line, Nalcor has undertaken extensive studies of conditions in the areas where the line is expected to be exposed to particularly harsh or extreme conditions and the analysis has led to the selection of a balanced load case set that optimizes structural design, and maintains system reliability.

The chosen Labrador-Island Transmission Line design provides an adequate level of reliability and an increase in the design standard will not significantly improve customer reliability. As Nalcor stated during the Board public hearings, should a higher level of customer reliability be deemed necessary by the Board, Nalcor believes that the increased reliability can be best achieved through the addition of combustion turbines on the island as opposed to an increase in line design.

Muskrat Falls General Information

The Muskrat Falls Generation Facility will have a capacity of 824 MW. The main components include:

- The powerhouse, with four variable-pitch Kaplan turbines;
- A South Rockfill Dam will be 29 m high and 325 m long, and the North RCC will be 32 m high and 432 m long; and
- A reservoir 60 km long, inundating 101 km^2 at FSL.

The construction of the dam at the Muskrat Falls site will result in the formation of a reservoir. The facility will not have penstocks; the approach channel will direct the water from the reservoir into the power intakes, where concrete spiral cases will distribute water through the turbines. The water will then discharge into the tailrace. The passage of flows in excess of power generation requirements will be through a spillway. The facility will also have transformers and a switchyard, which will raise the generation voltage to 315 kV.

Kaplan Runner Design

For the design of Muskrat Falls Kaplan runner, Andritz started its runner model testing process using its existing Brisay runner design, which has very similar operating characteristics to that of Muskrat Falls. This practice of referencing a proven design with characteristics in proximity of the required technical specifications is considered normal among all turbine suppliers.

The Brisay hydroelectric plant in Hydro Quebec, Canada, has been operating successfully since 1993. Each of the two units at Brisay is rated at a net head of 37.5 m (Muskrat Falls rated net head is 35 m) and each has the capability of producing 234.5 MW (Muskrat Falls turbine can produce 220 MW). Using this model as a reference only, in conjunction with CFD (computational fluid dynamics) studies, Andritz made many design enhancements through blade-shape configurations during modeling in order to meet Muskrat Falls specifications and increase efficiency above that of the Brisay design. The diameter of the runner, as compared to the Brisay design of 8600 mm, was increased slightly over 2 % to 8800 mm and the blade configuration was changed from a 6-blade to a 5-blade turbine type. The rpm of the turbine-generator was also reduced from 94.70 rpm to 85.714 rpm. A Finite Element Analysis was completed for the runner prototype to ensure a robust design. The Andritz contract guarantees rely heavily on the fact that the runner prototype must remain homogeneous to that of the runner model.

There are many Kaplan runners in operation today, made by other manufacturers, which are subjected to various operating characteristics that require the runner diameter to be larger than of Muskrat Falls. Attached below are a few for your reference.

1. Yacyreta power plant in Argentia ....9500 mm runner diameter
2. Gezbouba power plant, China....................10,200 mm runner diameter
3. Estreito power plant, Brazil.........................9,500 mm runner diameter
4. Uglichskaya power plant, Russia................9,000 mm runner diameter
5. Saratovskaga power plant, Russia.............10,300 mm runner diameter

SUMMARY

- Access
  - Site roads to be gravel surfaced; Permanent site access from south, along south site of river via TLH; Temporary site access to north side is also from TLH
  - No Permanent accommodations required
  - Construction power will be from NE-NLH whenever practical
- Reservoir
  - FSL = 39 m; LSL = 38.5 m; MFL = 45.1 m
  - Remove all trees that grow in, or extend into the area between 3 m above FSL and 3 m below LSL, except where determined otherwise by the reservoir preparation strategy
  - Trash management system required for the reservoir
  - Fish habitat will be based on compensation strategy agreed with DFO
- Diversion
  - Through spillway structure
  - Capacity = 13,060 m^3/s
  - Fish Compensation Flow will be approx. 30% of mean annual flow
  - Fish Compensation Flow will be through spillway structure
- Dams & Cofferdams
  - North Dam is to be RCC
  - South Dam is to be earth/rockfill with central impervious core
  - Development flood capacity is based on PMF
  - South Rockfill Dam crest elevation to be El. 45.5 m
  - North RCC Dam to be an overflow dam with a crest elevation of El. 39.3 m
  - All dams are to be founded directly on bedrock
  - Cofferdams are to be earth/rock fill dams
- Spillway (Gated Section)
  - Concrete structure in rock excavation
  - Capacity = PMF in conjunction with North RCC Dam at MFL elevation of 45.1 m
  - Spillway sill is at El. 5.0 m, without rollaways (diversion) and 18.0 m with rollways (final configuration)
  - Gates with heating and hoisting mechanisms designed for severe cold climate operation
  - 1 set (upstream and downstream) interchangeable steel stop logs with a permanent hoist system
- North Spur
  - Infrastructure required for long term stabilization (Geotechnical Information)
- Tailrace
  - Draft tubes discharge directly into river in rock excavation
- Intakes
  - Approach channel in open cut earth/rock excavation
  - Designed to eliminate frazil ice
  - Concrete structure in rock excavation
  - 4 intakes (one per unit)
  - 4 sets of vertical lift operating gates with individual wire rope hoists in heated enclosures
  - 1 set of Bulkhead Gates with a permanent hoist system
  - 4 sets of removable steel trash racks
  - 1 permanent trash management system
- Penstocks
  - No penstocks
  - 4 individual water passages in concrete (close-coupled intake/powerhouse)
- Powerhouse Civil Works

  - Concrete structure in rock excavation
  - Structural steel super-structure with metal cladding
  - Energy Star qualified building systems (Nalcor Energy's LEED program)
  - 4 unit powerhouse with maintenance bay large enough to assemble 1 complete turbine/generator unit, plus assembly and transfer of 1 extra rotor.
  - Provision of an unloading area
  - Area for offices, maintenance shops and warehouse.
  - 2 sets of draft tube stop logs with a permanent hoist system in a heated enclosure
- Turbines and Generators (Andritz Hydro - Design and Manufacture)
  - Four 206 MW (approx.) vertical axis generators
  - 229 MVA; 15kV; 60 Hz; 0.90 PF; 81.8 rpm
  - 4 Kaplan turbines with cavitation resistant design
  - Unitized approach from intake to generator step-up transformer
  - Failure of any equipment/system of one unit not to affect the operation of the remaining units
- Electrical Ancillary Equipment
  - Dual dc battery system
  - A minimum of 2 sources of station service
  - Dual digital protection systems
  - A distributed digital control and monitoring system
  - Dual CPU for control system functions
  - 2 standby emergency diesel generators, in separate locations, complete with fuel storage systems
- Mechanical Ancillary Equipment
  - Separate high & low pressure compressed air systems
  - Separate service, domestic, and fire water systems
  - HVAC systems; generators are to be a source of powerhouse heating
  - 2 overhead powerhouse cranes, with the capacity to operate in tandem having a combined design capacity, when operated in tandem, to lift a fully assembled rotor.
  - Elevator access to all levels
  - Dewatering and drainage systems c/w oil interception system
  - Permanent waste hydraulic & lubricating oil storage and handling system complete with a permanent centrifuge filtration system
  - Permanent hoist system required for each turbine pit
- Generator Transformers & Switching (Still in bidding process)
  - 4 step-up transformers (unit voltage to 315 kV) located on powerhouse draft tube deck; 175-230MVA; 15kV/315/kV
  - Each unit will have a generator breaker
  - Spare uninstalled transformer to be kept at site

Construction Camp

A Starter/Phase 1 campsite currently has six individual dormitories with a 300 person capacity and a separate starter camp kitchen/dining/recreation facility and dedicated parking areas.

The 1,500 person campsite will grow to ultimately include the following:

- Security Building
- Main Administration Offices
- Communications Building
- Fire Station/Ambulance Shelter
- Safety/Inductions Building
- Contractors Offices Area
- Camp Maintenance Workshops
- 26 separate dormitories (four sets of dormitories; 3 sets of 7 plus one set of 5)

- Innu Traditional Kitchen
- Main Kitchen/Dining & Recreation Center
- Sewage Treatment Facility
- Water Storage Tank
- Water Treatment/Distribution Building
- Emergency Power Generator Sets including Fuel Storage
- Helipad
- Vehicle and Bus Parking Lots

The site will have its own water supply and fire hydrants around the property. Power will be fed from the Labrador power grid with backup power from the emergency generator sets.

Accommodations buildings will consist of typical prefabricated wood-frame modular units. The units will involve the sharing of a shower fixture between two adjacent rooms.

All modules shall be equipped with sprinkler systems. The starter camp sprinkler system shall not be made operational until commissioning of the main camp. Records of pre-commissioning of all electrical and mechanical systems including fire alarms, lighting, heating, sprinkler, and air conditioning and kitchen equipment will be provided prior to delivery to site.

A full site drawing is located in an attachment (LCP Camp Arrangement) which shows the Starter Camp as well as the main camp.

Further technical details of the Muskrat Falls site are provided in Appendix H.

Further Hydrology/Hydraulics regarding the river and dams can be found in Appendix I.

LTA - HVac Transmission Information

The transmission line will consist of:

- Two 735 kV HVac interconnection lines approximately 0.6 km each
- Four 315 kV HVac interconnection lines between MF switchyard and MF power house approximately 0.5 km
- Two 315 kV HVac transmission lines approximately 250 km interconnecting Muskrat Falls to the Churchill Falls.

The transmission line structures from Muskrat Falls to Churchill Falls will be lattice steel type towers approximately 50 m high with an average span of 500 m between each tower. The line will have a ground clearance of 18 m over roads and 14 m over other areas, in accordance with design standards for this voltage class transmission line.

The HVac design will utilize the Newfoundland and Labrador Hydro standard practice of having a maximum of 20 spans between full tension, anti-cascade capable towers. The design was analyzed during the initial design stage and found to be acceptable by both Nalcor and SNC Lavalin. These anti-cascade towers can sustain full failure (no conductors) on one side and full design load and tension on the other. The lines are designed with a sequence of failure of components that makes best efforts to ensure that the conductor is the last to fail between suspension towers and conductor, thus reducing the chances of initiating a cascade failure event.

The specific number of towers between anti-cascade structures as per design does not change with differing ice zones; however the span lengths in higher ice zones, such as the Long Range Mountains (LRM) which is a HVdc line, are shorter, so the physical distance that a cascade will affect will be reduce in the LRM. For example, in a normal ice zone area with a 400 m ruling span, a cascade could cover a length of up to 8 km, whereas on the LRM with a 200 m ruling span this length is up to 4 km. Plans are in place to have stock of enough supplies to repair one section of the line from dead-end to dead-end.

Estimated costs of replacement are approximately $1 million per km of transmission line, thus given a failure of one zone between anti-cascade structures; this would be approximately $8 million. If the failure occurs where accessibility or the lack thereof becomes a problem, it is estimated that between $8 to $10 million would be reasonable.

The final transmission system construction method will be selected by the awarded contractor. Traditional construction methods involving typical trucks and lifts would be utilized in most of the areas except where there might be environmental or schedule concerns which may dictate the use of helicopters. All structural members have been designed to be installed by either method. All design drawings have detailed lifting points indicated for each type of construction method. The LCP team has also worked with a heavy lifting helicopter company to ensure the methods and equipment lifts are achievable. It is predicated that the LTA will only use traditional methods based upon the selected route and available timing.

SUMMARY

- HVac Overland Transmission – Muskrat Falls to Churchill Falls
    - Line power capacity to be 900 MW for each line, allowing for all load to be carried on a single circuit
    - 50 year Reliability Level Return Period of loads
    - All lines to have overhead lightning protection with one being for the Operations Telecommunications System
    - Counterpoise installed from station to station.
- Churchill Falls Substation/Switchyard (735-315 kV)
    - To accommodate 2 x 345 kV HVac transmission lines from Muskrat Falls

  - To be an extension to the existing CF Switchyard
  - Construction and operation not to adversely impact the existing CF operation
  - Concrete foundations and galvanized steel structures to support the electrical equipment and switchgear; fire alarm and protection system will be provided
  - Contains seven (7) 280 MVA Power Autotransformers (735 kV/315kV/13.8kV); single phase units; one uninstalled spare kept at the site
  - Digital impact recorder utilized on each individual transformer until installed on foundations
- Muskrat Falls Substation/Switchyard (315-138 kV)
  - Situated on the south side of the river on a level, fenced site
  - Concrete foundations and galvanized steel structures to support the electrical equipment and switchgear; fire alarm and protection system to be provided
  - Contains two (2) 75/100/125 MVA Power Autotransformers(315kV/138kV/25kV); three phase units; transformers for power supply to Happy Valley-Goose Bay
  - Digital impact recorder utilized on each individual transformer until installed on foundations
- Operations Telecommunication Systems
  - All permanent control, teleprotection, SCADA and voice circuits to have redundancy

LIL - HVdc Transmission Information

The approximately 1,080 km ±350 kVdc Labrador-Island Link will provide 900 MW of power transfer capacity between Labrador and the Island and was the recommended option to serve the Island in the Interconnected Island alternative. The long distance, water crossing and weakness of the Island electrical system make HVdc technology the only technically feasible option.

The HVdc transmission line is approximately 407 km from Muskrat Falls to the Labrador side of the Straight of Belle Isle at Forteau Point and approximately 561 km from the Newfoundland side of the Straight of Belle Isle at Shoal Cove to Soldiers Pond Converting Station. There will be a 60 m wide right-of-way provided to construct the line.

The system also includes two sections of wood pole electrode lines approximately 394 km near from Muskrat Falls Converter Station to Lanse-au-Diable Electrode and approximately 12 km between Soldiers Pond Converter Station and Dowden's Point Electrode. The 7.2 mm single strand soft galvanized steel wire with a grade 50 or higher will be used as counterpoise conductor for the HVdc transmission line.

The HVdc design, like the HVac design, will utilize the Newfoundland and Labrador Hydro standard practice of having a maximum of 20 spans between full tension, anti-cascade capable towers. The design was analyzed during the initial design stage and found to be acceptable by both Nalcor and SNC Lavalin. These anti-cascade towers can sustain full failure (no conductors) on one side and full design load and tension on the other. The lines are designed with a sequence of failure of components that makes best efforts to ensure that the conductor is the last to fail between suspension towers and conductor, thus reducing the chances of initiating a cascade failure event. Further details are noted above in the HVac section.

The transmission system construction method for the LIL will be selected by the awarded contractor. Traditional construction methods involving typical trucks and lifts will be utilized in most of the areas except where there might be environmental or schedule concerns which may dictate the use of helicopters. All structural members have been designed to be installed by either method. All design drawings have detailed lifting points indicated for each type of construction method. The LCP team has also worked with a heavy lifting helicopter company to ensure the methods and equipment lifts are achievable. It is predicated that the LIL will utilize both the traditional methods as well as helicopter utilization based upon the selected route and remoteness of parts the route.

Converter Stations

The Converter Stations will consist of all equipment and infrastructure associated with dc-to-ac and/or ac-to-dc power conversion. The Converter Stations will be operated as remote plants thus the Energy Control Center in St. John's will typically perform all operations. This includes consideration of aspects relating to system control, monitoring, operation, maintenance, surveillance, and security. During a converter outage, the HVdc systems will operate as a monopole with metallic return mode without interruption. During an outage to a pole conductor, the HVdc system will operate as a monopole using electrodes without interruption. HVdc system capacity during operation as a monopole will be 50% of system capacity during operation as a bipole.

The Converter Stations control systems will include a user-friendly, full-featured, graphics-based HMI for local control and monitoring. Meters and switches will be available for the local control and monitoring of equipment in the event of an HMI failure. Protection devices in the form of digital protection relays will be used to protect major converter station electrical equipment such as transformers.

The converter transformers will be separated by firewalls and fire detection & suppression systems is also being evaluated.

The control building will be equipped with adequate fire detection systems, alarms, and pull stations. Fire suppression systems for the control building (excluding the valve hall) are also being evaluated. The valve halls will be equipped with multiple fire detection systems including VESDA and optical systems.

Synchronous Condensers

The Synchronous Condenser Facility is similar to a powerhouse in its form and function consisting of three (3) large synchronous condensers, 175 MVar, H=7.84 kW-s/kVA, 15 kV, 60 Hz each, air or hydrogen-cooled with air or hydrogen-to-water heat exchangers, vertical or horizontal shaft disposition, flywheel or extended rotors, braking system, cooling, lubrication and monitoring systems, and all their auxiliary equipments.

The main building will consist of a machine hall, an electrical equipment gallery, a mechanical equipment gallery, a control room, battery rooms, MV rooms, mechanical rooms, drywall and masonry walls partitions. Included at the site will be 3 x 200MVA 230kV-25kV-15kV step-up power transformers as well as overhead cranes, SFC step-down and step-up power transformers, gantry structures, cooling units, the mechanical and electrical auxiliary equipment in machine hall.

