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## **1.0 INTRODUCTION**

### **1.1 Project Overview**

Mount Polley Mine is a copper and gold mine owned by Imperial Metals Corporation and operated by Mount Polley Mining Corporation (MPMC). The site is located 56 km northeast of Williams Lake, British Columbia. Mount Polley began mine production in 1997 and operated until October 2001, when operations were suspended for economic reasons. In March 2005, the mine restarted production and has been in continuous operation since. Currently, mill throughput is approximately 20,000 tpd. Tailings are deposited as slurry into the tailings storage facility (TSF). The TSF is comprised of one overall embankment that is approximately 4.2km in length. The embankment, based upon original separate embankments, is subdivided into three (3) sections; referred to as the Main Embankment, Perimeter Embankment and South Embankment. Heights vary along the embankment and are approximately 48m, 30m, and 20m respectively (based upon the Main, Perimeter and South nomenclature). The design and construction monitoring of the TSF embankments through 2010 was completed under the direction of Knight Piésold Limited (KP). AMEC Earth and Environmental now known as AMEC Environment & Infrastructure, a division AMEC Americas (AMEC) assumed the role of engineer of record for the TSF embankment as of 28 January 2011. The overall embankment has incorporated a staged expansion design utilizing a modified centerline construction methodology. The latest expansion was completed in September 2011, which entailed approximate 2.1m embankment raise to a crest elevation of 960.1m.

The next expansion, to an elevation of 963.5m, is planned for 2012 construction season. AMEC understands that planned 2012 raise falls under the existing permit that allows the embankment to be constructed to an elevation of 965.0m. To check the stability of the proposed 2012 expansion a slope stability analysis of the embankment was performed and is summarized in Appendix A.

### **1.2 Construction Schedule**

The optimal construction season for placement of moisture-sensitive till core material at the Mount Polley Project site typically falls between May and September. The 2012 Stage 8 Embankment raise (3.4 m to crest El. 963.5 m) is targeted for completion by the end of September 2012.

For the 2012 construction season, as per 2011 construction season, MPMC will use a contractor to excavate, transport, place, and compact the till core as specified, to place the adjacent filter zone, and to compact the filter zone and the transition zones as specified. Prior to placement of the till core MPMC will construct the upstream fill to the full extent of the 2012 raise. MPMC will also transport and place the transition and general rock on as needed basis.

In addition, MPMC or contractor will prepare abutment foundations to the full extent of the current ultimate embankment (970.0m) and place associated blanket materials.

### **1.3 Construction Monitoring**

The level of construction monitoring and QA/QC performed in previous years is to be continued. In 2011 MPMC undertook a greater role and responsibility in this regard. Specifically, MPMC engaged its own engineers, technicians, and summer students to provide full-time construction monitoring and field inspection during the construction of the embankment. AMEC provided support as required, which include regular site visits, particularly during key phases of the construction. Overall this arrangement was deemed to be successful however slight modifications to the 2011 construction monitoring program will be implemented for 2012. AMEC understands that for the 2012 construction similar field inspections will be applied. Mr. Luke Moger of MPMC will oversee the overall construction monitoring. The day to day monitoring, reporting and instrumentation readings will be the responsibility of the MPMC field inspectors, technicians, and coop students.

At the commencement of construction, AMEC will provide full-time supervision for approximately ten (10) days, to kick-off construction and to verify that proper construction methods are employed, material specifications are met and testing requirements and frequencies are understood and followed by MPMC personnel.

Once AMEC is satisfied that the design intent is being met, and that MPMC field inspectors are fully trained and prepared to undertake the construction monitoring and reporting role with primarily remote support required by AMEC, AMEC will reduce monitoring presence to monthly visits (though actual timing will vary somewhat with visits timed for key construction activities such as foundation preparation and approval, and till core trench approval). To be successful, this arrangement will require MPMC field inspector, devoted full-time to the dam construction project, to have good support and cooperation from senior Mt. Polley personnel, and from the Mt. Polley construction team, along with regular technical support as needed from AMEC project personnel.

Todd Martin, Senior Geotechnical Engineer or Daryl Dufault, Project Manager, will visit the site during construction activities. The objective of this senior personnel visit will be to conduct an annual site-visit, and get a “look-ahead” so that any future upcoming issues can be proactively identified and resolved. This visit will also be used to ensure that a good working relationship is being maintained between AMEC and MPMC project personnel, which will be critical to AMEC having the requisite confidence to provide as-built report sign off following the end of each stage of the embankment raise.

### **1.4 Purpose of Manual**

AMEC has prepared this manual for use by the embankment contractor, MPMC on-site personnel and for AMEC engineering support personnel, who will maintain close communication with the site throughout the construction season and carry out periodic site visits as required.

The objectives of this manual are as follows:

- Summarize the annual construction plans.
- Detail the technical specifications for the dam construction as presented in the design drawings.
- Outline the requirements for monitoring and reporting of the dam construction.
- Present the proposed performance monitoring procedures and design criteria.
- Clearly define the roles and responsibilities of both MPMC and AMEC personnel associated with the 2012 embankment construction activities.

## **2.0 CONSTRUCTION MONITORING AND TESTING REQUIREMENTS**

### **2.1 Construction Activities**

The 2012 construction of the TSF embankment will include the following activities:

- Foundation preparation of the abutments to an elevation of 970.0m, including excavation of the cut-off trench.
- Development of glacial till borrow areas.
- Development of non-acid-generating (NAG) rock borrow areas (mine rock).
- Development of the sand and gravel borrow area or production of sand and gravel from mine waste rock via processing.
- Excavating, hauling, placing, and compacting acceptable structural fills and waste zones to raise the dam core and shell in accordance with design specifications.

The guidelines for quality control testing procedures outlined in this manual are to be observed during construction to satisfy and document that the dam is constructed in accordance with the design intent.

