From: Tremblay, Jean-Daniel
To: Jason Kean/NLHydro
Subject: Revision 02 of Basis of estimate Draft no. 2
Date: Thursday, July 5, 2012 9:23:00 AM
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Global BOE REV 02 for JK July05 2012.docx

Jason,

As discussed yesterday, please find attached draft no. 2 of Rev.02 of the BOE document for your review.

Thank you for providing input and way forward with respect to integration with Nalcor BOE.

Regards.

JD

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nalcor energy

Lower Churchill Project

DG3 Capital Cost Estimate
BASIS OF ESTIMATE

SLI Document No. 505573-0000-33RA-I-0001-01

Nalcor Reference No. LCP-SN-CD-0000-EP-ES-0002-01

Date: 05-Jul-2012~~03 Feb 2012~~

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REVISION LIST

Revision					
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1 VOLUME I - CAPITAL COST BASIS OF ESTIMATE - GENERAL CONSIDERATIONS

1.1 PURPOSE OF THIS DOCUMENT

The purpose of this Basis of Estimate (BOE) document is to provide the critical context and clarity as to the scope of the estimate and the approach used to develop the estimate, as well as provide critical information that an experienced cost engineer can use to assess the quality and completeness of the estimate.

It is a method of documenting the critical aspects of the project cost estimate for the purpose of providing clarity of what is in the Base Estimate, thereby mitigating Project cost risk.

The purpose of this document is also to provide Project team members clarity as to how the estimate was developed, what are the estimate's limitations, main assumptions, exclusions, etc.

This document also provides a key basis to assist with management of change and as such, it will become one the Project's Key Controlled Document.

1.2 SCOPE OF THIS DOCUMENT

This document covers the basis of how the Capital cost related to the construction of the Project was estimated. These costs represent the sum of labour, permanent and consumable materials, equipment and sub-contractor costs to be incurred by contractors in order to build the physical components of the Projects, referred to as Project Direct Costs.

Also covered are the costs to be incurred by the Owner and Contractors for the support of the construction activities (access roads, camp facilities and air travel, construction offices and supervision, etc.) referred to as Project and Construction Indirect Costs.

This document does not cover the basis by which costs related to the development of the Project, which were estimated by Nalcor, such as Internal Costs, Environmental/Aboriginal Affairs, and Land Acquisition, and associated costs related to the MOM between Nalcor and Emera.

1.3 DEFINITIONS

Allowance Costs added to the base estimate, based on experience, to cover foreseen but not fully defined elements.

Analogous estimate an estimate based on previous similar projects.

Base Estimate Reflects most likely costs for known and defined scope associated with project's specifications and execution plan.

Baseline The project scope, in terms of quantity, quality, timing, hours, costs, etc that establishes a formal reference for comparison and verification of subsequent efforts, progress, analysis and control.

Decision Gates A Decision Gate is a predefined moment in time where the Gatekeeper has to make appropriate decisions whether to move to the next stage, make a temporary hold or to terminate the project. The option to recycle to the current stage is considered an undesirable option unless caused by changes in business conditions.

Escalation Provision for changes in price levels driven by economic conditions. Includes inflation.

Estimate Contingency Provision made for variations to the basis of an estimate of time or cost that are likely to occur, and that cannot be specifically identified at the time the estimate is prepared, but experience shows will likely occur. Contingency does not cover either of scope changes outside the project's boundaries, events such as strikes or natural disasters, or escalation and currency effects.

Inflation General changes in price levels caused by changes in the value of currency and other broader monetary impacts.

Physical Component A breakdown of major physical components identified/associated with the NE-LCP.

Project Scope A concise and accurate description of the end products or deliverables to be expected from the project and that meet specified requirements as agreed between the Project Stakeholders. It represents the combination of all project goals and tasks, and the resources and activities required to accomplish them.

Risk An uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives.

Work Breakdown Structure The decomposition of the project scope into more manageable packages of work or deliverables. Each WBS element will have an approved budget that will be defined in the Project Budget.

1.4 ABBREVIATIONS AND ACRONYMS

AACE	Association for the Advancement of Cost Engineering
ac	Alternating Current
BOQ	Bill of Quantities
CAPEX	Capital Expenditure
CCE	DG3 Capital Cost Estimate
CF	Churchill Falls
CFRD	Concrete Face Rockfill Dam
dc	Direct Current
DWSM	Dual Window Single Mode
EIA	Environmental Impact Assessment
ES	Estimating Software (HCSS Heavy Bid estimating software)
GI	Gull Island
HADD	Harmful Alteration, Disruption or Destruction
HVac	High Voltage alternating current
HVdc	High Voltage direct current
IBA	Impacts and Benefits Agreement
IPE	International Project Estimating
kV	kilovolt

LCPP1	Lower Churchill Project Phase One
LCPMT	Lower Churchill Project Management Team
MF	Muskrat Falls
MFGF	Muskrat Falls Generation Facility
MTO	Material Take Off
MW	Megawatt
NE-LCP	Nalcor Energy - Lower Churchill Project
OPEX	Operating Expenditure
OPGW	Optical Ground Wire
PMPC	Project Management / Project Controls
SLI	SNC Lavalin Inc.
SOBI	Strait of Belle Isle
RCC	Roller-Compacted Concrete
ROW	Right Of Way
SP	Soldier's Pond
Te	Metric Tonne (1000 kilograms)
WBS	Work Breakdown Structure

~~1.1~~1.5 PROJECT SCOPE DESCRIPTION

The Churchill River is located in Labrador in the Province of Newfoundland and Labrador, Canada. The existing 5,428 megawatt (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 percent is planned to be

developed via two sites on the lower Churchill River, known as the Lower Churchill Project (LCP).

~~1.1.1~~1.5.1 Description of the LCP

The LCP consists of two undeveloped hydroelectric sites and associated transmission systems: Gull Island Hydroelectric Development, located 225 kilometres downstream from the existing Churchill Falls Generating Station; and Muskrat Falls Hydroelectric Development, located 60 kilometres downstream from the proposed Gull Island Hydroelectric Development.

The Gull Island Hydroelectric Development will consist of a generating station with a capacity of 2,250 MW, while the Muskrat Falls Hydroelectric Development will consist of a generating station of 824 MW capacity and associated transmission systems.

~~1.1.2~~1.5.2 Configuration of LCP Phase 1

In the final week of the preparation of the CCE, Nalcor introduced a new configuration of the Project components. While considering the same scope of work, SLI and Nalcor configurations are different and reflect the needs and agreements of the SLI/Nalcor development team.

~~1.1.3~~1.5.3 SLI Configuration of Phase 1

Phase 1 of the Lower Churchill Project comprises the Muskrat Falls Hydroelectric Plant and associated transmission lines and DC specialties. It is comprised of three discrete groups of physical Components, as follows:

- Component 1: Muskrat Falls Hydroelectric Development
- Component 3: High voltage direct current transmission system specialties
- Component 4: High voltage overhead transmission lines (ac and dc) including:

Sub-component 4A: HVdc overhead transmission lines Muskrat Falls to Soldiers Pond

Sub-component 4B: HVac overhead transmission lines Muskrat Falls to Churchill Falls

~~1.1.3.1~~1.5.3.1 Component 1 – Muskrat Falls Hydroelectric Development

The Muskrat Falls Hydroelectric Development will include the following sub-components which are broken down under the five principal areas of the development.

Infrastructure

a) 22 km of access roads, including upgrading and new construction, and temporary bridges;

b) A 1,500 person accommodations complex (for the construction period); and

Dams and Spillway

a) A north RCC overflow dam;

b) A south RCC dam;

c) River diversion during construction via the spillway;

d) Gated spillway.

Reservoir

a) Reservoir preparation and reservoir clearing;

b) Replacement fish and of terrestrial habitat;

c) North spur stabilization.

Intake / Powerhouse / Turbine Generator

A close coupled intake and powerhouse, including:

4 intakes with gates and trash racks;
4 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.

A more detailed Project description of Component 1 is included in document 505573-3000-4000-0001.

~~1.1.3.2~~1.5.3.2 Component 3 – High Voltage Direct Current Transmission System Specialties

Component 3 consists of the HVdc converter station systems associated with the high voltage direct current (HVdc) transmission system. The Component 3 HVdc facilities will comprise the following:

AC switchyard at Muskrat Falls;

Churchill Falls switchyard extension.

Muskrat Falls HVdc converter station:

HVdc bipolar converter station;
315 kV ac, converted to ±350 kV dc;
Pole capacity of 450 MW; and
Shoreline pond electrode located on the Labrador side of the Strait of Belle Isle.

The Anse-au-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. The wood pole line and conductors will form part of Component 4.

a) Soldiers 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.

The Dowden's Point shoreline pond electrode will be connected to the converter station at Soldiers Pond with dual overhead conductors supported on a wood pole line. The wood pole line and conductors will form part of Component 4.

HVdc Transition Compounds for the Strait of Belle Isle submarine cable terminations:

One transition compound for each side of the Strait of Belle Isle submarine cable crossing,
Associated switch works to manage the junction of multiple submarine cables and the overhead transmission line.
Telecoms.

For the purposes of the EPCM Contract, the scope of work does not include any infrastructure or services associated with the actual crossing of the Strait of Belle Isle.

~~1.1.3.3~~1.5.3.3 Component 4 – High Voltage Overhead Transmission Lines

The high voltage overhead transmission lines required for Phase 1 comprise high voltage alternating current (Hvac) lines, high voltage direct current (HVdc) lines, and electrode lines described as follows:

Sub-Component 4A: HVdc Overhead Transmission Lines Muskrat Falls to Soldiers Pond

Overhead Transmission Line:

Transmission line from Muskrat Falls converter station to Soldiers Pond converter station (near St. John's, NL):

900 MW, ±350 kV dc, bipolar line, single conductor per pole;
Galvanized lattice steel guyed suspension and rigid angle towers;
1100 km long.

Connections to HVdc transmission system specialties installations, as described in Component 3 herein, will be required.

Electrode Lines:

Dual overhead conductors supported on a wood pole line from Muskrat Falls converter station to the shoreline pond electrode located on the Labrador side of the Strait of Belle Isle;
Dual overhead conductors supported on a wood pole line from Soldiers Pond converter station to the shoreline pond electrode located on the east shore of Conception Bay.

Sub-Component 4B: Hvac Overhead Transmission Lines Muskrat Falls to Churchill Falls

Churchill Falls (CF)

Transmission lines from Muskrat Falls to Churchill Falls:

2 – 315 kV ac, 3 phase lines, double bundle conductor;
Single circuit galvanized lattice steel guyed suspension and rigid angle towers;
265 km long.
735 kV Transmission Line at Churchill Falls interconnecting the existing and the new CF switchyards

~~1.1.4~~1.5.4 Nalcor Configuration of LCP Phase 1

Phase 1 of the Lower Churchill Project comprises the Muskrat Falls Hydroelectric Plant and associated transmission lines and DC specialties. The Nalcor configuration also considers three discrete groups of physical Components which are identified as follows (See Appendix 1-1):

- Project 3: Muskrat Falls Generation
- Project 4: Labrador Island Transmission Link (LITL)
- Project 6: Labrador Transmission Asset (LTA)

~~1.1.4.1~~1.5.4.1 Project 3 – Muskrat Falls Generation

The Muskrat Falls Generation Project will include the following sub-components which are broken down under the five principal areas of the development.

Infrastructure

c) 22 km of access roads, including upgrading and new construction, and temporary bridges;

d) A 1,500 person accommodations complex (for the construction period); and

Dams and Spillway

e) A north RCC overflow dam;

f) A south RCC dam;

g) River diversion during construction via the spillway;

h) Gated spillway.

Reservoir

d) Reservoir preparation and reservoir clearing;

e) Replacement fish and of terrestrial habitat;

f) North spur stabilization.

Intake / Powerhouse / Turbine Generator

A close coupled intake and powerhouse, including:

4 intakes with gates and trash racks;
4 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.

~~1.1.4.2~~1.5.4.2 Project 4 -– Labrador Island Transmission Link (LITL)

Project 4 consists of the overland high voltage direct current (HVdc) Transmission system and associated HVdc converter station systems, the Strait of Belle Isle (SOBI) Marine Crossing (not in SLI scope of work) and the new Synchronous condenser facility. Project 4 comprises the following:

Switchyard at Soldiers Pond.

Muskrat Falls and Soldiers Pond HVdc converter stations:

HVdc bipolar converter station;
345 kV ac, converted to ±320 kV dc;
Pole capacity of 450 MW; and
Shoreline pond electrode located on the Labrador side of the Strait of Belle Isle.

The shoreline pond electrode will be connected to the converter station at Muskrat Falls with dual overhead conductors supported on a wood pole line. The wood pole line and conductors will form part of Component 4.

Shoreline pond electrode located on the east shore of Conception Bay.

The shoreline pond electrode will be connected to the converter station at Soldiers Pond with dual overhead conductors supported on a wood pole line. The wood pole line and conductors will form part of Component 4.

HVdc Transition Compounds for the Strait of Belle Isle submarine cable terminations:

One transition compound for each side of the Strait of Belle Isle submarine cable crossing,
Associated switch works to manage the junction of multiple submarine cables and the overhead transmission line. Overhead Transmission Line:

Transmission line from Muskrat Falls converter station to Soldiers Pond converter station (near St. John's, NL):

900 MW, ±320 kV dc, bipolar line, single conductor per pole;
Galvanized lattice steel guyed suspension and rigid angle towers;
1100 km long.

New synchronous condenser at Soldiers Pond
Operations Telecommunication system.

~~1.1.4.3~~1.5.4.3 Project 6 Labrador Transmission Asset (LTA)

Project 6 consists in the AC transmission line system form Churchill Falls to Muskrat Falls. Project 6 comprises the following:

Churchill Falls switchyard extension;

Muskrat Falls switchyard;

Transmission lines from Muskrat Falls to Churchill Falls:

735 ~~2~~ 345 kV ac, 3 phase lines, double bundle conductor;
Single circuit galvanized lattice steel guyed suspension and rigid angle towers;
265 km long.

735 kV Transmission Line at Churchill Falls interconnecting the existing and the new CF switchyards

1.6 BASIS OF DESIGN

All design and engineering work performed for the purpose of DG3 sanctioning of the Muskrat Falls Project builds on the MF 1340 Feasibility study and the Basis of Design document LCP-PT-ED-0000-EN-RP-0001-01 issued by Nalcor and commented by SLI. These documents served as basis for establishing the design criteria to be considered for the complete design of the Project's facilities and systems.

Inputs provided to the estimating team, mainly scope definition and quantification, for the purpose of the DG3 Estimate were aligned with these documents and capture the latest intended technical scope and performance of the Muskrat Falls power generation and transmission Project.

1.6.1 Quantification process

For each of the components of the Project, the respective engineering units provided to the estimating team all the required quantities capturing the complete scope of work for each of the structures, facilities or systems to be estimated. The inputs provided to the estimating team took the form of quantity tables and spreadsheets that were developed by Engineering using various means and methods that could be summarized as follow:

- Use of the CATIA 3D Modeling tool to extract volumes, surfaces and lengths of key materials required for the construction of the fill and concrete structures, formwork areas, main piping lengths, etc.
- Use of Single line diagrams and Piping and Instrumentation Diagrams for the material take-off of the equipments included in the various systems considered by these diagrams.
- Use of transmission lines routing drawings for tower spotting and material take-off by type of tower including all steel and hardware.
- Material take-off of civil works quantities using traditional methods of cut and fill volumes calculations for all switchyards and various facilities along the Project ROW.

1.7 ESTIMATING TEAM STRUCTURE AND MEMBERS

The estimating team assembled to develop the DG3 Capital cost estimate was composed mainly of seasoned estimators having extensive experience in their respective fields. These estimators were in most parts sourced directly from SLI staff. However, where in-house expertise was not available, external specialized

consultants were called upon. Below is an organization chart detailing who the members of the estimating team were and their respective role in the development of the estimate.

The Lead Estimator was responsible for providing the framework and ground rules to be considered by all estimating team members. In addition to performing key portions of the estimate, the Lead Estimator provided assistance and validation to members of the team.

Coordination between Nalcor, SLI and the Engineering departments of each of the Project Components was provided by the Estimate coordinators from both Nalcor and SLI.

Most of the estimating team was comprised of SLI personnel with the exception of the following external consultants:

- Jim Daubersmith, Daubersmith Inc.: Powerhouse structural concrete estimate
- CGC Consultants: Powerhouse and spillway mass excavation estimate
- Desfor Consulting: Transmission Lines ROW clearing, access study and estimate.

The SLI Hydro Division lead estimator provided additional support to the Project estimating team through cold eye reviews of the estimate prior to closure.

