In accordance with the Terms of Reference, which instructed the developer to provide a comprehensive analysis of the key line inquiry, Tyhee should put more emphasis on the questions related to the key line of inquiry. To facilitate this, the information requests in part one contain short descriptions of the information gaps that the Review Board identified in the DAR.

Part 1 - Key Line of Inquiry Issues

IR Number: 1-1-1

Source: *Mackenzie Valley Review Board*
To: *Tyhee*
Issue: ***Estimation of Tailings Containment Area Concentrations***

Background

The DAR identifies effluent concentrations, estimated Tailings Containment Area (TCA) concentrations and TCA concentrations that would be required to achieve CCME guidelines in Narrow Lake (section 6.2, Technical Memo from EBA) for 6 elements. There are significant differences between the "estimated TCA" and "required TCA" concentrations, e.g. 199.7 µg/l vs. 5.8 µg/l for arsenic and 24.1 µg/l vs. 5.8 µg/l for cyanide. While the DAR provides detailed information on simulation modeling of contaminant behaviour in Narrow Lake, it provides virtually no information on how the "required TCA concentration" will be achieved from the "estimated TCA concentration".

Request

1. *Please provide an explanation for how the "required TCA concentrations" will be achieved for all six elements.*

Tyhee NWT Corp Response (Revised May 31, 2012)

Information Response 1-1-1 seeks to understand how the Tailings Containment Area (TCA) concentrations of six key elements will be controlled in order for Narrow Lake to meet Canadian Council of Ministries of the Environment (CCME) guidelines. To evaluate how the changed mine plan, which processes only ore from the Ormsby deposit, affects the expected concentrations of solutes in the TCA, an updated water balance and water quality modeling were performed. Additional modeling was needed due to the revised mine plan design and to incorporate the additional analytical geochemical characterization results performed on tailings from processing only the Ormsby ore instead of tailings prepared from processing combined Ormsby/Nicholas Lake ore.

The response to this IR is affected by the planned exclusion of Nicholas Lake ore from the revised mine plan/mill process and the change in TCA design concept. Previous geochemical characterization activities determined processed Nicholas Lake ore is potentially acid generating and may liberate elevated of metals (mainly arsenic). The exclusion of Nicholas Lake ore from the revised mine plan will improve TCA effluent water quality. The revised mine plan includes a revised TCA design, which will improve control

over discharges to Narrow Lake, and improve estimated TCA water quality. The revised TCA design calls for:

1. sub-aqueous disposal of the leach tailings to avoid oxidation and acid generation, and
2. Although the new water balance indicates that no discharge from the TCA to the downstream environment is expected during operation, Tyhee plans on discharging TCA supernatant to the downstream environment during the expected term of the initial water license and therefore would expect this option to be included in any water license issued following the Regulatory Phase under the MVLWB.

The geochemical characterization of tailings prepared by processing only Ormsby ore is described in Attachment B. The data demonstrate that the absence of Nicholas Lake ore in the mill process generally improves water quality present in the TCA. The changes in TCA design also contribute to improving TCA water quality. The project is committed to meeting Metal Mining Effluent Regulations (MMER) standards in effluent and CCME water quality guidelines in receiving water bodies downstream of the mine should water be discharged from the TCA. Cyanide treatment/ detoxification are specifically discussed in IR 1-1-2.

Expected Improvement in TCA Discharge Water Quality

The original mine plan presented in the DAR involved processing ore from both the Nicholas Lake and Ormsby deposits. Tailings produced from processing ore from both deposits would have been placed in the TCA. However, the revised mine plan excludes ore from the Nicholas Lake deposit and is based on processing only.

Recent flotation tailings geochemical characterization has been completed using solely Ormsby ore. A summary of these samples and results are presented in Attachment B. The results of these tests and their impact on the TCA water quality are outlined in the following sections.

