CANMET Mining and Mineral Sciences Laboratories

Assessment of Chemical Stability of Impounded Tailings at Mount Nansen, Yukon Territory

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EXECUTIVE SUMMARY

To aid with decision-making on the final decommissioning of the Mount Nansen site, the Water Resources Division of Indian and Northern Affairs Canada (INAC), Whitehorse, approached CANMET/MMSL in September 2001 to design a detailed tailings characterization program and conduct relevant field and laboratory testing to assess the chemical stability of the impounded tailings. CANMET/MMSL responded with a proposal incorporating the following major components for investigation:

1. Review of historical monitoring data to identify trends in the evolution of tailings water chemistry;
2. Geochemical and mineralogical analyses to identify a) remnant metal values in the tailings: b) parameters of concern and their modes of occurrence; and, c) relative proportions of various tailings types, if proved different;
3. Short-term leach tests to identify immediate releases of contaminants upon disturbing the tailings;
4. Column testing and selective leaching to predict the long-term behaviour of the impounded tailings;
5. INCO SO_2/Air treatment of selected tailings followed by batch leaching to clarify the functionality of the treatment; and,
6. Investigation of the effect of multiple freeze-thaw cycles on the physical and chemical properties of the impounded tailings.

The acceptance of the proposal by INAC in October commenced an intensive field sampling campaign in mid-November. Nineteen boreholes were drilled systematically across the 200m by 200m impoundment to sample tailings for subsequent laboratory testing. Based on their observed contrasts in mineralogy, colour and texture during core logging, the tailings were divided into four categories, namely, oxide silt, oxide clay, sulfide silt and sulfide clay. The drilling program also revealed accelerated thawing of permafrost in the vicinity of the tailings seepage return located near the centre of the tailings dam.

Geochemical analyses show that the tailings solids, regardless of detailed type, contain anomalous contents of silver (Ag, up to 80 μg/g), arsenic (As, up to 0.6%), copper (Cu, up to 0.06%), lead (Pb, up to 0.6%), antimony (Sb, up to 0.1%) and zinc (Zn, up to 0.3%) and they are all potentially acid-generating to a small degree. The Ag content represents the only remnant metal value in the tailings and the other trace elements pose potential environmental liabilities. Depending on the tailings type, the tailings porewater contains on average 4-17 mg/L strong acid-dissociable cyanide (SAD CN or Total CN) and 3-5 mg/L weak acid-dissociable cyanide (WAD CN). Numerically these are about an order of magnitude lower than the same associated with the tailings solids (with the latter expressed in μg/g). The average concentrations of 0.5-2.3 mg/L As and 3.6-6.5 mg/L Cu are also observed in the porewater of the four types of tailings. Generally, there is a good correlation between dissolved Cu and WAD CN in the porewaters.

Mineralogical analyses reveal that the tailings are comprised predominantly of quartz with minor to subordinate amounts of sericite/illite, alkali feldspar, jarosite, kaolinite,

montmorillonite, goethite, and gypsum. Pyrite is the most common sulfide mineral observed. Arsenopyrite is typically replaced by scorodite.

Eight columns have been set up to simulate, in duplicate, the disposal of coarse, high- and low-sulfide tailings under a shallow water cover, a mixture of silty slurried tailings under a water cover and mixed tailings under flow through conditions. While rates of cyanide degradation and trace element releases cannot yet be established due to the short duration of the experiment, the column testing demonstrates that thiocyanate (CNS), ammonia (NH_4-N), As and possibly Sb may be mobilized in tailings porewater and the water cover at concentrations of concern. If the tailings were to be relocated to the open pit, moving the tailings in a relatively dry form would likely have a less significant impact on the resultant water cover quality than transferring the tailings as a slurry.

Sequential batch leach testing with clayey tailings also indicates that As and Sb are the only trace elements susceptible to significant leaching with intense perturbation of the tailings. Although the INCO SO_2/Air treatment is effective in destroying CN associated with the tailings solids, simultaneous releases of elevated concentrations of Total CN, CNS and NH_4-N to the liquid phase have been observed. The process also seems to affect the leaching of As, Cu, Sb and Zn to various extents.

Partial sequential extraction analyses were conducted on six typical tailings from Mount Nansen to investigate the impact of a changing environment on the behaviour of the trace elements occurring in anomalous amounts in the tailings. The results indicate that As and Zn are susceptible to remobilization under mildly acidic or reducing conditions. In comparison, Cu, Pb and Sb are less readily released. Freeze-thaw studies with the same six samples indicate that multiple freeze thaw events do not significantly affect the metal leachability of the test tailings. However, an increase in average grain size may occur in some samples resulting from the aggregation of clay particles in the freezing process.

Overall, the impounded tailings appear to represent a relatively stable system from a chemical perspective. Only the CNS and NH_4-N will remain parameters of major concern in the medium term. Although laboratory testing suggests potential As and Zn release with changing environmental conditions and tailings perturbation, such has not yet been observed to occur in any significant extent in the tailings impoundment. Elevated concentrations of dissolved As have been found only in tailings porewater (up to an average of 2.33 mg/L in the clayey oxide tailings), which has not escaped the impoundment. It is recommended that detailed information on mineral distribution, hydrology and hydrogeology be collected from the Brown-McDade open pit. This would provide relevant data to critically compare, preferably by using a risk assessment approach, the benefits of retaining the tailings in the existing impoundment versus relocation to the open pit. Meanwhile, a scaled model of the impoundment can be constructed to study water-tailings interaction under simulated field conditions. Further research on the treatment of CNS and NH_4-N are also desirable.

DISCLAIMER

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INTRODUCTION

Project Background

The Mount Nansen Mine, hosting gold mineralization, was operated by BYG Natural Resources Inc. between November 1997 and February 1999. The operator went bankrupt and abandoned the mine site in July 1999, leaving significant environmental liabilities. Of particular concern is the chemical and physical stability of approximately 250,000 tonnes of impounded, cyanide- and arsenic-bearing tailings. Since mine abandonment, the Water Resources Division of Indian and Northern Affairs Canada (INAC), Whitehorse, has maintained operation of the effluent treatment system at the site to reduce the potential for serious environmental impacts resulting from tailings impoundment failure or uncontrolled discharge from the emergency spillway.

To facilitate decision-making with regard to long-term maintenance or decommissioning of the site, INAC requires the following information:

1. Metals and other contaminants occurring in the tailings and their response to long-term water contact and repeated wetting-drying cycles;
2. Long-term prognosis for treatability of thiocyanate generated by the modified INCO SO_2/Air water treatment system;
3. Cause of accelerated cyanide release from partially or completely drained tailings after a rainstorm event;
4. Proportion of sulfide versus oxide tailings in the impoundment and its impact on the long-term treatability of porewater which migrates to the collection pond; and,
5. Implications of moving the tailings and depositing them in the Brown-McDade Open Pit and the preferred means of transport.

To address the above issues, INAC approached CANMET/MMSL in September 2001 to design a detailed tailings characterization program and conduct relevant field and laboratory testing to acquire the necessary data. A draft research proposal was submitted to INAC in mid-September. After a preliminary visit to the Mount Nansen site followed by a meeting with INAC officials in early October, a formal proposal was prepared and approved by INAC in mid-October 2001. This started an intensive field and laboratory investigation program on the chemical stability of tailings impounded at the Mount Nansen tailings pond, the results of which are detailed in this report.

Scope of Work

All field and laboratory investigations were designed for completion by the end of March 2002. Because of the short time frame allowed for the research project, it is understood that not all of the questions raised by INAC may be fully answered at the end of the study. However, a comprehensive battery of test work has been incorporated to render sufficient data to reveal key issues related to the short- and long-term chemical stability of the impounded tailings

and to evaluate the advantages and pitfalls of alternative decommissioning strategies for the site. Major components of the investigation include the following:

1. Review of historical monitoring data for trend identification;
2. Detailed tailings characterization to identify:
   a) if there are remnant metal values in the tailings;
   b) parameters of concern and their modes of occurrence where appropriate; and,
   c) relative proportions of various tailings types if proved different;
3. Short-term leach tests to identify immediate releases of contaminant, if any, upon disturbing the tailings;
4. Column testing and selective leaching to predict the long-term behaviour of the impounded tailings;
5. INCO SO_2/Air treatment of selected tailings followed by batch leaching to clarify the functionality of the treatment; and
6. Cursory investigation of the effect of multiple-freeze-thaw cycles on the physical and chemical properties of the impounded tailings.

Report Structure

This report contains ten sections. Section 1 briefly describes the project background, the scope of work and the organization of the subject report. Section 2 outlines the setting and general geology of the study site. Section 3 presents the physical characteristics of the tailings impoundment as revealed in the drilling program conducted to sample tailings for laboratory testing. Historic site monitoring data based on company and government records are also summarized. Section 4 deals with tailings chemistry and mineralogy. Various data including solids and water analyses rendered by inductively coupled plasma atomic emission spectrometry (ICPAES) and mass spectrometry (ICPMS), acid-base-accounting (ABA) characteristics and results of mineralogical analysis by petrography, X-ray diffraction (XRD) and scanning electron microscopy (SEM) supplemented with energy-dispersive X-ray (EDX) analysis are described. The analyses of grab samples from the Brown-McDade open pit, which is a candidate for long-term disposal of the tailings, are also included in this section.

Sections 5 through 7 document the results of various tests completed with the collected tailings. These include column testing of the coarser tails (Section 5), sequential batch testing of the fine tails, which also incorporates INCO SO_2/Air treatment in one of the tests (Section 6), and other test work with various leach media as well as the investigation of freeze-thaw effects (Section 7). The test results, especially with regard to their implications on the long-term chemical stability of the impounded tailings and appropriate decommissioning strategies, are discussed in Section 8. Section 9 summarizes conclusions drawn in the study and recommended further work is outlined in Section 10.

SITE SETTING AND GENERAL GEOLOGY

Site Location and General Setting

The abandoned Mount Nansen Mine previously operated by BYG Natural Resources Inc. is located about 60 km west of Carmacks and 180 km north of Whitehorse (Figure 1-Inset). The mine site lies in the Dawson Range consisting of rounded ridges and shallow valleys with elevations ranging from 945 to 1525 m. Drainage from the property flows through Nansen Creek to the west and Victoria Creek to the east (Figure 1) to the Nisling River, which in turn drains into the Yukon River system. Dome Creek, a tributary of Victoria Creek, is directly impacted by the Mount Nansen mine site, especially by historical underground mine workings, the mill facility and the tailings impoundment.

The average monthly temperature in the Mount Nansen area ranges from a high of about 15°C in July to a low of about -15°C in January. The average annual precipitation, which occurs mostly as rain in the summer months, is about 25 cm. The winter snow pack is typically 30 to 40 cm. Discontinuous permafrost ranging from 30 to 60 m thick occurs at a depth varying from 0.4 to 5 m depending on the nature of ground cover. The active layer is up to 1.5 m thick.

The mine site lies within the Dawson Range Ecosystem. Open stands of black spruce and white spruce occur in valley bottoms and benchlands near Dome Creek. While upper slopes are generally devoid of trees, lower slopes host stunted black spruce and trembling aspen. From valley bottoms to above the treeline, birch and willow shrubs form an extensive cover while Labrador tea is the dominant understorey and mosses and lichens constitute the common ground vegetation. Natural weathering of geologic materials including bedrock and surface sediments generates unstable upper slopes and secondary surficial sediments along the valley bottoms. Where surface and subsurface weathering is intense, bedrock can become friable and unstable.

General Geology

The Mount Nansen area lies within the Yukon-Tanana Terrane, the regional geology of which has recently been described in detail by Carlson (1987). Hart and Langdon (1997) as well as Andersen and Stroshein (1997) further discussed the local geology and mineral deposits of the Mount Nansen camp. A brief account of the property geology is furnished below, providing the background information against which later mineralogical analyses can be compared and discussed.

The Mount Nansen property is located in the eastern part of the Yukon Crystalline Terrane between the Coast Plutonic Complex to the southwest and the Yukon Cataclastic Terane to the northeast. The oldest rocks occurring in the area are Palezoic (early Mississippian) meta-sedimentary schists and gneisses, which were intruded by early Cretaceous plutons ranging from diorite, monzonite to syenite in composition. These felsic plutonic rocks were in turn intruded by and host younger mid-Cretaceous mafic to intermediate volcanic rocks of the Mount Nansen Volcanic Suite.

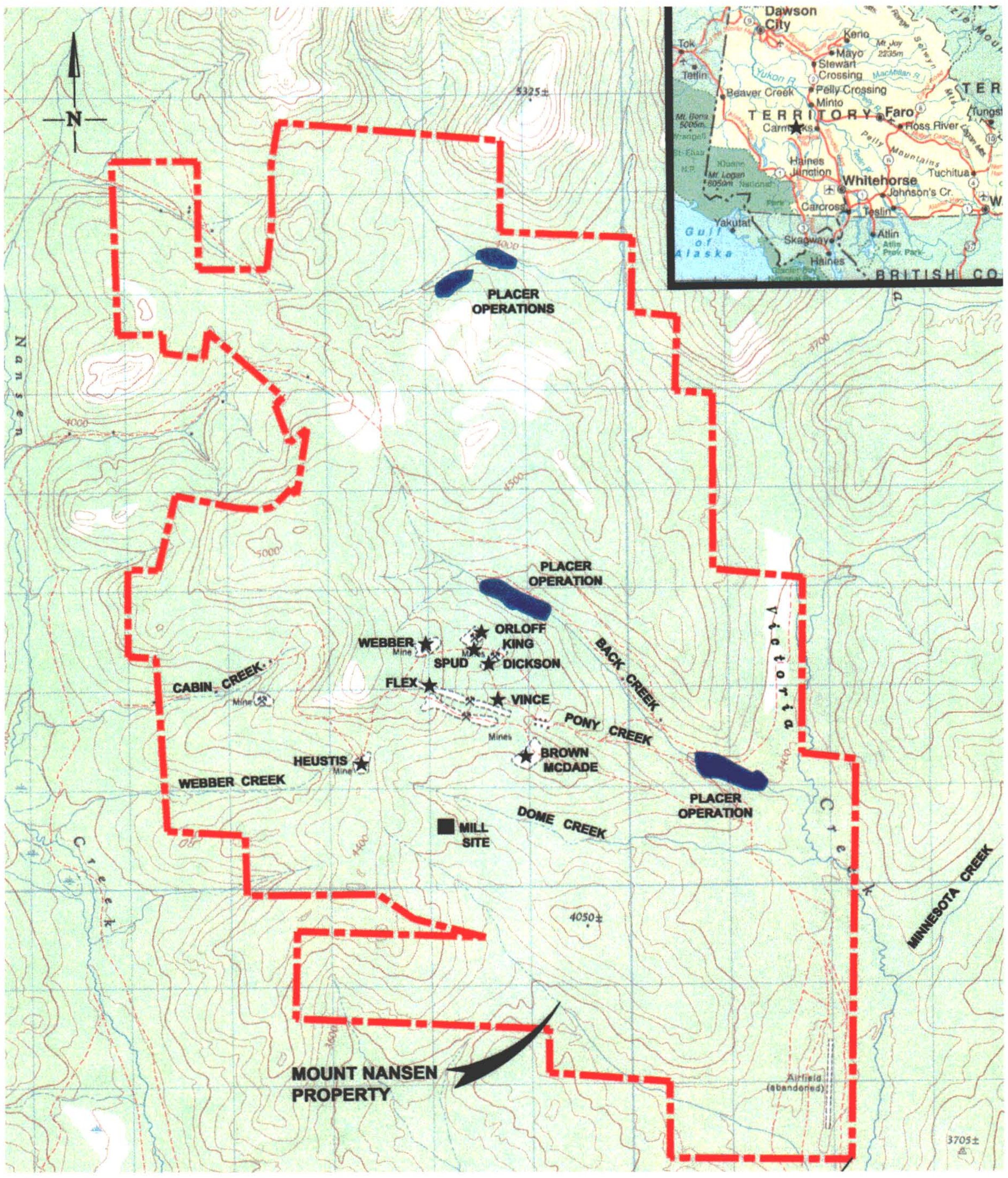


Figure 1. Location map of the Mount Nansen property. (Scale: each grid = 1 km)

Prior to abandoning the mine site, BYG Natural Resources Inc. had identified nine epithermal deposits at the Mount Nansen property (Figure 1). The three most westerly mineralized zones (i.e., Webber, Huestis and Flex) are hosted by older Paleozoic rocks dominated by strongly foliated, inter-layered quartz-feldspar-chlorite gneiss, quartzite, minor

amphibolite and augen gneiss. Further southeast, the main mineralized zone named the Brown-McDade deposit is hosted by locally foliated, mid-Cretaceous granodiorite, quartz diorite and quartz monzonite. Occurring in the northern portion of the property is a large quartz-feldspar porphyry intrusive complex (the Mount Nansen porphyry complex) with flanking andesitic flow and tuff units. Within this intrusive complex, zones of small and silicified breccia pipes occur, locally with associated gold values. Propylitic alteration, characterized by the replacement of hornblende by epidote, calcite, pyrite and magnetite, is widespread peripheral to the Mount Nansen porphyry complex and has affected most rocks in the property.

Structurally, faulting is the main feature occurring in the Mount Nansen property. Two fault sets are prominent. One set trends north-northwest with dips varying from 50 to 70 degrees to the southwest. This fault set is parallel to the main vein direction at the Brown-McDade deposit and locally mineralized. The other set trends southeast with subvertical dips and locally cuts some of the mineralized zones. These faults form part of the larger regional structure known as the Mt. Nansen Trend (Hart and Langdon, 1997).

The property has not been affected by recent glacial activities. Consequently, weathering can reach depths in excess of 70 m from the surface. Generally, the depth of oxidation as evidenced by alteration of sulfides to limonite is variable throughout the property.

Modes of Mineralization

As reviewed by Strathcona Mineral Services Ltd. (2000), two forms of mineralization occur in the Mount Nansen property. The more common form occurs as structurally controlled planar veins consisting of quartz, carbonate and varying amounts of sulfides. The vein systems can occur as simple veins like those observed at the Huestis and Webber zones or as a complex anastomosing series of veins and veinlets prominent at the Brown-McDade deposit. Better gold values are generally restricted to steeply plunging shoots with a stronger vertical rather than horizontal continuity. The less common form of mineralization occurs as siliceous pipe-like structures, which may be sulfide-rich as observed at the north end of the Brown-McDade open pit or sulfide-poor as noted at the PPBX showing.

Sulfide minerals occurring in mineralization zones at the Mount Nansen property include pyrite, arsenopyrite and lesser amounts of galena, sphalerite, chalcopyrite, stibnite and various sulfosalts. Gold occurs as minute inclusions (5 to 40 μm across) in early pyrite and arsenopyrite, as peripheral infiltrations in several sulfide minerals and as "free gold" intergrown with galena, freibergite and other sulfosalts. Silver occurs mostly as inclusions in galena and sphalerite but freibergite and miargyrite have been identified from the property. Silver/gold ratios vary from 7/1 in the planar vein mineralization to 3/1 in the breccia pipe mineralization. The silver content appears to vary directly with the base metal content of the ore material (Strathcona Mineral Services Ltd., 2000).

In the Mount Nansen camp, Hart and Langdon (1997) recognized two types of epithermal veins. These are (1) an early, cherty quartz-sulfide vein with fine-grained pyrite and arsenopyrite; and, (2) a later coarse-grained quartz-sulfide vein with pyrite, galena and sphalerite

and higher precious metal values. It is not clear if both vein types are prevalent in the two forms of mineralization described above.

Mineralization and Alteration at the Brown-McDade Open Pit

As the bulk of the tailings impounded at the Mount Nansen tailings pond is presumably derived from the processing of ore materials from the Brown-McDade open pit, it is instructive to review the mineralogy and alteration of the ore deposit. Moreover, transfer of impounded tailings to the Brown-McDade open pit has been considered as a long-term decommissioning option for the mine site (Strathcona Mineral Services Ltd., 2000). A better appreciation of alteration patterns prevailing at the open pit will aid with developing proper strategies for site closure.

In agreement with the general forms of mineralization reviewed above for the entire Mount Nansen camp, Conor Pacific Environmental Technologies Inc. (2000) also reported that open-pit mining of the Brown-McDade deposit revealed two separate ore mineralization types. These are (1) gold-silver vein mineralization forming a complex vein swarm hosted in a massive feldspar porphyry dike, and (2) a siliceous, sulfide-rich and gold-silver mineralized breccia in a pipe-like structure. The two mineralization types are separated by a complex, steeply dipping and north-easterly trending fault that crosscuts the open pit north of the Pony Creek adit. The gold-silver veins, which are largely planar in structure, are exposed in the southern two-thirds of the pit while the mineralized breccia zone is exposed in the northern one-third of the open pit. The latter is reportedly hosted by re-crystallized limestone, which has not been confirmed in the cursory examination of the open-pit during the course of this study.

Three main types of hydrothermal alteration, namely, silicification, argillic and phyllic alterations, have been reported by Conor Pacific Environmental Technologies Inc. (2000) in the Brown-McDade open pit. Silicification and bleached clay (argillic) alteration zones are commonly 1–3 m wide. Adjacent to veins and breccia zones, silicification usually occurs in vuggy form with yellow weathering and drusy quartz lining in the fine vug cavities. The silicified zone is usually enclosed by a phyllic alteration zone, in which the disseminated pyrite content increases away from the veins. The phyllic alteration consisting of sericite, pyrite and carbonates is in turn enveloped by argillic alteration which, within the feldspar porphyry, can be identified by the presence of kaolinite and montmorillonite. The argillic alteration can locally be so intense along vein contacts near the surface that the accumulation of clay has caused severe handling problems in the mining of the upper levels of the Brown-McDade deposit (Strathcona Mineral Services Ltd. 2000).

According to Conor Pacific Environmental Technologies Inc. (2000), near-surface oxide gold enrichment is well developed in the Brown-McDade mineralization. Within the oxide zone, gold has been liberated by the oxidation of sulfide minerals and cataclasis. In the subjacent sulfide zone, gold- and silver-bearing sulfides include pyrite, arsenopyrite, sphalerite, galena, sulfosalts, bornite, stibnite and chalcopyrite. Gold is apparently genetically related to an early phase of pyrite mineralization, occurring as 5-40 μm inclusions within pyrite.

CHARACTERIZATION OF THE MOUNT NANSEN TAILINGS POND

Field Investigation and Sampling

The primary purpose of the field program is to acquire adequate samples to determine the storage of remnant cyanide and potentially deleterious metals/trace elements in the tailings impoundment and for subsequent detailed characterization and water-tailings interaction studies. To plan field activities, a preliminary site visit was conducted on October 3, 2001 with INAC personnel to achieve the following goals:

1) Assess site conditions and finalize the field program;
2) Assess the nature and extent of chemical weathering in exposed tailings as well as geologic material in the pit area; and,
3) Sample pit water, tailings pond water and seepage for preliminary analysis.

The main sampling campaign took place on November 13-21, 2001. Assisted by two staff members each from Ace Drillings Services Ltd. and Laberge Environmental Services, 19 holes varying from 2.4 to 9.7 m deep were drilled using a sonic drill (Vibra-Corer) for systematic sampling of tailings in the impoundment (Figure 2). The sonic drill operates on the principle of drill-string oscillation. The drill head, which was powered by a 9-HP Honda engine, produced vibrations that were transferred to the drill string. The imparted vibrations essentially liquefied the surrounding material, allowing the drill rods to penetrate the tailings aided by the weight of the drill head and rod. A continuous tailings core was fed into the centre of the drill rod for later recovery. The drill cores were logged immediately upon retrieval and subdivided and sampled according to visible differences in composition and texture (Appendix A). A total of 132 samples including several overlying waters were collected. To aid classifying various types of tailings and to alleviate the complication of possible cyanide degradation during sample transport, the CANMET/MMSL team conducted 98 weak acid dissociable cyanide (WAD CN), 97 thiocyanate (CNS), 85 ammonia, 72 nitrite and 9 nitrate analyses on tailings pore and overlying water during the field campaign.

While the field sampling effort mainly focused on the tailings impoundment, the Brown-McDade open pit was also briefly examined. About 120 L of pit water was collected through the ice cover for subsequent column test work. Prominent alteration products were collected from the pit walls and two adits for mineralogical and geochemical analyses. An attempt was also made to secure a sample of the scarce sediments deposited at the bottom of the pit.

Classification of the Mount Nansen Tailings

Based on their apparent contrasts in mineralogy, colour and texture observed during field core logging, tailings impounded at Mount Nansen can be divided into four main types. These are (1) oxide-rich silt; (2) oxide-rich clayey silt; (3) sulfide-rich silt; and (4) sulfide-rich clayey silt. The oxide-rich varieties range from yellow-brown to light greyish brown in colour while the sulfide-rich varieties are typically greyish brown. The distribution of these four tailings types in

the tailings impoundment are depicted in cross sections (Appendix B), two of which are illustrated in Figure 3.