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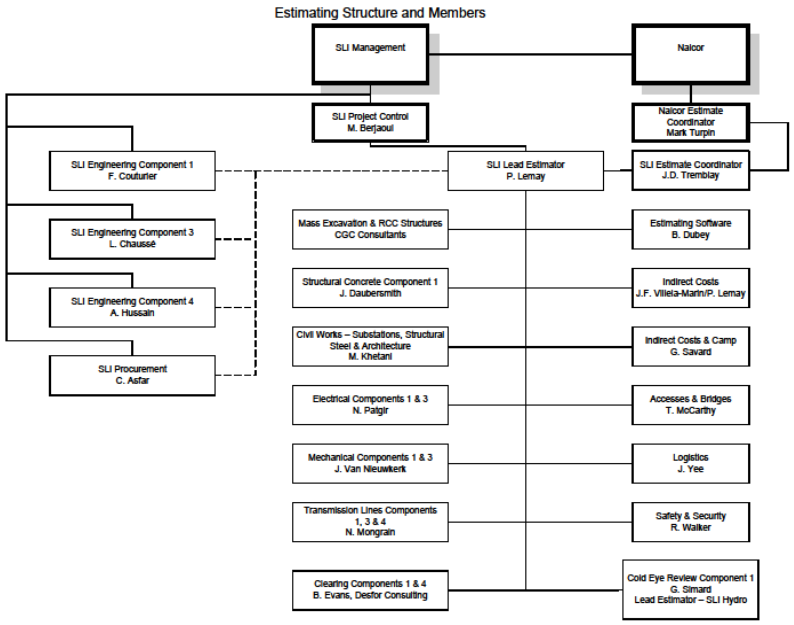


1.8 OVERALL COST ESTIMATING APPROACH AND METHODOLOGY

The overall estimating approach adopted for the DG3 capital cost estimate basically reflects what a construction contractor would need to do to evaluate project costs for which a bid is being prepared. This approach could be best described as a bottom-up first principle estimate or deterministic estimate as opposed to a parametric or stochastic method.

As such, for each item to be estimated in a given portion of scope under evaluation, crews and production rates were developed by estimators, quantified and multiplied

in order to establish the estimated cost of each of the required activities to be performed for the scope to be constructed.

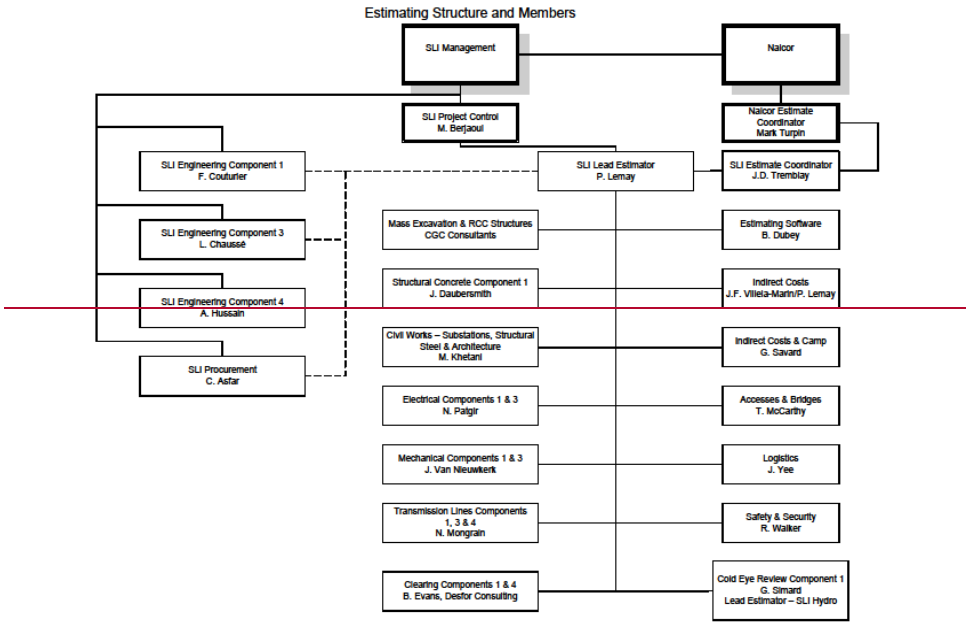
However, some elements of the scope of the estimate, where insufficient information was available at the time of the estimate, were evaluated using benchmarks from other recent similar projects in comparable condition and estimator experience. For example the Turbine Generator cost was estimated using historical costs from other comparable projects. Another example is the estimated cost for the supply and installation of accommodations camps which was based on the overall cost per installed bed witnessed on other similar projects.

1.8.1 Estimating tools

A spreadsheet template was provided by the Lead Estimator to every member of the estimating team. Each estimator performed his estimate using the tools and methods with which they were familiar and proficient and transferred the results of their respective estimate to the spreadsheet template. All the completed templates were forwarded to the Lead estimator who had them integrated into the *HCSS Heavy Bid* Estimating software. The estimated costs were segregated into the relevant cost categories usually considered for capital cost estimates as follows:

- Labour
- Equipment
- Permanent Materials
- Consumable Materials
- Sub-contractors

~~Estimating Team Structure and Members~~



~~1.2~~1.9 TYPE OF ESTIMATE

The DG3 Capital Cost Estimate (CCE) is a Class III AACE 17R-97 estimate. The CCE describes the complete project and installations to be built and provides sufficient scope definition for Management / Board approval, financing, budgeting and control. All costs are expressed in Canadian dollars Q4 of 2011.

Estimate accuracy is suitable for external financing (i.e. bankable document).

~~1.3~~1.10 SCOPE OF ESTIMATE AND COST STRATEGY

The CCE is a new "bottom-up" estimate reflecting the latest project configuration as defined in the latest Basis of engineering documents. The CCE was prepared to confirm the business case in order to proceed with the DG3 Project Sanction.

The strategy put forward by SLI to undertake and complete this Estimate focussed on the following:

- Assemble a Project estimating team in St-Johns reporting to the Lead estimator, supported by the Estimate Coordinator
- Source from within SLI seasoned estimators capable of taking over parts of the estimate from their head office location (mainly Calgary Alberta)
- Identify and mandate specialized firms for remainder of the scope for which no in-house estimator was available
- Conduct a kick-off meeting where complete estimating team was provided with relevant base documents and ground rules.
- Conduct a joint Nalcor/SLI estimate review one month prior to DG3 December 15, 2011 issue.

The CCE integrates the latest engineering layout, definition and quantification as developed by each of the SLI Components engineering teams. The CCE basis of estimate details the general assumptions and data considered in the estimating of the resources and work required for the Project. In this document, for the purpose of ensuring consistency in the estimating approach by all estimators, this information is presented according to four (4) types of estimate inputs, for which a summary description is presented below:

1. **Definition Factors (Scope)**: Design Criteria & Specifications, General Arrangements & Layouts, Design Drawings for major components, Rock and concrete quantities developed by 3D modeling, Material take-offs for Construction Bulks, Equipment Specifications, Geotechnical surveys, WBS Cost codes, etc.;

2. **Construction Methodology & Timeline Factors**: Construction Philosophies, Construction Execution Plan, Constructibility Reviews, Constrcuction Schedule, Logistics and Access, Contract Package Dictionaries, Organizations & Staff Plans, Construction Equipment Types, Labor Demands, Labor Demarcation, In-Directs Strategies, Site Services, Pre-Fabrication Plans, Crane & Access Studies, Material Sourcing Strategies, Seasonnality Constraints, Support Facilities,, etc.;
3. **Price**: Labour Agreements, Construction Equipment Rates, Bid Analysis when available, Budgetary Quotes, Site Services Costs, Construction Bulks Prices, Helicopters and Air Cranes, Contractine Market Intelligence-Overhead and Profit, Foreign Exchange Rates, tec.:.
4. **Performance**: Crew Make-Up and Assignments, Task Durations, Labor Productivity, Workface Restrictions, Labor Productivity & Benchmarks, Mobilization Constraints, Work Front Stacking, Seasonality Impacts, Equipment Productivity, In-Directs Usage, Offsite Fabrication, Project Management Resources, etc.

In addition to the above four (4) inputs, estimated costs for Engineering and Detailed Design, the provision of Owner Project Management, Internal Costs, Environmental/Aboriginal Affairs, and Land Acquisition, and associated costs related to the MOU between Nalcor and Emera were also calculated by Nalcor and included in the Capital Costs Estimate presented to the Gate keeper. However, the details pertaining to the basis of estimate of these costs are presented in a separate document entitled XYZ.

The DG3 Capital Cost Estimate reflects the key timelines and sequences as contained in the Project Preliminary Master Schedule which indicates early works construction commencing in Spring 2012 following release from Environmental Assessment and ends with commissioning of the final turbine/generator unit and thus full power in May 2017

The following estimating activities were performed by the estimating team and were integrated into the Estimating Software (ES) (HCSS's *Heavy Bid* software version 2010.3):

- Assemble the project MTO's from engineering (which were later transposed into engineering reports, see Appendix 1-2 – Quantification Basis Reports);
- Perform bottom up estimate on a first principle basis (quantities, crews, production rates and unit costs)
- Perform reasonable evaluation based on past experience for similar projects in comparable conditions if needed;
- Perform all commercial bid evaluations on equipment and bulk materials quotes;
- Compile and use In-House pricing as necessary;
- Prepare Basis of Estimate for estimator-specific scopes;
- Participate in estimate reviews with the engineering and project management team;
- Populate estimating forms for integration of estimates into the ES.
- Joint SLI / Nalcor estimate review meeting from November 15 to 18, 2011 from which an action items list was developed, addressed and integrated into the December 15, 2011 CCE. (See Appendix 1-3)

The CCE quantities have been developed using the Metric System of measurement. Cable and wire have been measured in American Wire Gauge (WG).

Others:

The CCE considers all costs from Project construction initiation to commissioning, including:

- All accesses and ancillary works
- Procurement and logistics

- Camps and living accommodations for all Components
- Camps security and medical services
- Contractor Construction Management (CCM)
- On-site Temporary Construction Facilities
- Construction
- Commissioning
- EPCM Costs

1.11 ESTIMATE REVIEWS

During the course of the Estimate one major estimate review was conducted as well as a major scope review through the development of the Commitment Package dictionaries and related review meetings.

The Estimate review took place in November 2011 and assembled Nalcor and SLI relevant representatives. The complete scope of the estimate was covered over the three and a half days of the review. Work sessions each focusing on sub-components of the estimate were conducted. Each estimator presented the details of their respective estimate which lead to constructive discussions between all attendees and actions being recommended. These Actions Items were logged in a register and addressed prior to the December 15 issue of the DG3 Estimate SLI Deliverable.

In the spring of 2012, as the Project Sanction was postponed, it was decided to proceed with structuring the Capital Cost estimate into Commitment packages. For each of the commitment Packages, a package dictionary was prepared by the Components Engineering departments outlining all aspects of the packages including, scope, major quantities, work included and excluded, interfaces with other packages, schedule conditions, etc. This effort required a fair amount of coordination between Engineering units.

The estimating team was deeply involved in the review process of the package dictionaries content, mainly to cross reference the scope of the packages reflected in the estimate with the scope stated in the package dictionaries. This exercise served as a Quality Assurance process which led to both Package Dictionaries and Packages in the estimate to be revised and aligned with one another. During the review workshop, action items were logged in a register and addressed.

~~1.4~~1.12 WORK BREAKDOWN STRUCTURE

The work breakdown structure coding system implemented for the CCE (Appendix 1-4) is a~~n eight (8)~~nine (9) digit coding system that integrates within the first Five (5) digits the NALCOR Project number (first digit) as well as the physical components coding structure as provided by NALCOR (digits 2 to 5) (Appendix 1-1). The last four digits of the coding system serve to further breakdown these physical components into ~~estimated~~ work items comprising the actual work activities to be estimated. The Nalcor physical components coding structure, part of the Nalcor Corporate coding structure, captures the full scope of the Project in a logical structure with physical and cost account breakout.

~~1.5~~1.13 TIME PHASING METHODOLOGY

The relevant portions of the latest Master Project Construction Schedule (at its developed stage on 13 September 2011 (See Appendix 1-5) were provided to each estimator along with the other documents required for them to produce the estimate. ~~Final~~ tTime phasing was also conducted and validated at estimate intermediate close-out using the December 2011~~16~~ Schedule for the issuance of the SLI formal DG3 Estimate deliverable on December 15, 2011(See Appendix 1-6).

In the spring of 2012, an additional period of time was provided to further detail and validate the DG3 Estimate. Concurrently, the Project Master Schedule was further detailed and finalized as well. This exercise enabled the Project team to review and validate certain scheduling assumptions as well as the constructability of various components of the Project, mainly the Powerhouse, the Transmission Lines and

Switchyards works. This process allowed the Estimating Team to review and fine tune portions of the CCE, increasing its overall accuracy.

~~Preliminary labour and cash flow curves were also developed at estimate close - out. (See Appendix 1-7 and 1-8)~~

~~1.6~~1.14 SPECIAL PROJECT ORDER (CRAFT WAGE RATES) AND LABOUR HOURS

At date of issuance of the CCE, the Lower Churchill Project SPO had not been sanctioned and negotiations between Nalcor and Unions were pending or underway. Craft wage rates used throughout the CCE were provided by Nalcor and reflect the rates of another unspecified SPO recently enacted. The CCE labour rates are presented in Appendix 1-9 and include all shifts, burdens/benefits, and premiums.

For the purpose of producing labour flow curves and indicating the labour requirements over the duration of the Project, the CCE includes all labour hours required to perform the work of all Components of the Project. The number of labour hours was evaluated based on the following:

- All direct labour hours based on readily available published productivity charts, ~~and/or~~ SLI historical data and Estimator experience
- ~~All base hours for electrical, mechanical, structural steel and architectural work estimates are based on USGC to which a site-specific adjustment factor was applied to the chart hours. The method by which these site-specific adjustment factors were developed is as follow:~~
- ~~XYZ~~
- For major items for which a turn-key lump sum budget or bid price was obtained for the purpose of the estimate, an evaluation based on past experience and proxy crews was conducted to establish the total labour hours by trade required for the construction of these items.

~~1.7~~1.15 EQUIPMENT RATES

Construction equipment rates taken mainly from WEB based *Equipment Watch* July 2011 (www.equipmentwatch.com). For specialized equipment not present in the *Equipment Watch* tables, rates were developed from past experience on similar project in comparable conditions. Fuel consumption per equipment included in the tables was used to determine the fuel consumption for the Project. The fuel costs reflected in these tables are the following:

- Diesel fuel cost at $1.44/litre
- Gasoline fuel cost at $1.44/litre

The equipment rates used in the CCE are presented in Appendix 1.10

~~1.8~~1.16 ASSUMPTIONS, EXCLUSIONS AND EXCEPTIONS

- General instructions were provided to estimators prior to commencement of detailed estimating work. These instructions, referred to as the *Estimate Ground Rules,* addressed general assumptions and base rates to be considered for estimating direct costs and construction indirect costs throughout the CCE. The *Estimate Ground Rules* are presented in Appendix 1-11.
- In the CCE, Room and board was initially considered to be provided to Contractors at free issue and estimated for each Component and identified as a Project Indirect Cost in the CCE. In accordance with the contracting strategy adopted by Nalcor where contractors are to include the room and board costs in their contract estimate, these costs were later allocated up on each of the relevant ~~estimate items~~Commitment Packages prorated on labour hours included in each ~~item~~Package.
- Labour rotation is 21 days work on site and 7 days off.
- No environmental Assessment report was available at time of CCE issuance. Assumptions and provisions included in the CCE related to environmental

impact mitigation (HADD mitigation work) items are based on past experience for similar projects

- The Goods and Services taxes are not included in the estimate.
- All equipment and bulk materials import duties are excluded.
- Brokerage/agents fees for equipment imported into Canada duty free are excluded.
- No provisions or allowances have been included in the CCE to account for the following costs as these are owned by NALCOR:
  - Contingencies and risks allowances
  - Escalation on labour rates and inflation
  - Financing costs
  - Insurance and bonding
  - Land acquisitions
  - Project level governmental permitting
  - Owner costs

~~1.9~~1.17 ALLOWANCES

The CCE includes no allowances other than those indicated in the details of the following sections of this Basis of estimate document for specific items for which they were deemed necessary to properly estimate the work item. These specific allowances were evaluated based on past projects and estimator experience in their specific fields.

~~1.10~~1.18 PROJECT AND CONSTRUCTION INDIRECT COSTS

Project indirect costs are incurred on a Project level to support all the construction work package activities whereas the Construction indirect costs are incurred by

Contractors in the effort of executing their awarded construction work package. The basis for the estimation of these costs is presented below.

~~1.10.1~~1.18.1 Project Indirect Costs

~~1.10.1.1~~1.18.1.1 Main access road to Muskrat Falls site

The estimated cost of the 22 km main access road from the Trans Labrador Highway to the Muskrat Falls project site was developed on a bottom up basis and cost was developed through estimator experience and input from local contractors.

Quantification basis for this work is captured in the following Engineering documents included in Appendix 1-2:

- CH0004 South Side Access road
- CH0048 – Construction of Site Clearing Access Road & Ancillary Areas

~~1.10.1.2~~1.18.1.2 Other Muskrat Falls Access Roads, Existing Bridges Replacement and new McKenzie River Bridge

The estimated cost of the access roads to the North Spur, Granular Deposit Pit GR-5, Till deposit Pit T-4B and Quarry No.1 were based on the cost of other road work in Labrador and factored to reflect the project's current construction costs on a per km basis. The estimated cost allowance for the replacement of the existing Kenamu and Paradise bridges, located between the Churchill River Bridge and Cartwright, on the Trans-Labrador Highway (required to increase the load capacity to 250 metric tons) are based on the actual construction cost of the existing bridges which have been adjusted to reflect increases in labour and material cost.

