Q. Has the new North Spur stabilization plan been subjected to independent third party review? If so, please provide details of who carried out the review, when, and the results of their review. If not, are there any plans for such independent review? If not, why not?

A. [ ]

Yes. The Muskrat Falls Independent Engineer discussed the multiple reviews of the North Spur stabilization plan in its September 19, 2014 report[1], attached as GRK-NLH-057 Attachment 1. These reviews were discussed in Section 8.3 of the report, reproduced below:

> Concerns have been raised during earlier project reviews about potential liquefaction of the sensitive silt/clay strata during the design earthquake. In the fall of 2013 the IE and other reviewers commented that the stability studies had not considered the special liquefaction and strength loss strength properties under earthquake loadings and that further studies were needed to deal with this issue. New studies to address these issues were subsequently carried out during the first half of 2014. Nalcor and SNC presented the results of the studies in a meeting on July 20, 2014. This presentation was based on the following reports, which were submitted to the IE at that time.
>
> **Report No. 1:** "Earthquake Hazard Analysis - Muskrat Damsite, Lower Churchill, Labrador", issued by Gail M. Atkinson Ph. D., on May 22, 2014.

[1] http://muskratfalls.nalcorenergy.com/wp-content/uploads/2014/10/Lower-Churchill-Project-July-2014-IE-Site-Visit-issued-Oct-2014.pdf.

> **Report No 2**: ”Three Dimensional (3D) Hydrogeological Study for the North Spur”, Report no. H346252-0000-00-124-0001, Rev A, issued by Hatch on June 16, 2014.
>
> **Report No. 3**: “North Spur Stabilization Works – Dynamic Analysis Study – Phase 2”, Nalcor Doc No. MFA-SN-CD-2800-GT-RP-0007-01, Rev A1, issued by SNC-Lavalin in May 2014.

Report No. 1, the Atkinson earthquake hazard analysis, consisted of a site specific earthquake hazard analysis of The Muskrat Falls damsite. This report concluded that the 1/10,000 year maximum design earthquake would produce a Peak Ground Acceleration value (PGA) 0.06 g at the site. This could be generated by an event of M6.1 to M6.5 at a distance of about 90 to 100 km or an event of approximately M7.3 at a distance of 350 to 450 km. The new 0.06 PGA is a significant reduction of the previously assumed PGA 0.09g that was extrapolated from an earlier seismic hazard analysis for the Gull Island Project. The new PGA value would result in significantly reduced earthquake shaking than had been earlier assumed. The report also established earthquake spectral ground motions for use in dynamic stability analyses.

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> events. The analyses concluded that the design earthquake ground motions did not destabilize the North Spur slopes and that there is no liquefaction hazard. The analyses validated the remedial designs. It was considered that ongoing geotechnical observations and monitoring during construction will be calibrated with the expected conditions to ensure the accuracy of the analyses.
>
> The geotechnical assessments and dynamic studies were reviewed by Professor Idriss and Dr. Serge Leroueil. Professor Idriss is an internationally renowned expert of seismic hazard analyses and dynamic analyses of earthworks and civil structures. Dr. Leroueil is recognized for his expertise in dealing with sensitive soils, particularly the slopes of the St. Lawrence Valley in Quebec. With the involvement of these two experts, Nalcor can rest assured that analytical work of the North Spur has been done to a world class standard.
>
> The IE considers that the various geotechnical concerns for the North Spur have generally been satisfied by the studies described above. These studies confirm that the designed remediation and stabilization works are adequate and that there is no significant hazard from stability problem-related seepage, strength loses in sensitive soils and/or earthquake shaking during construction or operation of the project. The IE also agrees with the plan that further geotechnical observations will be made as the remedial works progress and as new geotechnical monitoring is performed. These observations will be calibrated against the expectations of the various analysis reports. Designs will be amended if any significant surprises or discrepancies are encountered.

This excerpt summarizes the multiple reviews that were undertaken as work on the stabilization plan progressed. After an initial review undertaken by the Independent Engineer in the fall of 2013 (see Attachment 1 to Hydro's response to PUB-NLH-210), additional studies as noted above were undertaken by LCP, and the results of those additional studies were reviewed by the Independent Engineer and two renowned experts within their respective areas of study.

MWH

LOWER CHURCHILL PROJECT

SITE VISIT REPORT JULY 14 TO 23, 2014.

Prepared for: Natural Resources Canada and Nalcor Energy

Project Manager: Nik Argirov

Date: September 19, 2014

Quality Assurance Statement

Office Address	740-1185 W Georgia Street, Vancouver BC, V6E 4E6
Prepared by	John Young
Reviewed by	Nik Argirov
Approved for Issue by	Nik Argirov

Disclaimer

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1. GENERAL

The MWH Independent Engineer team, together with a representative of Natural Resources Canada attended project briefings in St John's and participated in site visits to the Muskrat Falls Project during July 14 to 23, 2014. The site visits included tours of project work at Soldier's Pond and Dowden's Point in Newfoundland and various sites in the areas of Forteau, Muskrat Falls and Churchill Falls in Labrador (see Figure 1.1 for locations of major project works). Joe Krupski represented Canada on the site visits and the Independent Engineer was represented by Nik Argirov (IE Project Manager), John Young (IE Geotechnical Subject Matter Expert (SME) Derek Penman (IE Civil/Hydro SME) and Paul Hewitt (IE Cost and Schedule SME). Representatives from GNL included Craig Martin, Cory Grandy and Richard Noble (Ernst and Young). The itinerary was as follows:

- July 14:
  - am: Update briefings at the St. John's Nalcor office
  - pm: Site visit to the Soldier's Pond switchyard and converter site
- July 15
  - am: Travel from St. John's to Forteau, via Blanc Sablon
  - pm: Site visit to inspect the directional drilling operation, quarry and electrode pond in the Forteau area
- July 16:
  - am: Travel from Blanc Sablon to Goose Bay, followed by a tour of the Goose Bay Marshaling Yard and the main camp.
  - pm: Tour of the North Spur, HVac transmission line construction operations, reservoir clearing operations and the river crossing site in the upper reservoir
- July 17:
  - am and pm: tour of the Muskrat Falls site, including the cofferdams, spillway works, aggregate processing facility, powerhouse excavation.
- July 18:
  - am: Travel to Churchill Falls and site visit to the Churchill Falls New 315 kV Substation and Switchyard
  - am: Tour of the Churchill Falls underground power station and travel to St. John's via Goose Bay
- July 21:
  - am: Attended SNC presentation of stability studies for the North Spur at Nalcor office in St John's
  - pm: site visit to the proposed electrode site at Holyrood
- July 22:
  - am and pm: All day meetings re cost and scheduling at Nalcor' s office in St John's
- July 23:
  - am: Wrap-up meeting at Nalcor's office

Principal observations and comments on the active geotechnical construction and design works are presented in the following paragraphs. Labeled photographs are presented in Appendix A.

