



**NIBLACK MINING CORPORATION  
NIBLACK PROJECT**

**OPERATIONAL CHARACTERIZATION PLAN  
(REF. NO. VA102-00205/02-4)**

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**SECTION 1.0 - INTRODUCTION**

1.1 OBJECTIVES OF REPORT

The objective of this report is to provide a plan for the characterization and segregation of waste rock generated from underground excavation during advanced mineral exploration activities (Phase 1) at the Niblack property. Secondary goals are to establish a more complete description of the environmental behaviour of the Niblack waste rock that will support environmental assessment of possible Phase II activities (i.e., future larger-scale mining of the Niblack deposit).

1.2 BACKGROUND

The Niblack property is located approximately 30 miles southwest of the town of Ketchikan, Alaska, near the head of Niblack Anchorage, a small inlet on the southeastern shore of the Prince of Wales Island, as shown on Figure 1. The property is in the Ketchikan Recording District on Craig A 1 USGS Map Quadrangle geographic map sheet. The property is composed of 17 patented claims, 101 staked federal lode claims and 2 Alaska State tideland claims. All claims are owned 100% by Niblack Mining Corporation (NMC) subject to a variable 1%-3% NSR to Barrick Gold Corporation and a 15% NPI to Cook Inlet Region Inc. NMC acquired the Niblack property in 2005 as a result of a spin-out from Abacus Mining and Exploration Corporation, with the objective of advancing the Niblack property through the delineation of an economically viable ore deposit. A number of mineralized zones have been explored since the late 1800's. NMC and predecessor Abacus have completed work on the Dama zone, Niblack Mine, Trio Braudgauge zone, Mammoth zone, Lindsay zone and Lookout zone. Key to the advancement of the Niblack property is the development of an underground adit that will provide drill access to deeper extents of the Lookout zone – the main zone of interest.

## SECTION 2.0 - WASTE ROCK CHARACTERIZATION AND HANDLING

### 2.1 INTRODUCTION

The primary goal of the Niblack Operational Characterization Plan is to ensure that waste rock generated during the underground exploration program is properly characterized and handled. Project site planning is based on predictions of waste rock character, with an objective of ensuring surface water and groundwater are not degraded as a result of the underground exploration program (Phase I). Potentially acid-generating rock, referred to as PAG, has the potential to release solutes (sulfate, metals, metalloids) at higher concentrations than non-PAG rock, therefore this plan focuses primarily on a strategy for identifying and isolating PAG rock. Existing data is used to anticipate waste rock characteristics and design monitoring, but actual waste handling will be based on frequent on-site determinations of acid generating potential. Surface water and groundwater quality will be protected through a combination of active management of waste rock and water during the excavation and construction phase, and then through permanent waste rock disposal designs for PAG and non-PAG rock, to ensure that water protection continues as the waste rock facilities passively weather into perpetuity.

The secondary goal of the Niblack Operational Characterization Plan is to establish a more complete description of the environmental behaviour of the Niblack waste rock that will support environmental assessment of possible Phase II activities (i.e., future larger-scale mining of the Niblack deposit). To advance this goal, additional environmental characterization is planned during the tunnel excavation, which will support closure planning of the tunnel and also future potential mine planning.

Components of waste rock characterization include:

- *Acid/Base Accounting*, which are rapid and relatively inexpensive tests that measure the chemical potential for acid generation and neutralization based on sulfide S and carbonate C;
- *Total Metal Analyses*, which indicate the maximum potential solute release from rock;
- *Kinetic Tests (such as humidity cell tests)*, which are long-term tests that indicate the rate at which sulfide minerals oxidize, the rate at which this acidity is neutralized, and the rate at which sulfate and metals can be released by the oxidation process; and
- *Method Comparisons*, which compare rapid field methods, such as paste pH or NAG testing (rapid peroxide oxidation), against more definitive ABA methods, to allow real-time routing of waste based on its potential to leach solutes to the environment.

The conceptual plan for waste handling is to divide the waste into 2 categories, and handle it accordingly to prevent acid rock drainage ('ARD') release:

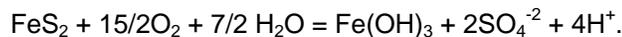
- Non-acid generating (non-PAG) waste rock (ANP/AGP >3; ~46,600 yd<sup>3</sup> anticipated) will be encountered first as the tunnel progresses through non-mineralized Hanging Wall stratigraphy. It will be placed in an unlined permanent storage facility near the exploration portal.
- Potentially acid generating (PAG) waste rock (ANP/AGP =<3; ~14,300 yd<sup>3</sup> anticipated) will be stored temporarily in a lined storage area where seepage can be captured and

treated. It will have an impermeable cover applied concurrent with rock placement to shed water.

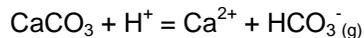
Permanent closure will then involve placement of PAG waste rock back in the tunnel where it will be submerged by groundwater and thus precluded from oxidizing. A vegetated soil cover will be placed on the non-PAG waste rock pile to reduce infiltration and erosion.

## 2.2 BACKGROUND ON POTENTIAL ACID ROCK DRAINAGE AND METAL RELEASE

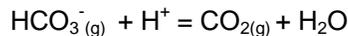
Acid rock drainage arises primarily by oxidation of pyrite under neutral pH conditions. The reaction that takes place is as follows:



Complete consumption of acid by calcite neutralization in an open system (i.e., where CO<sub>2</sub> gas can escape) proceeds in 2 steps, first with the consumption of one H<sup>+</sup> to bicarbonate,



With additional acidity, pH decreases further and a second H<sup>+</sup> is consumed as bicarbonate is converted to CO<sub>2</sub> gas,



At a pH of 4.5, essentially all carbonate is converted to CO<sub>2</sub> gas. Thus, each mole S in pyrite produces 2 mole H<sup>+</sup>, and each mole C in calcite can consume up to 2 mole H<sup>+</sup>.

In this report we use the convention where Acid Neutralizing Potential (ANP) and Acid Generating Potential (AGP) are converted to CaCO<sub>3</sub> equivalents and reported in g CaCO<sub>3</sub>/kg rock (i.e., parts per thousand, also cited as kg/tonne or ‰). This report focuses on the ratio of ANP/AGP as the primary indicator to identify the potential for rock to produce acidic drainage under oxidative weathering. Thus an ANP/AGP ratio of 2 indicates twice as much potential to neutralize acid as to create acid. In previous Niblack reports (e.g. Niblack Project, Plan of Operations, Knight Piésold 2006) ANP is synonymous with NP (Neutralizing Potential), AGP is synonymous with MPA (Maximum Potential Acidity), and ANP/AGP is synonymous with NP/MPA. Finally, net neutralizing potential (NNP), defined as ANP – AGP and also having units of ‰ CaCO<sub>3</sub> where negative NNP indicates net-acid generating material and positive indicates net-neutralizing material, is another measure of acid base accounting. Though NNP is not used as a criterion for Niblack waste rock in this report, it is noted here for completeness, as laboratories often report this value, and future characterization studies may indicate that NNP is a useful parameter for Phase II mining.

The ANP of a sample was determined by the Sobek (EPA-600) method, which measures the amount of strong acid consumed under boiling conditions. Normally, the majority of the ANP of a sample is made up of carbonate minerals. However, the Sobek (EPA-600) method can also

include some acid neutralization by slow-reacting silicate minerals that may not be effective at neutralizing acid under field conditions. To determine the neutralization potential that is due only to the more reactive carbonate minerals (CNP), a separate analysis is conducted to measure total inorganic carbon. The percentage of ANP resulting from carbonate minerals is determined from the CNP/ANP ratio. The case where CNP may not provide a reliable estimate for NP is if there are iron or manganese carbonates present (upon dissolution, iron and manganese carbonate minerals produce acid as the metals react with oxygen and water, so that the carbonates in these produce little or no net neutralizing potential).

Finally, oxidation of sulphide minerals can also be a direct source of dissolved metals. In the case of pyrite (FeS), iron is released. Base-metal sulphide deposits can include other metal sulphide minerals, such as zinc sulphides (e.g., sphalerite, ZnS) and copper sulphides (e.g., chalcopyrite, CuFeS<sub>2</sub>) to name a few. And metals can substitute for iron in the structure of pyrite. The result is that oxidation reactions in sulphide bearing mine waste can cause the release of metals to solution.

### 2.3 WASTE ROCK CLASSIFICATION CRITERIA

Effective use of Acid/Base Accounting (ABA) results to guide waste handling requires specific criteria to classify waste as PAG or non-PAG. At what ANP/AGP ratio is a material likely to generate acid? Regulatory guidelines for classifying waste as non-acid generating vary widely. Nevada state guidelines consider waste to be non-acid generating without additional kinetic testing if it has 20 percent excess neutralizing capacity (i.e. a safety factor of 1.2, ANP/AGP ratio  $\geq 1.2:1$ ; NDEP 1990). BLM guidelines set this criterion at 300 percent excess ANP (i.e., a safety factor of 3, ANP/AGP  $\geq 3$ ), and also suggest an ANP greater than 20‰ CaCO<sub>3</sub> (BLM 1996).

The following criteria are proposed for classifying waste rock from the Niblack Phase I exploration tunnel, based on the range of results from technical studies and regulatory guidance:

- PAG rock if ANP/AGP  $\leq 3$
- Non-PAG rock if ANP/AGP  $> 3$

This criterion is more environmentally conservative than most environmental guidance. Further, the use of a 3-fold excess neutralizing potential and avoidance of offsetting acid production by blending with neutralizing rock emphasizes safety and simplicity for this relatively small exploration project.

The broad overall plan for waste rock handling includes the following:

- Identify storage locations for potentially acid generating and non-acid generating waste rock facilities;
- Characterize waste rock by collection of a representative composite sample of drill cuttings from each blast round (~10 ft of advance) and analyze on-site for Total S (alternatively, Total S analysis will be performed on representative samples obtained from a pilot hole(s) drilled immediately parallel to the drift in advance of excavation);
- Visually examine the muck pile from each blast round for the presence of zinc or copper sulphide minerals (i.e., sphalerite or chalcopyrite)—samples with visible zinc or copper

sulphide minerals will be diverted to the PAG waste facility. (Samples with visible base-metal sulphide minerals are likely to exceed the sulphide threshold for PAG waste anyway).

- Place non-PAG waste rock (ANP/AGP ratio > 3) on the unlined waste rock storage site;
- Place all PAG waste rock (as determined by Total S analysis, and visibly high Zn or Cu sulphide minerals), at a lined and covered temporary storage location, where runoff will be captured and treated; and
- Close the facilities by capping non-PAG waste rock with a vegetated cover and place PAG waste rock back into the tunnel.

This design isolates PAG waste rock underground below the water table, where oxidation and acid generation will cease as oxygen is excluded by the flooding groundwater. To reduce the potential for PAG waste to cause short-term degradation of the groundwater that floods the drift, the paste pH or drainage quality of the PAG waste will be measured before it is placed back in the drift, and if it is acidic, lime will be added to bring pore water pH to 7 or above before placement.

#### 2.4 EXISTING GEOCHEMICAL DATA

Three types of analyses are used in the waste rock characterization; whole rock, multi-elemental, and acid/base accounting. The combined results of these analyses allow the potential environmental impacts of the underground exploration to be predicted. Characterization of the main rock units based on these analyses is presented in 'Niblack Project, Underground Exploration Plan of Operations' (Knight Piésold, 2006).

This Operational Characterization Plan report contains data that is complementary to the Plan of Operations, and presents the data in relation to waste rock classification criteria. Existing environmental samples from the Niblack project consist of acid/base accounting and total metal analysis of 105 samples collected from exploration drill core and surface outcrops. Included in this total are 38 samples collected in 2006 from locations in the vicinity of the proposed exploration tunnel (Figures 2 and 3). The samples represent the main lithological units, with 21 samples from the Footwall unit, 58 samples from the Hanging Wall unit and 26 samples from the Lookout unit. Although the number of samples are too few to definitively characterize the materials distribution in acid/base accounting, they are spatially dispersed, and numerous enough to provide a reasonable overview of the statistical characteristics of the acid-generating and acid-neutralizing potential within the project area.

Analyses to be conducted in parallel with project initiation will include solute release caused by oxidation of representative materials from the Hanging Wall, Footwall and Lookout unit materials (i.e., laboratory based long-term kinetic "humidity cell" tests to measure the rate of solute release; and on-site field tests, subject to local environmental conditions, that provide for site specific verification and calibration of the laboratory based humidity cell tests).

Estimates for the volume of PAG and non-PAG waste rock produced by the tunnel that were used to support the facility design (Table 1) are based on an assumption that these 105 samples are

statistically representative of the acid/base distribution within each of the 3 lithologic units. To ensure environmental compliance, however, waste handling under field conditions will be decided by analysis of the actual waste rock that is encountered.

#### 2.4.1 Acid/Base Accounting (ABA) of Waste Rock

The discussion of acid/base accounting of Niblack exploration tunnel waste rock is presented in terms of the criteria selected to distinguish potentially acid-generating waste (PAG) from non-PAG waste, i.e.:

- PAG rock if  $ANP/AGP \leq 3$
- Non-PAG rock if  $ANP/AGP > 3$

This criterion provides a 3-fold excess in neutralizing potential relative to acid production potential for waste rock proposed for permanent surficial disposal. Acid/base accounting results for the 105 rock samples from the Niblack project are presented in Tables 2 through 4 and a plot of ANP versus AGP for all Footwall, Hanging Wall, and Lookout unit samples are shown in Figure 4. A summary of estimated volumes of PAG waste rock and non-PAG waste rock produced by each unit is presented in Table 1.

Acid/base accounting analysis indicates that carbonate C is a good indicator of ANP at the Niblack project. The strong correlation is clearly demonstrated on a plot of ANP versus CNP ( $r^2 =$  of 0.94; see Plan of Operations, Figure 2.14, Knight Piésold 2006). On average, the acid neutralization potential measured by carbonate C concentration (CNP) is somewhat less than the acid neutralization potential estimated by direct acid titration (ANP). The median CNP/ANP ratio of all samples for which both ANP and CNP data are available is 0.78. This indicates carbonate minerals make up 78% of the ANP, with the remaining 22% made of slow reacting non-carbonate minerals. The median CNP/ANP ratio for the three main rock units is 0.83 for the Hanging Wall unit, 0.76 for the Lookout Unit, and 0.76 for the Footwall Unit (see values for CNP/ANP in Tables 2, 3, and 4).

Carbonate minerals are generally the most chemically available and effective forms of natural acid neutralization. However, iron and manganese carbonates are an exception—these minerals provide little or no net neutralizing potential. A query of the Niblack project drill database for carbonate species identified in rock samples yielded 1428 records of calcium carbonate, 18 records of iron carbonate, and 2 records of manganese carbonate. These data indicate that although iron and manganese carbonates can be present in some places, they appear to be rare in comparison to calcium carbonate, and are thus unlikely to be present in sufficient concentration to significantly reduce acid consumption. Additional sampling and analysis is proposed to further evaluate the effects of non-carbonate NP and iron and manganese carbonate on the 'effective' ANP under field conditions. The conservative 3-fold excess in neutralizing potential used in distinguishing non-PAG rock from PAG rock is designed to accommodate a reasonable percentage of non-carbonate ANP and the presence of minor iron and manganese carbonates.

Key results of acid/base accounting analyses of the expected waste rock from the Niblack exploration tunnel are as follows:

- Most of the rock produced from the exploration drift will be non-acid generating (i.e., ~46,600 yd<sup>3</sup> of waste rock will be non-PAG, which is ~77% of the estimated 60,900 total yd<sup>3</sup> of waste rock that the tunnel will produce);
- The average net-neutralizing potential of the non-PAG material is 50 kg/tonne CaCO<sub>3</sub> (i.e., potential to neutralize excess acid *after* all of its intrinsic acid has been produced by sulphide oxidation), the median value is 35.5 kg/tonne CaCO<sub>3</sub>;
- The average total sulfur content of non-PAG material is 0.06%, the median value is 0.01% (analytical detection limit is 0.01%);
- Most (~86%) of the total 46,600 yd<sup>3</sup> of non-PAG waste rock will be from the Hanging Wall unit;
- Most (~90%) of the early waste rock produced by the tunnel will be non-PAG (i.e., the first 2,500 ft of tunnel excavated will be in the Hanging Wall unit, as well as the Mammoth drift and the Footwall drift);
- Most of the PAG waste rock will be from the Footwall unit (i.e., ~8,400 yd<sup>3</sup>, or ~59% of PAG waste rock) with lesser amounts of PAG waste rock from the Hanging Wall unit (~4,700 yd<sup>3</sup>, or 33% of PAG waste rock) and Lookout unit (~1,200 yd<sup>3</sup>, or 8% of the PAG waste rock);
- Some of the Lookout unit waste rock or tunnel wall rock may produce acid within a few days to a few months after exposure to the atmosphere – 42 % of the samples from the Lookout unit (11 out of 26 samples) have negligible carbonate concentrations (e.g., below ~10 kg/tonne CaCO<sub>3</sub>), so ~1,200 yd<sup>3</sup> of waste rock could produce acid almost immediately upon excavation. (This is supported by acidic paste pH [values between 3.5 and 6] in some Lookout unit samples; see Plan of Operations, Figures 2.10 through 2.11, Knight Piésold 2006).

There may be a slight bias toward over-predicting the volume of PAG rock, because waste predictions have not accounted for mafic dykes, which typically fizz readily with HCl due to modal calcite (suggesting high ANP) and occupy as much as 15% by volume of the main stratigraphic units. Nor have predictions accounted for the fact that the material with the highest sulphide concentration is ore, which will be transported off-site for metallurgical testing. It is anticipated that a maximum of 50 ft of the total 5,940 ft of underground development (or 0.8%) will be in these base metal mineralized rocks. The adit and drifts are for the purpose of establishing drill stations and therefore are typically at some distance from zones of mineralization.

#### 2.4.2 Relationship between Total Sulfur and ANP/AGP Ratio

The use of total sulfur to estimate the ANP/AGP ratio follows from results of the acid/base accounting analyses of rock samples collected from drill holes on the Niblack project, including a set of samples collected in 2006 from near the proposed portal entrance. A linear regression of total extractable sulfur vs. the ANP/AGP ratio is shown on Figure 5 and yields the equation:

$$\text{Log (ANP/AGP)} = [-1.225 \text{ Log (S}_{\text{total}})] - 0.319$$

The threshold proposed for distinguishing PAG rock from non-PAG rock (i.e. ANP/AGP ratio = 3:1) corresponds to a total S concentration of 0.22% in this regression. There is some uncertainty in this threshold due to scatter in the data, but an additional safety factor on the regression fit is not included in the plan because the use of an ANP/AGP ratio of 3 as a threshold for PAG rock already contains a 3-fold safety factor of excess neutralizing potential.

The proposed criteria for handling waste rock are thus:

- $S_{\text{tot}} \geq 0.22\%$  is considered to be PAG rock, and
- $S_{\text{tot}} < 0.22\%$  is considered to be non-PAG rock.

