October 25, 2006 EBA File: 1100060.004

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Attention: Dan Johnson

**Subject: Reply to NWB Response to Jericho Divider Dyke Design**
**Jericho Diamond Mine**

EBA Engineering Consultants Ltd.'s (EBA's) replies to questions and comments in NWB Letter dated September 12, 2006 regarding the Tahera Divider Dyke are presented below. The original NWB comments are in italics. EBA's reply follows each comment.

*1. (Riprap Materials Item 6.2) Figure 1 of the design report and Tables 3.1 to 3.3 indicate the grain size distributions for the different materials. According to the U.S. Army Corps of Engineers (1955) and the U.S. Army et al. (1971), which use the filter criterions suggested by Terzaghi, the following criterions have to be met:*

$$\frac{15\%\,size\,of\,material\,A}{85\%\,size\,of\,material\,B} \le 5$$

and

$$\frac{50\%\,size\,of\,material\,C}{50\%\,size\,of\,material\,D} \le 25$$

*The grain size distributions presented fulfill criterion 1, but for the second criterion a value of 115 was calculated. Please explain why the second criterion was not met.*

The dyke filter was designed according to:

- Martin, T.E., Lighthall, P.C., and Rudyk, N. 1998. Filter design for tailing dams. Tailings and Mine Waste '98, proceedings of the Fifth International Conference on Tailings and Mine Waste '98, Fort Collins, Colorado, 26-28 January 1998, pp. 249-262.

This reference, as well as other references, recommends designing on the first filter criteria (Terzaghi) criteria without D50 criteria. The specified particle size distributions have a range of D50/d50 from 17 to 115. The actual placed material has a D50/d50 of approximately 30. The filter dykes at Jericho have been designed using similar materials to the filter dykes at the EKATI mine. These structures have been performing well since construction in 1998.

*2. (Long-term Monitoring Item 8.0) The effectiveness of the LLDD assumes that the dyke does not freeze during winter, which currently is not controlled. In addition to the proposed monitoring of the water quality and the dyke movements, it is recommended to measure dyke temperatures. However, since a frozen dyke only affects the performance*



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*of the dam with respect to filtering and not the stability, this is only a recommendation, that does not have to be addressed.*

A portion of the filter above the water level and adjacent to the ice sheet on the PKCA water is expected to freeze. This was considered in the PKCA water balance. In 2006, water flowed through the filter during spring freshet, with nearly equal water levels upstream and downstream of the dyke throughout the spring and summer. The water levels and seepage flow through the dyke will be a better indicator of the filter performance than a ground temperature cable.

*3. (Design Intent Item 2.0) TDC stated that a low sill or overflow channel may be required to allow water to overflow the dyke. Within reference document vi., EBA stated that the "overflow could consist of pipes, or siphons or a low sill (emergency spillway). Details of a low sill emergency spillway structure will be presented in the PKCA management plan". TDC should be reminded that the Divider Dyke design is a stand alone document and therefore should include sufficient description of all design details (i.e., location type of materials, size, etc.) and under what criteria or conditions are required for construction. If TDC has provided this detail through another stand alone document, the NWB invites TDC to appropriately reference where this information can be found (document title, document section, page numbers where detail can be found).*

Details of the overflow structure will be submitted to the NWB under separate cover.

*4. (Stability Analysis Item 4.0) Within reference document iv., it was stated "results of stability analysis were presented graphically in Appendix A. Figures A4, A5 and A6 showed stability analysis for the downstream slope. The phreatic water surfaces generated in these figures do not appear to be representative for long term or static conditions." The Board requests further detail and discussion on how water levels on upstream and downstream of the dyke, as well as, the phreatic surface of the water within the dyke were determined to complete the stability analysis. Were the conditions analysed for water flow through the dyke and foundation representative of freezing conditions, filter blinding conditions, or otherwise? Clarification is also requested to address why Figures A1 to A3 have a phreatic line on the upstream and downstream face of the dyke to be at a similar level, while Figures A4 to A6 show a phreatic line that drops dramatically within the dyke between the upstream and downstream face. Was this not considered because it was not a critical structure?*

The factor of safety for a free draining slope is highest for a dry slope or a fully submerged slope. A partially submerged slope provides a slightly lower factor of safety. The assumed water levels on the upstream and downstream sides of the dyke are the case of a partially submerged slope. Sensitivity analyses were used to confirm that assumed water levels resulted in the lowest factor of safety. The figures shown in the report are representative of a worst case as oppose to the long term or static case.

The water head is expected to drop very quickly as it flows from the filter into the coarse rockfill. The phreatic surface is an estimate based on the knowledge of the fill materials and experience with other structures.

