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1.0 INTRODUCTION

The Mount Polley Mining Corporation (MPMC) has retained AMEC Environment and Infrastructure, a division of AMEC Americas Ltd. (AMEC), to provide a hydrogeological assessment of the Mount Polley mine site. The mine site is located approximately 60 km northeast of Williams Lake B.C. and approximately 20 km southwest of Likely B.C. The purpose of this assessment is to address concerns expressed by the British Columbia Ministry of Environment (MOE) regarding changes in groundwater quality at the mine site and to characterize the hydrogeologic setting at the mine site.

1.1 Objectives and Scope of Work

The main objectives of the hydrogeological assessment are to;

- Provide a data gap analysis and attempt to resolve gaps in the available data;
- Identify the surface water receptors of local groundwater flow and other surface/groundwater interactions;
- Characterize the local hydrogeological conditions at the mine site and develop a site specific conceptual model;
- Identify surface and/or groundwater quality changes related to mining activity, specifically acid rock drainage (ARD).
- To determine infiltration rates into the Springer Pit and identify potential groundwater impacts related to the Springer Pit development;
- Identify areas of potential environmental concern and potential contaminants of concern.

To achieve the stated objectives, the following scope of work has been performed:

- An in-depth data review and compilation of relevant groundwater information collected by MPMC and from the public domain;
- Resolve identified data gaps with the installation of ten (10) monitoring wells at five locations;
- Development of a conceptual site model and the identification of wells exhibiting significant changes in either baseline static water levels and/or water quality;
- Hydrogeological mapping to define discharge and recharge areas;
- Decommissioning of one (1) monitoring well.

This report is organized into the main text with supporting figures, tables and appendices. The main text provides a discussion of the regional setting, a summary of the field program, characterization of the hydrogeological setting, potential impacts and conclusions and recommendations.

Portions of this report will be used as part of the annual environmental reporting to the regulators.

1.2 MPMC Background Information

MPMC provided AMEC with the following information that is used in this report:

1. *2011 Environmental and Reclamation Report*, Mount Polley Mining Corporation, 2011
2.

1.3 Summary of Background Information

2.0 REGIONAL SETTING

The mine site is positioned on a ridge that separates Polley Lake and Bootjack Lake. The regional study area includes the Mount Polley mine site and the adjacent Bootjack Lake/ Morehead Creek drainage basin and the Polley Lake/ Hazeltine Creek drainage basin located southwest and northeast of the mine site respectively (Figure 1).

2.1 Physiography

The regional topographical relief and drainage networks are shown in Figure 3. The study area covers approximately 100 km2. The Mount Polley mine site is located within the geographic region known as the Fraser Plateau. This region is west of and adjacent to the Quesnel Highlands and the Cariboo Mountain Range. The topography of this area is bedrock controlled and the elevation ranges from approximately 915 masl to 1470 masl. The topographic highs in the area are Mount Polley which peaks at approximately 1470 meters above sea level (masl) and is located at the center of the mine site, Bootjack and Jacobie mountains are located east of Mount Polley with elevations of 1270 masl and 1310 masl, respectively. These topographic highs have volcanic origins. The terrain within the study area slopes towards east with a total relief of approximately 680 meters, with the topographic low being the surface of Quesnel Lake at approximately 790 masl.

This area was glaciated during the last glaciation and the overburden in the area is mostly glacial and glacio-lacustrine sediments. The composition of the till is silty clay/clayey silt with varying amounts of gravel and boulders. The overburden thickness in the area ranges from less than 1 meter to greater than 25 meters and bedrock is typically not exposed within most of the site. Bedrock exposure is limited to steep slopes and cuts. The majority of the area is tree covered and supports an active logging industry in the area.

As mentioned above, within the study area are the Bootkack/Morehead and Polley Lake/ Hazeltine Creek drainage basins. These are both sub-basins of the larger Quesnel River/Lake drainage basin and ultimately the Fraser River drainage basin.

2.2 Regional Climate

The climate in the area can be described as a humid, continental climate with warm summers, with spring being the driest season and the summer being the wettest season.

The climate data is from Environment Canada's Canadian Climate Normals (1971-2000) database. Climate data for Likely B.C. is available from 1974 to 1993 and the findings are summarized below:

- Precipitation rates range from a maximum monthly average of 81.8 mm in June to a minimum monthly average of 35.5 mm in March;
- The average yearly precipitation is 692.4 mm, with 215.2 mm occurring as snow;
- Temperatures range from a maximum daily average of 15.4 degrees Celsius in July to minimum daily average of -7.0 degrees Celsius in January.
- The average yearly daily temperature is 4.6 degrees Celsius.

The Likely B.C. meteorological station is located approximately 20 kilometres from the mine site.