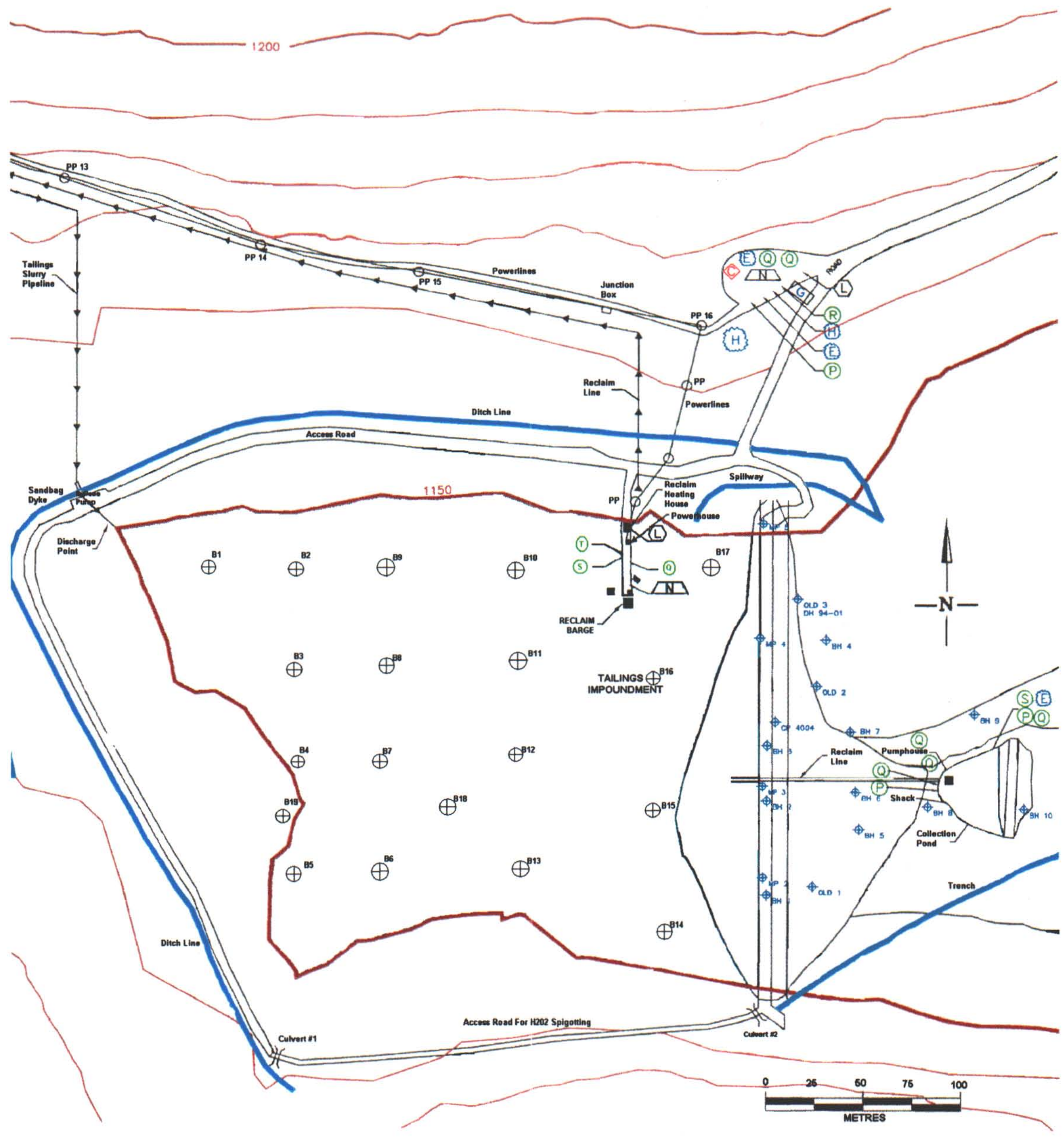
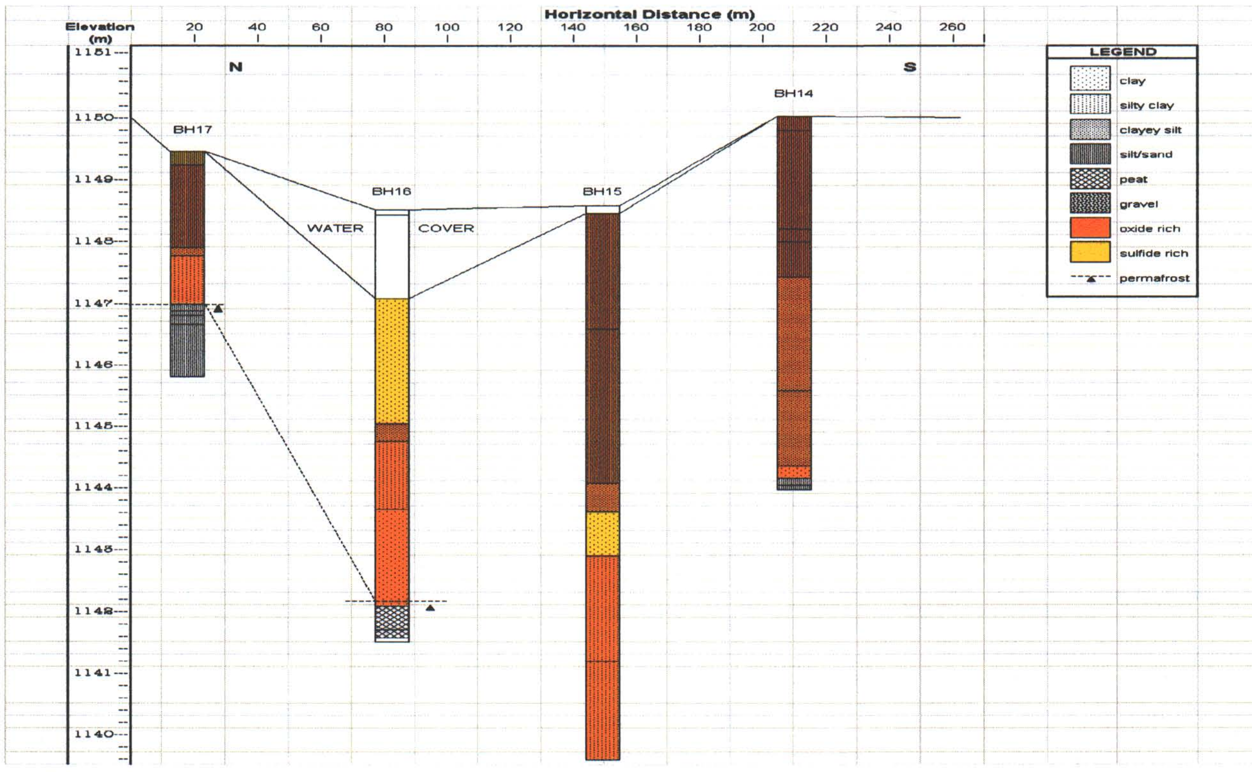


Figure 2. Map of tailings impoundment at Mount Nansen showing drill hole locations.



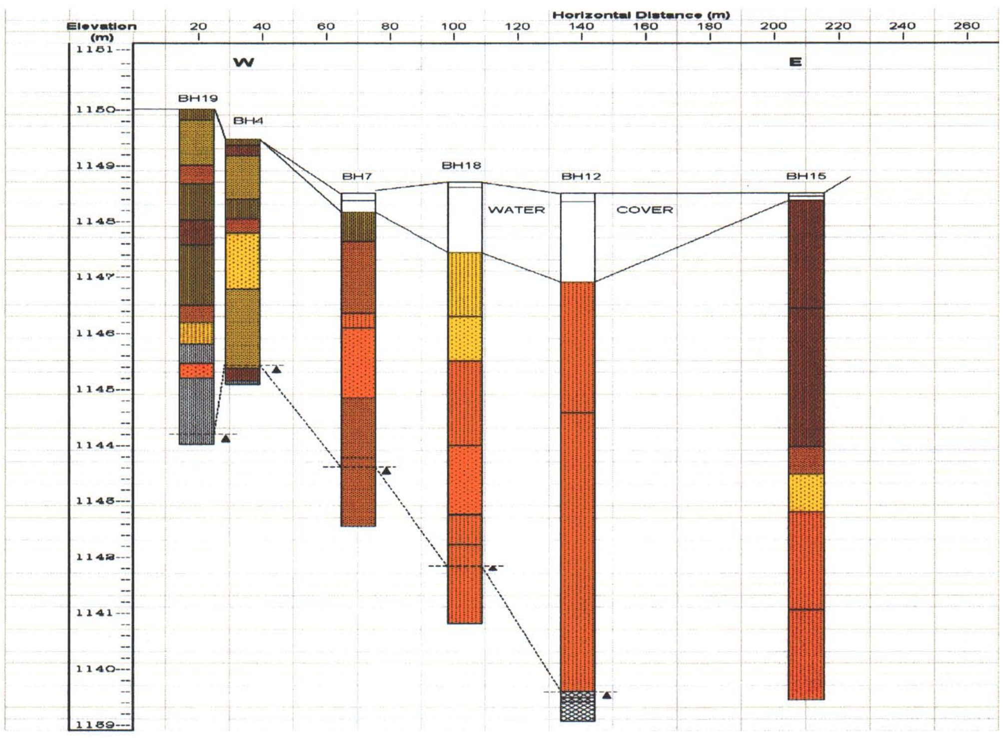


Figure 3. Selected N-S and W-E sections across the Mount Nansen tailings impoundment showing the distribution of various tailings types and the permafrost table.

Estimated from summing core lengths of similar materials, the impounded tailings are comprised of 35.0% oxide silt, 29.8% oxide clay, 16.5% sulfidic silt and 18.7% sulfidic clay. A perusal of a total of eight sections across the impoundment (Appendix B) leads to the following observations:

1. Sulfide-rich tailings are more widespread in the western half (particularly the southwestern quadrant) of the impoundment.
2. The fine tailings (silty clay instead of sandy silt) account for nearly half of the impounded tailings by volume. They are ubiquitous but more concentrated in the middle part of the tailings pond where a water cover usually exists.
3. Contrary to expectation, depth to permafrost is shallower towards the north side (3-4 m) instead of the south side (~7 m) of the impoundment. However, the greatest depth to permafrost is apparently near the seepage return to the pond such that at Hole Location B15 (Figures 2 and 3), no frozen ground has been detected at the drilled depth of 8.8 m.

To quantitatively measure the grain size distribution of the impounded tailings, seven selected samples including four composite and three individual samples were analyzed using a laser scattering particle size analyzer (Horiba LA-300). The detailed results are shown in Appendix C. The coarser tails (oxide and sulfide silts) typically show a trimodal distribution (Figure 4A) with mean particle size ranging from 30 to 119 μm and modes varying from 55-142, 6-7 and 0.4-0.5 μm, respectively. The fine tails (oxide and sulfide clayey silts) typically exhibit a bimodal distribution (Figure 4B) with mean grain size ranging from 4.8 to 13 μm and modes varying from 4-8 μm and 0.3-0.4 μm, respectively.

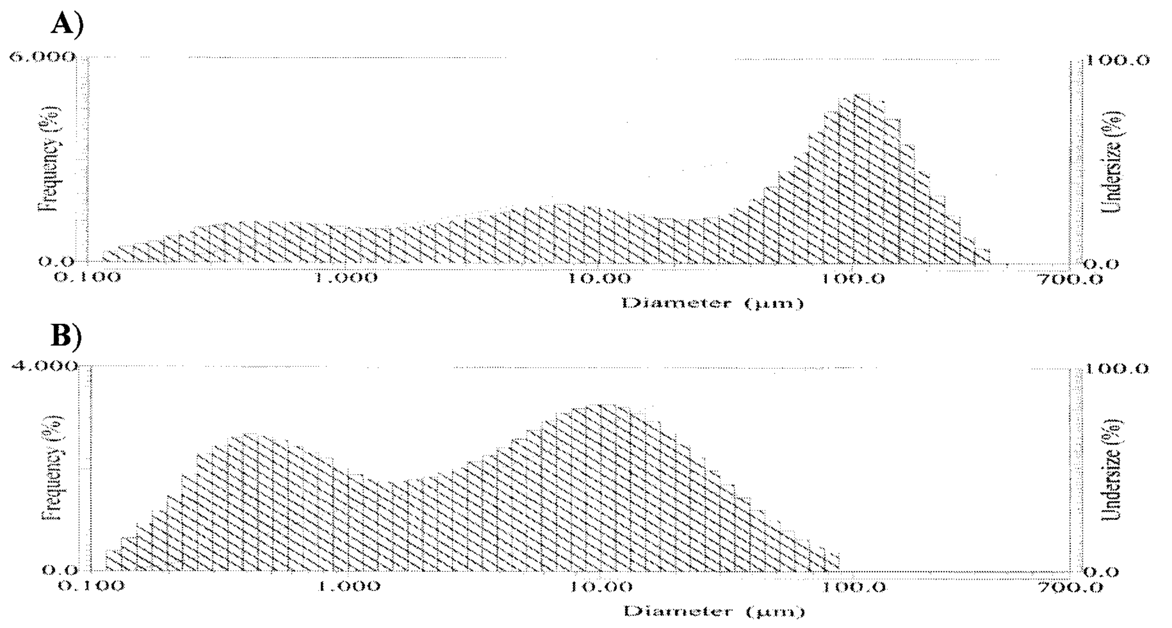


Figure 4. Typical grain size distribution in coarse silt tailings (A) and fine clayey silt tailings (B) at the Mount Nansen tailings impoundment.

Previous Monitoring Work at the Mount Nansen Tailings Pond and Brown-McDade Open Pit

Tailings impounded at Mount Nansen are presumably derived largely from the processing, by cyanidation, of oxidized ore originally containing gold-silver mineralization associated with pyrite and arsenopyrite. The tailings are thus relatively enriched in arsenic and cyanide. Since the commencement of mining operation in 1997, the tailings pond water and seepage return have been closely monitored by both the mine operator and government agencies. Since mine abandonment in 1999, INAC has continued the monitoring to ensure the discharge of effluents meet all water quality criteria stipulated in the expired BYG Natural Resources Inc. water licence, demonstrating INAC's commitment to the standards imposed on licensees. The monitoring data are useful in revealing trends in the evolution of water chemistry in the tailings impoundment. They are thus reviewed to help direct the focus of investigation in the subsequent laboratory test work.

Figures 5 to 8 show time series plots of parameters of interest based on the review of a database containing monitoring data collected by INAC. Salient observations include the following:

1. Since the cessation of mining at Mount Nansen, Total CN (SAD CN) and WAD CN (Figure 5) as well as Total Cu (Figure 8) concentrations in both the tailings pond water and seepage return have continued to decrease with time but there appears to be insignificant attenuation so far for thiocyanate and ammonia (Figures 6 and 7).

2. Although both the cyanate (Figure 6) and Total As (Figure 7) concentrations in the tailings pond water appear to follow a decreasing trend with time, minor cyanate and As remobilization is suggested if the 2001 analyses are accurate.

3. It is intriguing to note that the Total Fe concentration in the seepage return has remained higher than that of the tailings pond water by an order of magnitude most of the time since mine operation (Figure 8).

In contrast to the large number of water monitoring data collected at the tailings impoundment, very few data are available to reveal the temporal evolution in composition for water accumulated in the Brown-McDade open pit since mine abandonment. Cu and Zn appear to be the main parameters of concern. Three samples collected by INAC personnel between March and August 2001 gave 0.06-0.12 mg/L total Cu, 1.6-3.7 mg/L total Zn and pH 7.2-7.8. A sample collected by Conor Pacific Environmental Technologies Inc. in September 1999 gave 0.08 mg/L total Cu, 15 mg/L total Zn and pH 7.5. In contrast, a sample collected by the Environmental Protection Service of Environment Canada in May the same year at presumably the same location rendered 4.9 mg/L dissolved Cu, 49 mg/L dissolved Zn and a pH value of 4.8. In all cases, however, the Zn analyses appear to correlate with dissolved Mn contents. The sparse data available also suggest that there are significant seasonal variations in the pit water chemistry.

CANMET Mining and Mineral Sciences Laboratories

Assessment of Chemical Stability of Impounded Tailings at Mount Nansen, Yukon Territory

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Work performed for:
Water Resources Division, Indian and Northern Affairs Canada, Whitehorse

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EXECUTIVE SUMMARY

To aid with decision-making on the final decommissioning of the Mount Nansen site, the Water Resources Division of Indian and Northern Affairs Canada (INAC), Whitehorse, approached CANMET/MMSL in September 2001 to design a detailed tailings characterization program and conduct relevant field and laboratory testing to assess the chemical stability of the impounded tailings. CANMET/MMSL responded with a proposal incorporating the following major components for investigation:

1. Review of historical monitoring data to identify trends in the evolution of tailings water chemistry;
2. Geochemical and mineralogical analyses to identify a) remnant metal values in the tailings: b) parameters of concern and their modes of occurrence; and, c) relative proportions of various tailings types, if proved different;
3. Short-term leach tests to identify immediate releases of contaminants upon disturbing the tailings;
4. Column testing and selective leaching to predict the long-term behaviour of the impounded tailings;
5. INCO SO_2/Air treatment of selected tailings followed by batch leaching to clarify the functionality of the treatment; and,
6. Investigation of the effect of multiple freeze-thaw cycles on the physical and chemical properties of the impounded tailings.

The acceptance of the proposal by INAC in October commenced an intensive field sampling campaign in mid-November. Nineteen boreholes were drilled systematically across the 200m by 200m impoundment to sample tailings for subsequent laboratory testing. Based on their observed contrasts in mineralogy, colour and texture during core logging, the tailings were divided into four categories, namely, oxide silt, oxide clay, sulfide silt and sulfide clay. The drilling program also revealed accelerated thawing of permafrost in the vicinity of the tailings seepage return located near the centre of the tailings dam.

Geochemical analyses show that the tailings solids, regardless of detailed type, contain anomalous contents of silver (Ag, up to 80 μg/g), arsenic (As, up to 0.6%), copper (Cu, up to 0.06%), lead (Pb, up to 0.6%), antimony (Sb, up to 0.1%) and zinc (Zn, up to 0.3%) and they are all potentially acid-generating to a small degree. The Ag content represents the only remnant metal value in the tailings and the other trace elements pose potential environmental liabilities. Depending on the tailings type, the tailings porewater contains on average 4-17 mg/L strong acid-dissociable cyanide (SAD CN or Total CN) and 3-5 mg/L weak acid-dissociable cyanide (WAD CN). Numerically these are about an order of magnitude lower than the same associated with the tailings solids (with the latter expressed in μg/g). The average concentrations of 0.5-2.3 mg/L As and 3.6-6.5 mg/L Cu are also observed in the porewater of the four types of tailings. Generally, there is a good correlation between dissolved Cu and WAD CN in the porewaters.

Mineralogical analyses reveal that the tailings are comprised predominantly of quartz with minor to subordinate amounts of sericite/illite, alkali feldspar, jarosite, kaolinite,

montmorillonite, goethite, and gypsum. Pyrite is the most common sulfide mineral observed. Arsenopyrite is typically replaced by scorodite.

Eight columns have been set up to simulate, in duplicate, the disposal of coarse, high- and low-sulfide tailings under a shallow water cover, a mixture of silty slurried tailings under a water cover and mixed tailings under flow through conditions. While rates of cyanide degradation and trace element releases cannot yet be established due to the short duration of the experiment, the column testing demonstrates that thiocyanate (CNS), ammonia (NH_4-N), As and possibly Sb may be mobilized in tailings porewater and the water cover at concentrations of concern. If the tailings were to be relocated to the open pit, moving the tailings in a relatively dry form would likely have a less significant impact on the resultant water cover quality than transferring the tailings as a slurry.

Sequential batch leach testing with clayey tailings also indicates that As and Sb are the only trace elements susceptible to significant leaching with intense perturbation of the tailings. Although the INCO SO_2/Air treatment is effective in destroying CN associated with the tailings solids, simultaneous releases of elevated concentrations of Total CN, CNS and NH_4-N to the liquid phase have been observed. The process also seems to affect the leaching of As, Cu, Sb and Zn to various extents.

Partial sequential extraction analyses were conducted on six typical tailings from Mount Nansen to investigate the impact of a changing environment on the behaviour of the trace elements occurring in anomalous amounts in the tailings. The results indicate that As and Zn are susceptible to remobilization under mildly acidic or reducing conditions. In comparison, Cu, Pb and Sb are less readily released. Freeze-thaw studies with the same six samples indicate that multiple freeze thaw events do not significantly affect the metal leachability of the test tailings. However, an increase in average grain size may occur in some samples resulting from the aggregation of clay particles in the freezing process.

Overall, the impounded tailings appear to represent a relatively stable system from a chemical perspective. Only the CNS and NH_4-N will remain parameters of major concern in the medium term. Although laboratory testing suggests potential As and Zn release with changing environmental conditions and tailings perturbation, such has not yet been observed to occur in any significant extent in the tailings impoundment. Elevated concentrations of dissolved As have been found only in tailings porewater (up to an average of 2.33 mg/L in the clayey oxide tailings), which has not escaped the impoundment. It is recommended that detailed information on mineral distribution, hydrology and hydrogeology be collected from the Brown-McDade open pit. This would provide relevant data to critically compare, preferably by using a risk assessment approach, the benefits of retaining the tailings in the existing impoundment versus relocation to the open pit. Meanwhile, a scaled model of the impoundment can be constructed to study water-tailings interaction under simulated field conditions. Further research on the treatment of CNS and NH_4-N are also desirable.

DISCLAIMER

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INTRODUCTION

Project Background

The Mount Nansen Mine, hosting gold mineralization, was operated by BYG Natural Resources Inc. between November 1997 and February 1999. The operator went bankrupt and abandoned the mine site in July 1999, leaving significant environmental liabilities. Of particular concern is the chemical and physical stability of approximately 250,000 tonnes of impounded, cyanide- and arsenic-bearing tailings. Since mine abandonment, the Water Resources Division of Indian and Northern Affairs Canada (INAC), Whitehorse, has maintained operation of the effluent treatment system at the site to reduce the potential for serious environmental impacts resulting from tailings impoundment failure or uncontrolled discharge from the emergency spillway.

To facilitate decision-making with regard to long-term maintenance or decommissioning of the site, INAC requires the following information:

1. Metals and other contaminants occurring in the tailings and their response to long-term water contact and repeated wetting-drying cycles;
2. Long-term prognosis for treatability of thiocyanate generated by the modified INCO SO_2/Air water treatment system;
3. Cause of accelerated cyanide release from partially or completely drained tailings after a rainstorm event;
4. Proportion of sulfide versus oxide tailings in the impoundment and its impact on the long-term treatability of porewater which migrates to the collection pond; and,
5. Implications of moving the tailings and depositing them in the Brown-McDade Open Pit and the preferred means of transport.

To address the above issues, INAC approached CANMET/MMSL in September 2001 to design a detailed tailings characterization program and conduct relevant field and laboratory testing to acquire the necessary data. A draft research proposal was submitted to INAC in mid-September. After a preliminary visit to the Mount Nansen site followed by a meeting with INAC officials in early October, a formal proposal was prepared and approved by INAC in mid-October 2001. This started an intensive field and laboratory investigation program on the chemical stability of tailings impounded at the Mount Nansen tailings pond, the results of which are detailed in this report.

Scope of Work

All field and laboratory investigations were designed for completion by the end of March 2002. Because of the short time frame allowed for the research project, it is understood that not all of the questions raised by INAC may be fully answered at the end of the study. However, a comprehensive battery of test work has been incorporated to render sufficient data to reveal key issues related to the short- and long-term chemical stability of the impounded tailings

and to evaluate the advantages and pitfalls of alternative decommissioning strategies for the site. Major components of the investigation include the following:

1. Review of historical monitoring data for trend identification;
2. Detailed tailings characterization to identify:
   a) if there are remnant metal values in the tailings;
   b) parameters of concern and their modes of occurrence where appropriate; and,
   c) relative proportions of various tailings types if proved different;
3. Short-term leach tests to identify immediate releases of contaminant, if any, upon disturbing the tailings;
4. Column testing and selective leaching to predict the long-term behaviour of the impounded tailings;
5. INCO SO_2/Air treatment of selected tailings followed by batch leaching to clarify the functionality of the treatment; and
6. Cursory investigation of the effect of multiple-freeze-thaw cycles on the physical and chemical properties of the impounded tailings.

Report Structure

This report contains ten sections. Section 1 briefly describes the project background, the scope of work and the organization of the subject report. Section 2 outlines the setting and general geology of the study site. Section 3 presents the physical characteristics of the tailings impoundment as revealed in the drilling program conducted to sample tailings for laboratory testing. Historic site monitoring data based on company and government records are also summarized. Section 4 deals with tailings chemistry and mineralogy. Various data including solids and water analyses rendered by inductively coupled plasma atomic emission spectrometry (ICPAES) and mass spectrometry (ICPMS), acid-base-accounting (ABA) characteristics and results of mineralogical analysis by petrography, X-ray diffraction (XRD) and scanning electron microscopy (SEM) supplemented with energy-dispersive X-ray (EDX) analysis are described. The analyses of grab samples from the Brown-McDade open pit, which is a candidate for long-term disposal of the tailings, are also included in this section.