The water level on the upstream side of the dyke may rise if the filter blinds. This will result in submerged slope on the upstream side of the dyke. This will result in higher factor of safety for the slopes.

Figures A1 to A3 represent analyses of the upstream side of the dyke. The water level was the same on both sides of the dyke as this represents the worst case for the stability analyses (given the fact that the water level will always be higher on the upstream side of the dyke as opposed to the downstream side).

*5. (Riprap Materials Item 6.2) Within reference document vi., TDC acknowledges that the recommended gradation for riprap is smaller than that required for full wave heights (as was stated in reference document iv). The riprap gradation curve provided in Figure 1 of the design report, specifies a d50 of about 130 mm ("top size"), which is less than the required 155 mm. Additionally, Table 3.3 from the construction specifications stated that the percent passing of 25 to 55% is to have a particle size of 50 mm, which is also less than the required 155 mm. The Board requests additional detail outlining why is there inconsistency between the specified grain size in the construction specification (Table 3.3) for the riprap material and that provided in the design report (Figure 1). To partially address this issues described above, EBA responded, "the specified size is less than the required size, such that the riprap meets the filter criteria between the underlying 20 mm minus material and the rip-rap". Further to this point, EBA's response stated "it [riprap layer] is expected to perform adequately as rip-rap material; however additional run of mine material will be placed if degradation is observed". Is there a monitoring program implemented to assess riprap layer performance and quantitative criteria established to benchmark when riprap repair should be implemented? If so, does TDC plan to include information for this monitoring in the annual geotechnical report (Part G, Item 2 (g))?*

The particle size distribution for the rip rap in the specification agrees with the rip rap size in the design report, Figure 1.

It was recognized that the specified rip rap is smaller than that required for the maximum hourly wind speed and maximum fetch length of Cell A. The smaller rip rap size was justified based on the knowledge that the fetch length in Cell A is going to decrease very quickly as the PK fines fill the cell. The required rip rap size for a shorter fetch is smaller. The probability of experiencing the maximum wind speed over the short life of the cell and the short open water season is lower than a for a long term facility.

The riprap layer thickness is on the dyke is approximately 1.5 m. The usual recommended and applied rip thickness is two times the D50, which would be approximately 0.3 m. The thick rip rap layer provides a significant amount of "sacrificial" rip rap.

It is anticipated that the rip rap will perform adequately over the life of the structure. The dam monitoring plan includes daily annual inspections by mine personnel as well as annual inspection by a geotechnical engineer. The mine has the resources to repair any damage to the riprap that may occur.

*6. (Design Intent Item 2.0) TDC stated that particles passing the dyke will combine and settle in the deposition cell following flocculation. Will a flocculent or chemical be used to aid in this process? If so, what are the characteristics of the flocculent/chemical and method of application or does TDC anticipate settling due to gravity?*

No additional flocculant will be added to the fine PK besides that added for the process plant operation. The properties of the process plant flocculant are described in the PKCA Management Plan.

*7. (Design Intent Item 2.0) TDC stated that divider dyke B will be constructed during future mine operations or as required for water quality. What criteria and measures will be used when future operations require an additional dyke? Additionally, what criteria will be used if an additional dyke is required for water quality reasons?*

The PKCA water and solids balance will be used estimate future fine PK levels to determine when the Divider Dyke B is required to retain fine PK solids. Divider Dyke B may also be required if the water quality downstream of Divider Dyke A is approaching the discharge limits, and it is determined that the construction of Divider Dyke B will improve the water quality. The water quality downstream of Divider Dyke A met discharge limits in 2006.

*8. (Design Intent Item 2.2 - Foundation Conditions) TDC stated that additional site characterization will be carried out during the open water season to further evaluate lake bottom and foundation conditions. The Board requests that this information be included in the final construction and engineering records? Will this information be presented in the construction records as per Part D, Item 19?*

During construction it was determined that only a thin layer of sediments were present on the lakebed. This information will be presented in the construction summary report.

*9. (Design Cross-Sections Item 3.0) TDC stated that a key trench will be required along shore abutment portion where existing terrain is covered by boulder fields. No details of the key trench have been provided in the design report. The Board request additional detail and discussion on a typical design and construction specifications of the key trench, information on how it will be constructed (location, type of materials, size, etc.), and under what criteria or conditions are required for construction.*

The purpose of the key trench is to provide a secure contact between the filter zone and soils or rock that contain material that will not allow flow of fine PK through the foundation. The key trench will be excavated to undisturbed competent rock, lacustrine sediments or well graded till. The base of the key trench will be inspected for fractures in the rock, or coarse material (boulders, cobbles or gravel). These unsuitable materials will be removed. The key trench base shall be a well graded material with the matrix between larger particles filled sand with a trace of fines, and varying amounts of gravel, or a finer grained material.