Figure 1.1: Layout of the Lower Churchill scheme in Newfoundland and Labrador.

2. SOLDIER'S POND SYNCHRONOUS CONDENSER CONVERTER STATION/SWITCHYARD SITE

A site visit was made to the 20 hectare Soldier's Pond Synchronous Condenser Converter Station/Switchyard site on July 14, 2014. Excavation, fill placement and other site preparation works were well advanced at the time of the site visit. Photographs are presented in Appendix A.

The site is inclined from the west to east. The terrain is covered by several metres of glacial till and there are bedrock outcrops in the higher ground of the eastern half of the site. The till consists of dense, heterogeneous mixtures of silt, sand, gravel and cobbles with varying percentages of medium sized boulders. Extensive muskeg deposits and poor drainage characterized much of the lower ground of the eastern area.

Site preparation works started on April 15, 2014. Site levelling will result in an overall 3% gradient, dropping towards the southeast. During initial site work, the lower areas were drained and all muskeg was removed. These activities proceeded concurrently with cut and fill site leveling works. Bedrock and glacial till overburden are excavated from the higher ground and placed in lifts as engineered fill in the lower ground in the south east. Overburden is being excavated with mechanical excavators and bedrock requires drill and blast excavation methods.

Bedrock and overburden materials are processed to remove boulders and oversized blocks to ensure their suitability for use as compacted fill. Fill is placed in 450 mm lifts and compacted to 98% Proctor with vibratory rollers. A rigorous quality control program ensures the quality of the works. Fill samples are subjected to soil mechanics laboratory testing and frequent in-situ density tests are conducted in the fields to verify compaction.

The quality of the excavation and fill placement work is very good. All work is being carried out in a very safe manner, in accordance with Nalcor safety guidelines and regulations.

3. STRAIT OF BELLE ISLE (SOBI) MARINE CROSSING - FORTEAU DRILLING SITE

The IE team visited the Forteau drilling site on July 15, 2014. Work on the directional drill holes has been underway since late 2013. Final completion of the last drillhole is scheduled for the third quarter of 2014. All work is on schedule and is reportedly under budget.

A total of three HVdc cables (two plus one spare) will be placed across the 30 km wide Strait of Belle Isle. Studies have shown that pack ice and iceberg scour can disturb the sea bed down to depths of about 65 m. To protect them against pack ice and iceberg scour, the cables are to be installed in boreholes in the near shore area. The boreholes are being drilled under the shallow near shore area that is prone to iceberg scouring. They are about 2 km long each and are angled downwards from the shoreline exiting from the sea bed, below the depth of about 70 m below sea level (See Figure 2.1 below). At a later date cables will be threaded though the holes and then laid on the sea bed across the strait. Below the 70 m depth the cables will be placed on the sea bed and covered by a rockfill berm.

Excellent progress has been made on the directional drillholes for the marine crossing of the Strait of Belle Isle. All three holes at Shoal Cove on the Newfoundland side have been completed. One of the planned three holes (Forteau 1), on the Labrador side, has been finished and work was underway on the second hole (Forteau 2) the time of the site visit. All directional drilling work will be completed by early September, 2014. Final cable and rock berm placement will be completed by the end of 2016.

At the time of the site visit the directional drilling rig (Photo 2.1 in Appendix A), owned and operated by Direct Horizontal Drilling was set up on drill hole Forteau 2. The holes at this site are collared in competent, layered sandstone that has subhorizontal to gently inclined bedding (Photo 2.2 in Appendix A). As shown in Photo 2.3, the hole is collared near surface with 30 inch casing installed in a 36' boring. Inserts of 24"and 14" casing are telescoped into this and advanced in the hole as needed until sound bedrock is encountered. The main portion of the hole is drilled with a 14 ¾ '' bit. The hole orientation and route are guided by a steerable bit that is oriented by compass guided instrumentation in non-magnetic rods (tool), 20 m behind the drill bit.

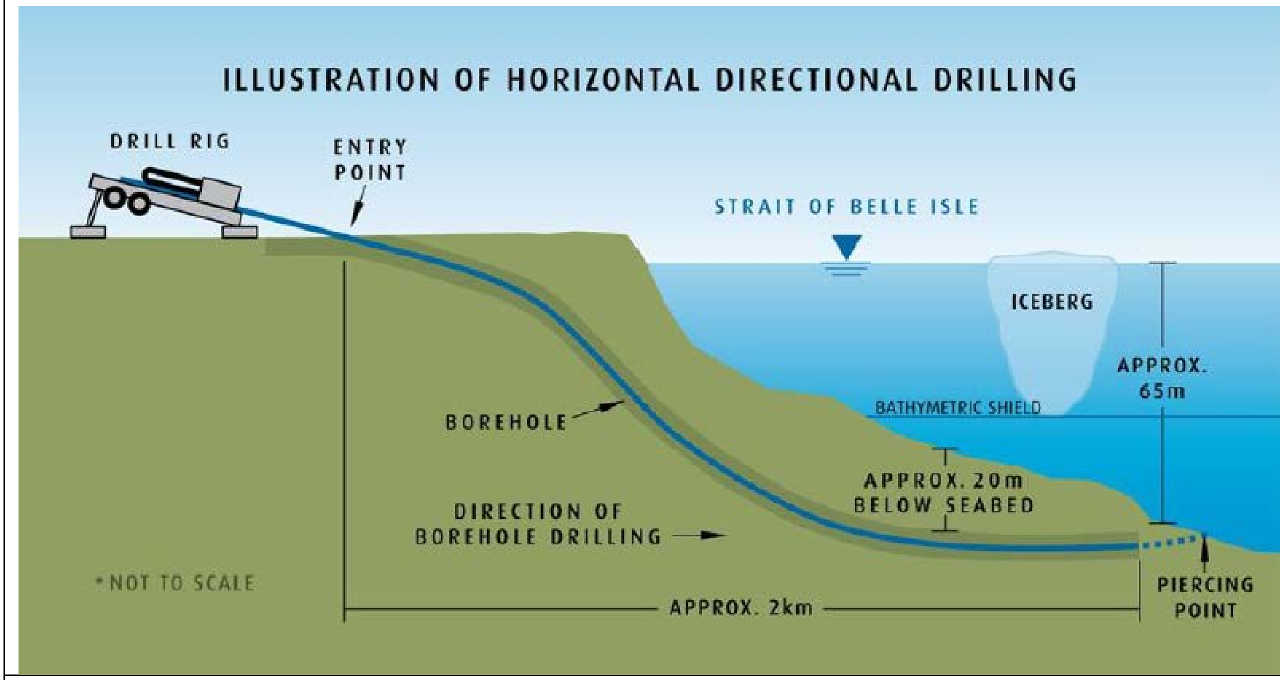


Figure 2.1: Schematic profile showing direction drilling on the shores of the Strait of Belle Isle.

