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June 30, 2015
Ref No.: PM-0866003.0011

Mr. Tim Fisch
General Manager, Red Chris Mine.
Red Chris Development Company Ltd.
580 Hornby Street, Suite 200
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Dear Tim,

Re: BGC Support in Response to Chief Inspector's Order of February 3rd, 2015

On February 3, 2015, the British Columbia Ministry of Energy and Mines (MEM) Chief Inspector of Mines issued a request for all mines in B.C. to address the conditions that the Mount Polley Expert Panel Report concluded had contributed to the incident at the Mount Polley tailings storage facility (TSF). The February 3rd request requires that mine managers "*undertake an assessment to determine if the dam(s) associated with your tailings storage facility/facilities may be at risk due to:*

1. *undrained shear failure of silt and clay foundations;*
2. *water balance adequacy;*
3. *filter adequacy."*

Fourteen specific sub-issues were noted under these three topics, and a "letter of assurance" responding to these items is required by June 30, 2015.

Per your request, BGC Engineering Inc. (BGC) as Engineer of Record for the TSF at the Red Chris Mine, has prepared this letter summarizing relevant technical information and responses in support of the Red Chris Development Company (RCDC) letter of assurance. AMEC Foster Wheeler (AMEC) has provided the response related to the water balance and their contribution is attached as an appendix to this letter.

It is noted that the Chief Inspector of Mines requested a response from RCDC directly, specifically:

- Is your mine implementing the "Toward Sustainable Mining" initiative of the Mining Association of Canada? Are there any plans to do so?
- Does your mine have an Independent Tailings Dam Review Board (ITRB) in place? Is one planned?

It is understood that RCDC will address these questions in their letter of response and that this letter, along with that provided by AMEC (see Appendix A) regarding the adequacy of the water balance, will be appended to support the response to items 1 through 3.

BACKGROUND

The Red Chris Mine site is located in northwest British Columbia, approximately 80 km south of Dease Lake by road. The site is accessed by traveling 18.5 km from Highway 37 along a gravel-surfaced, radio-controlled, mine access road. Mine commissioning began in mid-February of 2015. The operation includes conventional open pit mining and flotation processing with conventional slurry tailings stored behind a cross-valley tailings dam.

The current TSF is formed by the North Starter Dam (NSD) to the north of the impoundment and a topographic high to the south as shown in Figure 1. The North Reclaim Dam (NRD) has been constructed downstream (north) of the NSD where seepage that has surfaced between the NSD and NRD and associated catchment runoff is collected and pumped back to the TSF.

Figure 1. Aerial view of the Red Chris TSF looking south (October 2014). The North Reclaim Dam is approximately 300 m long and the North Starter Dam approximately 600 m long.

The NRD was completed to its final crest El. 1053 m in 2013 corresponding to a maximum height of 7 m. The dam crest is 11 m wide and 330 m long. The upstream (Zone 1) and downstream slopes of the dam are 2.5H:1V and 2.25H:1V, respectively. The upstream riprap zone has been placed at about 1.75H:1V.

At the end of the 2014 construction season, the crest elevation of the NSD was 1097 m corresponding to a maximum height of 30 m. The crest was 130 m wide and 570 m long. The dam had an upstream slope of 2H:1V and a downstream slope of 2.5H:1V. The NSD is currently being raised towards the 2015 target crest elevation of 1118 m, at which time it will be about 51 m high.

BGC assumed the role of Engineer of Record from AMEC for the Red Chris TSF in 2013. The design reports and supporting site investigation (SI) were completed by AMEC.

MEM INFORMATION REQUESTS

The following provides specific responses to the questions outlined in the MEM letter. The response uses the numbering sequence from the MEM letter to facilitate tracking.