*10. (Stability Analysis Item 4.0) In addition to the dyke retaining some of the PK materials, it will be used as a haul road for the construction of the west dam. The Board request further discussion and detail on how the stability analysis completed accounts for these expected traffic loads. Additionally, TDC stated that the dyke "can be classified in a very low consequence category" since the "dykes are internal to the tailings disposal facility and failure of the dykes would cause no loss of life and would generally limit economic, social and environmental losses to the Owner's property. The Board requests additional detail and discussion on what provisions are in place to monitor dyke performance during temporary use as a haul road since personnel will be using the road and therefore failure may lead to loss of life.*

The haul traffic will be limited to the rockfill portion of the dyke and used predominately for the construction of the West Dam. The rockfill portion of the dyke is of a similar construction, or better, than typical mine haul roads. The stability of the coarse angular rockfill is not sensitive to the haul truck loading. Haul roads over the dyke shall be designed and constructed in accordance with the Mine Safety Act.

*11. (Stability Analysis Item 4.0) TDC stated that the stability analyses were completed on the deepest dyke cross section without tailings upstream of the dyke and with no tailings at the downstream toe. Since the dyke's primary function is to retain tailings, is it not expected that the upstream face of the dyke could be subjected to an applied loading due to the accumulation of saturated tailings in the upstream reservoir? Was tailings loading considered in the stability analysis and global stability of the dyke?*

Tailings loading is not a critical case loading on the dyke given the width of the dyke and the centerline construction method. The critical stability surfaces are shallow failures in the upstream and downstream dyke slopes.

*12. (Settlement Item 5.0) TDC stated that if excessive movements of the dyke occurred, design or operation modifications can be made to limit thaw settlements. The Board requests additional detail and discussion of what design and operation modifications would be acceptable and how these modifications may impact the design of the dyke as presented in the design report.*

Significant foundation settlement is not anticipated due to the presence of shallow bedrock over most of the dyke footprint and the limited amount of time that deep standing water will be adjacent to the dyke; however, if settlement does occur, its impact on stability and function of the dyke is not expected to be significant but will be assessed. Remediation may comprise topping up the fill and installation of deformation monitoring systems.

*13. (Material Properties Item 6.1 – Filter) TDC recommended that the effectiveness of the filter be tested with fine PK or supernatant. The Board requests additional detail and discussion on why TDC recommends filter testing. Is TDC confident in the design of the filter from a stability point perspective, or is the recommended testing only to assess the efficiency of the filter to retain fine PK? When should the recommended testing be completed? How would the results from the recommended testing impact the design and stability of the dyke? Will this information be presented in the construction records as per Part D, Item 19?*

Testing of the filter material to retain fine PK was recommended at the time of design since no PK fines were available for testing prior to design. The filter design (particle size distribution) was based on filter performance at other facilities. The filter has performed adequately during the summer of 2006. It is recommended that filter testing be considered prior to the construction of Divider Dyke B.

*14. (Construction Item 7.4 – Material Placement) TDC stated that materials placed in open water will assume it natural angle of repose and that materials placed above open water will be compacted to a specified density. Thus, the construction procedure may result in different density materials spatially within the dyke, and therefore, potentially different material strengths spatially within the dyke. How has this issue been addressed in the stability analysis? Will this information be presented in the construction records as per Part D, Item 19?*

The water at the dyke location during construction was less than 1 m deep; therefore, the amount of filter material placed in the water was relatively small. Conservative values for the friction angles were assumed in the stability analyses for the granular fill materials. The fill placed below water is

not anticipated to have a significant impact on the stability analyses, given the assumed strength parameters and the limited quantities of material.

*15. (Long-Term Monitoring Item 8.1 – Purpose) TDC stated that a program should be developed to "satisfy regulatory requirements for dyke performance". The Board requests additional information into what specific "regulatory requirements" this statement refers to with reference to the document outlining these requirements.*

The monitoring program for the dyke performance is outlined in the PKCA Management Plan. Dyke monitoring will be reported in the annual geotechnical inspection report.

*16. TDC has included design drawings in the Divider Dyke Design Report. The NWB requests signed and stamped design drawings from TDC.*

Copies of the original stamped and signed drawings will be submitted to the NWB.

We trust this addresses the NWB questions and comments. We welcome the opportunity to discuss them further at the scheduled meeting between NWB, EBA and Tahera.

Regards,
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