The protection system planned for this facility includes fire walls between oil filled transformers including oil spill containment, fire protection/detection and security access control system. A UPS Uninterruptible Power System (UPS) as well as an emergency diesel generator set, rated 150 kW, 600/347 Volts, complete with diesel fuel day tank will also be provided.

Fire detection and protection systems will be provided with a central control and monitoring system, including building fire protection/detection system, sprinkler systems and clean agent fire extinguishing system (machine hall, electrical and mechanical galleries, control room and personnel areas), synchronous condenser machines fire detection and protection system of the deluge type, and outdoor fire detection and protection system, with sprinkler systems for the main and step power transformers and the static frequency converter transformers. Fire hydrants along with fire pumps will be provided including fire fighting water distribution system, including water storage tank.

An attachment (Synchronous Condenser Facility Site Layout) provides a layout of the synchronous condenser facility.

The contract for the design, manufacturing, factory testing, transportation to site, installation, as well as testing and commissioning is currently out for bidding and evaluation. Final decision on this contract will occur in 2013.

Electrode Sites

Each end of the HVdc system will be provided with an electrode system to enable power transmission during monopole conditions and to provide a return path for the unbalanced current between the two poles during bipolar operation. The electrical design is dominated by the monopole operation case with a continuous current of 1930A to be dissipated into the sea through 80 electrodes at each site. During normal operation, unbalanced current is estimated to be 10 amps.

The HVdc system will have shoreline pond electrodes at L'Anse au Diable in Labrador and Dowden's Point in Newfoundland. The electrodes will be located in a sea water filled pond and protected against the sea waves and floating ice by a breakwater. The breakwater crest lengths are predicted to be roughly 410 m at Dowden’s point and 425 m at L’Anse Au Diable. The breakwater is typically a 12m high wall of rock out in the seawater. Base to crest height of the L'Anse breakwater will be slightly higher as it will be placed in deeper water

SUMMARY

Muskrat Falls Converter Station

- 900 MW, ±350 kV bi-pole, LCC Converter Station capable of operating in mono-polar mode.
- Each pole rated at 450 MW with 100% overload protection for 10 minutes and 50% overload protection for continuous operation (at 40°C).
- Situated on the south side of the Churchill River on a level fenced site.
- Concrete foundations and galvanized steel structures to support the electrical equipment and switchgear.
- Mono-polar operation shall be supported by an Electrode.
- Buildings to include 1 HVdc building comprised of 2 halls with a control building in the middle, warehouse building and diesel generator building; fire protection and detection will be provided per NFPA
- Two (2) converting transformers and two (2) smoothing reactors
- Two (2) AC harmonic filters and two (2) capacitor banks per pole.

Electrode Line - Muskrat Falls to L'Anse-Au-Diable

- An Electrode Line carrying 2 conductors – route to be selected within the same ROW of the HVdc transmission line.
- Wood pole construction.
- 50 year Reliability Level Return Period of loads
- Electrode line will have provision for lightning protection.

Electrode - Labrador (L'Anse-Au-Diable)

- A shoreline pond electrode to be located on the Labrador side of the SOBI.
- Nominal rating of 450 MW with 100% overload protection for 10 minutes and 50% overload protection for continuous operation.

HVdc Overland Transmission - Muskrat Falls to Strait of Belle Isle (Forteau Point)

- A 407 km HVdc overhead transmission line, ±350 kV bi-pole, to connect the Muskrat Falls Converter Station to the Labrador Transition Compound at the Strait of Belle Isle.
- Line to carry both poles (single conductor per pole), and one OPGW.
- This segment of the HVdc line is to have a designed nominal power capacity of 900 MW; however, given the mono-polar operation criteria, each pole is to have a nominal rating of 450 MW with 100% overload capacity for 10 minutes and 50% overload capacity for continuous operation.
- Counterpoise installed from station to station.
- Towers are to be galvanized lattice steel, with self supported angles and deadends, and guyed suspension towers.
- 50 year Reliability Level Return Period of loads


LABRADOR-ISLAND TRANSMISSION LINK
Nain
Natuashish
Hopedale
Makkovik
Postville
Kawawachikamach
Schefferville / Matimekush-Lac John
Rigolet
Happy Valley-Goose Bay
Churchill Falls
Muskrat Falls
North West River
Sheshatshiu
Mud Lake
Cartwright
Black Tickle
Paradise River
Labrador City / Wabush
Gull Island
Norman Bay
Charlottetown
Pinsent's Arm
Port Hope Simpson
Williams Harbour
Mary's Harbour
St. Lewis
Lodge Bay
LABRADOR
Red Bay
L'Anse au Diable
Forteau
St. Anthony
Shoal Cove
Flower's Cove
QUEBEC
Pakua Shipi
Atlantic Ocean
Ekuanitshit
Nutashkuan
Unamen Shipu
Uashat mak Mani-Utenam
Gulf of St. Lawrence
Deer Lake
Gander
Grand Falls-Windsor
NEWFOUNDLAND
Clarenville
Dowden's Point
St. John's
Holyrood
Soldiers Pond
Channel-Port aux Basques
Marystown
Converter Station
Proposed Transmission Corridor
Submarine Cable Crossing Corridor
Trans-Labrador Highway
Electrode Site

Transition Compound - Forteau Point, Labrador

- Situated on a level fenced site.
- Provision for cables and associated switching requirements.
- Concrete pads and steel structures to support the electrical equipment and switchgear.
- Overhead line to cable transition equipment.
- Switching, control, protection, monitoring and communication equipment.
- Buildings to include 1 control building in the middle, switchyard enclosure building and diesel generator building (100 kW); fire protection and detection will be provided per NFPA

Transition Compound – Shoal Cove, Northern Peninsula

- Situated on a level fenced site.
- Provision for cables and associated switching requirements.
- Concrete pads and steel structures to support the electrical equipment and switchgear.
- Cable to overhead line transition equipment.
- Switching, control, protection, monitoring and communication equipment.
- Buildings to include 1 control building in the middle, switchyard enclosure building and diesel generator building (100 kW); fire protection and detection will be provided per NFPA

HVdc Overland Transmission - Strait of Belle Isle (Shoal Cove) to Soldiers Pond

- A 681 km HVdc overhead transmission line, ±350 kV bi-pole, to connect the Northern Peninsula Transition Compound at Shoal Cove to the Soldiers Pond Converter Station.
- Line to carry both poles (single conductor per pole) and one OPGW.
- This segment of the HVdc line is to have a designed nominal power capacity of 900 MW; however, given the mono-polar operation criteria, each pole is to have a nominal rating of 450 MW with 100% overload capacity for 10 minutes and 50% overload capacity for continuous operation.
- Counterpoise installed from station to station.
- Towers are to be galvanized lattice steel, with self supported angles and deadends, and guyed suspension towers.
- 50 year Reliability Level Return Period of loads.

Soldiers Pond Converter Station

- 900 MW, ±350 kV bi-pole, LCC Converter Station capable of operating in mono-polar mode.
- Each pole rated at 450 MW with 100% overload protection for 10 minutes and 50% overload protection for continuous operation.
- Situated on the north side of the Soldiers Pond Tap on the Avalon Peninsula on a level fenced site.
- Concrete foundations and galvanized steel structures to support the electrical equipment and switchgear.
- Mono-polar operation shall be supported by an Electrode.
- Buildings to include 1 HVdc building comprised of 2 halls with a control building in the middle, warehouse building and diesel generator building; fire protection and detection will be provided per NFPA
- Two (2) converting transformers and two (2) smoothing reactors
- Two (2) AC harmonic filters and two (2) capacitor banks per pole

Electrode Line – Soldiers Pond to Dowden’s Point

- An Electrode Line carrying 2 conductors generally follows the existing transmission ROW from Soldiers Pond to Dowden’s Point.
- Wood pole construction.
- 50 year Reliability Level Return Period of loads.

- Electrode line will have provision for lightning protection.

Electrode - Soldiers Pond

- A shoreline pond electrode to be located on the east side of Conception Bay (Dowden's Point).
- Nominal rating of 450 MW with 100% overload protection for 10 minutes and 50% overload protection for continuous operation.

Soldiers Pond Switchyard (230kV) and Synchronous Condenser Station

- Remotely operated switchgear operating at 230 kV
- Three (3) 175 MVAR high inertia synchronous condensers to maintain system performance.
- Four (4) 230kV/25kV/15kV – 120/160/200 MVA Synchronous Condenser Step-Up transformers; one spare step-up transformer
- Additional upgrades to be determined by NE-NLH's System Planning following further studies and analysis.

Operations Telecommunication Systems – Island Link

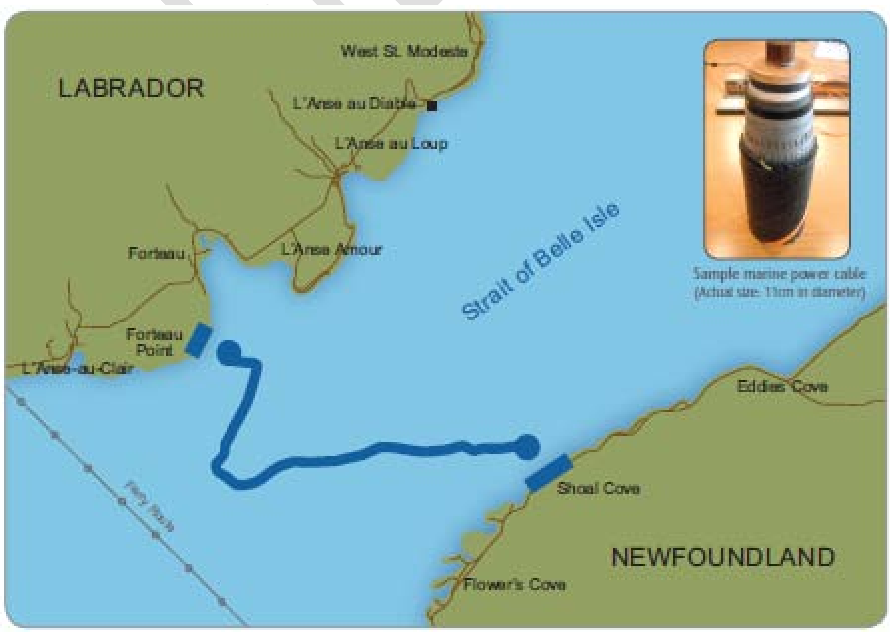
- All permanent control, teleprotection, SCADA and voice circuits to have communication redundancy.

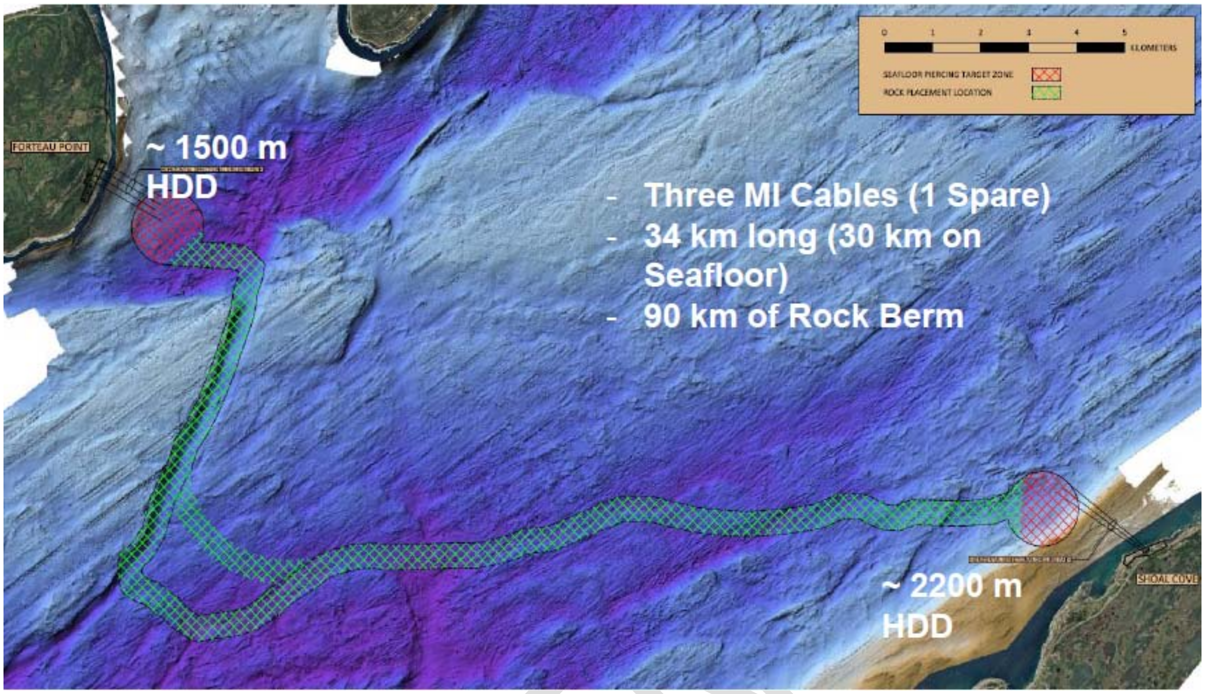
LIL - HVdc Subsea Transmission Information

Strait of Belle Isle Marine Cable Crossing (SOBI)

The transmission project will include the design, procurement, manufacturing, testing, installation and operation of marine power cables across the Strait of Belle Isle, including:

- Cable landing sites identified at Forteau Point (Labrador) and Shoal Cove (Newfoundland).
- Horizontal directional drilling from the land under the Strait of Belle Isle. Drilling will begin 50-100m from the shoreline and continue out under the seabed for 1.5-2km on each side to protect the mass impregnated cables from shore and pack ice at the landfall points.
- The conduits will take each cable to a water depth of between 70 and 80 m, thus avoiding iceberg scour. [Natural bathymetric shield protects against icebergs with a draft greater than 60 m]
- Three power cables will be installed through the HDD drilled holes lined with steel casing and placed on the seabed across the Strait. Each cable will be approximately 30km long and 100m apart within the identified marine cable corridor.
- A transition from submarine to land cable occurs near the HDD cable conduit land entry location. The land cable will be trenched approximately two meters underground to the two transition compounds (TC) located approximately one kilometer from the steel conduit land entry location. The transition compounds house the terminations, surge arresters, cable arrestors, switch gear and transition the power flow to the overhead line transmission system.
- Embedded fiber optics in each cable for distributed temperature sensing and telecommunications.
- Rock berms will be constructed over each cable to provide additional protection from marine vessel traffic dropped objects, fishing activity and other external aggression. Each rock berm will be approximately 1-2m high and 8-12m wide.





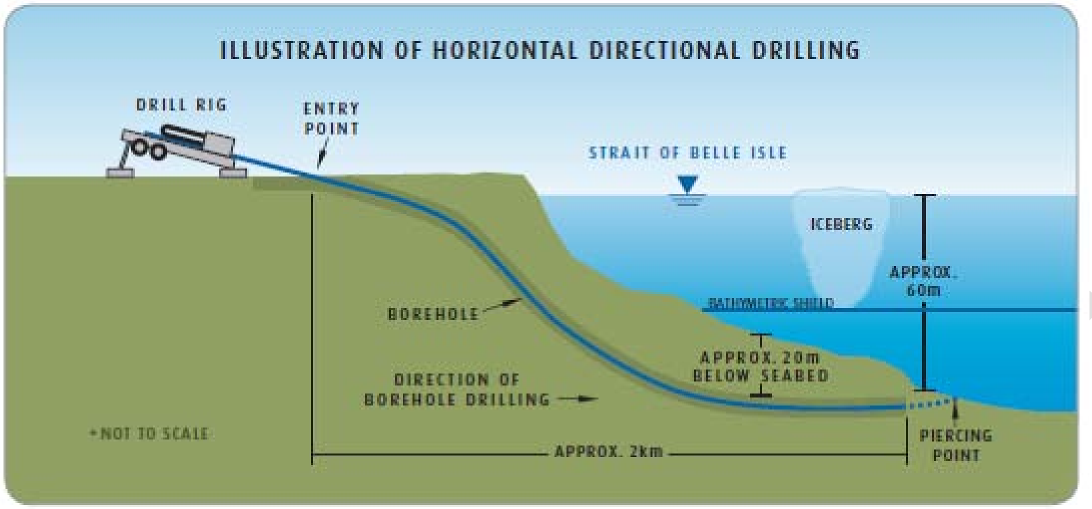
Drilling activities will take approximately two years for both the Newfoundland and Labrador sides of the Strait. The cables are planned to be installed and protected in one construction season thereafter. In planning for this component of the transmission project, Nalcor Energy has and will continue to consult with key stakeholders in the area, such as fishers groups, local municipalities and government regulators.