2.3 Regional Geology

The mine site is located within the Quesnellia Terrane. The Quesnellia Terrane consists chiefly of west-facing Upper Triassic to Lower Jurassic (Karnian to Sinemurian) volcanic arc rocks (Nicola Group, Rossland Formation), coeval calc-alkalic and alkalic plutons, and laterally equivalent clastic sedimentary rocks (Mortimer, 1987; Monger, 1989; Andrew and others, 1990; Parrish and Monger, 1992).

The mine site is located within Quesnellia on the eastern margin of the lntermontane Belt. This part of Quesnellia consists of a sequence of volcanic units that dip east to northeast 5 kilometers west of the property, and dip predominantly to the west or southwest 4 kilometres east of the property (Bailey, 1987).

The volcanic rocks include flows, breccias and tuffs. Volumetrically the most important are augite-porphyritic basalt to trachybasalts that locally form pillowed units. Less common are purple and maroon polymictic volcanic breccias, and green crystal and lapilli tuffs. An analcite-bearing flow and flow breccia are interpreted to be the youngest volcanic units in the area (Bailey, 1987).

2.4 Regional Hydrogeology and Hydrology

3.0 FIELD PROGRAM METHODOLOGY

A field program took place between November 14, 2012 and December 18, 2012 and involved borehole drilling, monitoring well installation, well development, groundwater monitoring and single well response tests.

3.1 Monitoring Well Installation

This section summarizes the monitoring well installations for the ten (10) MPMC monitoring wells. The monitoring wells were installed as pairs, with each pair having a shallow and deep component. Geological logs for the above monitoring wells are provided in Appendix A.

AMEC supervised the operation of a Fraste Multidrill XL, air rotary, track mounted drill rig to advance a total of ten (10) boreholes at five locations to facilitate the observation of groundwater conditions, collect groundwater samples and perform single well response tests. Rock chip samples were collected every 3.0 meters at each of the deep boreholes. These samples were submitted to the MPMC for analysis. Each of the five locations has both a shallow and deep monitoring well installation. At each location the shallow monitoring wells were installed at the first indication of persistent groundwater conditions and the deep monitoring wells were installed at or around 100 mbgs.

Installation of PVC monitoring wells and the well development was completed by the drilling contractor, GeoTech Drilling Ltd., with AMEC providing guidance. The monitoring wells were constructed using 5 cm diameter PVC pipe risers and slotted screens. Screen lengths were 3.0 meters and 6.1 meters for the shallow and deep wells respectively. A sand pack was placed around the slotted screen and approximately 0.3 to 1.0 meter above the PVC screen. Bentonite pellets were placed above the sand pack to maintain a hydraulic seal. The remainder of the borehole was grouted to surface and completed with an above ground protective casing. Monitoring well details are summarized in Table 1.

Table 1: Monitoring Well Installation Details

Monitoring Well ID	Total Well Depth (m)	Ground Surface Elevation (masl)	Well Screen Interval (masl)	Screened Formation
GW12-1A	99.6	991.6	892.0 - 899.2	Bedrock
GW12-1B	24.4	991.4	967.0 - 970.7	Weathered Bedrock
GW12-2A	100.6	1035.4	934.8 - 941.5	Bedrock
GW12-2B	30.2	1035.4	1005.2 - 1008.9	Bedrock
GW12-3A	99.7	1039.1	939.4 - 946.4	Bedrock
GW12-3B	16.1	1039.2	1023.1 - 1026.4	Fractured Bedrock
GW12-4A	100.6	989.9	889.3 – 896.5	Bedrock
GW12-4B	36.3	990.1	953.8 – 957.3	Bedrock
GW12-5A	100.4	965.3	864.9 – 872.2	Bedrock
GW12-5B	12.7	966.2	953.5 – 957.6	Glacial Till

The completed monitoring wells were developed using air injection. Each monitoring well was air developed for at least 2 hours and/or until the purged water was clear and contained no sediments. Prior to well development and sampling static water levels were taken and are summarized in section 4.1.1.

3.2 Single Well Response Tests

Upon completion of the air development water levels were taken to record the recovery in each well (rising head test). The rising head test data was used to calculate hydraulic conductivities of subsurface materials.

3.3 Groundwater Sampling

The environmental staff at MPMC conducted the groundwater sampling/monitoring program on March 25, 2013? Prior to sampling the monitoring wells the static water level was recorded. The wells were then purged by the removal of approximately three well volumes or until dry. Well purging and sampling was completed using dedicated poly tubing and a Grunfos Redi-Flo 2 submersible pump. Groundwater samples collected for dissolved metal analyses were field filtered using a dedicated 0.45 µm filter. One groundwater sample was collected from each of the monitoring wells (ten (10) in total). A duplicate sample was collected from BH-12-? (identified as Dup-1) for QA/QC purposes. The groundwater samples were collected directly into laboratory supplied bottles, placed in an insulated cooler with ice packs, and submitted under chain of custody documentation to ALS for analysis of dissolved metals, VOCs, PHC
F1 to F4 and glycol.

- 1
- 2
- 3

The laboratory certificate of analysis is in AppendixA.

