ANSWERS FOR QUESTIONS ASKED BY NATURAL RESOURCES CANADA

FOLLOWING THE REVIEW OF JOURNEAUX ASSOC PERMAFROST REPORT FOR HOWSE DEPOSIT

NRCan Request: Please confirm that the borehole HW-GT13-01 equipped with a thermistor cable as reported by Golder Associates (Volume 2, Appendix A) is the same cable mentioned in the Report No. L-15-1802. If yes, please confirm the location of the borehole according to the "potential permafrost map" (Figures 6.19 and 6.20, Volume 1, Main Document).

Answer:

The thermistor cable HW-GT13-01 mentioned in the Journeaux Assoc report L-15-1802 is the thermistor cable installed by Golder Associates in borehole HW-GT13-01 drilled in December 2013.
The borehole HW-GT13-01 is located at the south east limit of Howse deposit as shown below in Figure 1. As shown, HW-GT13-01 is between 50 m and 100 m outside the potential permafrost boundary limit shown on the plan prepared by IOC in the 1980s.

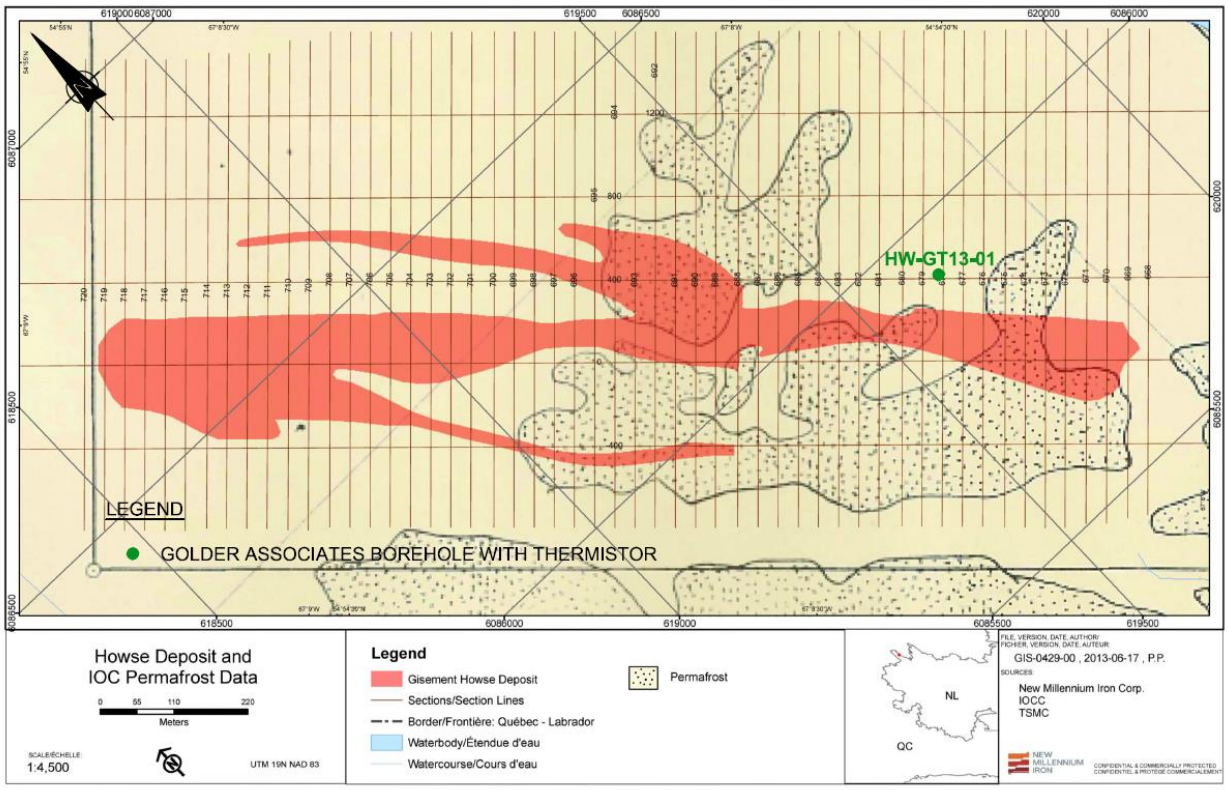

Figure 1: Location plan showing Golder Associates borehole HW-GT13-01 equipped with thermistor

The permafrost boundary limit shown on the plan is a virtual line which does not exist in the field. When the drillers located the borehole on site, they intended to drill an inclined hole to intersect the east pit wall.