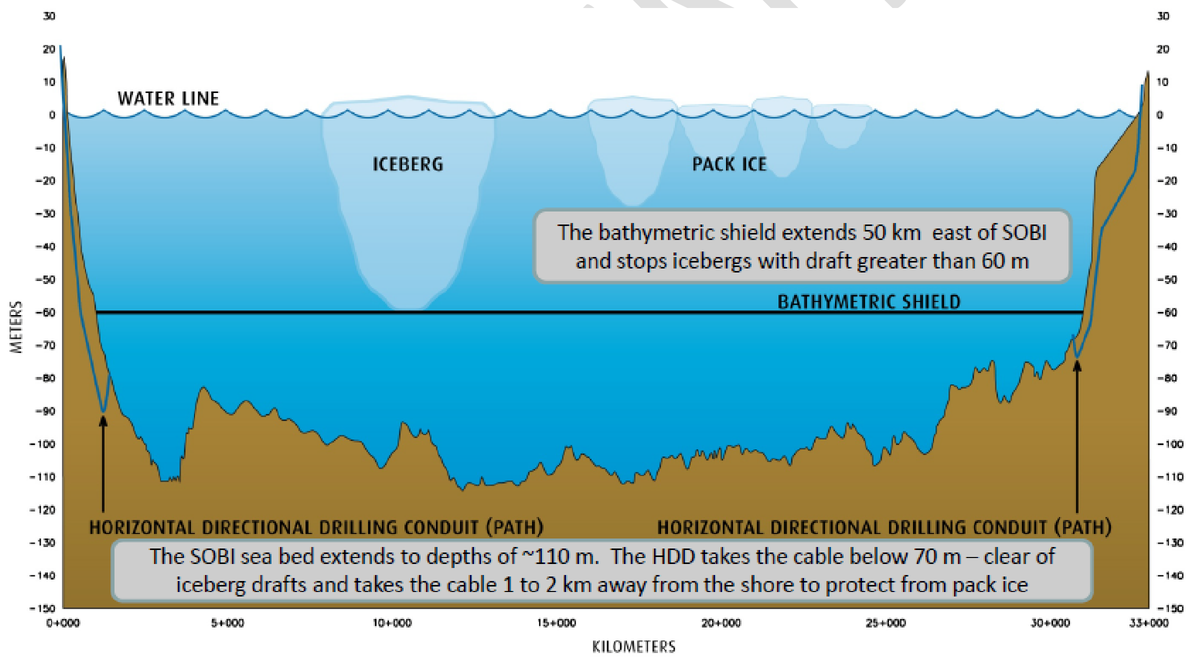
GEOTECHNICAL

Feasibility studies and risk assessments were conducted by the Marine Crossing Team (MCT) which identified areas that required further knowledge and investigation prior to the initiation of the work. The gaps were primarily in the site specific geotechnical information on both Forteau Point and Shoal Cove sites. To address these gaps, significant geotechnical field programs on both sides of the SOBI were conducted. The field programs were necessary to characterize the rock properties where geotechnical information was not previously available. Data obtained further refined the design and de-risked the HDD portion of the landfall.

On the Newfoundland side of SOBI a HDD pilot bore was chosen as the best method to achieve the goals. The HDD pilot bore was successfully drilled in Shoal Cove with a portion reamed to a larger diameter. To ensure the appropriate data was gathered the MCT provided continual site representation to oversee the drilling operation. The pilot bore drilled used typical HDD industry equipment, personnel, means and methods. Valuable information was gathered to characterize the bedrock properties and how they will react when using HDD methods (i.e. drilling muds) as opposed to typical geotechnical coring. Additionally, as this method of drilling is the same as will be used it provided valuable data for refining the execution plan, schedule and cost impacts.

Due to the remoteness of this site, the field program on the Labrador side in Forteau, a HDD pilot bore similar to Shoal Cove was not possible and as a result more conventional geotechnical methods were utilized. The work consisted of core drilling and surface test pits dug at several points around the potential drill entry locations where preparations were needed for constructing a drilling pad. Core samples and subsequent laboratory testing obtained from Forteau fed the final design and construction methods by ensuring that the appropriate equipment was selected for the project, as well as the best contingency planning.



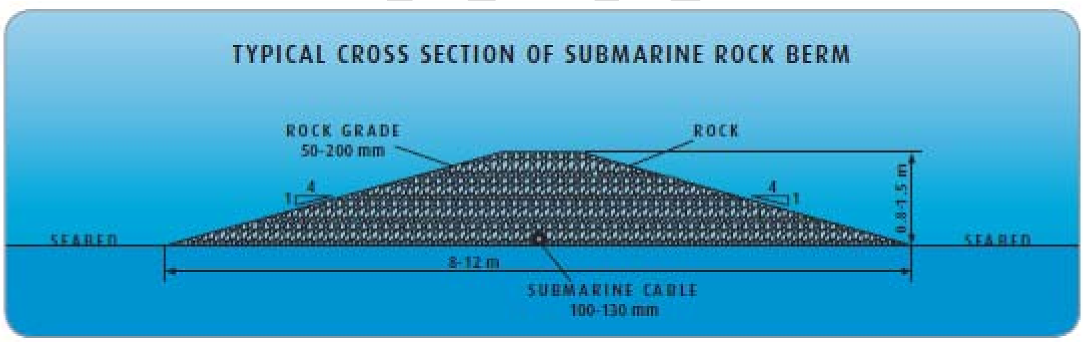


SUMMARY

Marine Crossing - SOBI

- Three ±350 kV dc sub-sea cables transmit power across the SOBI. One of these cables is a spare/redundancy.

- Cable(s) for each pole to have a nominal rating of 450 MW (Total Bipole Transmission Capacity of 900 MW Continuous) with 100% overload capacity for 5 minutes [Nominal Rating: 1286 A (1 pu per pole); Transient Rating: 2572 A (2 pu) for 5 minutes in mono-pole mode].
- Cable(s) to be operable in either bi-pole or mono-pole configuration
- Cable(s) to be suitable for power flow in either direction
- The route for the sub-sea cable(s) crossing has been designed to meet the transmission, protection, reliability, and design life requirements, and gives consideration to technical and economic optimization.
- Cable corridor as per indicated in picture above.
- Cables shall be adequately protected along the entire length of the crossing as required.
- Where discrete protection application is required, protection measures shall be designed to meet the transmission and reliability requirements.
- Cable protection methodology will employ proven technologies only.
- Warranty for individual cable systems is 36 months after approval by the company of the last cable system.
- Contractor (Nexans Norway AS) to provide spare cable and equipment as part of the cable supply as follows:
  - Three thousand two hundred (3200) meters of submarine cable;
  - Five thousand (5000) meters of landfall cable;
  - Six hundred (600) meters of land cable on reel;
  - Two (2) off terminations;
  - Quantity of spare surge arresters to be defined;
  - Four (4) off submarine cable joints;
  - Two (2) off transition joints; and,
  - Two (2) off land cable joints;
- Rock placement supply and installation to be performed by a contractor. Rock placement will be performed on all cables from landfill conduit submarine interface on Newfoundland side to Labrador side and will commence after successful completion of installation testing of the first cable.
- The installation contractor will be required to develop and submit site specific weather forecasting and contingency plans for all marine operations. The plans shall include appropriate severe weather responses for all vessels during their planned operations.
- Cables will be supplied such that the number of factory joints utilized throughout all phases of the work is minimized. In addition, there will be no use of joints of any description within the landfall cables.
- There are no planned field joints/splices.
- The cables are designed with a minimum of ten (10) years satisfactory operating performance for the design without internal failures of cable or accessories.
- The Cable System has a design life of at least fifty (50) years continuous DC operation at rated capacity.
- The cables are insulated with mass impregnated insulation. A metallic sheath will be resistant to fatigue and be of a high creep ductility material and provided with an extruded jacket over the circumference as well as armoring to provide high tensile strength and protection from impact loads due to rock placement for the submarine cables and trench backfill operations for the land cable.
- Each Cable System will be equipped with twelve (12) embedded fibers for telecommunications and DTS.



The drilling for the cables will begin in late 2013 until mid 2015.

CABLE DESIGN LIFE STUDY

A formal study to confirm the design life of the proposed 350 kVdc submarine cable system was also conducted by Cabletricity Connections Ltd. The review was done on the expectations for a 50 year design life for the SOBI system. The performance history of similar cable systems was investigated, as well as the factors influencing actual achievement of expected life, including good design, installation, operation and maintenance practices. Consideration was also been given to investigations by others into longevity of mass impregnated (MI) cables, as well as RFP responses. In summary, results showed that a 50 year design life is a reasonable expectation and is achievable.

Key conclusions were:

- A ‘first generation’ 300 kV dc MI submarine cable system connecting mainland British Columbia to Vancouver Island has been operating since 1969 without internal cable failures.
- If the Vancouver Island 300 kV dc cables have performed well using 1960’s manufacturing technology, it is reasonable to expect that modern manufacturing technologies will produce cables with even greater longevity.
- All installed MI dc submarine cables remain in service, except for those strategically replaced due to increased transmission capacity requirements, or abandoned as not economic to repair following damage by third parties.
- The thermal life of SOBI cable insulation would be much greater than 50 years.
- 50 year electrical life equivalency can be approximated by performing new Type Tests on SOBI cables (an RFP requirement) with a test voltage equal to 1.85 times 350 kV, or 547.5 kV, in accordance with the criteria outlined in Electra No. 189.
- The main mechanical aging factors would be: i) lead sheath fatigue due to cyclic loading, ii) lead sheath fatigue due to tidal current-driven vortex induced vibration at free spans, and iii) tidal current-driven abrasion at free span touchdown points. Plans are to eliminate the second and third factors by placing backfill around the submarine cables for the entire route. Plans are to assure the first factor by an RFP requirement for cable supplier design submittals and Special Tests to confirm adequate sheath fatigue life for 50 years.
- The main chemical aging factor is corrosion of steel wire armor and HDD steel casings. The RFP calls for provision of adequate corrosion protection measures for 50 year longevity.
- Investigations by two major power utilities (Statnett and Tennet) planning a new 450 kV dc submarine MI cable system, concluded that there is a high probability the technical lifetime would be more than 50 years. In response to the SOBI RFP, three proposals were received. None objected to the specified 50 year design life requirement.
- Expectations about design life assume that the complete cable system will be operated and maintained in accordance with the EPC Contractor’s instructions and specifications.

General Support Works

In support of the design, and to provide further definition of the SOBI Marine Crossing there was several general data acquisition programs initiated. These consisted of the Marine Data Acquisition Program, the Iceberg Monitoring Program, and the Ocean Characteristic Monitoring Program and MetOcean Report.

The Marine Data Acquisition Program was executed covering both the SOBI and Cabot Strait (CAST) regions. The firm was contracted to perform the marine survey, which included; collection of bathymetry, sub-bottom profile and General Visual Inspection (GVI) data. The program was categorized into both a near-shore component and an offshore component. The near-shore work was conducted covering the area from shore (approximately 5 m water depth) out to a notional water depth of 20 meters. The offshore component was conducted to traverse both straits between the near-shore work areas and utilized a Remotely Operated Vehicle (ROV) and Remote Operated Towed Vehicle (ROTV) to deploy survey sensors in deeper water for higher data resolution. The program consisted of collecting geophysical data including bathymetry, side scan, and sub-bottom profiler (SBP) data both near-shore and offshore. As well, GVIs (using the ROV cameras) were conducted offshore SOBI and geotechnical data was acquired offshore CAST. A multi-beam system along with side scan was used to collect the bathymetry to 0.25 m resolution with limited portions, between safe ROV operating depth and shallow water data acquisition system limitations, having 0.5 m resolution. The SBP penetration was interpretable throughout the surveyed area.

The Iceberg Monitoring Program consists of the erection of a 30 m tower with radar detection and visual interrogation devices located in Shoal Cove. The tower started collecting data in Q2 2012 and the program is planned for at least two years of data collection. The overall purpose of the iceberg tracking program is monitoring iceberg size and behavior in the SOBI in the vicinity of the proposed cable route. To refine engineering design and confidence, more information will be obtained to understand the behavior of ice formations in the area; their frequency, size, roll rates and thus potential long term impact to the subsea cable installation. Data collected will be used to refine the previous iceberg model. The tower has the following equipment integrated in the tower design: radar device positioned on the tower with a view over the SOBI, video device positioned on the tower with a view over the SOBI delivering photos and video images, anemometer, delivering wind speed and direction, and Automatic Identification System (AIS)/ Global Positioning System (GPS) transceiver, delivering AIS contact information (boats / vessels). During the operations phase, the site will collect data and report for a minimum period of 2-years.

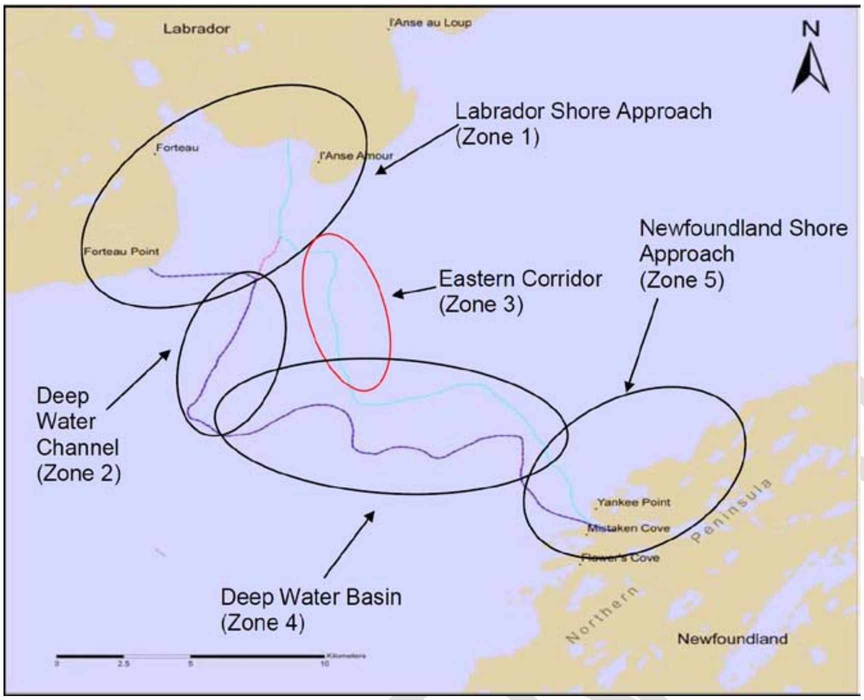
The Ocean Characteristic Monitoring Program and MetOcean Report consist of current and wave monitors placed in strategic locations across the SOBI. The program is planned for two years of data collection. These monitors will provide a profile of the entire water column and wave/current movements along the proposed cable corridor. This contract will also generate a Meteorological and Oceanographic (MetOcean) Report to provide the MCT and contractors with a greater understanding of the meteorological and oceanographic conditions in the SOBI. The data acquired from the scope of work will provide a more extensive understanding of the sea currents and waves in the SOBI and function as inputs into detailed cable, installation and protection design.

Marine Crossing Design

The Strait of Belle Isle seabed crossing, although merely some 18 km from shore to shore, is extremely complex and poses numerous challenges for installation and protection that include sea currents, icebergs, pack-ice, tidal forces, hard rock sea bottom, varying water depths, fishing activities, and vessel traffic.

To develop an adequate solution a zone approach was implemented. The route was divided into the following zones:

- Labrador Landfall (Zone 1) – This zone starts on land that is nominally 150 to 1000 m from the shoreline, and extends to a water depth between 65 and 85 meters, near the Deepwater Channel. Protection in this zone is primarily required for tidal, pack ice, icebergs, and fishing.
- Deepwater Channel (Zone 2) – A nominally 400 – 750 m wide deepwater channel that starts on the Labrador side and runs to approximately the midpoint on the route. Protection in this zone is primarily required for vessel traffic (dropped objects) and fishing.
- Eastern Corridor (Zone 3) – A region of nominally 65 - 75 m water depth that runs from the Labrador Landfall to the Deepwater Basin. Protection in this zone is primarily required for vessel traffic and fishing and has a higher probability of iceberg scour.
- Deepwater Basin (Zone 4) – A region of nominally 100 to 120 m water depth that runs from Deepwater Channel to the Newfoundland landfall in both corridors. Protection in this zone is primarily required for vessel traffic (dropped objects) and fishing.
- Newfoundland Shore Approach (Zone 5) – This zone that is nominally 150 to 1000 m from the shoreline, and extends to a water depth between 65 and 85 meters. Protection in this zone is primarily required for tidal, pack ice, icebergs, and fishing.



Upon review of all the engineering data, it was determined that the preferred route for the SOBI seabed crossing was the more westerly crossing. This route takes into account the landfall and natural protection methods. The estimated length is approximately 36 km with roughly 32 km on the sea floor. The route is depicted as a 500 m wide corridor with a 1500 m diameter circular seafloor piercing target zone. Detailed cable spacing and routing are being carried out with a recommendation that a no fish zone be established.

Repair Costs

There have been no documented cases of internal failure on standard single core designed MI cables. All documented failures of standard designed cables have been due to external aggression. Although cable protection will be designed to be sufficiently robust and a failure during the service life is unlikely, it may be possible in an extreme case to sustain damage and hence require intervention.