This 'cut-off' value of 0.22% Total S will be further evaluated using additional analyses of waste rock samples prior to initiating underground excavation (see Section 3.1). However, this cut-off is lower than some other full-scale mine projects (e.g., the recently permitted POGO mine in the Goodpaster River Valley, Alaska, where a Total S cut-off value of 0.5% is used to segregate PAG from non-PAG waste types).

#### 2.4.3 Potential for Metals Leaching – Non-PAG Waste Rock

Analysis of ICP and whole rock data presented in the Niblack Plan of Operations (Knight Piésold, 2006) indicates the primary metals of environmental concern are copper and zinc. Metals bound as sulphide minerals may be released directly by oxidation (Section 2.2), and acidic pore water tends to increase the solubility of most metals of environmental concern.

Segregation of non-PAG rock based on an S% value of  $<0.22\%$  and absence of visible zinc or copper sulphide minerals will likely ensure a low potential for release of soluble metals from the non-PAG waste rock pile. This approach is supported by copper and zinc analyses of non-PAG ABA samples (i.e. those samples with ANP/AGP ratio of  $>3$ ).

Metals leaching is determined by a wide variety of chemical and physical factors that make it difficult to accurately predict a total metal threshold below which there is negligible metal leaching and limited potential to degrade the environment. For planning purposes, we use a logical, if somewhat arbitrary screening threshold for metals of concern at total metals concentrations above five times the average crustal abundance (5x average crustal concentrations are 290 ppm copper and 410 ppm zinc). These values are one to two orders of magnitude lower than what would be considered economically significant mineralization and were developed based on personal communications with Stephen Day (December, 2006), an internationally recognized expert in ARD studies. More definitive estimates relating metal leaching to total sulphur or total in non-PAG and PAG rock will be obtained by conducting humidity cell tests, as described in Section 3.1.4.

Of the 52 samples of non-PAG material for which copper analyses are available, there is one sample (1.9% of non-PAG samples) that contains >290 ppm copper (Table 5). Additionally, of the 52 samples of non-PAG material for which zinc analyses are available, there is one sample (1.9% of non-PAG samples) that contains > 410 ppm zinc. The average and median values of copper within non-PAG samples are 97 ppm and 70 ppm, respectively. The average and median values of zinc within non-PAG samples are 151 ppm and 100 ppm respectively. Thus, rock identified as non-PAG, based on Total S below the 0.22% threshold, is very likely to also have low concentrations of metals of concern.

Dissolved metal concentrations in seepage from non-PAG waste rock can not be determined at this time with the available data. Representative estimates for leachate quality will be provided by the upcoming kinetic tests, which will be conducted on a wide range of rock types (Section 3.1.4). At all times however, waste handling is focused on preventing pore water from becoming acidic; usually the underlying cause of elevated metal concentrations in mine drainage. This rock handling plan therefore includes detailed sampling to remove PAG rock from the non-PAG waste rock facility, ensuring that the non-PAG waste has excess neutralizing potential (Average = 50 kg/tonne CaCO<sub>3</sub>), and relatively low total metals concentrations. The low sulphide content of non-PAG material (average Total S = 0.06%; median Total S = 0.01%, which is equal to the detection limit) indicates that most copper and zinc is probably bound with non-sulphide minerals (e.g., silicates, metal hydroxides, or clays). Metals in silicate and oxide species are typically less readily leachable than from sulphide species.

Based on all currently available data, negligible metal leaching is anticipated to occur in NAG waste rock, therefore degradation of surface and ground waters is not expected. This assertion will be further verified, and the threshold values for total copper and total zinc refined, based on additional test work planned prior to and during excavation of the adit (see Section 3.1).

#### 2.4.4 Potential for Metals Leaching – PAG Waste Rock

Assuming total copper and zinc concentrations above five-times the average crustal abundance indicate a potential concern (i.e., above 290 ppm copper and 410 ppm zinc, see analysis of ICP and whole rock data presented in the Niblack Plan of Operations, Knight Piésold, 2006), the primary metals of environmental concern are copper and zinc.

Copper and zinc are typically bound to sulphides (sulfur bearing minerals), which at Niblack include sphalerite ([Zn,Fe]S) and chalcopyrite (CuFeS<sub>2</sub>). The PAG waste rock pile will include all waste rock with a S% content of >0.22%, which includes rocks containing appreciable sulphide content. The dominant sulphide mineral species at Niblack is Pyrite (FeS<sub>2</sub>), which accounts for the majority of the measured S%.

Of the 17 samples of PAG material for which copper analyses are available, there are five samples (29% of PAG samples) that contain >290 ppm copper (Table 6). Of the 17 samples of PAG material for which zinc analyses are available, there are seven samples (41% of PAG samples) that contain > 410 ppm zinc. The average and median values of copper within PAG samples are 808 ppm and 130 ppm respectively. The average and median values of zinc within the PAG samples are 2,063 ppm and 340 ppm respectively. Averages for both metals are above the established threshold values (>290 ppm for copper and >410 ppm for zinc), whereas median values are below the threshold values.

Sample N28938 is of massive sulphide mineralization and has a strong influence on metal averages. If this sample is excluded from the calculations, average and mean copper values reduce to 317 ppm and 120 ppm respectively, and average and mean zinc values reduce to 1,267 ppm and 290 ppm respectively. Massive sulphide rock extracted during the underground exploration program will be transported off-site for metallurgical testing and will not be placed on the PAG waste rock facility, providing the rationale for excluding samples of massive sulphide from future predictions of PAG waste rock metal leaching.

The potential for metal leaching from the PAG waste rock pile into water that comes in contact with this material is dependent on a wide variety of chemical and physical factors. Estimates of metal concentrations in PAG waste rock seepage can not be made at this time with the available data.

There are a sufficient number of PAG samples that have copper and zinc concentrations in excess of the adopted threshold values to warrant additional testing in order to evaluate metal leaching potential. Proposed tests will provide data that can be used to make estimates of water quality in the waste rock pore water (see Section 3.1). These include both laboratory and site-specific field based kinetic oxidation tests, which will provide estimates for field oxidation rates and secondary solute concentrations (e.g. zinc, copper, etc.). However, reliable predictions of metal concentrations in waste rock seepage based on kinetic tests can take months or years to determine. In the absence of such data, precautionary measures for handling of the PAG waste rock include water collection and treatment facilities to ensure water quality standards are met.

#### 2.4.5 Potential Acid Consumption from Non-Sulphidic Waste Rock

The non-sulphidic rock in the Hanging Wall and Footwall units contains significant excess acid-neutralizing potential. The average NP of the low sulphide material (using <0.1% sulfide as a definition for non-sulphidic; note that this differs from the <0.22% sulphide as a definition for non-PAG) is 58 kg CaCO<sub>3</sub>/t CaCO<sub>3</sub>, (standard deviation = 54 kg/tonne CaCO<sub>3</sub>), with a range between 9 and 200 kg/tonne CaCO<sub>3</sub>. Most of this neutralizing potential is present in the Hanging Wall unit, though appreciable excess neutralizing potential is also present in the Lookout unit, as shown in Figure 4. Underground excavation will encounter non-sulphidic material first, and the basal layer of non-sulphidic material in the non-PAG waste rock facility provides an important additional safety factor

above the ANP/AGP 3:1 criterion for surface storage. Should small zones of net-acid generating waste exist in the non-PAG waste rock facility (i.e. zones of rock smaller than the individual blast round average used to characterize the waste) pore water acidity would be neutralized as it flowed through underlying zones with excess neutralization potential.

## SECTION 3.0 - SAMPLING AND ANALYSIS PROGRAM

### 3.1 GEOCHEMICAL TESTS AND ANALYSIS

A multi-faceted environmental testing program will be conducted in parallel with the Niblack exploration tunnel construction to support the environmental management of exploration tunnel waste and also the design of possible full-scale future mining (i.e., Phase 2). The testing program will include the following:

- NAG tests (field), conducted at a frequency of one per blast (i.e., ~10 ft of tunnel advance, and an anticipated advance rate of 2 blast rounds per day) to classify and route waste rock based on total S released by the peroxide oxidation process used in the NAG test;
- Pre-development testing on 15 samples to include acid/base accounting (ABA), NAG tests (lab), ICP multi-element analysis, XRF multi-element analysis, and X-ray Diffractometer (XRD) Rietveld analysis to further validate or refine the 0.22% Total S threshold, to confirm the appropriateness of the field NAG test for the determination of Total S, and to provide data in support of alternative test procedures should they be required;
- External laboratory analysis conducted on 10% of individual blast round waste rock samples collected during drift construction to confirm results of on-site classification of PAG and non-PAG waste rock, this analysis would include most of the same procedures used on the 15 samples selected for pre-development testing;
- Laboratory based kinetic tests (humidity cell tests), conducted on 15 samples of sulfide bearing waste rock (sulfide S > 0.1%, selected to represent the approximate range of total metal concentration expected in waste rock and including each of the 3 major formations) to estimate sulfide oxidation rates in waste rock, the time before onset of acid production, and solute release from waste rock during oxidation; and
- Field based kinetic tests (bins, cribs, or barrels) conducted on site on representative samples of excavated waste rock for each lithology. These field tests would provide information that would allow better use of the data developed by the humidity cell tests for possible future mine planning purposes.

Analytical methods and references are provided in Appendix A.

#### 3.1.1 NAG Tests (field): Waste Rock Routing

NAG tests will be conducted on a representative composite sample from every blast round (~10 ft of tunnel advance, with 2 blast rounds per day) at the project site to measure pH following complete oxidation with hydrogen peroxide, and the total sulfur released by the oxidation process. If samples are obtained every 10 ft of advance, this will produce approximately 600 total analyses. Results will be used to route material as PAG waste rock or non-PAG waste rock.

Fifteen samples will be submitted to a commercial laboratory in advance of tunnel excavation in order to further validate and refine the field NAG test methodology, and to provide data in support of alternative test procedures should they be required (types of analysis to be performed on the 15 samples are detailed below in Section 3.1.2). A potential alternative to the field NAG test is on-site XRF analysis of Total S. Sample collection procedures would be the same for either the field NAG test or on-site XRF analysis. If on-site XRF is selected as the method for on-site determination of sulphur, copper, and zinc, then the analytical procedures specific to the machine selected for this site will be produced as an addendum to this report.

### 3.1.2 Pre-Development Tests

Prior to tunnel excavation, additional testing will be conducted on 15 samples by commercial laboratories on samples of existing drill core from the three main lithologies of both PAG and non-PAG material. Samples will be obtained from drill core with existing multi-element ICP data (including Total S), and will account for material with varying metal content. Sampling will include:

- Hanging Wall – 2 non-PAG and 3 PAG;
- Footwall – 2 non-PAG and 3 PAG;
- Lookout unit – 2 non-PAG and 3 PAG.

Analytical procedures will include:

- NAG Tests (external laboratory);
- ABA by Standard Sobek method;
- ABA by Modified Sobek (with peroxide addition);
- Carbonate NP;
- Total S by Leco Furnace;
- Total S, Cu and Zn by X-ray Fluorescence (XRF);
- X-ray Diffraction (XRD) with Rietveld Analysis.

#### NAG Tests (external laboratory):

Samples will be subjected to complete oxidation with 15% hydrogen peroxide, then analyzed for metals, sulfate, acidity and alkalinity. Results will be used to estimate the potential release of metals in proportion to sulfate during oxidation of waste rock and tunnel wall rock. These analyses will aid in establishing water treatment requirements for seepage and runoff from the temporary PAG storage facility. Actual water treatment requirements will be adjusted in the field based on actual seepage quality.

An important secondary goal of these NAG tests is refinement of the oxidation step to determine whether a short (1-hr) oxidation step is sufficient for complete reaction of the samples (The NAG procedure calls for 12-hour reaction plus 2 hrs boiling). The laboratory will therefore conduct a set of comparison tests on the 15 samples. This comparison will measure total sulfur released to solution by the NAG extraction tests on sample splits. One set will be analyzed using the standard NAG procedure, and the

other using a 1-hr boiling peroxide step. Results of these tests are important because they will allow field personnel to make rapid decisions on routing waste rock. If a shorter peroxide oxidation time is inadequate, then other rapid analytical methods for total S (e.g., XRF) will be considered for the on-site analyses.

*ABA by Standard Sobek Method:*

Splits will be collected of the 15 samples submitted for the laboratory based NAG test for Acid/Base Accounting (ABA) by the Standard Sobek Method. This will allow comparison with the existing database which used this test to evaluate ANP/AGP.

*ABA by Modified Sobek Method (with peroxide addition):*

In addition to the Standard Sobek Method, splits will be collected of the 15 samples submitted for the laboratory based NAG test for ABA by the Modified Sobek Method. The lower temperature used in the modified Sobek Method minimizes the potential for inclusion of NP resulting from non-carbonate minerals that may not provide actual NP in the field. The addition of peroxide ensures full oxidation of iron and manganese that may have been present as carbonates, ensuring complete accounting of the additional acidity that iron and manganese carbonates may impart.

*Carbonate NP:*

Splits will be collected of the 15 samples submitted for the laboratory based NAG test for Carbonate NP to allow the evaluation of the percentage of the Standard Sobek NP that is due to carbonate minerals versus non-carbonate minerals. Carbonate NP is calculated from an analysis of Inorganic Carbon (CO<sub>2</sub>).

*Total S by Leco Furnace:*

Splits will be collected of the 15 samples submitted for the laboratory based NAG test for Total S analysis by the Leco Furnace method. Leco Furnace is an industry standard method for determining Total S, and will be used to confirm Total S determined by the NAG test, which is less well known and used in North America.

*Total S, Cu and Zn by X-ray Fluorescence (XRF):*

Splits will be collected of the 15 samples submitted for the laboratory based NAG test for Total S, Cu and Zn analysis by XRF. On-site XRF analysis is an alternate methodology to the field NAG test for determining Total S for waste rock segregation. Total S and metals analysis will be evaluated by comparison with Leco Furnace, NAG, and multi-element ICP analysis.

A relatively small, and easy to operate XRF instrument is currently in use for waste rock characterization at the POGO mine. Total sample turnaround time, including drying, crushing, pulverizing, pelletizing and analysis is from 3 to 6 hours. An advantage of on-site XRF over the NAG test is the ability to also analyse for copper and zinc.

*X-ray Diffraction (XRD) with Rietveld Analysis:*

Splits will be collected of the 15 samples submitted for the laboratory based NAG test for XRD/Rietveld Analysis. The process provides semi-quantitative determination of mineral species. Particular attention will be given to the determination of carbonate mineralogy. The XRD data will allow better evaluation of NP data, and will complement the current understanding of carbonate mineralogy that is based on mapping and information within the drill hole database.

3.1.3 External Laboratory Confirmation of Field Analysis

Off site analysis will be conducted on 10% of the individual blast round composite samples collected during excavation of the exploration tunnel to route waste rock. The confirmation testing will produce ~60 analyses throughout the course of tunnel construction, and will include Total S by Leco Furnace, as a check on Total S by the field NAG test, and multi-element ICP analysis for metals determination. Results will provide confirmation of the on-site analysis to identify PAG and non-PAG waste rock. In order to increase the overall characterization of acid/base accounting for the project, additional testing will be done on the same sample splits for ABA by Standard Sobek, ABA by Modified Sobek (with peroxide addition), Carbonate NP, and XRD/Rietveld Analysis for carbonate mineralogy determination.

3.1.4 Kinetic Tests (lab): Oxidation Rate and Solute Release from Waste Rock

Kinetic tests (humidity cell tests) will be conducted on 15 samples of waste rock excavated during tunnel construction that contain ~0.1% Total S or greater. In addition to Total S, sample selection for humidity cell tests will be based on metal concentrations as determined by multi-element ICP analysis. The objective is to obtain samples with metal concentrations that are statistically representative of the stratigraphic unit for the Total S range bracket that is sampled. Samples will include:

- Hanging Wall Unit
  - 2 low sulphide (between 0.1% and 0.22%)
  - 2 intermediate sulphide (0.22% to 0.5%S)
  - 1 high sulphide (S>1%).
- Footwall units
  - 2 low sulphide (between 0.1% and 0.22%)
  - 2 intermediate sulphide (0.22% to 0.5%S)
  - 1 high sulphide (S>1%).
- Lookout unit (the primary waste rock unit in a potential Phase II mining scenario)
  - 2 low sulphide (between 0.1% and 0.22%)
  - 2 intermediate sulphide (0.22% to 0.5%S)
  - 1 high sulphide (S>1%).

These tests emphasize characterization of leachate release from the low and intermediate sulphide material (0.1% to 0.22%S and 0.22% to 0.5%S) to support possible

refinement of the 0.22% Total S threshold between PAG and non-PAG rock. Samples of intermediate and high sulphide content support estimates of time before acid production and leachate quality expected from temporary surface storage of PAG rock.

Leachates will be collected weekly, and analyzed for sulfate, pH, alkalinity, acidity, and conductivity. Bi-weekly samples will also be analyzed for metals and major anions. Results will support estimates of oxidation rates in waste rock and tunnel walls, and estimates of solute release associated with oxidation. The collected data will be evaluated with site-specific kinetic tests (discussed below in Section 3.1.5) that will support environmental assessment of possible future mining operations.

In addition to Total S and multi-element ICP analysis, sample splits will be collected from the humidity cell test samples for ABA by Standard Sobek, ABA by Modified Sobek, Carbonate NP, thin section petrography, and XRD/Rietveld Analysis.

3.1.5 Kinetic Tests (field): Oxidation Rate and Solute Release from Waste Rock under Local Environmental Conditions

On site kinetic tests will be performed to better calibrate humidity cell and ABA data to local field conditions. The tests will consist of small scale leach pads of 1 to 5 cubic yards of waste rock contained within uncovered boxes, bins or cribs that are subject to local environmental conditions. The number of test leach pads and sample selection criteria will be determined following review of the pre-development testing described in Section 3.1.2. The appropriate government agencies will be consulted regarding the selection criteria for both the laboratory and field based kinetic tests to ensure suitable data is collected for potential future permitting purposes.

## SECTION 4.0 - WASTE ROCK MANAGEMENT

### 4.1 WASTE ROCK MANAGEMENT AND SAMPLING PROGRAM

Below is a description of the sampling and analysis program that will be used during construction of the Niblack exploration tunnel to determine whether waste rock produced each blast round is to be handled as non-PAG waste rock (ANP/AGP > 3) or PAG (ANP/AGP ≤ 3) waste rock.

#### 4.1.1 Production Estimates, Locations, Schedules

The exploration tunnel will advance at a rate of ~20-ft per day, which corresponds to ~190 yd<sup>3</sup> of waste rock per day. The total length of the tunnel is projected to be 5,940 ft, including 2,860 ft in the Main Access Tunnel, 1,140 ft in the Hanging Wall Drift, 940 ft in the Footwall Drift, and 1,000 ft in the Mammoth Drift (Figure 3). Waste rock production will be dominated by the Hanging wall unit, which will account for ~45,600 yd<sup>3</sup> of the 60,900 total yd<sup>3</sup> of waste rock produced by the tunnel. The length of tunnel in each unit, and associated waste rock production schedule are provided in Table 7.