The drilling operations, which are using state-of-the-art oil field technology, are being carried out to a high standard. As far as could be seen during the site visit, the work is being carried out competently and fully meets the requirements of the project. Safety and environmental standards are high.

4. L'ANSE AU DIABLE ELECTRODE STATION

The IE team visited the L'Anse au Diable Electrode Station site on July 15, 2014. The proposed electrode site consists of a bedrock embayment, north of Forteau. Site photographs are presented in Appendix A.

There is good road access to within 200 m of the water's edge at this location. Site conditions are favorable for the planned civil and electrical works and no significant geotechnical problems are anticipated, providing design and construction are carried out to normal engineering standards. Quarrying of the local granitic bedrock can produce ample supplies of durable rockfill and armour stone needed for the planed berm and other civil works.

As per the project schedule, no work has been carried out at this site up to the time of the site visit.

5. FORTEAU ROCK QUARRY

The IE team visited the Forteau rock quarry site on July 15, 2014. Site photographs are presented in Appendix A. The work at this site, which is being carried out by Tideway company from the Netherlands, commenced on June 17, 2014. The objective is to produce 490, 000 tonnes of crushed and processed rock fill for use in constructing the submarine protective berm over the sea floor cables. Sandstone bedrock material is crushed and screened at the sites to produce a stockpile of 3/4" to 6" graded rockfill.

Work was progressing well at the time of the site visit. As can be seen on the photos in Appendix A, the quarrying operation has produced an 8 to 10 m high quarry face. The quality of blasting is good (Photo 4.1) and there is adequate equipment to blast, excavate and remove blasted rock from the face. The crushing and screening operation has produced a large stockpile if processed rockfill (Photos 4.2 and 4.3 Appendix A). The rock fill is made up of strong durable sandstone that is suitable for the intended use.

In conclusion, the quarrying operation is well executed and meets the project requirements.

6. GOOSE BAY MARSHALLING YARD AND MAIN CAMP

The IE team visited the marshalling Yard and main camp on July 16, 2014. Photographs are presented in Section 5 of Appendix A.

A main marshalling yard has been set up near Goose Bay (Photos 5.1 and 5.2). It is very well organized and has ample space for the planned quantities of construction materials for the various construction sites across Goose Bay, Muskrat Falls and the transmission lines.

Nalcor is providing camp facilities for the various contractors. The new permanent camp is now completed (Photo 5.3 in Appendix A). Accommodations for approximately 1500 persons are available in the new permanent camp, supplemented by an additional 300 in the original "temporary" camp. The camps are of the accepted and even higher standard for northern work sites in Canada. The facility has adequate dining and recreation (a gym facility is still in construction) facilities for the residents. The main camp's kitchen and lounge for 500 single seating are very well organized and generally of a high standard. The kitchen layout accommodates a second (spare) serving bay that provides increased capacity during peak hours demand. The living quarters are with individual units, each one equipped with TV and wireless internet, individual toilet and shared (by two units) shower. Additional camps have been established at Churchill Falls and along the transmission line route, upstream of Muskrat Falls.

7. MUSKRAT FALLS SITE - POWERHOUSE/TAILRACE AND SPILLWAY

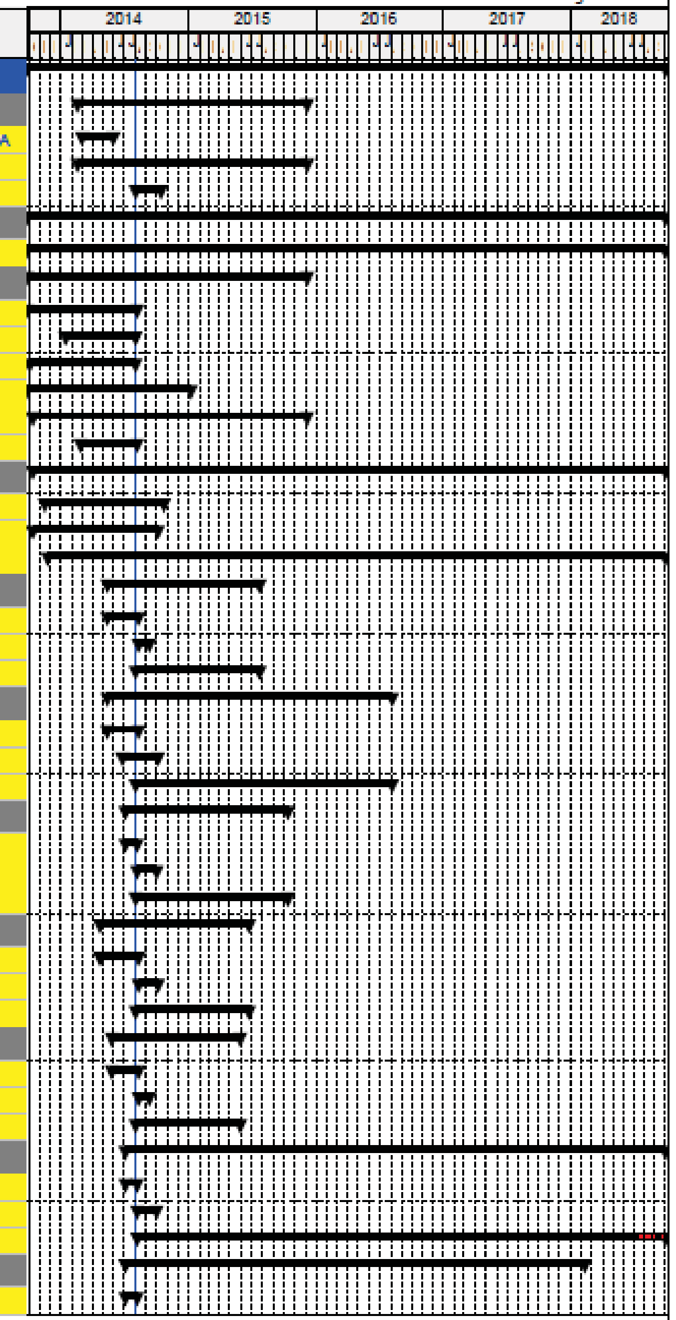
The IE team visited the Muskrat Falls site on July 17, 2014. Observations made during the tour included:

- Excavation of the Power Intake/Powerhouse/Tailrace channel is 100% complete. Controlled blasting techniques were used to form the final walls and the results are generally very good. Line drilling techniques (no explosives in the control line holes) were used in the concrete structures areas and presplit blasting is employed to form final walls in the open channels of the tailrace, intake and spillway. Rock support installations are adequate and no significant rock slope stability issues have developed. The final excavated walls are in very good condition and there is minimal overbreak. There are a few cases of small localized overbreak that are triggered by shallow block sliding or toppling along natural discontinuities adjacent the face (Photos 6.3 and 6.5 in Appendix A). None of these features significantly diminish the overall integrity of the slopes or the quality of the slopes.

- Astaldi was still mobilizing to the site at the time of the site visit and was carrying out work on various civil structures. It is understood that there has been some schedule slippage by Astaldi, but the IE was assured by Nalcor that the lost time can be easily recovered once Astaldi's full mobilization is complete. Astaldi is still on track with the original contract milestones.

CH0007-MUSKRAT FALLS - EXECUTION DETAILED SCHEDULE | CH0007 - Summary | 06-Aug-14 08:35

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish
CH0007-MUSKRAT FALLS - EXECUTION DETAILED SCHEDULE		1391	1018	23-Sep-13 A	29-Sep-18
CONTRACT GENERAL		438	331	17-Feb-14 A	05-Dec-15
Engineering		83	0	03-Mar-14 A	29-May-14 A
Procurement		438	331	17-Feb-14 A	05-Dec-15
Construction		50	50	01-Aug-14	14-Oct-14
LNTP SITE CONDITIONS MILESTONES		1663	215	23-Sep-13 A	29-Sep-18
Management		1663	215	23-Sep-13 A	29-Sep-18
MOBILIZATION & TEMPORARY SITE INSTALLATION		537	333	24-Sep-13 A	09-Dec-15
Management		213	4	24-Sep-13 A	06-Aug-14
Permits		112	0	13-Jan-14 A	01-Aug-14
Engineering		206	0	01-Oct-13 A	01-Aug-14
Procurement		307	103	24-Sep-13 A	07-Jan-15
Construction		524	333	11-Oct-13 A	09-Dec-15
Commissioning		117	5	24-Feb-14 A	07-Aug-14
SPILLWAY		1211	1018	10-Oct-13 A	29-Sep-18
Engineering		368	55	13-Nov-13 A	21-Oct-14
Procurement		241	46	10-Oct-13 A	06-Oct-14
Construction		1175	1018	23-Nov-13 A	29-Sep-18
NORTH TRANSITION DAM		488	237	15-May-14 A	23-Jul-15
Engineering		488	7	15-May-14 A	11-Aug-14
Procurement		28	28	12-Aug-14	08-Sep-14
Construction		237	237	01-Aug-14	23-Jul-15
CENTRE TRANSITION DAM		1110	492	15-May-14 A	06-Aug-16
Engineering		1110	7	15-May-14 A	11-Aug-14
Procurement		84	66	26-Jun-14 A	06-Oct-14
Construction		492	492	01-Aug-14 A	06-Aug-16
SOUTH TRANSITION DAM		316	295	02-Jul-14 A	14-Oct-15
Engineering		25	4	02-Jul-14 A	06-Aug-14
Procurement		56	56	07-Aug-14	01-Oct-14
Construction		295	295	01-Aug-14	14-Oct-15
SEPARATION WALL		469	219	21-Apr-14 A	25-Jun-15
Engineering		469	7	21-Apr-14 A	11-Aug-14
Procurement		56	56	12-Aug-14	06-Oct-14
Construction		219	219	01-Aug-14	25-Jun-15
RETAINING WALL		439	198	26-May-14 A	27-May-15
Engineering		439	7	26-May-14 A	11-Aug-14
Procurement		28	28	12-Aug-14	08-Sep-14
Construction		198	198	01-Aug-14	27-May-15
SPILLWAY DISCHARGE CHANNEL		1039	1018	02-Jul-14 A	29-Sep-18
Engineering		25	4	02-Jul-14 A	06-Aug-14
Procurement		56	56	07-Aug-14	01-Oct-14
Construction		1016	1016	04-Aug-14	29-Sep-18
ROLLWAYS		882	861	02-Jul-14 A	10-Feb-18
Engineering		25	4	02-Jul-14 A	06-Aug-14



Actual Level of Effort | Remaining Work | ◆ Milestone
Actual Work | Critical Remaining Work | summary

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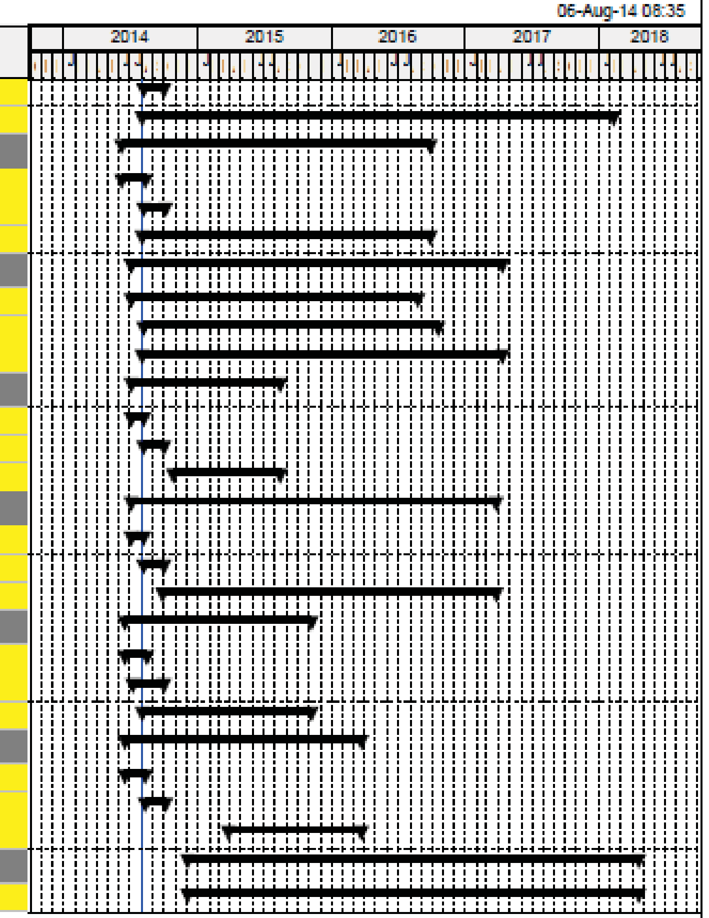
TASK filter: All Activities