Sections 5 through 7 document the results of various tests completed with the collected tailings. These include column testing of the coarser tails (Section 5), sequential batch testing of the fine tails, which also incorporates INCO SO_2/Air treatment in one of the tests (Section 6), and other test work with various leach media as well as the investigation of freeze-thaw effects (Section 7). The test results, especially with regard to their implications on the long-term chemical stability of the impounded tailings and appropriate decommissioning strategies, are discussed in Section 8. Section 9 summarizes conclusions drawn in the study and recommended further work is outlined in Section 10.

SITE SETTING AND GENERAL GEOLOGY

Site Location and General Setting

The abandoned Mount Nansen Mine previously operated by BYG Natural Resources Inc. is located about 60 km west of Carmacks and 180 km north of Whitehorse (Figure 1-Inset). The mine site lies in the Dawson Range consisting of rounded ridges and shallow valleys with elevations ranging from 945 to 1525 m. Drainage from the property flows through Nansen Creek to the west and Victoria Creek to the east (Figure 1) to the Nisling River, which in turn drains into the Yukon River system. Dome Creek, a tributary of Victoria Creek, is directly impacted by the Mount Nansen mine site, especially by historical underground mine workings, the mill facility and the tailings impoundment.

The average monthly temperature in the Mount Nansen area ranges from a high of about 15°C in July to a low of about -15°C in January. The average annual precipitation, which occurs mostly as rain in the summer months, is about 25 cm. The winter snow pack is typically 30 to 40 cm. Discontinuous permafrost ranging from 30 to 60 m thick occurs at a depth varying from 0.4 to 5 m depending on the nature of ground cover. The active layer is up to 1.5 m thick.

The mine site lies within the Dawson Range Ecosystem. Open stands of black spruce and white spruce occur in valley bottoms and benchlands near Dome Creek. While upper slopes are generally devoid of trees, lower slopes host stunted black spruce and trembling aspen. From valley bottoms to above the treeline, birch and willow shrubs form an extensive cover while Labrador tea is the dominant understorey and mosses and lichens constitute the common ground vegetation. Natural weathering of geologic materials including bedrock and surface sediments generates unstable upper slopes and secondary surficial sediments along the valley bottoms. Where surface and subsurface weathering is intense, bedrock can become friable and unstable.

General Geology

The Mount Nansen area lies within the Yukon-Tanana Terrane, the regional geology of which has recently been described in detail by Carlson (1987). Hart and Langdon (1997) as well as Andersen and Stroshein (1997) further discussed the local geology and mineral deposits of the Mount Nansen camp. A brief account of the property geology is furnished below, providing the background information against which later mineralogical analyses can be compared and discussed.

The Mount Nansen property is located in the eastern part of the Yukon Crystalline Terrane between the Coast Plutonic Complex to the southwest and the Yukon Cataclastic Terane to the northeast. The oldest rocks occurring in the area are Palezoic (early Mississippian) meta-sedimentary schists and gneisses, which were intruded by early Cretaceous plutons ranging from diorite, monzonite to syenite in composition. These felsic plutonic rocks were in turn intruded by and host younger mid-Cretaceous mafic to intermediate volcanic rocks of the Mount Nansen Volcanic Suite.

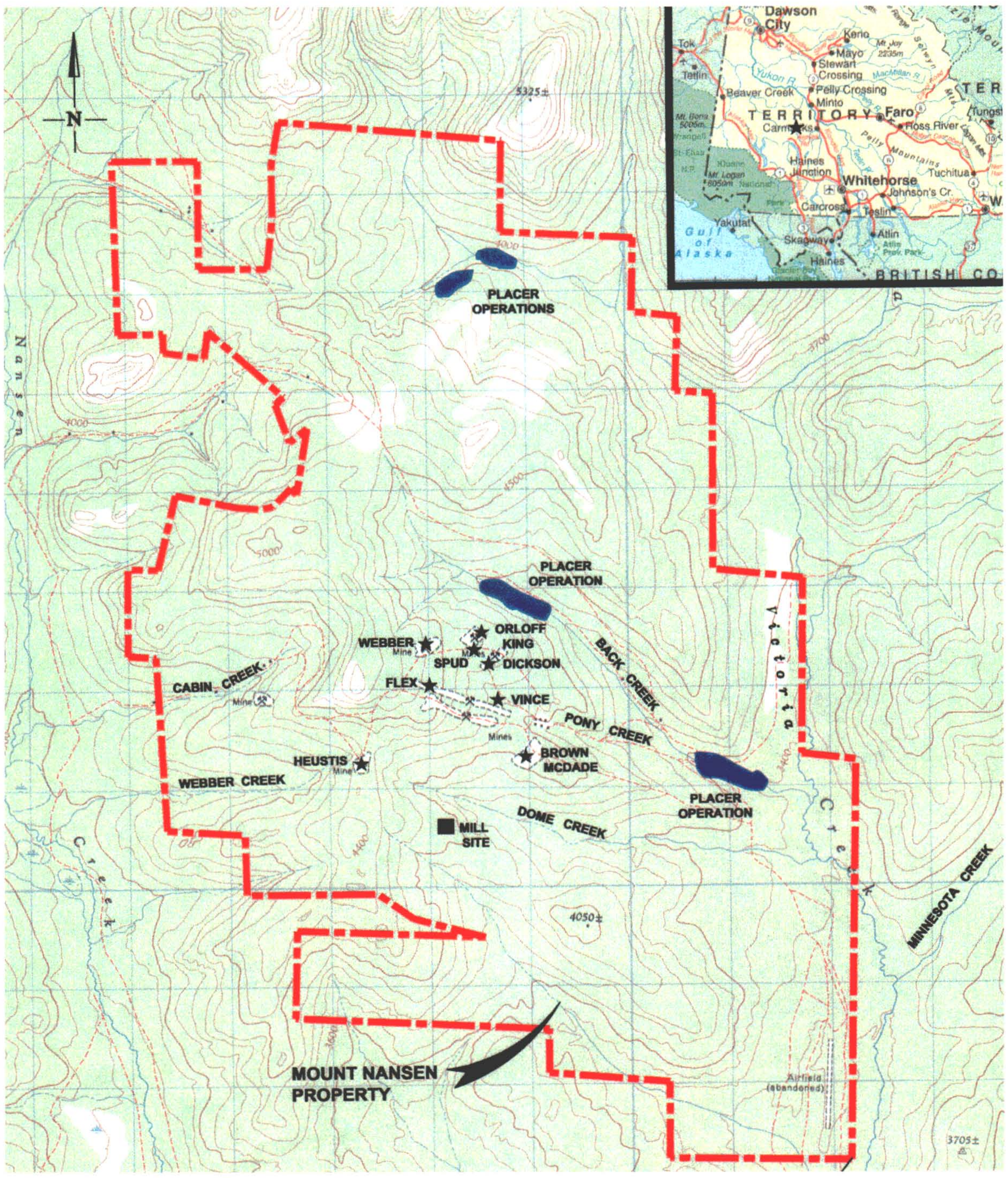


Figure 1. Location map of the Mount Nansen property. (Scale: each grid = 1 km)

Prior to abandoning the mine site, BYG Natural Resources Inc. had identified nine epithermal deposits at the Mount Nansen property (Figure 1). The three most westerly mineralized zones (i.e., Webber, Huestis and Flex) are hosted by older Paleozoic rocks dominated by strongly foliated, inter-layered quartz-feldspar-chlorite gneiss, quartzite, minor

amphibolite and augen gneiss. Further southeast, the main mineralized zone named the Brown-McDade deposit is hosted by locally foliated, mid-Cretaceous granodiorite, quartz diorite and quartz monzonite. Occurring in the northern portion of the property is a large quartz-feldspar porphyry intrusive complex (the Mount Nansen porphyry complex) with flanking andesitic flow and tuff units. Within this intrusive complex, zones of small and silicified breccia pipes occur, locally with associated gold values. Propylitic alteration, characterized by the replacement of hornblende by epidote, calcite, pyrite and magnetite, is widespread peripheral to the Mount Nansen porphyry complex and has affected most rocks in the property.

Structurally, faulting is the main feature occurring in the Mount Nansen property. Two fault sets are prominent. One set trends north-northwest with dips varying from 50 to 70 degrees to the southwest. This fault set is parallel to the main vein direction at the Brown-McDade deposit and locally mineralized. The other set trends southeast with subvertical dips and locally cuts some of the mineralized zones. These faults form part of the larger regional structure known as the Mt. Nansen Trend (Hart and Langdon, 1997).

The property has not been affected by recent glacial activities. Consequently, weathering can reach depths in excess of 70 m from the surface. Generally, the depth of oxidation as evidenced by alteration of sulfides to limonite is variable throughout the property.

Modes of Mineralization

As reviewed by Strathcona Mineral Services Ltd. (2000), two forms of mineralization occur in the Mount Nansen property. The more common form occurs as structurally controlled planar veins consisting of quartz, carbonate and varying amounts of sulfides. The vein systems can occur as simple veins like those observed at the Huestis and Webber zones or as a complex anastomosing series of veins and veinlets prominent at the Brown-McDade deposit. Better gold values are generally restricted to steeply plunging shoots with a stronger vertical rather than horizontal continuity. The less common form of mineralization occurs as siliceous pipe-like structures, which may be sulfide-rich as observed at the north end of the Brown-McDade open pit or sulfide-poor as noted at the PPBX showing.

Sulfide minerals occurring in mineralization zones at the Mount Nansen property include pyrite, arsenopyrite and lesser amounts of galena, sphalerite, chalcopyrite, stibnite and various sulfosalts. Gold occurs as minute inclusions (5 to 40 μm across) in early pyrite and arsenopyrite, as peripheral infiltrations in several sulfide minerals and as "free gold" intergrown with galena, freibergite and other sulfosalts. Silver occurs mostly as inclusions in galena and sphalerite but freibergite and miargyrite have been identified from the property. Silver/gold ratios vary from 7/1 in the planar vein mineralization to 3/1 in the breccia pipe mineralization. The silver content appears to vary directly with the base metal content of the ore material (Strathcona Mineral Services Ltd., 2000).

In the Mount Nansen camp, Hart and Langdon (1997) recognized two types of epithermal veins. These are (1) an early, cherty quartz-sulfide vein with fine-grained pyrite and arsenopyrite; and, (2) a later coarse-grained quartz-sulfide vein with pyrite, galena and sphalerite

and higher precious metal values. It is not clear if both vein types are prevalent in the two forms of mineralization described above.

Mineralization and Alteration at the Brown-McDade Open Pit

As the bulk of the tailings impounded at the Mount Nansen tailings pond is presumably derived from the processing of ore materials from the Brown-McDade open pit, it is instructive to review the mineralogy and alteration of the ore deposit. Moreover, transfer of impounded tailings to the Brown-McDade open pit has been considered as a long-term decommissioning option for the mine site (Strathcona Mineral Services Ltd., 2000). A better appreciation of alteration patterns prevailing at the open pit will aid with developing proper strategies for site closure.

In agreement with the general forms of mineralization reviewed above for the entire Mount Nansen camp, Conor Pacific Environmental Technologies Inc. (2000) also reported that open-pit mining of the Brown-McDade deposit revealed two separate ore mineralization types. These are (1) gold-silver vein mineralization forming a complex vein swarm hosted in a massive feldspar porphyry dike, and (2) a siliceous, sulfide-rich and gold-silver mineralized breccia in a pipe-like structure. The two mineralization types are separated by a complex, steeply dipping and north-easterly trending fault that crosscuts the open pit north of the Pony Creek adit. The gold-silver veins, which are largely planar in structure, are exposed in the southern two-thirds of the pit while the mineralized breccia zone is exposed in the northern one-third of the open pit. The latter is reportedly hosted by re-crystallized limestone, which has not been confirmed in the cursory examination of the open-pit during the course of this study.

Three main types of hydrothermal alteration, namely, silicification, argillic and phyllic alterations, have been reported by Conor Pacific Environmental Technologies Inc. (2000) in the Brown-McDade open pit. Silicification and bleached clay (argillic) alteration zones are commonly 1–3 m wide. Adjacent to veins and breccia zones, silicification usually occurs in vuggy form with yellow weathering and drusy quartz lining in the fine vug cavities. The silicified zone is usually enclosed by a phyllic alteration zone, in which the disseminated pyrite content increases away from the veins. The phyllic alteration consisting of sericite, pyrite and carbonates is in turn enveloped by argillic alteration which, within the feldspar porphyry, can be identified by the presence of kaolinite and montmorillonite. The argillic alteration can locally be so intense along vein contacts near the surface that the accumulation of clay has caused severe handling problems in the mining of the upper levels of the Brown-McDade deposit (Strathcona Mineral Services Ltd. 2000).

According to Conor Pacific Environmental Technologies Inc. (2000), near-surface oxide gold enrichment is well developed in the Brown-McDade mineralization. Within the oxide zone, gold has been liberated by the oxidation of sulfide minerals and cataclasis. In the subjacent sulfide zone, gold- and silver-bearing sulfides include pyrite, arsenopyrite, sphalerite, galena, sulfosalts, bornite, stibnite and chalcopyrite. Gold is apparently genetically related to an early phase of pyrite mineralization, occurring as 5-40 μm inclusions within pyrite.

CHARACTERIZATION OF THE MOUNT NANSEN TAILINGS POND

Field Investigation and Sampling

The primary purpose of the field program is to acquire adequate samples to determine the storage of remnant cyanide and potentially deleterious metals/trace elements in the tailings impoundment and for subsequent detailed characterization and water-tailings interaction studies. To plan field activities, a preliminary site visit was conducted on October 3, 2001 with INAC personnel to achieve the following goals:

1) Assess site conditions and finalize the field program;
2) Assess the nature and extent of chemical weathering in exposed tailings as well as geologic material in the pit area; and,
3) Sample pit water, tailings pond water and seepage for preliminary analysis.

The main sampling campaign took place on November 13-21, 2001. Assisted by two staff members each from Ace Drillings Services Ltd. and Laberge Environmental Services, 19 holes varying from 2.4 to 9.7 m deep were drilled using a sonic drill (Vibra-Corer) for systematic sampling of tailings in the impoundment (Figure 2). The sonic drill operates on the principle of drill-string oscillation. The drill head, which was powered by a 9-HP Honda engine, produced vibrations that were transferred to the drill string. The imparted vibrations essentially liquefied the surrounding material, allowing the drill rods to penetrate the tailings aided by the weight of the drill head and rod. A continuous tailings core was fed into the centre of the drill rod for later recovery. The drill cores were logged immediately upon retrieval and subdivided and sampled according to visible differences in composition and texture (Appendix A). A total of 132 samples including several overlying waters were collected. To aid classifying various types of tailings and to alleviate the complication of possible cyanide degradation during sample transport, the CANMET/MMSL team conducted 98 weak acid dissociable cyanide (WAD CN), 97 thiocyanate (CNS), 85 ammonia, 72 nitrite and 9 nitrate analyses on tailings pore and overlying water during the field campaign.

While the field sampling effort mainly focused on the tailings impoundment, the Brown-McDade open pit was also briefly examined. About 120 L of pit water was collected through the ice cover for subsequent column test work. Prominent alteration products were collected from the pit walls and two adits for mineralogical and geochemical analyses. An attempt was also made to secure a sample of the scarce sediments deposited at the bottom of the pit.

Classification of the Mount Nansen Tailings

Based on their apparent contrasts in mineralogy, colour and texture observed during field core logging, tailings impounded at Mount Nansen can be divided into four main types. These are (1) oxide-rich silt; (2) oxide-rich clayey silt; (3) sulfide-rich silt; and (4) sulfide-rich clayey silt. The oxide-rich varieties range from yellow-brown to light greyish brown in colour while the sulfide-rich varieties are typically greyish brown. The distribution of these four tailings types in

the tailings impoundment are depicted in cross sections (Appendix B), two of which are illustrated in Figure 3.

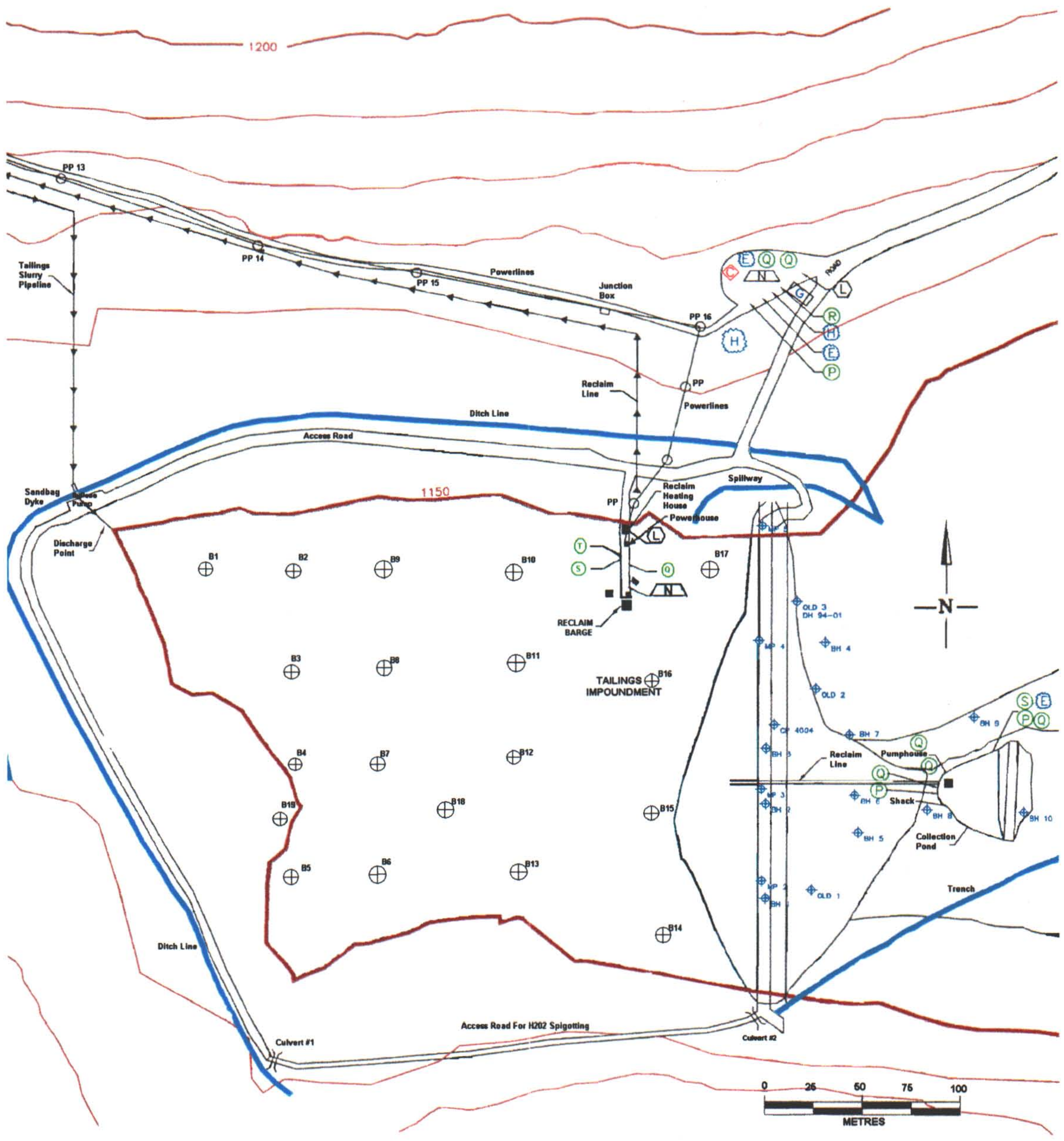


Figure 2. Map of tailings impoundment at Mount Nansen showing drill hole locations.

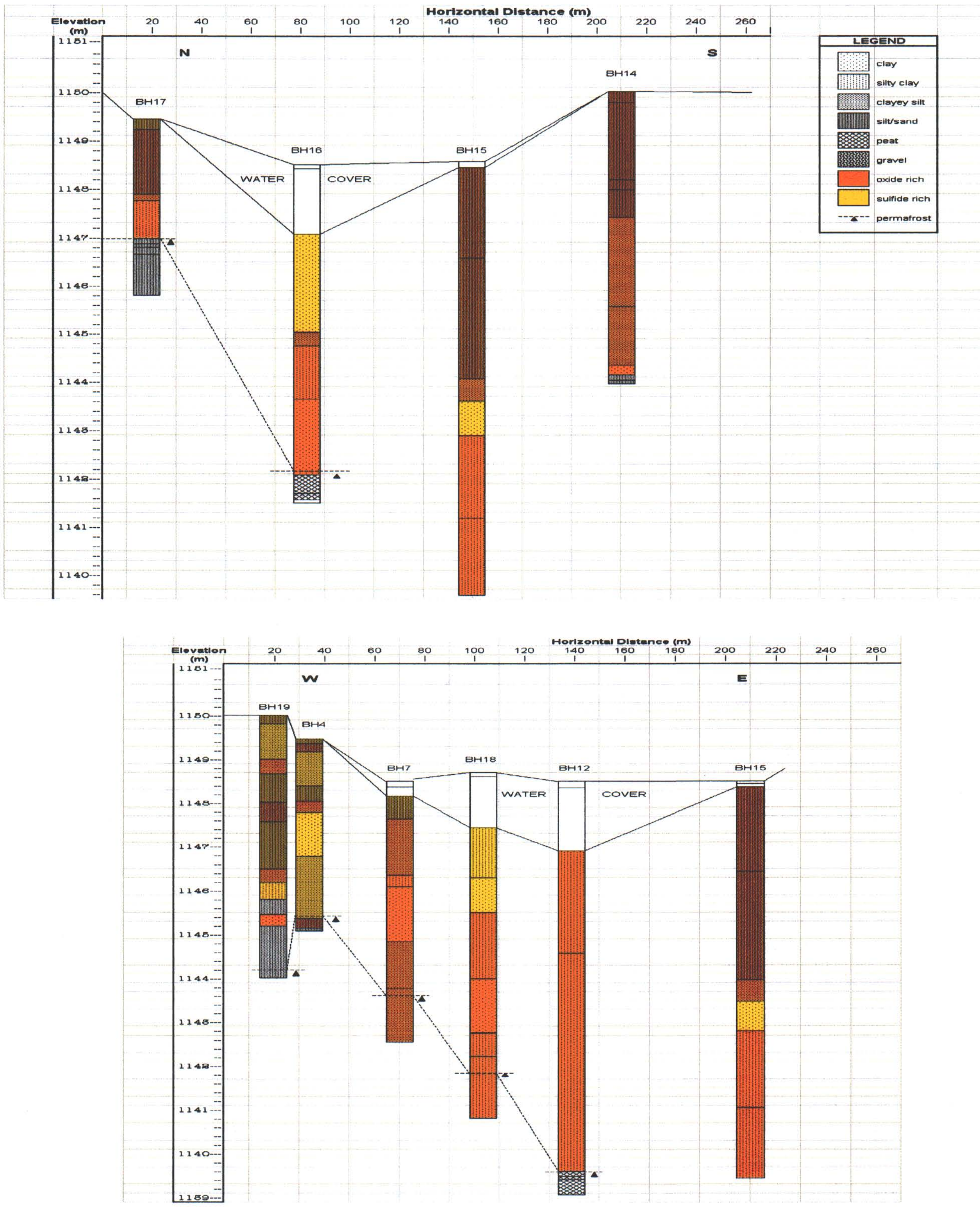


Figure 3. Selected N-S and W-E sections across the Mount Nansen tailings impoundment showing the distribution of various tailings types and the permafrost table.

Estimated from summing core lengths of similar materials, the impounded tailings are comprised of 35.0% oxide silt, 29.8% oxide clay, 16.5% sulfidic silt and 18.7% sulfidic clay. A perusal of a total of eight sections across the impoundment (Appendix B) leads to the following observations:

1. Sulfide-rich tailings are more widespread in the western half (particularly the southwestern quadrant) of the impoundment.
2. The fine tailings (silty clay instead of sandy silt) account for nearly half of the impounded tailings by volume. They are ubiquitous but more concentrated in the middle part of the tailings pond where a water cover usually exists.
3. Contrary to expectation, depth to permafrost is shallower towards the north side (3-4 m) instead of the south side (~7 m) of the impoundment. However, the greatest depth to permafrost is apparently near the seepage return to the pond such that at Hole Location B15 (Figures 2 and 3), no frozen ground has been detected at the drilled depth of 8.8 m.

