MEETING REPORT

Main Issue: Teleconference to discuss NRCan's Recommendations provided in the Technical Report

Attendees: **Meeting Date:** 26 July 2012

(1) Christine Rivard (CRi) [NRCan]
(2) John King (JKi) [NRCan]
(3) Fons Schellekens (FSc) [NRCan]
(4) Aruna Dixit (ADi) [NRCan]
(5) Rob Johnstone (RJo) [NRCan]
(6) Veronica Mossop (VMo) [NRCan]
(7) Rick Schryer (RSc) [Fortune]
(8) Ken Bocking (KBo) [Golder]
(9) Devin Hannan (DHa) [Golder]
(10) Lasha Young (LYo) [Golder]

Summary of Discussion:

NRCan, Fortune, and Golder went through each of the recommendations provided by NRCan in the Technical Report on the NICO Project during the teleconference. The following provides NRCan's recommendation and a summary of the answers provided during the call are provided.

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Recommendation 1

NRCan recommends that the Proponent consider, during final detailed design, the potential localized uranium anomalies near Borrow Source 1. NRCan is willing to working collaboration with the Proponent.

Response during Teleconference

Fortune is committed to avoiding sites with any potential uranium anomalies

NRCAN is satisfied with this response

Recommendation 2

NRCan recommends that the Proponent provide:

a) Explanation in which projects, where and how the runoff coefficients and infiltration coefficients for CDF, perimeter dyke and till cover shown in Table 3.III.3-4 were determined

b) Clarification how recharge rates of 10 mm/y in lowlands and 30 mm/y in highlands were estimated;

c) Explanation how the specific yield values in Table 11.I.4-3 were determined; and

d) Clarification what the right mean precipitation value is for the NICO site.

Response during Teleconference

2a) Golder will provide a written response on the coefficients and cite examples from other Projects

2b) Golder will provide a written response. The groundwater model utilized recharge rates of 30 mm/yr and 10 mm/yr in the uplands and lowlands, respectively. Golder noted that the justification and implementation of the recharge rates were discussed in Appendix 11.I Sections 11.I.2.3, 11.I.2.4, 11.I.3, 11.I.4.6.1, and 11.I.5 – selected text excerpts from these sections were read during the call. The justification for these values was further elucidated as follows (minor additional details beyond those mentioned during the call are provided for clarification):

- Prior to model parameterization, the baseline hydrology study (Annex G, Section 5.8) was consulted. Infiltration rates for Burke and Lou watersheds were estimated to be on the order of 50 mm/yr on average. However, as explained in Annex G, this estimate is considered high. As such, 50 mm/yr was considered an initial upper bound on recharge input for the preliminary model, with an understanding that lower recharge rates were likely acceptable.
- In the upland areas downward gradients have been measured. Conversely, in the lowland areas the water table is generally at or close to ground surface. As such, it was conceptualized that higher recharge rates would occur in the upland areas versus the lowland areas. This quasi-quantitative conclusion provided an additional constraint on the model input.
- The recharge rates in the upland and lowland areas were fine-tuned and finalized through model calibration. The model was calibrated through a “trial-and-error” process by varying the recharge and hydraulic conductivity of the hydrostratigraphic units within the model until simulated groundwater elevations, flow directions and stream discharge compared reasonably well with observed conditions. Calibration targets included average static water levels measured at 82 NICO wells and low flow measurements at 10 surface water stations. It was found that the recharge rates utilized in the model generally resulted in a reasonable match to observed heads. Furthermore, the simulated baseflows were below or within the measured low-flows at the gauges. As baseflow separation was not possible at these gauges (mainly due to interference from beaver dams), a modelled flow below or between the measured low-flow range was considered a reasonable match.