1. Undrained Shear Failure of Silt and Clay Foundations

    a. *Including a determination with respect to whether or not similar foundation conditions exist below the dam(s) on your site*

In regards to *"the presence of weak glaciolacustrine soils in the dam foundation"* cited as the chief cause of failure at Mount Polley in the MEM request letter, the information pertinent to that specific material is summarized below:

The surficial geology and glacial history of the Red Chris Mine area is unusually complex. Based on work completed to date by BGC and others, some of the controlling regional factors and their influence on glacial deposition in the Red Chris TSF include the following:

- The last glacial period, Fraser Glaciation, is the one that most influences the Red Chris Mine area. It began ~35 ka ago with glaciers from the Boundary Ranges west of the Stikine River valley entering the valley and blocking westward drainage along the Stikine River. At about the same time, plateau glaciers formed in the cold, periglacial environments of the Klastline and Spatsizi plateaus.
- The Stikine Valley drainage obstruction caused a vast glacial lake to form in the Stikine River valley and its tributaries, including the Iskut and Klappan valleys. Known as Glacial Lake Stikine, its maximum extent was in the order of 200 km into the watershed. Because it formed early in the Fraser Glaciation period, it is referred to as an advance-phase glacial lake.
- Boundary Range glaciers continued to enter the Stikine watershed, flowing both west toward the ocean and east, upstream into Glacial Lake Stikine. The impoundment level of the lake slowly but steadily increased as the glacial obstruction became more significant.
- After several thousand years (probably ~28 ka ago), the eastward advance of Stikine Valley glaciers reached the Red Chris Mine area, merged with, and over-rode the much less mobile and much smaller plateau glaciers. BGC has found evidence that periglacial colluvium and, possibly, till deposited by plateau glaciers were present in the Red Chris TSF when the Stikine Valley glaciers flowed into the area from the southeast.

- It is likely that some late form of Glacial Lake Stikine was present in the Red Chris TSF valley when this coalescence of the glaciers occurred, likely extending into the TSF area from the Klappan Valley side. Fine grained glaciolacustrine silt and clay sediments deposited at this time are most likely preserved beneath the NSD and NRD dams.
- Between ~28 ka and ~14 ka Stikine Valley glaciers were present in the Red Chris Mine TSF valley. Having been overridden and compressed by the weight of glaciers for many thousands of years, the advance-phase glaciolacustrine sediments, if present in the Red Chris TSF, are expected to be heavily overconsolidated.
- Fraser Deglaciation occurred between ~14 ka and ~11 ka. BGC has preliminary evidence that Stikine Valley glaciers remained active into the Ealue and Kluea lakes in the early deglacial period whilst glaciers disappeared from the Klappan River valley. It is possible that a retreat-phase glacial lake existed briefly in the vicinity of the NSD and NRD until the Klappan ice disappeared. However, its extent would have been temporally and spatially limited, if at all, because there is also evidence at the site and through the region that subglacial drainage during deglaciation precluded development of retreat-phase glacial lakes.

Foundation soil conditions at the NSD and NRD footprints comprise very dense till (basal till) that contains gravel, sand, silt, and clay as well as cobbles and boulders. There is local evidence of heavily overconsolidated glaciolacustrine materials which BGC attributes to deposition in Glacial Lake Stikine as noted above. Work is ongoing to determine the extent and properties of these fine-grained materials. The basal till and glaciolacustrine materials are overlain by deposits of sand and gravel which are considered outwash from the degrading Stikine glaciers. These materials may locally be intercalated with retreat-phase, normally consolidated glaciolacustrine sediments, and this possibility is the focus of ongoing study.

Subsurface investigations at the NRD encountered a normally consolidated silt and clay layer near surface which has been sampled and tested. Below the normally consolidated material there exists dense sand and gravel zones intermixed with laminated fine grained soils. The underlying fine grained soils are currently undergoing testing with preliminary results indicating that they are heavily overconsolidated and likely deposited during an older glacial event. To date the same normally consolidated silt and clay material encountered at the NRD has not been identified within the foundation of the NSD. Boreholes advanced within the NSD footprint have encountered discontinuous laminated silt and clay within a till unit within larger sand and gravel units. Preliminary test results indicate that the fine grained material under the NSD is heavily over-consolidated; further sampling and testing is underway to validate this.

b. Whether or not sufficient site investigation has been completed to have confidence in this determination

A summary of the SI performed by other consultants prior to 2013, and by BGC since 2013 within the TSF area is provided in Table 1.

Table 1. Summary of SI work within the Red Chris TSF Area.