The cost for the new McKenzie River Bridge includes the design, fabrication, supply, delivery, and construction necessary to erect a 30 m bridge structure across the McKenzie River located on the south side of the Churchill River, approximately 2 km east of the Muskrat Falls site. The bridge shall be designed to accommodate the passage of a 250 tonne transformer.

The estimate is based on engineering judgment and experience to construct a bridge as described with approximately 250 m^2 of deck area.

Quantification basis for this work is captured in the following Engineering documents included in Appendix 1-2:

- Access roads for North Spur and Quarries, Strengthening of Kenamu and Paradise River Bridge
- CH0039 – McKenzie River Bridge

~~1.10.1.3~~1.18.1.3 Construction Camps Construction and Operations for the Duration of the Project

Costs of site preparation of the main Camp area at Muskrat Falls include the following:

- Clearing based on a cost per hectare established on a first principal basis developed for clearing highway right of ways in Labrador and applied to the main camp area.
- Civil works and camp infrastructure construction based on similar work being done in Labrador by SLI, factored to project cost.
- ~~A provision for the procurement, installation and operation of a 150 people starter camp to lodge first workers and staff on site.~~ ~~The definite scope of this work item still needs to be clarified and agreed by Nalcor.~~

Procurement cost of the 1500 people camp facilities as well as administrative and support facilities including transport to site and installation are based on parametric data as well as quotes provided by suppliers and validated by benchmarking with similar projects in comparable conditions. Firm quotes from suppliers are expected in early 2012.

Camp operations costs include all necessary activities to provide suitable living and working accommodations. These costs were allocated to all relevant commitment packages prorated on the total man-hours of each Commitment package. The Basis of Camp operation costs are as follow:

- Catering costs based on past experience and Nalcor recommendations

- House keeping costs based on past experience
- Facilities maintenance and cleaning based on past experience
- Site maintenance costs based on past experience
- Garbage removal based on past experience
- Provision of fuel supply and dispensing services based on past experience
- Provision of ground transportation based on past experience

Cost of Transmission lines (TL) camps to be constructed along the TL ROW were estimated by factoring the main camp cost as well as by benchmarking similar project in comparable conditions on a *per bed* basis and adjusted to consider additional operating costs due to lower capacity and increased remoteness.

Quantification basis for this work is captured in the following Engineering documents included in Appendix 1-2:

- CH0002 – Accommodations Complex Buildings
- CH0003 - Accommodations Complex Administrative Buildings
- CH0005 – Accommodations Complex Site Utilities
- CH0048 – Construction of Site Clearing Access Road & Ancillary Areas
- Following documents grouped in one single document:
- SH0021 – Provision Of Road Maintenance And Snow Clearing Devices (MF)
- SH0022 – Provision Of Fuel Supply And Dispensing Services (MF)
- SH0040 – Provision Of Garbage Removal And Dispensing Services (MF)
- SH0041 – Provision Of Ground Transportation Services (HVGB To MF)
- SH0051 – Provision Of Buildings Maintenance Services (MF)

1.18.1.4 Air Travel and Transportation of ~~Workforces,~~Contractors personnel ~~EPCM and Client Personnel between Work Areas and Point of Origin~~

Air travel costs were estimated by establishing the foreseeable number of round trips according to the number of anticipated turnarounds for construction personnel on site and applying the following allowance.

- $ 1,200 per round trip covering the following expenses:
  - plane ticket costs;
  - Travel expenses (taxi, bus, car) from home to airport;
  - Travelling time from home to Goose Bay Airport;

Air travel costs for Owner's and EPCM personnel are captured in Owner's Costs.

~~Air travel costs were estimated using a unit value per kilometre travelled provided by local airlines for commercial flights and chartered flights applied to distances between five points of origins and the Muskrat Falls site. Over the duration of the Project, an estimated total of 138 000 trips will be made to the Muskrat Falls site, based on the assumptions of a 21-7 rotations for craft personnel and 11-3 rotations for staff, from five origins in the following proportions for all Components of the Project:~~

- ~~St-John's: 25%~~
- ~~Deer Lake: 25%~~
- ~~Moncton: 20%~~
- ~~Montreal: 15%~~
- ~~Toronto: 15%~~
- ~~Charter Plane capacity utilization at 75%~~
- ~~Chartered flights for the St-John's and Deer lake origins~~
- ~~Commercial flights for Toronto, Montreal and Moncton origins~~

- ~~Travel time paid to personnel includes only 8hres hire-in and 8hres termination-out for a total 16hrs per turnaround. Assumption for the number of turnarounds is 1000 pers x 3 turnarounds = 3000.~~
- ~~No travel time is paid on 21-7 rotations~~
- ~~Hotel & Meals at St-John's and Deer Lake at a cost of 150$ for each rotation~~
- ~~Hotel & Meals at Toronto, Montreal and Moncton at a cost of 190$ for each rotation~~
- ~~Transportation expenses (Taxi, bus, etc.) between home and airport at 100$ for each rotation~~

~~1.10.1.4~~1.18.1.5 Health and Medical Services

The CCE includes Construction health and medical services for both the Muskrat Falls facilities as well as services to be provided along the TL ROW.

Quantification of the required provision of medical services is based on the assumption that the services include the following:

Component 1:

- a well equipped 24/7 medical facility at the Muskrat Falls construction camp site to cover the camp's medical requirements as well as a portion of the requirement for the reservoir clearing.
- Medical transport vehicles adequate to transport patients to the Happy Valley Goose Bay hospital
- For the remainder of the reservoir clearing operations, Emergency Medical Technician (EMT) equipped with Mobile Treatment Centers (MTC) which can double as Medical transport vehicles

Component 4:

- EMTs and MTCs in each of the satellite camps
- Provision

Component 3:

- Medical services provided by either Component 1 or Component 4 services in the Labrador portion of the Project and in remote area in Long Range Mountains in Newfoundland
- Medical services will be provided by existing medical facilities in Newfoundland where work areas are relatively close by.

Scope of medical services requirement was developed while preparing the Medical services contract document to be issued for bids in late 2011 and integrate coordinated needs of Components 1, 3 and 4. Cost of medical services was estimated based on estimator experience and input from specialized vendors and service providers.

The CCE also includes the cost for helicopter medical evacuations (medevacs) based on the following assumptions:

- Over the course of the entire project, there will be 1 medevac made per week (both non-work related medical emergencies and work related injuries and illnesses) for a total of 50 medevacs per year for 5 years, resulting in a total of 250 medevacs for the project.
- Each medevac flight will have an average duration of 3 hours
- Average cost for flight hour is $2,200.00

Quantification basis for this work is captured in Engineering document entitled: *SH0019 – Provision of Safety Services, SH0020 – Provision of Medical services* included in Appendix 1-2:

~~1.10.1.5~~1.18.1.6 Mandatory Pre-Access Drug and Alcohol Testing

All personnel working on any phase of the project outside the project office in St. John's will be required to undergo a Drug and Alcohol Screening Test and have a

Medical Examination completed prior to being dispatched to site. The estimate included in the CCE is based on the current market value of those services and the projected number of personnel anticipated to work on the Project and comprises the following assumptions and rates:

- Cost of Drug and Alcohol Screen using current Urine or Mouth Swab techniques will be $250.00 per test
- Pre access Medical Examination will be $250.00 per test

It is projected that a total of 12,000 personnel (SNC-Lavalin, Nalcor and Contractor personnel) will be engaged over the life of the project. This number also takes into consideration those personnel who will be away from the project for a period of 3 months or more and will require to be retested.

~~1.10.1.6~~1.18.1.7 Safety and Security Services and Equipment

The CCE includes estimates based on estimator experience and supplier input for the following:

- On site security service including security personnel, vehicles and equipment
- Rescue boat including 1 boat trailer and rescue equipment
- Safety signage on Sites and on access road to Main site
- Security access swipe cards for access to Main site and accommodation complex
- Personal Protection Equipment for EPCM personnel

Quantification basis for this work is captured in Engineering document entitled: SH0019 – Provision of Safety Services, SH0020 – Provision of Medical services included in Appendix 1-2:

~~1.10.2~~1.18.2 Construction Indirect Costs

Construction indirect costs included in the CCE are based on typical costs, based on past experience, incurred by Contractors required for executing their awarded construction work packages such as:

- Contractor mobilization and demobilization costs
- Rental, installation and operation of temporary construction site offices and facilities
- Contract administration and management personnel
- Site supervision, health and safety, survey and Contractor quality assurance personnel over viewing work performed by own foremen and direct workforce
- Utility supply such as air, water, electricity, etc.
- Job office expenses
- Pickups, site communication, heavy equipment repair and maintenance shops and ownership insurance.
-
- Administration fees to cover contractor home office expenses, overhead and profits were included to the estimated items as follow:
    - A 10% of direct costs allowance was added to all electrical, mechanical, powerhouse superstructure and architecture as well as substations electrical and civil works
    - A 15% of direct costs allowance was added to the powerhouse concrete works
    - ~~No~~An allowance of 40% of direct costs was included in the mass excavation, dams and cofferdams estimate to cover contractor in-directs ~~as direct and indirect values are at cost.~~

- All other estimates developed using market pricing or budget quotes are deemed to be inclusive of profit and administration at a reasonable rate.

- ~~Pickups, site communication, heavy equipment repair and maintenance shops and ownership insurance.~~

~~1.11~~1.19 EPCM COSTS

Engineering, Procurement and Construction Management (EPCM) costs were evaluated using Manpower Front-end Loading (MFL) ~~developed using a bottom-up approach~~ for each Component of the Project as well as general items which are not Component specific. The EPCM costs are ~~presented in the estimate as a one line item and estimate details and backup are~~ submitted as a separate document along with Owner costs.

~~1.11.1 Engineering of Components 1, 3 and 4~~

~~The engineering of all Project Components was sufficiently developed to allow for the production of Bill of Quantities (BOQ) sufficiently detailed to allow for bottom up estimation for most.~~

~~1.12~~1.20 OWNER COSTS

Owner costs are not included in the scope of the CCE basis of estimate (BOE) document. These costs include:

- All contingencies
- Project risks and exposure
- Land acquisition costs
- Project level permitting costs
- Escalation of labour rates through the duration of the Project
- Inflation in the cost of commodities, materials, and equipment rates

- Air travel costs and related expenses for Owner and EPCM Staff
- Financing costs
- All-risk Project insurance
- Contract Bonding Costs
- Costs related to Owner personnel and equipment

2 VOLUME II - COMPONENT 1 AND PROJECT 3 DIRECT COSTS DETAILED BASIS OF ESTIMATE

2.1 INTRODUCTION

As described in Volume I, the Nalcor Project 3 as well as SLI's Component I include the facilities, installations and equipments relative to infrastructure and main camp accommodations, the reservoir work, the dams and spillway and the powerhouse intake and turbine generators.

The following sections describe the basic assumptions considered as well as the means and methods utilized to develop the relevant cost estimates included in the CCE.

2.1.1 Commitment~~ontract~~ packages

The CCE was developed based on the work breakdown structure (WBS) of the Project. As stated in Volume I, ~~T~~these work items were later structured into Commitment~~ontract~~ packages ~~that~~ capturing~~e~~ the same scope of work in a fashion that allow for bid packages to be issued to potential bidders and Contracts to be awarded, executed and managed up to and following procurement or construction completion.

Package numbers give an indication of the nature of the contract: "C" packages are Construction Packages, "P" packages are Purchase Orders or Procurement and "S" packages are Service Contract Packages. The second letter is Component specific; H for Component 1 (Hydro), D for Component 3 (DC Specialties) and T for Component 4 (Transmission). For each of these Commitment~~ontract~~ Packages a Quantification Basis report was prepared by Engineering (see Appendix 1-2). The following list is the Commitment~~ontract~~ packages structure that was developed for Component 1:

CH0002 Supply and Install Accommodations Complex Buildings

CH0003 Supply and Install Administrative Buildings

CH0004 Construction of Southside Access Road

CH0005 Supply and Install Accommodations Complex Site Utilities

CH0006 Construction of Bulk Excavation Works and Associated ~~Civil~~ Works

CH0007 Construction of Intake and Powerhouse, Spillway and Transition Dams

CH0008 Construction of North Spur Stabilization Works

CH0009 Construction of North and South Dams

CH0023 Construction of Reservoir Clearing South Bank

CH0024 Construction of Reservoir Clearing North Bank

CH0029 Construction of Site Restoration at Muskrat Falls ~~It is being completed~~

CH0030 Supply and Install Turbines and Generators ~~Tender Process closed.~~

CH0031 Supply and Install Mechanical and Electrical Auxiliaries (MF)

CH0032 Supply and Install Powerhouse Hydro-Mechanical Equipment

CH0033 Supply and Install Powerhouse Cranes

CH0034 Supply and Install Powerhouse Elevator

CH0039 Supply and Install McKenzie River Permanent Bridge

CH0046 Supply and Install Spillway Hydro-Mechanical Equipment

CH0048 Construction of Site Clearing Access Road & Ancillary Areas

CH0049 Supply and Install Log Booms

CH0050 Supply of Concrete including Batch Plant (MF)

CH0052 Construction of Habitat Compensation Works It is being completed

PH0014 Supply of Generator Step-up Transformer

PH0015 Supply of Isolated Phase Bus

PH0016 Supply of Generator Circuit Breakers

PH0035 Supply of Station Service Transformers~~Supply of 15kV Switchgear and Station Service Breakers~~

PH0036 Supply of Auxiliary Transformers

PH0037 Supply of 25kV Switchgear

PH0038 Supply of Emergency Diesel Generators

SH0018 Provision of Catering, Housekeeping and Janitorial Services (MF)

SH0019 Provision of Security Services

SH0020 Provision of Medical Services

SH0021 Provision of Road Maintenance and Snow Clearing Services (MF)

SH0022 Provision of Fuel Supply and Dispensing Services (MF)

SH0040 Provision of Garbage Removal and Disposal Services (MF)

SH0041 Provision of Ground Transportation Services (HVGB to MF)

SH0051 Provision of Buildings Maintenance Services (MF)

2.1.2 Master Equipment list

All the major permanent mechanical and electrical equipment that are to be included in Component 1 have been compiled into a Master Equipment List. This list presents equipment that is ultimately to be individual tagged and incorporated into the Owner's asset management database. As an estimating tool, this list also ensures that the cost of all the required equipment has been captured. The master equipment list for Component 1 is included in this report as Appendix 2-1.

2.2 BASIS OF ESTIMATE – DIRECT COSTS

2.2.1 Reservoir Clearing

2.2.1.1 Scope

- The reservoir will be cleared using the "partial clearing criteria" as defined by Nalcor in their "Design Philosophy for LCP – Reservoir Preparation Plan"
- 40% of the area is located on the North Bank and 60% on the South bank
- the clearing method will be by a mechanical harvesting operation
- total area to be cleared, including reservoir, road rights-of-way and storage yards, is approximately 2200 ha, total merchantable wood is approximately 448,000 m3 which will be trucked out of the reservoir and piled at storage yards
- total road construction will be approx. 152 km. and 99 streams will be crossed

Quantification basis for this work is captured in the following Engineering documents included in Appendix 1-2:

- CH0023 - Construction of Reservoir Clearing South Bank
- CH0024 – Construction of Reservoir Clearing North Bank

2.2.1.2 Construction Methodology & Timeline Factors

- Mechanical harvesting of merchantable & non-merchantable wood with feller-bunchers and skidded to roadside
- Process merchantable wood at roadside to remove limbs and tops
- Merchantable wood will be trucked to storage yards and piled
- When possible deadfalls will be skidded to roadside as non-merchantable wood

- Non-merchantable wood, including deadfalls, and slash from processing merchantable wood will be mulched at roadside and the mulched fibre will be left
- Any areas of deadfalls not skidded and areas of shrubs (alder and willow) will be mulched wherever they occur within the ice and stickup zones and the mulched fibre will be left
- Clearing of the North Bank is scheduled to start in mid 2012 and will be finished at the end of 2014
- Clearing of the South Bank is scheduled to start towards the end of 2012 and will finish in early 2016
- People employed by the clearing contractor must be very skilled – from operators and mechanics to foremen and supervisors

2.2.1.3 Price Factors

- Labour and equipment rates as per general CCE rates as stated in Volume I
- Materials costs were obtained from suppliers of the various products used for the estimate and were FOB Goose Bay (as examples: bridges, culverts, material to construct bridge abutments, etc.)
- Certain items were estimated from past experience and bench-marking with industry contacts

2.2.1.4 Performance Factors

- Assumed labour productivity at 70% based on rotation times of 21 days work/7days home and evaluated by using industry standard productivity tables.
- Equipment productivity factored to account for operating in sandy soils which offer poor traction and for skidding full-tree uphill to honour Nalcor's requirement that, where possible, roads be constructed 2m below full supply level of 39-m ~~asl~~above sea level.

- 42 – 43 weeks/year considered as the time frames for clearing operations. Note: there may be times during winter months that operations will be curtailed because of extreme snow depths and the weeks/year will be less than considered average

2.2.2 Mass Excavation

2.2.2.1 Scope

Bills of quantities (BOQ) were issued by engineering and a check BOQ was developed by estimators. Reconciled Engineering and Estimator BOQs revealed no significant differences in quantities. CCE Mass excavation major Quantities are as follow:

- Overburden material at the Powerhouse site: 455 000 m3
- Overburden material at the North Spur site: 600 000 m3
- Rock excavation : total volume 2 092 000m3
    - Powerhouse : 1 590 000 (including rock plugs)
    - Spillway : 250 000m3
    - North Spur : 100 000m3
- 4,0m long Rock bolt quantity : 882 units
- Wire mesh area and pins : 50 000m2

Rock bolts were quantified by engineering on the basis of available geotechnical information suggesting that the rock is of “excellent” quality (1 bore hole on North side) to “very good” quality (1 bore hole on South side) and based on rock bolt quantities for similar projects with similar rock conditions.