CH0007-MUSKRAT FALLS - EXECUTION DETAILED SCHEDULE | CH0007 - Summary | 06-Aug-14 08:35

Activity ID / Activity Name	Original Duration	Remaining Duration	Start	Finish
Procurement	56	56	07-Aug-14	01-Oct-14
Construction	861	861	01-Aug-14	10-Feb-18
INTAKE	1208	528	09-Jun-14 A	28-Sep-16
Engineering	1208	7	09-Jun-14 A	11-Aug-14
Procurement	61	61	07-Aug-14	06-Oct-14
Construction	528	528	01-Aug-14	28-Sep-16
POWERHOUSE	681	660	02-Jul-14 A	14-Apr-17
Engineering	527	506	02-Jul-14 A	25-Aug-16
Procurement	775	775	07-Aug-14	20-Oct-16
Construction	660	660	01-Aug-14	14-Apr-17
DRAFT TUBE	275	254	02-Jul-14 A	15-Aug-15
Engineering	25	4	02-Jul-14 A	06-Aug-14
Procurement	56	56	07-Aug-14	01-Oct-14
Construction	195	195	26-Oct-14	15-Aug-15
TAIL RACE	667	646	02-Jul-14 A	24-Mar-17
Engineering	25	4	02-Jul-14 A	06-Aug-14
Procurement	56	56	07-Aug-14	01-Oct-14
Construction	606	606	28-Sep-14	24-Mar-17
SOUTH SERVICE BAY	337	312	15-Jun-14 A	07-Nov-15
Engineering	29	11	15-Jun-14 A	16-Aug-14
Procurement	87	62	07-Jul-14 A	01-Oct-14
Construction	312	312	01-Aug-14	07-Nov-15
NORTH SERVICE BAY	526	398	16-Jun-14 A	21-Mar-16
Engineering	526	7	16-Jun-14 A	11-Aug-14
Procurement	56	56	12-Aug-14	06-Oct-14
Construction	240	240	27-Mar-15	21-Mar-16
DEMOBILIZATION	1173	1173	02-Dec-14	19-Apr-18
Construction	1173	1173	02-Dec-14	19-Apr-18



Actual Level of Effort | Remaining Work | ◆ Milestone
Actual Work | Critical Remaining Work | summary

Page 2 of 2

TASK filter: All Activities

Figure 7.1: Astaldi schedule of works; planned and actual.

- During the IE site visit, work was underway at the first four base slabs of the spillway (Photo 6.2 in Appendix A). Foundation preparation had been completed, but could not be inspected by the IE on foot because of the limitations of the tour itinerary and heavy concentration of work at the foundation area.

- Concrete works for the powerhouse and intake have commenced. Formwork was being erected at the time of the IE site visit (Photo 6.6 in Appendix A)

- A trial fitting of the pier formwork components was carried out (Photo 6.7 in Appendix A). The quality of the formwork was judged by the IE to be excellent.

- Construction work will continue throughout the winter. The powerhouse works will be covered and completely enclosed by a large temporary steel structure shelter to enable civil works construction to continue without interruption during winter conditions. The enclosure building stretches over 3 bays, each one equipped with a 6 tonnes overhead crane. Work on the structure was underway at the time of the site visit. Concrete foundations for three of the four column lines were near completion.

- The com pleted first stage cofferdams are shown on Photos 6.3 and 6.4 in Appendix A. These structures performed very well during the winter of 2013-2014 despite the unusual severity of the river ice conditions.

- Planned reservoir clearing is substantially complete. The clearing which by design, covers only portions of the reservoir, was viewed at several locations during the IE site visit.

In conclusion, while schedule slippage by Astaldi should be monitored, site works are being done in a timely manner to a high standard.

8. NORTH SPUR

8.1. General

The North Spur is a 1000m long, 500m wide and 45 to 60m high ridge that connects the Muskrat Falls rock knoll to the north bank of the river (Photo 6.1). When the reservoir is impounded this feature will form a natural dam and become a major part of the river impoundment system. The feature is composed of unconsolidated mixed sand and marine silt/clay sediments. The depth to bedrock underneath the spur is in the range of 200 to 250 m. It contains a significant amount of glacio-marine silt/clay sediments, including horizons of highly sensitive clay strata, mixed with some sandy layers. The upstream and downstream slopes of this feature are subject to ongoing river erosion and mass wasting. This has contributed to local slope over-steepening of the slope, which triggers rotational sliding on both the downstream and upstream sides of the spur.

Various earlier studies have raised concerns for the stability of the spur when it becomes part of the water retention system after the reservoir is impounded. The project designers have incorporated special features to ensure long term stability. These include slope modifications, the installation of a cutoff wall under the upstream slope, a drilled well system, special drainage measures and the placement protective zones to protect against erosion.

8.2. July 16, 2014 Site Visit

A brief site visit was made on July 16, 2014 (Photos 7.1 and 7.2 in Appendix A). As shown on the photographs most of the clearing for the transmission line at this site has been completed. This work has been done to a high standard.

None of the planned remedial stabilization works had started as of the time of the site visit. It is understood that contracts for this work will be awarded in the near future.

8.3. Design Studies and Technical Issues

Concerns have been raised during earlier project reviews about potential liquefaction of the sensitive silt/clay strata during the design earthquake. In the fall of 2013 the IE and other reviewers commented that the stability studies had not considered the special liquefaction and strength loss strength properties under earthquake loadings and that further studies were needed to deal with this issue. New studies to address these issues were subsequently carried out during the first half of 2014. Nalcor and SNC presented the results of the studies in a meeting on July 20, 2014. This presentation was based on the following reports, which were submitted to the IE at that time.