To quantitatively measure the grain size distribution of the impounded tailings, seven selected samples including four composite and three individual samples were analyzed using a laser scattering particle size analyzer (Horiba LA-300). The detailed results are shown in Appendix C. The coarser tails (oxide and sulfide silts) typically show a trimodal distribution (Figure 4A) with mean particle size ranging from 30 to 119 μm and modes varying from 55-142, 6-7 and 0.4-0.5 μm, respectively. The fine tails (oxide and sulfide clayey silts) typically exhibit a bimodal distribution (Figure 4B) with mean grain size ranging from 4.8 to 13 μm and modes varying from 4-8 μm and 0.3-0.4 μm, respectively.

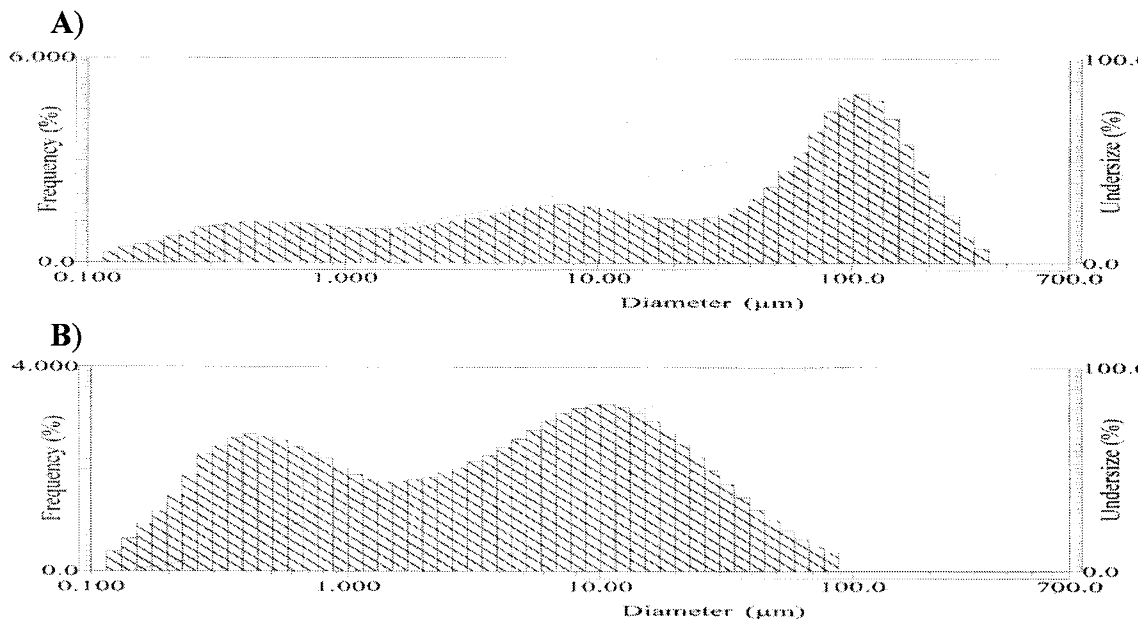


Figure 4. Typical grain size distribution in coarse silt tailings (A) and fine clayey silt tailings (B) at the Mount Nansen tailings impoundment.

Previous Monitoring Work at the Mount Nansen Tailings Pond and Brown-McDade Open Pit

Tailings impounded at Mount Nansen are presumably derived largely from the processing, by cyanidation, of oxidized ore originally containing gold-silver mineralization associated with pyrite and arsenopyrite. The tailings are thus relatively enriched in arsenic and cyanide. Since the commencement of mining operation in 1997, the tailings pond water and seepage return have been closely monitored by both the mine operator and government agencies. Since mine abandonment in 1999, INAC has continued the monitoring to ensure the discharge of effluents meet all water quality criteria stipulated in the expired BYG Natural Resources Inc. water licence, demonstrating INAC's commitment to the standards imposed on licensees. The monitoring data are useful in revealing trends in the evolution of water chemistry in the tailings impoundment. They are thus reviewed to help direct the focus of investigation in the subsequent laboratory test work.

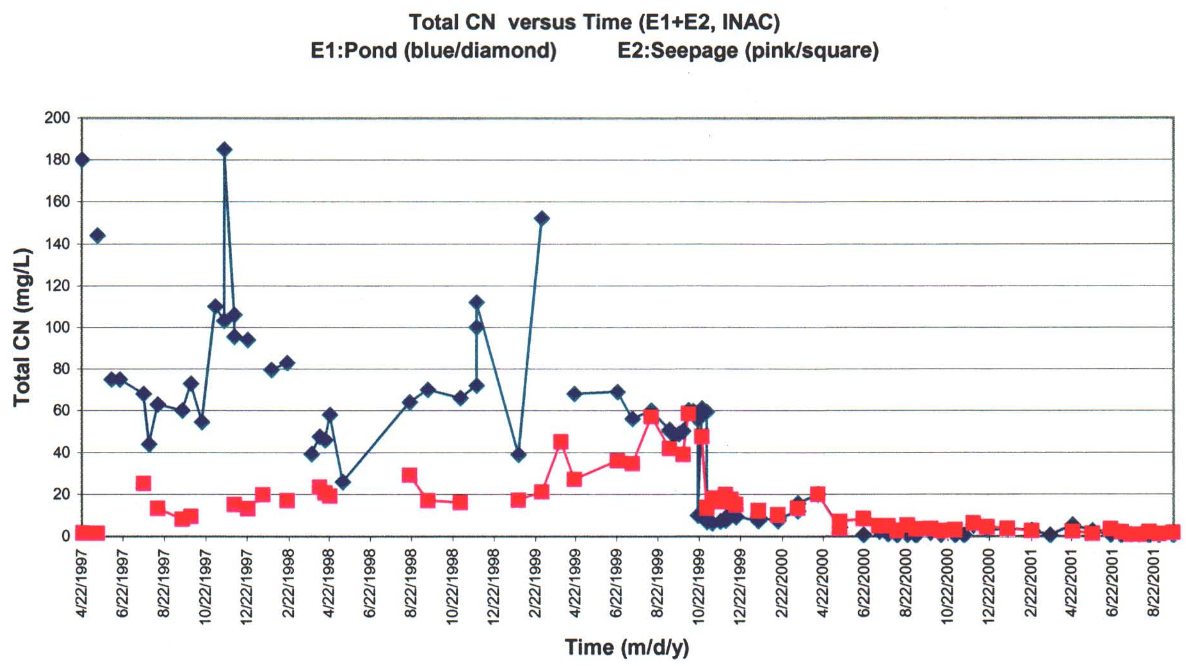
Figures 5 to 8 show time series plots of parameters of interest based on the review of a database containing monitoring data collected by INAC. Salient observations include the following:

1. Since the cessation of mining at Mount Nansen, Total CN (SAD CN) and WAD CN (Figure 5) as well as Total Cu (Figure 8) concentrations in both the tailings pond water and seepage return have continued to decrease with time but there appears to be insignificant attenuation so far for thiocyanate and ammonia (Figures 6 and 7).

2. Although both the cyanate (Figure 6) and Total As (Figure 7) concentrations in the tailings pond water appear to follow a decreasing trend with time, minor cyanate and As remobilization is suggested if the 2001 analyses are accurate.

3. It is intriguing to note that the Total Fe concentration in the seepage return has remained higher than that of the tailings pond water by an order of magnitude most of the time since mine operation (Figure 8).

In contrast to the large number of water monitoring data collected at the tailings impoundment, very few data are available to reveal the temporal evolution in composition for water accumulated in the Brown-McDade open pit since mine abandonment. Cu and Zn appear to be the main parameters of concern. Three samples collected by INAC personnel between March and August 2001 gave 0.06-0.12 mg/L total Cu, 1.6-3.7 mg/L total Zn and pH 7.2-7.8. A sample collected by Conor Pacific Environmental Technologies Inc. in September 1999 gave 0.08 mg/L total Cu, 15 mg/L total Zn and pH 7.5. In contrast, a sample collected by the Environmental Protection Service of Environment Canada in May the same year at presumably the same location rendered 4.9 mg/L dissolved Cu, 49 mg/L dissolved Zn and a pH value of 4.8. In all cases, however, the Zn analyses appear to correlate with dissolved Mn contents. The sparse data available also suggest that there are significant seasonal variations in the pit water chemistry.



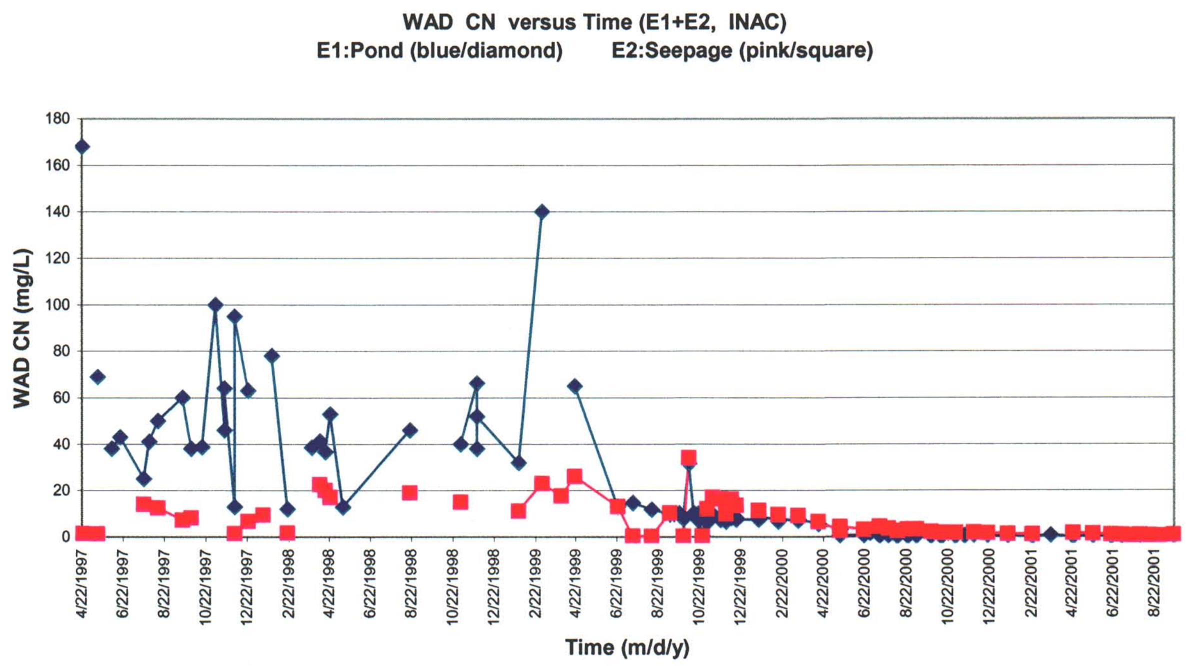
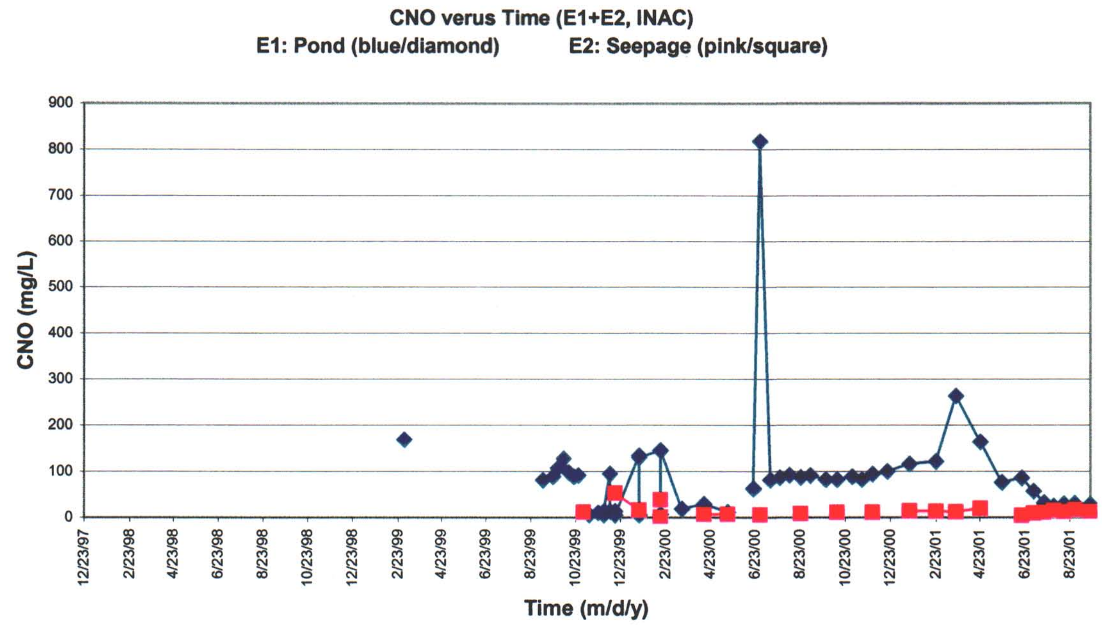


Figure 5. Temporal variation of total CN (upper plot) and WAD CN (lower plot) in the tailings pond water and seepage return based on INAC monitoring data.



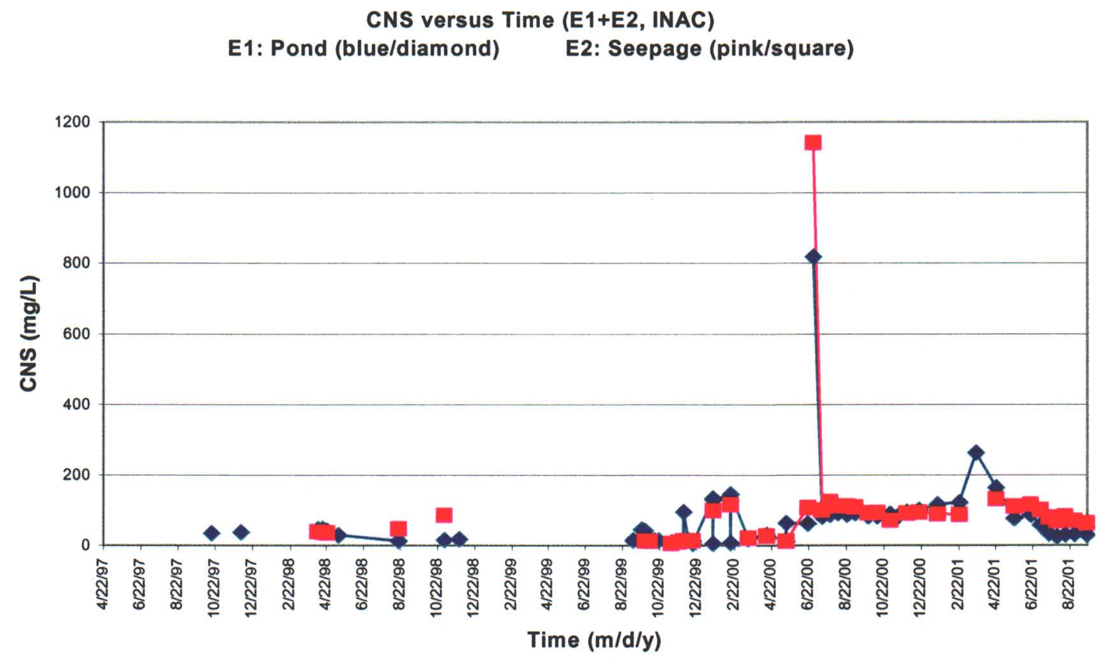
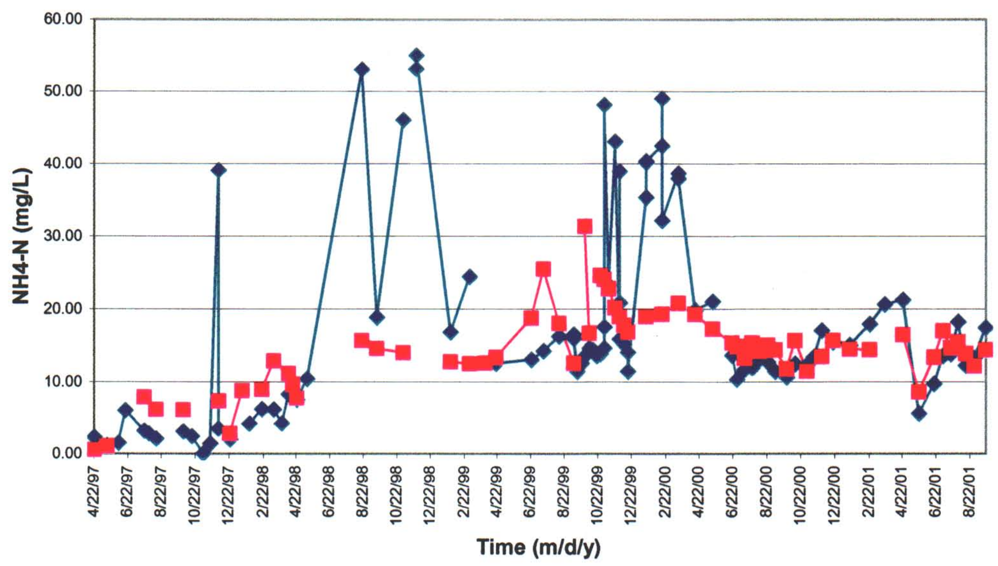


Figure 6. Temporal variation of cyanate (CNO, upper plot) and thiocyanate (CNS, lower plot) in the tailings pond water and seepage return based on INAC monitoring data.

Dissolved Ammonia versus Time (E1+E2, INAC)
E1:Pond (blue/diamond) E2:Seepage (pink/square)



Total Arsenic versus Time (E1+E2, INAC)
E1:Pond (blue/diamond) E2:Seepage (pink/square)

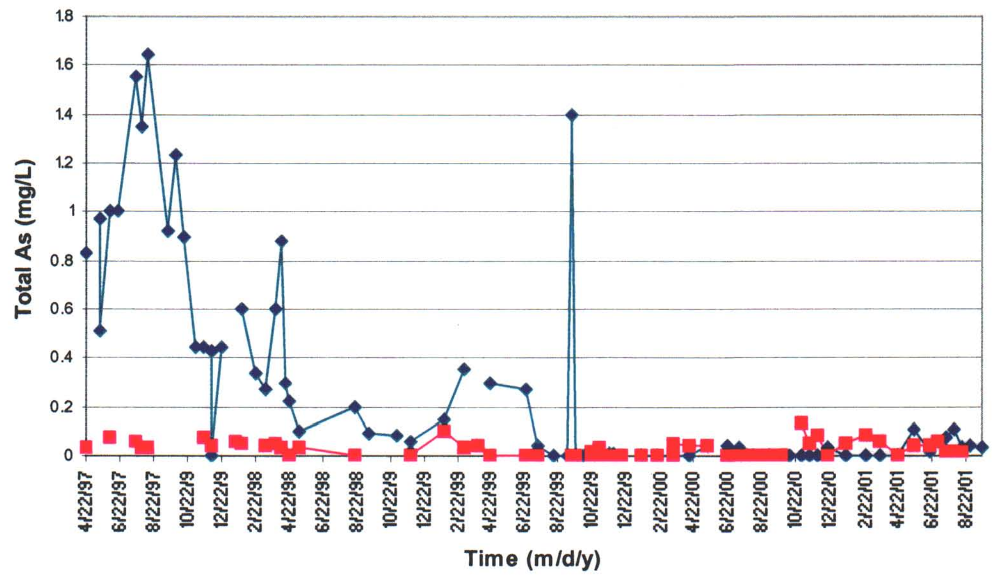
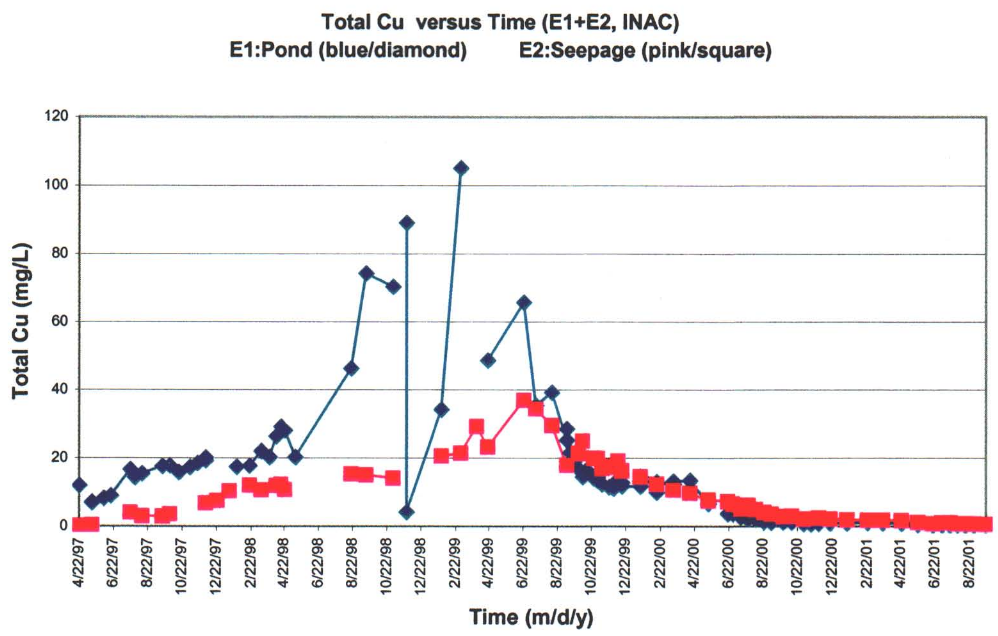


Figure 7. Temporal variation of dissolved ammonia (NH_4-N, upper plot) and total arsenic (Total As, lower plot) in the tailings pond water and seepage return based on INAC monitoring data.



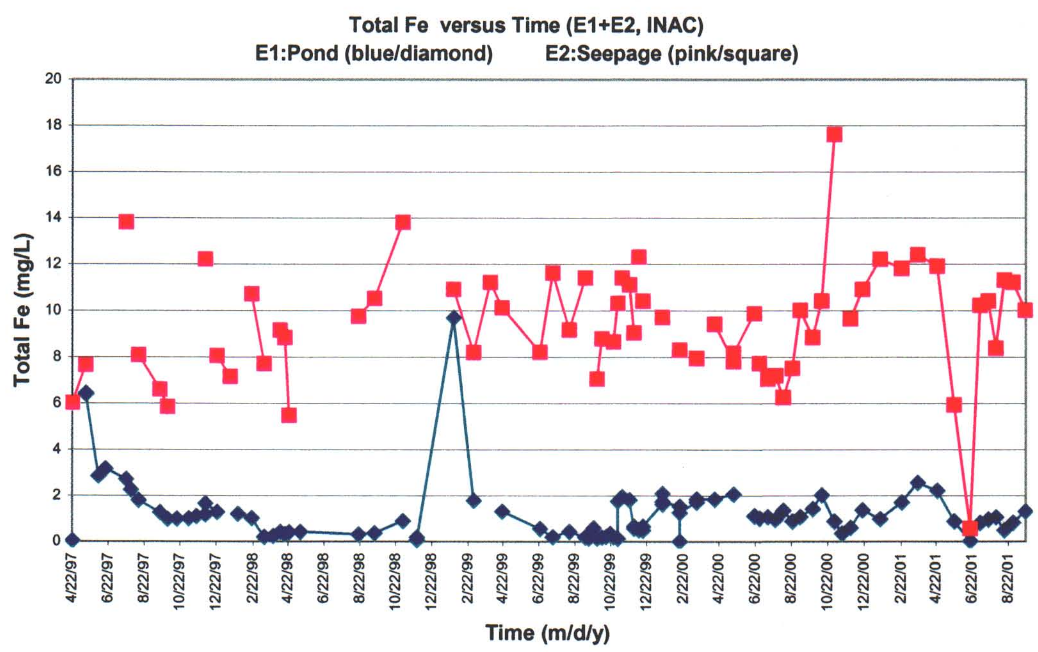


Figure 8. Temporal variations of total copper (Total Cu, upper plot) and total iron (Total Fe, lower plot) in the tailings pond water and seepage return based on INAC monitoring data.

GEOCHEMISTRY AND MINERALOGY

As described in the previous section, based on core logging in the field, tailings impounded at Mount Nansen can be divided into four categories according to apparent sulfide content and grain size variations. These are oxide silt (± sand), oxide clay (± silt), sulfidic silt (± sand) and sulfidic clay (± silt). To ascertain their mineralogical composition, 38 polished thin sections were prepared from individual or composite samples and examined with a petrographic microscope. Twelve of these were selected for further detailed analysis including point counting under a scanning electron microscope (SEM) equipped with an energy-dispersive X-ray (EDX) analyzer. In addition, 36 samples were analyzed by X-ray powder diffractometry (XRD). For geochemistry, 38 individual or composite samples were analyzed for ABA characteristics at BC Research Inc. and 110 for total metals content using four-acid digestion and ICP-AES scan at both CANMET/MMSL and BC Research Inc. Grab samples from the Brown-McDade pit were also subjected to similar analyses. In addition, 58 tailings solids resulting from the field analysis program were analyzed for Total CN. A lesser number of pond and porewater samples were also analyzed for various cyanide-related species and dissolved metals. Salient results and observations are presented below.