#### 4.1.2 Recommended Chemical Characterization (Sampling and Analysis) Plan

The sampling and analysis program is intended to provide rapid field identification of waste rock as PAG or non-PAG and should include the following:

1. Collect composite sample in advance of every blast round from produced drill cuttings (composite sample size of ~10 pounds each, prepared from five sub-samples of about equal size from holes spaced equally across the face) [To confirm the accuracy of this sampling, 10 of the first 30 composite samples from drill cuttings will be compared to duplicate analyses conducted on samples collected from muck grab samples or “cut-channel samples” taken from the face and resulting ribs].
2. Prepare and analyze the composite on site for total sulfur, based on the amount of soluble sulfur recovered from the NAG leach extraction tests. (The on-site NAG tests are being used primarily to estimate the total S in rock samples, based on sulphate recovered in the peroxide extract. Studies conducted by Knight Piésold for private clients have found that NAG extract sulphate to be a reliable indicator of total sulfur in other deposits. The comparison of NAG tests to acid/base accounting will evaluate the accuracy of this relationship for the Niblack project). On-site XRF analysis is contemplated as an alternate methodology for Total S determination.
3. Material containing >0.22 % S is classified as PAG waste rock (ANP/AGP ≤ 3) – stored temporarily on the lined PAG waste rock pile and covered shortly after placement with an impermeable membrane, then returned to the exploration drift at the end of the project for permanent subaqueous disposal.
4. Material containing ≤ 0.22 % S is handled as non-PAG waste rock (ANP/AGP > 3) – stored permanently in the non-PAG waste rock pile, then capped with a

vegetated soil or benign waste rock layer for permanent disposal at the end of the exploration program.

5. Confirm the accuracy of the field method by subjecting 10% of the blast round composites to a commercial laboratory analysis of ANP/AGP ratio based on Standard Sobek, Modified Sobek, Carbonate NP, and XRD/Rietveld analysis. Total S by Leco Furnace and multi-element ICP analysis will also be performed on these samples.

In addition to the chemical characterization of waste rock, a visual geological log will be made of the muck pile from each blast round. The log will include rocktype, alteration, sulphide mineralogy, and carbonate mineralogy. Waste rock containing copper or zinc sulphide minerals will be routed to the PAG facility. The collected geological data will contribute to the overall characterization and environmental evaluation of Niblack waste rock.

The threshold of 0.22 % sulfur to separate non-PAG from PAG waste is based on the observed correlation between total S and the ANP/AGP ratio in samples collected previously from the Niblack project (Figure 5). Additional samples are to be collected from drill cuttings or waste rock for analysis by humidity cells, or solute released by NAG extraction tests, as described in Section 3 of this report. Methods for collection and analysis of samples are presented in Appendix A.

An alternate methodology to waste characterization by sampling of drill cuttings on an individual blast-round basis is waste characterization by sampling of a pilot diamond drill hole(s) drilled immediately parallel to the drift in advance of excavation. Chemical analysis would be done either on-site or at an external laboratory. PAG versus non-PAG segregation would be based on Total S determination, and visual or analytical determination of copper and zinc mineralization. Advance drilling would also provide information on geotechnical conditions and hydrology.

#### 4.1.3 Waste Rock Segregation Tracking Plan

Segregation and tracking of PAG versus non-PAG waste rock will be achieved according to the plan herein. Chemical characterization is accomplished by analyzing a sample of blast-hole drill cuttings collected from each round of development rock (as described in Section 4.1.2). The analyses are completed on-site by Total S determination (NAG test or XRF instrument). The principal responsibilities of the geological staff include delivering the sludge sample to the on-site lab, tracking the whereabouts of each round pending the chemical analyses, obtaining the analytical results from the lab, communicating the classification of the round to the underground crews and documenting the final disposition of the round. It is the responsibility of the underground crews to collect the drill cutting (sludge) samples and maintain the identity and separation of waste rounds while the rounds are underground and until they are placed (separately) at the staging pads outside the portal. It is the responsibility of the surface crews to maintain the

identity of the rounds until they are designated as PAG or non-PAG by the geologic staff, and haul the rounds to the appropriate final disposition location.

Specific steps required to meet rock segregation objectives include the following:

1. Upon completing blast hole drilling at any face, the jumbo operator will collect a sample of cuttings (sludge) from the sill using a Swede pick or shovel. The sample is to be collected into a 17" by 24" Tyvek bag. The sample should weigh approximately 10 lbs. The sampler should write the heading, date and shift ("NS" or "DS") on the sample bag. It is the sampler's responsibility to bring the sample to the surface and leave it at the predetermined point for pickup. This is typically the tag-in board for their heading.
2. It is the underground crew's responsibility to stake and maintain separation of rounds for as long as they are underground.
3. It is also the underground crew's responsibility to stake the round after it has been hauled to the surface. The stake should be labelled with the heading, date and shift of the original blast that made the muck.
4. The surface crews are responsible for hauling muck to the proper location from the staging pads AFTER IT IS FLAGGED by geology. No muck piles can be removed from any staging area until the stake has been flagged by the geology department. The geology department will make every effort to flag the piles as soon as possible.
5. Scoop/loader operators are responsible for communicating the proper destination for muck as they load the haul trucks. PAG waste rock (red flag) must go to the lined PAG waste rock storage facility, non-PAG muck (green flag) will go to the permanent non-PAG waste site or be used for roads or other surface uses at the discretion of the Underground Operations Manager. When the scoop operator begins to load a muck pile into the haul trucks, the scoop operator should take possession of the stake for that pile and keep it for as long as he is working that muck pile. He should either 1) insert the stake back into the partial pile at the end of shift or when he stops loading to go to another task, (this way piles at the staging pads are always staked when they are not actively being moved), or 2) give the stake to the haul truck driver after loading the last load of muck for that pile into the truck
6. The haul truck driver must deposit the stake in the proper bin at the PAG waste rock storage facility or permanent non-PAG storage site after he dumps the last load.
7. The shift geologist should pick up sludge samples at the tag-in boards in the morning and evening. Using a sample number book, a unique sample number will be assigned to the sample and written on the bag, and a sample tag will be placed in the bag of sludge.
8. The shift geologist will write the sample number on one side of the wood stake in the muck pile, if the round has already been hauled to the surface.
9. The shift geologist will visually inspect the muck pile for copper and zinc sulphide mineralization.

10. The shift geologist will deliver the sludge sample to the on-site lab.
11. The shift geologist will map the location with the sample number and date/time stamp for that round on the appropriate CAD map in the geology office. The same information, with heading information, will be entered into an Excel spreadsheet in the geology database.
12. Immediately following receipt of the chemical analyses for a sample from the on-site lab (or visual identification of copper and zinc sulphides in the muck pile) the shift geologist will return to the appropriate muck pile (on the surface) and flag the stake RED for PAG, or GREEN for non-PAG. Then notify the shifter by radio or in person that a determination has been made and that the stake has been flagged accordingly. The underground crews are then free to dispose of this muck pile in accordance with 5 and 6 above.
13. The staff geologist will remove stakes from the stake bins after it has been confirmed that the muck has been completely removed from the staging pads.
14. The staff geologist will update the computer spreadsheet and map with the final disposition of each round as it becomes known.
15. Anytime the identification of a muck pile at one of the portals is unclear because the picket has been buried or otherwise misplaced, the surface operators are required to notify the geology staff, who will then help determine the identification of the pile and make the final decision as to the final disposition of that muck pile.

#### 4.1.4 Quality Control and Monitoring

Quality control on the daily analysis of acid/base accounting will include:

- One duplicate sample should be collected per 20 composite samples analyzed for the total sulfur at the field Total S method.
- One duplicate sample should be collected per 10 samples submitted to a commercial analytical laboratory for confirmation testing. The duplicate would be subjected to the full suite of analyses used in the confirmation testing.
- Five cut-channel samples of the face and ribs of the tunnel will be taken from each lithology for comparison with drill cutting/sludge samples (for a total of 15 samples). The samples will be analyzed by the same on-site techniques used to segregate waste, as well as multi-element ICP analysis.

Results of the waste rock monitoring will be recorded and reported monthly to ADEC and ADNR in electronic form, including:

- Tabulated results of on-site and laboratory analysis for total S of the composite samples produced each day.
- Comparison of duplicate analysis conducted by the field and commercial laboratory for total S.
- Discussion of discrepancies where duplicate analyses varied by more than 20% relative percent difference
- Graphical presentation of sulfide S, carbonate C, and estimated ANP/AGP in the waste rock that is produced, with results shown for individual samples and cumulative averages of the waste rock that is produced.

- Digital copies of the geologist's log from visual examination of the muck pile from each blast round. The log will include rocktype, alteration, sulphide mineralogy, and carbonate mineralogy, as well as if the muck round was routed to the PAG site based on visual identification of copper or zinc sulphide minerals.

## 4.2 WASTE ROCK STORAGE

Classification of rock as PAG and non-PAG will be based upon analyses of drill cuttings for individual blast rounds to measure Total S as described above in Section 4.1. The permanent non-PAG storage facility will be constructed first to serve as the permanent repository for the majority of the waste rock produced by the first 2,500 ft of advance into the Hanging Wall unit. This will form a layer of non-PAG waste rock with an average of 49 kg/tonne CaCO<sub>3</sub> net excess neutralizing capacity (i.e. average NNP of the Hanging Wall unit). At closure, this will be capped with topsoil or benign waste rock and vegetated for permanent disposal.

PAG waste rock will be stored at a specially engineered, lined storage facility and will be covered with an impermeable liner to prevent infiltration of water. All wastewater generated from precipitation runoff from the facility will be collected and routed to a separate water treatment facility. The PAG waste storage facility is a temporary facility, and upon closure, PAG waste rock will be placed back into the tunnel. The tunnel design includes a decline beginning 2,000 ft towards the back end of the main cross-cut, producing a zone at the back of the drift that will be submerged with groundwater. The section of the tunnel in the decline will include most of the PAG wall rock, and will also be the repository for PAG waste rock, ensuring that oxidation and associated acid production in all PAG waste rock and most PAG wall rock will cease when the tunnel is submerged upon closure.

Completion of the PAG waste rock storage facility construction is designed to coincide with initiation of portal development. However, should there be a delay in completion of the PAG facility a temporary staging area will be prepared to accommodate the nominal amount of PAG waste rock anticipated during initial development of the drift. The temporary staging area will be elevated, lined and covered with an impermeable liner to prevent interaction with precipitation and surface water. Alternatively, PAG waste may be temporarily stored underground in unused muck bays. The majority of PAG waste rock will not be encountered until reaching the back end of the tunnel, approximately 2,500 ft from the portal entrance (after ~125 days of tunnel advance, assuming 20-ft/day).

### 4.2.1 Short Term Environmental Considerations for Waste Storage

Environmental considerations for the storage of waste rock, and the proposed management remedy, address the following issues:

Consideration 1. High TSS in runoff from non-PAG rock may contaminate surface water.

Remedy: Runoff from un-capped waste rock will be routed to settling ponds and sediment traps to remove solids prior to being directed for dissipation over the forest floor.

Consideration 2. Acidic metal-laden water in contact with PAG waste rock could percolate to the water table.

Remedy: Most PAG rock will be capped shortly after emplacement with MineGuard or another similar impermeable layer to prevent infiltration or runoff of meteoric water. Runoff from uncapped PAG waste rock will be captured and treated, along with adit discharge, prior to release to the environment.

#### 4.2.2 Long-Term Environmental Considerations for Waste Storage

Consideration 1. High TSS in runoff from non-PAG rock may contaminate surface water.

Remedy: Non-PAG waste rock will be capped with topsoil or benign waste rock and vegetated to reduce the TSS in runoff.

Consideration 2. PAG waste rock or tunnel wall rock may produce acidic leachate that contaminates surface water or groundwater.

Remedy: All PAG waste rock will be returned to the decline section in the back of the tunnel. After completion, the PAG waste rock and most PAG wall rock will be inundated with groundwater, which will stop oxidation and associated release of acid or soluble metals. An engineered concrete plug will be placed in the adit to limit groundwater discharge from the portal.

**SECTION 5.0 - REFERENCES**

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SECTION 6.0 - CERTIFICATION

This report was prepared, reviewed and approved by the undersigned.

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*for:*

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**TABLE 1**

**NIBLACK MINING CORPORATION  
NIBLACK PROJECT**

**OPERATIONAL CHARACTERIZATION PLAN**

**ESTIMATED VOLUMES OF POTENTIALLY ACID-GENERATING AND NON-POTENTIALLY ACID-GENERATING WASTE ROCK PRODUCED BY THE NIBLACK EXPLORATION DRIFT**

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Rev'd: Apr 10/07

Unit	Length in Tunnel (ft)	Chemical Analyses			Tunnel Length (ft)	PAG Rock <sup>1</sup>			Tunnel Length (ft)	Non-PAG Rock <sup>2</sup>		
		PAG <sup>1</sup> ANP:AGP =<3 (# samples)	Non-PAG <sup>2</sup> ANP:AGP>3 (# samples)	PAG <sup>1</sup> (%)		Volume in-situ <sup>3</sup> (ft <sup>3</sup> )	Volume in-situ <sup>4</sup> (yd <sup>3</sup> )	Volume as waste <sup>5</sup> (yd <sup>3</sup> )		Volume in-situ <sup>3</sup> (ft <sup>3</sup> )	Volume in-situ <sup>4</sup> (yd <sup>3</sup> )	Volume as waste <sup>5</sup> (yd <sup>3</sup> )
Hanging Wall	4,440	6	52	10%	459	86,810	3,247	4,708	3,981	752,350	28,138	40,800
Lookout	275	11	15	42%	116	21,989	822	1,192	159	29,986	1,121	1,626
Foot Wall	1,225	14	7	67%	817	154,350	5,773	8,370	408	77,175	2,886	4,185
<b>Totals:</b>	<b>5,940</b>	<b>31</b>	<b>74</b>	<b>- -</b>	<b>1,392</b>	<b>263,149</b>	<b>9,842</b>	<b>14,271</b>	<b>4,548</b>	<b>859,511</b>	<b>32,146</b>	<b>46,611</b>

**Notes:**

1. PAG = Potentially Acid-Generating Rock, defined as: (acid neutralizing potential) / (acid generating potential) =< 3.
2. Non-PAG = Non-Potentially Acid Generating Rock, defined as: (acid neutralizing potential) / (acid generating potential) > 3, or sulfide S < 0.22%.
3. Nominal 13.5 X 14 ft tunnel dimension - multiply linear footage totals by 189 to get cubic footage (unbroken).
4. Volume in cubic yards = cubic ft \* 0.0374.
5. Waste volume assumes 45% expansion of waste relative to in-situ volume.

TABLE 2

NIBLACK MINING CORPORATION  
NIBLACK PROJECT

OPERATIONAL CHARACTERIZATION PLAN  
ACID BASE ACCOUNTING, COPPER AND ZINC DATA FOR HANGING WALL UNIT

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M:\1102\00205\02\AI\Report\4-Operational Characterization Plan\Rev 0\4-Tables - r0.xls\Table 2