### **2.2 Monitoring and Testing**

The general monitoring and testing requirements for construction of the 2012 construction of the TSF embankment correspond to the construction activities outlined in Section 2.1; these general requirements are:

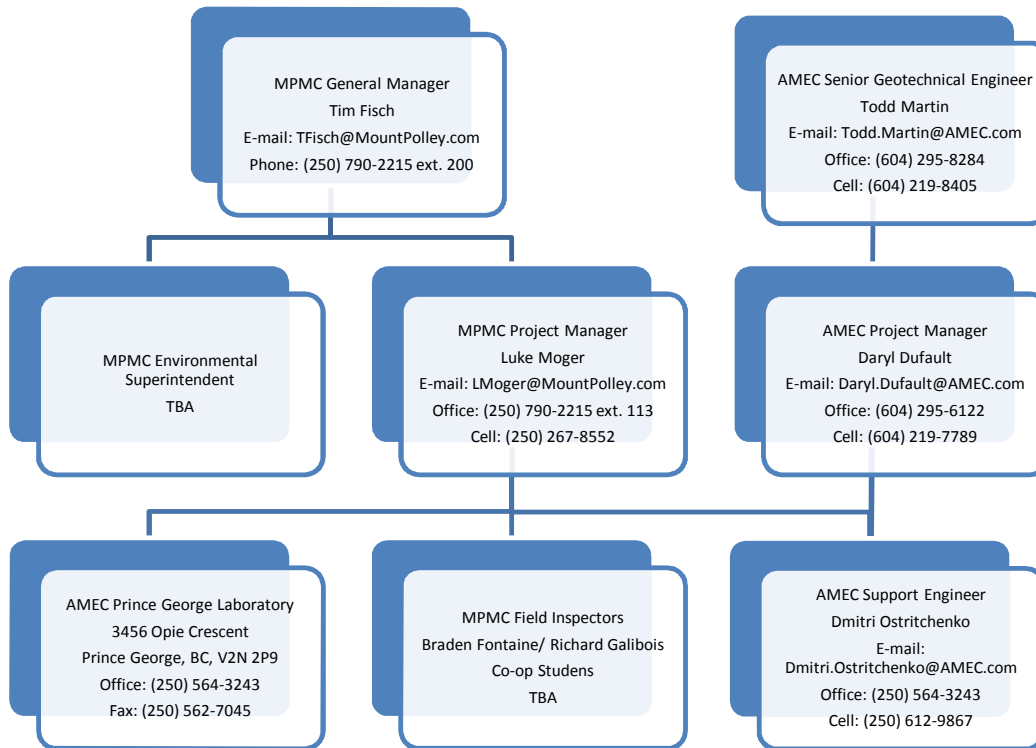
- Review and confirm that the prepared foundation areas are acceptable for support of structural fills.
- Review and confirm that the borrow materials are acceptable for use as structural fill.
- Monitor and test (where required) the placement and compaction of accepted structural fill.
- Monitor dam performance by reading and recording instruments in the dam(s) and preparing cumulative change and time plots of the results.
- Monitor drain performance by measuring flow and inspecting water quality

Construction monitoring of activities such as placement of structural fills and foundation preparation will proceed on a continuous basis. Schedules based on minimum test frequencies per unit volume of compacted structural fill will be followed for the various field and laboratory tests, with additional tests to be performed as required to reassess out-of-compliance results or at the discretion of AMEC.

The results of the monitoring and testing program will be reported to the appropriate parties (MPMC, AMEC) as they are obtained.

## 2.3 Organization and Responsibilities

Overall Figure 2.1 below outlines the overall organizational structure for Stage 8 TSF embankment construction, while the responsibilities are summarized in Table 2.1.



**Figure 2.1 2012 Construction Organization Chart**

### 2.3.1 MPMC Field Inspector

MPMC is to provide a full-time field inspector to monitor daily embankment expansion construction. The MPMC's field inspector is to have support and cooperation from the senior MPMC personnel and construction team.

The responsibilities of MPMC's field inspector will be as follows:

- Monitor and photograph daily construction activities related to TSF embankment.
- Set out construction limits, and verify lift thicknesses and zone widths.
- Prepare daily technical/activity reports. (See Appendix B).
- Conduct instrumentation readings on a regular basis and promptly report them to AMEC.
- Document and conduct compaction testing and visual and laboratory material testing as per specified.
- Report any non-compliance issues observed to AMEC and MPMC.

