Box 2004, 1004 Michie Place
Marsh Lake, YK, Canada
Y0B 1Y2

Telef. 1-867-660-4630
Fax: 1-604-608-4753
E-mail: dianelister@gmail.com

Altura Environmental Consulting

To: Alistair Kent, AECOM

Cc: Mount Nansen Closure Analysis Team (via Sharepoint posting)

From: Diane Lister

Date: December 22, 2009

RE: **Mount Nansen Mine Closure: Mine to Mill Haul Road – Summary of Rock Characterization Studies**

The purpose of this summary is to present the characteristics of rock placed in the 'Mine to Mill Haul Road' at the Mount Nansen Mine site. The main focus areas of this summary are the rock's geochemical characteristics, general physical characteristics as they apply to use in closure activities, and estimated volume potentially available for use during closure.

Key information utilized for this estimate includes:

1. Static test results of berm samples collected in 2008 (n=2)
2. Static test results and observations of test excavations conducted in 2009 (n=32)
3. Estimates of available volume, carried out by AECOM in November 2009.

Overview

While the general alignment of the road from the Brown McDade area to the Mount Nansen mill site has been largely unchanged for over 20 years, during the course of mining from the Brown McDade pit from 1996 to early 1999 the road was widened, its gradient improved, and safety berms maintained. Most if not all of the fill for these activities originated from the open pit.

The haul road material is of specific geochemical interest for two main reasons:

1. *The material may have potential construction use for closure work:* Mann (2008 and 1997) reports that the fill material used for widening the haul road from fall 1997 to early 1998 was primarily footwall granodiorite and was first examined to ensure that no sulphides were present. Thus, it is hoped that rock backfilled in the road has more uniform characteristics than found in much of the waste rock pile (Altura 2009b), and be of favourable geochemistry.
2. *Water Quality Model Considerations:* Waste rock stored in the haul road was not considered as a specific source term in the site water quality model, and hence, a basic assessment to flag any anomalous issues is warranted.

Results

Key results are summarized in the following paragraphs; it should be noted that the following and is not meant to be an exhaustive summary of the entire analysis, but rather highlights the most salient results of interest with respect to the material comprising the haul road and berms. Complete analytical results and sample descriptions are given in Altura (2009c).

Estimated Available Volume

Available volume for construction was estimated considering that the width of the haul road could be reduced to an approximately 9m wide thoroughfare following closure (see Figure 1). As shown, only the 1.1 km stretch from the mine area to below the site office/bunkhouse was considered for potential use for closure activities. The mill area material is of mixed origin and tends to contain more mineralized material, so was not incorporated in the estimate.

A total of 11 sections were generated in AutoCAD®, and the available cross-sectional wedge on each determined by extending the gradient of original ground below the toe of existing fill up to its intersection with the road bed, and ensuring sufficient remaining road width. Using this method, a total of 14,000m^3 of available volume is indicated.

Field Program

A total of 22 test pits were excavated in the road bed of the haul road in 2009, starting at mill area near the crusher feeder and stockpile area and terminating adjacent to the mine shop. Excavations were also cut through the road berm material at nine locations in order to augment the two samples taken in 2008. A John Deere excavator (model 350?) was used to conduct the 2009 work. Figures 2 and 3 show the locations of all test pits and berm samples.

Upon excavation the pits and berm cuts were briefly examined and photographed. Characteristics of rock fragments and fines were noted, and in almost all cases, one or more samples taken for follow-up analysis and re-examination. The excavations were backfilled and field paste pH and conductivity of the samples were later measured. Most samples were submitted for multi-element analysis via ICP-MS, with a subset subjected to acid base accounting and shake flask testing. The analyses focussed on assessing the minus ¼" fraction of material, with only one coarse fraction sample submitted. In all, the 2008 and 2009 samples include 28 field paste pH, field paste conductivity and ICP-MS analyses, 13 acid base accounting analyses, and 10 shake flask extractions.