For repair on a seabed cable an intervention vessel will be required with at a minimum a cable jointing area on the deck, a functioning crane, a work class ROV, and a suction / excavation type ROV. This type of vessel could be mobilized from the fleet of vessels based out of St. John's or Halifax. Also required would be a spare section of cable (included at the time of order and stored locally) and a cable vendor repair team with tools and consumables for execution of a repair. Localized protection for the expansion loop will also be required and will likely include articulated pipe, rock, or mattresses.

A preliminary cost has been developed by the MCT for a repair and is approximately $15 MM CAD.

Testing Program

In order to prove the HVDC cable system design for the conditions occurring in the SOBI, a special type testing has been developed for a pre-production program. This testing program was proposed in the cable supply and install RFP, and has been further defined leading into DG3. Special mechanical tests will be executed to replicate installation loading, particularly in the landfall conduits, and will include high tensile and abrasion testing. Electrical tests will be performed to replicate system loading following the mechanical testing. This will also validate the calculated 50 year design life requirement. In addition, the high tensile testing will validate the embedded fiber optic strand survivability during a long pull-in, in the event the embedded solution is feasible to pursue.

INSTALLATION

The envisaged installation process is initiated by the transpooling of all three of the cables onto a capable Cable Installation Vessel (CIV) (confirmed Nexans vessel is the Skaggerak) from the manufacturing plant and transiting to installation site. A list of CIVs worldwide has also been maintained as well as CIVs under construction. The typical cost of utilizing a CIV was noted at $254,000 per day.

To ensure streamlined pre-commissioning of the complete submarine system, the land cables will be installed prior to the submarine cable installation campaign. The land cables will be shipped by a vessel to a suitable offloading marine terminal and subsequently transported on heavy or oversized road transportable reels. Once on site, the land cable will be offloaded and mounted in a spooling system and the trench will be equipped with rollers. The land cable will be installed in the prepared land trench via the rollers and crane. A single land cable to land cable joint will be required for each crossing, thus six (6) in total. The land cable will be installed through the allotted locations at the base of the TC for termination. The completed land cable installation and termination will allow for the submarine system to be tested through to the termination once the transition joint between submarine and land cable is completed.

The submarine installation philosophy consists of the installation of three HVDC cables in one continuous length from a CIV. The cable installation all indicated no joints as their primary solution with a modified second end pull in. The second end pull in would consist of floating the second end conduit pull in cable length with a secondary handling setup (vessel, barge, secondary tensioning equipment onboard the CIV) to establish the proper catenary or curve for the pull in. Utilizing slice kits/joints remains as a contingency.

If a submarine joint would be required, the cost quoted by Nexans for a repair would be approximately $2.85 million.

Cable lay initiation will consist of the abandonment of the cable first end (capped by a pulling head) at the location of the first bore hole on either side of the SOBI. A messenger line from a high powered winch located onshore will be passed through the HDD conduit to the opening on the seafloor. A ROV will be utilized to secure the pulling head to the prepared winch line and the vessel will pay out as the winch hauls the cable through the bore hole. Once the cable is secured onshore, the CIV will perform normal lay to the second pull-in as noted.

This operation will be repeated for the following two cables. Once the initial cable is installed a transition joint from marine cable to land cable will be completed. Following the transition joint the cable will be tested and the protection campaign may commence. The current schedule ensures that there is adequate float so that protection and installation campaigns due not conflict unless there are unforeseen delays.

In the event that the cable will require a submarine joint after the installation campaign, any spare equipment will be offloaded at a local storage port following installation during demobilization. The jointing method has been detailed and explicitly defines the requirement for spare cable, lifting heads, and other ancillary equipment.

Operational details on a cable inspection program, repair (including fault finding, spare cable & equipment, preparation for recovery, repair vessel, repair operation) and maintenance have been also developed.

Capital Spending Profile

The following is a preliminary envisaged capital spending profile for the project that indicates the percentage of the CAPEX estimate spent between now and 2016.

Year	2011	2012	2013	2014	2015	2016
%CAPEX	0%	5%	7%	24%	24%	40%

General Liability Exposures

General

The LCP operations represent a Liability Exposure typical of a hydrogeneration construction project, that is:

- Hydroelectric generation and associated premises and dam exposures
- High voltage transmission and substations (both overland and underwater)

Site Security

The sites are remote and in rugged terrain. There will be only one access road to each site. The main hydrogenation site will have full time site security with main gate access point.

A full Project Security Management Plan has been developed.

General Public Liability

There is little risk exposure. Given the remote site and the Security in place, unauthorized access is unlikely.

Water Rights & Access to Watershed

The water rights for the project are owned by the Province of Newfoundland and Labrador and Nalcor is a wholly owned entity of the province. Water rights have been granted by the government to Nalcor for the use of power generation.

Access to the watershed will be limited during construction and monitored by security as well as employees of Nalcor.

When the project is complete, typical public announcements as well as local signage will be provided to education and notifies any public of the site and hazards therein.

River Diversion

The Churchill River will not be diverted during the construction or after the completion of the project. Temporary coffer dams will be provided during construction to allow construction of the site but water will still pass the project during all times.

Contracts

There will be a large number of contracts, large and small, in place during the construction of this project.

General contracts have been developed and reviewed by Risk Management as well as legal to ensure that Nalcor interests have been protected or indemnified.

A list of the larger contracts is provided in this document elsewhere.

Environmental

The Project underwent an extensive and rigorous environmental review, to meet the requirements of both the Government of Newfoundland and Labrador and the Government of Canada. Provincial environmental assessment requirements are set out in the Newfoundland and Labrador *Environmental Protection Act* (*NLEPA*), while federal government requirements are found in the *Canadian Environmental Assessment Act* (*CEAA*).

Further details regarding environmental commitment by Nalcor are provided under the heading of Environmental Risk Exposures.

Land and Resource Use

Land and resource use throughout the region includes hunting and trapping, fishing, wood harvesting, berry picking, snowmobiling and boating. Both Aboriginal and non-Aboriginal people are active land and resource users

Borrow Pits and quarry sites

Rock and gravel will be needed to build the generation facilities, dams and other Project facilities. After the borrow pits and quarry sites are no longer needed, they will be allowed to re-grow naturally.

Spoil Areas

During construction, rock and soil will need to be removed from some of the sites. This waste material will be placed in piles in selected areas that are called spoil areas. When the Project is complete, the piles of rock and soil in the spoil areas will be shaped to make them stable and to control erosion, and plants will be allowed to grow naturally.

Endangered Species

A detailed analysis is being completed on all impacted wildlife as part of the environmental assessment.

Through its studies, Nalcor is gathering information on the existing biophysical and socioeconomic environments in the transmission project area. This information will be used throughout the environmental assessment process and in ongoing project planning and design.

The environmental study has included field surveys and other studies related to:

- Terrestrial (Vegetation and Wildlife)
- Freshwater
- Marine
- Historic and Heritage Resources
- Land and Resource Use

Dams

The 430 m long North Dam closes the river channel on the north side of the north transition dam, and serves as an overflow spillway. This dam will be constructed primarily of RCC, with a conventional concrete skin on the upstream side, overflow cap and downstream slope. A small concrete flip at the toe of the dam will assist in energy dissipation and separating the high energy flow from the rock surface at the toe.

The North Dam will be constructed in the dry behind the upstream and downstream cofferdams. The upstream cofferdam will comprise an RCC dam connected to the north transition dam, and will run upstream to connect with the upstream rockfill cofferdam.

The North Transition Dam is located on the north side of the gated spillway structure and is about 15 m long. Its purpose is to form an abutment for the north dam constructed of RCC, and to contain a stairwell shaft for the gallery. It will be constructed of conventional concrete.

The Center Transition Dam is located between the gated spillway and the Intake, and is about 60 m long. Its purpose is to form the bend in the dam to allow the Intake to be rotated 45 degrees with the north dam alignment, to accommodate the large differential in foundation excavation elevations between the dam foundation and the intake and to contain one stairwell shaft at either end for access to the gallery.

The South Transition Dam is located at the south end of the intake structure, and is about 7.6 m long. Its purpose is to form an abutment for the south dam, to contain a stairwell and elevator, and to accommodate the foundation elevation difference between the south dam and the intake. It will be constructed of conventional concrete.

The South Dam closes the river valley on the south side of the intake, and is about 320 m long. It is a non-overflow dam, and will be rockfill dam.

Coffer Dams

The attenuating effect of the reservoir during construction was investigated by a third party engineering firm based on the discharge capacity of the diversion facilities. Three flood scenarios were considered and in each case, the peak water level was less than the current upstream cofferdam design elevation. These results indicate that should similar flow conditions be encountered during construction, the proposed cofferdam at elevation 25 m should be adequate.

Downstream Exposures

The degree of exposure to downstream liability in the event of a major dam failure is always a major concern.

The following information is known at this time:

- There is a highly variable flow past the Dam, ranging from none in the dry season to heavy flows in the wet season.
- Two loss scenarios were analyzed and developed:
    - *Fair Weather Failure – no loss of life, 3 hour time span from Failure to reach Happy Valley-Goose Bay;* the mode of failure would be monolithically by overturning or sliding.
        - Economic damages associated with loss of homes (~350) = $47,250,000.
        - Approximate area of incremental flooding = 120 km_2.
        - Overtopping of Blackrock Bridge.
        - Loss of access and transportation routes in and around Happy Valley - Goose Bay.
        - Loss of transmission line infrastructure in and around Happy Valley - Goose Bay.
        - Loss of Muskrat Falls Hydroelectric Station and energy.
    - *PMF Failure – more serious but Dam Design can withstand, and since a PMF is extreme weather over an extended period of days, there would be lots of warning time, i.e. 36 hours or more.*
        - Economic damages associated with loss of homes (~40) = $5,400,000.
        - Approximate area of incremental flooding = 45 km_2.
        - Overtopping of Blackrock Bridge.
        - Loss of access and transportation routes in and around Happy Valley - Goose Bay.
        - Loss of transmission line infrastructure in and around Happy Valley - Goose Bay.
        - Loss of Muskrat Falls Hydroelectric Station and energy.
- The first major settlement downstream is the town of Happy Valley-Goose Bay.
- Happy Valley-Goose Bay currently has a formal Emergency Response Plans for the town. They will be working with the provincial government to update and include a plan for events such as dam breach.
- All the dams have been analyzed relative to downstream consequence, rated in accordance with Canadian Dam Association and Provincial Regulations.
- Dam safety reviews are conducted annually on all Owned Dams and are available on request.

- Inundation Studies were done in the 2000's by a third party, which simulated the effects of a dam breach, to identify downstream Inundation potential. (Lower Churchill Project – Hydraulic Modeling & Studies 2010 Update – Muskrat Falls Dam Break Study by Hatch which is available upon request).
- These maps will form the basis for the Emergency Preparedness Plans which will be developed by the town and province.
- The current reservoir filling scheme for Muskrat Falls involves no cessation of flow since the strategy is to have spillway capacity available during reservoir impoundment. Therefore dewatering of the downstream reach and potential salt water intrusion during reservoir filling is not expected to have a great concern.

Upstream Exposures

With the construction of the dam, flooding upstream will be limited as the valley already exists with little or no damage to others.

Trees will be cleared if they are tall enough to be hazards to boats using the reservoir, or if they will be close enough to the edge of the reservoir that they are likely to fall into the water as the new shoreline becomes established. The Muskrat Falls Reservoir will be almost completely cleared. In some areas tree clearing will not be possible because of steep slopes.

Once the dams are built, the reservoir will fill with water. Depending on the time of year, it will take up to approximately 15 to 20 days to fill the Muskrat Falls reservoir.

Financial

Details of the financial arrangements for this project are covered elsewhere in this report.

Vehicles/Vessels

There is a formal Fleet Safety Program already in place at Nalcor.

All company vehicles undergo recorded vehicle inspections. Inspections include engine checks, transmission checks, driveline checks, steering and suspension checks, exhaust check, brakes check, cab & chassis check and all attachments are checked.

A vehicle refueling station at the Muskrat Falls site will be provided. The fueling station will be removed from service with the tank removed when construction is complete. All fuel tanks will be double walled tanks to comply with the corporate environmental policy.

Other

HEALTH & SAFETY PROGRAM

Nalcor has a detailed Health & Safety Program that is strictly enforced at all levels. All findings are recorded and reported to upper management who review the findings monthly.

MEDICAL SERVICES

Provincial Regulations require Nalcor to maintain a certain capability level in this regard. Therefore, the Muskrat Falls Project will maintain the following:

- Emergency Medical Vehicle (owned and operated under contract by 3rd party)
- First Aid Room
- A qualified First Aid persons

Roads/Access/Remote Site

About 22 km of temporary roads will be needed to provide road access to the building sites and to reach the area which will be cleared for the reservoirs. The temporary access roads will be flooded when the reservoir is filled, or rehabilitated after the Project has been built. About 30 km of permanent roads will be constructed or upgraded to provide access from the Trans Labrador Highway to Muskrat Falls Hydro site.

A temporary bridge will be built along access roads at any stream crossings and removed after the Project has been built.

The Company requires access to gravel deposits which involves clearing of approximately 3.5 km of haul road and a second of approximately 2.0 km of haul road. A haul road is defined as a gravel two lane road suitable for the transporting of material by CAT 772 off-highway haulage trucks or equivalent.

Housing

Currently there are no properties at any of the proposed sites. Temporary living accommodations will be constructed to permit the majority of contract workers to live and work at the site. Details of the living accommodations are provided elsewhere in this report. The camp will be removed when the project is complete.

Additional housing can and has been used at the NATO base in Happy Valley-Goose Bay.

Forest Fire

Nalcor will be exposed to claims for Fire Fighting expenses. The company currently is insured for this exposure.

In case of a forest fire project personnel shall refer to the Emergency Response Plan for detailed contingency measures. Precautions and further details can be obtained in the EPP plan Section 7.4.

People Resettlement

There is no people resettlement with this project.

Contractors

All contractors will undergo approval and training programs before being permitted on the sites.

A list of all approved contractors and employees will be kept on file.

Claims Handling

A formal system to handle all claims that occur during the project is being setup. This process shall be in-house but supported by external consultants.

Provincial Inspections

The province of Newfoundland and Labrador will be involved at all stages. Required provincial inspections will be carried out as required.

Adjacent Communities

The effects likely to happen in the adjacent communities include increased traffic through the airport t Happy Valley-Goose Bay, increased use of the port and Trans Labrador Highway to move people and supplies to the work camp, demand for commercial and industrial land in Happy Valley-Goose Bay, and a demand for housing. Local businesses may find that there is more competition for workers.

Because the workers will be housed in camps at the work sites, Nalcor does not expect that a large number of people will move to these communities to work on the Project. This will reduce the types of impacts that happen to communities when a large number of people move to a community in a short period of time. So it is not expected that this will result in problems related to available housing, medical or social services available in the Happy Valley-Goose Bay area.

Environmental Risk Exposures

The Project has and is in the process of undergoing an extensive and rigorous environmental review, to meet the requirements of both the Government of Newfoundland and Labrador and the Government of Canada. Provincial environmental assessment requirements are set out in the Newfoundland and Labrador *Environmental Protection Act* (*NLEPA*), while federal government requirements are found in the *Canadian Environmental Assessment Act* (*CEAA*).

The environmental assessment process was initiated in December 2006, prior to the creation of Nalcor Energy, by Newfoundland and Labrador Hydro (Hydro). Hydro filed the Project Registration/Description Document with both governments. Upon review of the Registration and consideration of comments received from the public, the provincial Minister of Environment and Conservation determined that an EIS was required. The federal Minister of the Environment, who is responsible for the Canadian Environmental Assessment Agency, subsequently announced that the Project should undergo an environmental assessment by an independent review Panel. The two governments have decided to coordinate the two assessments through a Joint Review Panel.

To guide the environmental assessment process, the federal and provincial governments have issued joint EIS Guidelines. These describe the scope of the Project to be assessed, as well as the scope of the assessment itself. The Guidelines describe in detail those aspects of the Project that require consideration in the EIS, as well as the specific components of the environment and potential issues to be considered. In response to these government requirements, Nalcor Energy has produced a comprehensive and well-researched EIS. Thus, the Project, upon release, can proceed with minimum adverse effects on the land, its resources and its people, while maximizing the benefits for the environment and the citizens of the Province.

COMMITMENT TO THE ENVIRONMENT

An Environmental Services Department was established in 1975. Since that time, the corporation has demonstrated leadership in managing the environmental aspects of its activities and will continue to do so under Nalcor Energy. Through the 1970s and 1980s, Hydro (now a subsidiary of Nalcor Energy) was an innovator both provincially and nationally with respect to environmental assessment, environmental compliance and effects monitoring, environmental auditing and environmental protection planning. Hydro has confirmed its leadership role in environmental management by adopting the stringent International Organization for Standardization (ISO) 14001 standard for its Environmental Management System (EMS) at its facilities. ISO certification is a demonstration of a high level of commitment to the policy and practice of environmental management, including review and audit.