**Table 2.1 Construction Monitoring Tasks**

No.	Tasks Description	Responsibility
<b>1.0</b>	<b>Foundation Preparation</b>	
1.1	<u>Abutment Extensions</u> : Review of exposed soil and or rock conditions and confirmation that suitable dense, undisturbed, native soil, or sound bedrock conditions are exposed for dam construction.	AMEC
1.2	<u>Core Trench Construction</u> : Review of exposed soil and/or rock conditions, perform test pits as required to confirm the thickness of glacial till over bedrock along the core trench alignment. Review of core trench excavation and confirmation of proper excavation slopes. Direct rock excavation and clearing work as deemed necessary.	AMEC
1.3	<u>Approval</u> : Review the provided photos of the foundation preparation and provide approval.	AMEC
<b>2.0</b>	<b>Review of Borrow Areas and Materials</b>	
2.1	<u>Glacial Till Borrow Pit</u> : <ul style="list-style-type: none"> <li>• Review cut slopes.</li> <li>• Collect samples of borrow material for testing to assess both suitability of materials and to evaluate the Standard Proctor maximum dry density and optimum moisture content of the material.</li> <li>• Report test results to AMEC and MPMC's Project Manager as they are obtained.</li> </ul>	MPMC
2.2	<u>NAG Rock Source (Zone C)</u> : <ul style="list-style-type: none"> <li>• Review the selective borrowing / classification of material for the coarse NAG rockfill.</li> <li>• Visual verification of the material for conformance to the gradation specifications.</li> <li>• Report observation to AMEC and MPMC's Project Manager as they are obtained.</li> </ul>	MPMC
2.3	<u>NAG Rock Source (Zone T)</u> : <ul style="list-style-type: none"> <li>• Monitoring the selective borrowing/classification/processing of material for the fine NAG rock transition zone.</li> <li>• Collect periodic samples for conformance to the gradation specifications.</li> <li>• Report observation to AMEC and MPMC's Project Manager as they are obtained.</li> </ul>	MPMC
2.4	<u>NAG Crushing Operation (Zone F)</u> : <ul style="list-style-type: none"> <li>• Monitoring the filter sand and gravel crushing and decking operation.</li> <li>• Collect periodic samples for conformance to the gradation specifications.</li> <li>• Report observation to AMEC and MPMC's Project Manager as they are obtained.</li> </ul>	MPMC
2.5	<u>Materials Approval</u> : <ul style="list-style-type: none"> <li>• Conduct Tests on collected samples.</li> <li>• Approve the materials to be used during construction of the embankment.</li> </ul>	AMEC
<b>3.0</b>	<b>Review of Structural Fill Placement</b>	
3.1	<u>Zone S</u> : <ul style="list-style-type: none"> <li>• Review and confirm that the locations of zone interfaces are in their correct locations.</li> <li>• Confirm the width of the core zone is sufficient.</li> <li>• Test the placed and compacted Zone S structural fill for in-place density.</li> <li>• Collect samples for moisture content determinations and density (rock content) corrections.</li> <li>• Collect samples of fill for confirmation index testing.</li> <li>• Report observations and test results to AMEC and MPMC's Project Manager as they are obtained.</li> </ul>	MPMC
3.2	<u>Zone C</u> : <ul style="list-style-type: none"> <li>• Review and confirm that the NAG rock is in conformance to the gradation specifications.</li> <li>• Observe and confirm the compaction specification is followed.</li> </ul>	MPMC
3.3	<u>Zone T</u> : <ul style="list-style-type: none"> <li>• Review and confirm that the NAG transition zone rock is in conformance to the gradation specifications.</li> <li>• Observe and confirm the compaction specification is followed.</li> <li>• Collect samples for gradation analysis.</li> <li>• Report observations and test results to AMEC and MPMC's Project Manager as they are obtained.</li> </ul>	MPMC
3.4	<u>Zone F</u> : <ul style="list-style-type: none"> <li>• Review and confirm that the zone interfaces are in their correct locations.</li> <li>• Confirm the width of the filter zone is sufficient.</li> <li>• Collect samples for gradation analysis.</li> <li>• Review and confirm that the crushed fine filter material is in conformance to the gradation specifications.</li> <li>• Confirm via hand-excavated test pits that segregation of filter sand and gravel is not occurring.</li> <li>• Report observations and test results to AMEC and MPMC's Project Manager as they are obtained.</li> </ul>	MPMC
3.5	<u>Zone U</u> : <ul style="list-style-type: none"> <li>• Review and confirm that the zone interface is in the correct location.</li> <li>• Collect samples for gradation analysis.</li> <li>• Monitor material reworking to ensure proper distribution within the cell.</li> <li>• Report observations and test results to AMEC and MPMC's Project Manager as they are obtained.</li> </ul>	MPMC
<b>4.0</b>	<b>Dam Performance Monitoring</b>	
4.1	Coordinate biweekly readings of vibrating wire piezometers and slope inclinometers during the construction. Submit the raw data collected to AMEC for review.	MPMC
4.2	Review submitted weekly readings, prepare associated graphs and analyze the collected data. Report monitoring results to AMEC and MPMC's Project Manager as they are obtained.	AMEC
<b>5.0</b>	<b>Construction Monitoring</b>	
5.1	Daily meetings between MPMC's Field Inspectors and Contractor to establish and review daily construction plan, identify concerns, and discuss other relevant issues.	MPMC
5.2	Monthly meeting between MPMC's Field Inspector, Project Manager, AMEC Support Engineer and Contractor.	MPMC/AMEC
5.3	Establish and confirm construction boundaries between various zones.	MPMC
5.4	Addressing any concerns or out-of-compliance situations observed and recorded during construction.	MPMC/AMEC
<b>6.0</b>	<b>Record Keeping</b>	
6.1	Maintain daily construction site photographic record of construction activities.	MPMC
6.2	Completing daily construction reports, and delivering a copy to MPMC's Mine Superintendent, and by email to AMEC's Support Engineer.	MPMC
6.3	Completing monthly construction reports, with copies to MPMC's Project Manager and AMEC's Project Manager and Senior Geotechnical Engineer.	AMEC



### **2.3.2 AMEC Support Engineer**

The AMEC Support Engineer will provide full-time construction monitoring at the commencement of the Stage 8 construction. After confidence in the MPMC Field Inspectors is achieved, the AMEC Support Engineer will provide primarily remote assistance by reviewing daily reports and instrumentation data as required. The AMEC Support Engineer will also conduct monthly site visits (actual frequency to be determined by site performance) to verify construction methods and specifications are being followed.

The responsibilities of the AMEC Support Engineer are as follows:

- Provide remote assistance to MPMC Field Inspector.
- Provide on-site assistance with inspection and approval of abutment preparation.
- Review daily construction reports, communicate and document any concerns arising from the review to AMEC's Project Manager and/or Senior Geotechnical Engineer.
- Review instrumentation reading plots provided by MPMC, and communicate any concerns to AMEC's Project Manager and/or Senior Geotechnical Engineer.
- Carry out monthly site visits to monitor construction progress and perform quality assurance testing.
- Prepare monthly progress reports summarizing construction activities, test results, and milestone achievements.
- Prepare site As-built/Annual Review Report.

### **2.3.3 AMEC Project Manager**

AMEC's Project Manager will have overall responsibility for AMEC's role with upcoming and future dam raising projects. He will review all monthly construction progress reports. He will liaise with the AMEC Senior Geotechnical Engineer and MPMC's Project Manager to review any problems that may arise.

The AMEC Project Manager will liaise with the AMEC Support Engineer and the MPMC's Project Manager (and through him MPMC's Field Inspector), and will make site visits as deemed necessary during construction. The exact timing and duration of the site visits will be determined in consultation with the MPMC Project Manager so that critical aspects of the construction can be viewed during these visits.

The responsibilities of AMEC's Project Manager will be as follows:

- Review monthly construction reports prepared by the AMEC Support Engineer and document and communicate any concerns arising from these reviews to MPMC's Project Manager and AMEC's Senior Geotechnical Engineer.
- Review instrumentation interpretations and communication of any concerns to MPMC's

Project Manager and AMEC's Senior Geotechnical Engineer.

- Review monthly progress reports prepared by the AMEC Support Engineer and document and communicate any concerns arising from these reviews to MPMC's Project Manager and AMEC's Senior Geotechnical Engineer.
- Carry out periodic site visits as appropriate during the construction season, timed to coincide with critical aspects of the construction.
- Identification, review, and approve any design changes determined to be required by AMEC and/or MPMC.

### **2.3.4 AMEC Senior Geotechnical Engineer**

AMEC's Senior Geotechnical Engineer will serve as the engineer of record for the Mount Polley TSF embankment. He will review monthly construction and instrumentation reports as required and review the As-built/Annual Review reports, and will visit the site once during each year's construction.

### **2.3.5 AMEC Soils Laboratory – Prince George**

All off-site material testing will be carried out at the AMEC Prince George Laboratory. MPMC will be responsible for collection and shipment of samples as required. With the help of AMEC's Support Engineer the test results will be conveyed to MPMC.

### **2.3.6 Soils Testing – Mount Polley Site**

The Mount Polley on-site laboratory has the capability to carry out some of the required testing. During the 2011 construction period AMEC noted that the testing frequencies were not followed and testing results were not submitted for AMEC to review on a consistent basis. Thus, for the 2012 construction period AMEC will utilize AMEC's Prince George Laboratory to conduct most of the material testing required during the construction session. However, the following tests will still be conducted on site utilizing ASTM standards: three (3) gradation analysis for Zone T and Zone F during production (D422-07); daily moisture content confirmatory testing (D2216-10) of Zone S. All test results will be completed by the MPMC Field Inspector or the MPMC laboratory staff, and are to be submitted to AMEC's Support Engineer and attached with the daily construction reports for review and approval.