It should also be clarified that the original program of Golder Associates was to drill four holes at the two pit wall limits; but due to adverse winter conditions the program was abandoned. The main objective of these thermistors along the pit walls was to investigate if permafrost was to be encountered during the mining operations. For this reason, the thermistor HW-GT13-01 was oriented towards the north east into the pit wall instead to the permafrost area shown on the plan.

- **In the absence of the information requested (Granberg, 1983; IOCC 1974)**

Answer:

The Granberg article is available for consultation only at the McGill library in Montreal, Québec. The article is also available through the GEOSCAN search results at http://geoscan.nrcan.gc.ca/, but is currently un-digitized. TSMC has made a request to be alerted when the digitized request becomes available, and will communicate it to NRCAN when available.

The IOCC (1974) document is appended to this document.

- **NRCAN request: Please provide clarification as to how this "potential permafrost map" has been produced.**

Answer:

The predictive 'permafrost potential mapping' was completed prior to more current, field-based data becoming available from a combination of (i) recent, project-specific measurements of ground temperature data (e.g., from thermistors installed by Golder Associates in the Howse Deposit); (ii) a study completed by Journeaux Assoc (2015) that reveals the important local relationship between elevation and permafrost occurrence, based on both historic and current data; and (iii) additional field observations made by Journeaux Assoc (2015) and Gilles Fortin (pers. comm., 2015). While the general spatial trends predicted in the original mapping are still valid - that is, permafrost is most widespread on windswept hill crests - the new information indicates that ground temperatures in the woodlands in the area are insufficient to maintain permafrost. Accordingly, permafrost (if present) is likely restricted to windswept highs above about 660 m elevation.

The ground temperature of the thermistor HW 1008 CC published by Granberg (1983) is presented in Figure 3. As it can be noticed the ground temperatures available from this thermistor are not very reliable due to the limited data collected. Thermistor HW 1008CC data shows in general no frozen ground with all temperatures above or around zero except in 18/8/81 a year later the surface ground temperature is still positive but much lower. This data shown in Figure 3 confirms that there is no frozen

ground at the middle of the permafrost map therefore this map is in error. Therefore the potential permafrost map presented or questioned by the NRCan does not reflect the present observations and data collected on site.