Environmental Policy and Guiding Principles (Policy) were established by Hydro in 1997 and updated in 2006. This Policy has been adopted by all lines of business of Nalcor Energy and is provided below.

ENVIRONMENTAL POLICY AND GUIDING PRINCIPLES

The Nalcor Group of Companies will help sustain a diverse and healthy environment for present and future Newfoundlanders and Labradorians by maintaining a high standard of environmental responsibility and performance through the implementation of a comprehensive environmental management system.

The following guiding principles set out the Nalcor Group's environmental responsibility:

PREVENTION OF POLLUTION

• implement reasonable actions for prevention of pollution of air, water, and soil and minimize the impact of any pollution which is accidental or unavoidable;
• use the Province's natural resources in a wise and efficient manner;
• use energy as efficiently as possible during the generation, transmission, and distribution of electricity, and the operation of its facilities, and promote efficient use of electricity by customers;
• maintain a state of preparedness in order to respond quickly and effectively to environmental emergencies;
• recover, reduce, reuse and recycle waste materials whenever feasible;

IMPROVE CONTINUALLY

• audit facilities to assess potential environmental risks and continually improve environmental performance;
• integrate environmental considerations into decision-making processes at all levels;
• empower employees to be responsible for the environmental aspects of their jobs and ensure that they have the skills and knowledge necessary to conduct their work in an environmentally responsible manner;

COMPLY WITH LEGISLATION

• comply with all applicable environmental laws and regulations, and participate in the Canadian Electricity Association's *Environmental Commitment and Responsibility Program*;
• periodically report to the Board of Directors, Executive Management, employees, government agencies, and the general public which we serve on environmental performance, commitments and activities;
• monitor compliance with environmental laws and regulations, and quantify predicted environmental impacts of selected activities on the environment;
• respect the cultural heritage of the people of the Province and strive to minimize the potential impact of corporate activities on heritage resources.

The Policy is based on the principle of sustainable development, which espouses an appropriate balance among environmental, economic, and social aspects of its business. Specifically, as required by the ISO 14001 standard, the Policy commits to prevention of pollution, compliance with legal and other requirements, and continual improvement of environmental performance.

The main document is the Project-*Wide Environmental Protection Plan (P-WEPP)* which is a controlled document with revisions processed only by SNC Lavalin's Environmental Manager. The Project-Wide Environmental Protection Plan will ensure a high level of environmental protection in all of the Project's work areas during construction and commissioning. This P-WEPP is a working document for use at site by Project personnel and contractors. It will help ensure conformance with both NE-LCP and SLI policy statements. It also will serve as a tool for Project participants, including regulators, to monitor regulatory compliance and to improve on environmental performance.

This P-WEPP contains standard environmental protection procedures, or mitigation measures, for activities commonly associated with large projects of this type. The objectives of this P-WEPP are to:

a) Anticipate potential negative environmental effects associated with construction; and

b) Implement appropriate mitigation measures to minimize or avoid negative effects where practical.

It should be noted that the P-WEPP is one component of the Lower Churchill Project's Environmental Management Plan. Other subordinate documents of the Environmental Management Plan include the following:

a) Contract-Specific Environmental Protection Plan (C-SEPP) Template;
b) Rehabilitation Plan (RP);
c) Regulatory Compliance Plan (RCP); and
d) Waste Management Plan (WMP).

Nalcor's Emergency Response Plan is a companion document to the Environmental Management Plan. It contains a Master Spill Response Plan, which shall be used by contractors as a basis for preparing their own spill response plans.

This P-WEPP applies to all Project participants, including NE-LCP, SLI, contractors, subcontractors, suppliers, service providers, and all employees of these organizations.

A formal Responsibility Matrix has been developed:

Activity	SNC-Lavalin Inc	Project Manager	Environmental Manager	Environmental Co-ordinator (Hydro)	Environmental Co-ordinator (Transmission)	Permits Co-ordinator	Component Manager	Construction Managers	Interface Manager	Area Manager	On-Site Environmental Monitors	SLI Staff	Nalcor Energy	Contractors
Development of the P-WEPP		A	R	R	S	S	S	S	I	I	I	S	C	I
Review of P-WEPP		A	R	I	C	C	C	C	C	C	I	I	C	I
Accept P-WEPP		I	I	I	I	I	I	I	I	I	I	I	A	I
Implementation of the P-WEPP		A	R	R	R	S	R	R	I	R	R	R	C	R
Management/Revisions of the P-WEPP		A	R	R	R	C	I	C	I	I	S	S	C	I
Development of the C-SEPP		I	S	S	S	S	S	S	I	I	I	I	C	A/R
Review of the C-SEPP		A	R	R	R	C	C	C	I	I	I	I	C	I
Accept C-SEPP		A	R	R	R	I	I	R	I	I	I	I	R	I
Implementation of the C-SEPP		R	R	R	R	R	R	R	I	R	R	R	C	A/R
Management/Revisions of the C-SEPP		R	R	R	R	S	I	R	I	I	S	S	C	A/R
Toolbox Meetings		R	R	C	C	C	R	R	I	C	R	I	I	A/R
Project Environmental Awareness														
(i) SLI Employee Orientation		A	R	R	R	S	R	R	R	R	R	R	I	I
(ii) Visitor Orientation		A	R	R	R	I	R	R	R	R	R	R	I	I
(iii) Contractor Orientation		A	R	R	R	S	R	R	R	R	R	S	I	R
Environmental Compliance Monitoring														
(i) Daily Field Reports		A	R	R	R	S	R	R	I	C	R	S	I	C
(ii) Quarterly Environmental Audits		A	R	R	R	C	C	S	I	I	S	I	C	C
(iii) Annual Environmental Performance Review		A	R	S	S	S	C	S	I	I	S	I	C	I
Managing Non-conformances		A	R	R	R	C	I	R	I	S	S	S	C	I
Permit Registry		A	R	R	R	R	R	R	C	R	R	C	R	R
Environmental Effects Monitoring		I	I	I	I	I	I	C	I	I	I	I	A/R	C

Accountable, **R**esponsible, **S**upports, **C**onsulted, **I**nformed
P-WEPP: Project-Wide Environmental Protection Plan
C-SEPP: Contract-Specific Environmental Protection Plan

The two environmental assessments that were required for this project are:

1. Generation Environmental Assessment
2. Transmission Environmental Assessment

The Generation Environmental Assessment has been completed and approved by the appropriate governments (Federal and Provincial). Further details can be found at https://muskratfalls.nalcorenergy.com/newsroom/reports/

The Transmission Environmental Assessment has been completed and has been submitted for approval to the appropriate governments. Further details can be found at https://muskratfalls.nalcorenergy.com/newsroom/reports/

Natural Hazards Exposures

NATHAN Single Risk Assessment Report

Risk Location	CAN (Canada)
Longitude/Latitude	-60.7659E, 53.2467N
Munich Re Risk Location Quality	100% (exact coordinates)
Cresta Name	HAPPY VALLEY-GOOSE BAY
Cresta Id	A0P
People per km²	< 1

Risk Evaluation based on Munich Re Hazard Zones

	low … high	hazard rating
Earthquake		Zone 0
Volcanoes		No hazard
Tsunami		No hazard
Tropical cyclone		No hazard
Extratropical storm		Zone 2
Hail		Zone 1
Tornado		Zone 1
Lightning		Zone 1
Wildfire		No hazard
River flood		No information
Flash flood		Zone 2
Storm surge		No hazard
Population density		Class 1

Legends

Earthquake

- Zone 0: MM V and below
- Zone 1: MM VI
- Zone 2: MM VII
- Zone 3: MM VIII
- Zone 4: MM IX and above

Probable maximum intensity (MM: modified Mercalli scale) with an exceedance probability of 10% in 50 years (equivalent to a „return period“ of 475 years) for medium subsoil conditions.

Volcanoes

- No hazard*
- Zone 1: Minor hazard
- Zone 2: Moderate hazard
- Zone 3: High hazard

*Secondary effects that can occur as a result of the large-scale distribution of volcanic particles (e.g. climate impacts, supraregional ash deposits) are not considered

Tsunami

- No hazard
- Zone 1: Very low to low
- Zone 2: Medium to high

Detailed calculations for coasts and for the shores of large lakes between 60°S and 60°N, derived from the height above the mean sea or lake level and the distance from the respective body of water. Does not consider dykes.

Tropical cyclone

Peak wind speeds

- No hazard: < 76 km/h
- Zone 0: 76 – 141 km/h
- Zone 1: 142 – 184 km/h
- Zone 2: 185 – 212 km/h
- Zone 3: 213 – 251 km/h
- Zone 4: 252 – 299 km/h
- Zone 5: ≥ 300 km/h
- Typical track directions

Probable maximum intensity with an exeedance probability of 10% in ten years (equivalent to „return period“ of 100 years).

Extratropical storm

- No hazard

Peak wind speeds

- Zone 0: ≤ 80 km/h
- Zone 1: 81 – 120 km/h
- Zone 2: 121 – 160 km/h
- Zone 3: 161 – 200 km/h
- Zone 4: > 200 km/h

Probable maximum intensity with an average exeedance probability of 10% in ten years (equivalent to a „return period“ of 100 years). Areas were examined in which there is a high frequency of extratropical storms (approx. 30°–70° north and south of the equator).

Hail

- Zone 1: low
- Zone 2
- Zone 3
- Zone 4
- Zone 5
- Zone 6: high

Frequency and intensity of hailstorms.

Tornado

- Zone 1: low
- Zone 2
- Zone 3
- Zone 4: high

Frequency and intensity of tornados.

Lightning

Global frequency of lightning strokes per km² and year

- Zone 1: 0,2 – 1
- Zone 2: 1 – 4
- Zone 3: 4 – 10
- Zone 4: 10 – 20
- Zone 5: 20 – 40
- Zone 6: 40 – 80

Lightning frequency is determined by counting the total number of lightning flashes independently of whether they strike the ground or not.

Wildfire

- No hazard
- Zone 1: low
- Zone 2
- Zone 3
- Zone 4: high

The effects of wind, arson and fire-prevention measures are not considered.

River flood

- Zone 0: Areas of minimal flood risk
- Zone 500: 500 year return period
- Zone 200: 200 year return period
- Zone 100: 100 year return period
- Zone 50: 50 year return period

The areas threatened by extreme floods are depicted only in Australia, China, Bangladesh, India, parts of the United States, and a number of European countries.

Flash flood

- Zone 1: low
- Zone 2
- Zone 3
- Zone 4
- Zone 5
- Zone 6: high

Frequency and intensity of flash floods.

Storm surge

- No hazard
- Zone 1: Very low to low
- Zone 2: Medium to high

Detailed calculation for coasts and the shores of large lakes between 60°S and 60°N, derived from the height above the mean sea or lake level and the distance from the respective body of water. Does not consider dykes.

Population density

People per km² (2009)

- Unpopulated
- Class 1: < 1
- Class 2: 1 – 9
- Class 3: 10 – 49
- Class 4: 50 – 199
- Class 5: ≥ 200

The population density represents a 24-hour average value. This means that the figures include daily movements, such as commuter journeys, and not just the night-time population.

Lowe

River Flood

Probable Maximum Flood

The flood design guidelines utilized for the construction period as well as the operational period of Muskrat Falls utilized the Canadian Dam Association (CDA) guidelines. The EPCM contractor (SNC Lavalin), who has a member sitting on the Board of Directors of the CDA, utilized their CDA expertise for the design and verification of the methodology for the site protection against flooding conditions. Nalcor also performed hydraulic waterflow modeling of the river to determine and verify that the current construction sequence and final design are able to handle a PMF situation. An important note to remember is that the CDA does not require the use of an overflow structure to handle PMF during operation but his site does have that additional level of protection when fully operational.

Another point to consider is that the existing Churchill Falls Hydro site (which is also owned and operated by Nalcor) does control and can limit the amount of water entering upstream of Muskrat Falls. The existing Churchill Falls Hydro site has an enormous feed system and holding capacity that can attenuate the possible PMF flow in the short term. The reduction of waterflow through Churchill Falls Hydro site would affect power production at that site for up to one week which is the estimated flooding period at the Muskrat Falls site. The flooding events at the Muskrat Falls site have been predicted to occur in the spring of each year, specifically in early June.

It should also be noted that peak waterflow only occurs during a possible two week period each year (first part of June) for up to a single week. There are no flooding concerns either during construction or during operation outside of this period as the current river flow or spillway can easily handle the river water flows.

Construction Design Flood

In 2010, the Muskrat Falls Construction Design Flood (CDF) was estimated using hydrologic techniques, i.e., statistical flood frequency analysis of recorded in-stream data from the Water Survey of Canada (WSC) hydrometric station at Muskrat Falls. Because the analysis used historical flow data, pre-project conditions are implicit in the peak flow estimate.

The CDF inflow hydrograph was developed on the basis of the peak flow estimate, and the construction diversion was assessed using a level-pool storage routing model (ARSP). However, given the need for a detailed simulation of hydraulic conditions in the river during construction, the updated model was used in the most recent study to refine the estimate of peak diversion outflow and water level. Additionally, it was necessary to evaluate any change in the Muskrat Falls CDF assuming that the upstream Gull Island site has not yet been developed. It should be noted that both theoretical as well as 1/70th scale design model were used in the modeling of the flooding events.

The process of analysis introduced the Muskrat Falls cofferdam and diversion geometry to simulate the dynamic routing effect through the river channel and diversion facilities during the CDF.

Since the main powerhouse and spillway will be constructed in the “dry” and the spillway will be utilized instead of diversion tunnels during the construction of the North RCC dam, two separate events were modeled during the construction sequence to verify the project would not be affected by flooding events during construction.

The first event modeled relates to the protection of the powerhouse and spillway without the river being rerouted.

The second event modeled relates to the construction of the North RCC dam while utilizing the spillway as the water passage route.

The first event modeled utilizes cofferdams #3 and #4 during the spring of 2013 and cofferdams #1, #2 & #10 during 2014 to protect the powerhouse and spillway. The modeling indicated that the main risk was related to a possible ice jam downstream, thus the cofferdams were designed (design equal to greater than 1:40 yr. event) to protect this event.

In the spring of 2015, the spillway is expected to be complete as well as cofferdam #9 to allow rerouting the river through the spillway and permitting start of construction of cofferdam #5 (cofferdams #1 & #2 removed at this time to permit waterflow through the spillway) which will be utilized for the construction of the North RCC dam.

For the spring of 2016, cofferdams #5 and #6 will be complete to allow construction of the North RCC dam while the river has been diverted 100% through the spillway gates. These cofferdams will protect the North RCC dam from a 1:20 year flooding event.

In each of the three flood scenarios considered (1999 historic peak, 1/20 Annual Exceedance Probability (AEP) Construction Design Flood, and 1/40 AEP Construction Design Flood), the peak water level was lesser than the current upstream cofferdam design elevation (which is equal to a 40 year design event at almost 24 meters) used during the project. *These results indicate that should similar flow conditions be encountered during construction, the proposed cofferdam at elevation 25 m (40 yr event to 1 m freeboard) should be adequate to protect the powerhouse and spillway site from a flooding event.*

- Peak Elevation 1999 Flows 22.8 m
- Peak Elevation 1/20 AEP CDF Flows 22.7 m
- Peak Elevation 1/40 AEP CDF Flows 23.8 m

In addition, the current reservoir filling scheme for Muskrat Falls involves no cessation of flow since the strategy is to have spillway capacity available during reservoir impoundment and in reality for the summer of 2015. With the spillway in operation, 100% of the PMF can be handled through the spillway since the project has included the 5th spillway gate to handle such a situation.

It should also be noted that to protect the remaining areas, all cofferdams are being built during low flow conditions which were modeled and built into the design/build schedule.

Discussions with senior engineering staff at the EPCM firm regarding what would occur during such a PMF event in 2016 indicates that although unlikely, senior management would order the planned breach of North Cofferdam (Cofferdam #5) to protect the powerhouse and other associated infrastructure completed at that time. It was indicated that they have performed this procedure within the company and it was very effective limiting damage and downtime to the construction site. A formal plan and sign-off is planning to be in place before this possible event would occur. It should also be pointed out, as noted previously, the waterflow through the Muskrat Falls site can also be controlled with the use of the existing Upper Churchill Project which would be the preferred option.

With the loss of Cofferdam #5 and damages to the North RCC Dam construction site, the entire project would experience a delay in startup of up to 1 year due to the loss of a season of construction on the North RCC dam. Estimated costs of this delay were projected to be in the $150 million range. It was noted that if the North RCC Dam construction was halted and flooded, there would be no need for additional engineering work to be performed as this dam is tied to the bedrock as part of its design and thus minimal damages are estimated to occur to the partially finished dam. The estimated cost of the delay is mainly related to reconstruction of Cofferdam #5 and maintaining the construction site and works for an additional year of operation.

During Normal Operation

The pre-project scenario was run to verify consistency with the pre-project PMF estimates in the original design (which had the Gull Island site constructed first) conducted by Hatch in 2007. As expected, the difference is negligible and confirms that the modifications to the model sections have preserved the overall conveyance.