Year	Drill Holes	Condemnation Boreholes	Pump Wells	Pump Tests	Test Pits	Piezometers	SR[1] Lines	TEM[2] Survey Lines
1995	3				14			
2003	4				16			
2004	5		1	1	1		3	5
2009	2							
2010	32	10	2	2	80		6	
2011	59							
2013	6					16		
2013/2014	21		4	4				
2014	33							
Totals	**165**	**10**	**7**	**7**	**111**	**16**	**9**	**5**

[1] – Seismic Refraction

[2] – Transient Electromagnetics

The 2015 SI program is currently underway as discussed below in *d*. The purpose of the 2015 program is primarily to install piezometers to monitor pore pressures within the dam footprints. However, the continuous core returned by the sonic rig will be used to confirm and enhance the current understanding of the foundation conditions. In areas where bedrock has not been encountered, additional boreholes are currently underway to confirm soil types and depths for the NSD.

c. If present, whether or not the dam design properly accounts for these materials

The dam design for the current stage of the Red Chris TSF is considered to be satisfactory. The normally consolidated materials encountered under the NRD have sufficient undrained shear strength to support the structure as constructed. The materials encountered under the NSD, as mentioned above, appear to be over-consolidated, and the dam design was based on a dense foundation consistent with that assumption. If testing of the soil samples obtained from the foundation of the NSD indicate lower strength the dam slopes will be flattened if required to achieve the required factor of safety as the dam is raised (the dam will be transitioned to a cyclone sand dam and the available sand and footprint available could readily accommodate such a design modification).

d. If any gaps have been identified, a plan and schedule for additional sub-surface investigation.

The 2015 instrumentation program to install additional vibrating wire piezometers into the dam foundations is currently underway. The instrumentation program utilizes a sonic drill rig which

returns a continuous soil core from the borehole. BGC is monitoring the drilling program and logging and sampling the core. As previously noted, the instrumentation program also serves as a site investigation program to contribute to the geological database of information for the TSF area.

In response to the Chief Inspector's order, BGC has undertaken an additional detailed review of site ground conditions, including a review of published literature and available SI data regarding the regional and local Quaternary geological conditions with the objective of identifying targets for further investigation for the TSF area. The geotechnical investigation programs have been based on the geological interpretation of the area in conjunction with the position and size of the dams. As such, the foundation characterization targeted the full soil profile and a depth of bedrock relevant to stability and seepage modelling. These considerations were applied to the current installation/investigation program. The 2015 instrumentation/investigation program is expected to be completed in mid-July 2015 with a factual report, including laboratory testing results and a review of the dam design, to be issued in the fall of 2015.

The current state of site investigation at the Red Chris TSF, once complete in July, is expected to be sufficient to characterize, to a satisfactory level, the nature of the soil deposits that comprise the dam foundations for assessment of stability of the planned raises. This program will be expanded if the findings of the remaining program warrant additional investigation.

2. Water Balance Adequacy

a. Including the total volume of surplus mine site water (if any) stored in the tailings storage facility

The water balance for the TSF has been developed and maintained by AMEC and the response to this question is provided by AMEC (see Appendix A).

b. The volume of surplus mine water that has been added to the facility over each of the past five years

The water balance for the TSF has been developed and maintained by AMEC and the response to this question is provided by AMEC (see Appendix A).

c. Any plans that are in place or that are under development to release surplus mine water to the environment

RCDC has obtained Amended Permit #105017 under the provisions of the *Environmental Management Act*. The permit contains authorization to discharge up to a maximum of 4 Mm^3 of water per year (max. discharge of 34,000 m^3/day). The conditions for the discharge of water are contained in the permit. A more detailed response to this question is provided by AMEC (see Appendix A).

d. Recommended beach width(s), and the ability of the mine to maintain these widths

The NSD is designed as a water retaining dam with filter zones to guard against piping erosion and as such, minimum beach widths are not required to satisfy the stability or hydraulic design criteria for the dam. Although the NSD design does not rely on the presence of a beach, the Red Chris TSF Operations Maintenance and Surveillance manual, (BGC 2014a) specifies a minimum above water tailings beach width of 100 m for subsequent stages of the North Dam construction once the dam is raised above the starter dam using cyclone sand.