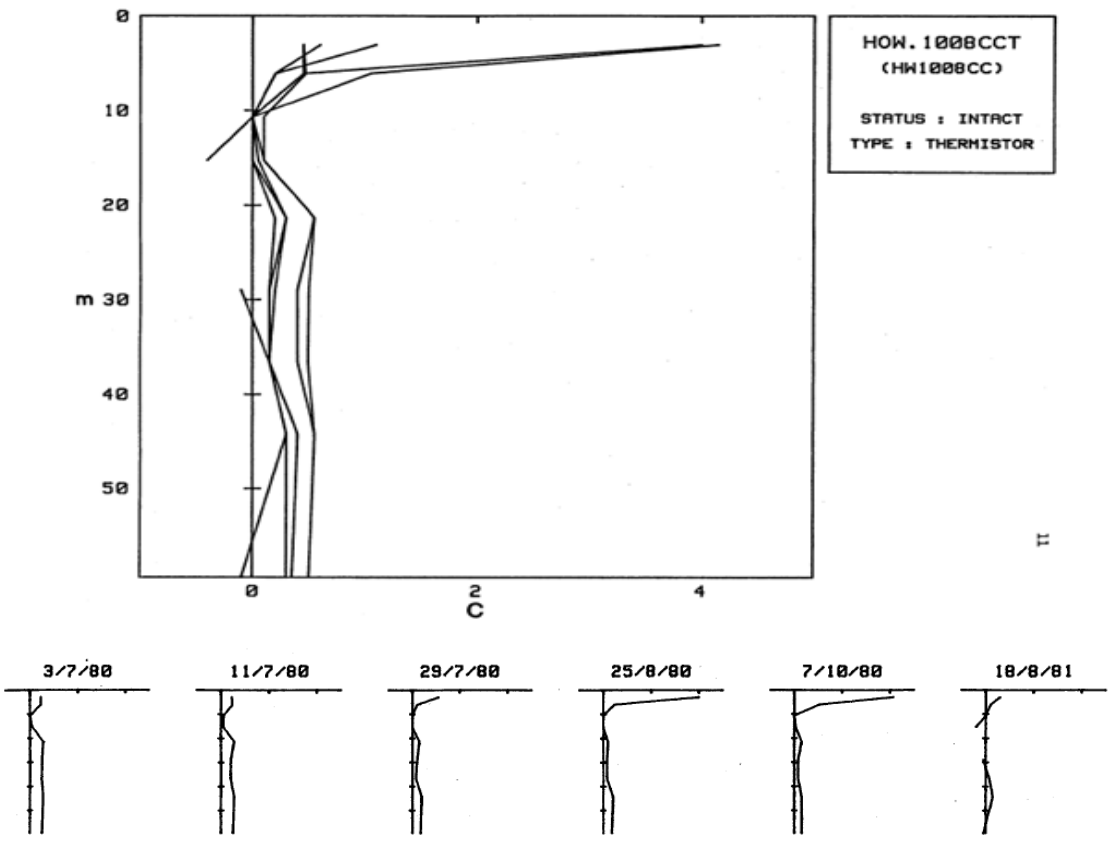

Figure 2: Ground temperature of McGill thermistor HW 1008 CC as reported by Granberg (1983)

- **NRCAN request: Based on the above clarification, NRCan proposes that the proponent install thermistor cable(s) at location(s) within the "potential permafrost map" area to assess the presence/absence of permafrost. NRCan suggests that this (the addition of thermistor cable(s) in permafrost areas) only be considered once an assessment of the literature, that has been used to produce the "potential permafrost map", is completed.**

Answer:

HML will install 2 additional thermistors in Spring 2016 to monitor the permafrost area within the Howse deposit. The location of the first hole is suggested to be at the west near the south end of the ore body.

The location of the second hole is suggested to be at the east side of the ore body half way to the pit wall.
There is no recent information showing permafrost areas in the Howse deposit. Therefore, it is concluded that a new permafrost map cannot be made since all available information does not provide data from which a map can be made.

The irregular line on the map is a surface expression of the permafrost area drawn arbitrarily on the plan. The accuracy of the surface plot on paper is not detectable on site, so there is no positive and definite indication nearby Golder borehole was either within the boundary or outside the boundary. However, it is clear that all subsequent drilling done in the area did not identify any frozen ground and we would conclude that the Golder borehole is in fact valid.

If the investigation was carried out by test pitting, the excavations would have been terminated in frozen ground, particularly if they were located in high, open and exposed areas where seasonal frost penetration could be very deep.

In reviewing the IOC test pit description done in the1980 Trenching Field Notes, for work carried on in the Howse deposit we note that the technician referred several times to (permafrost) with water not far below. These notes were prepared from shallow test pits and this would suggest that it was only frozen ground that the technician was observing. There is no way that the technician could confirm with the equipment he had to confirm that it was permanent frozen ground in the middle of the thawing season which can extend to October as it can be seen on the surface ground temperature of October 7 1980 in borehole HW 1008 CC.

It is considered that confusion was created by using very loosely the term permafrost. From observations at shallow depth in the test pit which in many locations encountered free water below the frozen ground. In this situation, the technician was only observing remnants of the frozen ground developed over the previous winter.

It is therefore it is not surprising that McGill Borehole HW1008 CC drilled in the middle of the potential permafrost map and the temperature readings over a period of 3 months do not show any permafrost mostly all above zero, with the exception of one reading taken nearly a year later which is incomplete and probably not reliable.

From all this information, it is clear that the map of potential permafrost area could only be accurate if one assumes that the frozen ground layer observed in test pits at extensive depth.

The McGill Borehole HW1000CC in the middle of the permafrost map did not confirm such a condition.

- **NRCan Request: Please clarify why permafrost is considered in the hydrogeological model if the conclusion of the Report No. L-15-1802 stated that there is no permafrost at the Howse deposit.**

Answer:

The new hydrological report has been amended to reflect the new permafrost status of the Howse Project.