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Report No. 3, by SNC Lavalin, presents the results of a geotechnical assessment and 2-dimensional (2-D) finite element dynamic stability analysis of the North Spur. The study used scaled ground motions from various earthquake records, scaled in accordance with the ground motion parameters set out in the Anderson seismic hazard report. Groundwater seepage and piezometric levels were input from the Hatch study (Report No. 2). Liquefaction criteria were established for the critical soil units based on cone penetration tests and other data from the geotechnical site investigations. 2-D dynamic analyses computed ground motions throughout the sour and established dynamic stress levels. These established ground deformations, pore water increases, cyclic stress strength losses and established if true liquefaction would occur during design earthquake events. The analyses concluded that the design earthquake ground motions did not destabilize the North Spur slopes and that there is no liquefaction hazard. The analyses validated the remedial designs. It was considered that ongoing geotechnical observations and monitoring during construction will be calibrated with the expected conditions to ensure the accuracy of the analyses.

The geotechnical assessments and dynamic studies were reviewed by Professor Idriss and Dr. Serge Leroueil. Professor Idriss is an internationally renowned expert of seismic hazard analyses and dynamic analyses of earthworks and civil structures. Dr. Leroueil is recognized for his expertise in dealing with sensitive soils, particularly the slopes of the St. Lawrence Valley in Quebec. With the involvement of these two experts, Nalcor can rest assured that analytical work of the North Spur has been done to a world class standard.

The IE considers that the various geotechnical concerns for the North Spur have generally been satisfied by the studies described above. These studies confirm that the designed remediation and stabilization works are adequate and that there is no significant hazard from stability problem-related seepage, strength loses in sensitive soils and/or earthquake shaking during construction or operation of the project. The IE also agrees with the plan that further geotechnical observations will be made as the remedial works progress and as new geotechnical monitoring is performed. These observations will be calibrated against the expectations of the various analysis reports. Designs will be amended if any significant surprises or discrepancies are encountered.

9. TRANSMISSION LINE CONSTRUCTION

Transmission line work started last winter and is proceeding on schedule. Clearing works (Photos 7.1 and 7.2 in Appendix A) are at an advanced stage and tower installation work (Photos in Section 8 of Appendix A) has commenced.

The IE visited the northern end of the Muskrat Falls to Churchill Falls HVac transmission line on July 17, 2014 to observe foundation preparation and tower assembly works by Vallard. Observations made in the field and in discussions with Nalcor technical staff include the following:

- Towers are being assembled in the field and a significant number of units (photo 8.1 in Appendix A) have been completed and are ready for erection. Vallarad will have a minimum of 200 towers assembled before starting the erection. An important fact is that Nalcor have insisted that all galvanized tower assembly bolts be checked out for a proper fit in holes at the production facility. This minimizes significantly the risk of bolts misfit and the resulting schedule delay of the towers' site assembly.

- Prepared foundations were viewed, as shown on Photo 8.2 in Appendix A. Work on the foundations examined has been carried out in accordance with good practice.

- Grillage footings (Photo 8.3 in Appendix A) are being used for overburden foundations. Two types of grillage footings were available for the HVac line; 100 kPa footing for loose to compact sandy foundations and 250 kPa footings for denser soils, including glacial till deposits. It is understood that there is a steel footing for competent bedrock foundations. Similar footings are used for the HVdc lines east of Muskrat Falls and on the island of Newfoundland. It is understood that footing types for various foundation conditions are chosen by qualified geotechnical personnel in accordance with a set of field guidelines prepared by the designers.

- Guy wires for towers are attached to fully grouted soil anchors. The IE team viewed installation work for one of these anchors on July 16, 2014 (Photos 8.5, 8.6 and 8.6 in Appendix A). The anchor details vary depending upon soil conditions and guy wire loadings. The following ground anchor design details apply:
  - o Fully grouted, untensioned, anchors up to 60ft m long; i.e. 60 ft in sand, 40 ft in till and 20 ft in bedrock.
  - o Williams galvanized ASTM 615 Grade 75 ksi thread bars. Bar diameters are 36 mm at the HVac towers and 43 mm for the HVdc towers.
  - o Thread bar anchors are supplied in 6 m lengths. Bars are coupled together with appropriate galvanized couplers to make up the required anchor lengths.
  - o Anchors are installed in cases and in inclined holes. They are tremie grouted through a plastic grout line as the casing is removed from the hole.
  - o Performance tests are performed at 200% design load (DL) and proof tests at 100% DL.

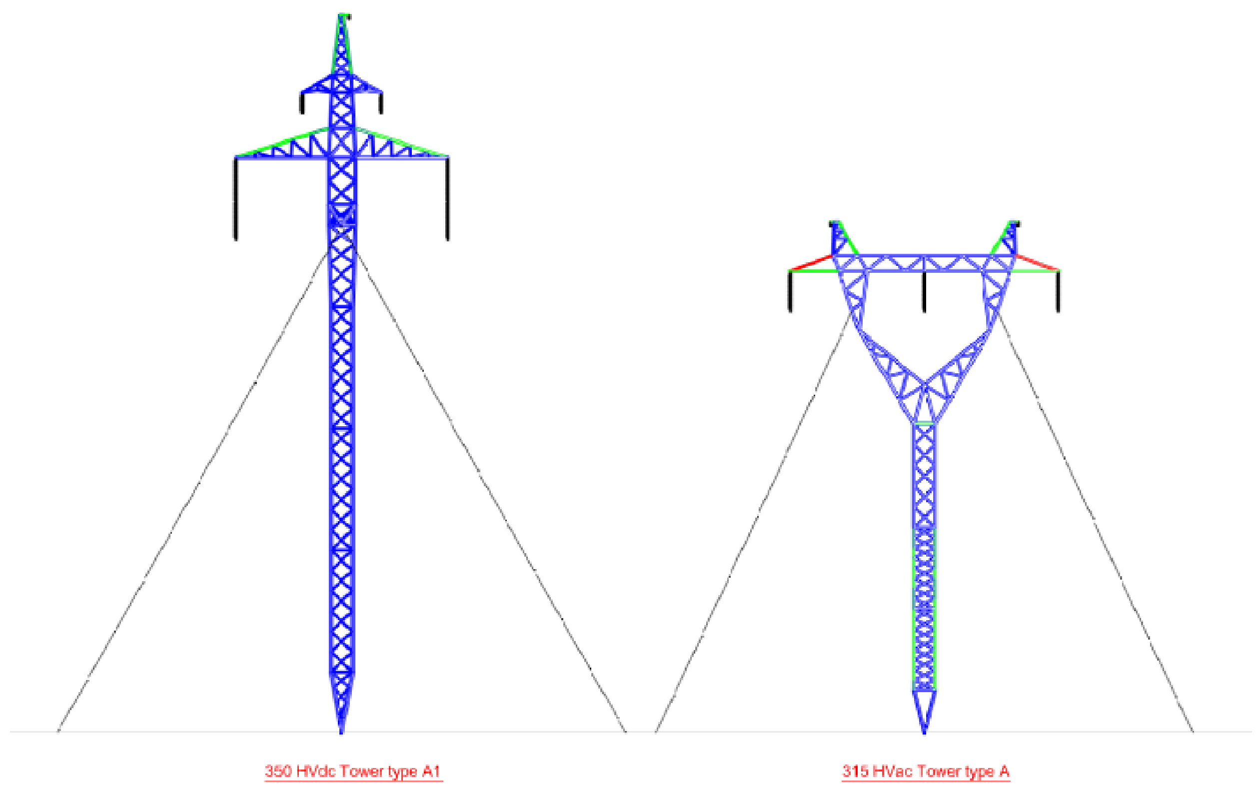

Figure 11.1: Typical HVac and HVdc towers.