Acid Base Accounting and Acid Generating Potential

Acid Base Accounting results for the Ormsby only tailings indicate that four of six composite flotation tailings samples are non-PAG and two are uncertain acid generating. NAG pH confirmed the non-PAG acid generating potential of four of the six composite flotation tailings samples. The two samples (OM-Master and Bruce Zone composite flotation tailings) that were uncertain acid generating by the ABA analyses reported a NAG pH of 7.8 and 8.4, respectively, which is considered non-acid generating. So, the flotation tailings produced from the Ormsby only ore will be non-acid generating.

As expected, Acid Base Accounting results indicate that all six composite detoxed tailings from the concentrate leach samples are PAG validating the need to manage the leach tailings in a subaqueous manner. NAG pH results confirmed the acid generating potential of all six detoxed leached tailings samples as PAG.

Trace Metals

Lab results for the six composite flotation samples prepared using only Ormsby ore indicate that all constituents of potential interest evaluated in the NAG leachate, synthetic precipitation leaching procedure (SPLP), and supernatant testing are below the Maximum

Average Concentration of the MMER criteria. The only constituent of potential interest (COPI) with reported concentrations above the MMER criteria is TSS in the supernatant analysis.

Change in TCA Design Concept

The original TCA design called for co-deposited flotation and leach concentrate tailings. Potential acid generating leach concentrate tailings would be deposited with flotation tailings throughout the TCA. The conceptual TCA design embankments were to be comprised of homogenous rock fill, which were thought to self-plug to create filtration of the tailings through the embankment over time. There was a risk the homogenous rock fill embankment would not self-clog resulting in discharge of untreated tailings to the downstream environment. For this reason, and to reduce the oxygen exposure of leach concentrate tailings, the TCA design has been updated.

As shown on the attached Figure 1, the revised mine plan includes a TCA design in which the tailings are deposited in separate cells. Flotation tails are deposited in the southern and northern cells while the leached tailings are deposited sub-aqueously in a center cell mixed with a yet to be determined amount of flotation tailings. The northern and southern embankments are designed with graded rock layers with a low-permeability core to minimize leakage. The center cell will contain the leach concentrate tailings which will be deposited sub-aqueously to decrease the potential for oxidation. Interception or pump back wells located downstream of the tailings embankments will collect and pump effluent back to the TCA or to an onsite treatment facility if necessary to meet water quality discharge criteria.

The revised mine plan allows for the interception, storage, and treatment of effluent passing through the TCA embankments and decreases the potential for oxidation of leach concentrate tailings. These design improvements mitigate the potential for acid generation, leading to a likely reduction in metals concentration, and decrease the likelihood for uncontrolled discharge to the surrounding environment. Request Responses 1-1-2 and 1-1-3 further discusses the potential treatment options.

Water Balance

Based on the planned operational philosophy, the TCA pond volumes were estimated throughout the life of the project where the initial pond volume is that of southern portion of Winter Lake, 1.4 million m^3. As the operations continue, the pond volume is continually decreasing as the water in the TCA is used to make up the process water shortfall for operations. For average climatologic conditions, the pond volume ranges from 300,000 to 1.4 million m^3 for the life of the project. After year 4, it is necessary to supply additional makeup water from Giauque Lake for the ore processing operations.

Although the new water balance indicates that no discharge from the TCA to the downstream environment is expected during operation, Tyhee plans on discharging TCA supernatant to the downstream environment during the expected term of the initial water license and therefore would expect this option to be included in any water license issued following the Regulatory Phase under the MVLWB. Again, Tyhee is committed to meeting MMER discharge criteria on any water released from the TCA to the downstream environment.

Estimated TCA Concentrations

The estimated TCA water quality was based on the data developed during the characterization of the tailings material produced during the testing of the Ormsby ore. The primary source of the solutes in the TCA are from the supernatant from the flotation process which accounts for approximately 94% of the tailings and supernatant produced by the plant, and the detoxified supernatant from cyanide leaching of the concentrate which account for 6 % of the liquid and solids entering the TCA.