### **2.3.7 MPMC Project Manager**

MPMC's Project Manager shall assume overall responsibility for MPMC construction management and MPMC supervision, monitoring, and quality control testing activities when AMEC is not on site. This person shall ensure that the design specifications and the QA/QC requirements as outlined in this manual are followed. In the absence of the MPMC Project Manager, the MPMC Technicians dedicated to the TSF embankment will take responsibility.

MPMC's Project Manager shall liaise with AMEC's Support Engineer, and AMEC's Project Manager to discuss construction progress, any problems encountered and their resolution, and the timing of site visits by AMEC personnel to view the construction.

The MPMC Project Manager will address any concerns raised by the Field Inspector/Support Engineer, including, but not limited to, the following:

- Placement of material unacceptable as dam fill.
- Unacceptable construction procedures (excessive lift thickness, inadequate compaction, inadequate foundation preparation, inadequate material testing etc.).
- Non-compliance issues identified by the AMEC Support Engineer and MPMC Field Inspector that are not immediately rectified by the construction forces, be they those of the contractors or MPMC.

### **2.3.8 MPMC Environmental Superintendent**

The MPMC Environmental Superintendent will address any concerns raised by the Field Inspector/Support Engineer as related to any potential environmental issues or concerns.

### 3.0 MATERIALS TESTING AND CONSTRUCTION INSPECTION

#### 3.1 General

The detailed technical requirements for the 2012 raise of the TSF Embankment are shown in attached drawing 2012.01 through 2012.07. The technical requirements for the construction are indicated on attached drawing and are restated in Sections 3.3 through 3.6.

#### 3.2 Estimated Fill Volumes

Table 3.1 below summarizes the estimated material quantities for Stage 8 expansion to be constructed in 2012.

**Table 3.1 Stage 8 Expansion (El. 963.5 m) Estimated Fill Volumes**

SECTION	ESTIMATED FILL VOLUMES (m <sup>3</sup> )			
	Zone C	Zone T	Zone F	Zone S
<b>Main Embankment</b>	57,900	7,400	7,400	20,600
<b>Perimeter Embankment</b>	70,100	11,900	11,900	33,200
<b>South Embankment</b>	32,400	6,400	6,400	17,900
<b>Total</b>	<b>160,400</b>	<b>25,700</b>	<b>25,700</b>	<b>71,700</b>

Notes:

1. Volumes are estimated from drawings 2012.02 through 2012.06, and are rounded up to the nearest 100 m<sup>3</sup>.
2. No settlement allowance has been considered.
3. Quantities are based on neat construction lines; with no contingency or allowance for overbuild or waste factors.

#### 3.3 Foundation Preparation, Inspection, and Approval

##### 3.3.1 General

Foundation preparation for the 2012 dam construction along the abutment extensions are to be completed to the following specifications and in accordance with drawing 2012.07:

- All topsoil, organic material, soft or loose soils, and other deleterious materials are to be removed from the foundation area.
- The exposed abutment foundation subgrade is to consist of dense to very dense glacial till, or bedrock.
- The abutment subgrade shall be proof-rolled with a smooth drum compactor.

Foundation preparation for the abutment cutoff trench extensions will be completed to the following specifications and in accordance with Detail 1 on drawing 2012.07:

- The cutoff trench shall extend a minimum of 0.5m into the undisturbed glacial till, where the glacial till is in excess of 1m thick.
- Where less than 1m thickness of glacial till exists, the cutoff trench shall extend to sound bedrock with removal of weathered or fractured bedrock completed to the approval of the AMEC Support Engineer. Additional specifications related to bedrock encountered in the cutoff trench are provided in Section 3.3.4 below.
- The thickness of glacial till at the cutoff trench is to be confirmed by performing test pits at locations along the cutoff trench alignment selected by the AMEC Support Engineer.
- The cutoff trench shall be constructed with a minimum 2 m width at its base. Where bedrock is encountered, the AMEC Support Engineer may direct that overburden be removed for the full 5 m width of the Zone S core.
- The cutoff trench shall have side slopes of 1H:1V or flatter. Steeper slopes may be accepted in bedrock at the discretion of the AMEC Support Engineer.
- Surface runoff water or groundwater shall not be permitted to collect in the cutoff trench.

Prior to placement and compaction of structural fill in the cutoff trench excavation, the Field Inspector will send photos to the AMEC Support Engineer for approval. The Field Inspector will verify that the cutoff trench is founded in the minimum specified depth of glacial till (and will conduct or oversee soil probing as required), or that the cutoff trench is founded on sound bedrock. Cutoff trench excavation inspections will be performed as required, and inspection dates and results will be tracked by the Field Inspector on copies of the construction drawings or by station number. MPMC surveyors will provide a survey pick-up of the cutoff trenches and maintain a project database for use in the as-built documentation.

### **3.3.2 Tie-In to Existing Till Core**

The 2012 raise of the core zones of the embankment will involve placement of structural fill on the existing dam crests. On the existing dam crests, removal of the crest running surface (by grading it off the upstream edge of the dam crest) may be required, followed by removal and/or drying and re-compaction of any loose, over-wet zones within the till fill. As the final lift of 2011 construction season was not tested, the material will be compacted and tested as specified in Section 3.5.1 of this document.

### **3.3.3 Foundation Preparation**

Foundation preparation is not to be conducted without AMEC's Support Engineer present on site. The foundation preparation for 2012 construction will consist of foundation preparation to the current ultimate design (El. 970.0m). MPMC will procure required permits undertake this work. The foundation will be drained (where required) and will be stripped of all organic material, loose or soft soils, and all other deleterious materials under the foot print of the embankment with an additional 1m buffer zone for tie-in capabilities and material placement inaccuracies. These unacceptable materials will be wasted in an approved manner, in an approved location as designated by MPMC personnel. Salvageable topsoil and organic material that could be

used for reclamation will be stockpiled in appropriate locations for future use, as directed by MPMC's Project Manager.

Suitable dense subgrade for the embankment will be exposed, then proof-rolled and scarified (if deemed necessary by the AMEC Support Engineer). Prior to placement of structural fill as specified on drawing 2012.07, AMEC's Support Engineer will approve the subgrade. The exposed subgrade is to be protected from moisture softening due to surface water runoff or excessive precipitation.