Mill Area of Haul Road (Test Pits HR1 to HR7)

Excavations in this area indicate the underlying fill to be predominantly a mix of weathered metamorphic rock (mafic schist or amphibolite?) of varying competence coupled with zones of what appears to be rust-weathered highly altered material, possibly including some low grade mineralization. Much of the existing running surface of the road is comprised of a veneer of the latter material.

The metamorphic material is unlike the rock found in the Brown McDade waste rock piles and is considered to be Yukon-Tanana Terrane Early Mississippian metamorphic rocks. This material was likely excavated from the immediate area of the mill. Only traces of fine grained pyrite were seen in the metamorphic material.

In the six samples tested, metal levels tend to be lower than that typical of the Brown McDade waste rock with Zn ranging from 116 to 776 ppm, and As from 40.5 to 260.0 ppm. The five field paste pH values obtained tend to be on the slightly acidic side and range from 4.35 to above 7.2, with the lowest value obtained from a black-weathering metamorphic with no visible sulphides. No acid base accounting nor leachate extraction testing were performed on samples from this area.

Utilizing the Brown McDade waste rock screening criteria proposed in Altura (2009b) of no visible sulphides and paste pH greater than or equal to 6.5, one of the five samples (pit HR1) is classified as 'Low-Reactivity'.

Main Section of Haul Road (HR8 through HR22)

Most of the fifteen test pits into the bed of the haul road encountered material predominantly composed of intrusive of granodioritic to dioritic composition typical of Brown McDade footwall rock, consistent with historical information. Rock tended to be variably altered and thus exhibited a range of competency. Other reported rock types include fine-grained intrusives, some with porphyritic texture, and silicic/phyllic altered fragments of unknown protolith. In several pits, a road surface veneer in the order of 0.1 m thick appears to be comprised of a more clay-altered material. The backfilled material encountered in the test pits has a median of 60 percent fragments of greater than 5 cm size (visually estimated). Test pits HR 21 and 22 completed in the 150 metre stretch immediately west of the mine shop encountered a markedly greater degree of clay alteration and visible pyrite than the pits HR8 through HR20. Photos 1 through 2 demonstrate the range of material characteristics in the test pits.

A strong hydrocarbon odour was observed upon excavating test pit HR10 located on the road below the office/bunkhouse complex. Follow-up assessment is recommended as part of any future contaminated site studies.

Presence of pyrite was noted in rock from eight of the fifteen test pits, and eight of the test pits contained fragments with some notable effervescence. Field paste pH ranged from 4.06 to greater than 7.2, with a median of 6.90. Field paste conductivity for fines from all but one test pit tended to be low with a median of 195 μS/cm. The one outlier sample was from pit HR12: field-tested fines were highly anomalous, returning the most acidic paste pH and by far the highest paste conductivity (4.06 and 2190 μS/cm respectively). Although no sulphides could be seen in the fragments, upon re-examination, a few minute grains of pyrite were visible in the fines.

In the samples of road backfill material tested, As ranged from 20 to 900 ppm (median 300 ppm), and Zn from 150 to 2200 ppm (median 625 ppm). The six shake flask extractions returned very low metals concentrations with the exception of sample HR12 which returned high concentrations of Zn (30.6 mg/L), along with anomalous concentrations of Cu and Hg (0.194 mg/L and 0.19 μg/L).

Samples of both fine (-1/4") and coarse (5 cm and above) fragments were analysed from one test pit, HR13, and slightly less favorable acid base accounting, metal leaching and metal content properties were observed in the fine fraction.