Rev'd. Apr 10/07

Hole Number	Interval		Sample Number	Source	Net Neutralization Potential (t CaCO <sub>3</sub> /1000 t)	Acid Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>1</sup>	Paste pH	Acid Generating Potential (t CaCO <sub>3</sub> /1000 t) <sup>2</sup>	ANP/AGP Ratio	Sulphate Sulphur (%S) <sup>3</sup>	Sulphide Sulphur (%S) <sup>4</sup>	Total Sulphur (%S) <sup>5</sup>	Inorganic Carbon (%CO <sub>2</sub> ) <sup>6</sup>	Carbonate Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>7</sup>	CNP/ANP Ratio	Fizz Test	Copper (ppm)	Zinc (ppm)
	From (ft)	To (ft)																
LO-084	670.0	672.0	NBCA01	1997	12	13	9.4	1	13	-	0.01	0.01	-	-	-	2	-	-
LO-088	530.0	532.0	NBCA03	1997	6	11	9.5	5	2.2	-	0.14	0.16	-	-	-	1	-	-
LO-090	650.0	652.0	NBCA04	1997	48	49	9.5	1	49	-	0.01	0.01	-	-	-	3	-	-
LO-090	720.0	722.0	NBCA05	1997	45	46	9.4	1	46	-	0.01	0.01	-	-	-	3	-	-
LO-092	480.0	482.0	NBCA06	1997	14	15	9.6	1	15	-	0.01	0.01	-	-	-	2	-	-
LO-095	450.0	452.0	NBCA07	1997	-149	10	8.9	1	0.06	-	4.87	5.08	-	-	-	1	-	-
LO-099	550.0	552.0	NBCA08	1997	65	66	9.3	1	66	-	0.01	0.01	-	-	-	3	-	-
LO-102	57.0	60.0	NBCA04530	1997	199	200	9.3	1	200	0.01	0.01	0.04	9.2	209.09	1.05	3	-	-
LO-102	700.0	702.0	NBCA09	1997	64	70	9.8	6	11.67	-	0.17	0.19	-	-	-	4	-	-
LO-103	806.0	808.0	NBCA10	1997	26	27	9.5	1	27	-	0.01	0.02	-	-	-	3	-	-
LO-106	850.0	852.0	NBCA11	1997	117	123	9.2	6	20.5	-	0.16	0.18	-	-	-	4	-	-
LO-107	126.0	129.0	NBC04901	1997	142	143	8.9	1	143	0.01	0.01	0.01	5.1	115.91	0.81	4	4	78
LO-108	129.0	130.0	NBC06002	1997	144	145	8.9	1	145	0.01	0.01	0.01	5.9	134.09	0.92	4	6	84
LO-108	348.0	349.0	NBC06008	1997	183	184	9.1	1	184	0.01	0.01	0.01	7.3	165.91	0.90	4	81	84
LO-108	467.0	468.0	NBC06014	1997	193	194	8.3	1	194	0.01	0.01	0.01	7.7	175.00	0.90	4	14	81
LO-109	950.0	952.0	NBCA12	1997	14	15	9.4	1	15	-	0.01	0.01	-	-	-	2	-	-
LO-111	1081.0	1084.0	NBC06145	1997	11	17	9.5	6	2.83	0.02	0.17	0.2	0.5	11.36	0.67	2	28	60
LO-113	1221.0	1224.0	NBC06180	1997	14	16	9	2	8	0.02	0.02	0.07	0.5	11.36	0.71	2	170	108
LO-115	400.0	402.0	NBCA13	1997	60	61	9.3	1	61	-	0.01	0.01	-	-	-	3	-	-
LO-115	500.0	502.0	NBCA14	1997	107	108	9.4	1	108	-	0.01	0.01	-	-	-	4	-	-
LO-119	490.0	492.0	NBCA15	1997	26	27	9.4	1	27	-	0.01	0.01	-	-	-	2	-	-
LO-122	89.0	94.0	NBC06255	1997	65	66	8.8	1	66	0.01	0.01	0.03	2.8	63.64	0.96	3	182	100
LO-123	1368.0	1369.0	NBC06331	1997	8	20	9.3	12	1.97	0.01	0.33	0.39	0.5	11.36	0.57	2	85	115
LO-126	1460.0	1463.0	NBC06429	1997	7	10	9.6	3	3.33	0.01	0.07	0.1	0.2	4.55	0.45	1	95	100
LO-145	1153.0	1154.0	NBC07322	1997	71	72	9.3	1	72	0.01	0.01	0.01	2.5	56.82	0.79	3	95	85
LO-148	858.0	862.0	NBC05844	1997	87	88	9	1	88	0.01	0.01	0.04	3.3	75.00	0.85	3	120	320
LO-148	962.0	964.0	NBC05847	1997	66	77	9.2	11	7	0.01	0.27	0.34	2.8	63.64	0.83	3	50	125
LO-180	32.0	35.0	N28916	2006	40	45	9.2	5	9	-	-	0.16	-	-	-	3	40	90
LO-180	79.0	80.0	N28917	2006	42	43	9.4	1.3	34.4	-	-	0.04	-	-	-	3	240	100
LO-180	125.0	130.0	N28918	2006	102	102	9.6	0.3	326.4	-	-	0.01	-	-	-	3	80	80
LO-180	175.0	180.0	N28919	2006	134	134	9.8	0.3	857.6	-	-	0.01	-	-	-	3	90	100
LO-180	205.0	210.0	N28920	2006	68	68	9.9	0.3	435.2	-	-	0.01	-	-	-	3	50	50
LO-180	280.0	285.0	N28921	2006	54	54	9.9	0.3	345.6	-	-	0.01	-	-	-	3	80	90
LO-180	345.0	350.0	N28922	2006	34	44	9.4	10.3	4.27	-	-	0.33	-	-	-	3	270	100
LO-180	395.0	400.0	N28923	2006	15	20	9	5	4	-	-	0.16	-	-	-	2	60	120
LO-180	450.0	455.0	N28924	2006	35	41	9.6	5.9	6.91	-	-	0.19	-	-	-	2	240	100
LO-180	502.0	507.0	N28927	2006	77	83	9.4	5.9	13.98	-	-	0.19	-	-	-	3	40	110
LO-180	565.0	570.0	N28928	2006	66	67	9.4	0.6	107.2	-	-	0.02	-	-	-	3	160	100
LO-180	625.0	630.0	N28929	2006	122	125	9.8	3.4	36.36	-	-	0.11	-	-	-	3	40	70
LO-180	675.0	680.0	N28930	2006	180	191	9.4	11.3	16.98	-	-	0.36	-	-	-	3	50	110
LO-180	725.0	730.0	N28931	2006	22	26	9.2	4.1	6.4	-	-	0.13	-	-	-	2	50	150
LO-180	834.0	839.0	N28933	2006	22	26	9.3	4.1	6.4	-	-	0.13	-	-	-	2	60	140
Surface grab			NBS06101	2006	37	37	8.9	0.3	118.4	-	-	0.01	-	-	-	2	260	120
Surface grab			NBS06102	2006	40	41	9.1	0.9	43.73	-	-	0.03	-	-	-	2	580	80
Surface grab			NBS06103	2006	5	6	5.4	1.3	4.8	-	-	0.04	-	-	-	1	80	210
Surface grab			NBS06104	2006	7	7	9.6	0.3	44.8	-	-	0.01	-	-	-	1	70	70
Surface grab			NBS06105	2006	7	7	8.8	0.3	44.8	-	-	0.01	-	-	-	1	20	80
Surface grab			NBS06106	2006	-8	13	8.8	20.6	0.63	-	-	0.66	-	-	-	2	130	80
Surface grab			NBS06107	2006	31	35	8.7	4.1	8.62	-	-	0.13	-	-	-	2	30	150
Surface grab			NBS06108	2006	10	12	8.6	2.2	5.49	-	-	0.07	-	-	-	2	80	90
Surface grab			NBS06109	2006	15	15	8.6	0.3	48	-	-	0.01	-	-	-	2	50	120
Surface grab			NBS06110	2006	4	4	9.1	0.3	12.8	-	-	0.01	-	-	-	1	20	50
Surface grab			NBS06111	2006	31	31	9.3	0.3	198.4	-	-	0.01	-	-	-	2	70	80
Surface grab			NBS06112	2006	1	3	8.2	1.9	1.6	-	-	0.06	-	-	-	1	20	110
Surface grab			NBS06113	2006	5	7	8.5	1.6	4.48	-	-	0.05	-	-	-	1	70	110
Surface grab			NBS06114	2006	8	9	8.4	0.9	9.6	-	-	0.03	-	-	-	1	200	110
Surface grab			NBS06115	2006	10	12	8.6	2.2	5.49	-	-	0.07	-	-	-	1	60	90
Surface grab			NBS06116	2006	8	9	8.5	0.6	14.4	-	-	0.02	-	-	-	1	140	110
Average:					49	55	9.1	5.6	75.05	0.01	0.24	0.17	3.7	84.44	0.80	2	101	105
Median:					34.5	39	9.3	1	18.74	0.01	0.01	0.03	2.8	63.64	0.83	2	70	100

Total ANP/AGP =<3      6      10%  
Total ANP/AGP I >3      52      90%

<sup>1</sup> Acid Neutralization Potential (ANP) was reported by the lab as Neutralization Potential. Analytical Method: Sobek (EPA-600) through addition of acid, heating and titration.

<sup>2</sup> Acid Generating Potential (AGP) was reported by the lab as Maximum Potential Acidity. Value determined by calculating Total Sulphur (%S) \* 31.25.

<sup>3</sup> Analytical Method: Sobek (EPA-600) through acid leaching processing and gravimetric analysis.

<sup>4</sup> Analytical Method: Sobek (EPA-600) through bromine and nitric acid digestion, followed by gravimetric analysis.

<sup>5</sup> Analytical Method: Sobek (EPA-600) through heating in a Leco induction furnace and measuring the SO<sub>2</sub> released with an Infra-red detector.

<sup>6</sup> Analytical Method: Carbon assay through heating sample in a Leco induction furnace followed by a gasometric measurement of CO<sub>2</sub>.

<sup>7</sup> Carbonate Neutralization Potential (CNP) was calculated as follows: CO<sub>2</sub>% \*(100/44)\*10

Note 1: The detection limit has been used for plotting samples below the detection limit (<0.01 to 0.01 for S % and <0.2 to 0.2 for CO<sub>2</sub> %)

Note 2: ANP/AGP values less than 3 are shaded

Note 3: Copper values above threshold of 290 ppm (five times average crustal abundance) are shaded

Note 4: Zinc values above threshold of 410 ppm (five times average crustal abundance) are shaded

TABLE 3

NIBLACK MINING CORPORATION  
NIBLACK PROJECT

OPERATIONAL CHARACTERIZATION PLAN  
ACID BASE ACCOUNTING, COPPER AND ZINC DATA FOR LOOKOUT UNIT

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M:\1\02\00205\02\A\Report\4-Operational Characterization Plan\Rev 0\4-Tables - r0.xls\Table 3

Rev'd: Apr 10/07

Hole Number	Interval		Sample Number	Source	Net Neutralization Potential (t CaCO <sub>3</sub> /1000 t)	Acid Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>1</sup>	Paste pH	Acid Generating Potential (t CaCO <sub>3</sub> /1000 t) <sup>2</sup>	ANP/AGP Ratio	Sulphate Sulphur (%S) <sup>3</sup>	Sulphide Sulphur (%S) <sup>4</sup>	Total Sulphur (%S) <sup>5</sup>	Inorganic Carbon (%CO <sub>2</sub> ) <sup>6</sup>	Carbonate Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>7</sup>	CNP/ANP Ratio	Fizz Test	Copper (ppm)	Zinc (ppm)
	From (ft)	To (ft)																
LO-096	260.0	265.0	NBC04248	1997	26	27	9.2	1	27	0.01	0.01	0.01	0.9	20.45	0.76	2	-	-
LO-096	373.0	378.0	NBC04250	1997	36	37	9.6	1	37	0.01	0.01	0.01	1.7	38.64	1.04	2	-	-
LO-099	226.0	229.4	NBC04358	1997	-171	-2	4.5	169	0.01	0.43	4.54	0.2	4.55	-2.27	1	-	-	
LO-102	165.0	170.0	NBC04537	1997	-26	1	6.4	27	0.04	0.03	0.81	0.85	4.55	4.55	1	-	-	
LO-104	32.0	34.0	NBC04713	1997	63	64	9.6	1	64	0.01	0.01	0.01	3.1	70.45	1.10	2	-	-
LO-104	253.0	255.0	NBC04719	1997	33	34	9.5	1	34	0.01	0.01	0.01	1.1	25.00	0.74	2	-	-
LO-104	301.0	303.0	NBC04720	1997	27	28	9.4	1	28	0.01	0.01	0.01	0.8	18.18	0.65	2	-	-
LO-107	683.0	688.0	NBC04940	1997	54	55	9.3	1	55	0.01	0.01	0.02	2	45.45	0.83	3	-	-
LO-108	655.0	657.0	NBC06031	1997	12	13	9.3	1	13	0.02	0.01	0.03	0.3	6.82	0.52	2	6	167
LO-111	831.0	834.0	NBC06129	1997	-226	5	6.8	231	0.02	0.06	7.06	7.39	0.2	4.55	0.91	1	-	-
LO-111	1021.0	1024.0	NBC06141	1997	-252	-2	4.3	250	0.01	0.18	7.59	8	0.2	4.55	-2.27	1	-	-
LO-113	915.0	920.0	NBC06177	1997	8	9	9.7	1	9	0.01	0.01	0.01	0.4	9.09	1.01	2	6	102
LO-117	991.0	996.0	NBC06227	1997	-488	-4	4.1	484	0.01	0.42	14.76	15.5	0.2	4.55	-1.14	1	-	-
LO-117	1023.0	1028.0	NBC06236	1997	-383	-8	3.8	375	0.01	0.58	11.25	12	0.2	4.55	-0.57	1	-	-
LO-117	1250.0	1255.0	NBC06254	1997	14	15	9.7	1	15	0.01	0.01	0.01	0.6	13.64	0.91	2	1	118
LO-122	299.0	304.0	NBC06261	1997	-262	-3	3.4	259	0.01	0.18	7.92	8.28	0.2	4.55	-1.52	1	-	-
LO-122	384.0	389.0	NBC06279	1997	-184	23	7.8	207	0.11	0.03	6.59	6.63	1	22.73	0.99	2	-	-
LO-126	1309.0	1312.0	NBC06408	1997	-37	7	9	44	0.16	0.01	1.35	1.4	0.2	4.55	0.65	1	655	1125
LO-148	549.0	551.0	NBC05832	1997	34	35	9.8	1	35	0.01	0.01	0.01	1.2	27.27	0.78	3	30	30
LO-180	885.0	890.0	N28935	2006	54	56	9.6	2.2	25.6	-	-	0.07	-	-	-	3	160	110
LO-180	933.4	938.4	N28937	2006	38	42	9.1	4.1	10.34	-	-	0.13	-	-	-	3	290	1750
LO-180 <sup>4</sup>	938.4	941.4	N28938 <sup>4</sup>	2006	-652	20	6.5	671.9	0.03	-	-	21.5	-	-	-	2	8660	14800
LO-180	969.0	974.0	N28946	2006	-64	4	8.1	68.1	0.06	-	-	2.18	-	-	-	1	1430	2350
LO-180	1010.0	1015.0	N28953	2006	13	13	10.3	0.3	41.6	-	-	0.01	-	-	-	2	10	350
LO-180	1105.0	1110.0	N28954	2006	33	33	10	0.3	105.6	-	-	0.01	-	-	-	3	80	150
LO-180	1180.0	1185.0	N28955	2006	6	6	10.2	0.3	19.2	-	-	0.01	-	-	-	1	40	240
<b>Average:</b>					<b>-88</b>	<b>20</b>	<b>8.0</b>	<b>107.8</b>	<b>19.99</b>	<b>0.11</b>	<b>3.26</b>	<b>3.44</b>	<b>0.8</b>	<b>17.58</b>	<b>0.40</b>	<b>2</b>	<b>947</b>	<b>1774</b>
<b>Median:</b>					<b>10</b>	<b>14</b>	<b>9.3</b>	<b>1.6</b>	<b>11.67</b>	<b>0.01</b>	<b>0.01</b>	<b>0.05</b>	<b>0.4</b>	<b>9.09</b>	<b>0.76</b>	<b>2</b>	<b>60</b>	<b>204</b>

Total ANP/AGP <=3      11      42%  
Total ANP/AGP >3      15      58%

<sup>1</sup> Acid Neutralization Potential (ANP) was reported by the lab as Neutralization Potential. Analytical Method: Sobek (EPA-600) through addition of acid, heating and titration.

<sup>2</sup> Acid Generating Potential (AGP) was reported by the lab as Maximum Potential Acidity. Value determined by calculating Total Sulphur (%S) \* 31.25.

<sup>3</sup> Analytical Method: Sobek (EPA-600) through acid leaching processing and gravimetric analysis.

<sup>4</sup> Analytical Method: Sobek (EPA-600) through bromine and nitric acid digestion, followed by gravimetric analysis.

<sup>5</sup> Analytical Method: Sobek (EPA-600) through heating in a Leco induction furnace and measuring the SO<sub>2</sub> released with an Infra-red detector.

<sup>6</sup> Analytical Method: Carbon assay through heating sample in a Leco induction furnace followed by a gasometric measurement of CO<sub>2</sub>.

<sup>7</sup> Carbonate Neutralization Potential (CNP) was calculated as follows: CO<sub>2</sub>% \*(100/44)\*10

**Note 1:** The detection limit has been used for plotting samples below the detection limit (<0.01 to 0.01 for S % and <0.2 to 0.2 for CO<sub>2</sub>%)

**Note 2:** NP/MPA (ANP/AGP) values less than 3 are shaded

**Note 3:** Copper values above threshold of 290 ppm (five times average crustal abundance) are shaded

**Note 4:** Zinc values above threshold of 410 ppm (five times average crustal abundance) are shaded

**TABLE 4**  
**NIBLACK MINING CORPORATION**  
**NIBLACK PROJECT**  
**OPERATIONAL CHARACTERIZATION PLAN**  
**ACID BASE ACCOUNTING, COPPER AND ZINC DATA FOR FOOTWALL UNIT**

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M:\1102\00205\02\A\Report\4-Operational Characterization Plan\Rev 0\4-Tables - r0 .xls\Table 4

Rev'd: Apr 10/07

Hole Number	Interval		Sample Number	Source	Net Neutralization Potential (t CaCO <sub>3</sub> /1000 t)	Acid Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>1</sup>	Paste pH	Acid Generating Potential (t CaCO <sub>3</sub> /1000 t) <sup>2</sup>	ANP/AGP Ratio	Sulphate Sulphur (%S) <sup>3</sup>	Sulphide Sulphur (%S) <sup>4</sup>	Total Sulphur (%S) <sup>5</sup>	Inorganic Carbon (%CO <sub>2</sub> ) <sup>6</sup>	Carbonate Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>7</sup>	CNP/ANP Ratio	Fizz Test	Copper (ppm)	Zinc (ppm)
	From (ft)	To (ft)																
LO-102	676.0	681.0	NBC04567	1997	46	47	9.3	1	47	0.01	0.01	0.01	1.2	27.27	0.58	3	-	-
LO-104	440.0	442.0	NBC04739	1997	36	37	9.4	1	37	0.01	0.01	0.03	1.1	25.00	0.68	3	-	-
LO-107	985.0	987.0	NBC04998	1997	18	19	9.2	1	19	0.01	0.01	0.01	3.7	84.09	4.43	2	3	180
LO-107	1169.0	1171.0	NBC05051	1997	10	25	8.7	15	1.67	0.01	0.44	0.49	0.6	13.64	0.55	2	-	-
LO-107	1263.0	1265.0	NBC05054	1997	69	75	8.9	6	12.5	0.01	0.14	0.19	2.9	65.91	0.88	3	-	-
LO-108	400.0	401.0	NBC06011	1997	-54	37	8.3	91	0.41	0.02	2.79	2.9	1.5	34.09	0.92	2	230	9200
LO-108	1207.0	1208.0	NBC06066	1997	12	17	8.7	5	3.4	0.01	0.13	0.16	0.3	6.82	0.40	2	114	355
LO-111	42.0	47.0	NBC06101	1997	-54	5	8.5	59	0.08	0.02	1.86	1.9	0.2	4.55	0.91	1	10	240
LO-111	417.0	422.0	NBC06111	1997	-72	10	8.5	82	0.12	0.02	2.57	2.61	0.2	4.55	0.45	1	70	340
LO-111	499.0	504.0	NBC06114	1997	-186	18	8.1	204	0.09	0.03	6.32	6.53	0.5	11.36	0.63	2	650	200
LO-112	412.0	413.0	NBC05135	1997	52	53	9	1	53	0.01	0.01	0.01	2.2	50.00	0.94	3	18	85
LO-113	52.0	57.0	NBC06148	1997	-82	4	7	86	0.05	0.03	2.65	2.75	0.2	4.55	1.14	1	24	340
LO-113	435.0	439.0	NBC06157	1997	-63	30	8.3	93	0.32	0.01	2.97	2.99	1.1	25.00	0.83	1	13	180
LO-113	578.0	583.0	NBC06162	1997	-414	8	7.1	422	0.02	0.09	13.4	13.5	0.2	4.55	0.57	1	-	-
LO-117	166.0	171.0	NBC06183	1997	-35	33	8.3	68	0.49	0.01	2.16	2.18	1.2	27.27	0.83	2	1150	600
LO-117	255.0	260.0	NBC06185	1997	-45	27	8.3	72	0.38	0.02	2.31	2.29	0.9	20.45	0.76	2	-	-
LO-117	500.0	505.0	NBC06189	1997	-11	18	8.8	29	0.62	0.01	0.88	0.94	0.4	9.09	0.51	2	110	700
LO-117	727.0	732.0	NBC06198	1997	-93	26	8.1	119	0.22	0.02	3.76	3.81	0.5	11.36	0.44	2	-	-
LO-123	418.0	419.0	NBC06306	1997	-9	12	9.4	21	0.57	0.01	0.59	0.66	0.4	9.09	0.76	2	320	165
LO-123	633.0	634.0	NBC06309	1997	-145	27	8.6	172	0.16	0.02	5.21	5.5	0.9	20.45	0.76	2	145	4470
LO-146	993.0	995.0	NBC05802	1997	27	28	9.9	1	28	0.02	0.01	0.02	1.2	27.27	0.97	2	180	65
<b>Average:</b>					<b>-47</b>	<b>26</b>	<b>9</b>	<b>74</b>	<b>9.77</b>	<b>0.02</b>	<b>2.30</b>	<b>2.36</b>	<b>1.0</b>	<b>23.16</b>	<b>0.90</b>	<b>2</b>	<b>217</b>	<b>1223</b>
<b>Median:</b>					<b>-35</b>	<b>26</b>	<b>8.6</b>	<b>59</b>	<b>0.49</b>	<b>0.01</b>	<b>1.86</b>	<b>1.9</b>	<b>0.9</b>	<b>20.45</b>	<b>0.76</b>	<b>2</b>	<b>112</b>	<b>290</b>