The cutoff trench location will be identified in the field by surveyors, and the design vertical (depth) extent of the cutoff in native soil or weathered bedrock verified by test pits or soil probes that extend below the minimum specified trench depth (see Detail 1, drawing 2012.07). The cutoff trench excavation will be protected from moisture softening due to surface water inflow or excessive precipitation. Water seeping into the cutoff trench excavation will be removed by pumping, and will not be permitted to collect and remain in the excavation.

Prior to placement and compaction of structural fill in the cutoff trench excavation, AMEC's Support Engineer will approve the preparation of the trench. Inspections will occur as foundation areas are completed and the approval will be documented as described in the monthly report. Photographic records will be maintained to identify foundation areas that have been inspected and approved, clearly indicating their date of inspection. Areas not approved for placement of structural fill by the AMEC Support Engineer are not to be covered with fill under any circumstances.

### **3.3.4 Special Considerations for Bedrock Exposed in Till Cutoff Trench**

If bedrock is encountered in the dam foundation cutoff trench, special considerations exist and special bedrock treatment measures may be required. Guidelines and procedures for dealing with bedrock exposed in the cutoff trenches are as follows:

Weathered or fractured bedrock is defined as bedrock that can be readily excavated by a dozer or a hoe excavator equipped with a digging bucket and that, based on visual assessment, is highly pervious to groundwater flow due to the presence of fractures/joints/faults. Sound (competent) bedrock, is defined as bedrock that can be excavated only with significant difficulty (or not at all) by a hoe excavator equipped with a digging bucket. When excavating in bedrock, frequent communication with AMEC's Senior Geotechnical Engineer and transmission of photographs is to be carried out.

If shear/fault zones are encountered within the bedrock exposed in the core to abutment contacts, the following information should be collected and passed on to AMEC's Senior Geotechnical Engineer:

- Photographs of the shear zone from a variety of vantage points (both close-ups and photos giving an overall perspective).
- Orientation (strike & dip) of the feature and its orientation relative to that of the core zone (i.e. does it provide a potential upstream-downstream seepage pathway?).
- Thickness and continuity.
- Infilling (clayey gouge, granular material). The infilling material should be sampled and sent to the AMEC Prince George soils laboratory for grain size and Atterberg limits testing.

AMEC's Senior Geotechnical Engineer, upon analysis of the information provided, will determine what (if any) special treatment is required for the shear/fault zone. Such treatment may include hand excavation a few centimeters into the shear zone, followed by placement of bentonite powder in advance of till placement.

Once sound bedrock is encountered, the surface should be cleaned of loose materials using a hoe excavator equipped with a narrow cleaning bucket, followed by pressure washing using either air or water. Where the slope of the cleaned and approved sound bedrock surface, along the axis of the dam (i.e. up the abutment), is flatter than 1H:1V, then Zone S structural fill placement may proceed. Good compaction of the Zone S fill against the bedrock surface is required. If the undulations in the bedrock surface along the bottom of the trench are such that this cannot be achieved using dozers and the compactor, then such undulations (i.e. rock protrusions) should be removed if possible. If this is not possible, then compaction of thin till lifts with a walk-behind or plate-tamping compactor, or with tamping with a hoe bucket, will be required, to fill in the undulations. Once this is done, then normal spreading and compaction procedures can be undertaken.

Where the slope of the sound bedrock surface is steeper (overall) than 1H:1V, but flatter than 0.5H:1V, then the AMEC design office should be consulted for a decision on the need for any further treatment measures. Photographs of the bedrock surface should be sent to the design office. If the roughness of the rock surface is such that it is judged that effective compaction of till fill against the bedrock on the base of the trench cannot be achieved, then additional (small scale) bedrock excavation (removal of protrusions) should be attempted to attain a surface against which it is judged till fill can be effectively compacted. If this measure is unsuccessful, then one of the following additional measures will be required:

- (a) Additional (large scale) bedrock excavation should be undertaken to achieve a maximum 1H:1V overall slope for the bedrock surface. This can be achieved by mechanical means (dozers, hoe excavators), or by small scale, controlled drilling and blasting.
- (b) Dental concrete or shotcrete application will be required to fill in the undulations in the bedrock surface, and yield a maximum slope of 0.5H:1V, against which till fill can be effectively compacted.

Where the bedrock surface is steeper than 0.5H:1V, the same two measures outlined above will apply.

Where dental concrete is required against steep bedrock faces, it will likely be necessary to use formwork. Dental concrete, if used, will conform to the following specifications:

- 28 day strength – minimum 25 MPa if flyash included in mix, otherwise minimum 30 MPa.
- Water to cement ratio: 0.45:1 by mass.
- Air entrainment: to provide for 5% to 7% air entrainment.
- Cement to flyash ratio (if flyash used): 4:1 by mass, which would allow overall water:cement:flyash ratio of 0.45:0.8:0.2.

The dental concrete need not be of high strength. It does need to be sufficiently fluid that it will fill in irregularities in the bedrock surface to a reasonable extent. Addition of flyash to the mix would achieve that objective, as well as save on cement costs.

Should shotcrete be selected, then MPMC will prepare a mix design for review and approval by AMEC.

Prior to placement and compaction of structural fill in the cutoff trench excavation, the Field Inspector will send photos to the AMEC Support Engineer for approval. Core trench excavation inspections will be performed as required, and the Field Inspector will track inspection dates and results on copies of the construction drawings or by station number. MPMC surveyors will provide a survey pick-up of the core trench excavations and maintain a project database for use in the as-built documentation.

### **3.4 Borrow Materials Site Development and Operation**

The proposed borrow pit will be subjected to sampling, laboratory testing, and approval by AMEC Support Engineer. During the TSF embankment construction, detailed documentation will be maintained to ensure the source of the material being placed is known and material testing requirements are satisfied.

Topsoil and other overburden judged to be unsuitable as structural fill will be stripped from the borrow pit and hauled to an acceptable waste dump.

The borrow material site shall be developed such that groundwater inflow and precipitation runoff are directed in a controlled manner to designated sump area(s) of the site, and then removed as required. External surface water runoff shall be prevented from flowing into the borrow materials area by construction of diversion ditches as required.

The performance of the cut slopes in borrow areas will be inspected and recorded as required by the MPMC Field Inspector for documentation within the construction reports. AMEC's



Support Engineer may request modifications to the excavation plan, including flattening of the slopes and water control measures, based on the observed performance of the cut slopes.

### **3.5 Material Specifications, Material Testing, Inspection, and Approval**

The approved structural fill to be used for embankment construction is to meet the specifications shown on drawing 2012.03. Additional comments pertaining to each of the zones are provided below.