For a Project this size, the number of boreholes (2) is clearly insufficient to properly assess the quality of the rock. An investigation campaign will be required when Project goes forward.

- Costs were included to account for average 500mm thick concrete mud slabs where the Powerhouse and Spillway are to be concreted.

The mass excavation estimate also includes ~~A~~a provision for the procurement, installation and operation of a 150 people starter-camp to lodge first workers and staff on site.

Quantification basis for this work is captured in the following Engineering documents included in Appendix 1-2:

- CH0006 - Construction of Bulk Excavation Works and Associated Civil Works
- CH0007 – Intake and Powerhouse, Spillway and Transition Dams
- CH0008 – Construction of North Spur Stabilization Works
- CH0009 – Construction of North and South Dams

2.2.2.2 Construction Methodology & Timeline Factors

- General assumption is that rock quality is not a concern and Project is standard rock excavation project.
- All excavation activities estimated on a six days per week basis to allow for a buffer for bad weather conditions. A total duration of 200 workdays (end of July 2012 to mid-April 2013) is considered in the estimate for the mass excavation of the powerhouse and spillway
- Rock excavation to start when overburden excavation has exposed sufficient areas to allow drill and blast operations to start.
- Excavation crew :
  - Cat 992K loader
  - 5 Cat 775F off-road dump truck
  - Cat D8 at dump site
- No provision is included for the cost of spare stand-by equipment on site.

2.2.2.3 Price Factors

- Labour rates considered for this portion of the estimate is as provided by Nalcor.
- Equipment rates are a mix of *Equipment watch* rates with some specialized equipment having been adjusted to reflect actual rates of similar projects with comparable site conditions.

2.2.2.4 Performance Factors

- Haul and dump distance of 2,5km from site to stockpile
- Production drilling at 20m/hr per drill using ROC D7 drills
- Large diameter line drilling performed with three drills at a rate of 15m/hr (re: action itemS1-6).
- Rock excavation drilled and blasted on two work shifts on multiple faces at a daily average of 10000m3 (or 5000m3/shift) to meet the duration in schedule.
- Load and haul production estimated at 250m3/hr per crew and 2 crews are considered.
- Overburden mass excavation production rate = 150 m3/h
- Rock excavation – dry conditions production rate = 250 m3/h
- Drilling are estimated at a rate = 54 m/h
- Dynamite operations are estimated at a rate = 250 kg/h
- Excavated roc will be dump and stock piled at the north shore quarry.

2.2.3 Fill structures

2.2.3.1 Scope factors

The scope of work considered in the CCE was developed by the engineering group who provided bill of quantities to estimators. Quantities were validated by estimators through an independent take-off exercise which revealed minimal differences. The

quantities provided by the engineering group were used to develop the fill structures estimate and are as follow:

Powerhouse Downstream Cofferdam

- Compacted Till – Zone 1 : 12 900 m^3
- Compacted Granular – Zone 2C : 3 700 m^3
- Compacted Rockfill – Zone 3C : 12 400 m^3
- Riprap (produced by others) 4 Class 1 : 1 200 m^3

Spillway Upstream Cofferdam

- Compacted Till – Zone 1 : 8 000 m^3
- Compacted Granular – Zone 2C : 5 500 m^3
- Compacted Rockfill – Zone 3C : 43 000 m^3
- Riprap (produced by others) 4 Class 1 : 3 000 m^3

Spillway Downstream Cofferdam

- Compacted Till – Zone 1 : 5 700 m^3
- Compacted Granular – Zone 2C : 4 500 m^3
- Compacted Rockfill – Zone 3C : 33 660 m^3
- Riprap (produced by others) 4 Class 1 : 2 400 m^3

North Downstream Cofferdam

- Compacted Till – Zone 1 : 5 466 m^3
- Compacted Granular – Zone 2C : 2 489 m^3
- Compacted Rockfill – Zone 3C : 2 352 m^3

North Dam Upstream Rockfill Cofferdam

- Dumped Rockfill 0-900mm : 220 000 m^3

- Boulders 1000-1200mm : 20 000 m^3
- Boulders 1200-1500 : 25 000 m^3
- Dumped Granular or Crushed Rock max 300mm Zone 2E : 26 000 m^3
- Compacted Till - Zone 1 : 19 000 m^3
- Compacted Granular - Zone 2C : 14 000m^3
- Compacted Rockfill - Zone 3C (0-450mm) : 35 000m^3
- Compacted Rockfill - Zone 3D (0-900mm) : 38 000m^3
- Riprap (produced by others) 4 Class 1 : 3 200m^3
- Dumped Rockfill (access road) 0-900mm : 75 000 m^3
- Dumped Till : 159 000 m^3

South Rockfill Dam

- Compacted Till – Zone 1 : 22 118 m^3
- Compacted Filter – Zone 2 : 15 373 m^3
- Compacted Rockfill – Zone 3, 3B and 4 : 77 000 m^3

Quantification basis for this work is captured in the following Engineering documents included in Appendix 1-2:

- CH0009 – RCC Dams and River Cofferdams

2.2.3.2 Construction Methodology and Timeline Factors

- It is assumed that the main access road from the Trans-Labrador will be available for mobilization and commencement of the work in early summer 2012, that the contractor's pad will be ready, that the soil will be dry (overburden), that the borrow pits are suitable for the production of material.

- The productivity considered to perform the work was based on a 6 days/week, 10 h/shift, 2 shifts/day schedule. In the CCE, the paid 7th day is considered as a buffer day or make-up shift on which lost production on the previous 6 days can be recuperated.

The heavy equipment considered to develop the fill structures estimate are as follow:

Compacted Till zones heavy equipment:

- CAT 325B Backhoe
- CAT D8N Dozer
- CAT 345B Backhoe
- CAT D5 Dozer
- Vibratory compactor CAT 563
- 13 – 10 wheels dump truck

Compacted Granular zones heavy equipment:

- CAT 966F
- CAT D5G Dozer
- Vibratory Compactor CAT 563
- 6 – 10 wheels truck

Compacted rockfill zones heavy equipment

- CAT 992K
- CAT 365B Backhoe
- CAT D8N Dozer
- 4 CAT 775F Dump Truck
- CAT 325B Backhoe

Riprap zones heavy equipment:

- CAT 365B Backhoe
- 2 CAT 775F Dump Truck

Dumped Rockfill zones heavy equipment:

- CAT 992K
- CAT 365B Backhoe
- 2 CAT D8N Dozer
- 4 CAT 775F Dump Truck
- CAT 325B Backhoe

Boulders zones heavy equipment:

- CAT 992K
- 3 CAT 365B Backhoe
- CAT D8N Dozer
- 4 CAT 775F Dump truck

2.2.3.3 Price Factors

- Labour rates considered for this portion of the estimate is as provided by Nalcor.
- Equipment rates are a mix of *Equipment watch* rates with some specialized equipment having been adjusted to reflect actual rates of similar projects with comparable site conditions.

2.2.3.4 Performance Factors

- Load, haul and placing compacted till production rate = 170 m^3/h
- Load, haul and placing compacted granular production rate = 170 m^3/h
- Load, haul and placing compacted rockfill production rate = 250 m^3/h
- Load, haul and placing riprap production rate = 125 m^3/h

- Load, haul and placing dumped rockfill production rate = 250m^3/h
- Load, haul and placing boulders production rate = 200m^3/h
- Load, haul and placing dumped granular production rate = 170m^3/h

2.2.4 North Spur stabilization work

2.2.4.1 Scope Factors

The scope of work considered in the CCE was developed by the engineering group who provided bill of quantities to estimators. Quantities were validated by estimators through an independent take-off exercise which revealed minimal differences. The quantities provided by the engineering group were used to develop the North Spur Stabilization estimate and are as follow:

- Overburden Excavation: 368 242 m^3
- Overburden Excavation (2F Material): 228 638 m^3
- Till Blanket – Zone 1 North Shore deposit : 171 094 m^3
- Granular Material – Zone 2A: 123 462 m^3
- Granular Material – Zone 2C: 63 513 m^3
- Compacted Granular material – Zone 2F: 228 638 m^3
- Dumped Rockfill – Zone 3: 71 410 m^3
- Compacted Rockfill – Zone 3A: 14 222 m^3
- Compacted Rockfill – Zone 3A South Shore excavation: 14 222 m^3
- Compacted Rockfill – Zone 3B: 57 450 m^3
- Compacted Rockfill – Zone 3B South Shore excavation: 57 450 m^3
- Compacted Rockfill – Zone 3C: 58 115 m^3
- Compacted Rockfill – Zone 3C South Shore excavation: 116 231 m^3
- .Riprap – Zone 4 – North Shore quarry: 22 200 m^3

- Zone 5 Material crushed stone max 31.5mm(permanent road):8 000m^3
- Compacted Rockfill – Zone 3C South Shore excavation (permanent road): 16 000 m^3
- Geotextile: 20 000 m^2
- Geomembrane: 60 000 m^2
- Slurry Cut-Off wall: 41 150 m^2

Quantification basis for this work is captured in the following Engineering documents included in Appendix 1-2:

- CH0008 – North Spur Stabilization Works

2.2.4.2 Construction Methodology and Timeline Factors

Work on cofferdam to be performed before the 2014 flood. Approximately 200 000m3 , or 12% of the total excavated and filled material for the North Spur, borrowed rock will come from the south once the main upstream cofferdam is completed. The productivity considered to perform the work was based on a 6 days/week, 10 h/shift, 2 shifts/day schedule. In the CCE, the paid 7^{th} day is considered as a buffer day or make-up shift on which lost production on the previous 6 days can be recuperated.

2.2.4.3 Price Factors

- Labor rates considered for this portion of the estimate are as provided by Nalcor.
- Equipment rates are a mix of *Equipment watch* rates with some specialized equipment having been adjusted to reflect actual rates of similar projects with comparable site conditions.

2.2.4.4 Performance Factors

- Overburden excavation estimated production rate: 100 m^3/h
- Placing compacted materials estimated production rate: 100 m^3/h

- Placing dumped Rockfill materials estimated production rate: 150 m^3/h
- Geotextile and geomembrane installation rate: 250 m^2/h

2.2.5 Roller Compacted Structures

2.2.5.1 Scope

The scope of work considered in the CCE was developed by the engineering group who provided bill of quantities to estimators. Quantities were validated by estimators through an independent take-off exercise which revealed minimal differences. The quantities provided by the engineering group were used to develop the RCC structures estimate and are as follow:

Quantification basis for this work is captured in the following Engineering documents included in Appendix 1-2:

- CH0009 – RCC Dams and River Cofferdams

North Dam

- RCC volume: 188 750 m^3
- Total formwork area: 25 000 m2

Riverside Cofferdam

- RCC volume: 37 000 m^3
- Total formwork area: 6 600 m2

2.2.5.2 Construction Methodology and Timeline Factors

- RCC lift height = 300mm/lift
- RCC will be pour by conveyor

Main assumptions are that green cuts will be made when needed by the RCC crew during formwork preparation for the next lift but will be kept to a minimum by the use

of a low high paste low water demand (60% fly ash/40% cement) mix allowing for better maneuverability and a 16 to 20 hour setting time.

- Formwork will be fabricated on site by the formwork crew in sufficient quantities to allow continuous operations by jumping lower form panels.
- All formwork activities estimated on a 6 days/week, 10h/day basis.
- RCC activities estimated on a 7days/week, 20h/day basis.
- Foundations ready in 2014, RCC placement will begin in spring 2015

Formwork crews:

- 1 Foreman
- 3 Carpenters
- 3 Laborers
- 1 Welder
- RCC crew:
- 3 Heavy equipment operators
- 1 Backhoe operator
- 1 Dozer operator
- 6 Concrete laborers
- 1 Foreman
- 1 Concrete conveyor operator
- 10 Highway truck operator

RCC heavy equipment:

- CAT 315 DL Backhoe
- CAT D5 Dozer

- CAT D4 Dozer
- CAT 950H
- Vibratory compactor CAT cs 533E
- Boom truck with boom conveyor 100'
- 10 – 10 wheels dump truck
- 2 - twin shaft paddle batch mixer

North Dam

- Total duration of 90 workdays (3,5 months).
- A total of 60 upstream formwork panels will be needed.
- Upstream formwork panels will be used up to 8 times.
- A total of 155 downstream formwork panels will be needed.
- A total of 108 RCC lifts of 300mm high will be made.

Riverside Cofferdam

- Total duration of 52 workdays (2 months).
- A total of 54 formwork panels will be needed.
- Formwork panels will be used up to 7 times.
- A total of 56 RCC lifts of 300mm high will be made.

Price Factors

- Labor rates considered for this portion of the estimate is as provided by Nalcor.
- Equipment rates are a mix of *Equipment watch* rates with some specialized equipment having been adjusted to reflect actual rates of similar projects with comparable site conditions.

2.2.5.3 Performances Factors

- Formwork fabrication rate = 4 m2/h
- Formwork installation rate = 6.30 m2/h
- RCC average production/hauling/placing = 148 m3/h
- 2.5 km from concrete batch plant to RCC dam/cofferdam.

2.2.6 Structural Concrete Structures

Direct costs were determined by a “bottom-up” contractor-style estimate, starting with detailed quantity takeoffs for each structural concrete element. Takeoff quantities were reconciled with BOQ values prior to the Nov 15-18 estimate review meeting later adjusted according to agreed action items identified during review meeting. Crews and productions were assigned to each element of work, and resource requirements (e.g. form fabrication quantities) were also determined for each element of work. Crane layouts were sketched to determine required capacities and number of cranes (see Appendix 2-2).

Construction indirect costs related to the subject work scope are included in the estimate. Those costs were estimated up to a “Structure Level”, so no “Project Level” (e.g. camp, turnaround, right of way, higher level management) costs are included. In other words, the construction indirect costs included are sufficient to directly plan and supervise the work in the field only, including contractor’s quality control personnel, construction engineering, and surveying. The Construction indirect costs were estimated in four groups so as to be able to rationally distribute them to determine total costs for the main components of work estimated: Spillway; Intake; Powerhouse; and Transition Structures.

Construction Materials were estimated based on cost experience and research, unit rates were established for all construction materials required. In general, all construction material rates were determined by side estimate and input to the estimate by m, m2, or m3 as appropriate. Labour related small tools, supplies, and

safety equipment were input by the man-hour ($4.00) in the Construction indirect costs.

Included Items:

Supervision – Construction supervision and vehicles; quality control and assurance personnel; surveying; construction engineering. Established indirect wage rates are weighted to account for rotation of personnel.

Temporary Buildings – Office facilities; craft tool rooms/dry shacks; warehouses/shops; stair towers; winter protection enclosures (for Intakes and Powerhouse only). Scaffolding and walkways are included in the direct costs in the various formwork and falsework fabrication items.

Utilities – Power and water hook-ups; water pumping and transportation; sanitary facilities; phone and internet expenses (for site offices and indirect personnel only).

Support Equipment – Crew pickups/flatbeds; hydraulic cranes; boom trucks; labour related small tools, supplies, and safety equipment ($4.00 for every man-hour, including indirect man-hours).

Administration and Profit – 15% contractor mark-up on all costs, including indirect costs. No other adders for bond, liability insurances, home office overhead, etc. are included.

Excluded Items:

Labour Related – No turnaround or rotation transportation (airfare) costs are included in the structural cost estimate as these costs are captured as a Project Indirect Cost detailed in Volume I. No costs for employee training, safety indoctrinations, drug testing, bonuses, or other compensation outside the agreed wage rates are included as these are addressed in the Project Indirect costs. No costs for camp (room and

board) or other site services (other than construction office maintenance) are included.

Equipment, Construction Materials, Permanent Materials Related – No exclusions other than it was assumed access roads, equipment pads, yard areas, dewatering, snow removal, signs, barricades, etc. would be provided elsewhere in the estimate. No costs are included for any of these items, **other than** the costs included in the Construction indirect costs for surface water and snow control inside the structure footprints (only).

Contractor Overheads – Other than the 15% contractor mark-up on all costs (included in the Construction indirect costs), there are no other overhead or profit allowances. Separate allowances for items such as Bond, General Liability Insurance, Builders Risk Insurance, Home Office Overhead, etc. are not included.

Subcontractor Mark-ups – The assumption is that all the work is to be self-performed; hence any additional mark-ups due to subcontracted work are not included. If, for example, the contractor elects to subcontract the furnishing and placement of reinforcing steel on the project, a substantial mark-up would be required by the subcontractor (on approximately $100M worth of work).

2.2.6.1 Scope

Structural concrete estimate includes the direct and indirect costs for the following structural concrete elements of the project:

- Powerhouse Concrete Cofferdam
- Spillway Concrete Structure
- Spillway Centre Pier for temporary construction bridge
- Intake Concrete Structure
- Powerhouse Substructure

- North Transition Structure
- Centre Transition Structure
- South Transition Structure (estimated as part of the Powerhouse)

Structural concrete estimate includes costs for furnishing, forming, placing, finishing, and curing the structural concrete for the above listed elements. It includes installation of all scaffolding and shoring for concrete as well as furnishing and installing reinforcing steel and waterstops for those elements. It also includes installation only of primary anchors only for gate, stoplog, and trashrack assemblies as well as supply and install of miscellaneous embedded metals.