e. The ability of the TSF embankments to undergo deformation without the release of water (i.e. the adequacy of the recommended beach width)

The design considers deformation given two conditions: consolidation/deformation under normal loading, and deformation due to earthquakes. Deformation due to normal loading is not expected to be a significant design consideration given the annual construction to raise the dams will offset any settlement that occurs. Deformation due to earthquake loading has been evaluated for the design earthquake (AMEC, 2011) and is considered negligible compared to the design freeboard over the maximum pond level (i.e. with inflow design flood stored).

f. Provisions and contingencies that are in place to account for wet years

The water balance for the TSF has been developed and maintained by AMEC and the response to this question is provided by AMEC (see Appendix A).

g. If any gaps have been identified, a plan and schedule for addressing these issues.

The water balance for the TSF has been developed and maintained by AMEC and the response to this question is provided by AMEC (see Appendix A).

3. Filter Adequacy

a. Including the beach width and filter specifications necessary to prevent potential piping

The filter designs for the NSD and NRD are based on criteria to restrict particle migration, to control the phreatic surface within the dams, and to prevent segregation and crack formation as described in guidelines by ICOLD (1994) and FEMA (2011). Filter adequacy is supported by design documents (AMEC, 2011), construction drawings and specifications (BGC, 2014b), and construction records reporting (BGC, 2015).

The filter design and specifications for the NSD issued by BGC include a two-stage filter system between the till core and the downstream sand and gravel shell. The primary filter against the core has a maximum particle size of 30 mm and a maximum fines content of 5%. Slightly higher fines contents may be considered if non-cohesive behavior is demonstrated with the sand castle test (Vaughan and Soares, 1982) and permeability requirements are

satisfied. The transition zone between the primary filter and the downstream shell has a maximum particle size of 150 mm and a maximum fines content of 10%.

Blanket filters are included in the design to protect against piping resulting from seepage up from, or down into foundations. The blanket filter designs were completed on the basis of seepage gradients and velocity at ultimate steady state seepage conditions (Muckenthaler, 1989). The filter blanket of NSD dam extends approximately 150 m downstream of the toe of the chimney filter. The blanket filter of NRD covers the entire downstream footprint.

b. Whether or not the filter has been constructed in accordance with the design,

Satisfactory filter installation for TSF dams consistent with the design is supported by construction records reporting (BGC 2014b, and 2015).

c. If any gaps have been identified, a plan and schedule for addressing these issues.

BGC has not identified any gaps with the filter design or construction that require addressing.

SUMMARY

Glaciolacustrine soils have been encountered under the NRD and NSD that are potentially susceptible to undrained shear. The NSD and the NRD are currently considered to be stable. The stability with respect to new information gathered during the 2015 SI program is presently being assessed for subsequent raises. If required to meet stability requirements, the cyclone sand dam slopes could be made flatter than the planned 3H:1V downstream slope.

The water balance is currently operating at a deficit as the commissioning process continues. Any surplus water resulting from extreme events could be discharged as per the conditions outlined in Amended Permit #105017. Additional information regarding the water balance adequacy is provided by AMEC (see Appendix A).

The filters have been designed to the standard of practice based on international standards. Satisfactory installation of filters consistent with the design is supported through appropriate construction records reporting.

CLOSURE

BGC Engineering Inc. (BGC) prepared this document for the account of the Red Chris Development Company. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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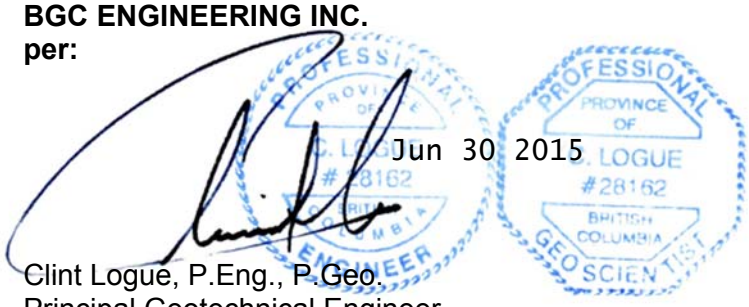
Yours sincerely,