**Total ANP/AGP =<3**      14      67%  
**Total ANP/AGP |>3**      7      33%

- <sup>1</sup> Acid Neutralization Potential (ANP) was reported by the lab as Neutralization Potential. Analytical Method: Sobek (EPA-600) through addition of acid, heating and titration.
- <sup>2</sup> Acid Generating Potential (AGP) was reported by the lab as Maximum Potential Acidity. Value determined by calculating Total Sulphur (%S) \* 31.25.
- <sup>3</sup> Analytical Method: Sobek (EPA-600) through acid leaching processing and gravimetric analysis.
- <sup>4</sup> Analytical Method: Sobek (EPA-600) through bromine and nitric acid digestion, followed by gravimetric analysis.
- <sup>5</sup> Analytical Method: Sobek (EPA-600) through heating in a Leco induction furnace and measuring the SO<sub>2</sub> released with an Infra-red detector.
- <sup>6</sup> Analytical Method: Carbon assay through heating sample in a Leco induction furnace followed by a gasometric measurement of CO<sub>2</sub>.
- <sup>7</sup> Carbonate Neutralization Potential (CNP) was calculated as follows: CO<sub>2</sub>% \*(100/44)\*10

- Note 1:** The detection limit has been used for plotting samples below the detection limit (<0.01 to 0.01 for S % and <0.2 to 0.2 for CO<sub>2</sub>%)
- Note 2:** NP/MPA (ANP/AGP) values less than 3 are shaded
- Note 3:** Copper values above threshold of 290 ppm (five times average crustal abundance) are shaded
- Note 4:** Zinc values above threshold of 410 ppm (five times average crustal abundance) are shaded

TABLE 5

NIBLACK MINING CORPORATION  
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OPERATIONAL CHARACTERIZATION PLAN  
ACID BASE ACCOUNTING, COPPER AND ZINC DATA FOR NON-PAG (ANP/AGP >3) ROCK SAMPLES

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Rev'd: Apr 10/07

M:\1\02\00205\02A\Report\4-Operational Characterization Plan\Rev 0\4-Tables - r0\_xls\Table 5

Hole Number	Interval		Sample Number	Unit	Net		Paste pH	Acid		ANP/AGP Ratio	Sulphate Sulphur (%S) <sup>1</sup>	Sulphide Sulphur (%S) <sup>2</sup>	Total Sulphur (%S) <sup>3</sup>	Inorganic Carbon (%CO <sub>2</sub> ) <sup>6</sup>	Carbonate		CNP/ANP Ratio	Fizz Test	Copper (ppm)	Zinc (ppm)
	From (ft)	To (ft)			Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>4</sup>	Acid Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>5</sup>		Generating Potential (t CaCO <sub>3</sub> /1000 t) <sup>5</sup>	Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>7</sup>						Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>7</sup>					
LO-126	1460.0	1463.0	NBC06429	HW	7	10	9.6	3	3.33	0.01	0.07	0.1	0.2	4.55	0.45	1	95	100		
LO-108	1207.0	1208.0	NBC06066	FW	12	17	8.7	5	3.4	0.01	0.13	0.16	0.3	6.82	0.40	2	114	355		
LO-180	395.0	400.0	N28923	HW	15	20	9	5	4	-	-	0.16	-	-	-	2	60	120		
LO-180	345.0	350.0	N28922	HW	34	44	9.4	10.3	4.27	-	-	0.33	-	-	-	3	270	100		
Surface grab			NBS06113	HW	5	7	8.5	1.6	4.48	-	-	0.05	-	-	-	1	70	110		
Surface grab			NBS06103	HW	6	5.4	1.3	2.2	5.49	-	-	0.07	-	-	-	1	80	210		
Surface grab			NBS06108	HW	10	12	8.6	2.2	5.49	-	-	0.07	-	-	-	2	80	90		
Surface grab			NBS06115	HW	10	12	8.6	2.2	5.49	-	-	0.13	-	-	-	1	60	150		
LO-180	725.0	730.0	N28931	HW	22	26	9.2	4.1	6.4	-	-	0.13	-	-	-	1	50	140		
LO-180	834.0	839.0	N28933	HW	22	26	9.3	4.1	6.4	-	-	0.13	-	-	-	1	60	140		
LO-180	450.0	455.0	N28924	HW	35	41	9.6	5.9	6.91	-	-	0.19	-	-	-	1	240	100		
LO-148	962.0	964.0	NBC05847	HW	66	77	9.2	11	7	0.01	0.27	0.34	2.8	63.64	0.83	3	50	125		
LO-113	1221.0	1224.0	NBC06180	HW	14	16	9	2	9	0.02	0.02	0.07	0.5	11.36	0.71	3	170	108		
Surface grab			NBS06107	HW	31	35	8.7	4.1	8.62	-	-	0.13	-	-	-	2	30	150		
LO-180	32.0	35.0	N28916	HW	40	45	9.2	5	9	-	-	0.16	-	-	-	2	40	90		
LO-113	915.0	920.0	NBC06177	LO	8	9	9.7	1	9	-	-	0.01	0.4	-	-	2	6	102		
Surface grab			NBS06114	HW	8	9	8.4	0.9	9.6	0.01	0.01	0.03	-	-	9.09	1.01	2	200	110	
LO-180	933.4	938.4	N28937	LO	38	42	9.1	4.1	10.34	-	-	0.13	-	-	-	1	290	1750		
LO-102	700.0	702.0	NBCA09	HW	64	70	9.8	6	11.67	-	-	0.169935	1.9	-	-	3	20	50		
LO-107	1263.0	1265.0	NBC05054	FW	69	75	8.9	6	12.5	0.01	0.14	0.01	2.9	65.91	0.88	3	20	50		
Surface grab			NBS06110	HW	4	4	9.1	0.3	12.8	-	-	0.01	0.3	6.82	0.52	1	6	167		
LO-08	655.0	657.0	NBC06031	LO	12	13	9.3	1	13	0.02	0.01	0.01	0.3	-	-	1	40	110		
LO-084	670.0	672.0	NBCA01	HW	12	13	9.4	1	13	-	-	0.19	-	-	-	1	40	110		
LO-180	502.0	507.0	N28927	HW	77	83	9.4	5.9	13.98	-	-	0.02	-	-	-	3	140	110		
Surface grab			NBS06116	HW	8	9	8.5	0.6	14.4	-	-	0.01	-	-	-	1	140	110		
LO-092	480.0	482.0	NBCA06	HW	14	15	9.6	1	15	-	-	0.01	-	-	-	1	-	-		
LO-109	950.0	952.0	NBCA12	HW	14	15	9.4	1	15	-	-	0.01	-	-	-	1	-	-		
LO-117	1250.0	1255.0	NBC06254	LO	14	15	9.7	1	15	0.01	0.01	0.01	0.6	13.64	0.91	1	1	118		
LO-180	675.0	680.0	N28930	HW	180	191	9.4	11.3	16.98	-	-	0.36	-	-	-	1	50	110		
LO-107	985.0	987.0	NBC04998	FW	18	19	9.2	1	19	0.01	0.01	0.01	3.7	84.09	4.43	3	180	180		
LO-180	1180.0	1185.0	N28955	LO	6	6	10.2	0.3	19.2	-	-	0.01	-	-	-	1	40	240		
LO-106	850.0	852.0	NBCA11	HW	117	123	9.2	6	20.5	-	-	0.160323	0.18	-	-	1	3	240		
LO-180	885.0	890.0	N28935	LO	54	56	9.6	2.2	25.6	-	-	0.07	-	-	-	4	160	110		
LO-096	260.0	265.0	NBC04248	LO	26	27	9.2	1	27	0.01	0.01	0.01	0.9	20.45	0.76	1	-	-		
LO-119	490.0	492.0	NBCA15	HW	26	27	9.4	1	27	-	-	0.01	-	-	-	1	-	-		
LO-103	806.0	808.0	NBCA10	HW	26	27	9.5	1	27	-	-	0.01	0.2	-	-	1	-	-		
LO-104	301.0	303.0	NBC04720	LO	27	28	9.4	1	28	0.01	0.01	0.01	0.8	18.18	0.65	1	-	-		
LO-146	993.0	995.0	NBC05802	FW	27	28	9.9	1	28	0.02	0.01	0.02	1.2	27.27	0.97	1	180	65		
LO-104	253.0	255.0	NBC04719	LO	33	34	9.5	1	34	0.01	0.01	0.01	1.1	25.00	0.74	1	-	-		
LO-180	79.0	80.0	N28917	HW	42	43	9.4	1.3	34.4	-	-	0.04	-	-	-	1	240	100		
LO-148	549.0	551.0	NBC05832	LO	34	35	9.8	1	35	0.01	0.01	0.01	1.2	27.27	0.78	3	30	30		
LO-180	625.0	630.0	N28925	HW	122	125	9.8	3.4	36.36	-	-	0.11	-	-	-	1	40	70		
LO-096	373.0	378.0	NBC04250	LO	37	37	9.6	1	37	0.01	0.01	0.01	1.7	38.64	1.04	1	-	-		
LO-104	440.0	442.0	NBC04739	FW	36	37	9.4	1	37	0.01	0.01	0.03	1.1	25.00	0.68	1	-	-		
LO-180	1010.0	1015.0	N28953	LO	13	13	10.3	0.3	41.6	-	-	0.01	-	-	-	1	10	350		
Surface grab			NBS06102	HW	40	41	9.1	0.9	43.73	-	-	0.03	-	-	-	2	580	80		
Surface grab			NBS06104	HW	7	7	9.6	0.3	44.8	-	-	0.01	-	-	-	1	70	70		
Surface grab			NBS06105	HW	7	7	8.8	0.3	44.8	-	-	0.01	-	-	-	1	20	80		
LO-090	720.0	722.0	NBCA05	HW	45	46	9.4	1	46	-	-	0.01	-	-	-	1	-	-		
LO-102	676.0	681.0	NBC04567	FW	46	47	9.3	1	47	0.01	0.01	0.01	1.2	27.27	0.58	1	-	-		
Surface grab			NBS06109	HW	15	15	8.6	0.3	48	-	-	0.01	-	-	-	1	50	120		
LO-090	650.0	652.0	NBCA04	HW	48	49	9.5	1	49	-	-	0.01	-	-	-	1	-	-		
LO-112	412.0	413.0	NBC05135	FW	52	53	9	1	53	0.01	0.01	0.01	2.2	50.00	0.94	3	18	85		
LO-107	683.0	688.0	NBC04940	LO	54	55	9.3	1	55	0.01	0.01	0.02	2	45.45	0.83	3	-	-		
LO-115	400.0	402.0	NBCA11	HW	60	61	9.3	1	61	-	-	0.01	-	-	-	1	-	-		
LO-104	32.0	34.0	NBC04713	LO	63	64	9.6	1	64	0.01	0.01	0.01	3.1	70.45	1.10	3	-	-		
LO-122	83.0	84.0	NBC06255	HW	65	66	8.8	1	66	0.01	0.01	0.03	2.8	63.64	0.96	3	182	100		
LO-099	550.0	552.0	NBCA08	HW	65	66	9.3	1	66	-	-	0.01	-	-	-	1	-	-		
LO-145	1153.0	1154.0	NBC07322	HW	71	72	9.3	1	72	0.01	0.01	0.01	2.5	56.82	0.79	3	95	85		
LO-148	858.0	862.0	NBC05844	HW	87	88	9	1	88	0.01	0.01	0.04	3.3	75.00	0.85	3	120	320		
LO-180	1105.0	1110.0	N28954	LO	33	33	10	0.3	105.6	-	-	0.01	-	-	-	3	80	150		
LO-180	565.0	570.0	N28928	HW	66	67	9.4	0.6	107.2	-	-	0.02	-	-	-	3	160	100		
LO-115	500.0	502.0	NBCA14	HW	107	108	9.4	1	108	-	-	0.01	-	-	-	3	-	-		
Surface grab			NBS06101	HW	37	37	8.9	0.3	116.4	-	-	0.01	-	-	-	2	260	120		
LO-107	126.0	129.0	NBC04901	HW	142	143	8.9	1	143	0.01	0.01	0.01	5.1	115.91	0.81	4	4	78		
LO-108	129.0	130.0	NBC06002	HW	144	145	8.9	1	145	0.01	0.01	0.01	5.9	134.09	0.92	4	6	84		
LO-108	348.0	349.0	NBC06008	HW	183	184	8.9	1	184	0.01	0.01	0.01	7.3	165.91	0.90	4	81	84		
LO-108	467.0	468.0	NBC06014	HW	193	194	8.3	1	194	0.01	0.01	0.01	7.7	175.00	0.90	4	14	81		
Surface grab			NBS06111	HW	31	31	9.3	0.3	198.4	-	-	0.01	-	-	-	2	70	80		
LO-102	57.0	60.0	NBC04530	HW	199	200	9.3	1	200	0.01	0.01	0.04	9.2	209.09	1.05	3	-	-		
LO-180	125.0	130.0	N28918	HW	102	102	9.6	0.3	326.4	-	-	0.01	-	-	-	3	80	80		
LO-180	280.0	285.0	N28921	HW	54	54	9.9	0.3	345.6	-	-	0.01	-	-	-	3	80	90		
LO-180	205.0	210.0	N28920	HW	68	68	9.9	0.3	435.2	-	-	0.01	-	-	-	3	50	50		
LO-180	175.0	180.0	N28919	HW	134	134	9.8	0.3	857.6	-	-	0.01	-	-	-	3	90	100		
Average:					50	52	9.2	2.1	68.42	0.01	0.03	0.06	2.6	58.44	1.12	2	97	151		
Median:					35.5	37	9.3	1	28	0.01	0.01	0.01	1.85	42.05	1.14	2.5	70	100		

<sup>1</sup> Acid Neutralization Potential (ANP) was reported by the lab as Neutralization Potential. Analytical Method: Sobek (EPA-600) through addition of acid, heating and titration.

<sup>2</sup> Acid Generating Potential (AGP) was reported by the lab as Maximum Potential Acidity. Value determined by calculating Total Sulphur (%S) \* 31.25.

<sup>3</sup> Analytical Method: Sobek (EPA-600) through acid leaching processing and gravimetric analysis.

<sup>4</sup> Analytical Method: Sobek (EPA-600) through bromine and nitric acid digestion, followed by gravimetric analysis.

TABLE 6

NIBLACK MINING CORPORATION  
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OPERATIONAL CHARACTERIZATION PLAN  
ACID BASE ACCOUNTING, COPPER AND ZINC DATA FOR PAG (ANP/AGP <=3) ROCK SAMPLES

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M:\1\02\00205\02\VA\Report\4-Operational Characterization Plan\Rev 0\4-Tables - r0 .xls\Table 6

Hole Number	Interval		Sample Number	Unit	Net Neutralization Potential (t CaCO <sub>3</sub> /1000 t)	Acid Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>1</sup>	Paste pH	Acid Generating Potential (t CaCO <sub>3</sub> /1000 t) <sup>2</sup>	ANP/AGP Ratio	Sulphate Sulphur (%S) <sup>3</sup>	Sulphide Sulphur (%S) <sup>4</sup>	Total Sulphur (%S) <sup>5</sup>	Inorganic Carbon (%CO <sub>2</sub> ) <sup>6</sup>	Carbonate Neutralization Potential (t CaCO <sub>3</sub> /1000 t) <sup>7</sup>	CNP/ANP Ratio	Fizz Test	Copper (ppm)	Zinc (ppm)
	From (ft)	To (ft)																
LO-088	530.0	532.0	NBCA03	HW	6	11	9.5	5	2.2	-	0.1411	0.16	-	-	-	1	-	-
LO-095	450.0	452.0	NBCA07	HW	-149	10	8.9	159	0.06	-	4.87005	5.08	-	-	-	1	-	-
LO-099	226.0	229.4	NBC04358	LO	-171	-2	4.5	169	0.01	0.43	4.54	5.41	0.2	4.55	-2.27	1	-	-
LO-102	165.0	170.0	NBC04537	LO	-26	1	6.4	27	0.04	0.03	0.81	0.85	0.2	4.55	4.55	1	-	-
LO-107	1169.0	1171.0	NBC05051	FW	10	25	8.7	15	1.67	0.01	0.44	0.49	0.6	13.64	0.55	2	-	-
LO-108	400.0	401.0	NBC06011	FW	-54	37	8.3	91	0.41	0.02	2.79	2.9	1.5	34.09	0.92	2	230	9200
LO-111	42.0	47.0	NBC06101	FW	-54	5	8.5	59	0.08	0.02	1.86	1.9	0.2	4.55	0.91	1	10	240
LO-111	417.0	422.0	NBC06111	FW	-72	10	8.5	82	0.12	0.02	2.57	2.61	0.2	4.55	0.45	1	70	340
LO-111	499.0	504.0	NBC06114	FW	-186	18	8.1	204	0.09	0.03	6.32	6.53	0.5	11.36	0.63	2	650	200
LO-111	831.0	834.0	NBC06129	LO	-226	5	6.8	231	0.02	0.06	7.06	7.39	0.2	4.55	0.91	1	-	-
LO-111	1021.0	1024.0	NBC06141	LO	-252	-2	4.3	250	0.01	0.18	7.59	8	0.2	4.55	-2.27	1	-	-
LO-111	1081.0	1084.0	NBC06145	HW	11	17	9.5	6	2.83	0.02	0.17	0.2	0.5	11.36	0.67	2	28	60
LO-113	52.0	57.0	NBC06148	FW	-82	4	7	86	0.05	0.03	2.65	2.75	0.2	4.55	1.14	1	24	340
LO-113	435.0	439.0	NBC06157	FW	-63	30	8.3	93	0.32	0.01	2.97	2.99	1.1	25.00	0.83	1	13	180
LO-113	578.0	583.0	NBC06162	FW	-414	8	7.1	422	0.02	0.09	13.4	13.5	0.2	4.55	0.57	1	-	-
LO-117	166.0	171.0	NBC06183	FW	-35	33	8.3	68	0.49	0.01	2.16	2.18	1.2	27.27	0.83	2	1150	600
LO-117	255.0	260.0	NBC06185	FW	-45	27	8.3	72	0.38	0.02	2.31	2.29	0.9	20.45	0.76	2	-	-
LO-117	500.0	505.0	NBC06189	FW	-11	18	8.8	29	0.62	0.01	0.88	0.94	0.4	9.09	0.51	2	110	700
LO-117	727.0	732.0	NBC06198	FW	-93	26	8.1	119	0.22	0.02	3.76	3.81	0.5	11.36	0.44	2	-	-
LO-117	991.0	996.0	NBC06227	LO	-488	-4	4.1	484	0.01	0.42	14.76	15.5	0.2	4.55	-1.14	1	-	-
LO-117	1023.0	1028.0	NBC06236	LO	-383	-8	3.8	375	0.01	0.58	11.25	12	0.2	4.55	-0.57	1	-	-
LO-122	299.0	304.0	NBC06261	LO	-262	-3	3.4	259	0.01	0.18	7.92	8.28	0.2	4.55	-1.52	1	-	-
LO-122	384.0	389.0	NBC06279	LO	-184	23	7.8	207	0.11	0.03	6.59	6.63	1	22.73	0.99	2	-	-
LO-123	418.0	419.0	NBC06306	FW	-9	12	9.3	21	0.57	0.01	0.59	0.66	0.4	9.09	0.76	2	320	165
LO-123	633.0	634.0	NBC06309	FW	-145	27	8.6	172	0.16	0.02	5.21	5.5	0.9	20.45	0.76	2	145	4470
LO-123	1368.0	1369.0	NBC06331	HW	8	20	9.3	12	1.67	0.01	0.33	0.39	0.5	11.36	0.57	2	85	115
LO-126	1309.0	1312.0	NBC06408	LO	-37	7	9	44	0.16	0.01	1.35	1.4	0.2	4.55	0.65	1	655	1125
LO-180	969.0	974.0	N28946	LO	-64	4	8.1	68.1	0.06	-	-	2.18	-	-	-	1	1430	2350
LO-180 <sup>4</sup>	938.4	941.4	N28938 <sup>4</sup>	LO	-652	20	6.5	671.9	0.03	-	-	21.5	-	-	-	2	8660	14800
Surface grab			NBS06106	HW	-8	13	8.8	20.6	0.63	-	-	0.66	-	-	-	2	130	80
Surface grab			NBS06112	HW	1	3	8.2	1.9	1.6	-	-	0.06	-	-	-	1	20	110
<b>Average:</b>					<b>-133</b>	<b>13</b>	<b>7.6</b>	<b>145.9</b>	<b>0.47</b>	<b>0.09</b>	<b>4.27</b>	<b>4.67</b>	<b>0.5</b>	<b>11.27</b>	<b>0.42</b>	<b>1</b>	<b>808</b>	<b>2063</b>
<b>Median:</b>					<b>-64</b>	<b>11</b>	<b>8.3</b>	<b>86</b>	<b>0.12</b>	<b>0.02</b>	<b>2.79</b>	<b>2.75</b>	<b>0.4</b>	<b>9.09</b>	<b>0.65</b>	<b>1</b>	<b>130</b>	<b>340</b>
																	<b>Average (excluding N28938):</b>	
																	<b>Median (excluding N28938):</b>	
																	<b>317</b>	<b>1267</b>
																	<b>120</b>	<b>290</b>