The structural concrete estimate does not include any other structural concrete elements (e.g. RCC dam facing, temporary structures other than the Spillway Centre Pier), structural steel, or grouting. It does not include embedded guides for gate, stoplog, and trashrack assemblies.

The quantities considered were provided to estimating by engineering and are derived from the CATIA model developed for the Project. An independent take-off by estimating revealed no significant differences with quantities provided by engineering.

Quantification basis for this work is captured in Engineering document entitled: *CH0007 – Intake and Powerhouse, Spillway and Transition Dams*, included in Appendix 1-2

2.2.6.2 Construction Methodology & Timeline Factors

General considerations and recommendations pertaining to the Schedule:

In the CCE, the basic assumption is that the Intake-Powerhouse-Draft tube structures are to be constructed concurrently along with the Spillway and transition structures all in accordance to the master Project schedule provided to the estimating team. In effect, the sequencing of the work and the volumes of the components to be poured dictate the required monthly production rates.

However, following the above mentioned assumption, the monthly placement volumes obtained using the resulting production rates are quite high. In effect, 16 months are required to pour 284 000m3 which represent two thirds of the structural concrete for all the structures resulting in an average of 17 775m3 per month or roughly 585m3 per day every day. Furthermore, in order to achieve this production, it is estimated that the necessary work schedule involves working 2 shifts, 7 days a week. **In these conditions there is no float or margin to account for any unexpected events.**

Sustaining such a high level of production for such an extended period of time will be quite challenging if not overly optimistic. As the critical path of the Project is generally through the centerline of the turbine/generator units, SLI's recommendation to alleviate the scheduling pressure on the structural concrete operations would be to remove from the critical path a portion of the concrete to be poured. This could be achieved by adding a construction joint upstream and downstream of the center portion of the Powerhouse, where the units are housed and pouring the Intake and Draft tube later.

Another way to reduce the required monthly pouring rate would be to extend the schedule to better spread over time the required volumes of concrete to be poured.

In any case, SLI has been instructed by Nalcor, in a meeting held on Friday November 18, 2011 to maintain as they are the current assumptions carried in the CCE.

Cold Weather Concreting – costs are included for heating concrete during winter months (generally ½ of each year) as well as a provision for a temporary building enclosure for the Intakes and Powerhouse only at a cost of $1320/m2 (plus heating and lighting costs) for a "substantial" building that would be insulated and structurally capable of supporting gantry cranes for work inside.

Remote Site –long truck hauls were considered necessary for mob/demob as well as the furnishing of all permanent and temporary materials and supplies.

Labour – Labour crafts were assigned by type of work as follow:

- Carpenters for formwork
- Labourers for concrete placing
- Operators for equipment
- Teamsters for trucking
- Cement masons for concrete finishing.

Crew sizes and makeups were established based on the elements of work.

Equipment – Equipment is included in each crew. Cranes, forklifts, generators, compressors, welding machines, concrete pumps, manlifts, etc. are all included in the direct cost of each element of the work. Only pickups and limited support equipment such as hydraulic cranes and boom trucks are included in the construction indirect costs.

Concrete Placing – The cost of the work was estimated under the assumption that all concrete would be pumped, and the average pump boom size would be 52m. There is a good chance that a contractor would place at least some of the concrete by other means, but an overall unit placing cost derived from pumping all concrete with a 52m pump adequately meets the required precision of this estimate.

Mob & Demob – Included in the estimate is the employee travel time (not including bus and driver costs) to/from site one-way from camp (1/2 hour on top of each 10 hour shift); equipment transportation and setup/down; site facilities setup/down.

2.2.6.3 Price Factors

All direct costs, including labour, equipment, construction materials, and permanent materials are included. All work was assumed to be self-performed; no

subcontractor costs are included (with the exception of provisions for mob/demob trucking). The potential (likely) added project cost due to mark-ups on subcontracted work could be significant but is not included in the structural concrete estimate.

- Labour rates are agreed “all-in” rates for each craft based on 10 hours a day 7 days a week.
- Equipment rates are agreed “all-in” rates for each equipment resource as stated in Volume I.

Permanent Materials – Unit rates considered are as follows:

- Supply only of Concrete (all) $235/m3
- Waterstop (all) $15/m
- Liquid Expansion Joint Filler $11/m2
- Rebar (all, black) $2.00/kg
- Concrete material unit cost does not include transportation costs from the batch plant, which was estimated separately and included in the various items of work at a rate of 8m3 per hour per truck and driver.

2.2.6.4 Performance Factors

Labour Productivity was factored to take into account remoteness, climate, and pace of work, large crew sizes, multiple shifts, and long work weeks resulting in labour not being as productive as it could be otherwise. Quantifying reduced productivity is subjective, but 60% to 80% of what could be expected under more favourable conditions is a reasonable estimate of what was assumed for hourly labour productivity. More favourable conditions would be: closer to metropolitan area; not as adverse climate conditions; 40 hours per week; single shift; smaller crew size; slower build-up to maximum crew size.

However, prior to CCE close-out, SLI has conducted a further review of the structural concrete component of the Project with respect to, amongst others, the aggressiveness of the concreting schedule, as described in the Construction

Methodology & Timeline Factors section above. As a result of this review and not withstanding Nalcor's directive to maintain unchanged the initial estimate assumptions, SLI has elected to carry in the CCE and additional 200 000 labour hours to cover for the inherent loss of labour productivity that will result from the congestion of the concreting work areas and the strain on the supply chain of materials to the worksite..

2.2.7 Powerhouse and Spillway Heavy mechanical systems

2.2.7.1 Scope factors

The Powerhouse Heavy Mechanical and the Spillway Heavy Mechanical systems have been divided into two packages due to schedule requirements and the need for the spillway to be operational for river diversion two years before the powerhouse is complete.

The scope of work for the Powerhouse Heavy Mechanical includes the following:

- Twelve intake vertical emergency closure head gates, including embedded guides and wire rope hoists, for reach water passage;
- One set of five bulkhead gate s section for one water passage, including twelve sets of embedded guides, for each water passage, and one lifting beam designed to install and remove the bulkhead gates with a mobile crane;
- Twelve sets of trashracks, including embedded guides, for each water passage;
- Four sets of draft tube stoplogs, two sets per unit, with eight sets of embedded guides, for each water passage;
- One draft tube stoplog handling overhead crane.

The scope of work for the Spillway Heavy Mechanical includes the following:

- five spillway vertical gates, including three vertical surface gates, and two low level outlet gates;

- two set of temporary upstream stoplogs needed for construction which will be modified to one set of permanent upstream stoplogs;
- two sets of temporary downstream stoplogs needed for construction;
- three hoist houses with two wire rope hoists, steel towers and two stairs for the vertical surface gates;
- two hoist houses with two wire rope hoists for the low level outlet gates;
- one monorail hoist for handling the permanent stoplogs;
- eighteen set of vertical embedded guides for the gates and stoplogs.

Quantification basis for this work is captured in the following Engineering documents, included in Appendix 1-2:

- CH0032 – Powerhouse Hydromechanicals
- CH0046 – Spillway Hydromechanicals

2.2.7.2 Construction methodology and timeline factors

The installation crew for the Powerhouse Heavy Mechanical is estimated at 13 total staff working 10 hour days on a 20/8 rotation for 36 months. The installation crew for the Spillway Mechanical is estimated at 10 total staff working 10 hour days on a 20/8 rotation for 28 months.

The Schedule was discussed with the two fabricators who supplied budget prices, and both agreed lead times were acceptable for fabrication and installation

2.2.7.3 Price Factors

Direct costs include the design, supply, transportation, installation and commissioning of the above listed packages.

For the direct cost estimate, preliminary design was completed to determine weights of all components, and the costs were estimated from other comparable

hydroelectric projects on a cost per kilogram basis. The estimate weights of all mechanical components for the Powerhouse Heavy Mechanical equipment is 7,726 tonnes, and for the Spillway Mechanical equipment is 2,843 tonnes.

Preliminary drawing and a summary specification were produced, and these were provided to three fabricators who were chosen as they had in house design capabilities and these companies were considered experienced in gate design and fabrication, and have participated in similar installations in remote sites similar to Labrador.

Budget prices were received from two of the three fabricators, and these prices were considered as acceptable as they were within 12% on the total price, so the higher of the two prices were used in the Gate 3 Estimate. On a price per kilogram basis, the budget prices were considered reasonable.

Indirect costs were not included in the estimate, but one fabricator provided a man-hour estimate for the installation from which the SLI estimators produced indirect costs for these two packages.

The project should realize a saving if both of these packages are awarded to one contractor, but these two packages cannot be awarded simultaneously as the start times for each project are offset by six to nine months depending on how the packages are finally assembled. The start times will be finalized if the Draft Tube Stoplogs and embedded steel is included in the Powerhouse Heavy Mechanical or the Spillway Mechanical packages, and will depend on the final construction sequence for the powerhouse civil contract.

2.2.8 Powerhouse Intake Trash Cleaning System

2.2.8.1 Scope factors

The Powerhouse Intake Trash Cleaning System was provided in the Gate 3 Estimate, but the requirement for this system is not yet finalized.

The scope of work for the Powerhouse Intake Trash Cleaning System includes the one purpose built trash cleaning system:

- capable of cleaning floating debris in front of the intake;
- capable of cleaning the trashracks; and capable of cleaning debris from the rock; and
- capable of cleaning sediment trap in from of the intake trashracks.

The only system available that has the above three capabilities is a purpose built trash cleaner built in Germany by Muhr and distributed in North America by Lakeside Industries.

Quantification basis for this work is captured in the Engineering document entitled: *CH0047 – Design, Supply and Installation of Trash Cleaning System*, included in Appendix 1-2

2.2.8.2 Construction methodology and timeline factors

Installation of this contract would take about six weeks for 8 workers working 10 hour days on a 20/8 rotation, and indirect costs such as accommodation and site transport were included in the direct costs.

2.2.8.3 Price Factors

Prices from Muhr were provided for design, fabrication, transportation, installation, and commissioning of the Trash Cleaning System.

Costs for the supply and installation of the rails on the intake deck were included in the Powerhouse General Civil Contract.

2.2.9 Powerhouse Bridge Cranes

2.2.9.1 Scope factors

The Powerhouse bridge cranes are required for installation and maintenance of the generating units. The arrangement used is two bridge cranes rated at 380 tonnes with two trolleys on each rated at 190 tonnes. Each of the cranes will be supplied with a lift beam to lift 360 tonnes; and another lift beam to connect both cranes to lift

680 tonnes which is estimated to be the largest single piece for assembly of the generating units.

Cranes weights received from one of the three suppliers was estimated at 212 tonnes each, or 472 tonnes for both cranes with lifting beams.

Quantification basis for this work is captured in the Engineering document entitled: *CH0033 – Supply and Install Powerhouse Cranes*, included in Appendix 1-2

2.2.9.2 Construction methodology and timeline factors

Installation of this contract would take about three weeks with 10 workers working 10 hour days on a 20/8 rotation, and indirect costs such as accommodation and site transport were included in the direct costs.

2.2.9.3 Price factors

Prices were received from three crane suppliers for supply, transport, and installation of the cranes including start up, commissioning and load testing. Prices received are within 15% and considered consistent with industry prices for this equipment.

Costs for the supply and installation of the rails on the powerhouse superstructure steel were included in the Powerhouse General Civil Contract.

2.2.10 Powerhouse Elevator

2.2.10.1 Scope factors

The powerhouse elevator is a passenger/freight elevator designed for access at seven landings from the drainage sump at EL.-20.2 m up to the Intake deck at El.45.5 m.

Quantification basis for this work is captured in the Engineering document entitled: *CH0034 – Supply and Installation of Powerhouse Elevator*, included in Appendix 1-2

2.2.10.2 Construction methodology and timeline factors

Installation of this contract would take about 20 weeks with two workers working 10 hour days on a 20/8 rotation, and indirect costs such as accommodation and site transport were included in the direct costs.

2.2.10.3 Price factors

Budget prices were received from two suppliers, but only one elevator system complied with the specified requirements for the size of the cab and doorway. although higher priced it was carried in the CCE.

Costs for the concrete structure were included in the Powerhouse General Civil Contract.

2.2.11 Steel Superstructure and Architecture

2.2.11.1 Scope

The scope includes Construction of Steel Structure for Powerhouse Superstructure, 46.965 m width, 198.840 m length and 27.80 m height (from +15.50 m to + 43.30 m). It also includes construction of two mezzanine floors at +25.00 and +34.47 m level, made of concrete floor over metal decking. Structural Steel for roof over mezzanine floors and catwalk access is also included as well as the steel columns and beams required to carry the loads of the two heavy overhead cranes in the Powerhouse. The scope also includes Metal access Doors, Ladders, Handrails, Guard Rails, Removable Handrails and Crane rails at Intake Deck.

Extension of the powerhouse structure by 2 bays for construction purpose is considered as an optional item (Option 1) and has been estimated separately as standalone case and is not included in the CCE.

Use the 2 units of steel superstructure as winter protection shelter is considered as an optional item (Option 2) and estimated separately as standalone case.

In-House pricing was used to estimate the majority of Architectural items and benchmarked with other projects using similar architectural systems as well as

specialized supplier input. For very few of these items, information from Richardson Cost Data was used. Wherever no information was available, a lump sum provisional amount was provided. The final architectural cost included in the CCE was adjusted to reflect architectural costs encountered in similar projects in comparable conditions.

- Quantities are based on 40% engineering progress, as of 24 November, 2011. Any changes resulting from development thereafter are excluded.
- Bill of quantities were issued by engineering on a basis of heavy, medium and light profiles for an approximate total of 3 200 tonnes.
- Quantities include connection allowance of 10% and quantity growth allowance of 10%.
- All structural steel is generally painted, except specified otherwise.
- Concrete for mezzanine floor is included in concrete works for powerhouse.
- All miscellaneous embedded steel is included in concrete works for powerhouse.
- No additional allowance needs to be added.
- Any changes resulting from development thereafter like addition of roofs over mezzanine floors are excluded.
- Costs and labour productivity included in the CCE have also been benchmarked with similar projects in comparable conditions.

Miscellaneous exterior steel guardrails (WBS30002100)

The scope includes guardrails along the south RCC dams, the intake, the center dam, the permanent access road and the tailrace deck.

- Foundation of the Guardrails is included in Civil / Concrete works of Powerhouse and is assumed to consist only of drilled holes for expansion anchors.

- Quantities are neat and do not include any kind of allowance what so ever.

2.2.11.2 Quantification basis for this work is captured in Engineering document entitled: *CH0007 – Intake and Powerhouse, Spillway and Transition Dams*, included in Appendix 1-2Construction Methodology & Timeline Factors

Construction will be carried out by multiple sub-contractors to the prime EPCM which will be chosen to perform the work under a competitive bidding process.

Sub-contractor will be given responsibility for the supply, construct, manage, perform and deliver the following on site construction activities in general:

- Craft Labour, Discipline foremen and for all construction / installation activities;
- Construction Equipment for all construction / installation activities;
- Permanent materials and associated bulks;
- Small tools, consumables and supplies;
- Scaffolding;
- Construction supervision and management;
- Temporary facilities & offices and expenses;
- Personnel transportation;
- Mob / Demob of Personnel, Equipment and all facilities
- Construction Equipment requirements have been identified on an as needed basis for individual crews;
- An average of $8.00 per Direct Labour Hour has been considered. On average the following breakdown applies;
    - Small Tools 4 – 5 % of DFL Cost.
    - Consumables 3 – 4 % of DFL Cost.
    - PPE 2 – 3 % of DFL Cost.

Any kind of pre-assembly / dry assembly at site is not envisaged. All structural steel components are stick built for erection purpose. Roof truss is assembled at shop and delivered in two parts.

Duration based on schedule PCS – Oct 6.pdf supplied by the Project Controls group.

2.2.11.3 Price Factors

Budgetary Offers from fabricators were invited for supply, fabricate (including shop drawing), paint and delivery at site of structural steel components. Offers were received from OCEAN STEEL of New Brunswick, SUPER METAL of Quebec and DAERONG of South Korea. Detailed bid evaluation was not carried out and it is assumed the bids are within the acceptable limits of exclusions. An average price of all three bids is considered for present estimation.

- All direct labour hours for Civil / Concrete / Steel are based on readily available USGC (United States Gulf Coast) charts and/or SLI historical data.
- Construction Equipment rates are based on blue book hourly rates provided with the *Estimate Ground Rules*– September 12th 2011; and is inclusive of Fuel, Lubricants and Periodic routine maintenance but excludes operating personnel.

2.2.11.4 Performance Factors

- All direct labour hours based on readily available published charts and/or SLI historical data.
- All base hours based on USGC.
- A site-specific adjustment factor 1.25 for Structural Steel by prime account was applied to the chart hours.
- Factors that were considered for site conditioning include; Work week, Project Size, Plant Type, Work Space per Man, & Climate.
- Factors not considered for site conditioning include; Craft Availability, Craft Skill, Quality of Craft Supervision, & Union Influence.

