

Hardrock Gold Mine – Tailings Management Facility Peer Review Recommendations and Responses

No.	Peer Review Recommendations	Amec Foster Wheeler Comments
1.	A site specific seismic hazard analysis should be undertaken to determine the seismic design parameters corresponding to the 'Very High' hazard category (i.e., return period of 10000 years) of the TMF dams. The hazard analysis should include the de-aggregation analysis to determine the magnitude-distance of the design earthquake for the liquefaction assessment.	A site specific seismic hazard study will be carried out in the detailed engineering stage.
2.	A special placement rock fill zone should be shown at the upstream edge of the downstream shell on the design cross-sections of the TMF dams. The specifications should indicate that, within this zone, rock fill is to be spread in thin lifts to prevent segregation. Also, a reduced maximum size should be specified for this zone.	A clear distinction has been made between the “mine rock shell placed by the Contractor (Zone 6A)” and “mine rock placement by the mine fleet (Zone 6B)” in the drawings issued with the subsequent revisions to the Feasibility Reports. Material gradations, placement and compaction specifications for all aspects of the TMF construction will be included in the 'Technical Specifications' to be issued with the Detailed Engineering Study package.
3.	Gradation specifications for the core, filter and transition zones should be prepared in the near future to demonstrate the filter compatibility of the zones and the adjacent rock fill.	The gradation specifications for all types of rockfill will be specified in the technical specifications under the detailed engineering study package.
4.	Borrow sources should be identified and tested and rock fill processing requirements should be identified to demonstrate how the filter and transition zones can be produced before construction is tendered.	A technical memo on borrow source identification and material suitability has already been submitted to GGM. Development areas for till, 'sand and gravel' filter have been provided for permitting purposes. Preparation of a construction execution plan has been recommended.
5.	The closure scenario for the TMF should be detailed.	Closure plan is being developed by Stantec. Amec Foster Wheeler will provide required support to Stantec.
6.	A CPT investigation is recommended in the area of the Southwest Dam where potentially liquefiable loose sands were noted on surface.	Additional geotechnical investigations were recommended in the feasibility report. Accordingly additional boreholes and CPTs have been performed and the revised feasibility report contains the findings of the investigations and modified foundation cut-off measures.
7.	Consideration should be given to carrying out a test grouting program prior to construction tendering in areas of pervious rock under the North Dam and the East Dam.	Relatively shallow consolidation grouting has been specified. The technical specifications to be issued with the detailed engineering design. A test grouting program may have limited benefit in that technical challenges are not anticipated. Rather, we would recommend commencement of grouting early in the construction program to allow changes if required.
8.	More geotechnical investigation should be carried out in the area of the Southwest Dam where a bentonite slurry cut-off wall is contemplated in order to better define the conditions at the top of the till. In addition, a study should be undertaken to define the best excavation technique to build the cut-off trench.	Additional geotechnical investigations has been carried out to characterize sand and silt layers in the southwest dam foundation. The slurry wall is no longer being considered based on the findings – lower permeability silt layers are present & till can be reached from surface (i.e. a cutoff trench).

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9.	Additional geotechnical testing should be carried out on the interbedded silt layer to better characterize its shear strength and to confirm the current stability assessments. This should include obtaining undisturbed samples and carrying out laboratory triaxial shear testing.	We agree with this comment. Undisturbed samples will be taken of the interbedded silt layers for triaxial shear testing to confirm stability analyses. Thin walled tube samples will be collected and tested in laboratory for their undrained shear strength and consolidation properties.
10.	Given the high permeability of the glacio-fluvial deposits that underlie much of the TMF area it is important to achieve good seepage cut-off under all of the perimeter dams.	<p>Agreed – construction quality control / quality assurance monitoring will be important to meet with the design intent.</p> <p>Contingency details will be developed during the detailed design stage to provide flexibility in the field to accommodate change conditions, if encountered.</p> <p>Further, the current tailings deposition plan envisages pushing the tailings pond to the natural ground towards the west and wide tailings beaches will be formed in the rest of the TMF area. The tailings have relatively low permeability in the deposited state, tend to consolidate over a period of time with further reduction in the permeability.</p>