Tailings Geochemistry

Residual metals and parameters of environmental concern: The results of geochemical analysis of tailings solids from the impoundment and a few grab rock samples from the Brown-McDade open pit are tabulated in Appendix C. Generally, the tailings are heterogeneous in composition with anomalous contents of As (up to 0.6%), Cu (up to 0.06% and higher if contaminated by process chemicals), Pb (up to 0.6%), Sb (up to 0.1%) and Zn (up to 0.3%). The Ag content varies from 10 to 80 μg/g but Au is generally not detected (i.e., <4 μg/g). The Total CN content of selected samples analyzed ranges from 5 to 165 μg/g with most high values associated with the fine tails. From a geochemical perspective, the tailings can readily be differentiated from the underlying native sediments by an enrichment in Ag, As, Cu, Fe, Mn, Pb, Sb, Zn and Total S as well as a relative depletion in Na, Sr and, to a less extent, Ca and Mg. The contrast is best illustrated by comparing the chemical analyses of composite samples of the four tailings types with those of the native sediments (Table 1).

Nine individual native sediments sampled in the tailings coring program were analyzed to arrive at the average composition given in Table 1. A few other samples collected near the tailings contact and thus contaminated by the tailings to a varied extent were deliberately excluded. The four tailings composite samples were comprised of several samples (5 to 10) of the same type mixed together and subsequently homogenized to give a large bulk sample for various laboratory testing. For two reasons, the clayey composites were analyzed more often. First, the clayey tailings were more difficult to mix than the silty tailings, multiple analyses are required to demonstrate their homogeneity. Second, the two sets of samples have been used as inter-laboratory check samples. The mean and standard deviation shown in Table 1 are derived from analyses produced by both the CANMET-MMSL Analytical Services and BC Research Inc.

Table 1. A comparison of chemistry of the four tailings types and the underlying native sediments at the Mount Nansen tailings impoundment

Parameters	Oxide Silt Composite (MNOMIX)	Sulfidic Silt Composite (MNSMIX)	Oxide Clay Composite (BATCHO)	Sulfidic Clay Composite (BATCHS)	Native Sediments (9 samples)
Samples analysed	1	1	6	4	1 (each)
Ag (μg/g)	36	42	56 ± 3	44 ± 3	2 ± 2
As (μg/g)	2800	2270	4930 ± 383	3590 ± 166	99 ± 94
Ca (%)	0.77	1.43	1.04 ± 0.05	1.36 ± 0.10	2.50 ± 0.64
Cu (μg/g)	290	365	483 ± 225	356 ± 20	42 ± 62
Fe (%)	4.85	5.02	6.66 ± 0.04	6.06 ± 0.17	2.1 ± 0.4
K (%)	1.79	2.02	2.49 ± 0.09	2.28 ± 0.15	1.70 ± 0.18
Mg (%)	0.24	0.37	0.27 ± 0.01	0.33 ± 0.01	0.70 ± 0.18
Mn (μg/g)	1330	2380	1680 ± 94	2250 ± 155	510 ± 100
Na (%)	0.10	0.16	0.13 ± 0.01	0.13 ± 0.01	2.30 ± 0.20
Pb (μg/g)	1470	1800	4510 ± 149	2750 ± 96	49 ± 37
Sb (μg/g)	386	433	847 ± 104	443 ± 55	7 ± 6
Sr (μg/g)	96	125	131 ± 2	127 ± 1	448 ± 47
Zn (μg/g)	1020	1940	1590 ±120	1920 ± 56	92 ± 53
Total S (%)	2.30	2.36	1.38 ± 0.05	1.96 ± 0.16	0.05 ± 0.04

In addition to demonstrating the compositional differences between the tailings and the native sediments, the data shown in Table 1 lead to the following observations with regard to the geochemistry of the four tailings types:

1. The clayey tailings are more enriched in As, Mn, Pb, Zn and, to a lesser extent, in Fe and K as well as slightly impoverished in Total S than the silty varieties.
2. The sulfidic tailings are only marginally higher in Total S content than the oxide tailings regardless of grain size.
3. The oxide clayey tailings appear to be preferentially enriched in Ag, As, Pb and Sb while the oxide silt tailings are apparently depleted in Zn and, to a lesser extent, in Ca and Sr.
4. Regardless of grain size and sulfide content, Mn appears to correlate with Zn.

An odd observation regarding the tailings analyses is that the variation of Cu is significantly higher than those of the other elements. As explained later, this appears to be related to both the mode of occurrence of the prevalent Cu-containing minerals and contamination from process chemicals, especially during water treatment using the INCO-SO_2/Air process.

ABA Characteristics: Forty selected samples were analyzed for various ABA parameters using the modified ABA procedure (MEND, 2001) at BC Research Inc. The detailed data acquired are given in Appendix C. A brief perusal of the appended data readily reveals that the impounded tailings are potentially acid-generating. However, the sulfide-sulfur content does not exceed 4 wt.% in any of the analyzed samples. Thus, the worst net neutralization potential

(NNP) measured is only -82 kg $CaCO_3$/tonne. Although the inorganic carbon analyses indicate the presence of carbonate minerals in most tailings, the fact that the Carbonate NP is often lower than the sample neutralization potential (NP, determined by back titration) suggests that some of the carbonates are Fe- or Mn-bearing. Table 2 summarizes selected ABA parameters of the impounded tailings and the underlying native sediments. These data demonstrate that there are large variations in ABA properties within each tailings grouping such that the four types of tailings are not, statistically speaking, significantly different. However, it is apparent that the oxide tailings, regardless of grain size, are relatively depleted of carbonates while the fine tails, especially the oxide clay tailings, are relatively impoverished in sulfide-S.

In contrast to the tailings, native sediments underlying the impoundment appear to have some inherent acid buffering capacity. This is reflected by the positive NNP values (up to 20 kg $CaCO_3$/tonne) of the few samples analyzed.

Table 2. Summary ABA characteristics of tailings and native sediments sampled from the Mount Nansen tailings impoundment.

Sample Type	Paste pH	Carbonate-NP*	MPA*	NP*	NNP*
Oxide silt tails:					
Composite	7.7	13.2	62.8	11.1	-51.7
8 more samples	7.5 ± 0.5	29.1 ± 20.2	66.6 ±30.7	24.1 ±13.6	-42.6 ± 25.7
Sulfide silt tails:					
Composite	8.0	29.7	58.1	24.9	-33.2
10 more samples	7.9 ± 0.5	29.6 ± 15.9	63.2 ± 31.0	24.1 ± 9.8	-39.1 ± 23.1
Oxide clay tails:					
Composite	8.6	11.6	25.9	14.1	-11.8
3 more samples	8.9 ± 0.3	12.0 ± 2.9	39.2 ± 1.5	16.3 ±1.9	-22.8 ± 1.8
Sulfide clay tails	8.3	21.6	40.6	18.8	-21.8
6 native sediments	7.5 ± 0.8	12.2 ± 10.5	0.4 ± 0.6	12.9 ±11.4	12.6 ± 11.1

*Carbonate-NP=carbonate neutralization potential based on inorganic-C, MPA=maximum potential acidity based on sulfide-S, NP=neutralization potential and NNP=net neutralization potential, all measured in kg $CaCO_3$/tonne.

Tailings Mineralogy

To determine the tailings mineralogy, polished thin sections were made from 36 selected individual and composite tailings samples for petrographic examination. Portions of the same samples were also analyzed by XRD. Based on the results obtained, 12 selected polished thin sections were examined in detail under a SEM equipped with an EDX analyzer to reveal the mineral associations and composition. Salient observations are presented below.

Petrography: Largely due to the fine grain size of the tailings samples, not much detailed mineralogical identification and decipher of textural relationships can be achieved by examination under the petrographic microscope. However, even from a cursory examination of the polished thin sections, it is evident that quartz is the dominant mineral in all of the tailings samples. Alkali feldspar appears to be a subordinate phase in many sections but it is often intensively replaced by sericite ± carbonate ± clay ± epidote. Gypsum or a similar sulfate appears to be a common accessory mineral. Pyrite, generally amounting to less than 5 modal %, is the dominant sulfide identified. While many of the pyrite grains show an oxide rim, the majority of them are fresh, fully liberated grains up to about 100 μm across. In contrast, arsenopyrite is only rarely observed, mostly embedded in larger quartz grains.

XRD results: The analysis of the 36 selected tailings samples confirms that quartz is the dominant mineral in all four tailings types. In addition, muscovite ± illite, gypsum, kaolinite and jarosite are the ubiquitous accessory minerals. Montmorillonite and small amounts of pyrite, alkali feldspar and calcite are also positively identified in some of the samples. Largely due to overlapping reflection peaks, minerals occurring in less than about 5 wt.% cannot be always confirmed by XRD. Based on the XRD analysis, the clayey tails can readily be differentiated from the silty tails by the presence of a greater abundance of clay minerals (Figure 9). The oxide and sulfide varieties of the same grain size group, however, cannot be differentiated based on XRD evidence alone. Additional X-ray diffractograms of representative samples in each tailings type are appended (Appendix D-1).

SEM/EDX analysis: With the supplementary capability of an EDX analyzer for chemical analysis in situ, mineral identification can be performed in the examination of polished thin sections of tailings samples under a SEM. By setting up a grid across the thin section, the traditional point counting technique can be applied to ascertain mineral abundance. This procedure was applied in the examination of 12 selected polished thin sections. The results (Appendix D-2) show that, similar to bulk geochemistry, the tailings are heterogeneous in mineralogical make-up. However, the coarser tails generally contain more quartz (58-69 versus 41-51 modal %) and less sericite (>20 versus <16 modal %) than the fine tails. Alkali feldspar occurs in subordinate amounts (up to 17 modal %), which tends to be more concentrated in the sulfidic tails. The most abundant sulfide mineral observed in the tailings is pyrite (0.2-5 modal %). Most arsenopyrite has been altered to scorodite (Figure 10). Because of the common occurrence of encapsulation of sulfides in coarse quartz particles in all the tailings types (e.g., Figures 10 and 11) the sulfidic tailings show only marginally more sulfides than the oxide tails. In addition to iron oxyhydroxide (3-6 modal %), a common secondary mineral found in the tailings is jarosite (1-7 modal %). Other minor to trace minerals identified in the tailings include kaolinite, gypsum, calcite, ankerite, Mn-rich carbonate, manganese oxide, albite, sphalerite, galena, chalcopyrite, covellite, argentite, bournonite, rutile, ilmenite, apatite, epidote, monazite, zircon and a couple of sulfosalts enriched in Fe and Sb and Pb and Sb, respectively.

Although amorphous iron oxyhydroxide, loosely called goethite in this report, constitutes only a minor component of the tailing solids, it plays a significant role in attenuating the transport of some potentially deleterious metals and trace elements. The sorption of Zn in goethite enriched in Mn is demonstrated by a series of X-ray maps in Figure 11. Other examples of textural features of interest observed during the SEM analysis as well as chemical analyses of rare minerals are illustrated in Appendix D-2.

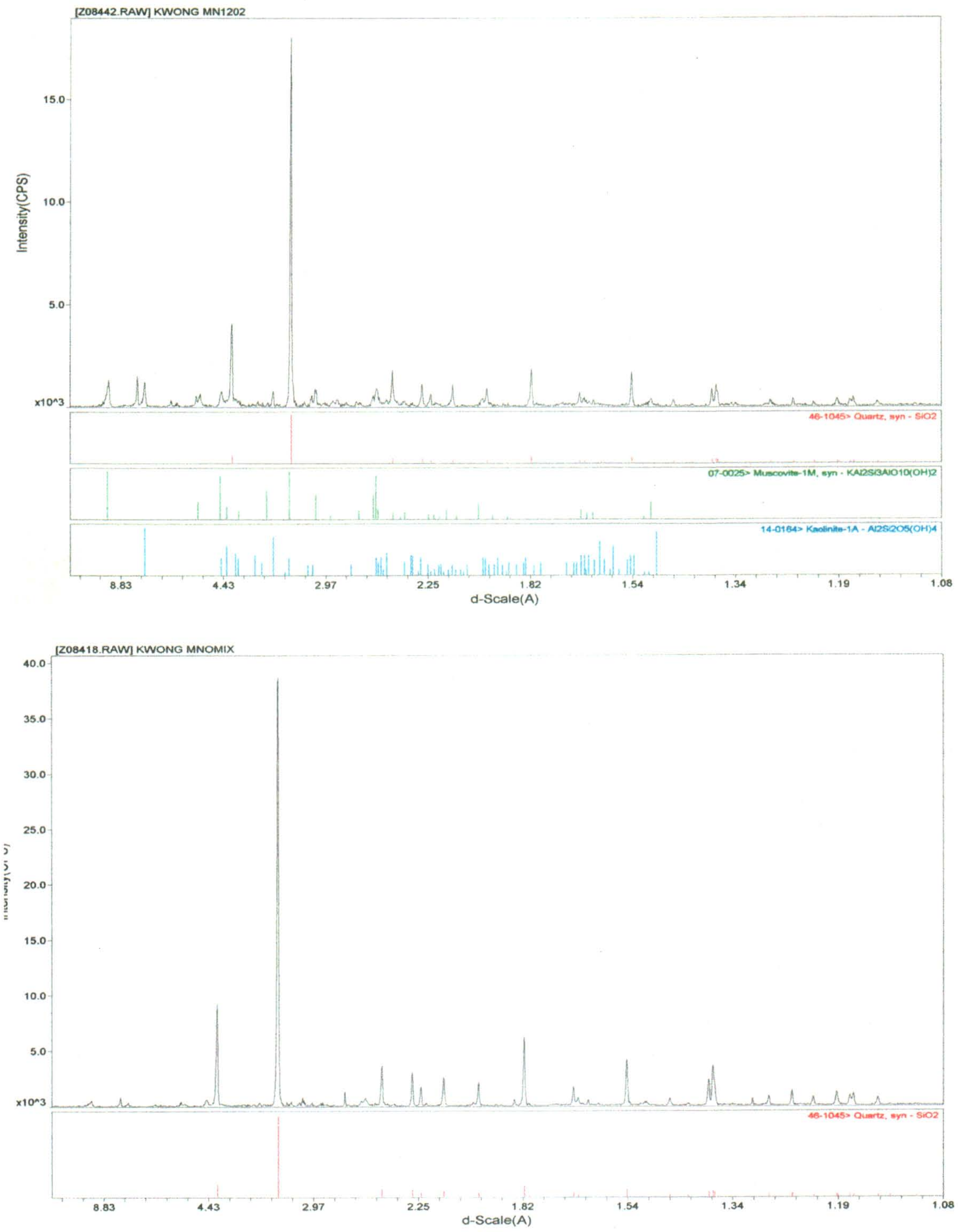


Figure 9. A pair of X-ray diffractograms illustrating that clayey tailings (above) differ from silty tailings (below) by the amount of clay minerals present regardless of sulfide content. Reference XRD patterns of relevant minerals are provided below each diffractogram to demonstrate positive identification.

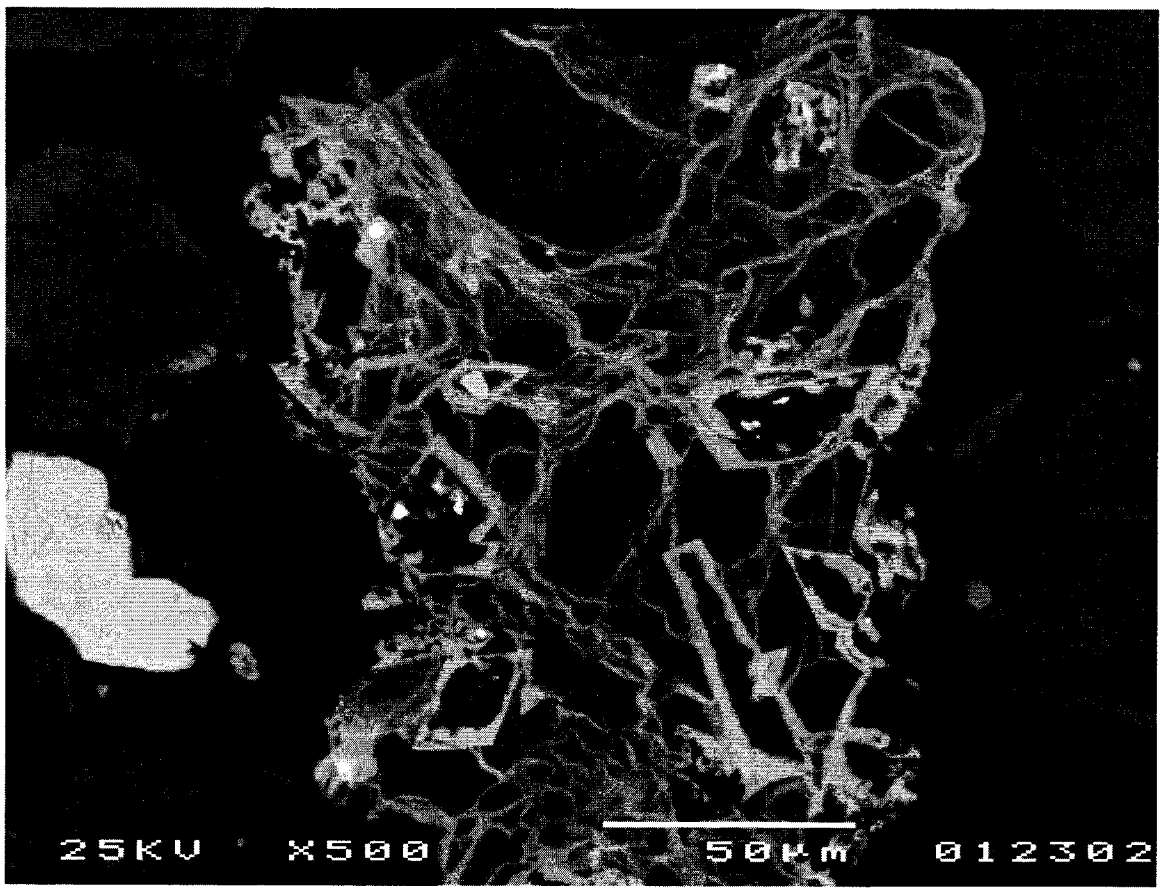


Figure 10. A backscattered electron photomicrograph illustrating complete replacement of arsenopyrite (angular grains with apparent voids in the centre and embedded in a composite grain of quartz) by scorodite. A subhedral pyrite grain (light grey, left edge of picture) is totally devoid of alteration. The small white grain inside one of the weathered-out arsenopyrite is bournonite, a lead antimony sulfide.

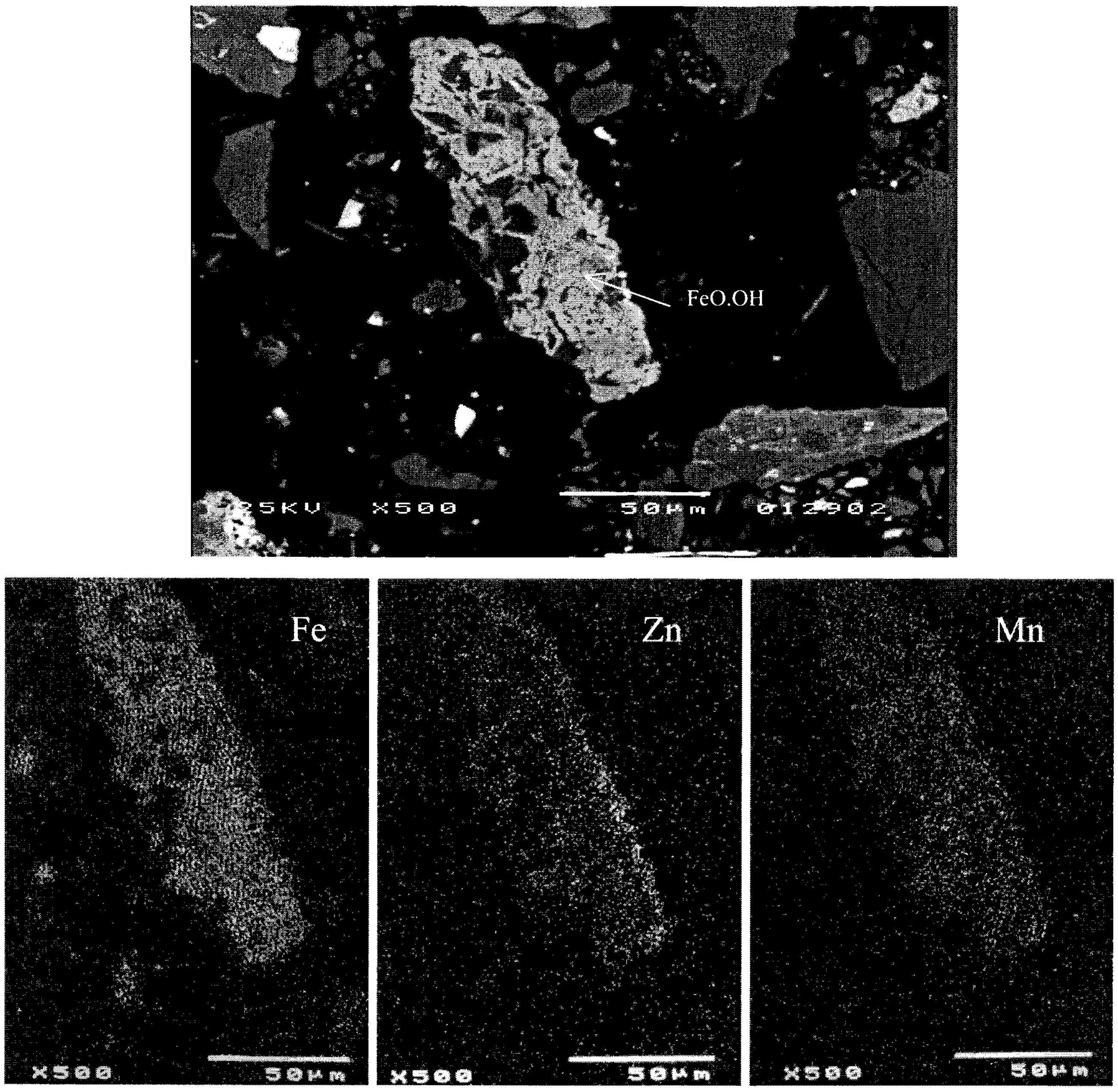


Figure 11. Top: Secondary electron photomicrograph of an aggregated grain of goethite (FeO.OH) with included quartz (dark grey). Bottom: X-ray maps of Fe, Zn and Mn of the aggregated grain above illustrating the sorption of Zn with the iron oxyhydroxide enriched in Mn content. Note also the partial encapsulation of pyrite in quartz (upper left corner in the secondary electron photomicrograph) that has hampered its oxidation to goethite.

Tailings Porewater Chemistry

Most of the core samples acquired in the drill program were saturated tailings. Upon transport from the tailings pond to the field laboratory, compaction often led to the bleeding of porewater to the surface of the tailings in a sample bag. Such porewater was carefully decanted and filtered (0.45 μm) for various analyses. For clayey tailings that did not readily bleed water, centrifuging was required to extract any porewater. Frozen tailings were allowed to thaw before porewater extraction. For samples that did not yield any porewater, leaching with de-ionized distilled water at a 1:1 liquid to solid ratio was conducted to provide a leach water (simulated porewater) for field analysis of cyanide-related species only.

The porewater samples were analyzed for pH, weak acid dissociable cyanide (WAD CN), thiocyanate (CNS), ammonia (NH_4-N), nitrite (NO_2-N) and nitrate (NO_3-N). In the field, WAD CN was measured using a Perstorp analyzer obtained from INAC. The analysis of NH_4-N, NO_3-N, NO_2-N and CNS was conducted using a Hach DR 2010 analyzer. Upon completion of the field analyses, excess porewater samples were preserved and shipped to CANMET/MMSL, Ottawa for further analysis. An aliquot of each sample (~25 mL) was preserved with concentrated nitric acid (one drop per 20 mL of sample) for ICP/MS metal scan and sulfate. The remainder was preserved using 1.0M NaOH (to pH >12) for the analysis of various CN species.

The detailed porewater analyses on each sample and a summary of the CN-related parameters and selected metals are tabulated in Appendix C-3 on a hole-by-hole basis. Briefly, the porewater Total-CN concentration ranged from 0.1 to 65.3 mg/L while the Total CN content of tailings solids ranged from 53 to 145 μg/g. The maximum porewater WAD CN concentration measured, which appeared to be strongly related to dissolved Cu, was 38.3 mg/L. The total CN and WAD CN concentrations increased with depth in Bore Holes 2, 3 and 4 while in the majority of other holes they did not follow any specific pattern with either increasing or decreasing depths. For nine porewater samples the WAD CN values obtained in field were higher than the Total-CN concentrations determined at the CANMET/MMSL laboratory. The Total CN concentration in the majority of these samples was lower than 1 mg/L. The total CN analysis was conducted in Ottawa about two weeks after the field program. Given the low initial concentrations, the time delay and the impact of NaOH addition (for sample preservation) on a variety of metal-CN complexes may have contributed to the observed discrepancies.