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2.2.12 Power Generation

A complete bid package has been issued to Alstom, Andritz and Voith on October 14, 2011 with expected return date of quotation of January 27, 2012. The scope of the work includes the supply, installation testing and commissioning of four (4) 206 MW Kaplan units including the following for each unit:

- Turbine
- 229 MVA Generator
- Governor
- Static excitation system

As the actual quoted cost was not available at the time of the CCE, a provision based on similar projects in comparable conditions was included. It is assumed in the CCE that the Power Generation Contract is scheduled to be awarded in early spring of 2012.

Quantification basis for this work is captured in Engineering document entitled: *CH0030 – Design, Supply and Installation of Turbines and Generators*, included in Appendix 1-2

2.2.13 Auxiliary Mechanical Works

2.2.13.1 Scope

The Mechanical Equipment Bill of Quantities received from project engineering is the basis for the scope of the Mechanical Equipment estimate and cover the following Powerhouse systems:

- Raw and cooling water system
- Fire protection system
- Service water system

- Shaft seal water system
- Dewatering system
- Drainage system
- Oily water drainage system
- Domestic water and Wastewater systems exclusive of appliances carried in architecture estimate
- High and low pressure compressed air systems
- Lubricating and hydraulic oil handling system
- Piezometer and water level system
- Powerhouse HVAC as well air fans in inspection gallery of main RCC dam
- Instrumentation and related piping systems
- Miscellaneous small hoist and handling systems
- Machine shop equipment

Mechanical Engineering Group also added a number of control panels required into BOQ to facilitate the electrical needs for the mechanical equipment material and labour cost calculation.

- Individual datasheets with applicable Codes and NALCOR standards to solicit the Vendor Bids for individual equipment were not received.
- Portable pumps assumed to be un-crated and stored in warehouse. No additional hours for permanent installation.
- Pre-commissioning spares have not been considered.
- Cost of Vendor Representatives has been excluded.
- No Material Take off Allowance was added.

- No Design Development Allowance was added.

HVAC:

HVAC BOQ received from project engineering department is the basis of mechanical HVAC account. Mechanical Engineering Group also added number of control panels required into BOQ to facilitate the electrical needs for the mechanical equipment material and labour cost calculation.

- Individual datasheets with applicable Codes and NALCOR standards to solicit the Vendor Bids for individual equipment were not received.
- Take off is measured through fittings.
- HVAC duct estimated by hrs per lb. Assumed fitting mix is 20 – 30% of weight.
- 20% waste included in weight.
- Pre-commissioning spares have not been considered.
- Cost of Vendor Representatives has been excluded.
- No Material Take off Allowance was added.
- No Design Development Allowance was added.

Piping:

- The BOQ has been verified by engineering against the P&ID's.
- BOQ includes all large bore, small bore piping and valves.
- Assumed local fabrication of piping spools.
- Pipe Insulation requirements were indicated on the insulation specifications.
- Pipe Paint requirements were indicated on the painting specifications.
- The piping layout is based on the 3D model.

- High point vents and low point drains captured on BOQ were developed by estimating, one vent or drain for every 150 LM of large bore piping.
- Assumed 5 - 10% of welds require NDE testing.
- Assumed 30% of welds on site and 70% shop welds where shop rates were estimated through contacting east coast suppliers
- Additional man-hours included for hydro testing and air blowing.
- Additional hours for material handling (prorated on LM of pipe).
- No Material Take Off allowance was added.
- No Design Development allowance was added.
- An allowance for Standard Pipe supports has been included. This includes man-hours as well as material cost.
- All BOQ quantities are “neat”
- No allowances were considered by engineering.

Instrumentation:

Instrumentation cable & bulks for the Auxiliary Mechanical Package were defined by estimation. An allowance including man-hours and material cost has been included in the estimate.

- Instrumentation items for the Auxiliary Mechanical Package have been defined by SNC engineering. No additional instrumentation items have been added by estimating.

Insulation:

- Piping systems requiring insulation have been identified in the project Insulation specifications.
- Insulation quantities have been calculated based on pipe and fitting length using the Denis formula.

Electrical:

- Electrical bulks for the Auxiliary Mechanical Package were defined by estimation.
- Electrical control panels for the Auxiliary Mechanical Package have been defined by SNC engineering. Control Panel assumed to have 50 LM Control Cable, 50 LM Power Cable, 25 LM Conduit & 12.5 LM of Tray.
- An allowance for cable, conduit, & tray for the Auxiliary Mechanical Package has been included. This includes man-hours as well as material cost.

Paint:

- Piping systems requiring painting have been identified in the project paint specifications provided by engineering.
- An allowance for paint material and labour has been included based upon system requirements as well as field touch-ups after welding

Also, the Mechanical Equipment Bill of Quantities received from project engineering is the basis for the scope of the Mechanical Equipment estimate and cover the following North Spur systems:

- Refurbish existing pump wells including pump removal, inspection, cleaning and reconnection.

Quantification basis for this work is captured in Engineering document entitled: *CH0031 – Supply and Installation of Mechanical Auxiliaries*, included in Appendix 1-2

2.2.13.2 Construction Methodology & Timeline Factors

As a result of mechanical construction sequence prior and after installation of Power generation units, the estimate considers a 6 month period where little or no mechanical work is performed which extends the duration for which the temporary contractor installations would be required. For the calculation of the construction indirect costs it was assumed that two packages would be included in one contract.

Mechanical work was assumed to be performed using shared supervision of multiple crews as well as shared service and access equipment.

2.2.13.3 Price Factors

Detailed Technical bid evaluation (TBE) was not carried out for budget quotes; it is assumed the bids were within the acceptable limits of exclusions.

- All Items were sent for budget pricing through the SNC Procurement group.
- Mechanical and Piping packages were sent to multiple Vendors. When vendor response was limited In house pricing was used to estimate the remaining items.
- Those items that did not receive a budget quote were priced in house using data from similar major projects from the last eighteen months.
- Supply of piping and fittings, valves, accessories have been quoted by vendor or in house priced
- Shop Fabrication of spools pricing is based on multiple offers from East Coast Fabricators.
- HVAC equipment has been quoted by vendor or in house.
- Major Equipment has been quoted by vendor or in house.
- Electrical equipment for power and control of Aux Mechanical package was priced in house.
- Instrument cable for Aux Mechanical package was priced in house.
- Instrument hardware for Aux Mechanical package was vendor quoted.
- Insulation material has been quoted in house.
- An allowance for Standard Pipe supports has been included. This includes man-hours as well as material cost.

Budget quotes were obtained from suppliers for (or part of) the following systems:

- Mechanical system and equipment
- Piping bulks.
- Fire protection items.
- Sand filter.
- Mobile oil purifying unit.
- Oil storage tank
- Oil Water Separator
- Fans, diffusers, coils
- Shop Fabrication

Freight

In-house prices were carried for:

- Construction materials, mechanical equipment, electrical equipment and instruments not mentioned above and for which, generally, an 8% allowance was carried for freight.

2.2.13.4 Performance Factors

Labour productivity assumptions are as follow:

- All direct labour hours are based on readily available USGC (United States Gulf Coast) charts and/or SLI historical data.
- The following productivity factors were added to the chart to account for the location of the Project:
    - 1.13 for Mechanical and HVAC systems man hours.
    - 1.55 for Piping / Insulation systems man hours.

- A 6% allowance was added to direct labour costs to account for congestion of the worksite

2.2.14 Auxiliary Electrical Works

2.2.14.1 Scope

The Auxiliary Electrical work estimate includes the direct and construction indirect costs for the following elements of the project:

- Spillway Electrical Works
- North Spur pumping system upgrade Electrical Works
- RCC inspection gallery Electrical Works
- Building Electrical Services
- Electrical Ancillary / Auxiliary Systems
- Powerhouse Grounding Works
- Protection, Control and Monitoring
- Generator Transformers (4 working and 1 standby)
- Emergency Diesel generator
- Spare Parts and Special Tools
- Operations Telecommunication System - Muskrat Fall

All material take-off quantities were developed based on the single-line-diagram and drawings prepared by engineering. Cable lengths were estimated by evaluating horizontal and vertical runs throughout the Powerhouse along with the cable tray layout drawings.

Quantities are neat from engineering and no quantity allowance is considered at this stage of estimate.

This applies to the following WBS BOQ's:

- Powerhouse Station AC/DC Electrical Auxiliaries
- Generator Step-up (GSU) Transformers
- Generator Circuit Breakers
- Station Auxiliary Service Transformers
- Isolated Phase Bus
- MF Power Station BOQ Telecom, CCTV, PA, SACS, TELEPHONY
- MF Spillway BOQ Telecom, CCTV, PA, SACS, TELEPHONY

For the HV Power Transformers elements of the Electrical Works, an estimate validation check for Labour hours was performed using the Aspen Capital Cost Estimator estimating software.

Quantification basis of this work is captured in the following Engineering documents grouped in a single document, included in Appendix 1-2:

- CH0031 – Supply and Installation of (Mechanical and) Electrical Auxiliaries
- PH0014 – Generator Step-Up Transformers
- PH0015 – Isolated Phase Bus
- PH0016 – Generators Circuit Breakers
- PH0035 – Station auxiliary Service Transformers

2.2.14.2 Construction Methodology & Timeline Factors

No heavy lifting equipment has been considered as it is assumed all heavy permanent equipment such as the generator transformers are directly off loaded onto foundation by others.

As the duration of the Electrical Works for the Powerhouse and area considered in the CCE extends from mid 2014 to 2016, the construction indirect costs are calculated accordingly. The contracting packaging strategy to be developed with

respect to Electrical Works could alleviate these costs be optimizing and possibly decreasing the overall duration of the electrical contractors need to be on site.

Scaffolding and accesses

- A provision of 5 % of total direct Labour hours for Scaffolding labour and 3 % of total direct Labour cost for scaffolding materials cost are included in the estimate.

Construction equipment

- Diesel Generators are used to provide requisite electrical supply to construction works
- Lifting and carrying equipment like forklifts, small cranes, pickup trucks, welding machines, etc are estimated to be mobilized for the construction duration as required

Congestion of work site

- A small percentage of 4-5% idle time is assumed to account for site congestion
- Its assumed the work front from other disciplines will be available as per schedule

2.2.14.3 Price Factors

- Majority of Items were sent for budget pricing through the project Procurement group.
- For some of the high value items average costs of two higher quotes are considered.
- Those items that did not receive a budget quote were priced in house using data from similar major projects from the last eighteen months.

- DC portion of cost will be provided by engineering discipline as a Sub Contract all inclusive cost.
- Telecommunication portion of cost will be provided by engineering discipline as a Sub Contract all inclusive cost.
- For the accessories which were not quantified by engineering an allowance was used.

Freight

In-house prices were carried for:

- Construction materials.
- Mechanical equipment, electrical equipment and instruments.

Generally an 8% allowance was carried for freight.

2.2.14.4 Performance Factors

Labour productivity assumptions are as follow:

- All direct labour hours are based on readily available USGC (United States Gulf Coast) charts and/or SLI historical data.
- A productivity factor of 1.44 over Richardson was added to the chart to account for the location of the Project
- A 6% allowance was added to direct labour costs to account for congestion of the worksite

2.2.15 Log Booms and Safety Buoys

The lump sum amount is included in the CCE to cover the cost for the design, supply and installation 3 sets of Log Booms located upstream of the Powerhouse in the North Spur area and directly upstream of the Powerhouse Intake and approximately 4.5km downstream of the Powerhouse along with approximately 1km of access road to access this third log boom.

Also included is the design, supply and installation of a Safety Booms with safety buoys located directly downstream of the Powerhouse.

Quantification Basis for this work is included in Engineering document entitled: CH0049 – Supply and Install Log Booms, included in Appendix 1-2.

3 VOLUME III - COMPONENT 3 DETAILED BASIS OF ESTIMATE

3.1 INTRODUCTION

As described in Volume I, the Project's Component 3 includes the facilities, installations and equipments relative to the Churchill Falls, Muskrat Falls and Soldier's Pond Switchyards, the Muskrat Falls Tap, the Muskrat Falls and Soldier's Pond AC/DC Converters, the SOBI Transition Compounds and Pond Electrodes, the Soldier's Pond Synchronous Condenser and the Telecommunication System.

These facilities are captured as follow in the Nalcor breakdown of phase 1, which is also detailed in section 1 of this document:

Project 4 - Labrador Island Transmission Link (LITL)

Switchyard at Soldiers Pond.

Muskrat Falls and Soldiers Pond HVdc converter stations:

Shoreline pond electrode located on the Labrador side of the Strait of Belle Isle.

Shoreline pond electrode located on the east shore of Conception Bay.

HVdc Transition Compounds for the Strait of Belle Isle submarine cable terminations:

New synchronous condenser at Soldiers Pond
Operations Telecommunication system.

Project 6 Labrador Transmission Asset (LTA)

Churchill Falls switchyard extension;

Muskrat Falls switchyard;

3.1.1 ~~Contract~~ Commitment packages

The CCE was performed based on the work breakdown structure (WBS) of the Project. These work items were later structured into ~~Contract~~ Commitment packages

that capture the same scope of work in a fashion that allow for bid packages to be issued to potential bidders and Contracts to be awarded executed and managed up to and following procurement or construction completion. Package numbers give an indication of the nature of the contract: “C” packages are Construction Packages, “P” packages are Purchase Orders and “S” packages are Service ~~Contract~~ Commitment Packages. The following list is the ~~Contract~~ Commitment packages structure was developed for Component 3:

CD0501 Supply and Install Converters and Cable Transition Compounds

CD0502 Construction of AC Substations and Synchronous Condensers Facilities

CD0503 Construction of Earthworks at Various Power Distribution Sites

CD0508 Supply and Install of Electrode Sites

CD0509 Construction Telecommunication Services - Phase 2

CD0510 Supply and Install Permanent Communication Systems

CD0512 Construction of Construction Power Facilities

CD0534 Supply and Install Soldiers Pond Synchronous Condensers

CD0535 Construction Telecommunication Services - Phase 2 Remote Camps

CD0538 Supply and Install Accommodations Camp (CF)

CD0564 Construction of Land Mobile Radio System - Labrador

PD0505 Supply of Switchyard Equipment, AC Substations at CF, MF and SP

PD0513 Supply of 138/25 kV Transformers

PD0514 Supply of 138 kV & 25 kV Circuit Breakers

PD0515 Supply of 230 kV, 138 kV & 25 kV Disconnect Switches

PD0518 Supply of 138 kV Capacitor Voltage Transformers

PD0519 Supply of 25 kV Vacuum Interrupters

PD0520 Supply of 25 kV 6 x 3.6 MVAR Capacitor Banks

PD0522 Supply of Pre-fabricated Control Room Building

PD0523 Supply of Substation Service Transformer

PD0529 Supply of 25 kV Reclosers~~, MV Switches & Fuse Cut-outs~~

PD0530 Supply of 138 kV & 25 kV Surge Arrestors

PD0531 Supply of MV Instrument Transformer

PD0533 Supply and Install Early Works Telecom Devices

PD0537 Supply of Power Transformers, AC Substations at CF, MF and SP

PD0561 Supply of D20 RTU and Cabinet (CF) - Construction Power

PD0562 Supply of Specific Relays and Test Switches (CF) - Construction Power

PD0563 Supply of 138 kV Circuit Switcher (CF) - MV Switches & Fuse Cut-outs - Construction Power

SD0536 Provision of Integrated Commissioning Support Services

SD0560 Provision of Early Works Construction Telecommunication Services (MF)

~~SD0565 Provision of Land Mobile Radio System - Newfoundland~~

3.1.2 Master Equipment list

All the major permanent mechanical and electrical equipment that are to be included in Component ~~1~~ 3 have been compiled into a Master Equipment List. This list presents equipment that is ultimately to be individual tagged and incorporated into the Owner's asset management database. As an estimating tool, this list also ensures that the cost of all the required equipment has been captured. The master equipment list for Component 1 is included in this report as Appendix 3-1.

The following sections describe the basic assumptions considered as well as the means and methods utilized to develop the relevant cost estimates included in the CCE.

3.2 BASIS OF ESTIMATE – DIRECT COSTS

The following general assumptions were considered for estimating the AC and DC above mentioned work items of Component 3.

For each of the sites, engineering was developed to provide sufficiently detailed material take off quantities for the CCE. Approximately 130 drawings were issued including site layouts and line diagrams.

Approximately 25 short-term specifications were issued by Engineering and provided to the Procurement team for the purpose of costing of the major equipments.

3.2.1 Scope Factors

The scope of work includes, for each of the sites, all clearing and grubbing, cut & fill for site grading, fencing, slope protection, access roads, cable trenches and duct banks, concrete foundations, galvanized steel gantries and supports, pre engineered buildings, Supply and Installation of all electrical equipment, auxiliary building mechanical works as well as mechanical handling equipment and operation and maintenance shops where required.

- Quantities are based on 40% engineering progress, as of 5 December, 2011.
- Quantities are neat and do not include any kind of allowance what so ever.
- The preliminary civil/structural design is based on the National Building Code of Canada.
- In the absence of geotechnical information, shallow footing with allowable soil bearing capacity of 150 kPa and a frost depth of 2.40 meters is considered for all the foundations.
- Site grading design is based on balanced cut and fill with site specific assumptions for overburden / rock ratios
- Piling for foundations not envisaged.
- Civil works related to Cathodic Protection are excluded.