<sup>1</sup> Acid Neutralization Potential (ANP) was reported by the lab as Neutralization Potential. Analytical Method: Sobek (EPA-600) through addition of acid, heating and titration.

<sup>2</sup> Acid Generating Potential (AGP) was reported by the lab as Maximum Potential Acidity. Value determined by calculating Total Sulphur (%S) \* 31.25.

<sup>3</sup> Analytical Method: Sobek (EPA-600) through acid leaching processing and gravimetric analysis.

<sup>4</sup> Analytical Method: Sobek (EPA-600) through bromine and nitric acid digestion, followed by gravimetric analysis.

<sup>5</sup> Analytical Method: Sobek (EPA-600) through heating in a Leco induction furnace and measuring the SO<sub>2</sub> released with an Infra-red detector.

<sup>6</sup> Analytical Method: Carbon assay through heating sample in a Leco induction furnace followed by a gasometric measurement of CO<sub>2</sub>.

<sup>7</sup> Carbonate Neutralization Potential (CNP) was calculated as follows: CO<sub>2</sub>% \*(100/44)\*10

**Note 1:** The detection limit has been used for plotting samples below the detection limit (<0.01 to 0.01 for S % and <0.2 to 0.2 for CO<sub>2</sub>%)

**Note 2:** NP/MPA (ANP/AGP) values less than 3 are shaded

**Note 3:** Copper values above threshold of 290 ppm (five times average crustal abundance) are shaded

**Note 4:** Zinc values above threshold of 410 ppm (five times average crustal abundance) are shaded

**TABLE 7**

**NIBLACK MINING CORPORATION  
NIBLACK PROJECT**

**OPERATIONAL CHARACTERIZATION PLAN  
WASTE ROCK PRODUCTION SCHEDULE**

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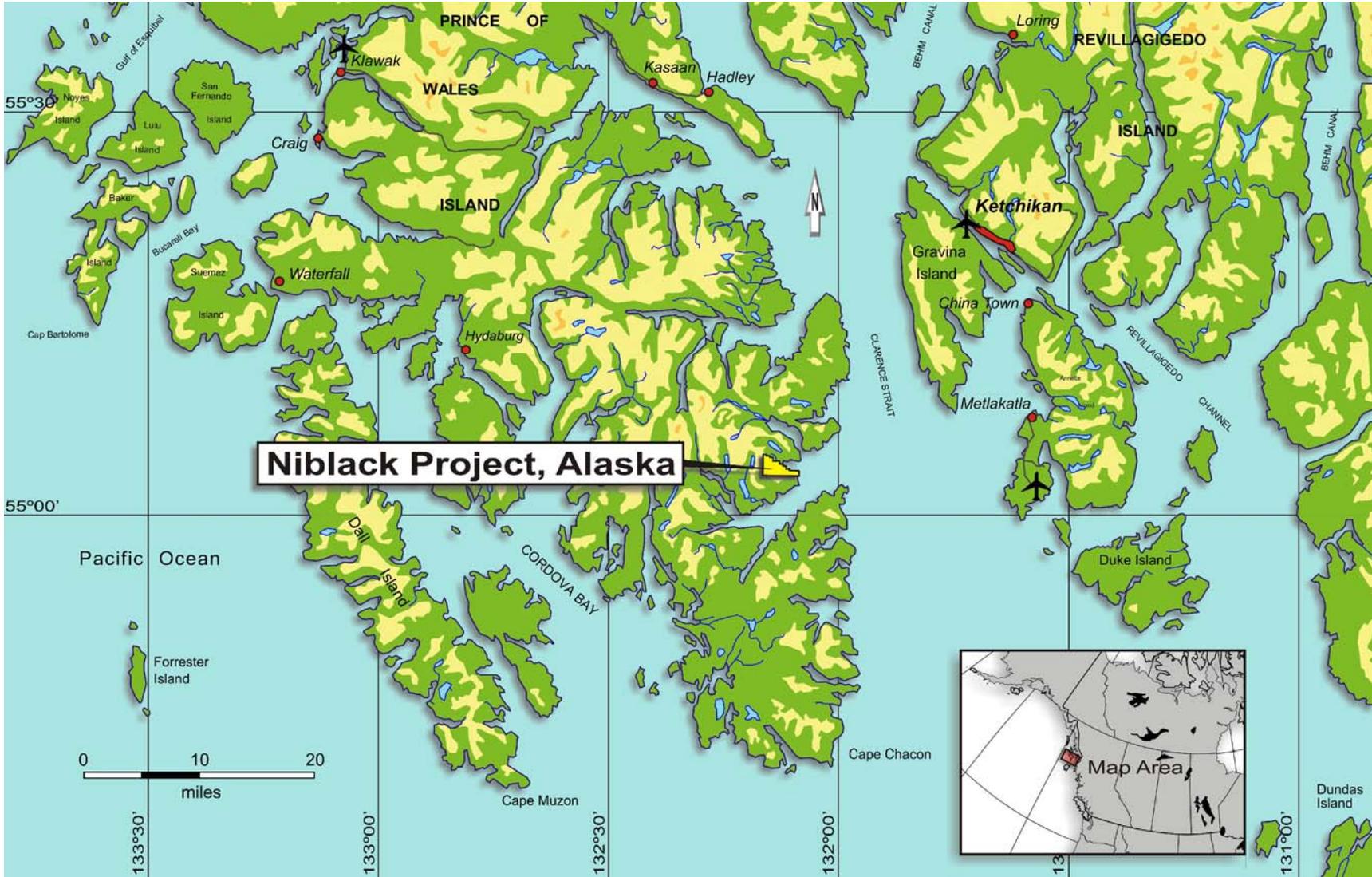
Rev'd: Apr 10/07

M:\1\02\00205\02\A\Report\4-Operational Characterization Plan\Rev 0\4-Tables - r0 .xls]Table 7

Unit	Tunnel Lengths					Volumes		
	Main Access Tunnel (ft)	Hanging Wall Drift (ft)	Footwall Drift (ft)	Mammoth Drift (ft)	Total length in each formation (ft)	Volume in situ <sup>1</sup> (ft <sup>3</sup> )	Volume in situ <sup>2</sup> (yd <sup>3</sup> )	Volume as waste <sup>3</sup> (yd <sup>3</sup> )
<b>Hanging Wall</b>	2,500	--	940	1,000	4,440	839,160	31,385	<b>45,508</b>
<b>Lookout</b>	275	--	--	--	275	51,975	1,944	<b>2,819</b>
<b>Foot Wall</b>	85	1,140	--	--	1,225	231,525	8,659	<b>12,556</b>
<b>Totals:</b>	2,860	1,140	940	1,000	5,940	1,122,660	41,987	<b>60,882</b>

**Notes:**

1. Nominal 13.5 X 14 ft tunnel dimension - multiply linear footage totals by 189 to get cubic footage (unbroken).
2. Volume in cubic yards = cubic ft \* 0.0374.
3. Waste volume assumes 45% expansion of waste relative to in-situ volume.

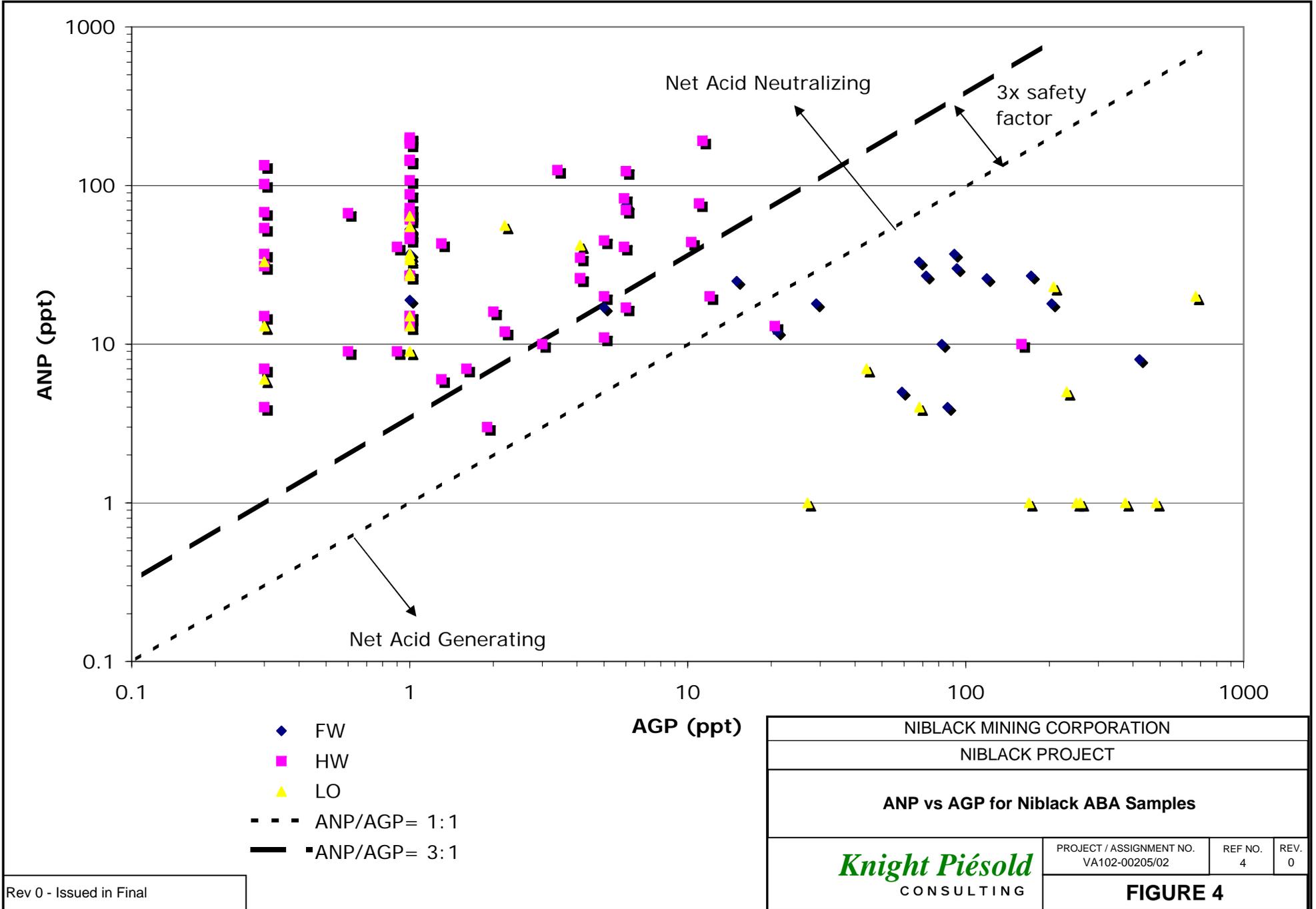


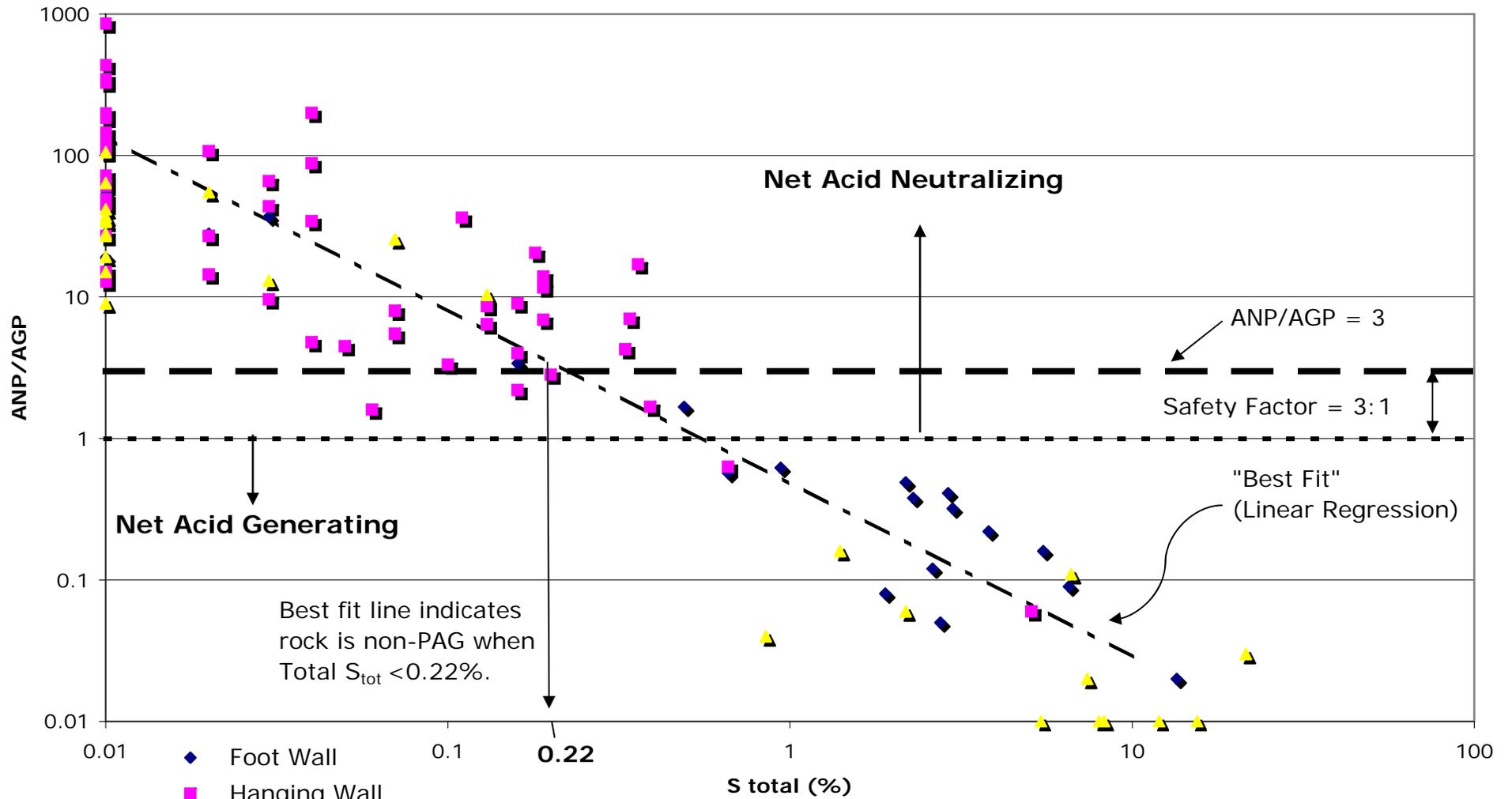
VANCOUVER B.C. CAD FILE: M:\1\02\00205\02\Acad\Figs\Fig2.dwg PLOT: 1=1(FS) Apr 12 2007 by:rschizor

NIBLACK MINING CORP.	
PROPOSED EXPLORATION PROGRAM	
LOCATION MAP	
	PROJECT/ASSIGNMENT NO. VA102-205/2
	REF. NO. 4
<b>FIGURE 1</b>	
REV. 0	REV. 0









Net Acid Generating

Net Acid Neutralizing

ANP/AGP = 3  
Safety Factor = 3:1

"Best Fit"  
(Linear Regression)

Best fit line indicates  
rock is non-PAG when  
Total S<sub>tot</sub> < 0.22%.