2c) The following text from Section 11.I.4.6.3 Porosity and Storage was read during the call:

> *A porosity of 0.4 and a storativity of 0.18 were used for the overburden material. These values are considered typical for silt till (Freeze and Cherry, 1979 and Johnson, 1967).*
>
> *The bedrock porosity was derived by analyzing packer testing data in combination with rock characterization descriptions for boreholes 03-281, 03-282 and 03-283. Using the “Osnes Extraction from Fixed-Interval-Length Effective Transmissivities” (OxFilet) method (Lim and Dershowitz, 2010), a mean effective porosity of 3.4E-4 was calculated, with an upper end of 0.002 and a standard deviation of 2.4E-4. An effective porosity of 0.002 was used for the fractured rock at surface. The mean porosity of 3.4E-4 was used in the model elsewhere in the rock.*
>
> *Specific yield in the bedrock was considered to be equivalent to porosity. Specific storage was assigned as 1E-6/m.*

Golder noted during the call that, in the absence of site specific storage data, assigning a specific yield value equivalent to porosity was a reasonable assumption.

It was explained that the OxFilet method is based on in-situ measurements, as such it may provide a superior estimate of porosity over general “textbook” values.

NRCan questioned the low porosity in the upper fractured rock (0.2%), indicating that references they had consulted frequently showed fractured rock porosities higher than 1%. Golder notes that the upper fractured rock is largely composed of rhyolite, a crystalline rock which could be considered the extrusive equivalent of plutonic granite rock. While Golder acknowledged that the porosity is low compared to some other fractured rock environments, our references indicate that a porosity of 0.2% is not unprecedented in crystalline rock. After the call, Golder confirmed that *Groundwater* (Freeze and Cherry, 1979) presents a fractured crystalline rock porosity range of **0%** to 10% (emphasis added by Golder), while *Porosity and Permeability of Materials* (Davis, 1969) lists a granite porosity of 0.3%.

Additional details will be provided in a formal written response

2d) Golder acknowledged that there are conflicting precipitation values in the documentation and the reason for this was not immediately resolvable. Clarification will be provided in a formal written response.

Recommendation 3

NRCan recommends that the Proponent provide:

a) Explanation why the piezometric map was produced using the topography as an indicator of mean groundwater depth, while the correlation between topography and groundwater levels is very low;

b) Clarification how groundwater levels were estimated in lowlands, beyond streams;

c) Explanation which method of interpolation was used to create the piezometric map; and

d) Clarification if groundwater levels were measured during packer tests, and if vertical hydraulic gradients were estimated.

Response during Teleconference

3a) Golder expressed disagreement with NRCan's conclusion that "correlation between topography and groundwater levels is very low". Prior to the call, Golder internally produced a chart showing topography vs. measured water level that indicated a high degree of correlation between the two variables (it was not sent to those on the call, however).

NRCan indicated that their assessment was based on data provided in Table 11.I.2-1: Groundwater Level Data. However, Golder noted that there were no topographic elevations provided in this table, as such it was unclear how NRCan was able to compare topography to measured groundwater elevation solely based on this data.

Additional details will be provided in a formal written response.

3b) Golder read the following from Figure 11.I-6 during the call:

> *The inferred regional groundwater elevation map was developed using the following data: Average site water levels, lake and river levels as per DEM, and assumed groundwater table depth of 17 m below ground in the upland areas (i.e. regions reaching above 260 masl topography). As actual regional water table elevations from wells are not available, water level contours should be for illustrative purposes only.*

Golder further explained that water levels in the lowlands were constrained by lake and river levels. The interpolation routine was allowed to freely calculate water table values between these features, however, the resulting surface was constrained such that it would not surpass topography.

3c) Golder noted that the minimum curvature method, utilized within the Surfer 9.0 software, was used to produce the water table map. A grid spacing of 100 m x 100 m was utilized. A written response will be provided.

3d) Golder noted that Golder's Marc Rougier (absent during the call) was the most qualified to address this item. A detailed written response will be provided.

Recommendation 4

NRCan recommends that the Proponent provide:

a) A few (or at least one) cross-sections showing borehole logs with their depth, depth to bedrock and stratigraphy, as well as associated piezometric levels (at different depths if available) to better understand the hydrogeological context;

b) Clarifications how hydraulic conductivities (K) of the 1st, 5th, and 6th layers of the conceptual model (show in Figure 11.1-9) were selected;

c) Explanation if the K values were measured before or determined a posteriori during numerical modelling;

d) Clarification if different combinations of K and recharge values were tried in groundwater flow model runs;

e) Explanation if the high value for layer 1 (10-6 m/s) was selected to be on the conservative side for infiltration;

f) Clarification if the modelled discharge (outflows) in different areas were compared in measured low flow values, and how the model was calibrated;

g) Explanation why not at least one pumping test was conducted, if a pumping test is planned, and if it is planned, when it will be conducted;

h) Clarification is the reason for this underestimated hydraulic heads could be a locally increased recharge; and

i) Justification to neglect runoff in this work, since the open pit floor will soon be situated at a lower elevation than a large part of the watershed.

