INFORMATION REQUEST DIRECTED TO THE PROPONENT PART 1 Water Quality &Quantity, Fish & Fish Habitat						
CEAA 4	ECCC-IR-12	5(1)(a)(i) Fish and Fish Habitat	6.2.2, 6.3.1	Appendix IV - Technical Note, Water Management Plan- Conceptual Engineering for Howse Water Management Plan. Section 8	<u>Water Balance Model</u> The water balance model is used to characterize the existing stream flow regime in local streams, to assess the project's effects on surface water quantity (and hence fish habitat), as well as to quantify the volume of monthly mine-drainage water to be treated by the sedimentation ponds. In the water balance model, water losses appear to be overestimated, possibly underestimating the monthly volumes of mine-drainage water to be treated, and the estimates of existing and post-development flows in the local streams. The results of the water balance model for Sedimentation Pond Howse A are examined. Based on the water balance model methodology (Section 8.1) runoff is obtained by multiplying total precipitation by a runoff coefficient, in this case 1.0 for months where the ground is generally frozen, and 0.4 for the months of June to September. The precipitation that does not run-off is referred to as "infiltration" (refer to the 4th column of Table 8-2). The above method to estimate runoff volume is current practice, as combining all water abstractions (sublimation, evaporation, transpiration, etc.) into a single parameter (i.e. the runoff coefficient) minimizes the complexity and hence errors associated with estimating several hydrologic components. The part of the methodology that is questionable is the abstraction of evapotranspiration (6th column) from runoff, as this water abstraction would be already accounted for in the "infiltration" column. As such, there seems to be a double-counting of water losses, which would result in an underestimation of the runoff quantities. Indeed, the estimated annual inflow (7th column, 271,610 m^3 / year) appears to be on the low side. The estimated volume translates to a runoff depth of 460 mm, which is about 30% lower than the value quoted from the 1997 regional analysis by K. Rollings "The Hydrology of Labrador", i.e. 650 mm (reported on page 11, Section 2.5). We note that in a more recent regional analysis by Statistics Canada "The Water Yield for Canada as a Thirty-year Average (1971 to 2000)", even larger runoff volumes are estimated for the area, for instance approximately 700 mm (refer to Map 13).	Review analysis and confirm if water balances were underestimated or provide a rationale on why they are appropriate. Provide additional references or sources of information if needed to support rationale. If the balances were underestimated, revise and update the analysis and determination of significance.
HML Answer						

Request from EC June 30 2016:

1. Add a new column to the water balance tables that will provide the «all-encompassing" runoff coefficients, i.e. runoff coefficients that incorporate all water abstractions including evapotranspiration. This new column could be inserted between column 6 (Evapotranspiration) and column 7 (Inflow). Using Table 8-2 as an example, the runoff coefficients would be of 1.0 and 0.0 for the months of May and June respectively. The new column should provide all twelve monthly runoff coefficients and the average annual runoff coefficient.

2. Support and validate the observation that local hydrology differs from the regional hydrology using data obtained during the local monitoring campaign. We understand that the local monitoring campaign included measurements of flows (i.e. runoff) at different sites as well as measurement of precipitation. We are not certain what was the duration of the monitoring period, but for the purpose of this example, we are assuming that the proponent has monitoring data from 2011 and 2014. An acceptable method to validate this observation could be to compare the local runoff coefficients observed during the local monitoring period with the regional coefficient. For example:

a. determine the total depth (or volume) of precipitation for each year at the site, e.g. for 2011 and for 2014.
b. determine the total depth (or volume) of runoff based on the local monitoring campaign for each year
c. compute the two annual runoff coefficients for the site (one for each year)
d. based on historical precipitation data, determine if 2011 and 2014 were dry, average or wet years
e. compare qualitatively the local runoff coefficients to the regional coefficient taking into consideration the information from point "d".

3. Sensitivity analysis: assuming that the average long-term inflows estimated by HML as having a total depth of 460 mm per year could be 50% larger (up to 700mm/year as suggested by ECCC), how would the assessment of the project's effects and infrastructure sizing vary should the estimated inflows be augmented by 50%?

Email sent from HML to EC on July 11 2016:

Prior to commencing the work on water balance modelling at the Howse mine site, can you please consider the following points:

1 With respect to the 700 mm runoff volume suggested in CEAA 4, we would like to point out that the 66-year average for precipitation in Schefferville is 780 mm. As such, it would be impossible, even in the absence of infiltrations and thus simplifying the water balance tremendously, for the runoff volume to be 700 mm, as suggested (precipitation = runoff + infiltrations + evapotranspiration = 700 + 0 + 240 = 940mm). We suggest that a much smaller runoff would be more realistic under the circumstances.

2 We would also like to clarify that, with respect to impact on infrastructures, design considerations were based on both the type / life of structure and on a determined return period of design storm and not on water balance computations. Adopted design storm return periods are 100 years for ditches and sedimentation ponds emergency spillways, and 25 years for design particle sedimentation in sedimentation ponds. The design storm event is typically mathematically generated from intensity-duration-frequency (IDF) data for a specific project location. Therefore the two calculation methods are not related. This methodology is standard in the mining industry.

We believe that these two points may impact your request for follow-up items 2 and 3 below. Can you provide comment?

