From:	Bob Ilett
To:	robertwoolgar@lowerchurchillproject.ca; petermadden@lowerchurchillproject.ca; lanceclarke@lowerchurchillproject.ca
Cc:	Scott O"Brien; Ken Sparkes; Regis Bouchard; nasser.daiyan@snclavalin.com; alvaro.ceballos@snclavalin.com
Subject:	Re: Fw: Outstanding Items for MWH / Canada Due Diligence
Date:	Tuesday, November 5, 2013 3:17:47 PM
Attachments:	.png North Spur - IE Responses 06-Nov-2013.ppt

Robert/Peter/Lance,

Please see attached.

North Spur - IE Responses 06-Nov-2013.ppt

Bob Ilett
Package Leader - North Spur Stabilization
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Robert Woolgar---11/05/2013 02:09:35 PM---Jim/ Peter - follow-up on outstanding items... Julia/ Mark/ Michel are addressing Items 2/3 that wer

From: Robert Woolgar/NLHydro

To: James Meaney/NLHydro@NLHYDRO, Peter Madden/NLHydro@NLHYDRO,

Cc: Lance Clarke/NLHydro@NLHydro, Ken Sparkes/NLHydro@NLHYDRO, Julia Hiscock/NLHydro@NLHydro, Mark Turpin/NLHydro@NLHYDRO, Michel Maeyens/LCP/NLHydro@NLHYDRO, Bob Ilett/NLHydro@NLHYDRO, Scott O'Brien/NLHydro@NLHYDRO

Date: 11/05/2013 02:09 PM

Subject: Fw: Outstanding Items for MWH / Canada Due Diligence

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Jim/ Peter - follow-up on outstanding items...

Julia/ Mark/ Michel are addressing Items 2/3 that were noted on table...
Bob/ Ken are addressing Item 1 on table - they are preparing slide deck for meetings tomorrow...

I reviewed Item 58 with Ed Over today and not sure what we can say in response to that item - I will have to review with Scott tomorrow...

Julia/ Mark/ Michel/ Ken/ Bob - can you forward your information to Peter/ Lance this afternoon and cc me...

Thank-you,

Robert

Robert Woolgar, P.Eng.
Deputy Project Manager - MF Generation
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You owe it to yourself, and your family, to make it home safely every day. What have you done today so that nobody gets hurt?

----- Forwarded by Robert Woolgar/NLHydro on 11/05/2013 02:05 PM -----

From: Robert Woolgar/NLHydro

To: James Meaney/NLHydro@NLHYDRO, Peter Madden/NLHydro@NLHYDRO,

Cc: Scott O'Brien/NLHydro@NLHYDRO

Date: 11/04/2013 03:47 PM

Subject: Re: Fw: Outstanding Items for MWH / Canada Due Diligence

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Jim/ Peter - I have reviewed the list and reviewed the list with Peter today - my understanding is the following remain as gaps for C1...

Items 2/3 on table - follow-up e-mailed sent by Jim - I will action necessary resources from C1 to have answers mid this week...
Item 58 - commentary required from Scott on C1 Packages...
Item 71 - I believe we have covered what is needed from C1/ C3/ C4 - John is following up with SOBI...

Jim/ Peter - I have reviewed the table, but sometimes hard to see is an action is closed or who has been assigned the action to be closed. Outside of what I am noting above that needs to be closed from C1, can you let me know if others within C1 have been actioned to closed items

that are still outstanding and I can follow-up with them directly - I will focus on the 3 bullets above, unless there is something I have missed and please let me know and I will address...

Thank-you,

Robert

Robert Woolgar, P.Eng.
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Lower Churchill Project

North Spur Stabilization Works

6 November, 2013

Boundless Energy

SNC·LAVALIN EPCM consultant for Nalcor

nalcor energy
LOWER CHURCHILL PROJECT

North Spur Questions

Slope Stability

- Are the current designs backed up by new stability analyses?
- Yes, updated to reflect 2013 data.
- Have progressive failure mechanisms and/or other considerations appropriate for sensitive clays been considered?
- Yes. Key issue is prevention of the trigger mechanism
- Have any finite element analyses been carried out in this regard?
- No – LEM was used.

Slope Stability

- It would be useful to see if the analyses have quantified the impact of the various remediation measures that have been proposed; can Nalcor furnish the analyses?