- Requirement of fire protection of the power transformers at the Churchill Falls and Muskrat Falls Tap have been excluded following consultation with Nalcor.
- For miscellaneous works where quantities were not available estimating has assumed a quantity

3.2.1.1 Civil Works

All the site locations are considered as green field locations and any kind of demolitions are not envisaged with the exception of the existing Churchill Falls 230/138 kV switchyard and the existing 138/25kV Construction Power installations at Muskrat Falls 315/138 kV switchyard. All earthworks are considered to be performed during summer as these types of works are not recommended to be performed during winter to avoid freezing of ~~granular foundation~~subgrade material and no provision has been added for winter works. Other civil works such as the construction of buildings are to be performed according to the Project Schedule (See Appendix 1-5).

- Access roads / approach roads are included.
- Ditches/Swales along periphery of the plot are considered as un-lined ditches and are part of site grading activities. No additional quantities are considered.
- Buried Cable Trenches are not envisaged. Precast Polymer Concrete cable trenches are considered.
- In the absence of geotechnical information, ~~E~~excavation in rock is considered at some of the locations ~~as per information available at this point in time~~ and the agreed assumptions as to the presence of rock are ~~carried in the CCE~~detailed in site-specific sections below.

3.2.1.2 Concrete

- Manholes / Cable Pull Pits are not envisaged at this time. If required to be placed outside the control buildings and between cable run, shall be included at a later date.
- Transformer blast/fire wall is considered in the BOQ.

3.2.1.3 Steel

- All Steel structures like Gantries and Support steel are considered as galvanized, unless specified otherwise.

3.2.1.4 Buildings

- All buildings are considered as Pre-Engineered Buildings.
- Civil / Concrete works up to grade are part of Civil/Concrete BOQ.
- Building wall acting as Firewall, if required is under concrete BOQ.
- Building includes electromechanical works like HVAC, Plumbing, and Lighting etc.
- Over Head Cranes, Handling equipment, Shop equipments etc are quantified and included in estimate.
- Building Includes Furniture, Furnishings and Kitchen / Washroom fittings / appliances.
- Tie in points for Potable Water, Sanitary Drainage, Lighting are considered available near building.

3.2.1.5 Electrical Works

- All required supply and installation of electrical equipment including:
    - Circuit breakers
    - Disconnect switches
    - Capacitor voltage transformers

- Current transformers
- Surge arresters
- Power transformers
- Batteries and chargers
- Busbars and overheard connections
- Grounding
- Control system (panels)

- Lighting and building electrical services
- Operations Telecommunication System - Island Link
- Tie in for Small Power for Lighting etc are considered available near building.
- Cathodic Protection works are not included.

3.2.2 Construction Methodology & Timeline Factor

Standard construction methods have been considered for of each of the facilities and installations of Component 3. Productivity factors by discipline have been applied as indicated in the Performance factors section below.

Where the remoteness of the site requires the provision of a camp to lodge workers and staff during construction, an estimate has been included in the CCE. The sites where such camps are required are indicated in the site-specific considerations below.

3.2.3 Price factors

- Following the issuance of a short-term specification, two turn-key budget quotes were received for the Synchronous Condenser from the following suppliers:
  - Alstom for a 3 unit +150/-100 MVAr
  - Toshiba for a 2 unit +300/-200 MVAr

For the purpose of the CCE, the Alstom budget quote was considered.

- Following the issuance of a short-term specification, three turn-key budget quotes were received for the Muskrat Falls and Soldiers Pond Converter stations from the following suppliers:
  - ABB
  - Siemens
  - Alstom

For the purpose of the CCE, the ABB budget quote was considered.

- Following the issuance of a short-term specification, three (3) turn-key budget quotes were received for the Shoal Cove and Forteau Point Transition Compounds from the following suppliers:
  - ABB
  - Siemens
  - Alstom

For the purpose of the CCE, the ABB budget quote was considered.

- Pre-engineered building were estimated on a unit cost per area basis in using the following assumptions:
  - 1 level standards height : 1,800$ / m^2
  - 1 level “tall” building : 2,000$ / m^2
  - 2 levels standard building: 2,700$ / m^2
  - Foundation works for all buildings 600$ / m^2
- All other standards electrical equipment were priced through issuance of short-form technical specifications for the purpose of obtaining budget prices from suppliers. Generally, and where applicable, the average of two highest

submitted prices were considered. Where not applicable an estimator judgement call was applied based on past experience.

- For site Testing, Commissioning and Training work of substation electrical equipment approximately 12% of total material costs is assumed.

3.2.4 Performance Factors

Labour productivity assumptions are as follow:

- All direct labour hours are based on readily available USGC (United States Gulf Coast) charts and/or SLI historical data.
- For civil works, productivity factor of 1.31 over Richardson was added to the chart to account for the location of the Project
- For electrical works, productivity factor of 1.44 over Richardson was added to the chart to account for the location of the Project
- For mechanical Works, productivity factors over Richardson were added to the chart to account for the location of the Project:
  - 1.13 for Mechanical and HVAC systems man hours.
  - 1.55 for Piping / Insulation systems man hours.
- A 6% allowance was added to direct labour costs to account for congestion of the worksite

3.3 SITE-SPECIFIC CONSIDERATIONS

For each of the Component 3 facilities and installations, some site-specific assumptions were made to adequately capture costs that relate to conditions that apply to these sites only. These site-specific considerations are indicated in the following sections.

3.3.1 New Churchill Falls Switchyard 735/315kV

The remoteness of this site will require the construction of a ~~-~~camp with a ~~maximum~~ capacity of ~~150~~ 148 workers. The cost calculation in the CCE considers an average of ~~80~~ 75 workers for a 4~~4~~6 months period at this site. Two (2) new 735kV interconnections lines will need to be built from the existing CFLCO switchyard to feed the new Churchill Falls switchyard. Some work will need to be performed within the existing CFLCO switchyard and it is assumed that all required permits and authorizations will have been secured by Nalcor at commencement of the Works.

3.3.1.1 Site Preparation and Access

Minimal access roads are required for this site as it next to the existing Trans Labrador Highway. Clearing and soil stripping works are included in the CCE.

3.3.1.2 Civil Works

As no geotechnical information was available for this site an agreed assumption of balanced cut and fill mass excavation work, comprising 50% overburden and 50% rock was considered in the CCE.

The switchyard area of the 735kV portion of the switchyard is ~~300m~~ 348m x ~~246m~~275m. The area of the 315kV portion of the switchyard is ~~192m~~ 220m x ~~175m~~210m. In order to reduce the earthworks it is considered in the CCE that the 735kV portion of the switchyard will be at a level 3m higher than the 315kV portion.

All earthworks including final grade using crushed stone as well as fencing around the full extents of the switchyard are included in the CCE including the oil containment and fire wall structure around the power transformers.

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, surge arresters, power transformer, gantries, etc. are included in the CCE.

3.3.1.3 Electrical Equipment

No backup 735/230kV transformer is included in the estimate as this option was not retained.

3.3.1.4 Other Works

An 11m x 30m meter pre-engineered type maintenance and operations building complete with a 5 tonnes overhead crane and all tools and equipment are included in the CCE. There are no provisions for cabinets, tool chests or heavy shelving.

A control building housing 44 control panels, batteries, chargers is also included.

3.3.2 Construction Power

The supply of Construction Power to the Project will be provided by a new 138/25kV terminal station at Muskrat Falls with a tap to the existing 138kV transmission line between Churchill Falls-Happy Valley substations. This tap station will be located on the North side of the Churchill River with access from Trans Labrador highway. The construction power will be extended to the construction site and camp site through a 25 kV transmission line approximately 17km long crossing the Churchill River to the south side.

The new tap substation at Muskrat Falls and an extension by third transformer at Churchill Falls substation is required as supporting infrastructure for the construction of the Muskrat Falls power generation and the camp facilities.

3.3.2.1 Site Preparation and Access

Minimal access roads are required at this site as it is next to an existing road

3.3.2.2 Civil Works

The area of the Muskrat Falls construction power substation is 100m x 100m. All earthworks including final grade using crushed stone as well as fencing around the full extents of the substation are included in the CCE.

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, surge arresters, power transformer, gantry, etc. are included in the CCE.

A provision for the demolition of the temporary Muskrat Falls Construction Power substation following completion of the works is included in the CCE.

3.3.2.3 Electrical Equipment

Supply and Installation of all electrical equipment required for Construction Power have been estimated using budget quotes provided by suppliers and in-house estimating.

Quantification basis for this work is captured in the following Engineering documents included in Appendix 1-2:

- PH0036 – Accommodation and Construction Site Distribution System – Auxiliary Transformers
- PH0037 – Accommodation and Construction Site 25kV Switchgear
- PH0038 – Accommodation and Construction Site Diesel Generators

3.3.2.4 Other Works

A 17 km wood pole 25kV transmission line will connect the new tap substation to the Muskrat Falls powerhouse construction site and the camp site. A provision of 100 000$ per km was made for the construction of the power line

~~**3.3.3 Muskrat Falls TAP 315/138kV**~~

~~This substation will be fed by two new 315kV lines from Churchill Falls and will supply Happy Valley at 138kV.~~

~~**3.3.3.1 Site Preparation and Access**~~

~~Minimal access roads are required at this site as it is next to an existing road~~

~~3.3.3.2 Civil Works~~

~~The area of the Muskrat Falls TAP 315/138kV is 175m x 275m. As no geotechnical information was available for this site an agreed assumption of balanced cut and fill mass excavation work, comprising 100% overburden was considered in the CCE.~~

~~All earthworks including final grade using crushed stone as well as fencing around the full extents of the switchyard are included in the CCE including the oil containment and fire wall structure around the power transformers.~~

~~All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, surge arresters, power transformer, gantry, etc. are included in the CCE.~~

~~3.3.3.3 Other Works~~

~~A control building housing 42 control panels, a telecommunications room, batteries, and chargers is also included in the CCE.~~

~~3.3.4~~3.3.3 Muskrat Falls Switchyard 315kV and Converter Station 350kV DC

As this site is located next to the Muskrat Falls Main Camp facilities, it is assumed in the CCE that all workers and staff for this portion of the Project will be lodged at this Camp. For the ~~34~~ 44 months duration of the construction work at this site it is ~~expected~~ estimated that the required accommodations needs form the Muskrat Falls main camp will peak at 208 workers. The estimate considers an average of 108~~for a peak of 276~~ workers ~~will be required~~for a period of 44 months.

~~3.3.4.1~~3.3.3.1 Site Preparation and Access

Minimal access roads are required at this site as it is next to an existing road that will have been constructed by the Project prior to the start of this work.

Civil Works

The extents of the Muskrat Falls AC Switchyard / HVDC Converter area including the required area to accommodate the Construction Power Tap facilities in the AC switchyard ~~area~~ are ~~187m~~ 260m x ~~252m~~210m for the AC Switchyard and 354m X 304m for the HVDC Converter area. No rock excavation is anticipated at this site as the area will consist mainly of fill laid down in 2013 during the Powerhouse mass excavation activities and used as a lay down area until the substation work begins.

All earthworks including final grade using crushed stone as well as fencing around the full extents of the switchyard are included in the CCE including the oil containment and fire wall structure around the power transformers.

315kV Switchyard

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, surge arresters, gantries, etc. are included in the CCE.

A control building housing 60 control panels, batteries, chargers is also included.

Converter 350 kV DC

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, power transformers, surge arresters, filters, gantries, etc. are included in the CCE.

For the valves control building, typical engineering referenced with similar projects was performed. A provision of 2,700$+600$ / m2 was considered in the CCE.

~~3.3.4.2~~3.3.3.2 Electrical Equipment

Switchyard

All standard electrical equipment was priced through issuance of short-form technical specifications for the purpose of obtaining budget prices from suppliers. Generally, and where applicable, the average of two highest submitted prices were considered. Where not applicable an estimator judgement call was applied based on past experience.

Converter 350 kV DC

For the converter's specialized electrical equipment a short-form technical specifications was issued for the purpose of obtaining budget prices from suppliers. This specification stated that Supply of equipment needed to include the design, manufacturing, quality control, transportation to site, storage and documentation. The supply is to include all equipment and materiel, required to provide a complete and operational converter station. The main equipments included in the Converters station are as follow:

- Thyristor valves and valve cooling system
- Converter transformer
- Smoothing reactors
- Surge arresters
- AC filters
- DC filters
- Measuring devices
- Control and protection system
- DC switching Device
- AC breakers and switching devices
- Busworks and insulators
- AC/DC station auxiliary power supply
- Smoke detectors in valve hall
- CCTV (camera system)
- Steel structures

~~3.3.4.3~~3.3.3.3 Other Works

An 20m x 50m meter pre-engineered type maintenance and operations building complete with a 5 tonnes overhead crane and all tools and equipment are included in the CCE. There are no provisions for cabinets, tool chests or heavy shelving.

~~3.3.5~~3.3.4 Forteau Point and Shoal Cove Transition Compounds

The remoteness of the~~se~~ Forteau Point site~~s~~ will require the construction of a remote temporary camp with for a maximum capacity of 80 workers. ~~s at each location with a maximum capacity of 95 workers~~. The cost calculation included in the CCE for this~~ese~~ camp~~s~~ considers an average of ~~56~~ 39 workers for a ~~24~~ 23 months duration ~~at~~. This temporary camp will also accommodate the workers required for the L'Anse-au-diable electrode site, as discussed in the Electrode sites section of this document.

However, as these facilities are located in the Transmission Line ROW, there could be an opportunity to save the mobilization and demobilization costs of the Forteau Transition Compound camp facilities~~, mainly the Forteau camp,~~ if the personnel required for this work could be lodged at the camp required for the construction of the Transmission lines. The CCE currently carries distinct camp facilities.

The Shoal Cove site being deemed close enough to readily available lodging in the surrounding area, no construction accommodation camp is included in the CCE. However, the CCE considers a *per diem cost* of 80$ (per day) to cover accommodation costs for an average of 31 workers over a period of 23 months. A peak of 55 workers is expected at this site.

The transition compounds are required to interface the submarine/land cable terminated at both transitions compounds through air-bushing cable sealing ends and the DC transmission lines. However, the CCE includes no provision whatsoever for any interface with the SOBI Directional Drilling Contractor at these locations.

~~3.3.5.1~~3.3.4.1 Site Preparation and Access

Access roads to both these sites are included in the CCE.

~~3.3.5.2~~3.3.4.2 Civil Works

The extents of the Transition compounds area are 100m x 100m. As no geotechnical information was available for this site an agreed assumption of balanced cut and fill mass excavation work, comprising 100% overburden was considered in the CCE.

All earthworks including final grade using crushed stone as well as fencing around the full extents of the switchyard are included in the CCE including the oil containment and fire wall structure around the power transformers.

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, surge arresters, transformer, gantries, etc. are included in the CCE.

A 14m x 24m control building is also included in the CCE housing the control equipment provided by the Turnkey contractor.

~~3.3.5.3~~3.3.4.3 Electrical Equipment

The transition compounds will be provided with all required switching equipment, including:

- 350 kV dc switchyard including all necessary disconnecting and ground switches, surge arresters, post isolator, bushings, voltages dividers, DC current transducers and busworks
- Gantries and steel structures for supporting the equipment on its foundations
- Auxiliary power supply: one 14.4 kV transformer and one 150 KW diesel generator
- LV and telecommunication
- Control and protection equipment
- Electrode line monitoring equipment

~~3.3.5.4~~3.3.4.4 Other Works

In order to protect the Transition Compounds' electrical equipment from the salt spray inherent to their location near the SOBI, a ~~28m~~ 36m x ~~43,2~~35m x 13,5m high pre-engineered building is included in the CCE for each site. These building will consist mainly in a steel shell to house the cable sealing end, circuit breakers, surge arresters, current transformers, disconnect switches, etc. Main access doors will enable service vehicles to access the building and proceed to any assembly or maintenance work from within the building.

3.3.5 Soldier Pond Converter Station 350kV, Switchyard 230kV and DC Synchronous Condensers

The Soldiers Ponds site being deemed close enough to readily available lodging in the surrounding area, no construction accommodation camp is included in the CCE. However, the CCE considers a *per diem cost* of 80$ (per day) to cover accommodation costs for an average of 165 workers over a period of 46 months. A peak of 340 workers is expected at this site.

~~3.3.5.5~~3.3.5.1 Site Preparation and Access

An access road connecting the site to the Trans-Canada Highway is included in the CCE.

~~3.3.5.6~~3.3.5.2 Civil Works

The extents of the Soldier Pond Switchyard area are 314m x 500m. For the synchronous condenser, the yard area is 150m x ~~300m~~200m.

Following review of a 2008 report relative to a geotechnical study conducted at this site, an agreed assumption of balanced cut and fill mass excavation work, comprising 85% overburden and 15% rock was considered in the CCE excluding the synchronous condenser portion of the site.

In order to avoid disrupting an existing small pond near the Soldier Pond Project site, the Synchronous Condenser was detached from the main facilities and located

approximately 140 meters to the (South-East). The assumption considered for the synchronous condenser site excavation work is 100% rock.

315kV Switchyard

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, surge arresters, gantries, etc. are included in the CCE.

A control building housing 72 control panels, batteries, chargers is also included.

Converter 350 kV DC

All concrete foundations work for circuit breakers, disconnect switches, capacitor voltage transformers, current transformers, power transformers, surge arresters, filters, gantries, etc. are included in the CCE.