#### **3.5.1 Zone S (Core) – Glacial Till**

The glacial till borrow materials approved for construction are to be well graded, organic-free mineral soils, having moisture contents near their optimum for compaction and conforming to the specified gradation envelope provided on drawing 2012.03. The optimum moisture content range of the borrow soils is to be determined by Standard Proctor moisture-density relationship testing. A general guideline for allowable moisture contents for the Zone S structural fill is  $\pm 1\%$  of the optimum moisture content as determined by the Standard Proctor test.

The proposed till borrow soils are to be visually inspected for consistency on a daily basis by MPMC Field Inspectors. Any material not meeting specification shall not be placed within the embankment. The till borrow pits are to be sampled bi-weekly or every 10,000 m<sup>3</sup> removed whichever is less and shipped to the AMEC Prince George Laboratory. The samples are to be collected and shipped according to ASTM standard: Standard Practices for Preserving and Transporting Soil Samples (D4220-07); and consist of two (2) three-quarter (3/4) full 5-gal buckets, void of any oversized rocks (<75mm in diameter). If the representative sample is to contain oversized rocks, they are to be collected, weight, and noted as being removed from the collected sample.

Prior to placement of glacial till the top 25mm of the previous lift or prepared abutment is to be scarified to promote bonding between successive lifts. Scarification of the grade should only be done to the section of grade that will be immediately covered (during the work day). After scarification if the grade appears crusted and/or is outside the  $\pm 1\%$  optimum moisture content the grade is to be moisture-conditioned or dried as the case requires.

Placement of glacial till on grade needs to be monitored closely to visually confirm that the material is consistent to the material that has been sampled, tested, and approved. A sample of on-grade glacial till is to be collected bi-weekly offset from the borrow pit sample or every 6,500 linear meters whichever is less and shipped to the AMEC Prince George Laboratory for laboratory testing. The samples are to be collected and shipped according to ASTM standards: Standard Practices for Preserving and Transporting Soil Samples (D4220-07); and consist of two (2) three-quarter (3/4) full 5-gal buckets, void of any oversized rocks (<75mm in diameter). If the representative sample is to contain oversized rocks, they are to be collected, weight, and noted as being removed from the collected sample.

The approved Zone S glacial fill is to be spread in loose 0.3m thick lifts and compacted by a 10 ton vibratory smooth drum compactor. Care during placement of glacial till is to be taken to ensure even distribution throughout the entire width of the zone, to promote proper compaction. A minimum of 95% compaction of the Standard Proctor maximum dry density is to be achieved.

Placed and compacted in-situ glacial till is to be tested for compaction at least once (1) per 100 linear meters per lift per day to confirm that specified compaction of 95% has been established. Compaction testing will be carried out with the aid of a nuclear densometer (ND) and Density Indicator (MDI) as back-up. The compaction testing should be conducted with accordance to ASTM standards D6938-10 and D6780-05. The compaction test locations are to be surveyed and identified by three dimensions: elevation, northing and easting in sequential order, and submitted for approval and review to AMEC Support Engineer on a daily basis.

In addition, to the density tests a confirmatory in-situ moisture content sample is to be collected once (1) per 1,000 liner meters per lift or once (1) per day per lift whichever is less. The moisture content testing should be conducted with accordance to ASTM standard: Water (Moisture) Content of Soil and Rock (D2216-10) and Correction of Unit Weight and Water Content for Soils Containing Oversize Particles (D4718-07). The confirmatory moisture test will identify the accuracy of ND and MDI density testing. If there is a greater than 10% difference between the ND/MD and laboratory sample a secondary is to be conducted, and if the issue persists AMEC's support Engineer is to be informed immediately.

Upon receiving collected samples AMEC's Prince George Laboratory will perform the following tests utilizing ASTM standards: Particle Size Analysis of Soils (D422-07), Laboratory Compaction Characteristics of Soil Using Standard Effort (D698-07), Liquid Limit, Plastic Limit, and Plasticity Index of Soils (D4318-10).

### **3.5.2 Zone F (Filter) – Manufactured Sand and Gravel**

The sand and gravel filter material is to be well graded, organic-free mineral soil, falling within the specified gradation envelope shown on drawing 2012.03. Preliminary grain size testing of stockpiled material is to be carried out on site in order to establish the suitability of the material prior to its use as fill in the dam. Three (3) point gradation tests are to be carried out once (1) per 5,000m<sup>3</sup> during production and submitted to AMEC for review.

Zone F material is to be placed in maximum 0.6m thick lifts prior to compaction. Care will be taken during handling and placement of the material to minimize segregation and to avoid cross contamination of the zones. If cross contamination of the zones occurs the material contaminated is to be removed from grade. MPMC's Field Inspector is to visually inspect placed Zone F material to ensure the material is well graded and the specified width of the zone is established and maintained.

A sample of placed Zone F material is to be taken once (1) per placement event or once (1) per 2,500 linear meters of placed material whichever is less. The samples are to be collected and shipped according to ASTM standard: Standard Practices for Preserving and Transporting Soil Samples (D4220-07); and consist of one (1) three-quarter (3/4) full 5-gal buckets, void of any oversized rocks (<75mm in diameter). If the representative sample is to contain oversized rocks, they are to be collected, weighed, and noted as being removed from the collected sample. The collected sample is to be shipped to AMEC Prince George Laboratory, where the sample will be tested utilizing ASTM standard: Particle Size Analysis of Soils (D422-07) to confirm material specifications are followed.

After the placement of Zone T for confinement is completed, previously established compaction pattern minimum of four passes with a 10 ton vibratory smooth drum is to be applied to both Zones T and F. Visual inspection after compaction will be carried out and approved by the MPMC Field Inspector.

### **3.5.3 Zone T (Transition) – Fine NAG Rock Transition**

Fine NAG rock transition material shall be confirmed to be NAG by MPMC, and shall fall within the specified gradation envelope shown on drawing 2012.03. During the 2011 construction period produced aggregate was utilized for this zone. AMEC understands that for the 2012 construction period similar produced aggregate will be utilized. The following procedure and testing frequencies are only valid for the produced aggregate and thus if the material for this unit differs, AMEC is to be notified prior to switching materials. A new procedure and testing frequency would be established for the new material

Zone T material is to be placed in maximum 0.6m thick lifts prior to compaction. Care will be taken during handling and placement of the material to minimize segregation and to avoid cross contamination of the zones. MPMC's Field Inspector is to visually inspect placed Zone T material to confirm the material is well graded, and the specified width of the zone is established.