Location	2010 Peak Inflow (m^3/s)	2007 Peak Inflow (m^3/s)
Gull Island	24,230	24,260
Muskrat Falls	26,060	26,020

Muskrat Falls PMF Routing without Gull Island

The spilling capacity at Muskrat Falls will be provided by two hydraulic structures: the gated spillway (5 gates in total) and the North RCC overflow dam. Primary spill capacity will be provided by five surface gates and secondary spill is provided by the north overflow dam once the capacity of the gated spillway is exceeded. The structures are designed for a reservoir water level of 45.1 m and a combined total spillway capacity of 25,060 m^3/s (pre Gull Island development flow) dictated by PMF routing results carried out in 2009/2010.

The scenario for the Muskrat Falls facility alone, without the upstream Gull Island facility was run. It was assumed that the water level at Muskrat Falls is maintained at Full Supply Level (FSL) 39.0 m by opening spillway gates until the gate capacity is exceeded, at which time the reservoir surcharges, and the north dam overflow comes into play. The plant discharge capacity was omitted from the simulation. The current spillway design discharge is 22,100 m^3/s at a design maximum flood level (MFL) of 44.0 m (SNC-Lavalin 2007).

The maximum water level reached in the Muskrat Falls reservoir while routing the PMF without the Gull Island Project is 44.6 m and the peak outflow is 24,800 m^3/s.

The resulting simulated peak outflow at Muskrat Falls was 25,060 m^3/s and the simulated peak water level was 44.78 m (first week of June). Introduction of the dam resulted in an attenuation of 1,000 m^3/s, or 4 percent, of the pre-project peak flow.

Estimate of Required Spill Capacity

The estimated peak water level of 44.78 m was of concern, as it exceeds the design MFL of 44.0 m. Consequently, the model was run to estimate the required discharge to limit the peak water level at 44.0 m in the PMF. For modeling purposes, the approach was to iteratively increase the available gate capacity until the simulated peak water level did not exceed 44.0 m.

The final iteration assumed five gates with a design capacity of 3,200 m^3/s each, added to the overflow section design capacity of 8,800 m^3/s, for a total design capacity of 24,800 m^3/s at MFL 44.0 m.

Thus the site can handle a PMF condition utilizing the 5 gates plus the North side overflow dam when the project is complete.

Flood Frequency Analysis

The statistical flood frequency analysis was done on a 30-year data set of annual maximum instantaneous flows for the Churchill River at Muskrat Falls from 1978 to 2008 (1989 missing), representing the period in which the Churchill River has been regulated by the Churchill Falls development. The analysis was performed on this series, which incorporates discharges from the Churchill Falls development, and also on a series representing the local (Lower Churchill) inflows only, which was synthesized by subtracting the recorded flows from the Churchill Falls powerhouse.

The upper and lower bounds of the 95 percent confidence interval were plotted. That is, the probability that the true value lies between the upper and lower curves is 95 percent. The estimated 1/20, 1/40 and 1/60 annual exceedance probability (AEP) flood peaks at Muskrat Falls are shown below.

Peak Inflow (Pre-Project)	1/20 AEP (m^3/s)	1/40 AEP (m^3/s)	1/60 AEP (m^3/s)
Local	4,520	4,830	5,000
Total	5,910	6,250	6,430

The difference between the local and total peaks is consistent, at approximately 1,400 m^3/s, which is representative of the normal outflow from the Churchill Falls powerhouse during the spring flood season.

MFL/PML Calculations

Introduction

The estimates of loss for direct damage and business interruption from the effects of fire and/or explosion have been based on values provided to us by our client. When no values are available, our estimate is based upon percentage of area for property and percentage of production plus duration of downtime for business interruption. The size of the loss has been estimated from three standpoints: Construction Maximum Foreseeable Loss, Maximum Foreseeable Loss and Probable Maximum Loss. Since not all organizations have uniform definitions of these terms and since they are extremely important, we are defining each briefly as follows, along with our estimates.

Definitions

Construction Maximum Foreseeable Loss (CMFL)

Direct Damage

This is the estimate of the most serious loss which we can reasonably foresee, resulting from a single peril to the construction site.

Our CMFL estimate includes catastrophic losses (such as impact by aircraft, earthquake or flood).

Business Interruption

The operations of the property involved can be considered as being entirely subject to interruption. Our estimates are based on replacement times of critical equipment and associated structures/buildings. The extent of interruption to operations may be reduced should there be capability of obtaining new equipment. Our estimates are based upon physically replacing the damaged property and restoring the site to the level which existed prior to the loss. The estimates do not consider losses attributed to loss of customers and ensuing loss of profits when the property has been restored as mentioned.

Maximum Foreseeable Loss (MFL)

Direct Damage

This is the estimate of the most serious loss which we can reasonably foresee, resulting from a single fire (or other peril when that peril may be the controlling factor) to any given property, taking into consideration the impairment of fire protection that may be visualized on the basis of past experience. Impairment of fire protection is assumed so that control of a fire is dependent solely on physical fire barriers or space separation between buildings (or process areas) and manual fire fighting by public fire departments or equivalent outside aid such as a Plant Fire Brigade. Also taken into consideration are other factors such as water supplies which may be available under adverse conditions, delayed notification, accessibility and conflagration.

Our MFL estimate excludes catastrophic losses (such as impact by aircraft, earthquake or flood) resulting from events that are not, in our opinion, reasonably foreseeable for the occupancy involved in this analysis.

Business Interruption

The operations of the property involved can be considered as being entirely subject to interruption when they are dependent on process equipment which is not duplicated, or when duplicated equipment is exposed to a single fire (or other peril) and also is not capable of being bypassed. Our estimates are based on replacement times of critical processing equipment and associated structures/buildings. The extent of interruption to operations may be reduced should there be capability of quickly obtaining new and/or satisfactory used equipment which would permit operations to be restored quickly. Our estimates are based upon physically replacing the damaged property and restoring the plant capabilities to the level which existed prior to the loss. The estimates do not consider losses attributed to loss of customers and ensuing loss of profits when the property has been restored as mentioned.

Probable Maximum Loss (PML)

Direct Damage

This is our estimate of the loss expected from a single fire when a critical element of fire protection is out of service or proves ineffective, but the remaining fire protection elements are functioning. An example would be where a sprinkler system does not extinguish or control a fire promptly, yet the security guard, a part of the protection system, may summon the fire department. The damage may be substantially less than the MFL as the fire may be extinguished prior to consuming all the fuel or reaching a physical barrier. The favorable factors of subdivision and fire and/or explosion control have been considered against unfavorable factors such as congestion and potential failure of certain major fire protection features such as sprinklers, fire pumps, waterspray systems, etc.

Business Interruption

Industry experience and the particular conditions of our client's operations are the basis of our analysis. Overall operations may permit production to be made up, in whole or in part, by increasing output at another plant where one is available. The maintaining of spare parts and the capability of setting up temporary structures/equipment are some of the factors which we consider in our estimate of the largest loss that could reasonably be expected to occur.

Loss Scenario

Direct Damage

CMFL

Flood: The CMFL scenario for this site during construction would be a >1:10,000 flood event occurring early in May in 2016 due to greater than predicted snowfall and rapid warming temperatures over a long period throughout Labrador, thus dramatically increasing the volume of water entering the Churchill River. The scenario has the South Dam failing and the North Dam failing monolithically.

Description	Value	% Damaged	Value Damaged
Construction of Bulk Excavation Works and Associated Civil Works	$132,970,112	20	$26,594,022
Construction of Intake and Powerhouse, Spillway and Transition Dams	$687,994,112	20	$137,598,822
Construction of North and South Dams	$117,166,506	100	$117,166,506
Supply and Install Turbines and Generators	$200,000,000	50	$100,000,000
Supply and Install Mechanical and Electrical Auxiliaries in Hydro Plant	$91,913,298	75	$68,934,974
Supply and Install Powerhouse Hydro-Mechanical Equipment	$101,525,168	75	$76,143,876
Supply and Install Powerhouse Cranes	$8,872,175	50	$4,436,088
Supply and Install Powerhouse Elevator	$755,300	75	$566,475
Supply and Install Spillway Hydro-Mechanical Equipment	$50,794,781	50	$25,397,391
Supply of Generator Step-up Transformer	$19,464,468	100	$19,464,468
Supply of Isolated Phase Bus	$1,860,952	100	$1,860,952
Supply of Generator Circuit Breakers	$5,056,000	100	$5,056,000
Total	$1,418,372,872		$583,219,573

MFL

Fire: The MFL scenario for this site during construction would be a fire event occurring on one of the first units in operation while installation is ongoing on one or more remaining units. This scenario would involve the hydraulic oil unit providing the main source of fuel, the fire suppression system not operating and with the windings of the stator and rotor heavily damaged with some mechanical/structural damage to the generator but not the turbine. Estimate of damage ranges from 50% to the unit (i.e. Unit #1) which caught fire and 10% to two units (i.e. Units #2 & #3) which may sustain smoke and heat damage as they would not be completely installed (top covers off exposing the windings to excessive heat and smoke damage). Minor damage to the building and contents would also occur.

MFL = 50% of Unit #1 + 10% of Unit #2 + 10% of Unit #3 + Bldg/Contents Damage

= 50% of $50 M + 10% of $50 M + 10% of $50 M + $1 M

= $25 M + $5 M + $5 M + $1 M

= $36 million

B&M: A second MFL scenario would be loss of the guide bearing during initial full load operation causing a catastrophic event to the entire turbine generator unit as well as damage to the civil infrastructure.

MFL = 100% of Unit #2 + Civil Repairs

= 100% of $50 M + $10 M

= $50 M + $10 M

= $60 million

PML

Fire: The PML scenario for this site during construction would be a fire event occurring on startup of one of the units in operation. Estimate of damage range from 20% to the unit (no hydraulic oil involved in fire) which caught fire and 2% to two units which may sustain smoke damage while not completed installed (top covers off exposing the windings to excessive heat and smoke damage). Minimal building and contents damage would occur.

MFL = 20% of Unit #1 + 2% of Unit #2 + 2% of Unit #3

= 20% of $50 M + 2% of $50 M + 2% of $50 M

= $10 M + $1 M + $1 M

= $12 million

B&M: A second PML scenario would be damage to the guide bearing during run-up before final commissioning. A catastrophic event would not be expected as the unit would not be fully loaded and only minimal mechanical and structural damage would occur (estimated at 10%).

MFL = 10% of Unit #1 + Minor Civil Repairs

= 10% of $50 M + $1 M

= $5 M + $1 M

= $6 million

Business Interruption

CMFL

Flood: The business interruption estimation is based upon returning the site to the original condition at the time of the loss would be 24 to 36 months.

MFL

Fire: The business interruption estimation is based upon returning the heavily damaged the unit to full production and repairing the two other units which sustained minor damage. It is estimated that it would take between 12 to 18 months to return the unit to full operation. The other units could be returned to service within this period as well.

B&M: It is estimated that it would take between 18 to 24 months to return the unit to full operation.

PML

Fire: The business interruption estimation is based upon returning damaged the unit to full production and repairing the two other units which sustained minor damage. It is estimated that it would take between 9 to 12 months to return the unit to full operation.

B&M: It is estimated that it would take 9 months to return the unit to full operation.

Delayed Start-Up/Additional Increase Cost of Working

The amount of Delayed Start-Up/Additional Increase Cost of Working coverage being sought for this project includes the incremental costs to continue to operate the existing Holyrood Thermal Power Plant owned by Newfoundland & Labrador Hydro (NLH) located on the island of Newfoundland assuming the Muskrat Falls hydro plant was commissioned but the LIL was delayed. Thus the DSU/Additional Increase Cost of Working or Extra Expense coverage is to protect the subsidiary NLH.

Due to the existing contractual commitments and relationships between Emera, the other Nalcor entities and NLH as well as due to the Provincial contingent equity commitment, no other DSU/Additional Increase Cost of Working coverage is required for the project.

Further details on NLH and its relationship with Nalcor Energy and the Lower Churchill Project were provided under the Corporate Profile of this report. Additional details are also provided in the Shareholder Support & Commitment section of this report as well.

The DSU/Additional Increase Cost of Working or Extra Expense has a “double trigger”, namely a physical damage event to the LIL that delayed the LIL commissioning beyond the actual commissioning of the MF Hydro Plant. Coverage would not be triggered solely by a delay of the MF hydro plant. It is important to understand that the schedule currently has the LIL planned for completion approximately 12 months before completion of MF, thus providing additional time to finish construction and making a possible claim more remote.

The fuel costs for the Holyrood Thermal Power Plant were calculated using the annual fuel conversion rates for Holyrood and the January 2013 fuel forecast. The remaining operating costs of running the thermal plant are well known since it has operated for approximately 40 years. Total costs for the Holyrood operations are currently estimated to be approximately $320 million annually based upon an average hydrology but as high as $500 million annually during a low-water year. The variation is the result of the predicted available hydro power production which is the main source of power generation on the island during any single year. Further details on the monthly and seasonal fluctuations are being researched.

An important note to consider is that the amount of power available to be imported over the Maritime Link if completed would be limited but could displace some of the demand at the Holyrood thermal plant. In addition, potential offsetting revenue can be generated through export/market sales of the “trapped” Muskrat Falls power via the existing Hydro Quebec booking (via Upper Churchill Falls Hydro Plant Agreement) and LTA to offset the costs of running the Holyrood plant.

Appendix

Appendix A – Salient Features of Muskrat Falls Generation Site

Commercial Structure		
	Project Name	Muskrat Falls Generation Project
	Project Owner	Muskrat Falls Generation Co. (wholly owned subsidiary of Nalcor Energy)
	Project Operator	Muskrat Falls Generation Co.
Power Generation		
	Capacity	824 MW
	Annual Generation	Firm energy: 4.5 TWh/yr Average energy: 4.9 TWh/yr
Schedule		
	Commence Construction	Q3-2012
	Commence Commercial Power from First Unit	Q4-2017
	Commercial Power from All Units	2018
Cost		
	Capital Cost Estimate at DG3	$ 2.901 billion
	Annual Operating/Maintenance Cost Estimate at DG3	$ 11 million (approx. in 2018)

Configuration		
	Powerhouse	Concrete structure in rock excavation, with structural steel superstructure. Maintenance bay large enough to assemble 1 complete turbine/generator unit, plus assembly and transfer of 1 extra rotor.
	Number of Units	4 units, each 206 MW @ 0.90 pf
	Type of Units	Kaplan with vertical axis generators
	Powerhouse Cranes	2 overhead powerhouse cranes, with the capability to operate in tandem. In tandem, having a combined design capacity to lift a fully assembled rotor.
	Main Transformers	4 step-up transformers (convert unit voltage from 15 kV to 315 kV), located on powerhouse draft tube deck
	Switchyard	Located on south side of river, on level, fenced site
	Dams:	2
	South dam	Earth/rockfill with central impervious core
	Crest	El. 45.5 m (i.e. 29 m high)
	Length	370 m
	North dam	Roller compacted concrete capped with conventional concrete, founded directly on bedrock; Overflow dam
	Crest	El. 39.3 m (i.e. 32 m high)
	Length	430 m
	Spillway	PMF, in conjunction with North dam at MFL
	Type	5-bay vertical gated spillway. Concrete structure in rock excavation. Gates with heating and hoisting mechanisms designed for severe cold climate operation. Overflow North dam acts as secondary spillway.
	Sill	El. 5.0 m for 2 gates and 17. 2 for 3 gates
	Temporary Diversion Structure	None - through low level gates at spillway structure, with capacity of 5,930 m^3/s
	Tailrace	Draft tubes discharge directly into river in rock excavation

	Intakes	Open cut approach channel in earth/rock excavation, designed to eliminate frazil ice. 4 intakes (1 for each unit), each with three gates and removable steel trash racks.
	Penstocks	None. Close-coupled intake/powerhouse with 4 individual water passages in concrete, 1 for each turbine.
	Reservoir	
	El.	FSL = 39 m; LSL = 38.5 m; and MFL = 45.1 m
	Length	60 km
	Area	Approximately 101 km^2
	Storage Volume	Muskrat Falls generating station is basically "run of river" as the reservoir has little storage capacity. Accordingly, the reservoir will normally be operated close to FSL, while giving consideration to short term inflows and near term production requirements.
Battery Limits		
	Battery Limits between Muskrat Falls Generation Project and Labrador Transmission Assets Project	Muskrat Falls Generation Project includes the dam, powerhouse and everything outside the fence of the 315 kV Switchyard. The Labrador Transmission Assets Project commences at the fence line of the Switchyard.
	Battery Limits between Muskrat Falls Generation Project and Labrador-Island Link Project	Muskrat Falls Generation Project includes the dam, powerhouse and everything inside the fence of the 315 kV Switchyard. The Labrador-Island Link Project commences at the fence line of the Switchyard, and includes the slack span that links the Switchyard take-off structure to the first transmission line tower located outside the Switchyard.