While the sulfidic clays contained a higher average amount of Total CN (72.7 μg/g), the oxide tailings, regardless of grain size, were more enriched in both porewater Total CN and WAD CN (Figure 12). Incidentally, the oxide tailings (both silt and clay) were also observed to have the higher average dissolved Cu and Fe concentrations in their porewater samples.

Porewater CNS concentrations ranged from <2 mg/L to a maximum of 315 mg/L. They generally did not show any relationship with either porewater Total CN or WAD CN. The CNS concentration reached 100 mg/L even for porewater samples with Total CN and WAD CN concentrations of less than 1 mg/L. The average CNS concentration for sulfide clay, sulfide silt, oxide clay and oxide silt samples were 168, 104, 118 and 140 mg/L, respectively (Figure 12). Thus sulfide clay tailings are apparently most enriched in CNS.

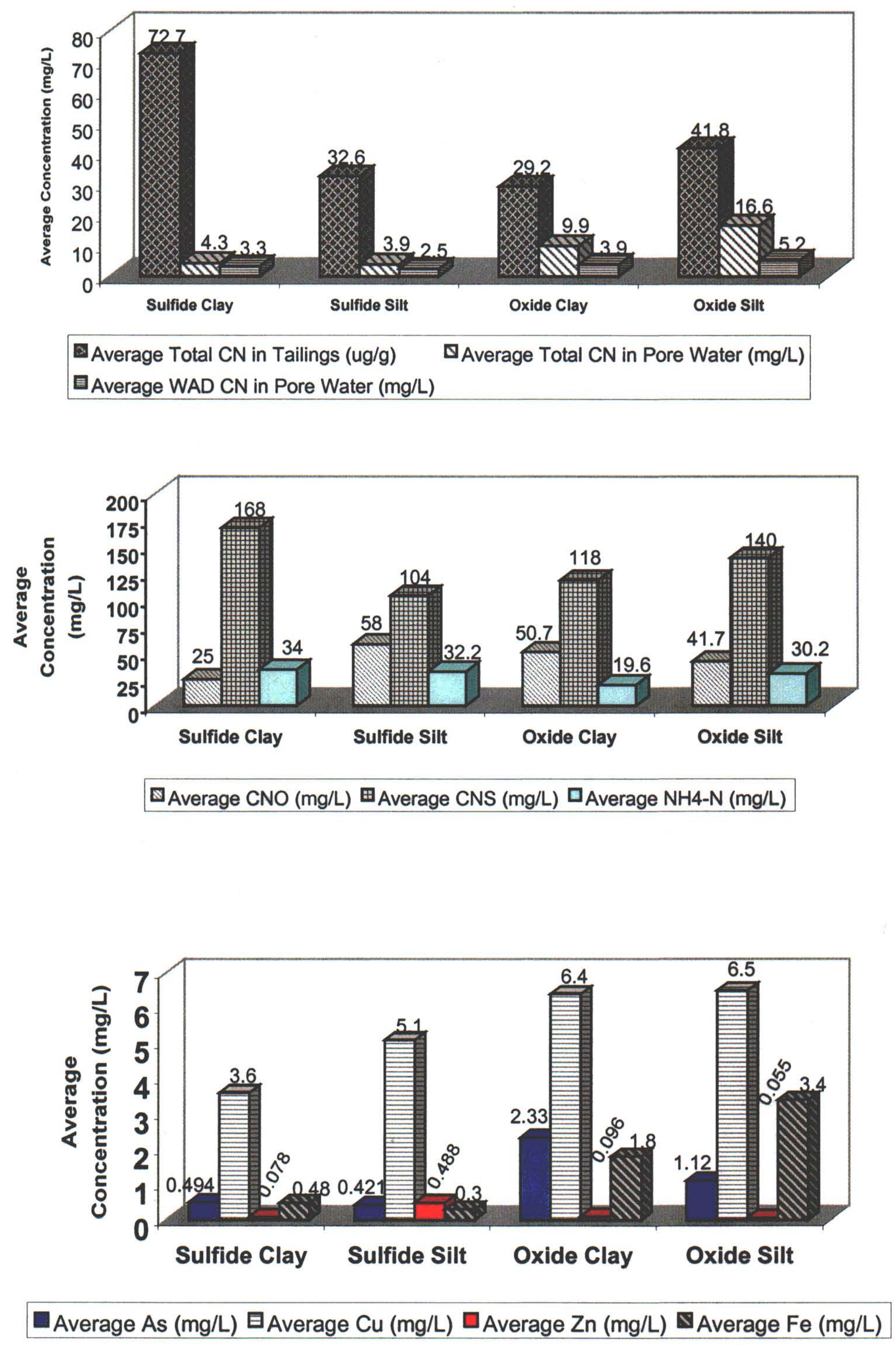


Figure 12. Average concentration of Total CN in tailings solids and various CN-related species and selected metals in porewaters of the four types of tailings identified in the Mount Nansen tailings impoundment.

Porewater CNO values in the Mount Nansen tailings ranged from 3 mg/L to 153 mg/L. Porewater samples with Total CN and WAD CN below 1 mg/L had CNO concentration below 20 mg/L. The thermodynamics of the cyanide-cyanate reaction indicates that cyanate should be the predominant species under natural conditions. However only strong oxidants are capable of directly oxidizing cyanide. Under natural conditions microbial enzymatic reactions and catalytic surfaces of minerals are able to promote this oxidization. Cyanate is also generated by the hydrolysis of thiocyanate. The average CNO concentrations in porewaters associated with the sulfide clay, sulfide silt, oxide clay and oxide silt tailings are shown in Figure 12.

The ammonia concentration in the porewater samples ranged from 1 mg/L to 59 mg/L. Ammonia concentrations in general were higher for samples containing higher amounts of CNS. In the leach water samples (mainly on BH 5 cores that yielded no porewater) the WAD CN, CNS and NH_4-N concentrations were <0.2, 10 and 10 mg/L, respectively. The analysis of frozen ice samples below the snow cover gave <0.1 mg/L WAD CN but the CNS concentrations were between 50 to 65 mg/L and ammonia in the 20 to 25 mg/L range. The variation of average NH_4-N in porewaters of the different tailings types is also shown in Figure 12.

As expected, the average Total S concentration in the porewaters was higher in sulfide silt/clay cores than in oxide clay/silt cores. The dissolved As concentration in porewaters ranged from as low as 1 μg/L to as high as 5,620 μg/L. The maximum Zn concentration in the porewater samples was 5,774 μg/L. The Cu concentration ranged from 0.01 mg/L to 27.7 mg/L. In general, samples with a higher Cu concentration also showed higher WAD CN. The average porewater Zn concentration was higher for sulfide silt cores (Figure 12). The average As concentration in porewater samples was higher for oxide cores than for sulfide cores. The Cu concentration in general was higher in oxide silt (6.5 mg/L) and oxide clay (6.4 mg/L) than in sulfide silt (5.09 mg/L) and sulfide clay (3.6 mg/L). The average porewater Fe concentration in the oxide silt/clay cores was higher than that in the sulfide clay/silt cores.

Analyses of Grab Samples from the Brown-McDade Pit

Samples collected during a brief examination of alteration and remnant mineralization at the Brown-McDade pit and subjected to detailed analysis include the following:

1. Four grab samples of intense alteration at the two adits and a breccia zone in the north wall near the middle of the pit;
2. Two pit water samples from the top and bottom of the pit pond, respectively; and
3. A small sample of sediments accumulated at the bottom of the pit.

The results of XRD, SEM/EDX and geochemical analyses of the grab alteration samples confirm the presence of pyrite as the dominant sulfide and gypsum, jarosite, muscovite/illite and kaolinite the common crystalline alteration products. Two samples submitted for ABA characterization are shown to be potentially acid-generating with NNP values of -92 and -147 kg $CaCO_3$/tonne, respectively. X-Ray diffraction analysis of the pit sediment reveals that it differs from the impounded tailings by the presence of a significant amount of montmorillonite and the absence of gypsum. Quartz, muscovite/illite and kaolinite are the other constituents identified.

The analysis of the pit waters by ICPAES reveals the presence of chemical stratification in the pit pond. The sample collected from just beneath the ice cover, which was used in the column and leaching studies, contained significantly less dissolved metals than the sample collected near the bottom of the pit. Notable contrasts include 0.04 versus 0.35 mg/L Al; 127 versus 426 mg/L Ca; 0.05 versus 0.86 mg/L Fe; 1.25 versus 5.99 mg/L K, 29.0 versus 397 mg/L Mg; <0.006 versus 0.025 mg/L Mn; 7.99 versus 15.8 mg/L Na; 81.7 versus 899 mg/L total S; and, 0.82 versus 1.74 mg/L Zn. Dissolved Si, however, was enriched near the top of the pit (9.84 versus 3.72 mg/L). Dissolved As, Cu, Pb and Sb in both of the water samples were below the ICPAES quantification limits (which is defined as 10X the detection limits) of 0.55, 0.018, 0.52 and 0.32 mg/L, respectively. Supplementary ICPMS analyses gave 0.024 mg/L As and 0.060 mg/L Sb in the surface pit water, 0.014 mg/L As and 0.022 mg/L Sb in the bottom water and <0.020 mg/L Pb in either water. The pit surface water gave a field pH measurement of 7.1 while that of the pit bottom water was pH 7.5. It thus appears that both As and Sb are more soluble in a higher pH medium.

COLUMN TESTING

Purpose of Study

To investigate possible interactions of the impounded tailings with water accumulated in the Brown-McDade pit, eight columns were set up to simulate four disposal scenarios in duplicate (Figure 13). The scenarios are:

1. High sulfide tailings under a water cover;
2. Low sulfide tailing under a water cover;
3. Mixed (high and low sulfide) tailings slurried and placed under a water cover; and
4. Mixed tailings under flow-through conditions.

Figure 13. Eight columns set up to study four disposal scenarios for the Mount Nansen tailings

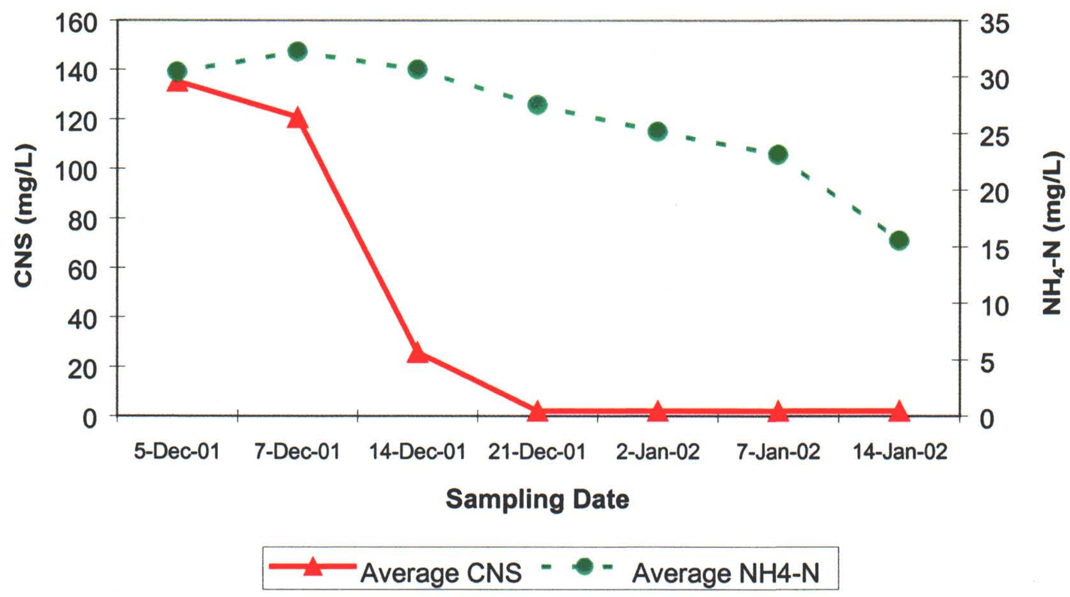
Scenarios 1 and 2 simulate the transfer of tailings with relatively little water followed by placement under a shallow water cover. Scenario 3 simulates transfer of mixed coarse tailings as a slurry, followed by settling under a shallow water cover. Scenario 4 (flow through) simulates leaching of exposed tailings by natural precipitation. For practical reasons (time and permeability of the test solids), only composite samples of the coarser tailings (sulfide and oxide silts) were used in the column testing. The column configuration and set up, test procedures and monitoring data acquired to date are detailed in Appendix E. Between December 2001 and February 2002, the columns with a water cover were sampled four times and the flow-through columns ten times. For the former, samples of the overlying water and porewater at 5 cm below the water/tailings interface were collected in addition to one drawn from the base of the columns. For the latter, sampling was done only from the base of the columns. Salient observations on the water analyses are presented and discussed below.

Results and Observations

Since the commencement of the column testing in December 2001, Total and WAD CN have not been released into the water to any significant degree in all the disposal scenarios studied. Total CN in concentrations ranging from 0.05 to 0.07 mg/L were observed in the last two sampling events at the base of the columns with tailings under a water cover (Scenarios 1 and 2). The high-sulfide columns had the higher CNS concentrations in porewater and at the base of the column. The average CNS concentrations in the porewater and at the base of the high-sulfide column were 39 and 131 mg/L, respectively, at the last sampling event conducted on February 11, 2002. In the low-sulfide columns, CNS was detected only at the base of the columns during the last two sampling events with a concentration range of 9.9 to 12 mg/L. Ammonia was detected in all columns. The NH_4-N concentration in the high-sulfide columns ranged from a minimum of 3.75 mg/L in the water cover to a maximum of 35 mg/L in the porewater. In the low-sulfide columns, the NH_4-N concentration ranged from a minimum of 0.54 mg/L in water cover to a maximum of 24.7 mg/L at the base of the column. The water cover of the mixed slurry columns in general had higher NH_4-N compared to the low- and high-sulfide columns, with a maximum NH_4-N concentration of 21.4 mg/L at the start of the column study. For the columns with a water cover, NH_4-N at the base of the columns was observed to increase with time, whereas porewater NH_4-N was observed to decrease with time. A similar trend was observed for CNS and SO_4 concentrations in the porewater and at the base of the columns with a water cover. The flushing of porewater from the upper regions of the columns through extraction of water samples at the base of the column may have contributed to the observed increase in the NH_4-N at the base of the columns. As ammonia is a degradation product of CN and CNS, its presence indicates that CN/CNS degradation reactions were taking place. Since the column testing is conducted at room temperature (considerably higher than that under field conditions) the CN/CNS degradation rates may have been enhanced. Cyanate was not observed in the columns with the water cover during the first two sampling events. In the high-sulfide tailings, a maximum CNO concentration of 25 mg/L was observed in the tailings porewater and at the base of the columns. Lower CNO concentrations were observed in the low-sulfide, mixed slurried tailings and flow-through columns. The presence of CNO also confirms that CN/CNS degradation reactions were taking place in the columns and possibly the reactions rates were enhanced towards the last two sampling events. It is thus desirable to continue the column testing for at least three additional sampling events to clarify the evolution trends. The oxidation of ammonia to nitrite and nitrate was not observed to any significant levels in any of the columns. The only other ammonia removal mechanisms from water would be by volatilization and/or by ion exchange/sorption with the clay particles in the tailings. Since the pH in the columns was generally below 9.5, ammonia removal by volatilization would not be significant.

Arsenic was observed in the water cover, porewater and base flow of all the columns. The dissolved arsenic concentration in the water cover, porewater and at the base of the high-sulfide and mixed slurry tailings columns increased with time and appeared to have stabilized at concentrations of 1.5 ± 0.2 mg/L. A maximum arsenic concentration of 2.58 mg/L was observed at the base of the low-sulfide columns at the last sampling event. Dissolved zinc in the porewater and at the base of the columns decreased with time to concentrations of less than 0.038 mg/L at the last sampling event. However, zinc was generally present in higher concentrations (0.08 to 0.62 mg/L) in the water cover compared to porewater and at the base of the columns. This can readily be explained by the higher Zn concentration (0.74 mg/L) in the pit water, which was used in the column testing. Lower dissolved Zn in the porewater and at the base of the columns suggests that Zn was removed by precipitation/sorption on mineral surfaces as overlying water was drawn downward during sample collection. A maximum dissolved Cu concentration of 0.194 mg/L was observed at the start of the testing in the flow-through columns. Generally, the dissolved Cu concentrations in the water cover, porewater and at the base of the columns have decreased to levels ranging from 0.03 to 0.05 mg/L by the last sampling event. Dissolved Cu at much higher concentrations was observed in porewater samples collected from the tailings pond. Here the porewater results indicate a strong relationship between Cu and WAD CN concentrations. Dissolved Cu, Total and WAD CN were not found in the column samples at concentrations comparable to the tailings pond porewater results. It is possible that WAD CN (predominantly as copper-cyanide complex) degraded between the time the core samples were extracted from the tailing pond and the set up of the columns. The Cu released from WAD CN degradation could have precipitated or sorbed onto mineral surfaces and the CN could have either volatilized, degraded or formed complexes with Fe and also precipitated among the tailings solids. It is also possible that redox-potential changes and other secondary reactions may have led to the formation of a variety of precipitates such as Cu (I, II) and ferri/ferro cyanide complexes, which are highly insoluble and can remain inert (Smith and Mudder, 1991). Compounds such as hexacyanoferrates are usually tightly bound to the tailings solids. They are thermodynamically stable and do not dissociate readily. In an iron-rich medium containing excess ferric, ferrous and copper ions, an insoluble metal hexacyanoferrate often forms and precipitates out from solution. This could also explain why total CN was not released to any significant degree in the column testing.

While the column test work to date indicated that tailings might not release significant amounts of Total CN and WAD CN to the water cover and base flow, seepage water collected during the drilling program had Total CN and WAD CN contents of approximately 0.3 mg/L. The tailings seepage at the site has been continuously pumped back to the tailing pond. The CNS and NH_4-N concentrations in the tailings pond seepage water were 60 mg/L and 17 mg/L, respectively. The average CNS and NH_4-N concentrations observed in the last sampling event at the base of the mixed slurried tailing columns were 58 mg/L and 21.7 mg/L, respectively. However, in the flow-through columns (simulating a storm accelerated flushing scenario) CNS was no longer detectable at the base approximately two weeks after the column set up. Instead, its degradation product NH_4-N was observed at an average concentration of 15.5 mg/L during the last sampling event. Thiocyanate was present in the base flow of the columns with a water cover at the last sampling event. The average CNS concentrations ranged from 11.5 mg/L in the low-sulfide columns to 131 mg/L in the high-sulfide columns. Figure 14 shows time-series plots of CNS, NH_4-N, SO_4, As and Sb observed at the base of the flow-through columns. The flow-through column results to date show that the release of NH_4-N from the tailings will likely continue to decrease with time in concentration. The concentration of As initially increased and now appears to have stabilized at a concentration of approximately 0.9 mg/L. The leaching of Cu, Zn and Sb appears to have stabilized at approximately <0.03 mg/L, 0.03 mg/L and 0.08 mg/L, respectively. The average dissolved As concentration in the base flow samples of columns with a water cover was approximately 1.6 mg/L in the high-sulfide and mixed slurry tailings columns and 2.58 mg/L in the low-sulfide columns.



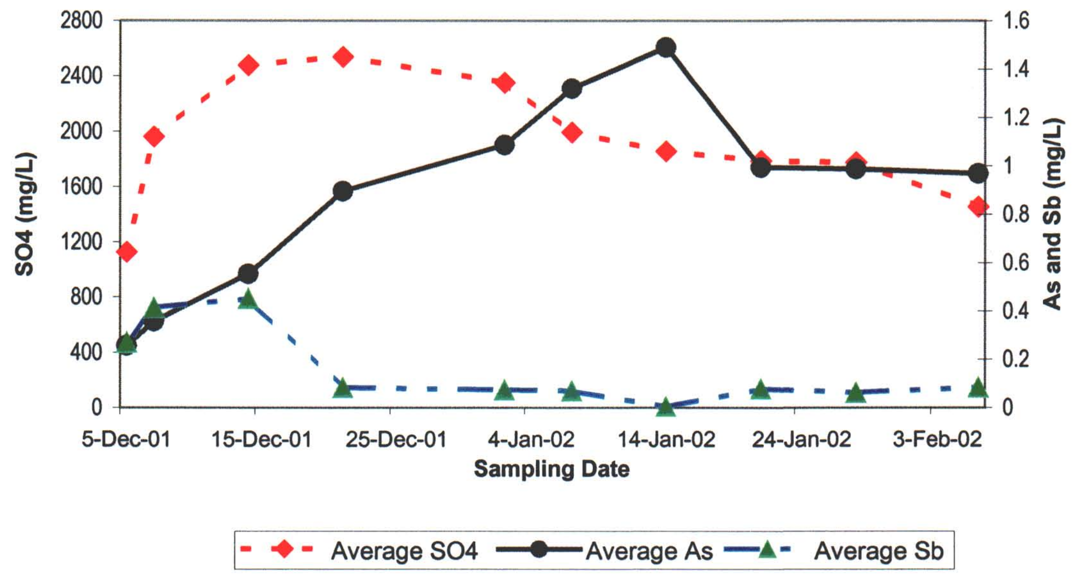


Figure 14. The average concentration of CNS, NH_4-N, SO_4, As and Sb in samples collected at the base of the flow-through columns.

Based on observations made to date in the column study, the method used for moving the tailings from the present location to the pit could also impact the water quality of the resultant water cover and seepage water. The tailings, if slurried and then pumped to the pit, will initially generate higher concentrations of CNS, SO_4, NH_4-N, As and Sb in the water cover. Moving the tailings in a relatively dry form may not have as significant an impact on the water cover quality. At the time of the field sampling campaign, the tailing pond seepage water had dissolved As, Cu, Sb and Zn concentrations of 0.037, 0.389, 0.004 and 0.643 mg/L respectively. In the flow-through columns after approximately three months of pit water application the average concentrations of dissolved As, Cu, Sb, and Zn in the collected samples were 0.969 mg/L, 0.029 mg/L, 0.084 and 0.013 mg/L, respectively. In all of the columns, the base flow samples in general had higher concentrations of dissolved As and Sb and lower concentrations of dissolved Cu and Zn than those measured in the tailings pond seepage return water. The column testing to date shows that, with the exception of overlying water in the low-sulfide columns, dissolved As levels in most samples were higher than the 0.5 mg/L limit of maximum acceptable monthly mean value indicated in the Environment Canada's Metal Mining Liquid Effluent Regulations and Guidelines (1977). Total CN and WAD CN were below the detection limit of 0.05 mg/L in the majority of samples collected. The maximum Total CN and WAD CN concentrations observed in the column study were 0.10 and 0.17 mg/L, respectively. It appears that to date Total CN associated with the tailings in the columns did not leach into the water as Total CN or WAD CN to any significant degree.

CANMET Mining and Mineral Sciences Laboratories

Assessment of Chemical Stability of Impounded Tailings at Mount Nansen, Yukon Territory

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EXECUTIVE SUMMARY

To aid with decision-making on the final decommissioning of the Mount Nansen site, the Water Resources Division of Indian and Northern Affairs Canada (INAC), Whitehorse, approached CANMET/MMSL in September 2001 to design a detailed tailings characterization program and conduct relevant field and laboratory testing to assess the chemical stability of the impounded tailings. CANMET/MMSL responded with a proposal incorporating the following major components for investigation:

1. Review of historical monitoring data to identify trends in the evolution of tailings water chemistry;
2. Geochemical and mineralogical analyses to identify a) remnant metal values in the tailings: b) parameters of concern and their modes of occurrence; and, c) relative proportions of various tailings types, if proved different;
3. Short-term leach tests to identify immediate releases of contaminants upon disturbing the tailings;
4. Column testing and selective leaching to predict the long-term behaviour of the impounded tailings;
5. INCO SO_2/Air treatment of selected tailings followed by batch leaching to clarify the functionality of the treatment; and,
6. Investigation of the effect of multiple freeze-thaw cycles on the physical and chemical properties of the impounded tailings.

The acceptance of the proposal by INAC in October commenced an intensive field sampling campaign in mid-November. Nineteen boreholes were drilled systematically across the 200m by 200m impoundment to sample tailings for subsequent laboratory testing. Based on their observed contrasts in mineralogy, colour and texture during core logging, the tailings were divided into four categories, namely, oxide silt, oxide clay, sulfide silt and sulfide clay. The drilling program also revealed accelerated thawing of permafrost in the vicinity of the tailings seepage return located near the centre of the tailings dam.