A sample of placed Zone T material is to be taken once (1) per placement event or once (1) per 4,500 linear meters of placed material whichever is less. The sample is to be collected and shipped according to ASTM standard: Standard Practices for Preserving and Transporting Soil Samples (D4220-07); and consist of four (4) three-quarter (3/4) full 5-gal buckets. The collected sample is to be shipped to AMEC's Prince George Laboratory, where the sample will be tested utilizing ASTM standard: Particle Size Analysis of Soils (D422-07) to ensure material specifications are followed.

After placement of Zone T material is completed, the previously established compaction pattern, comprising a minimum of four passes with a 10 ton vibratory smooth drum, is to be applied to Zone F and Zone T simultaneously. Visual inspection after compaction will be carried out and approved by the MPMC Field Inspector.

### **3.5.4 Zone C (General Rockfill) – Coarse NAG Rock Shell**

Coarse NAG rockfill shall be confirmed to be NAG by MPMC prior to being used as fill on the dam. MPMC personnel are to visually confirm that particles no larger than 1 m are used as structural fill. Larger sizes are to be dozed away from the contact with Zone T.

Prior to placement of Zone C the existing top 0.3m of Zone C material is to be scarified if “pavement” type appearance that might impede vertical drainage is noted. The rockfill shell (Zone C) will be constructed using approved coarse NAG rockfill, placed in lift thicknesses of 2 m or less. The Zone C lifts will be compacted by uniform routing of haul trucks and spreading equipment. Some degree of compaction of Zone C is required nearer Zone T as excessive settlement of the rockfill could disrupt the continuity of the overlying transition and fine filter materials (Zones T and F respectively).

### **3.5.5 Zone U (Selected Upstream Fill) – Tailings/NAG**

The selected upstream fill (Zone U) will be constructed using cells of total tailings. The cells are constructed by confining the discharged tailings with berms. The confining berms are to have a culvert to allow for the water and fine materials to escape into the TSF. The coarse tailings sand that settles out into the cells are to be reworked with the help of a dozer to achieve proper distribution within the cells, provide compaction and to expedite the excess water drainage. This construction method has been used and proved effective in previous TSF embankment raises.

In areas of the dam (along the Main Embankment) where there is not sufficient tailings line pressure to deposit with the cell method, NAG mine waste rock will be substituted for Zone U Material. Care will be taken to taken during construction of the berm to ensure the NAG is well graded and free of boulders larger than 0.5m in diameter.

## **3.6 Criteria for Suspension of Work**

The till borrow material is highly sensitive to moisture in terms of its compaction characteristics and workability. Consequently, during periods of wet weather, construction of the core zone will be suspended. Adequate slopes will be maintained on till fill surfaces, and they will be sealed with a smooth drum vibratory roller, to promote surface water runoff and prevent excessive softening of compacted fill. Moisture-softened lifts must be removed or scarified, dried to acceptable moisture content and re-compacted.

Embankment construction will stop if the inclinometer data or piezometers fall under the yellow or red condition as indicated in Table 3.2, or if the piezometers indicate increasing trend in the foundation piezometers. For more details refer to the stability analysis in attached Appendix A.

**Table 3.2      Inclinator Trigger Levels**

Condition	Inclinometer Movement Rate		Main Embankment Foundation Piezometer	
	(mm/day)	(bi-weekly)	Elevation (m)	Above original ground (m)
RED	> 1 mm/day	>14mm	> 925 m	>13 m
YELLOW	0.5 mm/day to 1.0 mm/day	7 mm to 14 mm	921 m to 925 m	9 m to 13 m
GREEN	< 0.5 mm/day	7 mm	< 921 m	< 9 m

Embankment construction work will stop for the season when freezing weather prevents acceptable fill placement and compaction.

## 4.0 TEST PROCEDURES

### 4.1 Scheduled Tests

The following tests, as described by the American Society for Testing and Materials (ASTM), will be used for quality control of materials and earthworks during the 2012 construction.

ASTM STANDARD PRACTICE	DESIGNATION
Sieve in Mineral Aggregates by Washing	C117-04
Sieve Analysis of Fine and Coarse Aggregates	C136-06
Dry Preparation of Soil Samples	D421-07
Particle Size Analysis of Soils (Hydrometer test)	D422-07
Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft <sup>3</sup> (600 kN-m/m <sup>3</sup> ))	D698-07
Water (Moisture) Content of Soil and Rock	D2216-10
Standard Practices for Preserving and Transporting Soil Samples	D4220-07
Liquid Limit, Plastic Limit, and Plasticity Index of Soils	D4318-10
Correction of Unit Weight and Water Content for Soils Containing Oversize Particles	D4718-07
Water Content and Density of Soil in Place by Time Domain Reflectometry	D6780-05
Particle-Size Distribution (Gradation) of Soils	D6913-04
In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)	D6938-10

Laboratory and field procedures for each test are provided in the corresponding ASTM Standard Practice document. Copies of those standards for the tests to be performed on site are provided in Appendix C of this manual. Moistures and density tests will be conducted by the Field Inspectors and Engineers on site. Replicate samples of those tests carried out on site will be forwarded to the AMEC Prince George laboratory for confirmation testing, typically at a rate of one confirmation test per fifteen field tests. Atterberg limits and proctor tests will be carried out in the AMEC Prince George soils laboratory.

The tests outlined above will be carried out initially at the minimum frequencies indicated on drawing 2012.03. As trends and consistency in the test results develop, AMEC's Support Engineer may reduce testing frequencies where deemed appropriate.

### 4.2 Additional/Supplemental Tests

Determinations of specific gravity (ASTM D854-10) for the approved glacial till and borrow soils may be required if significant material changes are observed. These tests will be conducted at the AMEC Prince George laboratory, following the Standard Practice noted below. Typically, two or three specific gravity determinations would be required for each soil type.

### 4.3 Sample Collection Procedures

Samples to be transported to the AMEC Prince George laboratory for field laboratory verification testing will be sealed to minimize soil moisture losses, and shipped in an expedient manner. The shipping address is as follows:

Attn: Dmitri Ostritchenko (Mt. Polley)  
AMEC Earth and Environmental  
3456 Opie Crescent  
Prince George, BC  
V2N 2P9

The MPMC Field Inspector shall include transmittals with the samples outlining the tests to be carried out for each respective sample. These transmittals are to be emailed to AMEC's Support Engineer in advance of the shipment and are to be included in the daily construction report. The Prince George laboratory will check that the label information attached to each sample is incorporated onto the corresponding test sheets, and that copies of the test sheets and results are forwarded to AMEC's Support Engineer as the tests are completed. AMEC's Support Engineer will review the test results and submit them in the monthly report, or sooner if immediate actions are needed.