Appendix B – Salient Features of Labrador Island Link Project

Commercial Structure		
	Project Name	Labrador-Island Transmission Link Project
	Project Owner	Labrador-Island Link Limited Partnership, a partnership of Nalcor Labrador-Island Link Holding Co., a wholly owned subsidiary of Nalcor, which will have a 65% interest, and Emera Newfoundland and Labrador Inc., an existing wholly owned subsidiary of Emera, either directly or through a wholly-owned Newfoundland and Labrador subsidiary, which will have a 35% interest, upon Emera's participation.
	Project Operator	Nalcor Labrador-Island Link Operations Co. ("LIL Opco"), a wholly owned subsidiary of Nalcor, pursuant to a lease (Transmission System Asset Lease) with LIL LP under which LIL Opco assumes capacity operating control and responsibility for maintenance. LIL Opco will provide operating control to the system operator through a Transmission Operator Agreement. The system operator will be responsible for the operational control of the transmission asset as part of its responsibility for the reliable operation of the NL bulk electric system. It will also provide transmission service using these transmission assets to transmission customers.
Transmission Line General Features		
	Voltage	±350 kV HVdc
	Capacity	900 MW
	Length	1,100 km, including Strait of Belle Isle Crossing
	Strait of Belle Isle Crossing	30 km, with depths on seabed beyond HDD exit holes ranging from 70 to 83 m
Schedule		
	Commence Construction	Late 2013
	Complete Strait of Belle Isle cable installation	2016
	In-Service Date	Q4-2017

Cost		
	Capital Cost Estimate at DG3	$ 2.360 billion
	Annual Operating/Maintenance Cost Estimate at DG3	$ 14 million (estimated in 2018)
Configuration		
	At Muskrat Falls	
	Switchyard	The HVac Switchyard at Muskrat Falls is part of the LTA Project. The dividing line between the Labrador-Island Link and LTA Project is the fence line of the HVac Switchyard.
	Station	HVdc Converter Station
	Switchyard to HVdc Converter Station	2 x 315 kV HVac transmission lines to connect Muskrat Falls switchyard to ±350 kV HVdc Converter Station. Each 315 kV HVac line to have designed power capacity of 900 MW.
	At Strait of Belle Isle, in Labrador	
	Station	Transition Compound, comprised of a building within which there is a transition structure for the transition from the overhead cable to the submarine cable for the marine crossing
	Overland between Muskrat Falls and Strait of Belle Isle, and between Strait of Belle Isle and Soldiers Pond	
	Type	±350 kV HVdc
	Capacity	900 MW
	Length	1080 km

	SOBI Crossing	
	No. of Crossings	3 cables (2 with one spare), all spatially separated
	Length	Crossing is 18 km, but each cable is approximately 30 km to follow natural features and seabed contours
	Max. Depth	120 m
	HDD	Six horizontal directional drills ("HDD") to mitigate risk of potential damage caused by iceberg scour, three on each side of the Strait of Belle Isle (1 for each cable), extending from the surface to a target water depth of approximately 80 m, with each HDD approximately 1.7 km in length on the Labrador side and approximately 2.2 km in length on the Newfoundland side.
	Bottom Protection	Between HDD exit points, cables will be covered by a rock berm, to a minimum height of 1 m from the seabed to mitigate risk of potential damage
	Timeline	Drilling starting late 2013 till mid 2015; Land cables complete by 2015; Subsea cables complete by 2016
	At Strait of Belle Isle, in Newfoundland	
	Station	Transition Compound, comprised of a building within which there is a transition structure for the transition from the overhead cable to the submarine cable for the marine crossing
	At Soldiers Pond, in Newfoundland	
	Station	HVdc Converter Station
	Switchyard	New Switchyard for connection to NLH's Island Transmission System
Battery Limits		
	Battery Limits between Labrador-Island Link Project and Muskrat Falls Generation Project	The Labrador-Island Link Project commences at the fence line of the 315 kV Switchyard which is part of the LTA Project, and includes the slack span that links the Switchyard take-off structure to the first transmission line tower located outside the Switchyard.

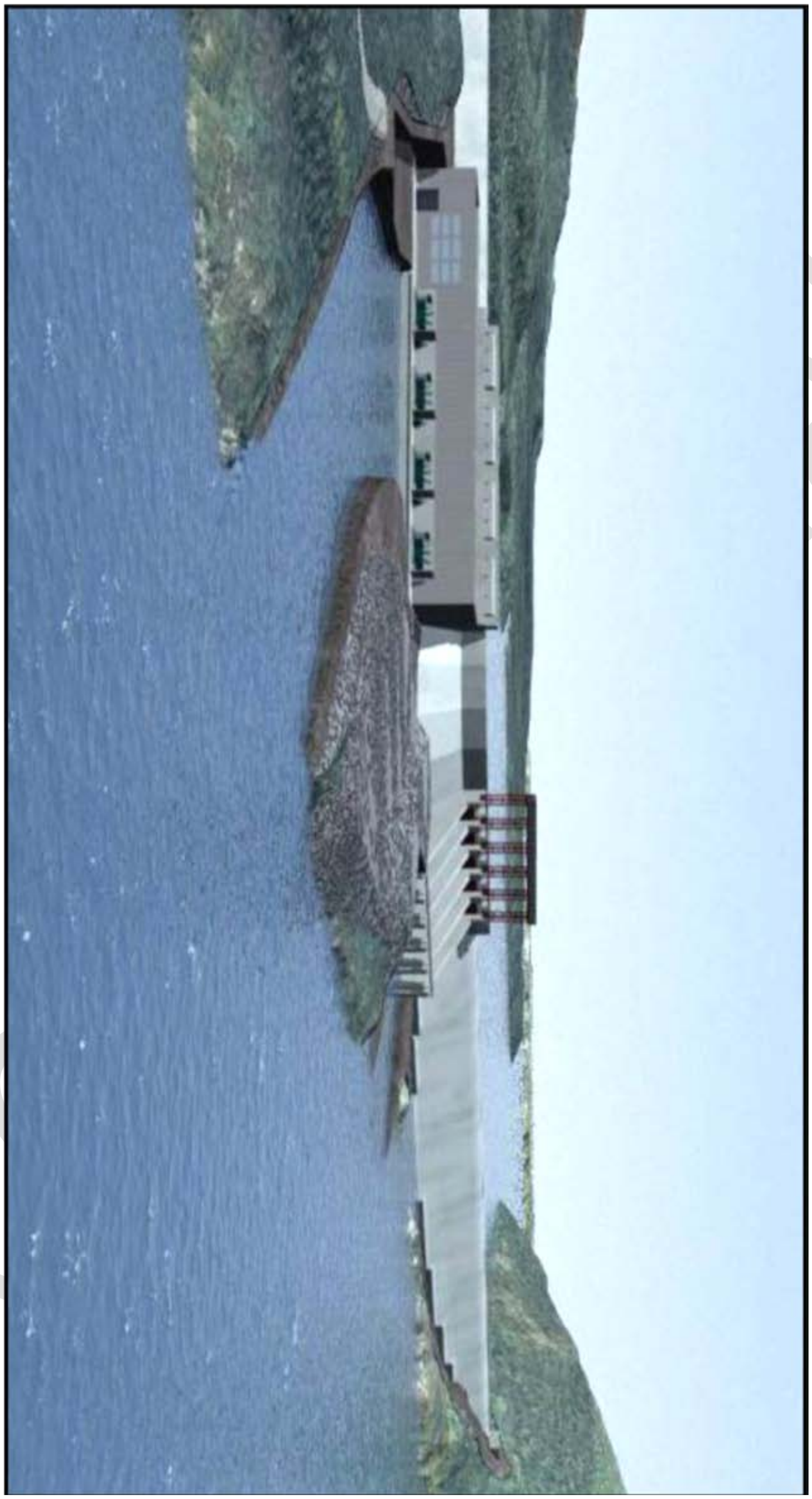
	Battery Limits between Labrador-Island Link Project and NLH's facilities at Soldiers Pond, NL	A new HVac Switchyard will be constructed at Soldiers Pond which, although funded, owned and constructed by Labrador-Island Link Limited Partnership, will be operated by NLH. The Labrador-Island Link Project owned by Labrador-Island Link Limited Partnership will include the slack span that links the Switchyard take-off structure to the first transmission line tower located outside the Switchyard which is owned by NLH.

Appendix C – Salient Features of Labrador Transmission Assets

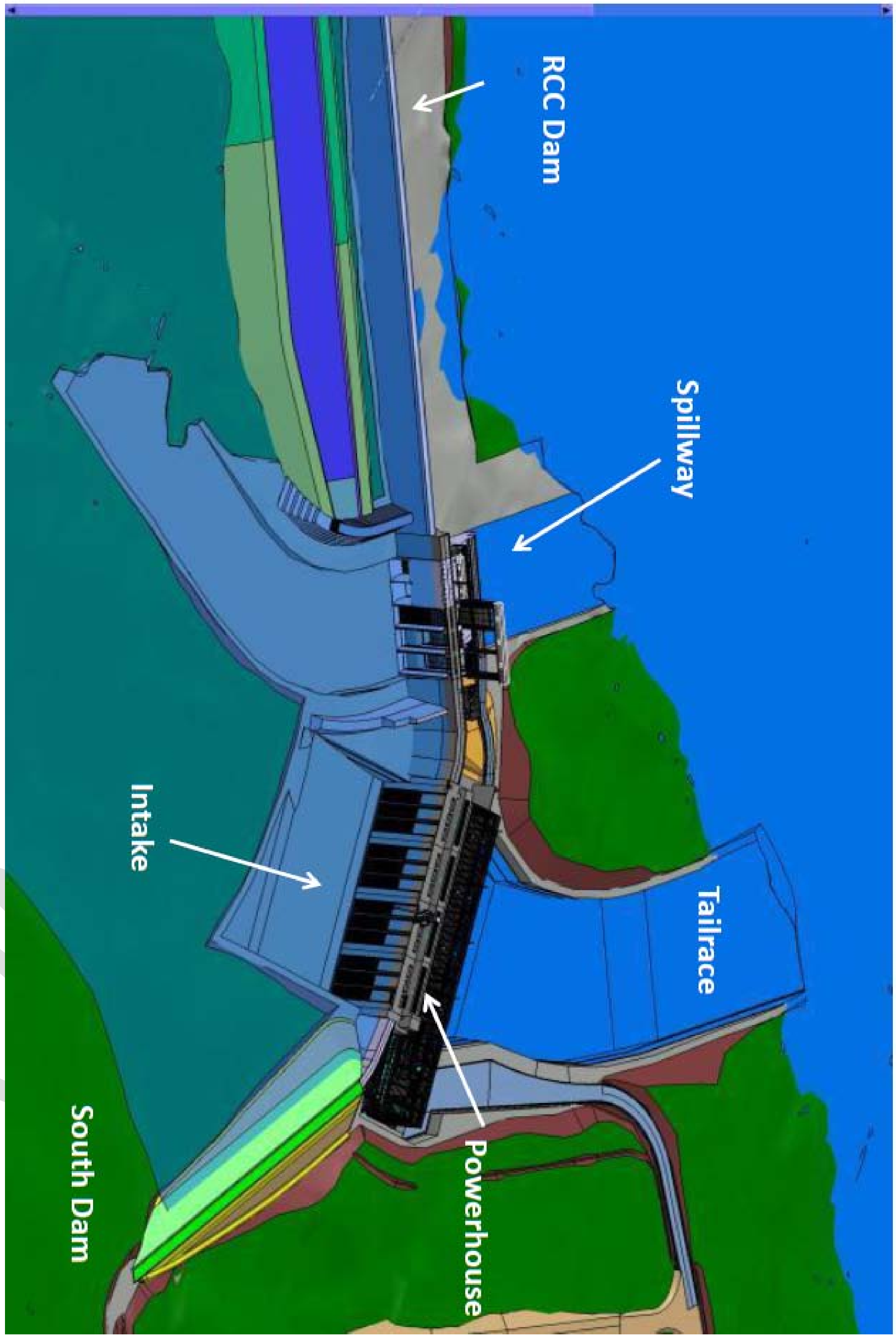
Commercial Structure		
	Project Name:	Labrador-Transmission Assets Project
	Project Owner:	Labrador Transmission Co., a wholly owned Nalcor subsidiary
	Project Operator:	The Project owner will have capacity operating control and responsibility for maintenance. The Project owner will be responsible for the operational control of the transmission asset as part of its responsibility for the reliable operation of the NL bulk electric system. It will also provide transmission service using these transmission assets to transmission customers.
Transmission Line General Features		
	Type/Capacity:	Two x 315 kV HVac
	Length:	243 km
Schedule		
	Commence Construction	2013
	In-Service Date	Q3-2016
Cost		
	Capital Cost Estimate at DG3	$601 million
	Annual Operating/Maintenance Cost Estimate at DG2	$2.4 million (estimated in 2018)

Configuration		
	At Muskrat Falls	
	Switchyard:	The HVac Switchyard at Muskrat Falls is part of the Labrador Transmission Assets Project. The Labrador Transmission Assets Project commences at the fence line of the Switchyard.
	At Churchill Falls	
	Switchyard:	The Labrador Transmission Assets Project includes a new HVac Switchyard at the Churchill Falls generating station constructed and owned as part of the project, located in a separate, fence-enclosed yard across the road from the existing Churchill Falls switchyard. The Switchyard connects the 315 kV transmission lines to the Churchill Falls generating station via a short 735 kV transmission link.
Battery Limits		
	Battery Limits between Labrador Transmission Assets Project and Muskrat Falls Generation Project	The Labrador Transmission Assets Project commences at the fence line of the 315 kV Switchyard and includes the slack span that links the Switchyard take-off structure to the first transmission line tower located outside the Switchyard.
	Battery Limits between Labrador Transmission Assets Project and Churchill Falls generating station.	The Labrador Transmission Assets Project includes a new HVac Switchyard at the Churchill Falls generating station constructed and owned as part of the project, located in a separate, fence-enclosed yard across the road from the Churchill Falls switchyard. The Switchyard connects the 315 kV transmission line to the Churchill Falls generating station via a short 735 kV transmission link. Contractors for the Churchill Falls generating station will connect the slack span that links the 735 kV take-off structure in the Switchyard to the first transmission line tower of the short 735 kV transmission link.

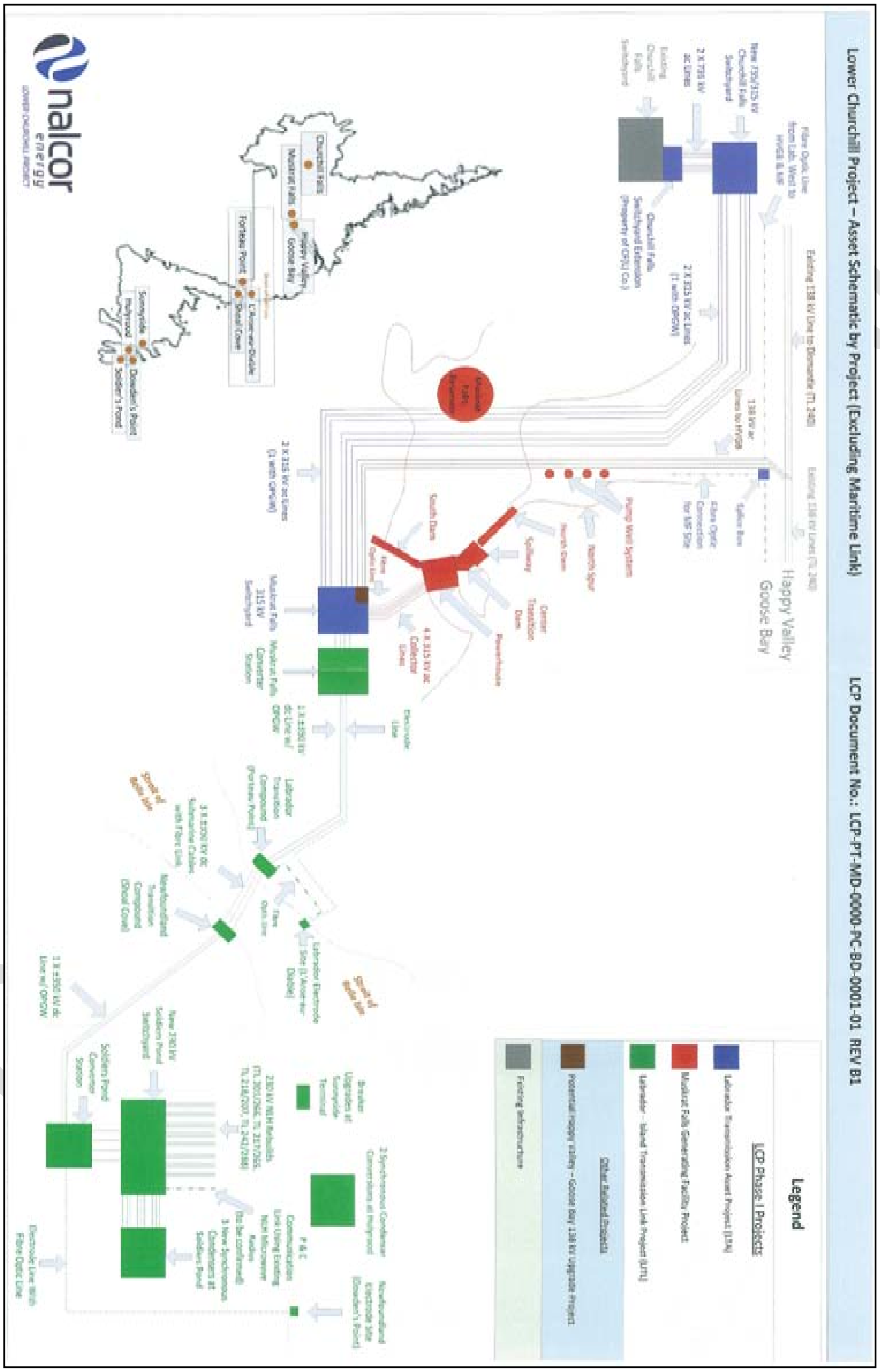
Appendix D – Digital Picture of Muskrat Falls Generation Site