- ◆ Foot Wall
- Hanging Wall
- ▲ Lookout
- ✱ Lithology
- ANP/AGP = 3:1
- - - ANP/AGP = 1:1
- · - · Best Fit Line

NIBLACK MINING CORPORATION			
NIBLACK PROJECT			
Predicting ANP/AGP Ratio from Total Sulphur Analysis for Niblack ABA Samples			
<i>Knight Piésold</i> CONSULTING	PROJECT / ASSIGNMENT NO. VA102-00205/02	REF NO. 4	REV. 0
	<b>FIGURE 5</b>		

## **APPENDIX A**

### **ANALYTICAL METHODS**

- Appendix A1 Collecting, Compositing and Preparation of Rock Samples (page A1-1)
- Appendix A2 Acid-Base Accounting – Laboratory Method (pages A2-1 to A2-4)
- Appendix A3 Static Net Acid Generating (NAG) Test - Field (pages A3-1 to A3-5)
- Appendix A4 Total Soluble Sulfur in Rock by Leachable Sulfate S – Field (page A4-1)
- Appendix A5 Humidity Cell Operation and Sampling (pages A5-1 to A5-6)

**APPENDIX A1**

COLLECTING, COMPOSITING AND PREPARATION OF ROCK SAMPLES

(Pages A1-1)

## APPENDIX A1

### Collection, Compositing and Preparation of Rock Samples

**Goal:**

Obtain a single sample that is representative of the waste rock that will be produced by tunnel excavation over each blast interval (~10-12 feet of tunnel advance, typically 2 per day) and that is suitable for chemical analysis (<75 um particles).

**Methods:**

Two sources of material are proposed for obtaining representative composite samples of waste rock:

1. Drill-hole cuttings, collected directly from the fragments produced by multiple holes prior to blasting, and
2. Muck (i.e., blasted rock) or “cut-channel samples” (i.e., taken from the face and resulting ribs of the tunnel face)

In either case, the sample is collected to represent the material associated with a single blast interval.

The compositing and handling is essentially identical for both methods. Each composite sample should be made of 5 discreet sub-samples, where each sub-sample weighs 2-pounds (+/- ~0.3 pounds), producing a total sample weight of 10 +/- 1.5 pounds. Each sub-sample should be unbiased as to particle size, except as necessary to avoid collecting samples larger than the sample preparation crusher can accommodate (e.g., <~8 cm diameter). These sub-samples should, to the extent possible, be spatially representative of the target material. For drill hole samples or “cut-channel samples,” this means collecting from drill holes that are spatially separated across the face of the tunnel. For muck samples, the composites should be collected from locations dispersed across the width of the blasted zone. The result is a 10 -pound composite sample of coarse (~ 8 cm and smaller) waste rock.

The sample will be crushed first to < 10 mm using a jaw crusher<sup>1</sup>, then crushed to < 4 mm with a smaller crusher, and then a final ~250-g sample crushed to < 75 um using an electric mortar and pestle or ball mill<sup>2</sup>.

---

<sup>1</sup> Jaw crushers available from Sanger (<http://www.sanger.net/>)

<sup>2</sup> Mortar and pestle available from Fischer Scientific, <https://www1.fishersci.com/index.jsp>, and bench-top ball mills are available from Spex, Inc., <http://www.spexcsp.com/>.

**APPENDIX A2**

**ACID-BASE ACCOUNTING – LABORATORY METHOD**

(Pages A2-1 to A2-4)

## APPENDIX A2

### Acid/Base Accounting - Laboratory Method

(This method is from ALS Chemex laboratory)

#### Static Test – Acid/Base Accounting Packages

The acid rock drainage static test has been designed to measure the balance between potentially acid-generating minerals (maximum potential acidity) and acid-neutralizing minerals (neutralization potential) in a sample. This procedure, known as Acid/Base Accounting (ABA), yields a figure known as Net Neutralization Potential (NNP), which determines whether a particular sample will theoretically generate acidity over time. Depending on the parameters included, there are different options of the static test.

**Method Code: OA-VOL08**

Parameter	Symbol	Units	Lower Limit	Upper Limit
Net Neutralization Potential	NNP	t CaCO <sub>3</sub> /1000 t ore	1	1000
Neutralization Potential	NP	t CaCO <sub>3</sub> /1000 t ore	1	1000
Maximum Potential Acidity	MPA	t CaCO <sub>3</sub> /1000 t ore	0.5	2000
Fizz Rating	-	Unity	1	4
Ratio (NP:MPA)	NP:MPA	Unity	0.01	1000

#### Neutralization Potential

Approximately 0.5 g of sample is treated with 1 or 2 drops of 25% HCl to determine its “fizz rating”, which determines the volume and normality of HCl to be used in the titration. A 2.0 g sample is then treated with the appropriate volume and normality of HCl by gentle heating until reaction is complete, followed by the addition of carbon-dioxide free de-ionized water and a one minute boiling period. The solution is covered tightly to cool, then titrated with the appropriate normality of sodium hydroxide solution until the pH reading remains at 7.0 for at least 30 seconds.

The Neutralization Potential is expressed as “tonnes CaCO<sub>3</sub> equivalent per 1000 tonnes of material”.

Calculation: Neutralization Potential (NP) =  $50a[x-(b/a)y]/c$

Where:

- a = normality of HCl
- b = normality of NaOH
- c = sample weight in g
- x = volume of HCl added (mL)
- y = volume of NaOH added (mL) to pH 7.0

### Maximum Potential Acidity

The sample is analyzed for Total Sulfur using a Leco sulfur analyzer. The Maximum Potential Acidity (MPA) is calculated by multiplying the Total Sulfur result by 31.25.

MPA (tonnes CaCO<sub>3</sub> equivalent per 1000 tonnes of material) = % Total Sulfur x 31.25

### Fizz Test

Before performing the analysis for Neutralization Potential, the sample must be rated as to its carbonate content in order to determine the volume and normality of hydrochloric acid to be used in the analysis. This is done by conducting a “fizz test”. Approximately 0.5 g of sample is treated with one or two drops of 1:3 HCl and the degree of fizzing is assessed. The following table outlines the volume and normality of hydrochloric acid to be used with each “fizz rating”.

Fizz Rating	Volume (mL) of HCl to be used	Normality of HCl to be used
None (1)	20	0.1 N
Slight (2)	40	0.1N
Moderate (3)	40	0.5 N
Strong (4)	80	0.5 N

### Paste pH

**Method Code: OA-ELE07**

Parameter	Units	Lower Limit	Upper Limit
pH	Unity	0.1	14

Approximately 10 g of sample is allowed to become saturated with water by adding approximately 5 mL of de-ionized water to the sample without stirring. More water can be added as required to saturate the sample. The sample is then stirred and adjusted to the required consistency with additional de-ionized water. The pH of the paste is then measured by a pH electrode in combination with a pH meter.

### Total Sulfur

**Method Code: S-IR08**

Parameter	Symbol	Units	Lower Limit	Upper Limit
Total Sulfur	S	%	0.01	50

The sample is analyzed for Total Sulfur using a Leco sulfur analyzer. The sample (0.01 to 0.5 g) is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

**Sulfide Sulfur****Method Code: S-IR07 (method used to determine sulfide sulfur in 'A' packages)**

Parameter	Symbol	Units	Lower Limit	Upper Limit
Sulfide Sulfur	S	%	0.01	10

A prepared sample is selectively leached by converting metal sulfide to insoluble carbonates and soluble sulfate by heating with sodium carbonate solution. The resulting insoluble carbonates are removed by filtration and the sulfide residue is washed free of carbonate solution and analyzed by a Leco sulfur analyzer.

**HCl-Leachable Sulfate****Method Code: S-GRA06a**

Parameter	Symbol	Units	Lower Limit	Upper Limit
Sulfate Sulfur	S	%	0.01	50

A prepared sample (0.2 to 1.0 g) is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and calculated as %S (of the HCl-leachable sulfate) in the original sample.

**Sulfide Sulfur****Method Code: S-CAL06a**

Parameter	Symbol	Units	Lower Limit	Upper Limit
Sulfide Sulfur	S	%	0.01	50

Sulfide Sulfur (%S) is calculated by subtracting the Sulfate (%S) obtained from the HCl Leach from the Total Sulfur (%S) obtained from the Leco analyzer.

**Total Sulfate (Carbonate Leach)****Method Code: S-GRA06**

Parameter	Symbol	Units	Lower Limit	Upper Limit
Total Sulfate	S	%	0.01	50

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and calculated as %S (of total sulfate) in the original sample.

**Sulfide Sulfur****Method Code: S-CAL06**

Parameter	Symbol	Units	Lower Limit	Upper Limit
Sulfide Sulfur	S	%	0.01	50

Sulfide Sulfur (%S) is calculated by subtracting the Sulfate (%S) obtained from the Carbonate Leach from the Total Sulfur (%S) obtained from the Leco analyzer.

**Inorganic Carbon (CO<sub>2</sub>)****Method Code: C-GAS05**

Parameter	Symbol	Units	Lower Limit	Upper Limit
Inorganic Carbon	CO <sub>2</sub>	%	0.2	50.0

A prepared sample (0.01 – 0.03 g) is acidified in a heated reaction vessel to evolve inorganic carbon as carbon dioxide. Carbon Dioxide free air is then used to move the evolved carbon dioxide into the CO<sub>2</sub> coulometer.

In the coulometer, CO<sub>2</sub> is quantitatively absorbed and reacts with monoethanolamine to form a titratable acid, which causes the colour of the solution to fade. A photodetector is used to measure the change in colour as percent transmittance, and from this value µg of carbon dioxide are calculated.

**APPENDIX A3**

STATIC NET ACID GENERATING (NAG) TEST - FIELD

(Pages A3-1 to A3-5)

## APPENDIX A3

### Static Net Acid Generating (NAG) Test - Field

The Static NAG Test presented here follows the method presented by Miller et al., 1997. The abbreviated plan presented here is from CANTEST Laboratory (formerly Vison SciTech), Vancouver, BC, Canada.

#### Procedure

##### Introduction

The oxidation of iron sulphide minerals, such as pyrite ( $\text{FeS}_2$ ), is responsible for the majority of acid production by mine wastes. Acidic flow which is not neutralized within the mine waste will exit as acid rock drainage (ARD).

The NAG test provides a direct assessment of the potential for a material to produce acid after a period of exposure and weathering and is used to refine the results of the theoretical Acid Base Accounting (ABA) predictions.

The purpose of the Standard Operating Procedure (SOP) describes the procedures to determine the potential acid generation of solid materials after complete oxidation with hydrogen peroxide and titration with sodium hydroxide. The amount of NaOH needed is equivalent to the Net Acid Generation (NAG) of the material and it is expressed in kg of  $\text{H}_2\text{SO}_4$  per metric tonne.

This method is based on Miller (1997).

##### Principle of Method

NAG is determined by the oxidation of iron sulphide with hydrogen peroxide and this reaction produces sulphuric acid. The chemical reaction can be written as:



For every mole of iron sulphide, 4 moles of  $\text{H}^+$  ions are generated. The acidic conditions tend to liberate any carbonates present in the sample. These carbonates will partially or completely neutralize the acid generated by the sample.

If NAG value exceeds 25 kg  $\text{H}_2\text{SO}_4$  per tonne, that means there was probably not enough peroxide taken to extract all possible acidity from the sample and the test must be re-run using a smaller (e.g. 1. g) sample.

##### Scope and Application

This SOP is applicable to all ARD soil, rock, and tailings samples.

##### Method Performance

This method is fit for its intended use for determining the neutralization potential of soil, rock, and tailings samples.

Method performance parameters were determined by replicate analysis of duplicate samples for precision and bias.

### **Detection Limits**

A detection limit is not applicable for this test. Samples may not consume acid and may even generate acid and therefore may consume more base than the added acid on back titration, in which case the result will be 0 kg/tonne or negative. Readability of the burette is 0.1 mL therefore results are read to within  $\pm 0.25$  or 1.25 kg/tonne depending on the normality of the titrate used.

### **Analytical Range**

For a 2.5 g sample, up to 25 kg H<sub>2</sub>SO<sub>4</sub>/tonne.

### **Precision**

1.02

### **Accuracy**

Not applicable.

### **Bias**

Not applicable.

### **Combined Uncertainty (U(95%))**

For example, a combined uncertainty was calculated to be 5 kg H<sub>2</sub>SO<sub>4</sub>/t for a NAG of 20 kg CaCO<sub>3</sub>/t. For more information on calculating uncertainty, refer to current version of the Vizon SOP for Calculation and Reporting of Measurement Uncertainty (ADM 25).

### **Sample Requirements**

Air dry wet samples, or oven dry on low heat (<60°C) if necessary. Prior to analysis, the sample is pulverized to a target size of 80% minus 180 mesh (Tyler). Tailings and process residue samples can be tested as received. For instructions on sample preparation, refer to the current version of the Vizon SOP for the ARD Sample Preparation (EQP 33).

There are no specific sample storage conditions, sample containers, or holding times required for this test method. Typically, samples are stored at ambient room temperature.

### **Interference**

There are other components in some samples that can dissolve during the test and contribute to the neutralization potential. For example, dissolution of silicates, such as plagioclase-feldspar and olivine can neutralize acid. However, their rates of dissolution and consequent acid neutralization are slow relative to the carbonate minerals. Organic material can lead to false positive NAG results due to decomposition by peroxide.

Caution should be taken in the interpretation of NAG results for coal reject samples and other materials that may contain high content of organic materials.

### **Apparatus and Equipment**

Balance, sensitive to 0.01 g

Erlenmeyer flask (e.g., 1000 mL)

Burette, graduation 0.1 mL or less (e.g., 10-50 mL)

Hot plate with temperature regulator

pH meter with combination pH Electrode

Watch glasses

Magnetic stirrer and magnet stir bar

Glass or PET graduated cylinder (e.g., 250 mL)

Glass pipette (e.g., 1-2 mL)

### **Labware Cleaning Requirements**

No special cleaning is required for glassware used in this procedure. General information on labware is described in the current version of the Vison SOP for Labware Cleaning (EQP 8).

### **Reagents and Supplies**

- Reagent grade chemicals are used in test. Other grades may be used, provided that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.
- Purity of water – references to water, de-ionized or DI water are understood to mean reagent water conforming to the specifications for Type II DI water. For more information on de-ionized water, refer to the current version of the Vison SOPs for the Operation of the Milli-Q/ROs 16 Water Purification System (EQP 05) and Operation/Calibration of Laboratory Water Purification System Milli-RO 60 and Super Q (EQP 06).
- Hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), 30-35% - BDH “Analar” Analytical reagent 30-35% w/v (100v), or equivalent.
- Standardized or certified sodium hydroxide solutions: 1 N, 0.1 N and/or 0.5 N
- 37% concentrated phosphoric acid
- Potassium Hydrogen Phthalate Solution, approximately 0.05 N. For directions on the preparation of this solution, refer to the current version of the Vison SOP for the Analysis of Acidity (7720).

### **Health and Safety Concerns**

**Samples with high sulphide or high organic content can react rapidly and violently.** Ensure that peroxide additions are done in a fume hood with adequate controls to stop spills if a sample should boil over. Refer to MSDS for safety precautions for all products used.

### **Test Procedures**

#### **Analysis**

1. The standardized 0.1 or 0.5 N NaOH only needs to be standardized against a solution of potassium hydrogen phthalate (KHC<sub>8</sub>H<sub>4</sub>O<sub>4</sub> or KHP) if it is used past its expiration date. If the NaOH is used after its expiration it is standardized before every use. For directions

on how to standardize NaOH, refer to the current version of the Vison SOP for the Analysis of Acidity (7720).

2. Prepare a necessary amount of 15% hydrogen peroxide solution diluting hydrogen peroxide Analytical reagent 30-35% (Section 9) 1:1 with DI water. The 15% H<sub>2</sub>O<sub>2</sub> solution is buffered with 1 N NaOH to ensure a pH between 4 and 7. If the pH is <4 then add 1 N sodium hydroxide solution with glass pipette until the pH is greater than 4 and if the pH is >7 use phosphoric acid to ensure a pH below 7. If the solution is not intended for immediate use, it is stored in a PET or a glass container in a cold place (0-10°C). The pH of the 15% H<sub>2</sub>O<sub>2</sub> should always be checked to ensure that any stabilizing acid is neutralized, otherwise, false positive results may be obtained. This is to avoid decomposition of H<sub>2</sub>O<sub>2</sub>. However it is used at room temperature in the test.
3. Weigh 2.5 g of the pulverized sample into a wide-mouthed labeled Erlenmeyer flask (e.g., 1000 mL) that has been labeled with sample name. Refer to Section 12 for the quality control samples that are analyzed.
4. In a fume hood, slowly and carefully add 250 mL of 25% H<sub>2</sub>O<sub>2</sub> solution using a graduated cylinder (See #1 above), into a flask containing the sample. Record the weight of the flask with slurry, then cover the flask with a watch glass and leave it to react overnight. The NAG reaction can be vigorous and violent; therefore flasks are kept in a fume hood. Record observations such as specific sample behavior after peroxide addition, measurement of temperature, speed and intensity of oxidation reaction, etc.
5. The next day boil the flasks gently on a hot plate until effervescence stops or a minimum 2 hours. Do not allow sample to boil dry – add DI water as necessary. Allow solution to cool down to room temperature then rinse the inside surface of the flask and make up weights in flask to initial quantity with DI water.
6. Measure and record the final NAG pH while stirring the slurry and titrate the slurry (using a pH meter attached with a pH electrode) to pH 4.5 and 7.0, while stirring on a magnetic stir plate, with an appropriate sodium hydroxide concentration based on NAG pH as listed in Table 1. For information on measuring pH, refer to the current version of the Vison SOP for Fisher Scientific Accumet Basic pH Meter (EQP 13). Record the volume of titrant.

NAG Solution pH	NaOH Concentration
>2	0.1 N
<2	0.5 N

7. If calculated NAG value exceeds 25 kg H<sub>2</sub>SO<sub>4</sub> per tonne (see Section 2), repeat steps 1 to 5, using a sample of 1 g weight.

### Calculations

Calculate NAG values as follows:

$$\text{NAG} = \frac{98 \times V \times M}{2 \times W}$$

Where:

NAG – net acid generation potential (kg H<sub>2</sub>SO<sub>4</sub>/tonne)  
 98 – H<sub>2</sub>SO<sub>4</sub> molar mass

- V – volume of NaOH (mL) titrated to pH=4.5
- M – molarity of NaOH (moles/L) = normality of NaOH
- W – Pulverized sample weight, 2.5 g.
- 2 – H<sub>2</sub>SO<sub>4</sub> molar equivalence.

### Quality Control

#### Blanks

Method blank(s) are used to monitor pH of the peroxide after digestion and the pH should be between 4 and 7. If not, the batch of samples is repeated.

#### Replicates

Replicate 10% of samples for groups of ten or more samples or 1 duplicate for smaller batches. Repeat the duplicates if the duplicates disagree by  $\pm 10\%$  relative difference.

#### Reference Standards

No reference standards have been found for this test that have values above the detection limit.

### APPENDIX 1

#### Table of Net Acid Generation Test Results

The results of the test are presented in the form of table.