Samples collected by the Field Inspectors for the scheduled tests during the 2012 construction will be identified by a detailed labeling scheme, the following is an example:

SAMPLE LABEL	
Project name :	Mt. Polley Mines Project
Construction :	Stage 8 Raise – 2012
Material :	<i>Glacial Till (Zone S)</i>
Source :	<i>Main Embankment</i>
Location :	<i>Elev. 960, 1 m d/s of CL, sta 21+00</i>
Date :	<i>06/20/12</i>
Sample Number :	<i>06/20/12-(initials)1</i>
Sample Destination:	AMEC Prince George Laboratory
Test Type(s):	<i>Standard Proctor, Gradation</i>

Sample locations, material descriptions, and other relevant notes will be recorded by the MPMC Field Inspectors. The sample label information, accompanying field notes, and test results will be included in the construction reports as part of the permanent record of the 2012 construction program.

Samples will be collected and preserved in a manner consistent with their scheduled tests, such as the placing and sealing of samples for natural moisture content determinations in plastic bags.

## **5.0 REPORTING**

### **5.1 Construction Documentation**

MPMC's Field Inspectors will document the monitoring and testing program for Stage 8 embankment raise construction by means of daily construction reports, field and laboratory test sheets, survey reports as provided, and notes from relevant on-site meetings, discussions, and decisions. Other documents, such as borrow area excavation diagrams or dam construction progress maps, may be included with the construction records. A photographic record will also be maintained on site. Select photographs will be captioned, dated, and included in the daily construction report and final as-built report.

### **5.2 Daily Construction Reports**

MPMC Field Inspectors with the aid of coop students will be responsible to submit a daily construction report. A sample of a daily construction report and associated spread sheets are attached in Appendix B and a digital copy of the reports will be submitted to MPMC Project Manager. The information to be provided in these reports includes but is not limited to the following:

- Construction Activities – What preparation work was conducted prior to placement of material? What material was placed where and how was the material placed, compacted, etc?
- Material Testing – What samples were collected? Where was the sample collected?
- Compaction Testing – At what station and offset was the test conducted? (Northing, Easting) What elevation was the sample collected? Was a comparative laboratory moisture content sample taken?
- Instrumentation Readings – What instrumentation data was collected?
- Non-compliance Issues and Mitigating Actions to be taken
- Daily Activities Photographs – Photographs depicting various activities performed in relation to TSF embankment construction. A minimum of 6 high quality photographs are generally appropriate per daily report.

Daily reports are to be signed and submitted via email by 10:00am of the following day to AMEC's Support Engineer and MPMC's Project Manager for review.

### **5.3 Monthly Progress Reports**

Monthly progress reports will be prepared by the AMEC Support Engineer for those periods when active construction is ongoing; documenting the construction activities, material testing results, instrumentation readings and compliance with the design specifications. These reports will be issued to MPMC Project Manager, AMEC Project Manager and Senior Geotechnical Engineer.



#### **5.4 As-Built Report/Annual Review**

AMEC will prepare a report summarizing the construction methodology followed and documenting the as-built dam conditions for the 2012 construction season. This as-built report for 2012 will be combined with the 2012 annual review report. The report will be confirmation that the dam was raised in conformance with design intent, and will serve as a guide for construction of TSF embankment in subsequent years.

The as-built report will also outline any modifications made in the field to the initial methods of foundation preparation; borrow soils excavation, hauling, placement, and compaction; or other relevant work. Documentation of any such refinements made during construction will be of benefit for subsequent embankment raises. The as-built report will also include recommendations pertinent to the construction and QA/QC monitoring of future construction.

MPMC will mark-up the construction drawings based on as-built surveys of the raised dam. These marked-up drawings will be used by AMEC to produce CADD as-built drawings for the report.

## **6.0 INSTRUMENTATION & MONITORING**

### **6.1 General**

As part of the 2011 construction program new instrumentation was installed to replace defective and damaged instruments. No new instrumentation is planned to be installed during the 2012 construction program.

### **6.2 Inclinerometers**

Overall eight (8) inclinometers have been installed in around the TSF embankment, seven (7) along the main embankment and one (1) along the perimeter embankment. Slope inclinometers are installed to measure the potential displacement in the glaciolacustrine unit that underlies the embankment.

One (1) of the inclinometers has sustained damage (SI01-01) such that it can no longer be probed. An investigation during the 2012 construction program will be conducted by AMEC support Engineer with the aid of an MPMC operated excavator to attempt to fix the damaged (SI01-01) inclinometer.

During active construction the slope inclinometers are to be read, and the data plotted and submitted to AMEC Support Engineer, bi-weekly. During non-active construction the data should be collected monthly. Based on dam performance the reading frequency may be increased or decreased at the sole discretion of the AMEC Senior Geotechnical Engineer.

### **6.3 Vibrating Wire Piezometers**

The vibrating wire piezometers are required for monitoring changes in pore pressure during construction and dam foundation pore pressure changes over time. As the embankment height increases, the pore pressure in the foundation, results in near-immediate increase due to additional loading. The data obtained provides the pore pressure parameters that are used for limit equilibrium stability analyses. This information will continue to be required for monitoring the short and long term performance of the structure and for design optimization of future raises.

During active construction piezometers are to be read, plotted, and submitted to AMEC Support Engineer bi-weekly. During non-active construction the data should be collected, plotted, and submitted monthly. Based on dam performance the reading frequency may be increased or decreased at the sole discretion of the AMEC Senior Geotechnical Engineer. The Field Inspector shall indicate on these plots when construction activities have taken place within 100m of S.O.L chainage from the piezometers. This is required so that changes in piezometric pressures and measured displacements can be correlated with construction activities.

## 7.0 CLOSURE NOTE

This report has been prepared for the exclusive use of Mount Polley Mining Corporation for specific application to the area within this report. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. AMEC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. It has been prepared in accordance with generally accepted engineering geology and geotechnical engineering practices. No other warranty, expressed or implied, is made.

If you have any questions about the content of this manual, please do not hesitate to call.

Respectfully submitted,

### **AMEC Earth & Environmental Limited**

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**MOUNT POLLEY MINES**  
**TAILINGS STORGA FACILITY – STAGE 8**  
**2012 CONSTRUCTION MONITORING MANUAL**

Submitted to:

**MOUNT POLLEY MINING CORPORATION**  
Vancouver, BC

Submitted by:

**AMEC Earth & Environmental Limited**  
Prince George & Burnaby, BC

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## **APPENDIX A - Stability Analysis**

**APPENDIX B - Sample Daily Construction Report**

## **APPENDIX C - ASTM Test Standards**