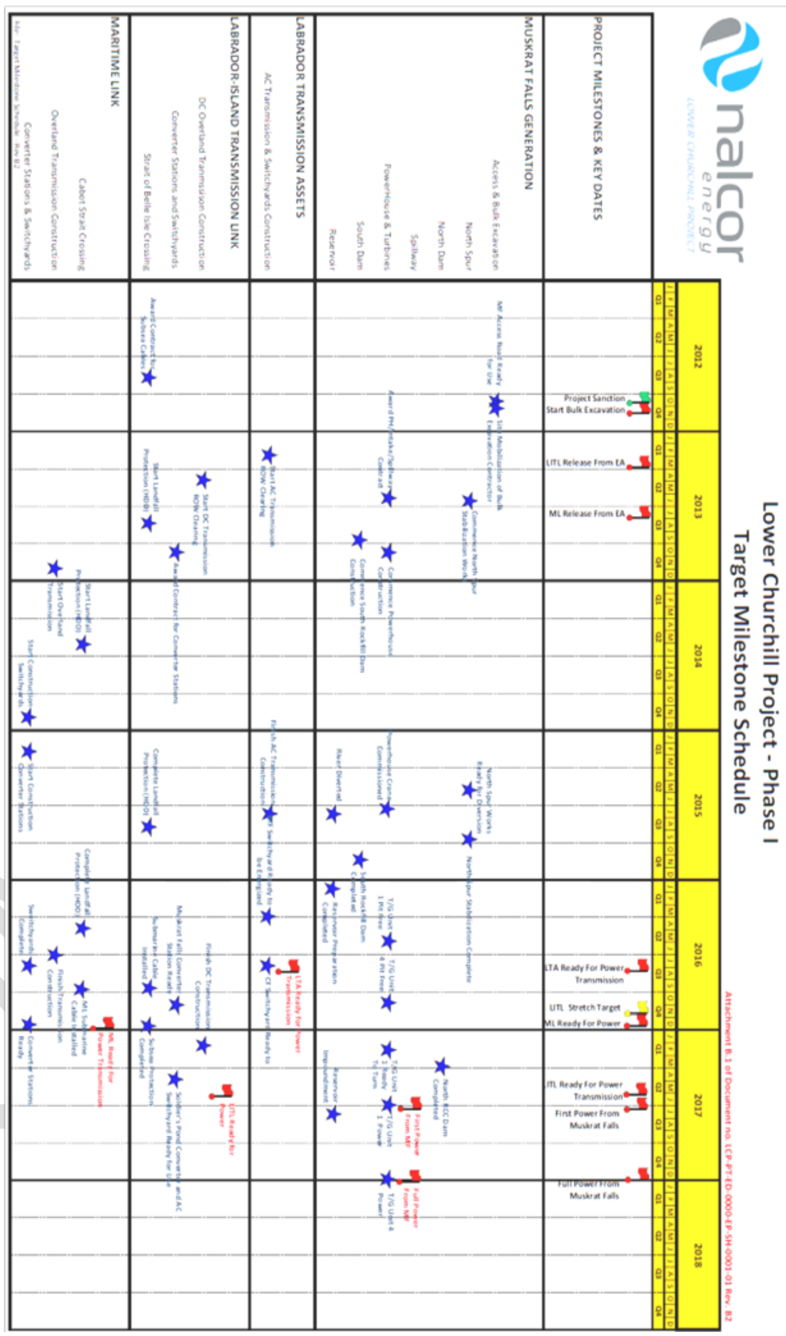
Appendix E – Schematic of Muskrat Falls Generation Site



Appendix F – Site Project Overview



Appendix G – Target Milestone Schedule



Appendix H – Muskrat Falls Site Project Data

D1 PROJECT DATA SUMMARY

Salient data on components of the project are as follows:
(Note: All elevations are based on geodetic datum)

D1.1 Drainage Basin

• Total drainage basin area	92,355	km^2
• Regulated drainage basin area (Churchill Falls)	78,850	km^2
• Long term average flow (1973-2006)	1,830	m^3/s
• Maximum plant flow capacity	2,667	m^3/s
• Diversion design flood (1:20) (without Gull Island)	5,890	m^3/s
• Design flood (PMF) Peak outflow	25,060	m^3/s

D1.2 Reservoir

• Maximum flood level at PMF	45.1	m
• Full supply level	39.0	m
• Low supply level	38.5	m
• Maximum water level at diversion design flow (1:20)	24.0	m
• Flooded area at full supply level	101	km^2
• Reservoir length	60.0	km
• Total storage at elevation 39.0 m	1,520	$x\ 10^6\ m^3$

D1.3 Diversion Facilities

D1.3.1 Upstream Cofferdam

• Freeboard (on MFL at Q_{20})	1.0	m
• Crest elevation	25.0	m
• Maximum height	20.0	m
• Crest length	320.0	m
• Volume rockfill	306,800	m^3

D1.3.2 Upstream RCC Cofferdam

See item D1.7.2 below

D1.3.3 Downstream Cofferdam

See item D1.7.3 below

D1.3.4 Spillway Approach Channel

• Invert elevation	5.0	m
• Approach channel width	65 to 74.5	m
• Approach channel length	240	m

D1.3.5 Gated Spillway as Diversion Passage

• Approach channel invert elevation	5.0	m
• No. of bays	5	
• Bay width	10.5	m
• Base slab invert elevation	5.0	m
• Maximum design diversion forebay elevation	24.0	m
• Forebay elevation at design diversion flow (5,890 m^3/s)	22.5	m

D1.4 Intake Facilities

D1.4.1 Approach Channel

• U/S channel base elevation	10.0	m
• Invert elevation	1.0	m
• Width at invert	138	m

D1.4.2 Intake Structure

• Close coupled to powerhouse		
• Deck elevation	45.5	m
• Sill elevation	-1.7	m

• Width	142.0	m

D1.4.3 Intake Head Gates

• Number	12	
• Width	6.5	m
• Height	20.1	m

D1.4.4 Bulkhead Gates

• Number of sets	1	
• Width	6.5	m
• Height	21.6	m

D1.4.5 Trashracks

• Number of sets	12	
• Width	7.16	m
• Height	28.0	m
• Clear spacing between bars	100	mm

D1.5 Power Facilities

D1.5.1 Power Installation

• Gross head	36.0	m
• Rated net head	35.0	m
• Number of units	4	
• Rated plant output	824	MW
• Speed	90	rpm
•		

D1.5.2 Powerhouse

• Length	199.0	m

• Total width	55.3	m
• Width of main generator floor	28.0	m
• Roof elevation	37.5	m
• Draft tube invert elevation	-31.1	m
• Unit spacing	35.5	m
• Concrete semi-spiral inlet dimensions (W x H)	25.5 x 14.0	m
• Service bay length	57	m

D1.5.3 Draft Tube Gates

• Number of sets	2	
• Width	12.0	m
• Height	9.72	m

D1.5.4 Tailrace

• Invert elevation at DT outlet	-26.9	m
• Width of tailrace at DT outlet	142.0	m
• Slope of apron	1V:3 H	
• Invert elevation at D/S end of transition	-8.0	m
• Tailrace width at D/S end of transition	100	m
• Length of Tailrace channel	320	m

D1.5.5 Turbines

• Type	Kaplan	
• Rated discharge, per unit (at efficiency 92%)	665	m^3/s
• Runner diameter	8.9	m
• Runner mass	230	tons
• Total turbine mass (one complete assembly)	1,800	tons

D1.5.6 Generators

• Rated output, each	206.0	MW
• Rated voltage	15.0	kV
• Power factor	0.90	
• Rotor diameter	14	m
• Rotor mass	680	tons
• Total generator mass	1,250	tons

D1.5.7 Powerhouse Cranes

• Number	2	
• Main hook capacity, each	360	tons
• Auxiliary hook capacity, each	25	tons
• Equalizing beam mass (capacity 680 tons)	40	tons

D1.5.8 Power Transformers

• Number	4	
• Rating	175 230	MVA ONAN MVA ONAF
• Voltage	345-15	kV
• Shipping mass, each	170	tons

D1.6 Flood Handling Facilities

D1.6.1 Gated Spillway

• Width out to out of end piers	74.5	m
• Length to end of apron	72.5	m
• Crest elevation of ogee	18.0	m
• Number of vertical fixed wheel gates	5	
• Width of gate	10.5	m
• Height of gate	21.5	m

- Stoplogs (U/S and D/S) 2 sets
- Maximum flow capacity (MFL at PMF = 45.1 m) 13,060 m^3/s

D1.6.2 North RCC Overflow Dam

- See item D1.7.4
- Maximum overflow capacity (MFL at PMF = 45.1 m) 13,050 m^3/s

D1.7 Dams

D1.7.1 Upstream Cofferdam

- See item D1.3.1 above

D1.7.2 Upstream RCC Cofferdam

- Freeboard (winter condition) 1.0 m
- Crest elevation 25.0 m
- Maximum height 20.0 m
- Crest length 140.0 m
- Volume RCC 17,750 m^3

D1.7.3 Downstream Cofferdam

- Maximum tailwater level at 1:20 flood (without ice-jam) 6.0 m
- Freeboard 1.0 m
- Crest elevation 7.0 m
- Maximum height 3.5 m
- Crest length 180.0 m
- Total volume 6,200 m^3

D1.7.4 North RCC Overflow Dam (North Abutment)

- Ogee Crest elevation 39.3 m
- Ogee Crest length 430 m

• Deck elevation (outside of ogee crest)	45.5	m
• Overall length	450	m
• RCC - total volume	72,000	m^3
• Maximum height	32.0	m

D1.7.5 North Transition Dam (between north Dam and Gated Spillway)

• Deck elevation	45.5	m
• Slope of north contact face (for North RCC Dam)	1/4H:1V	
• Slope of west contact face (for U/S RCC Cofferdam)	1/4H:1V	
• Length of dam at crest	15	m
• Maximum height of dam	33	m

D1.7.6 Center Transition Dam (between Gated Spillway and Intake)

• Deck elevation	45.5	m
• Length of dam at crest	60	m
• Maximum height of dam	24	m

D1.7.7 South Transition Dam (between Intake and South Dam)

• Deck elevation	45.5	m
• Slope of south contact face (for South RCC Dam)	1/4H:1V	
• Length of dam at crest	7.4	m
• Maximum height of dam	23.5	m
•		

D1.7.8 South RCC Dam (South Abutment)

• Deck elevation	45.5	m
• Maximum height	29.0	m
• Length	370.0	m
• Total volume	69,000	m^3

Appendix I – Muskrat Falls Site Hydraulic Data

D3 HYDROLOGY/HYDRAULICS

D3.1 Design Floods

• Project design flood (probable maximum flood - PMF):		
- Before development of Gull Island	25,060	m^3/s
- After development of Gull Island	23,270	m^3/s
• Construction flood (Q_{20})	5,890	m^3/s
• Off-peak season construction flood (Q_{20})	3,840	m^3/s

D3.2 Governing Elevations

D3.2.1 Upstream Reservoir

• Maximum flood level at PMF:		
- Before development of Gull Island	45.1	m
- After development of Gull Island	44.0	m
• Full supply level	39.0	m
• Low supply level	38.5	m

D3.2.2 Downstream

• Tailwater level (PMF)	12.3	m
• Tailwater level for 1:100 year flood	7.5	m
• Tailwater level for 1:20 year flood	6.3	m
• Mean tailwater level	3.0	m
• Minimum tailwater level	1.44	m

D3.3 Diversion Facilities

D3.3.1 Upstream Water Levels

- Construction flood level, 1:20 year flood 23.0 m
- Normal water level for ice control 24.0 m
- Typical summer water level (Q = 1,500 m^3/s) 13.0 m
-

D3.3.2 Downstream Water Levels

- Tailwater level for 1:20 year flood 6.3 m
- Mean tailwater level 3.0 m

D3.3.3 Hydraulic Design

The following factors were considered in hydraulic design:

- Spillway control structure with no rollways is used for the diversion.
- Spillway intake canal is designed to pass the diversion flood (Q_{20}).
- Head loss calculations at the spillway intake canal were done assuming a Manning coefficient of 0.033.
- Cofferdam closure – preliminary designs to be based on Izbash's equations (Ref. 1) final design should be based on model testing.

D3.4 Intake

- Intake will provide a transition from reservoir to concrete semi-spiral case.
- Intake geometry will take into account the following criteria:
  - Velocity at trashracks of 1.5 to 2.0 m/s on net area of trashracks.
  - Flow acceleration through intake less than 0.5 m/s per linear m.

- Intake set low enough to avoid creation of vortices in accordance with J.L Gordon's formula also used for the La Grande Project :

$$S = k\ V(d^{0.5}).$$

Where:

S = Submergence below low supply level, to soffit at gate section (m).

V = Velocity at gate (m/s).

d = Height of gate (m).

k = 0.73 for an asymmetrical approach flow.

D3.5 Spill Facilities

D3.5.1 Design Flood

- Follow Canadian Dam Safety Association Guidelines.
- Consequence Classification:
  - Category High,
  - Some increase in loss of life expected,
  - Substantial increase in social, economic and/or environmental losses.
- Criteria for Design flood:
  - Use probable maximum flood (PMF).
  - Flood routing effect is already taken into account in the PMF value.
  - Spillway design flow (PMF) = 25,060 m^3/s.

3.5.1.1 Extreme Condition – PMF

- PMF (without Gull Island): 25,060 m^3/s
- Flood level (without Gull Island): 45.1 m
- Spillway flows:
  - North dam 13,050 m^3/s
  - Gated spillway (surface) 13,060 m^3/s
  - Total 26,110 m^3/s

Appendix J – Acronyms

AACE	- Association for Advancement to Cost Engineering
CDA	- Canadian Dam Association
CDF	- Construction Design Flood
CF	- Churchill Falls
CFD	- Computational Fluid Dynamics
CMFL	- Construction Maximum Foreseeable Loss
COC	- Course of Construction
DFO	- Department of Fisheries and Oceans
DG	- Decision Gate
DFO	- Department of Fisheries & Oceans
DSU	- Delay in Start-Up
ECC	- Energy Control Centre (located in St. John's, NL and operated by NE-NLH)
EMS	- Emergency Management System
EPCM	– Engineering, Procurement and Construction Management
EPC	– Engineering, Procurement and Construction
FSL	- Full Supply Level
GHG	- Green House Gas
GPS	- Global Positioning System
GVI	- General Visual Inspection
HDD	- Horizontal Directional Drilling
HVac	- High Voltage Alternating Current
HVAC	- Heating, Ventilation and Air Conditioning
HVdc	- High Voltage Direct Current
IPA	- Independent Project Analysis
KPH	- Kilometers per Hour
kV	- kilovolts
LCP	– Lower Churchill Project
LEED	- Leadership in Energy and Environmental Design
LIL	- Labrador-Island Link Project
LRM	- Long Range Mountains
LSL	- Lower Supply Level
LTA	- Labrador Transmission Assets Project
MCT	- Marine Crossing Team
MF	- Muskrat Falls Project
MFL	- Maximum Flood Level

ML	- Maritime Link Transmission Project
MW	- Megawatts
NE-NLH	- Nalcor Energy-Newfoundland and Labrador Hydro
NL	- Newfoundland and Labrador
NLH	- Newfoundland and Labrador Hydro
NS	- Nova Scotia
PMF	- Probable Maximum Flood
PUB	- Public Utilities Board
RCC	- Roller Compacted Concrete
ROV	- Remotely Operated Vehicle
ROTV	- Remotely Operated Towed Vehicle
SBP	-Su-Bottom Profiler
SCADA	- Supervisory Control And Data Acquisition
SLI	- SNC Lavalin Inc.
SOBI	- Strait of Belle Isle
SPV	- Special Purpose Vehicle/Entity
TC	- Transition Compound
TLH	- Trans-Labrador Highway