For the valves control building, typical engineering referenced with similar projects was performed. A provision of 2,700$+600$ / m2 was considered in the CCE.

~~3.3.5.7~~3.3.5.3 Electrical Equipment

Switchyard

All standard electrical equipment was priced through issuance of short-form technical specifications for the purpose of obtaining budget prices from suppliers. Generally, and where applicable, the average of two highest submitted prices were considered. Where not applicable an estimator judgement call was applied based on past experience.

Converter 350 kV DC

For the converter's specialized electrical equipment a short-form technical specifications was issued for the purpose of obtaining budget prices from suppliers. This specification stated that Supply of equipment needed to include the design, manufacturing, quality control, transportation to site, storage and documentation. The supply is to include all equipment and materiel, required to provide a complete and

operational converter station. The main equipments included in the Converters station are as follow:

- Thyristor valves and valve cooling system
- Converter transformer
- Smoothing reactors
- Surge arresters
- AC filters
- DC filters
- Measuring devices
- Control and protection system
- DC switching Device
- AC breakers and switching devices
- Busworks and insulators
- AC/DC station auxiliary power supply
- Smoke detectors in valve hall
- CCTV (camera system)
- Steel structures

In order to perform the work related to the AC/DC Switchyard and Converter stations, the displacement and diversion of the LT-218 Hollyrood existing line is required prior to commencement of the Work in 2013. These costs are included in the Component 4 – Transmission Lines portion of the CCE.

Furthermore, if, following detailed engineering studies, the location of the facilities was to change from what is currently assumed in the CCE, it could be required to relocate the TL-242 Hollyrood line as well.

~~3.3.5.8~~3.3.5.4 Other Works

A 20m x 50m meter pre-engineered type maintenance and operations building complete with a 5 tonnes overhead crane and all tools and equipment are included in the CCE. There are however no provisions for cabinets, tool chests or heavy shelving.

For integration into existing Power Grid, modifications and upgrades to protection systems will be required at in the following Substations:

- Holyrood
- Western Avalon
- Oxen Pond
- Hardwood

The cost of the upgrades to protection systems have not been included in the CCE as they are part of the Owner's cost.

3.3.6 L'anse-au-Diable and Dowden's Point Shoreline Pond Electrodes

The Dowden's Point site being deemed close enough to readily available lodging in the surrounding area, no construction accommodation camp is included in the CCE. However, the CCE considers a *per diem cost* of 80$ (per day) to cover accommodation costs for an average of 14 workers over a period of 12 months. A peak 20 workers is expected at this site.

The remoteness of the L'Anse-au-diable site will require temporary construction accommodations. However, as stated above, due to its proximity to the Forteau Point Transition compound camp, the CCE considers that the workers of the L'Anse-au-diable site will lodge at this camp. The cost calculation included in the CCE for the L'Anse-au-diable site workers at this camp is included in the cost of the Forteau Point camp as stated above (80 workers capacity with an average of 39 workers for a 23 months duration).

Estimate is a unit Rate Based estimate based on scope, design and bulk quantities developed from the concept designs as detailed in the *Shoreline Pond Electrodes - Design Brief* SLI doc no. 505573-480B-47EM-0004 (the Design Brief)

All construction work, with the exception of the Dowden's Point dredging activities can be performed from shore.

L'anse-au-Diable Pond electrode

This proposed site at L'Anse-au-Diable is in a south facing cove with somewhat rectangular dimensions of 130 m to 150 m wide and length of approximately 150 m. It is assumed that no excavation will be needed at this site as it is exposed rock.

The construction of this facility will occur over a 6 to 8 month period. The facility is close to existing access roads and will use standard civil equipment for construction. It is not anticipated that the contractor would need to mobilize any marine based equipment.

Approximately 400m of access road will be required to access the site; there will be a small lay down construction area constructed at the approach for the new breakwater. All material will be end dumped into the ocean and shaped with a long reach backhoe. Armour stone will be dumped on the slope and repositions with a crane or long reach backhoe.

- Marine works rates are based on non union sites. (Marine Contractors are generally non-union)
- All other land work rates are union
- No dredging is anticipated at L'Anse-au-Diable
- Sheet pile cut-off wall work has been included to avoid silting of the permeable material during breakwater construction
- There is no allowance for winter construction.

- Armour stone in the sizes required is readily available within a 10 km radius.
- Service Building is prefabricated off site.

Dowden's Point Pond electrode

At the Dowden's Point Shoreline Pond Electrode, the crest of the breakwater aligns with the top of the existing bank and the sea side toe line coincides with the existing low tide shoreline. The depth of the soil above the bedrock at Dowden's Point is anticipated to be approximately 30 m, which would permit excavation without the need to blast bed rock.

The construction of this facility will occur over a 6 to 8 month period. The facility is close to existing access roads and will use standard civil equipment for construction. The current concept required that the contractor will mobilize marine based equipment for a dredging operation. Dredging costs are based on ocean dumping

Approximately 400m of access road will be required to access the site; there will be a small lay down construction area constructed at the approach for the new breakwater. All material will be end dumped into the ocean and shaped with a long reach backhoe. Armour stone will be dumped on the slope and repositions with a crane or long reach backhoe

- Unit Rates are based on historical data for Marine Construction in Atlantic Canada and Newfoundland.
- Dredging rates for Dowdens Point location assumed dredged spoils from dredging operations use disposal at sea.
- Rates assume availability of Marine contractors and competitive bidding.
- Rates are based on non union sites. (Marine Contractors are generally non-union)
- Disposal of mass excavation from Dowdens Point assumes a haul distance of 2 km.

- There is no allowance for winter construction.
- Service Building is prefabricated off site.
- Provisions have been included in the CCE for the relocation of the east coast trail at the Dowden's Point location.

3.3.6.1 Site Preparation and Access

Access roads

For both sites, access roads to the site will be constructed to link with existing local roads (approximately 400 m). From the entrance to the site, the road will extend along the inside of the breakwater to provide access for maintenance of the shoreline pond electrodes. The width of the access road is assumed to be 6.0 m

3.3.6.2 Civil Works

Marine Structures (Breakwater)

The breakwater is designed to withstand the expected worst case site conditions, including wave action, tidal effects, pack ice and freezing inside the shoreline pond. Wave height is assumed to be 6.0 m and this is the basis for sizing and pricing the armour stone. Armour stone has a maximum size of 10 tonnes that will need to placed on the ocean side at a shallower slope than the natural angle of repose of the material which implies increased construction cost that has been considered in the CCE. The core material is a uniformly sized material to allow maximum water permeability through the breakwater berm. This material will need to be selected and treated to meet these requirements and has been estimated accordingly.

Only preliminary topographical and bathymetric mapping of the site area was available at time of the CCE.

Electrode Supports and Protection

The structural supports and protection for electrode and cables are designed utilizing concrete to withstand the expected worst case site conditions, including freezing spray, tidal effects, and freezing inside the shoreline pond. Fibre reinforced plastic (FRP) reinforcements will be used to eliminate corrosion problems due to currents.

The CCE caries minimal cast in place concrete as most of the concrete elements will be prefabricated

Relatively small quantities of cast in place concrete will be required to encase electrical ducts element at both Pond electrode locations. These quantities are assumed to be mixed and placed using portable mixers using hand fed bagged concrete

3.3.6.3 Electrical Equipment

The electrical work for the pond electrodes includes the following:

- The threading of the electrodes from the surface through a 300mm protective concrete pipe reaching 1,5m below the low water level and depositing the electrode in a submerged PVC saddle supported on concrete blocks with the help of divers.
- Anotec electrodes type 4884H priced through budget quotes from specialized suppliers, Anotec
- Electrode main feeder cable, of 750 mm^2, Single core XLPE electrical cable at each location, estimated using load current bearing capacity and layout drawings
- 1 set of Telecommunication Service Panel and Optical Distribution Panel
- 1 set each of Service panel, Protection and Monitoring panel, 48 VDC battery chargers, 48 VDC battery bank, 120-240 V AC distribution panel, DC distribution panel, lighting control panel.

- The Electrode main feeder cable shall be laid in cable trench
- A small control building for which a provision has been included in the CCE

3.3.6.4 Other Works

Fencing

The site will be fenced on all sides by chain link fencing to prevent public access to the pond. The fencing in contact with the berm needs to be a special isolated fence comprised of timber posts with isolators between each panel of chain link fence

3.3.7 Telecommunication system

The estimate for the telecommunication services required for the Project was prepared considering three phases of development as follow:

- Phase 1 - Early works construction phase
- Phase 2 - Construction Phase
- Phase 3 - Permanent (Operations) Phase

For each of these phases, design was sufficiently developed to allow for detailed quantification of all required equipment and services as well as for obtaining budget quotations from specialised suppliers. The details pertaining to the development of these estimates is presented below. A quantification summary is presented in Appendix 3-XYZ.

3.3.7.1 Phase 1 - Telecommunication System – Early Works Construction Phase

3.3.7.1.1 Scope Factors

The scope of the work involved in the provision of early works telecommunication is presented in engineering document 505573-480A-47ER-0015-00 entitled, *Telecommunication system – Telecommunication Study Early Works Construction Phase – Technical Report.* (See Appendix 3-XYZ) This report gives a summary description of the system requirements ~~of the system~~ and forecasts the quantities of

required equipment for the provision of mobile connectivity for early construction work for Owner and EPCM services.

This construction work is to take place along the new access road, at the Muskrat Falls powerhouse area and the new accommodation Complex. The scope of work is further detailed in Engineering document 505573-480A-47ES-0004 entitled *Telecommunication Devices – early works Construction Phase – Scope specification* (See Appendix 3-XYZ). A summary of the scope of work is presented below:

- Provision of Land Mobile Radio (LMRS)
- Provision Cellular Telephony services
- Provision of Data transmission services
- The forecasted number of users for these services range from 10 persons in the initial stage of the early works to 45 persons at its peak.
- The forecasted number of vehicles to be equipped with LMRS range from 9 vehicles in the initial stage of the early works to 34 vehicles at its peak
- The forecasted number of cell phones range from 7 units in the initial stage of the early works to 32 units at its peak
- The forecasted number of desk phones range from 4 units in the initial stage of the early works to 14 units at its peak
- The forecasted number of personnel radios range from 10 units in the initial stage of the early works to 45 units at its peak
- For the supply of sufficient bandwidth for the provision of the mobile services, the estimate considers the development of a service agreement with a Telecom Service Provider (TSP)

Contractors on site are to provide for their own telecom services and equipment for which the cost is considered in the construction indirect costs discussed in section 1.

3.3.7.1.2 Construction Methodology and timeline Factors

The early works telecommunication estimate is based on the provision of services starting in ~~January~~ June 2012 in the initial stages of the work until ~~June 2012~~April 2013, considered as the beginning of the Phase 2 – Construction Phase.

3.3.7.1.3 Price Factors

Pricing of the telecommunication equipment was developed through the use of two sources:

- Budgetary Quotes or price lists received from specialized supplier for a variety of equipment required for this type of work from which the equipment required for this specific project were selected. The supplier who provided pricing information is Bell Alliant.
- In house pricing based on estimator experience from the recent construction of comparable hydroelectric projects in similar conditions

3.3.7.1.4 Performance Factors

Installation cost were estimated using information form budgetary proposal and estimator experience based on recent construction of comparable hydroelectric projects in similar conditions.

3.3.7.2 Phase 2 - Telecommunication System – Construction Phase

3.3.7.3 Scope Factors

The scope and details of the work involved in the provision of the Construction Phase telecommunication system is presented in engineering document 505573-480A-47ER-0009-00 entitled, *Telecommunication system – Design Brief – Construction Phase – Technical Report.*(See Appendix 3.XYZ) This report gives a description of the requirements of the system and forecasts the quantities of required equipment and infrastructure for the provision of the telecommunication services throughout the duration of the Construction Phase work.

The Construction phase work will support the construction work force required to build the permanent hydroelectric infrastructure and associated transmission line infrastructure.

The anticipated number of users considered in the CCE is as follows (these figures are detailed in Appendix A of the 505573-480A-47ER-0009-00 Technical report):

- Approximately 150 users during the Starter Camp Phase at Muskrat falls
- Approximately ~~1700~~ 1600 users at peak during the Main Construction Phase

Infrastructure and equipment considered in the CCE are to provide the following services:

- Data (Corporate and Entertainment);
- Telephony (Corporate and Entertainment);
- Video Conferencing;
- Cable Television (CATV) system;
- Land Mobile Radio System (LMRS);
- Cellular Telephony System (CTS) and Mobile Internet System (MIS);
- Building Management System (BMS);
- Network Management System (NMS);
- Closed Circuit Television (CCTV);
- Security and Access Control System (SACS);
- Supervisory Control and Data Acquisition (SCADA) and Protection.

The Muskrat Falls site includes all the facilities near the new Power Complex: the accommodation complex, Administration buildings, owner's laydown, contractor's laydown, power complex, and the construction power tap substation, etc.

The remotes sites are those located along the transmission lines: the new line from Muskrat Falls to Churchill Falls (Labrador) and the new lines from Muskrat Falls to

Soldier's Pond (Newfoundland). There is also the reservoir clearing crew's needs included in the remote sites.

The service available in the remote sites shall be essentially to SLI and Nalcor. This service will have limited capacity due to the ~~the same as the ones available in Muskrat Falls, but with some~~ bandwidth limitations. The contractor will be required to provide his own telecommunication services.

3.3.7.3.1 Construction Methodology and timeline Factors

The construction phase is to begin in ~~July~~ November 2012 with the starter camp until ~~October 2012~~April 2013 when the Main Camp Construction Phase shall begin and is scheduled to be completed sometime in 2017.

3.3.7.3.2 Price Factors

Pricing of the telecommunication infrastructure, equipment and services were developed through the use of two sources:

- Budgetary Quotes or price lists received from specialized suppliers for a variety of equipment required for this type of work from which the specific equipment required for this specific project were selected. The suppliers who provided pricing information are the following:
  - Cisco
  - Corning
  - Eaton
  - PANDUIT
  - Ruggedcom
  - 3M
- In house pricing based on estimator experience from the recent construction of comparable hydroelectric projects in similar conditions

3.3.7.3.3 Performance Factors

Installation cost were estimated using information from budgetary proposals and estimator experience based on recent construction of comparable hydroelectric projects in similar conditions.

3.3.7.4 Phase 3 - Telecommunication System – Permanent Phase

3.3.7.4.1 Scope Factors

The scope and details of the work involved in the provision of the Permanent Phase telecommunication system is presented in engineering document 505573-480A-47ER-0016-00 entitled, *Telecommunication system – Permanent Phase - Design Brief* .(See Appendix 3.XYZ)

The telecommunication system shall support the Protection, Control and Metering signals for all operation and maintenance activities of the project. It shall provide the platform for the administrative telecommunication systems associated with these activities. The telecommunication system shall be based on an Optical Transport Network (OTN) which shall use a Synchronous Optical Networking (SONET) cross-connected convergence section. The OTN shall use, as a physical medium, the Optical Grounding Wire (OPGW) installed as the guard cable of the electrical transmission network. This OPGW cable shall enclose 24 fiber optical strands.

Due to the changes on the existing transmission line at Soldiers Pond Station, it is required to include a Microwave Link from Soldiers Pond Station to Four Miles Hill telecommunication repeater. This link will bring the SCADA signals to the Holy Rood, Western Avalon, Hardwood, Oxen Pond and Soldiers pond stations.

An additional microwave link has been considered as backup of the submarine optical fibers which will cross the Strait of Belle Isle.

3.3.7.4.2 Construction Methodology and timeline Factors

The following schedule is considered in the CCE for the execution of the Phase 2 telecommunication work:

- Issue of RFP by end of year ~~2012~~2013
- Execution to follow construction of the facilities from 2014 to 2017.

Issuance of RFP at the end of year ~~2012~~ 2013 is a Nalcor requirement. SLI has recommended that RFP be postpone as much as possible in order to take advantage as much as possible of the technology upgrade that could take place during that additional period.

3.3.7.4.3 Price Factors

Pricing of the telecommunication equipment was developed through the use of two sources:

- Budgetary Quotes or price lists received from specialized suppliers for a variety of equipment required for this type of work from which the specific equipment required for this specific project were selected. The suppliers who provided pricing information are the following:
  - Alcaltel
  - Ciena
  - Cisco
  - Corning
  - Eaton
  - PANDUIT
  - Ruggedcom
  - 3M
  - XTERA

- In house pricing based on estimator experience from the recent construction of comparable hydroelectric projects in similar conditions

3.3.7.4.4 Performance Factors

Installation cost were estimated using information from budgetary proposals and estimator experience based on recent construction of comparable hydroelectric projects in similar conditions.

4 VOLUME IV - COMPONENT 4 DETAILED ESTIMATE ASSUMPTIONS

4.1 INTRODUCTION

The Component 4 estimate assumptions were developed by the SLI transmission lines Group and are included in document 505573-4600-33RA-0002 entitled GATE 3 ESTIMATE ASSUMPTIONS Component 4 - Transmission Lines. This document is presented herein as an integral part of the CCE.

4.2 DOCUMENT 505573-4600-33RA-0002-GATE 3 ESTIMATE ASSUMPTIONS COMPONENT 4 – TRANSMISSION LINES

See below.