The quality of the line clearing and transmission tower construction work is very good. All work is being carried out in a very safe manner, in accordance with Nalcor safety guidelines and regulations.

10. CHURCHILL FALLS NEW 315 KV SUBSTATION AND SWITCHYARD

A site visit was made to the 20 hectare Churchill Falls New 315 kV Substation and Switchyard site on July 18, 2014. Excavation, fill placement and other site preparation works were well advanced at the time of the site visit. Photographs are presented in Section 10 of Appendix A.

The site is inclined from the west to east. The terrain is covered by several metres of glacial till and there are bedrock outcrops in the higher ground of the eastern half of the site. The till consists of dense, heterogeneous mixtures of silt, sand, gravel and cobbles with varying percentages of medium sized boulders.

Site preparation works started in the spring of 2014. Bedrock and glacial till overburden are excavated from the higher ground and, after processing, placed in lifts as engineered fill in the lower ground in the south east. Overburden is being excavated with mechanical excavators and bedrock requires drill and blast excavation methods.

Bedrock and overburden materials are processed to remove boulders and oversized blocks to ensure their suitability for use as compacted fill. Fill is placed in 450 mm lifts and compacted to 98% Proctor with vibratory rollers. A rigorous quality control program ensures the quality of the works. Fill samples are subjected to soil mechanics laboratory testing and frequent in-situ density tests are conducted in the fields to verify compaction.

The quality of the excavation and fill placement work is very good. All work is being carried out in a very safe manner, in accordance with Nalcor safety guidelines and regulations.

11. DOWDEN'S POINT ELECTRODE STATION

The IE team visited the Dowden's Point electrode site on July 23, 2014. The proposed electrode site is on the shore of Conception Bay, near Holyrood .

There is good road access to the water's edge at this location. Site conditions are favorable for the planned civil and electrical works and no significant geotechnical problems are anticipated, providing design and construction are carried out to normal engineering standards. As per the project schedule, no work has been carried out at this site up to the time of the site visit.

12. COMMENTS AND CONCLUSIONS

The following conclusions and comments are presented.

- Work on the directionally drilled boreholes for the Strait of Belle Isle crossing was at an advanced stage during the site visits. The drilling operations, which are using state-of-the-art oil field technology, are being carried out to a high standard. As far as could be seen during the site visit, the work fully meets the requirements of the project.

- At Muskrat Falls the major excavations for the powerhouse /tailrace and the spillway channels have been completed. The blasting quality is excellent. The line drilled and pre-spit permanent faces have very little overbreak and blasting damage is minimal. Rock support installations are adequate and no significant rock slope stability issues have developed.

- Astaldi was still mobilizing to the Muskrat Falls site at the time of the site visit and was carrying out work on various civil structures. It is understood that there has been some schedule slippage by Astaldi, but the IE was assured by Nalcor that can be easily recovered once Astaldi's full mobilization is complete.

- During the IE site visit work was underway at the first four base slabs of the spillway. Concrete works for the powerhouse and intake have commenced. Formwork was being erected at the time of the IE site visit.

- The IE considers that the North Spur seismicity, hydrogeology and stability studies carried out during 2014 have satisfied the various geotechnical concerns for that feature. These studies confirm that the designed remediation and stabilization works are adequate and that there is no significant hazard from stability problems related seepage, strength reductions in sensitive soils and/or earthquake shaking during construction or operation of the project. The IE also agrees with the plan that further geotechnical observations and measurements will be made as the remedial works progress and as new geotechnical monitoring is performed. These observations will be calibrated against the expectations of the various analysis reports. Designs will be amended if any significant surprises or discrepancies are encountered.

- Site camps and infrastructure are adequate to handle the planned construction works. Roads are generally good, and are up the normal standard for a hydroelectric construction site.

- The IE team visited construction operation at the HVac transmission line between Muskrat Falls and Churchill Falls. The quality of the line clearing and transmission tower construction work is very good. All work is being carried out in a very safe manner, in accordance with Nalcor safety guidelines and regulations.

- The IE team made site visits to inspect site preparation works at the Churchill Falls New 315 kV Substation and Switchyard in Labrador and the Soldier's Pond - New 230 kV Switchyard, Synchronous Converter and HVdc Converter Site near Holyrood in Newfoundland. Cut and fill operations have been underway at each of these sites since the spring of 2014. The purpose of the current work is to level and prepare each site for the planned electrical installations. This work is being carried out to a high standard at each location and is on schedule.

- Schedule achievements are very good. Construction work will continue throughout the winter. The major works will be covered by large weatherproof shelters to enable civil works construction during winter conditions.

- At all sites, construction works are being carried out in compliance with very high standards of safety and environmental criteria.

APPENDIX NO. 1

Photos

1. Soldier's Pond - New 230 kV Switchyard, Synchronous Converter and HVdc Converter Site

Photo 1.1: Soldier's Pond site; excavation work at the west end of the site. (July 14, 2014)

Photo 1.2: Soldier's Pond site; placing compacted fill to grade at east half of the site. (July 14, 2014)

2. Forteau Directional Drilling

Photo 2.1: Forteau Directional Drilling. Inclined drill and equipment. (July 15, 2014)

Photo 2.2: Forteau Directional Drilling. Subhorizontal bedded sandstone at the Forteau drilling site.

Photo 2.3: Forteau Directional Drilling. , Photo of borehole Forteau 2 showing the 30 inch casing collar. (July 15, 2014)

Photo 2.4: Forteau Directional Drilling. Drilling rig looking towards the drillhole Forteau 2.