Utilizing the Brown McDade waste rock screening criteria proposed in Altura (2009b) of no visible sulphides and paste pH greater than or equal to 6.5, four of the fifteen samples (from pits HR9, HR16, HR17 and HR20) are classified as 'Low-Reactivity'. Due to its moderately acidic paste pH, the anomalous sample HR12 discussed in the above paragraphs is appropriately designated as 'Marginal'. On the other hand, three of the eleven samples also deemed 'Marginal', have low sulphide contents (<0.03% or less), laboratory paste pH of greater than 6.5, high NP : AP ratios of greater than 5, and low extractable metals in shake flask testing. This may indicate that there is some room for additional refinement of the field criteria for the haul road material, possibly allowing for trace amounts of visible sulphides in the material.

Berm Material (HRB01 through HRB 11)

In general, the haul road berm material is much more heterogeneous than the road bed material, with a tendency for more altered rock types (at times along with sulphides and associated metals) to be mixed with cleaner material. This seems to be more prevalent along the eastern half of the haul road from approximately site HRB04 towards the mine shop.

Data for the haul road berms consists of twelve samples from the eleven sites, which along with general description information is made up of a total of twelve ICP analyses, six acid base accounting analyses, four shake flask extractions, and seven field paste pH and conductivity measurements.

In the samples tested, metal levels of the berm material tended to be of greater range than from the road bed; for example As ranged from 50 to 3900 ppm, and Zn from 209 to 3171 ppm. Half of the twelve samples had a visual sulphide ranking of 2 or more (indicating minor to moderate sulphides), and the sample from site HRB06 was essentially of low grade ore composition (3.9 ppm Au), with over 1 percent sulphide. Paste pH values ranged from 5.7 to 7.2.

Utilizing the Brown McDade waste rock screening criteria proposed in Altura (2009b) of no visible sulphides and paste pH greater than or equal to 6.5, three of the eight samples with paste pH information (HRB01, HRB02, and HRB07) are classified as 'Low-Reactivity'.

Conclusions, Discussion and Recommendations

Largely owing to its more uniform composition, the road bed material from HR08 through HR22 shows more potential as a low-reactivity construction material than most waste rock pile material. Nonetheless, as indicated by one very high shake flask zinc concentration of over 30 mg/L, field verification using paste pH and assessment of sulphide presence is imperative prior to its use in closure construction. This may be some room for additional refinement of the field criteria for the haul road material, possibly allowing for trace amounts of visible sulphides in the material.

Preliminary estimates indicate that in the order of 14,000 m^3 of road bed fill is potentially available.

Compared to the HR08 to HR22 road bed fill, the berm material exhibits much more mixing with less desirable highly altered and sulphidic material, and is not considered a good candidate for use as a low-reactivity construction material. The roadbed fill from HR08 towards the mill tends to be mixed with altered and possibly low grade ore and is also not recommended.

Removal of the fines from excavated material would likely produce an improved product, however additional analyses would be necessary to confirm this. Several archived samples from 2009 are available for this work.

References

Altura Environmental Consulting, 2009a. *Brown McDade Waste Rock Pile, Mount Nansen Mine Site, Yukon – Geochemical Characterization.* Report prepared for Government of Yukon Assessment and Abandoned Mines Branch, Energy, Mines and Resources, 237 pp.

Altura Environmental Consulting, 2009b. *Mount Nansen Mine Closure – Summary of Studies Assessing Waste Rock Field Screening Potential.* Technical Memo to AECOM dated December 18, 2009, 10 pp.

Altura Environmental Consulting, 2009c. *Summary of 2009 Work Program, Mount Nansen Mine Site, Yukon.* In press.

Mann, William, P.Geo., Personal Communication, 2008. Former employee of BYG Natural Resources Inc.

Mann, William D., 1997. *Waste Rock and Pit Wall Acid Rock Drainage ("ARD") Study, Brown McDade Pit.* in 1997 Annual Report, Water Licence QZ94-004, Feb/98, Appendix 8, submitted by BYG Natural Resources Inc. to Yukon Territory Water Board.