BGC ENGINEERING INC.
per:



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CL/RM/igb/sjk

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APPENDIX A
AMEC LETTER

Memo

To:	Raj Anand		
From:	Charles Masala, P.E., P. Eng.		
Email:	Charles.masala@amecfw.com	**File No:**	VM00532C
Date:	25 June 2015	**Reviewed by:**	John Slater, P.Eng.
		Cc:	

Subject: Ministry of Energy and Mines letter of assurance. Water Balance Adequacy

This memo is in response to the request by Ministry of Energy and Mines (MEM) made on February 3, 2015 to Red Chris to undertake an assessment to determine if the dams associated with the tailings impoundment area (TIA) are at risk due to: undrained shear failure of silt and clay foundations, water balance adequacy or filter adequacy. Risks associated to undrained shear failure of silt and clay foundations and filter adequacy are being addressed by BGC Engineering Inc (BGC).

This memo addresses item 2 of the above referred to memo, especially items a, b, c, f and g under water balance adequacy listed below:

a) Total volume of surplus mine site water (if any) stored in the tailings storage capacity;
b) The volume of surplus mine water that has been added to the facility over each of the past five years;
c) Any plans that are in place or that are under development to release surplus mine water to the environment;
f) Provisions and contingencies that are in place to account for wet years;
g) Any gaps have been identified, a plan and schedule for addressing these issues.

The following items d) and e) under water balance adequacy are being addressed by BGC:

d) Recommended beach width(s) and the ability of the mine to maintain these widths;
e) The ability of the TSF embankments to undergo deformation without the release of water (i.e. the adequacy that is in place to account for wet years

For the purpose of this memo surplus water is assumed to be water stored in the TIA in excess of water volume planned (based on water balance modeling) or required for mine operation.

Table 1 presents available free water in the TIA, water volume required for operation or expected and surplus water over the past five years covering the period from 2011 to 2015. However, since the construction of the starter dam for the TIA only started in 2014, there was no water stored in the TIA for the period from 2011 to 2013.

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Table 1: Surplus Water Added to the Mine Year by Year (2011 to 2015) (m^3)

Year	Available Free water in the TIA (m^3)	Water volume required for operation or expected (m^3)	Surplus water (m^3)
2011	N/A	N/A	N/A
2012	N/A	N/A	N/A
2013	N/A	N/A	N/A
2014 (measured)	1,069,000	3,352,000	-2,283,000
2015 (estimated)	1,088,000	3,314,000	-2,226,000

N/A – not applicable

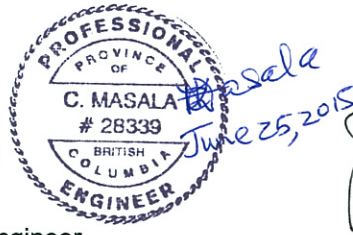
As presented in Table 1, a comparison of available free water in the TIA and water volume planned or required for operation indicates that there is no surplus water in the TIA. In fact for both 2014 and 2015 there is water deficit.

Based on the above assessment, items a, b, c, f and g under water balance adequacy are addressed as follows:

a) There is currently no surplus mine site water stored in the tailings facility.
b) No surplus mine site water has been added to the TIA over the past five years.
c) Since there is no surplus water stored in the TIA, there is no plan required for releasing surplus water to the environment at the moment. However in case of surplus water in the TIA in future, Red Chris is authorized to discharged up to 4,000,000 m3 from the TIA on an annual basis, per the Amended Permit 105017 issued by the Ministry of Environment under the Environmental Management Act.
f) Provisions and contingencies in place to account for wet years, include planned and available freeboard in the TIA to store up to the inflow design flood (IDF), which is the probable maximum flood. Depending on mine water requirements at the time, surplus water can then be released as part of the authorized discharge or as excess water.
g) No gaps are currently identified for addressing surplus water in the TIA.

Yours truly,

Amec Foster Wheeler Environment & Infrastructure,
a Division of Amec Foster Wheeler Americas Limited



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