Geochemical analyses show that the tailings solids, regardless of detailed type, contain anomalous contents of silver (Ag, up to 80 µg/g), arsenic (As, up to 0.6%), copper (Cu, up to 0.06%), lead (Pb, up to 0.6%), antimony (Sb, up to 0.1%) and zinc (Zn, up to 0.3%) and they are all potentially acid-generating to a small degree. The Ag content represents the only remnant metal value in the tailings and the other trace elements pose potential environmental liabilities. Depending on the tailings type, the tailings porewater contains on average 4-17 mg/L strong acid-dissociable cyanide (SAD CN or Total CN) and 3-5 mg/L weak acid-dissociable cyanide (WAD CN). Numerically these are about an order of magnitude lower than the same associated with the tailings solids (with the latter expressed in µg/g). The average concentrations of 0.5-2.3 mg/L As and 3.6-6.5 mg/L Cu are also observed in the porewater of the four types of tailings. Generally, there is a good correlation between dissolved Cu and WAD CN in the porewaters.

Mineralogical analyses reveal that the tailings are comprised predominantly of quartz with minor to subordinate amounts of sericite/illite, alkali feldspar, jarosite, kaolinite,

montmorillonite, goethite, and gypsum. Pyrite is the most common sulfide mineral observed. Arsenopyrite is typically replaced by scorodite.

Eight columns have been set up to simulate, in duplicate, the disposal of coarse, high- and low-sulfide tailings under a shallow water cover, a mixture of silty slurried tailings under a water cover and mixed tailings under flow through conditions. While rates of cyanide degradation and trace element releases cannot yet be established due to the short duration of the experiment, the column testing demonstrates that thiocyanate (CNS), ammonia (NH_4-N), As and possibly Sb may be mobilized in tailings porewater and the water cover at concentrations of concern. If the tailings were to be relocated to the open pit, moving the tailings in a relatively dry form would likely have a less significant impact on the resultant water cover quality than transferring the tailings as a slurry.

Sequential batch leach testing with clayey tailings also indicates that As and Sb are the only trace elements susceptible to significant leaching with intense perturbation of the tailings. Although the INCO SO_2/Air treatment is effective in destroying CN associated with the tailings solids, simultaneous releases of elevated concentrations of Total CN, CNS and NH_4-N to the liquid phase have been observed. The process also seems to affect the leaching of As, Cu, Sb and Zn to various extents.

Partial sequential extraction analyses were conducted on six typical tailings from Mount Nansen to investigate the impact of a changing environment on the behaviour of the trace elements occurring in anomalous amounts in the tailings. The results indicate that As and Zn are susceptible to remobilization under mildly acidic or reducing conditions. In comparison, Cu, Pb and Sb are less readily released. Freeze-thaw studies with the same six samples indicate that multiple freeze thaw events do not significantly affect the metal leachability of the test tailings. However, an increase in average grain size may occur in some samples resulting from the aggregation of clay particles in the freezing process.

Overall, the impounded tailings appear to represent a relatively stable system from a chemical perspective. Only the CNS and NH_4-N will remain parameters of major concern in the medium term. Although laboratory testing suggests potential As and Zn release with changing environmental conditions and tailings perturbation, such has not yet been observed to occur in any significant extent in the tailings impoundment. Elevated concentrations of dissolved As have been found only in tailings porewater (up to an average of 2.33 mg/L in the clayey oxide tailings), which has not escaped the impoundment. It is recommended that detailed information on mineral distribution, hydrology and hydrogeology be collected from the Brown-McDade open pit. This would provide relevant data to critically compare, preferably by using a risk assessment approach, the benefits of retaining the tailings in the existing impoundment versus relocation to the open pit. Meanwhile, a scaled model of the impoundment can be constructed to study water-tailings interaction under simulated field conditions. Further research on the treatment of CNS and NH_4-N are also desirable.

DISCLAIMER

CANMET makes no representation or warranty respecting the results arising from the Work, either expressly or implied by law or otherwise, including but not limited to implied warranties or conditions of merchantability or fitness for a particular purpose.

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INTRODUCTION

Project Background

The Mount Nansen Mine, hosting gold mineralization, was operated by BYG Natural Resources Inc. between November 1997 and February 1999. The operator went bankrupt and abandoned the mine site in July 1999, leaving significant environmental liabilities. Of particular concern is the chemical and physical stability of approximately 250,000 tonnes of impounded, cyanide- and arsenic-bearing tailings. Since mine abandonment, the Water Resources Division of Indian and Northern Affairs Canada (INAC), Whitehorse, has maintained operation of the effluent treatment system at the site to reduce the potential for serious environmental impacts resulting from tailings impoundment failure or uncontrolled discharge from the emergency spillway.

To facilitate decision-making with regard to long-term maintenance or decommissioning of the site, INAC requires the following information:

1. Metals and other contaminants occurring in the tailings and their response to long-term water contact and repeated wetting-drying cycles;
2. Long-term prognosis for treatability of thiocyanate generated by the modified INCO SO_2/Air water treatment system;
3. Cause of accelerated cyanide release from partially or completely drained tailings after a rainstorm event;
4. Proportion of sulfide versus oxide tailings in the impoundment and its impact on the long-term treatability of porewater which migrates to the collection pond; and,
5. Implications of moving the tailings and depositing them in the Brown-McDade Open Pit and the preferred means of transport.

To address the above issues, INAC approached CANMET/MMSL in September 2001 to design a detailed tailings characterization program and conduct relevant field and laboratory testing to acquire the necessary data. A draft research proposal was submitted to INAC in mid-September. After a preliminary visit to the Mount Nansen site followed by a meeting with INAC officials in early October, a formal proposal was prepared and approved by INAC in mid-October 2001. This started an intensive field and laboratory investigation program on the chemical stability of tailings impounded at the Mount Nansen tailings pond, the results of which are detailed in this report.

Scope of Work

All field and laboratory investigations were designed for completion by the end of March 2002. Because of the short time frame allowed for the research project, it is understood that not all of the questions raised by INAC may be fully answered at the end of the study. However, a comprehensive battery of test work has been incorporated to render sufficient data to reveal key issues related to the short- and long-term chemical stability of the impounded tailings

and to evaluate the advantages and pitfalls of alternative decommissioning strategies for the site. Major components of the investigation include the following:

1. Review of historical monitoring data for trend identification;
2. Detailed tailings characterization to identify:
   a) if there are remnant metal values in the tailings;
   b) parameters of concern and their modes of occurrence where appropriate; and,
   c) relative proportions of various tailings types if proved different;
3. Short-term leach tests to identify immediate releases of contaminant, if any, upon disturbing the tailings;
4. Column testing and selective leaching to predict the long-term behaviour of the impounded tailings;
5. INCO SO_2/Air treatment of selected tailings followed by batch leaching to clarify the functionality of the treatment; and
6. Cursory investigation of the effect of multiple-freeze-thaw cycles on the physical and chemical properties of the impounded tailings.

Report Structure

This report contains ten sections. Section 1 briefly describes the project background, the scope of work and the organization of the subject report. Section 2 outlines the setting and general geology of the study site. Section 3 presents the physical characteristics of the tailings impoundment as revealed in the drilling program conducted to sample tailings for laboratory testing. Historic site monitoring data based on company and government records are also summarized. Section 4 deals with tailings chemistry and mineralogy. Various data including solids and water analyses rendered by inductively coupled plasma atomic emission spectrometry (ICPAES) and mass spectrometry (ICPMS), acid-base-accounting (ABA) characteristics and results of mineralogical analysis by petrography, X-ray diffraction (XRD) and scanning electron microscopy (SEM) supplemented with energy-dispersive X-ray (EDX) analysis are described. The analyses of grab samples from the Brown-McDade open pit, which is a candidate for long-term disposal of the tailings, are also included in this section.

Sections 5 through 7 document the results of various tests completed with the collected tailings. These include column testing of the coarser tails (Section 5), sequential batch testing of the fine tails, which also incorporates INCO SO_2/Air treatment in one of the tests (Section 6), and other test work with various leach media as well as the investigation of freeze-thaw effects (Section 7). The test results, especially with regard to their implications on the long-term chemical stability of the impounded tailings and appropriate decommissioning strategies, are discussed in Section 8. Section 9 summarizes conclusions drawn in the study and recommended further work is outlined in Section 10.

SITE SETTING AND GENERAL GEOLOGY

Site Location and General Setting

The abandoned Mount Nansen Mine previously operated by BYG Natural Resources Inc. is located about 60 km west of Carmacks and 180 km north of Whitehorse (Figure 1-Inset). The mine site lies in the Dawson Range consisting of rounded ridges and shallow valleys with elevations ranging from 945 to 1525 m. Drainage from the property flows through Nansen Creek to the west and Victoria Creek to the east (Figure 1) to the Nisling River, which in turn drains into the Yukon River system. Dome Creek, a tributary of Victoria Creek, is directly impacted by the Mount Nansen mine site, especially by historical underground mine workings, the mill facility and the tailings impoundment.

The average monthly temperature in the Mount Nansen area ranges from a high of about 15°C in July to a low of about -15°C in January. The average annual precipitation, which occurs mostly as rain in the summer months, is about 25 cm. The winter snow pack is typically 30 to 40 cm. Discontinuous permafrost ranging from 30 to 60 m thick occurs at a depth varying from 0.4 to 5 m depending on the nature of ground cover. The active layer is up to 1.5 m thick.

The mine site lies within the Dawson Range Ecosystem. Open stands of black spruce and white spruce occur in valley bottoms and benchlands near Dome Creek. While upper slopes are generally devoid of trees, lower slopes host stunted black spruce and trembling aspen. From valley bottoms to above the treeline, birch and willow shrubs form an extensive cover while Labrador tea is the dominant understorey and mosses and lichens constitute the common ground vegetation. Natural weathering of geologic materials including bedrock and surface sediments generates unstable upper slopes and secondary surficial sediments along the valley bottoms. Where surface and subsurface weathering is intense, bedrock can become friable and unstable.

General Geology

The Mount Nansen area lies within the Yukon-Tanana Terrane, the regional geology of which has recently been described in detail by Carlson (1987). Hart and Langdon (1997) as well as Andersen and Stroshein (1997) further discussed the local geology and mineral deposits of the Mount Nansen camp. A brief account of the property geology is furnished below, providing the background information against which later mineralogical analyses can be compared and discussed.

The Mount Nansen property is located in the eastern part of the Yukon Crystalline Terrane between the Coast Plutonic Complex to the southwest and the Yukon Cataclastic Terane to the northeast. The oldest rocks occurring in the area are Palezoic (early Mississippian) meta-sedimentary schists and gneisses, which were intruded by early Cretaceous plutons ranging from diorite, monzonite to syenite in composition. These felsic plutonic rocks were in turn intruded by and host younger mid-Cretaceous mafic to intermediate volcanic rocks of the Mount Nansen Volcanic Suite.

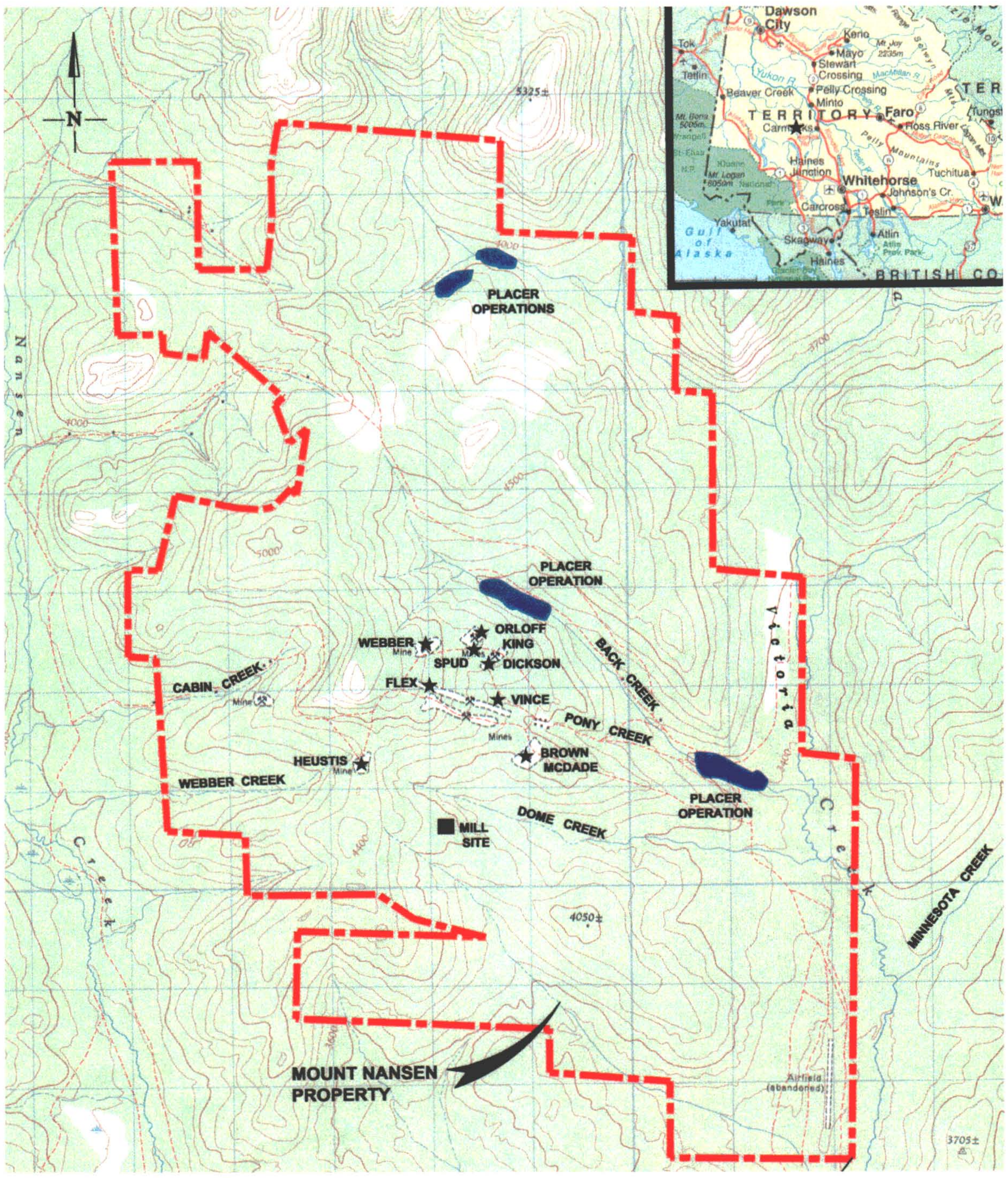


Figure 1. Location map of the Mount Nansen property. (Scale: each grid = 1 km)

Prior to abandoning the mine site, BYG Natural Resources Inc. had identified nine epithermal deposits at the Mount Nansen property (Figure 1). The three most westerly mineralized zones (i.e., Webber, Huestis and Flex) are hosted by older Paleozoic rocks dominated by strongly foliated, inter-layered quartz-feldspar-chlorite gneiss, quartzite, minor

amphibolite and augen gneiss. Further southeast, the main mineralized zone named the Brown-McDade deposit is hosted by locally foliated, mid-Cretaceous granodiorite, quartz diorite and quartz monzonite. Occurring in the northern portion of the property is a large quartz-feldspar porphyry intrusive complex (the Mount Nansen porphyry complex) with flanking andesitic flow and tuff units. Within this intrusive complex, zones of small and silicified breccia pipes occur, locally with associated gold values. Propylitic alteration, characterized by the replacement of hornblende by epidote, calcite, pyrite and magnetite, is widespread peripheral to the Mount Nansen porphyry complex and has affected most rocks in the property.

Structurally, faulting is the main feature occurring in the Mount Nansen property. Two fault sets are prominent. One set trends north-northwest with dips varying from 50 to 70 degrees to the southwest. This fault set is parallel to the main vein direction at the Brown-McDade deposit and locally mineralized. The other set trends southeast with subvertical dips and locally cuts some of the mineralized zones. These faults form part of the larger regional structure known as the Mt. Nansen Trend (Hart and Langdon, 1997).

The property has not been affected by recent glacial activities. Consequently, weathering can reach depths in excess of 70 m from the surface. Generally, the depth of oxidation as evidenced by alteration of sulfides to limonite is variable throughout the property.

Modes of Mineralization

As reviewed by Strathcona Mineral Services Ltd. (2000), two forms of mineralization occur in the Mount Nansen property. The more common form occurs as structurally controlled planar veins consisting of quartz, carbonate and varying amounts of sulfides. The vein systems can occur as simple veins like those observed at the Huestis and Webber zones or as a complex anastomosing series of veins and veinlets prominent at the Brown-McDade deposit. Better gold values are generally restricted to steeply plunging shoots with a stronger vertical rather than horizontal continuity. The less common form of mineralization occurs as siliceous pipe-like structures, which may be sulfide-rich as observed at the north end of the Brown-McDade open pit or sulfide-poor as noted at the PPBX showing.

Sulfide minerals occurring in mineralization zones at the Mount Nansen property include pyrite, arsenopyrite and lesser amounts of galena, sphalerite, chalcopyrite, stibnite and various sulfosalts. Gold occurs as minute inclusions (5 to 40 μm across) in early pyrite and arsenopyrite, as peripheral infiltrations in several sulfide minerals and as "free gold" intergrown with galena, freibergite and other sulfosalts. Silver occurs mostly as inclusions in galena and sphalerite but freibergite and miargyrite have been identified from the property. Silver/gold ratios vary from 7/1 in the planar vein mineralization to 3/1 in the breccia pipe mineralization. The silver content appears to vary directly with the base metal content of the ore material (Strathcona Mineral Services Ltd., 2000).

In the Mount Nansen camp, Hart and Langdon (1997) recognized two types of epithermal veins. These are (1) an early, cherty quartz-sulfide vein with fine-grained pyrite and arsenopyrite; and, (2) a later coarse-grained quartz-sulfide vein with pyrite, galena and sphalerite

and higher precious metal values. It is not clear if both vein types are prevalent in the two forms of mineralization described above.

Mineralization and Alteration at the Brown-McDade Open Pit

As the bulk of the tailings impounded at the Mount Nansen tailings pond is presumably derived from the processing of ore materials from the Brown-McDade open pit, it is instructive to review the mineralogy and alteration of the ore deposit. Moreover, transfer of impounded tailings to the Brown-McDade open pit has been considered as a long-term decommissioning option for the mine site (Strathcona Mineral Services Ltd., 2000). A better appreciation of alteration patterns prevailing at the open pit will aid with developing proper strategies for site closure.

In agreement with the general forms of mineralization reviewed above for the entire Mount Nansen camp, Conor Pacific Environmental Technologies Inc. (2000) also reported that open-pit mining of the Brown-McDade deposit revealed two separate ore mineralization types. These are (1) gold-silver vein mineralization forming a complex vein swarm hosted in a massive feldspar porphyry dike, and (2) a siliceous, sulfide-rich and gold-silver mineralized breccia in a pipe-like structure. The two mineralization types are separated by a complex, steeply dipping and north-easterly trending fault that crosscuts the open pit north of the Pony Creek adit. The gold-silver veins, which are largely planar in structure, are exposed in the southern two-thirds of the pit while the mineralized breccia zone is exposed in the northern one-third of the open pit. The latter is reportedly hosted by re-crystallized limestone, which has not been confirmed in the cursory examination of the open-pit during the course of this study.

Three main types of hydrothermal alteration, namely, silicification, argillic and phyllic alterations, have been reported by Conor Pacific Environmental Technologies Inc. (2000) in the Brown-McDade open pit. Silicification and bleached clay (argillic) alteration zones are commonly 1–3 m wide. Adjacent to veins and breccia zones, silicification usually occurs in vuggy form with yellow weathering and drusy quartz lining in the fine vug cavities. The silicified zone is usually enclosed by a phyllic alteration zone, in which the disseminated pyrite content increases away from the veins. The phyllic alteration consisting of sericite, pyrite and carbonates is in turn enveloped by argillic alteration which, within the feldspar porphyry, can be identified by the presence of kaolinite and montmorillonite. The argillic alteration can locally be so intense along vein contacts near the surface that the accumulation of clay has caused severe handling problems in the mining of the upper levels of the Brown-McDade deposit (Strathcona Mineral Services Ltd. 2000).

According to Conor Pacific Environmental Technologies Inc. (2000), near-surface oxide gold enrichment is well developed in the Brown-McDade mineralization. Within the oxide zone, gold has been liberated by the oxidation of sulfide minerals and cataclasis. In the subjacent sulfide zone, gold- and silver-bearing sulfides include pyrite, arsenopyrite, sphalerite, galena, sulfosalts, bornite, stibnite and chalcopyrite. Gold is apparently genetically related to an early phase of pyrite mineralization, occurring as 5-40 μm inclusions within pyrite.

CHARACTERIZATION OF THE MOUNT NANSEN TAILINGS POND

Field Investigation and Sampling

The primary purpose of the field program is to acquire adequate samples to determine the storage of remnant cyanide and potentially deleterious metals/trace elements in the tailings impoundment and for subsequent detailed characterization and water-tailings interaction studies. To plan field activities, a preliminary site visit was conducted on October 3, 2001 with INAC personnel to achieve the following goals:

1) Assess site conditions and finalize the field program;
2) Assess the nature and extent of chemical weathering in exposed tailings as well as geologic material in the pit area; and,
3) Sample pit water, tailings pond water and seepage for preliminary analysis.

The main sampling campaign took place on November 13-21, 2001. Assisted by two staff members each from Ace Drillings Services Ltd. and Laberge Environmental Services, 19 holes varying from 2.4 to 9.7 m deep were drilled using a sonic drill (Vibra-Corer) for systematic sampling of tailings in the impoundment (Figure 2). The sonic drill operates on the principle of drill-string oscillation. The drill head, which was powered by a 9-HP Honda engine, produced vibrations that were transferred to the drill string. The imparted vibrations essentially liquefied the surrounding material, allowing the drill rods to penetrate the tailings aided by the weight of the drill head and rod. A continuous tailings core was fed into the centre of the drill rod for later recovery. The drill cores were logged immediately upon retrieval and subdivided and sampled according to visible differences in composition and texture (Appendix A). A total of 132 samples including several overlying waters were collected. To aid classifying various types of tailings and to alleviate the complication of possible cyanide degradation during sample transport, the CANMET/MMSL team conducted 98 weak acid dissociable cyanide (WAD CN), 97 thiocyanate (CNS), 85 ammonia, 72 nitrite and 9 nitrate analyses on tailings pore and overlying water during the field campaign.

While the field sampling effort mainly focused on the tailings impoundment, the Brown-McDade open pit was also briefly examined. About 120 L of pit water was collected through the ice cover for subsequent column test work. Prominent alteration products were collected from the pit walls and two adits for mineralogical and geochemical analyses. An attempt was also made to secure a sample of the scarce sediments deposited at the bottom of the pit.

Classification of the Mount Nansen Tailings

Based on their apparent contrasts in mineralogy, colour and texture observed during field core logging, tailings impounded at Mount Nansen can be divided into four main types. These are (1) oxide-rich silt; (2) oxide-rich clayey silt; (3) sulfide-rich silt; and (4) sulfide-rich clayey silt. The oxide-rich varieties range from yellow-brown to light greyish brown in colour while the sulfide-rich varieties are typically greyish brown. The distribution of these four tailings types in

the tailings impoundment are depicted in cross sections (Appendix B), two of which are illustrated in Figure 3.