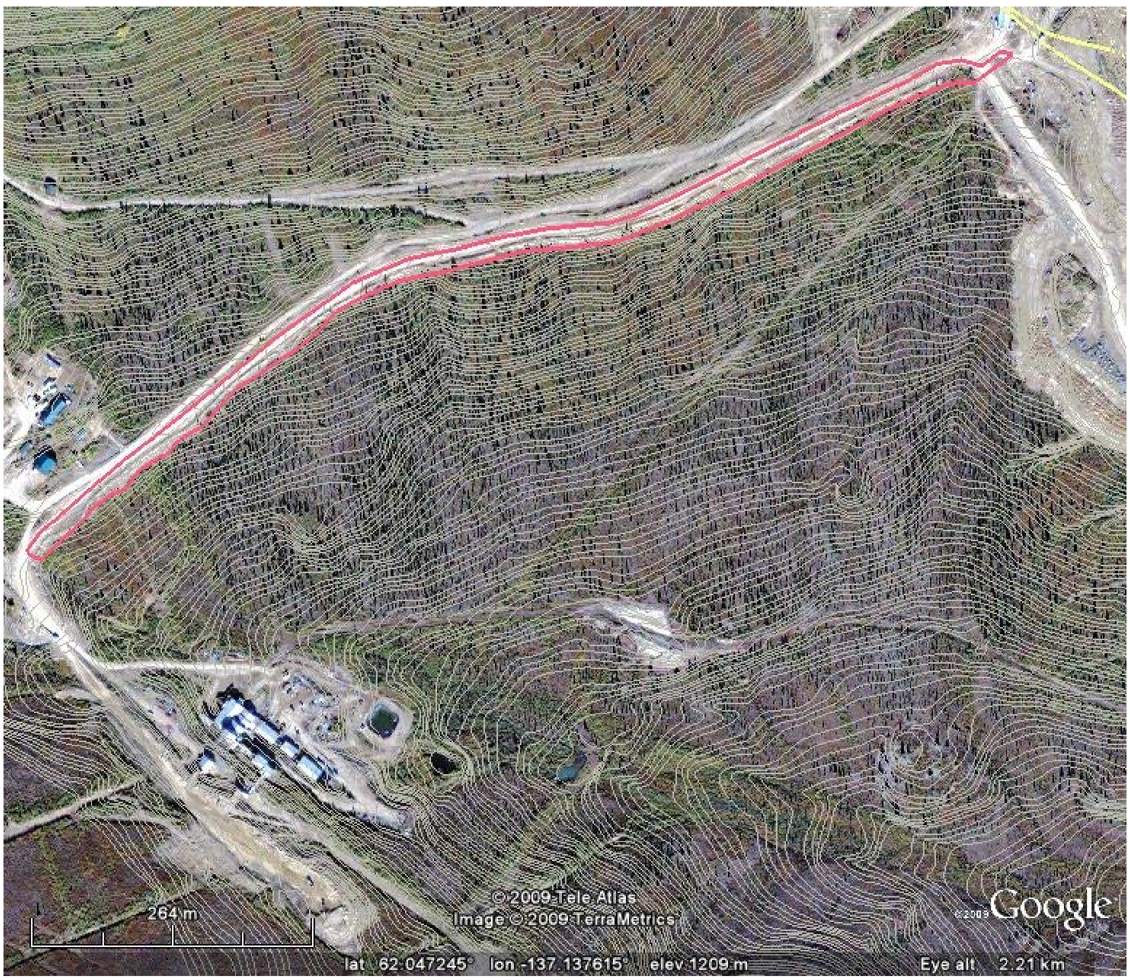

Figure 1. Haul road showing the polygon of material (pink outline) potentially available for closure activities.

Figure 2. West section of haul road showing location of test pits (HR series) and cuts through berms (HRB series).

Figure 3. East section of haul road showing location of test pits (HR series) and cuts through berms (HRB series).

Photo 1. Test pit HR13, very blocky digging with minor amount of fines.

Photo2. Test pit HR20, typical of material backfilled in road bed.