Response during Teleconference

4a) Golder noted that cross-sections have been completed but were not readily available for the call. Golder will provide the cross-sections to NRCan along with the aforementioned written responses.

4b) Golder read the following from Section 11.I.4.6.2 Hydraulic Conductivity:

> *The hydraulic conductivity distribution of each model layer is shown on Figure 11.I-7. The hydraulic conductivities utilized in overburden and bedrock fall within the range of measured values presented in Section 11.I.2.5, and were fine-tuned during the calibration process, as described in Section 11.I.5. The highest hydraulic conductivity layers are the upper fractured rock in the upland areas and the silts in the*

lowlands (1E-6 m/s); from these shallow zones the hydraulic conductivity decreases with depth (1E-9 m/s in the deep bedrock).

Upon further discussion it was Golder's understanding that a specific concern of NRCan's was linked to Figure 11.I.7, which shows a range of measured hydraulic conductivity values in rock corresponding to each model layer, and that perhaps the final hydraulic conductivity decided upon for the 100 mbgs deeper layers (1E-9 m/s) may be underestimated based on the available measurements corresponding to that depth range, particularly in lieu of 03-283 which shows a hydraulic conductivity of approximately 5E-8 m/s.

In response Golder noted that there are three measurements solely confined to the 100 mbgs+ range. For clarification: their values are 2E-10 m/s (03-283***), 8E-10 m/s (03-282), and 5E-8 m/s (03-283), resulting in a geometric mean of 2E-9 m/s for this interval. The higher value measured at 03-283 was identified as perhaps a local anomaly, and it would be unlikely that a fracture of this conductivity would be present and connected at a regional scale at this depth. In any event, the modelled bulk K falls within the range of measured values, is close to the geometric mean for this interval, and resulted in a satisfactory calibration. As such, Golder felt the value was appropriate.

Additional details will be provided in a formal written response.

4c) This question was not addressed directly during the call but Golder did note during the course of the discussion that hydraulic conductivity values utilized in the model had their basis on prior field measurements (see previous response and Figure 11.I-7). Field-derived hydraulic conductivity measurements and results were established before, and independent of, any groundwater modelling activities. Additional details will be provided in a formal written response.

4d) Golder confirmed that various combinations of hydraulic conductivity and recharge values (within reasonable ranges) were attempted during the calibration process. The final values utilized were those found to provide the best overall match to measured heads and measured stream flows. Additional details will be provided in a formal written response.

4e) This item was not addressed during the call but will be answered in a formal written response.

4f) Golder referred NRCan to Section 11.I.5 Model Calibration for a description of the calibration methodology, and Figure 11-I-16 for a comparison of simulated baseflows to measured stream flows ranges (including low flows). Based on this discussion, it was Golder's impression during the call that NRCan was satisfied with the calibration approach and the simulated baseflow results. Additional details will be provided in a formal written response.

4g) Golder suggested during the call that a pumping test with meaningful results may be difficult to achieve in the low permeability fractured rock environment. A more thorough discussion will be provided in a formal written response.

4h) This item was not addressed during the call but will be answered in a formal written response.

4i) This item was not addressed during the call but will be answered in a formal written response.