Photo 2.5: Forteau Directional Drilling. Drill bit and lower non-magnetic drill string components. (July 15, 2014)

Photo 2.6: Forteau Directional Drilling. Graded fill at future transition compound site above the drilling site. (July 15, 2014)

Photo 2.7: Forteau Directional Drilling. Excavated trench for the three cables between the transition compound and the drilling site. (July 15, 2014)

3. L'Anse au Diable Electrode Station

Photo 3.1: L'Anse au Diable Electrode Station site. The planned electrode pond site in a bedrock embayment. (July 15, 2014)

Photo 3.2: L'Anse au Diable Electrode Station site.

4. Forteau Rock Quarry

Photo 4.1: Forteau quarry. Principal quarry face on the right side of the photograph. Note stockpile of unprocessed rockfill in left background. (July 15, 2014)

Photo 4.2: Forteau quarry. Crushing and screening plant in operation.

Photo 4.3: Forteau quarry. Stockpile of processed rockfill. (July 15, 2014)

5. Goose Bay Marshalling Yard

Photo 5.1: Goose Bay Marshalling Yard (July 16, 2014)

Photo 5.2: Goose Bay Marshalling Yard. Labeled transmission components for tower foundation (July 16, 2014)

Photo 5.3: Muskrat Falls Camp, permanent and starter (Nalcor photo -Winter 2014)

6. Muskrat Falls Site

Photo 6.1: Panoramic view of the Muskrat Falls site looking towards downstream (July 18, 2014). The powerhouse/spillway site is visible on the upper right side of the photo. Transmission line clearing on the North Spur and reservoir clearing upstream of the falls are visible in the left side of the photograph.

Photo 6.2: Spillway base slab. Formwork for first four blocks of the base slab. (July 17, 2014)

Photo 6.3: RCC cofferdam above the spillway left wall. Note the localized blasting overbreak of the spillway rock slope caused by block sliding along pervasive foliation planes. (July 17, 2014)

Photo 6.4: RCC cofferdam above spillway left wall. (July 17, 2014)

Photo 6.5: Right rock slope at powerhouse. Note the excellent quality of the line drilled excavated rock walls. A single fallout of a small wedges has caused a very localized overbreak feature. (July 17, 2014)

Photo 6.6: Powerhouse excavation, view looking upstream. The excellent control blasting results are visible in the rock noses between the unit cut-outs. (July 16, 2014)

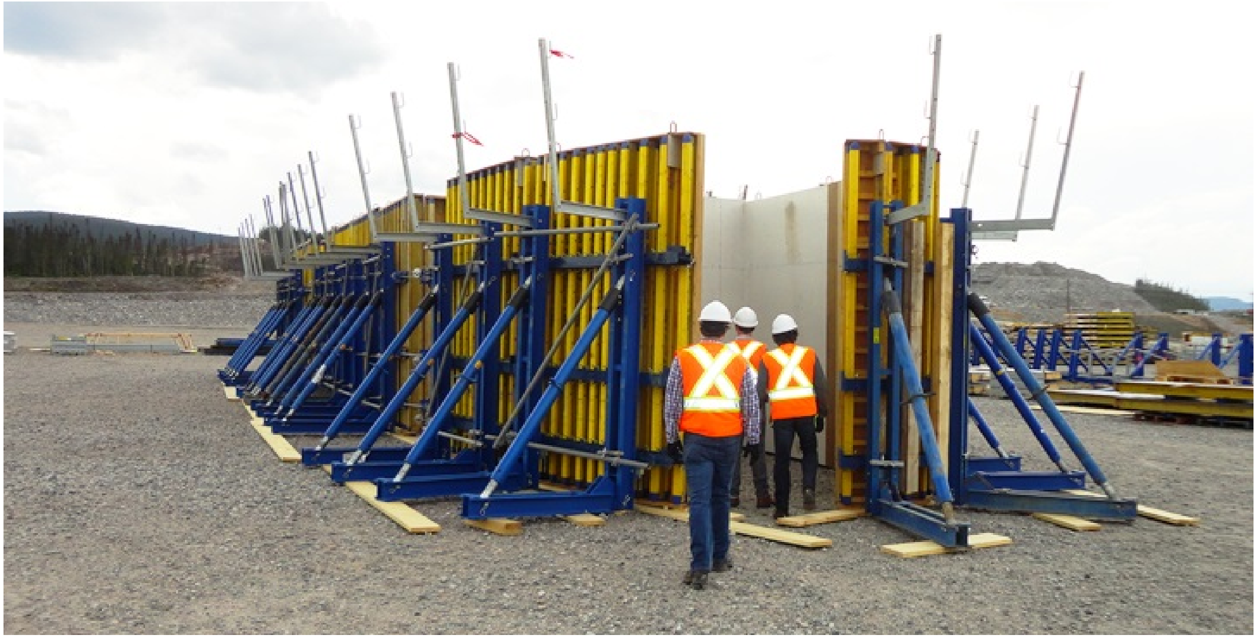

Photo 6.7: Trial assembly of tailrace pier formwork. (July 17, 2014)

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7. North Spur

Photo 7.1: North Spur. View from top of North Spur looking towards the upstream Churchill River. Note reservoir clearing in center field and right bank quarry aggregate stockpile in background. (July 16, 2014)

Photo 7.2: North Spur. Cleared transmission line corridor on top of the North Spur, looking northwest. (July 16, 2014)

8. Transmission Tower Erection and Foundations

Photo 8.1: Transmission Tower Erection and Foundations. Assembled single HVac tower unit. (July 17, 2014)

Photo 8.2: Transmission Tower Erection and Foundations. Excavated and prepared tower foundation (July 16, 2014)

Photo 8.3: Transmission Tower Erection and Foundations. Assembled grillage footings. (July 16, 2014)

Photo 8.4: Transmission Tower Erection and Foundations. Tower footings installed and backfilled (four legged tower) (July 16, 2014)

Photo 8.5: Transmission Tower Erection and Foundations. Ground anchorage assembly, complete with couplers. Inset shows a typical plastic centralizer (July 16, 2014)

Photo 8.6: Transmission Tower Erection and Foundations. Installing a ground anchor. (July 16, 2014)

Photo 8.7: Transmission Tower Erection and Foundations. Installed, fully grouted ground anchor. (July 16, 2014)

9. River Crossing site in Upper Reservoir

Photo 9.1: River crossing site in the upstream reservoir. (July 16, 2014)

10. Churchill Falls New 315 kV Substation and Switchyard

Photo 10.1: Churchill Falls New 315 kV substation and switchyard. Loading processed fill. Note stockpile of processed fill in the background and blasted rock in foreground. (July 18, 2014)

Photo 10.2: Churchill Falls New 315 kV substation and switchyard. Blast hole drilling in bedrock. (July 18, 2014)