Slope Stability

Calculated safety factors for stabilized slopes

	Loading case	Minimum Required Factor of Safety	Minimum Factor of Safety
Upstream Slope	Existing condition (W.L. 17 m)	_	1.1
	End of excavation (W.L. 17 m)	1.3	1.3
	Partial pool (W.L. 25 m)	1.3	1.8
	Steady state at F.S.L. (W.L. 39 m)	1.5	2.0
	Rapid drawdown, from W.L. 45 m to W.L. 39 m	1.3	1.5
	FSL with seismic loading, EDGM= 0.11 g	1.15	1.6
	End of construction (W.L. 17 m)	1.3	1.7
Downstream Slope	Existing condition	_	1.0
	End of excavations	1.3	1.4
	Steady state at F.S.L. (W.L. 39 m)	1.5	1.7
	FSL with seismic loading, EDGM= 0.11 g	1.15	1.4

Seepage Analyses

- Can Nalcor provide the new seepage analyses showing the impact of the upstream blanket and plastic cement cut-off wall (i.e., with and without this installation?
- 2D analyses were performed and can be provided.
- A supplementary hydrogeological 3D model is currently under way using the recently acquired data. This can be provided in due course.

Piezometer Levels After Impoundment

- Please provide the impact of increased piezometric pressures on the lower clay relative to the current saturation levels?
- Current saturation is 100%. Under the Spur no significant increase in piezometric pressure in lower clay is anticipated.

Piezometer Levels After Impoundment

- Does this increase in piezometric pressure change the properties of the clays whose water contents are greater than their liquid limits?
- No. Water contents in lower clay are not greater than LL and piezometric pressures will not change the properties.

Operation of Pumped Wells

- It is understood that the operation of the pumped wells will be discontinued once all of the stability measures have been completed. This decision will be subject to piezometric levels as indicated by monitoring. Has the project group established trigger piezometric levels that will indicate pumping must resume?
- The pumping system will remain operable for at least two years after construction and it is not intended to decommission it. However monitoring will be conducted to evaluate the system response, particularly during construction and the first stage of impoundment (2016-2017). During this time the trigger level has been set at El. 10 m. This level will be adjusted as required based on the monitoring program.

Landslide Generated Wave in Reservoir

- The reservoir contains at least 15 old and relatively recent landslide scars. Future landslides are likely after impoundment. It is understood that earlier studies have computed that a 4.5 m wave can be generated by the rapid failure of a 50 Mm^3 landslide. Is this the maximum wave for stability calculations and overtopping assessments?
- Maximum elevation for wave is calculated to be 45.3 m (PMF condition). Slope protection measures extend up the slope face to El. 47 m. Overtopping is not an issue at the North Spur (Elevation of crest 60 m.)

Landslide Generated Wave in Reservoir

- Has there been an evaluation of the impact of a severe landslide generated wave on the planned slope protection measures on the upstream slope of the Spur?
- Yes, slope protection measures have been incorporated to El. 47 m.

Earthquake Criteria

- Has the 0.09 PGA earthquake ground motion value (damsite, hard rock NEHRP Type A site) been increased for seismic analyses of the overburden terrain of the Spur (NEHRP Type D site)?
- Yes, it was increased in accordance with the site-specific seismic hazard assessment.

Liquefaction Analyses of Sensitive Silt/Clay

- Have liquefaction analyses for earthquake loadings been carried out for the sensitive silt/clay slopes?
- Yes, using several different approaches. CSR and CRR were evaluated in accordance with Seed et al. (1971 and later). Results derived show adequate FOS.
  Assessments were also made using method presented by Youd et al. (2001) and Boulanger and Idriss (2006 and 2007), with satisfactory results.
- Notwithstanding the above, a supplementary study is being initiated to obtain expert opinions from both R. Seed and I. Idriss to fully address this issue.

Liquefaction Analyses of Sensitive Silt/Clay

- Have the unique properties of the sensitive silt/clays been evaluated and what tests were performed?
- Yes, the materials have been evaluated. A range of testing has been carried out, including fall-cone tests, measurement of intact and remoulded strength and conventional index tests. In addition shear wave velocity profiles were measured on site using CPT equipment. Prof. Serge Leroueil (U. Laval) has provided expert opinion on the material testing and results.
- Has a summary report been prepared?
- This is still in preparation, but can be furnished on completion.

Planned Monitoring Program

- Has a long term monitoring program for recording instrument data and visual observations been produced? It would be useful to see details of this, particularly plans for continuing technical evaluation of the results.
- The construction program includes provision for an extensive geotechnical instrumentation system that will include piezometers, inclinometers and flow measurement. The system will be set up for real time remote reading. The calibration of the system will be carried out during construction and the first stage impoundment (2016-2017). The project O & M Manual will be developed based on observations and results through that period.

Sharing our ideas in an open and supportive manner to achieve excellence.

Teamwork

Open Communication

Fostering an environment where information moves freely in a timely manner.

Honesty and Trust

Being sincere in everything we say and do.

Relentless commitment to protecting ourselves, our colleagues, and our community.

Safety

Respect and Dignity

Appreciating the individuality of others by our words and actions.

Leadership

Empowering individuals to help, guide and inspire others.

Holding ourselves responsible for our actions and performance.

Accountability