Recommendation 5

NRCan recommends that the Proponent provide:

a) Information on the expected K value of the thickened tailings; and

b) Information on the expected groundwater flow through the CDF, and from the CDF into the underlying material

Response:
5a) 1 x 10^{-8} m/s is a typical k-value

5b) A written response will be provided

Recommendation 6

NRCan recommends the following in order to identify sensitive areas along the road corridor and to support final route selection and road design to ensure environmental effects are minimized:

a) Conduct detailed terrain analysis supported by geotechnical investigations to characterize terrain sensitivity along the proposed route and to identify areas of potential instability. The product associated with this analysis will be large scale route alignment sheets that include this detailed information;

b) Conduct thermal analysis and determined potential ground settlement for representative terrain types to support detailed road design including determination of the embankment height and other mitigation measures (such as drainage control). The analysis should consider changes in snow cover and drainage that may influence the ground thermal regime; and

c) Include in the assessment of environmental impacts, consideration of longer tem effects associated with vegetation removal and changes in permafrost and drainage conditions along the road corridor.

Response:
Fortune indicated during the call that the final access road alignment is pending the Tlicho Tradtional Knowledge study and that a detailed study will follow. Fortune understands that NRCan did not expect a response now, but it would be included in the final design.

Recommendation 7

NRCan recommends the following with respect to environmental monitoring and management plans:

a) Environmental monitoring and management plans include installation of instrumentation in addition to visual inspections to monitor changes to the ground thermal regime and ground movements especially in sensitive areas; and

b) Monitoring and mitigation/management plans be developed that define the criteria for the need for mitigation and selection of the appropriate mitigation technique.

Response:
Fortune indicated this would be something they will consider.

Recommendation 8

Recognizing the design of the CDF is at a preliminary design level, NRCan recommends the following for detailed and final design of the CDF:

a) The Proponent conduct further geotechnical investigations within the footprint of the CDF to improve the characterization of foundation materials and to support the detailed design;

b) The Proponent refine the seepage and stability analysis for the CDF incorporating the new information from detailed geotechnical investigations. This will also include updated creep analysis and consideration of effects related to the possible presence of frozen and unfrozen layers within the pile such as porewater expulsion and elevated pore pressures; and

c) The Proponent follow through on commitments to develop an effective CDF monitoring and management plan which includes installation of instrumentation (such as piezometers, slope inclinometers, settlement plates, thermistors). Plans should also include a definition of triggers (or critical values) that determine the need for implementation of mitigation and the criteria for selection of mitigation techniques.

Response:

8a) Agreed with NRCan's comments. More geotechnical information will be collected for detailed design.

8b) Agreed. Future analyses will consider if ice is found to be present in continuous layers.

8c) Fortune has committed to adaptive management plans

Consider instrumentation part of detailed design

Thermistors yes, settlement hubs, perhaps a few inclinometers on critical sections if identified

Recommendation 9

NRCan recommends the Proponent provide information about the open pit slope stability analysis.

Response:

This item was not addressed during the call but will be answered in a formal written response.

Recommendation 10

For the CDF slope stability modelling, NRCan recommends t**hat the Proponent clarify how the 22° friction angle** was derived for the glacio-laustrine unit.

Response:

Based on experience, most alluvial clays have Ph values between 20 and 25 degrees.

Recommendation 11

NRCan recommends that the Proponent provide further information to justify the use of a 22° friction angle for the glacio-lacustrine material and the use of circular slip surface in a cross-section in which a weak foundation layer exists.

Response:
Golder to check geotechnical database to see if they have any test results, and will be answered in a formal written response.

Recommendation 12

NRCan recommends that, if Figure 13.2-4a and Figure 13.2.2 (DAR: 13 SON Terrain and Soils, Section 13.2) are to be used in the future for regulatory or other applications, that the following inconsistencies be corrected:

Figure 13.2.4a and Figure 13.2.2 should use the same terrain units

a) Figure 3.2-1 should make use of other sources of data to complete "unclassified" regions; and

b) glacio-lacustrine deposits/soils and till exposed on hillsides and elsewhere should appear on terrain maps.

Response:
This item was not addressed during the call but will be answered in a formal written response.

Developer Commitment(s):

See below action items.

Outstanding Issue(s) for the Party:

See below action items.

Action(s):

(1) Fortune = Provide meeting minutes for NRCan review and approval

(1) Fortune = Provide written responses to 2a to 4i, 5b, 9, 11, and 12. These will be provided by 20 August 2012 to NRCan.

Signature of party representative: ______________________

Signature of Developer representative: ______________________

Date: Aug. 24/12

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