4.0 RESULTS

4.1 Summary of Historical Groundwater Data

4.2 Hydrogeology and Conceptual Site Model

Groundwater in the Mount Polley area is mainly confined with a bedrock type aquifer where flow is largely controlled by the orientation of frequency of fractures, faults and unconformities caused by volcanic events. The vertical flow is largely controlled by joint spacing.

Localized overburden aquifers occur in topographic low areas as these areas were not scraped/eroded during the last period of glaciation, thus glacial deposits (basal till) has remained intact in these locations.

4.2.1 Groundwater Levels and Flow Directions

Groundwater measurements were recorded at all well locations on and upon well installation. The groundwater level ranges from an elevation of 957.57 mbgs to 1036.25 mbgs.

A summary of the measured groundwater levels is presented in the following table:

Monitoring well ID	Measured Groundwater Level (m)	Ground Surface Elevation (m)	Groundwater Level Elevation (m)

GW12-1A	4.98	991.59	986.61
GW12-1B	5.12	991.37	986.25
GW12-2A	21.42	1035.45	1014.03
GW12-2B	21.39	1035.45	1014.06
GW12-3A	3.15	1039.06	1035.91
GW12-3B	2.99	1039.24	1036.25
GW12-4A	21.95	989.87	968.17
GW12-4B	12.81	990.12	977.06
GW12-5A	7.71	965.28	957.57
GW12-5B	5.31	966.22	960.91

Figure 4 and 5 display a cross section through the Mount Polley mine site these illustrate the groundwater flow directions

Monitoring well pairs GW12-4 and 12-5 each had downward vertical hydraulic gradients that are 0.14 m/m and 0.4 m/m respectively. Both of these well pairs are located on the eastern portion of the site adjacent to Polley Lake and downward vertical gradients indicate that the area adjacent to Polley Lake is an area of significant groundwater discharge.

4.2.2 Hydraulic Conductivity

Single well response tests were performed on all of the newly installed wells upon completion. The well response test used was the rising head test and hydraulic conductivities were calculated based upon the results.

Hvorslev mathematical solution was used to approximate the hydraulic conductivity. The solution assumes a homogeneous aquifer with infinite vertical extent. This solution is widely used and provides a straight forward and well documented solution. The results of the single well response tests are summarized in the following table.

Monitoring Well	Screened Formation	Ground Surface Elevation (masl)	Well Screen Interval (masl)	Hydraulic Conductivity (m/s)
GW12-1A	Bedrock	991.59	892.0 - 899.2	2.21 x 10-9
GW12-1B	Weathered Shallow Bedrock	991.37	967.0 - 970.7	>10-4
GW12-2A	Bedrock	1035.45	934.8 - 941.5	2.94 x 10-8
GW12-2B	Shallow Bedrock	1035.45	1005.2 - 1008.9	1.99 x 10-7
GW12-3A	Bedrock	1039.06	939.4 - 946.4	2.47 x 10-7
GW12-3B	Fractured Shallow Bedrock	1039.24	1023.1 - 1026.4	9.76 x 10-6
GW12-4A	Bedrock	989.87	889.3 – 896.5	3.68 x 10-9
GW12-4B	Shallow Bedrock	990.12	953.8 – 957.3	2.52 x 10-5
GW12-5A	Bedrock	965.28	864.9 – 872.2	>10-4
GW12-5B	Glacial Till	966.22	953.5 – 957.6	2.69 x 10-7

The hydraulic conductivities of all of the wells ranges from >10-4 to 2.21 x 10-9 m/s. The average hydraulic conductivity of the shallow wells is 2.71x10-5 m/s and the average hydraulic conductivity of the deep wells is 4.94x10-6 m/s. The difference in the average hydraulic conductivity between the shallow and deep wells is one order of magnitude and is similar to what is observed in monitoring well pairs GW12-2 and GW12-3. However in monitoring well pairs GW12-1, GW12-4 and GW12-5 the variation in hydraulic conductivity between the shallow and deep wells is three orders of magnitude, with shallow wells at GW12-1 and GW12-4 having the highest hydraulic conductivity. GW12-5 is the only monitoring well pair where the lower hydraulic conductivity was observed in the shallow well. Monitoring well GW12-5B was the only well screened within overburden/glacial till.

The well screen intervals in monitoring well pairs GW12-1, GW12-4 and GW12-5 are on average approximately fifty meters lower in elevation than monitoring wells GW12-2 and GW12-3. The relatively high hydraulic conductivities observed in the shallow well at GW12-1 and the relatively low vertical hydraulic gradient observed at this well location suggests groundwater interaction with Bootjack lake and is likely an area of recharge as is monitoring well locations GW12-2 and GW12-3.

4.2.3 Vertical Gradients and Groundwater Velocity

4.2.4 Groundwater Quality Results

4.2.5 Groundwater Surface Water Interaction

5.0 SUMMARY

6.0 CONCLUSIONS AND RECOMMENDATIONS