Sample ID	Sample Weight (g)	Batch Number	Observations	NAG pH	Normality of NaOH (N)	Volume to pH 4.50 (mL)	Vol. to pH 7.00 (mL)	NAG (kg H <sub>2</sub> SO <sub>4</sub> /tonne)

Where:

- **Sample ID** is a unique sample name or number.
- **Sample Weight** is a weight of sample taken for the test.
- **Batch number** applicable when more than one batch runs for one set of samples.
- **Observations** mean specific sample behavior after peroxide added to a sample and in accordance with customer's requirements, may include measurement of temperature, speed and intensity of oxidation reaction, etc.
- **NAG pH** – pH of sample slurry after boiling and making up volume with DI water to initial value.
- **Normality of NaOH** – concentration (normality) of standardized sodium hydroxide solution used for titration.
- **Volume to pH 4.50** – amount of mL of NaOH spent for slurry titration to reach pH = 4.50 and remain stable for at least 30 seconds.
- **Volume to pH 7.00** – amount of mL of NaOH spent for slurry titration to reach pH = 7.00 and remain stable for at least 30 seconds.
- **NAG** – calculated NAG value.

**APPENDIX A4**

TOTAL SOLUBLE SULFUR IN ROCK BY LEACHABLE SULFATE S - FIELD

(Page A4-1)

## APPENDIX A4

### Total Soluble Sulfur in Rock by Leachable Sulfate S - Field

This field method determines the total concentration of sulfur in a rock sample by measuring the soluble sulfate released by the peroxide oxidation step conducted by the NAG tests. The NAG test converts reactive sulfide S into soluble sulfate, and dissolves most or all of the soluble sulfate in the rock. The effluent from the peroxide-oxidation step NAG leachate is then analyzed using a Hach, Inc. *Pocket Colorimeter for Sulfate*.<sup>1</sup>

#### Method Summary:

Solution is added to a barium chloride powder that reacts with sulfate to form barite ( $\text{BaSO}_4$ ) precipitate. The absorbance of light through this solution, relative to a standard solution without sulfate, provides an estimate of sulfate concentration. Results are provided by direct readout from the colorimeter.

Detection limit: 1 mg/l.

Effective range: 1 – 80 mg/l. (high concentrations will require dilution).

The aqueous concentration of sulfate ( $\text{SO}_{4(\text{aq})}$ , in mg/l) can be converted back to the solid-phase sulfur concentration in the rock ( $S_{(\text{rock})}$ [%]) by correcting for the dilution used in the rock:water mixture in the peroxide extraction step, and also for the molecular weight of  $\text{SO}_4$  analyzed in the water relative to the molecular weight S in the rock sample:

$$S_{(\text{rock})}[\%] = \frac{(\text{SO}_{4(\text{aq})}[\text{mg/l}]) * (\text{vol H}_2\text{O}_2 [\text{l}])/\text{mass rock}[\text{kg}]}{(\text{MW S} [32,000 \text{ mg S/mole}]/\text{MW SO}_4 [96,000 \text{ mg SO}_4/\text{mole}]) * 10,000 [\%/\{\text{mg/kg}\}]}$$

Instructions for operation of the colorimeter will be provided with the instrument from Hach, or are available from Hach on line (<http://www.hach.com/>).

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<sup>1</sup> The *Pocket Colormimeter for Sulfate* (Part number 5870029) is available from Hach, Inc. for \$US352.00 (Hach, Inc., PO Box 389 Loveland, CO. 80539. Tel 800-227-4224, and 970-669-3050. Each analysis requires one reagent packet. Sets of 100 packets (part # 2106769) are available for from Hach for \$US21.50. <http://www.hach.com/>

**APPENDIX A5**

**HUMIDITY CELL OPERATION AND SAMPLING**

(Pages A5-1 to A5-6)

## APPENDIX A5

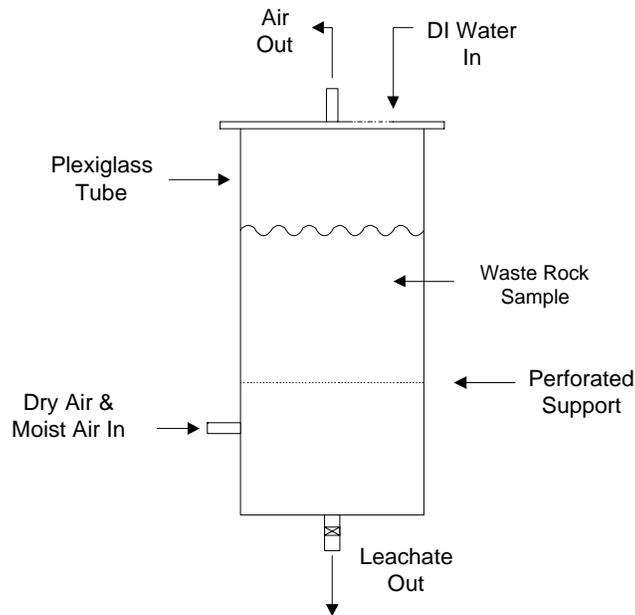
### Humidity Cell Operation and Sampling

(Method from Mine Environment Neutral Drainage, Canada)

#### Procedure

The recommended laboratory kinetic test is a humidity cell test (Figures 1 and 2). Humidity cells have been used in British Columbia for about a decade, and reflect in-field rates when retention has been taken into account.

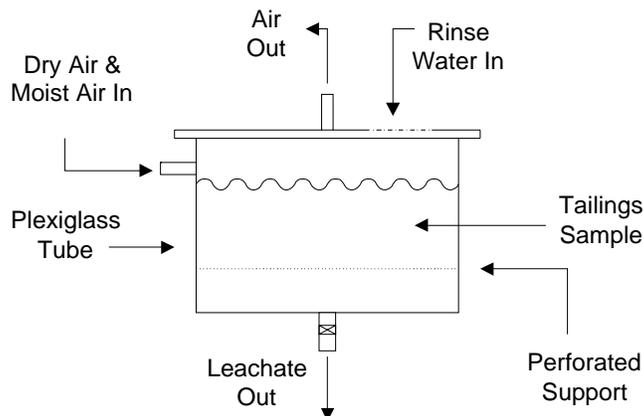
Figure 1: Humidity Cell for Rock



A humidity cell is typically a plexiglass cylinder fitted with a base plate and equipped with a drain hole and tubing nipple. Approximately 1 inch from the bottom of the base plate is a removable perforated plate or screen, which supports the sample. In some cases materials such as landscape fabric may be used to prevent particularly fine samples from passing through the perforated plate.

The size and shape of the humidity cell will vary whether the sample is waste rock or tailings. A waste-rock humidity cell is usually tall and slender, approximately 8 inches high and 4 inches wide as shown in Figure 1, whereas a cell for tailings samples tends to be shorter and wider as shown in Figure 2.

Figure 2: Humidity Cell for Tailings



Approximately 1 kg (dry weight) of sample is placed in a humidity cell, forming a relatively flat surface. Air is then continuously pumped into and through the cell. The pattern of air flow differs between the tailings and waste-rock cells. This difference reflects in part the deposition pattern and water-retention characteristics in the field. Tailings are typically fine materials with a high moisture content and are usually placed as a slurry into an impoundment. Usually the only air in constant contact with the tailings is that which passes over the top of the tailings mass. Subsequent air diffusion into the tailings is a slow process and limits the movement of oxygen down through the tailings. Waste rock, on the other hand is typically more coarse than tailings, and is placed in piles or dumps. The larger particle size allows for better drainage, more contact between waste rock and air, and greater air circulation. As a result, air is introduced below the sample in a waste rock cell so that it can more freely circulate through it.

One testing “cycle” takes place over seven days. The first three days make up the “dry” portion of the cycle during which background laboratory air is passed over a tailings sample and through a waste-rock sample. The next three-day period is the “wet” portion of the testing cycle, when laboratory air is first pumped through a humidifier unit and then into a cell.

On the final day of the testing cycle a sample “rinse/leach” is done. A known amount of distilled/de-ionized water is added to the top of the cell, allowed to soak the sample for a specific period, and then drained for analysis. The purpose of the weekly rinse/leaching is to wash out any weathering reaction products that have accumulated in the cell during the wet and dry segments of the cycle. After the sample rinse/leach, another cycle is initiated with the introduction of dry air. A detailed description of the Start-up, operating, and closure procedures are presented below. The weekly “leachate” or rinse water is usually analyzed for pH, sulphate, conductivity, acidity, alkalinity, and ICP metals. Metal samples should be filtered to provide dissolved concentrations. From the analyses, leaching rates can be calculated, typically in units of mg of parameter/kg of sample/week. Also, with pre-test static tests such as ABA and ICP metals analysis, rates of, and times to, depletion can be calculated.

The duration of humidity cell test is usually are least 40 weeks, or until the rates of sulphate generation and metal leaching have stabilized at relatively constant rates for at least five weeks.

Experience in British Columbia shows that stabilization can take over 60 weeks, and significant changes may take place even after several years. Therefore, the criteria on which to close down a cell depend on the site-specific objectives and uncertainty of predictions. Particularly because of uncertainty and associated risks, some British Columbian mines have continued kinetic tests for up to five years (and some are still continuing).

#### **Humidity cell Start-up Procedure**

1. Collect a minimum of 2 kg of sample for humidity cell testing. Record sample information, noting sample preparation, weight, texture, smell, moisture etc. .
2. The beginning of the humidity cell test program will be week 0. Humidity cells are operated on a weekly cycle.
3. If the sample is rock (i.e., waste rock, ore, etc.), crush the sample to 80% minus ¼ inch. If the sample is tailings, crushing is not required and is normally tested as received.
4. Split out sufficient representative portions of the sample and send for all static tests as required.
5. Accurately weigh 1000 g of the sample and carefully place in the appropriate humidity cell, either for waste rock or tailings (figure 1 and 2). If the sample is moist, determine water content so that a dry weight can be calculated. Charge cell with an equivalent to 1 kg dry weight. Ensure the sample has a relatively level surface in the cell.

[Procedures for Week 0:]

6. Clamp the drain hose at the bottom of the cell and the air inlet of waste rock humidity cells and place a clean bottle under the cell. Carefully add a known volume of demineralized water, approximately 750 mL, to the top of the humidity cell. Add enough demineralized water to thoroughly moisten the sample and allow for collection of at least 300-500 mL of leachate. Record the amount of water added on a weekly data sheet, a sample of which is shown in Figure 4). Put a collection flask under the cell with the hose draining into it. All samples must have good contact with the water, therefore gently agitate fine, semi-permeable samples for about one minute.
7. Allow rock samples to soak for ~2 hours and tailings samples to soak for ~4 hours allowing any suspended particles to settle. Disconnect the hose clamp for the drain hose and drain off the leachate into the collection bottle. If the cell will not drain in a reasonable time (i.e. about an hour) check to see if the drainage hose is blocked. If the leachate still will not drain carefully decant the leachate off the top of the sample. Record the volume of leachate collected. Note that if excess solids flow from the humidity cell with the leachate it may be necessary to filter the leachate through coarse filter paper into a clean weighed filter flask. Transfer as much of the solids as possible from the collection bottle to the filter apparatus by swirling before transferring.

**Figure 3: Weekly Report Form for Kinetic Testing**

Kinetic Test – Weekly Data Sheet

Project: Mine

Cell No.:

Sample ID/Description: Sample 45964 (Dump #6 – Waste Rock)

Week/ Cycle	Date	Leachate Volume Added (mL)	Leachate Volume Recovered (mL)	pH	Conductivity ( $\mu\text{S}/\text{cm}$ )	Humidifier Water Temp ( $^{\circ}\text{C}$ )	Comments/ Analyst
0	12-Feb-96	750	430	6.68	425	30.5	Filtered solids returned to cell. Water drained well
1	19-Feb-96	500	427	6.96	505	30.5	Filtered solids returned to cell. Water drained slowly
2	26-Feb-96	500	471	7.21	311	30.5	Filtered solids returned to cell.

8. As required filter enough of the leachate through a 45 micrometer filter for analysis and if metals are required acidified with  $\text{HNO}_3$  to a  $\text{pH} < 1.5$  in an acid washed bottle of test tube. Label the bottles with the project name, sample id., cycle number, and date. Record all data for this initial rinse as Week or Cycle 0.
9. As required by the client, perform pH, acidity and conductivity measurements on the sample using calibrated instrument, record all results. Keep a record of the instruments used, all QA/QC procedures, and any data resulting from calibration.
10. As required by the client, submit samples for alkalinity, sulphate and nutrient analysis. Submit the acidified sample for ICP metals. This suite of analyses is a standard request, but may vary somewhat according to the sample and the type of information needed (i.e. some samples may require low level arsenic and/or mercury analyses, etc.).
11. Carefully put any residue in the filter apparatus back into the humidity cell. If necessary place the filter paper on top of the humidity cell to dry ensuring it will not be disturbed. When the filter paper and residue have dried return any solids back to the humidity cell.

**[QA/QC Procedures for Week 0:] - Done Only At Client's Request**

12. *Method Blank Sample*: Take a sample of the demineralized water used as humidity cell rinse water, and process through a blank cell. Handle and filter the sample as was done with the humidity cell leachate. Measure pH and conductivity. Label the sample using the same naming convention as other samples (paying careful attention to not give it the same name as an actual sample) and record this as the 'method blank' in a field book. Do not identify it as a method blank in the laboratory chain of custody document. Submit for analysis.
13. *Blank Sample*: Take a sample of demineralized water used for leaching the cells (do not process in any way). Again, label the sample using the same naming convention as other samples and record this as the 'blank' in a field book. Do not identify blank samples as such on the laboratory chain of custody document. Submit for analysis.

## Humidity Cell Weekly Operating Procedure

1. For the first three days after the weekly rinse, dry air is passed over and through the sample within the humidity cell. Connect the humidity cell to a dry air source, use a gentle flow rate to move the air past the sample. If more than one humidity cell is running, splits can be taken from a main air line leading to each humidity cell. Use individual gang valves to ensure that each cell receives roughly the same air flow rate.
2. On the morning of the fourth day, a three day wet air cycle begins. Switch the air supply from a dry source to a humid one. Connect the humidifier to the main air supply line for the humidity cell shelving unit. The humidifier should be roughly half full of water, and contain an immersion heater which is set to 30 °C. The air from the main dry air supply is switched to pass through the humidifier unit. This air passes through the humidifier and exits from an aquarium-type diffuser. The air pressure is adjusted to provide an adequate air flow without causing rolling waves in the humidifier. Again, if more than one humidity cell is running, adjust gang valves associated with each humidity cell to ensure that each cell receives roughly the same air flow rate.
3. On the seventh day, sampling procedures begin. Shut off the main air supply. Clamp off the air inlets for waste rock cells. **Note:** the waste rock cells have the air inlet at the bottom and will allow leach water to drain back into the humidifier if not clamped. Gang valves are located above the top of the humidity cells to prevent cell water from entering the air system should a clamp fail.
4. Ensure that the drain hose at the bottom of the cell is clamped. Place a clean 500 mL bottle under each cell with the hose draining into it. Carefully add 500 mL of water, taken from the demineralized water reservoir, to the top of each humidity cell. Record the amount of water added. All samples must have good contact with the water, therefore gently agitate fine, semi-permeable samples for about one minute before and/or after the addition of water. Note how each cell is treated in the weekly records (figure 4).
5. Allow rock samples to soak for ~2 hour and tailing samples to soak for ~4 hours allowing any suspended particles to settle. Disconnect the hose clamp and drain off the leachate in to the collection bottle. If the cell will not drain in a reasonable time (i.e. about an hour) check to see if the drainage hose is blocked. If the leachate still will not drain carefully decant the leachate off the top of the sample. Record the volume of leachate collected.
6. As required, filter enough of the leachate through a 45 micrometer filter for analysis and if metals are required acidified with HNO<sub>3</sub> to a pH<1.5 in an acid washed bottle or test tube. Label the bottles with the project name, sample id., cycle number, and date.
7. As required by the client, perform pH, acidity and conductivity measurements on the sample using calibrated instrument, record all results. Keep a record of the instruments used, all QA/QC procedures, and any data resulting from calibration.
8. As required by the client, submit samples for alkalinity, sulphate and nutrient analysis. Submit the acidified sample for ICP metals. This suite of analyses is a standard request, but may vary somewhat according to the sample and the type of information needed (i.e. some samples may require low level arsenic and/or mercury analyses, etc.).
9. Carefully scrap any residue in the filter apparatus back into the humidity cell. If necessary place the filter paper on top of the humidity cell to dry ensuring it will not be disturbed. When the filter paper and residue have dried return any solids back to the humidity cell.

[QA/QC Procedures for Weekly Operation:] **Done Only At Client's Request**

10. *Method Blank Sample*: Take a sample of the demineralized water used as humidity cell rinse water, and process through a blank cell. Handle and filter the sample as was done with the humidity cell leachate. Measure pH and conductivity. Label the sample using the same naming convention as other samples (paying careful attention to not give it the same name as an actual sample) and record this as the 'method blank' in a field book. Do not identify it as a method blank in the laboratory chain of custody document. Submit for analysis.
11. *Blank Sample*: Take a sample of demineralized water used for leaching the cells (do not process in any way). Again, label the sample using the same naming convention as other samples and record this as the 'blank' in a field book. Do not identify blank samples as such on the laboratory chain of custody document. Submit for analysis.
12. *Humidifier maintenance*: Humidifiers should be cleaned out every three months or if water appears turbid. Also replace tubing whenever necessary.

### **Humidity Cell Closedown Procedure**

1. When the cell has stabilized geochemically, it can be terminated if desired. To properly interpret cell results from the beginning of the test, specific closedown procedures must be carried out and included in data interpretation.
2. Collect leachate after the last cycle rinse as per the humidity cell operational procedures. Note: the rinse from the last cycle must be submitted for the full suite of analysis.
3. Remove the sample from the test cell and place it into a clean 4L plastic pail with locking lid. To ensure that the test cell has been thoroughly cleaned, and all of the sample and its precipitates have been transferred to the pail, use a known amount of demineralized water of known composition to wash the cell. Add enough demineralized water to the rotary jar so that a total of 3 L of demineralized water has been added.
4. Gently agitate the sample on a roll cage for a period of 24 hours. On completion of the 24 hour agitation, let the sample stand for a minimum of three hours allowing suspended materials to settle.
5. Collect the supernatant, recording its volume. Handle and prepare the sample the same as was done during normal humidity cell operation. Label the sample "Final Leach" and submit it for leachate analysis.
6. Transfer the wet solid from the pail to pre-weighed drying tray, ensuring the entire sample has been moved. Record the weight of the wet sample.
7. Air dry the wet sample for 24 hours, or dry in an oven on low heat (<40°C) if necessary. Record the final weight of the dry sample. If sample was dried in an oven, cool in a dessicator prior to weighing.
8. Take a representative split from the sample and label it "Final Residue". Submit the split for all static tests previously conducted on the humidity cell head material. These analyses will be known as "post-test data".
9. Package the remaining sample and label it "Final Residue". Place it in cold storage for later examination.

### **Reference**

Recommended Methods for Drainage-Chemistry Predictions at Minesites in British Columbia – Draft #2 - British Columbia Ministry of Energy, Mines and Petroleum Resources. Fax from Bill Price June 6/1996