The concentration of the solute in the TCA is a function of its concentration in the flotation supernatant, the detoxified leach supernatant, the amount of water reclaimed from the tailings pond, and the amount of makeup water. As no makeup water is expected during the first four years of operation, the solute concentrations reach a maximum after the fourth year of operation. To show how the concentrations may evolve during the operation of the facility, estimates of the concentration of arsenic, copper, cyanide, nickel, lead and zinc in the TCA were calculated for the end of years 1, 4, 8, and 12. The results are presented below:

Estimated TCA Concentrations

			Year			
Parameter	MMER (µg/L)	CCME (µg/L)	1 (µg/L)	4 (µg/L)	8 (µg/L)	12 (µg/L)
As	500	5.0	10	59	15	8
Cu	300	2 - 4	50	208	75	35
CN	1000	5.0	100	144	100	50
Ni	500	25 - 150	0.8	3.3	1.2	0.5
Pb	200	1 - 7	3	14	4	2
Zn	500	30	0.7	2.9	1	0.8

As shown above, the evaluation indicated the maximum concentrations were present in the TCA in year 4. These concentrations are all below the MMER guidelines for discharge

Impact on Narrow Lake

The impact analysis in the DAR was based on the discharge of approximately 900,000 m^3 per year for the life of the project spread over the months of May through October. Approximately two-thirds of this volume was expected to be discharged in May and June. As previously mentioned, the new water balance indicates that no discharge from the TCA to the downstream environment is expected during operation. Tyhee plans on discharging TCA supernatant to the downstream environment during the expected term of the initial water license and therefore would expect this option to be included in any water license issued following the Regulatory Phase under the MVLWB.

To estimate the effects of any discharge to Narrow Lake, a plausible discharge scenario was needed to evaluate the potential impact of any potential discharge on the receiving water body. When TCA discharges occur, all water would be pumped from the TCA to Narrow Lake. The available pumps would be the reclaim pumps which have a capacity of approximately 140 m^3/hr. If the discharge lasted for 30 days and if the pumps ran at full capacity, a total volume of approximately 100,000 m^3 would be discharged. Any discharge

would only occur between May and October, however; the majority of water discharged is expected to occur in May and June. An evaluation of the attenuation potential of Narrow Lake for a 30 day discharge at a rate of 140 m^3/hr produced the following expected concentrations in Narrow Lake.

Equilibrium Concentration in Narrow Lake

			Year			
Parameter	**MMER (µg/L)**	**CCME (µg/L)**	**1 (µg/L)**	**4 (µg/L)**	**8 (µg/L)**	**12 (µg/L)**
As	500	5.0	0.8	4.8	1.2	0.6
Cu	300	2 - 4	4	17	6	2.8
CN	1000	5.0	8	11.5	8	4
Ni	500	25 - 150	*	*	*	*
Pb	200	1 - 7	0.2	1.1	0.3	0.2
Zn	500	30	*	*	*	*

Note:

*Concentration in the TCA is below CEQG guidelines so additional evaluation was not necessary.

As shown above, the highest concentrations occur at the end of year 4. The assumptions and methods used to calculate these values are discussed in Section 5.0 of the attached *Water Balance and Geochemical Characterization Report*.

Based on our analysis, the copper concentration in the TCA is the controlling parameter should discharge of TCA contents occur. The copper concentration in the TCA supernatant that could be discharged to Narrow Lake is estimated to be less than the MMER criteria. However, the estimated resulting concentration of copper in Narrow Lake for the assumed discharge is greater than the CCME guidance concentration. Although the new water balance indicates that no discharge from the TCA to the downstream environment is expected during operation, Tyhee plans on discharging TCA supernatant to the downstream environment during the expected term of the initial water license issued by the MVLWB following the Regulatory Phase. With specific reference to copper concentrations within the TCA, these would be monitored during operation as part of the water license SNP and the effects of these concentrations on Narrow Lake, including confirmation of water in Narrow Lake meeting CCME guidelines, would be evaluated prior to discharge.