Email from EC July 11 2016:

Point 1: This point illustrates well how the precipitation and runoff vary in time and how "reference values" also vary with the period on which they are based. The 700 mm runoff volume

(taken from the 2005 study by Statistics Canada) is a value derived from data observed during the 1971 to 2000 period, while the 240 mm evapotranspiration value (taken from the 1978 Hydrologic Atlas) is a value based on observations made during the 1941 to 1970 period. In our view, including the two reference values in the same equation would require that the difference in climate conditions between the two 30-yr periods be factored in. (note: in case this is not clear, as discussed in our meeting, the consultant is retaining the current methodology, i.e. both infiltration and evapotranspiration losses will be accounted for separately. Question CEAA 5 is therefore moot and evapotranspiration remains at 111 mm/yr for the analysis, not 240 mm/yr as suggested in CEAA 5.)
In our view, a better approach is to compare hydrologic parameters within the same period. If we go back to the two studies we referred to in CEAA 4, we have the following parameters:

- 1997 Rollings, which is based on data from the 1948 to 1996 period: Prec = 800 mm, Runoff=650 mm. Hence the runoff coefficient is 0.8
- 2005 Statistics Canada, which is based on data from the 1971 to 2000 period: Prec = 823 mm*, Runoff=700 mm. Hence the runoff coefficient is 0.85 (* Climate normal 1971-2000 for Schefferville)
- Table 8-2 (SNC-Lavalin), which is based on data from the 1949 to 2013 period: Prec = 780 mm, Runoff (named "inflow")=460 mm. Hence the runoff coefficient is 0.59. (Note: if we were to exclude the evapotranspiration losses, the runoff coefficient would be 0.72)

The average annual precipitation values (800 mm and 823 mm) associated with the two reference studies are consistent with the average annual precipitation from the Schefferville station (780 mm) although slightly higher (i.e. 2.5% to 5.5% higher, respectively). However the local runoff coefficient (0.59) based on the Schefferville station data is considerably smaller (26% to 31% smaller) compared to the regional analyses. If indeed local hydrology is different than the regional hydrology, a runoff coefficient of 0.59 could be reasonable. Data obtained during the local monitoring campaigns could therefore be used to validate this difference. We therefore retain our follow-up item no. 2.

Response from EC July 13 2016:
Thank you for clarifying that the results of the water balance model are not used in sizing of the infrastructure. Please include this explanation in your official response to CEAA. The sensitivity analysis can therefore focus only on the assessment of the project's effects on the environment (e.g. fish habitat, water quality, as applicable).

HML sent Report to EC on July 20 to validate that the local hydrology (at the Howse site) differs from the regional hydrology. Please see appended document:

Hemis PR185-19-14 Howse IR Appendix Answer to CEAA 4-5 Part 1 160712

Response from EC on July 22 2016:
This analysis of three years of data measured at two WSC local stations actually provides more evidence than we had anticipated possible. Considering this new information, the long-term average value for a typical average year of 460 mm that was estimated with the water balance model now appears to be conservative when compared with the runoff observed (approx. 200 mm) at the two stations in 2012 and 2014 (using these years as a proxy for average conditions). For that reason, we will not require a sensitivity analysis to be conducted, as we requested in my email dated July 11.

Additional note from Proponent:
The Proponent wishes to note that the work to date is conceptual in nature and that the data used was limited, simplified and conservative. This includes, for example, that snow melt was complete by the month of June in most years according to the 39 year of data used for the analyses. The Proponent therefore believes that this analysis is therefore representative of the

					long-term average. During the next phase of the project, additional data will be available, which will allow for a more complete calibration of the modelling. This will allow for the Proponent to eliminate the hypotheses made on the conceptual engineering to date, and therefore obtain more precise results on a daily/monthly basis.	
CEAA 5	ECCC-IR-13	5(1)(a)(i) Fish and Fish Habitat	6.2.2, 6.3.1	Appendix IV - Technical Note, Water Management Plan- Conceptual Engineering for Howse Water Management Plan. Section 2.4	**<u>Hydrologic Parameter:</u>** The evapotranspiration is one of the hydrologic parameters used in the water balance model to estimate the quantity of mine-drainage water and flow rates in local streams. The estimated evapotranspiration values appear to be underestimated, which could affect validity of the model results. The evapotranspiration is assumed to be equal to 35% of lake evaporation (i.e. 111 mm/yr). This estimation is based on the proponent's experience with similar projects; however, no references or data are given to support this estimation. Based on the Hydrological Atlas of Canada, the annual evapotranspiration (Plate 25) in the vicinity of the mine site is approximately 240 mm and the mean annual lake evaporation (Plate 17) is around 290 mm (which corroborates well with lake evaporation estimates for Churchill Falls the proponent provided in Table 2-10). Using the Atlas values, the ratio of evapotranspiration to lake evaporation would be around 83%, which is more than twice the value considered in Section 2.4.	Review analysis and confirm whether evapotranspiration was underestimated or if it remains adequate, and provide associated rationale. Provide additional references or sources of information if needed to support rationale. If the rate was underestimated, revise and update the analysis and determination of significance.
HML Answer Please see Proponent's response to CEAA 4 above that validate that the local hydrology (at the Howse site) differs from the regional hydrology.						