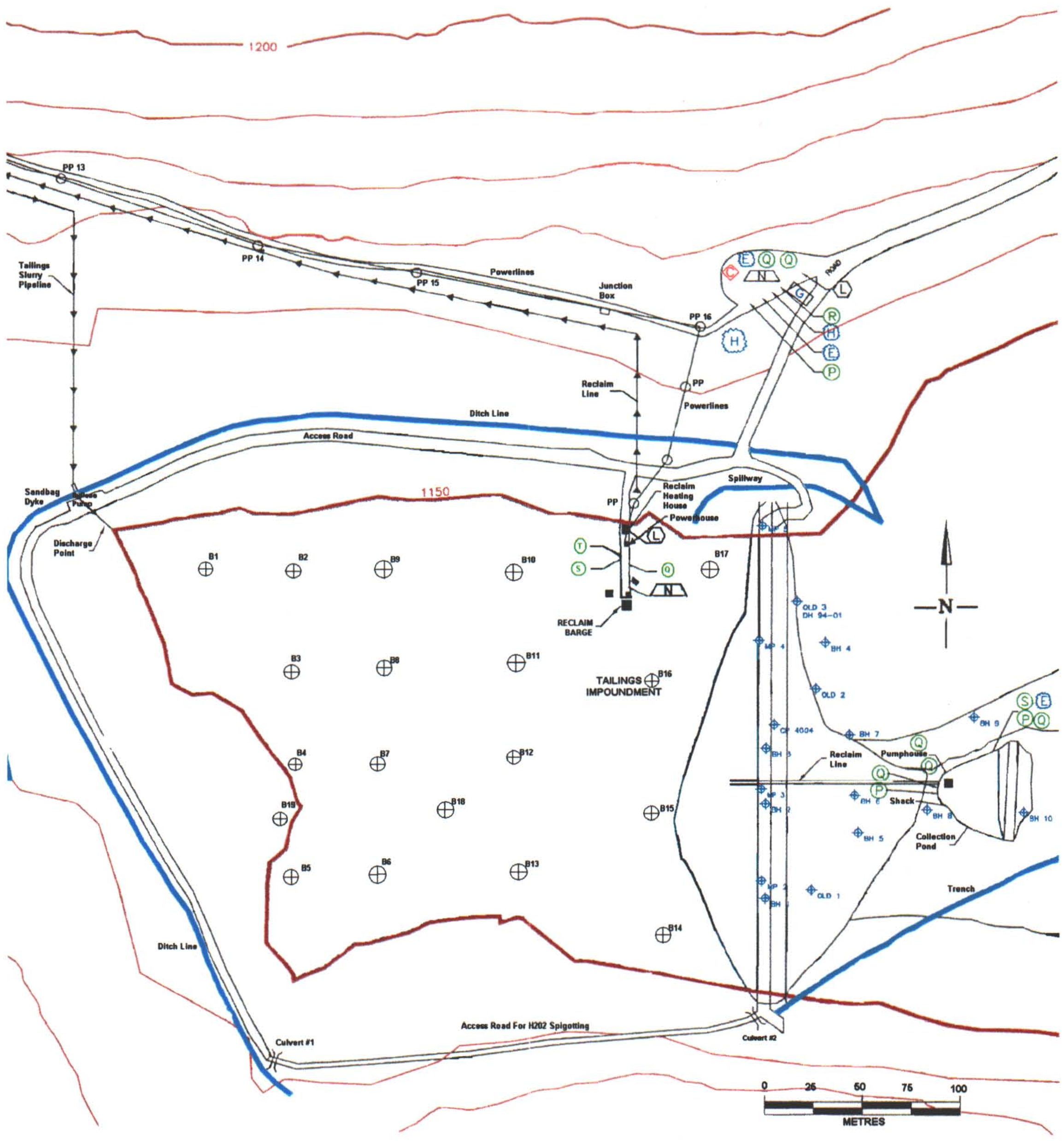


Figure 2. Map of tailings impoundment at Mount Nansen showing drill hole locations.

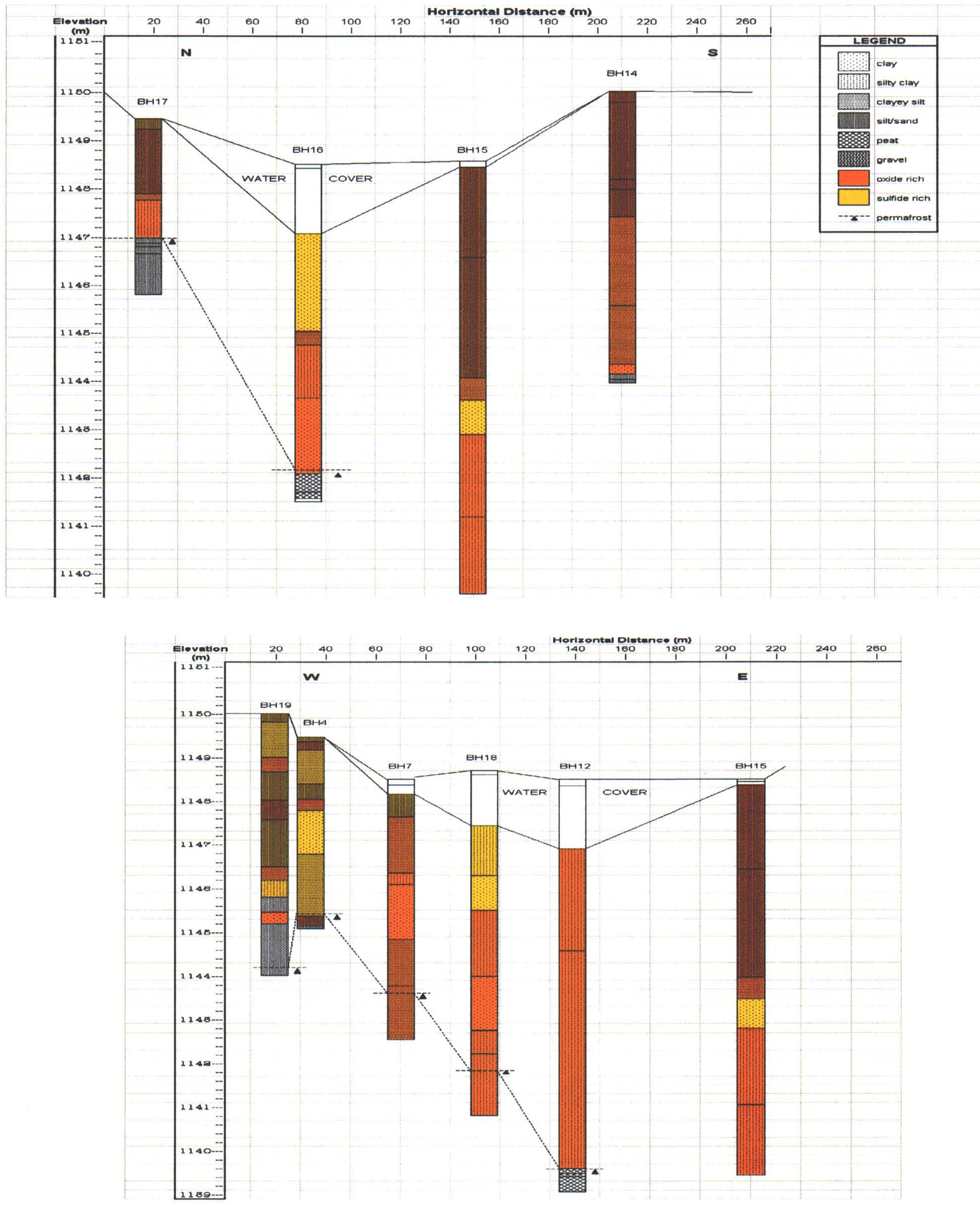


Figure 3. Selected N-S and W-E sections across the Mount Nansen tailings impoundment showing the distribution of various tailings types and the permafrost table.

Estimated from summing core lengths of similar materials, the impounded tailings are comprised of 35.0% oxide silt, 29.8% oxide clay, 16.5% sulfidic silt and 18.7% sulfidic clay. A perusal of a total of eight sections across the impoundment (Appendix B) leads to the following observations:

1. Sulfide-rich tailings are more widespread in the western half (particularly the southwestern quadrant) of the impoundment.
2. The fine tailings (silty clay instead of sandy silt) account for nearly half of the impounded tailings by volume. They are ubiquitous but more concentrated in the middle part of the tailings pond where a water cover usually exists.
3. Contrary to expectation, depth to permafrost is shallower towards the north side (3-4 m) instead of the south side (~7 m) of the impoundment. However, the greatest depth to permafrost is apparently near the seepage return to the pond such that at Hole Location B15 (Figures 2 and 3), no frozen ground has been detected at the drilled depth of 8.8 m.

To quantitatively measure the grain size distribution of the impounded tailings, seven selected samples including four composite and three individual samples were analyzed using a laser scattering particle size analyzer (Horiba LA-300). The detailed results are shown in Appendix C. The coarser tails (oxide and sulfide silts) typically show a trimodal distribution (Figure 4A) with mean particle size ranging from 30 to 119 μm and modes varying from 55-142, 6-7 and 0.4-0.5 μm, respectively. The fine tails (oxide and sulfide clayey silts) typically exhibit a bimodal distribution (Figure 4B) with mean grain size ranging from 4.8 to 13 μm and modes varying from 4-8 μm and 0.3-0.4 μm, respectively.

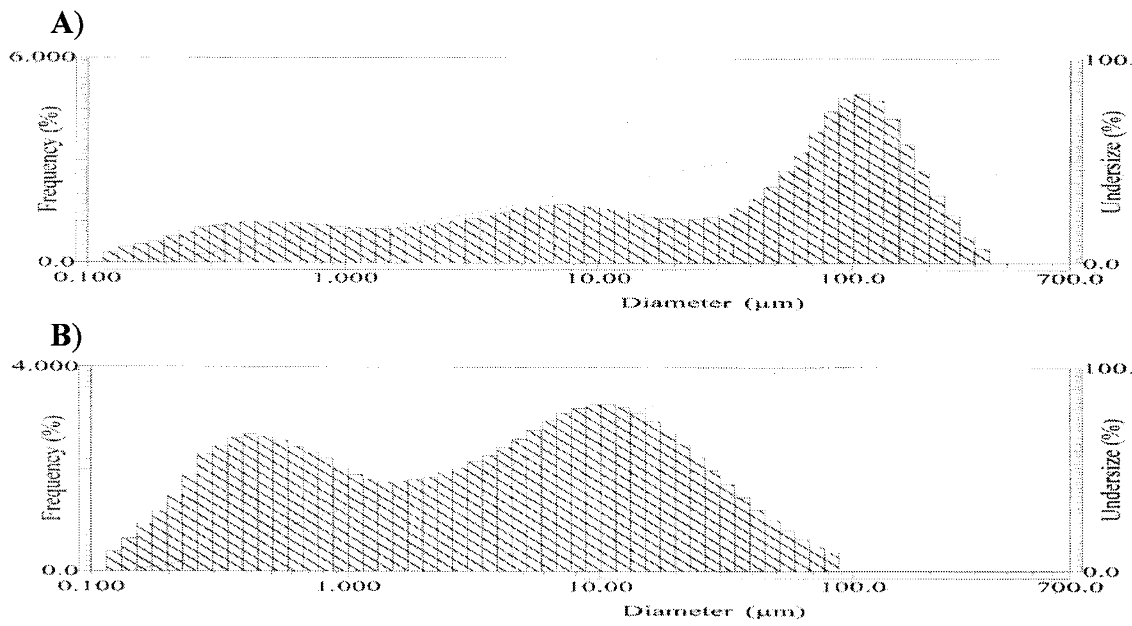


Figure 4. Typical grain size distribution in coarse silt tailings (A) and fine clayey silt tailings (B) at the Mount Nansen tailings impoundment.

Previous Monitoring Work at the Mount Nansen Tailings Pond and Brown-McDade Open Pit

Tailings impounded at Mount Nansen are presumably derived largely from the processing, by cyanidation, of oxidized ore originally containing gold-silver mineralization associated with pyrite and arsenopyrite. The tailings are thus relatively enriched in arsenic and cyanide. Since the commencement of mining operation in 1997, the tailings pond water and seepage return have been closely monitored by both the mine operator and government agencies. Since mine abandonment in 1999, INAC has continued the monitoring to ensure the discharge of effluents meet all water quality criteria stipulated in the expired BYG Natural Resources Inc. water licence, demonstrating INAC's commitment to the standards imposed on licensees. The monitoring data are useful in revealing trends in the evolution of water chemistry in the tailings impoundment. They are thus reviewed to help direct the focus of investigation in the subsequent laboratory test work.

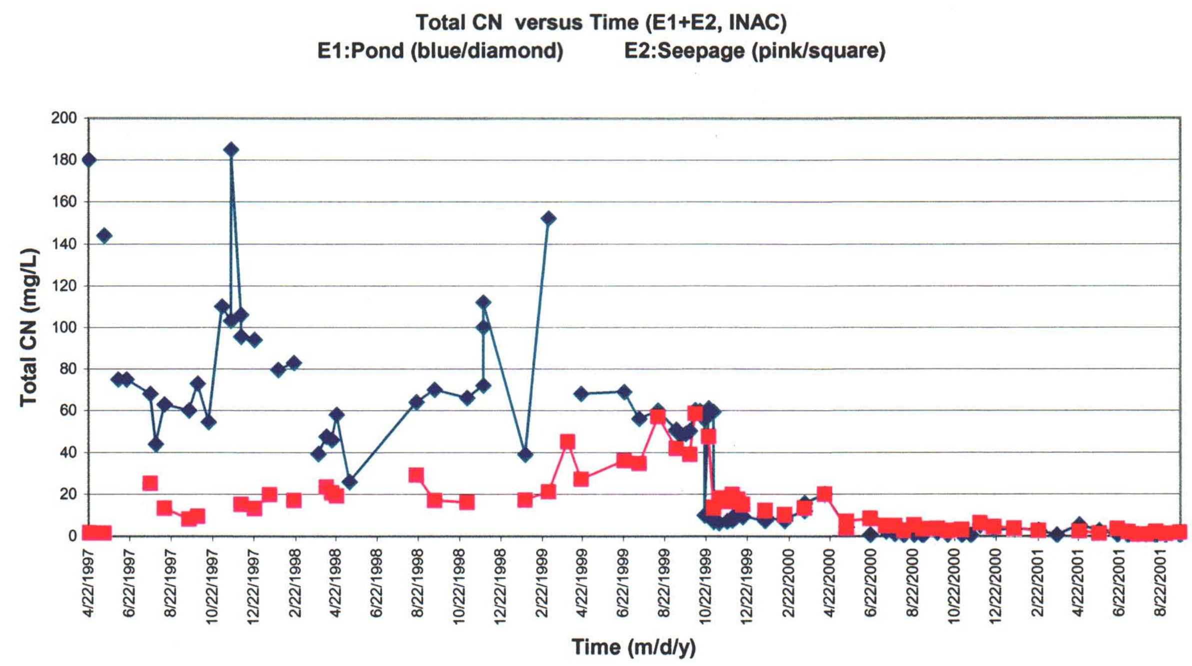
Figures 5 to 8 show time series plots of parameters of interest based on the review of a database containing monitoring data collected by INAC. Salient observations include the following:

1. Since the cessation of mining at Mount Nansen, Total CN (SAD CN) and WAD CN (Figure 5) as well as Total Cu (Figure 8) concentrations in both the tailings pond water and seepage return have continued to decrease with time but there appears to be insignificant attenuation so far for thiocyanate and ammonia (Figures 6 and 7).

2. Although both the cyanate (Figure 6) and Total As (Figure 7) concentrations in the tailings pond water appear to follow a decreasing trend with time, minor cyanate and As remobilization is suggested if the 2001 analyses are accurate.

3. It is intriguing to note that the Total Fe concentration in the seepage return has remained higher than that of the tailings pond water by an order of magnitude most of the time since mine operation (Figure 8).

In contrast to the large number of water monitoring data collected at the tailings impoundment, very few data are available to reveal the temporal evolution in composition for water accumulated in the Brown-McDade open pit since mine abandonment. Cu and Zn appear to be the main parameters of concern. Three samples collected by INAC personnel between March and August 2001 gave 0.06-0.12 mg/L total Cu, 1.6-3.7 mg/L total Zn and pH 7.2-7.8. A sample collected by Conor Pacific Environmental Technologies Inc. in September 1999 gave 0.08 mg/L total Cu, 15 mg/L total Zn and pH 7.5. In contrast, a sample collected by the Environmental Protection Service of Environment Canada in May the same year at presumably the same location rendered 4.9 mg/L dissolved Cu, 49 mg/L dissolved Zn and a pH value of 4.8. In all cases, however, the Zn analyses appear to correlate with dissolved Mn contents. The sparse data available also suggest that there are significant seasonal variations in the pit water chemistry.



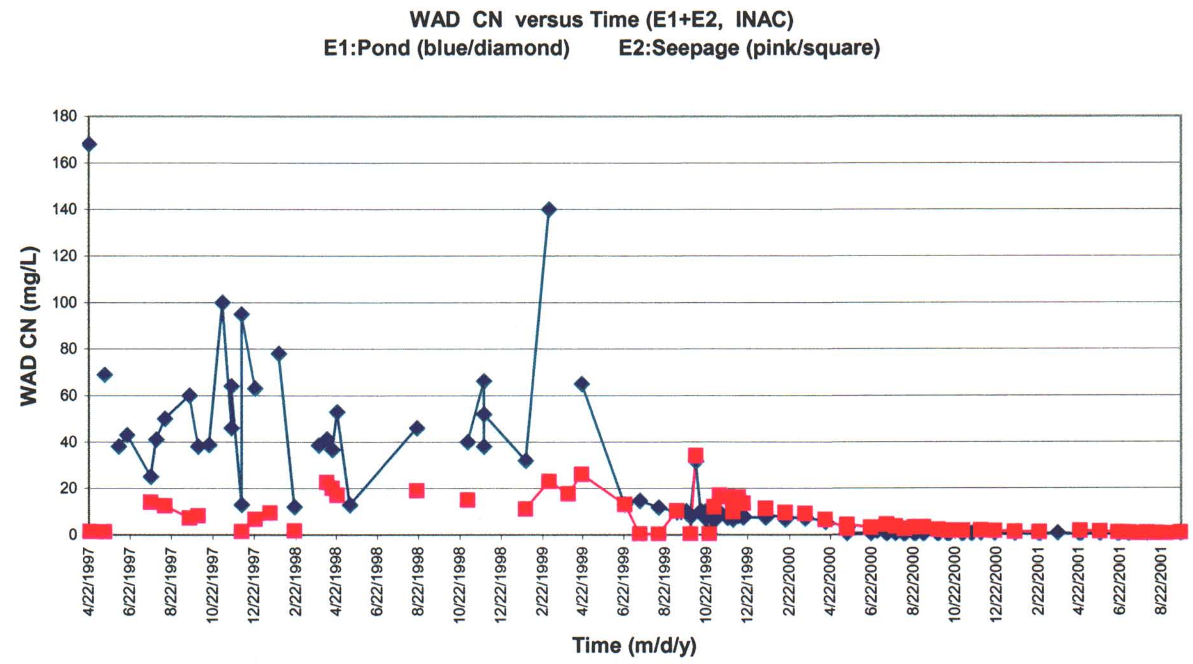
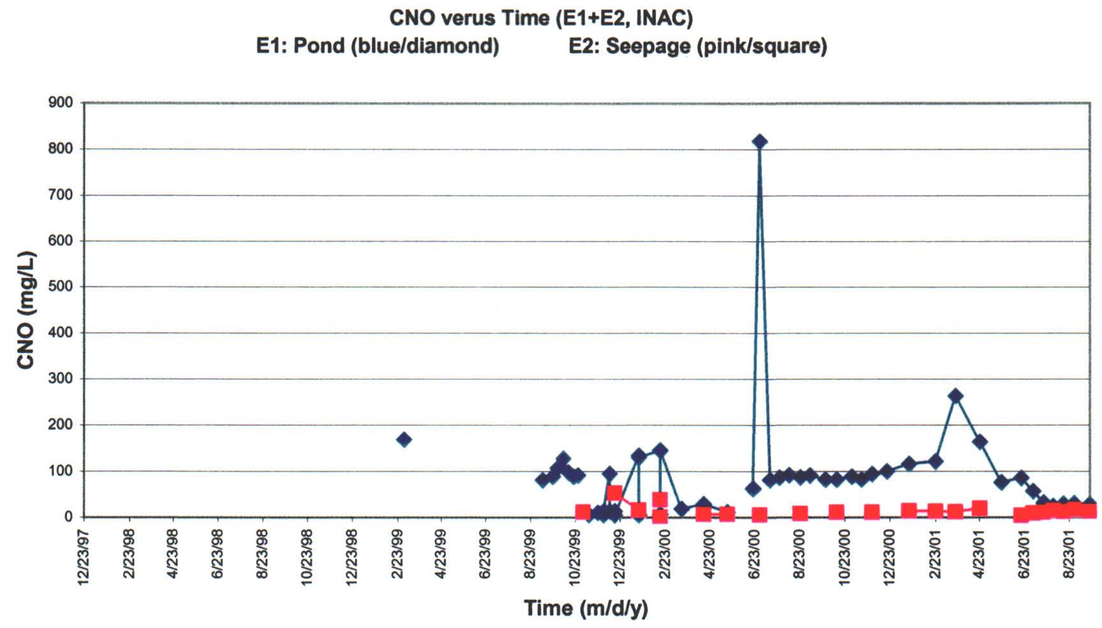


Figure 5. Temporal variation of total CN (upper plot) and WAD CN (lower plot) in the tailings pond water and seepage return based on INAC monitoring data.



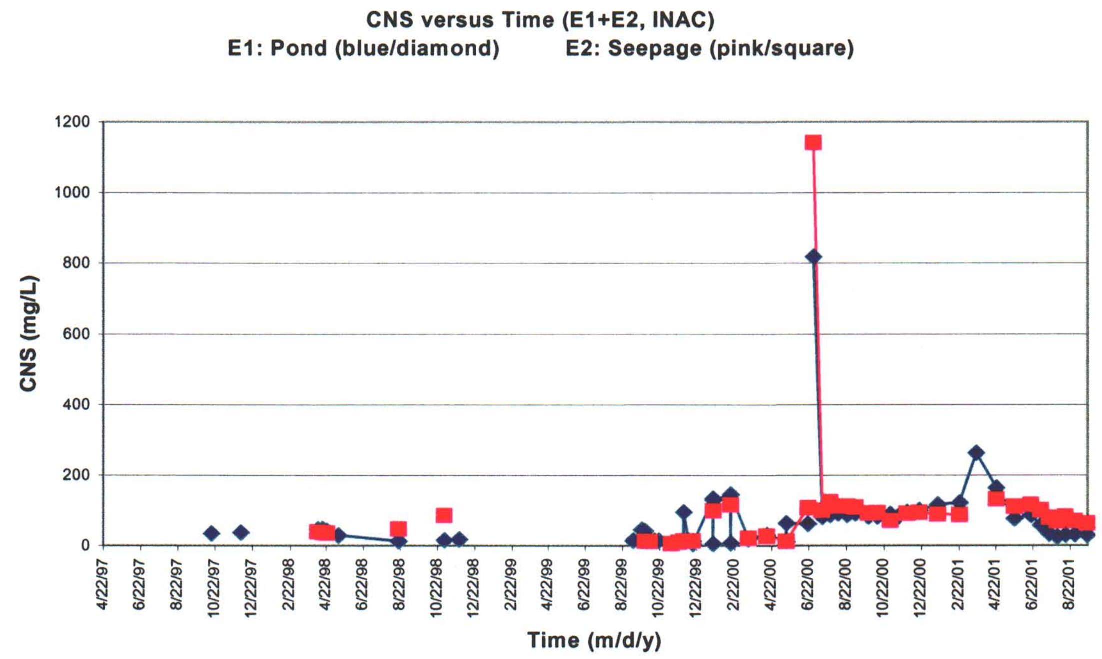
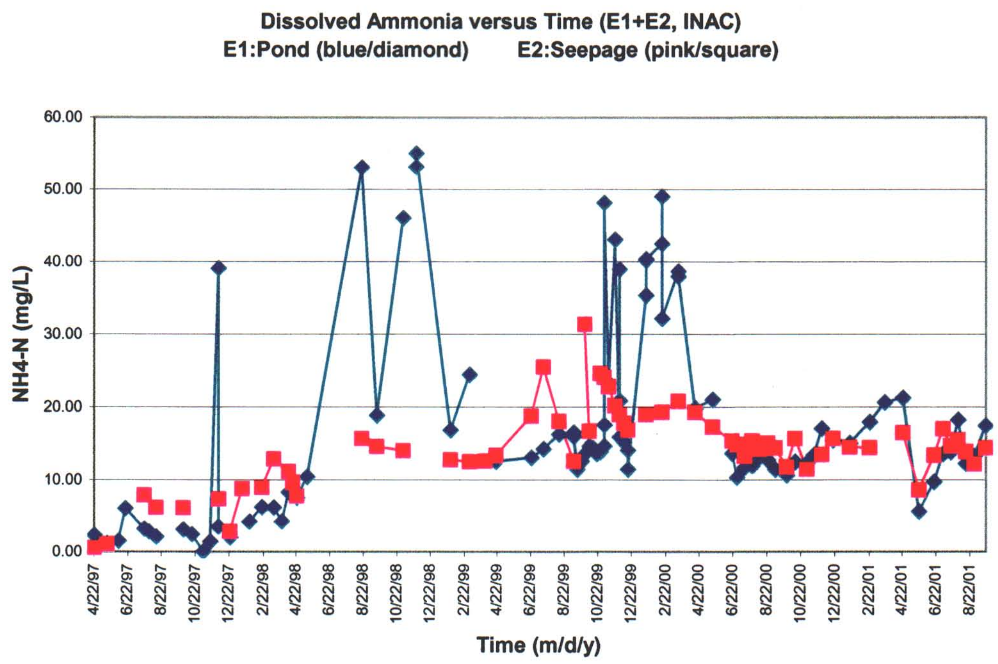


Figure 6. Temporal variation of cyanate (CNO, upper plot) and thiocyanate (CNS, lower plot) in the tailings pond water and seepage return based on INAC monitoring data.



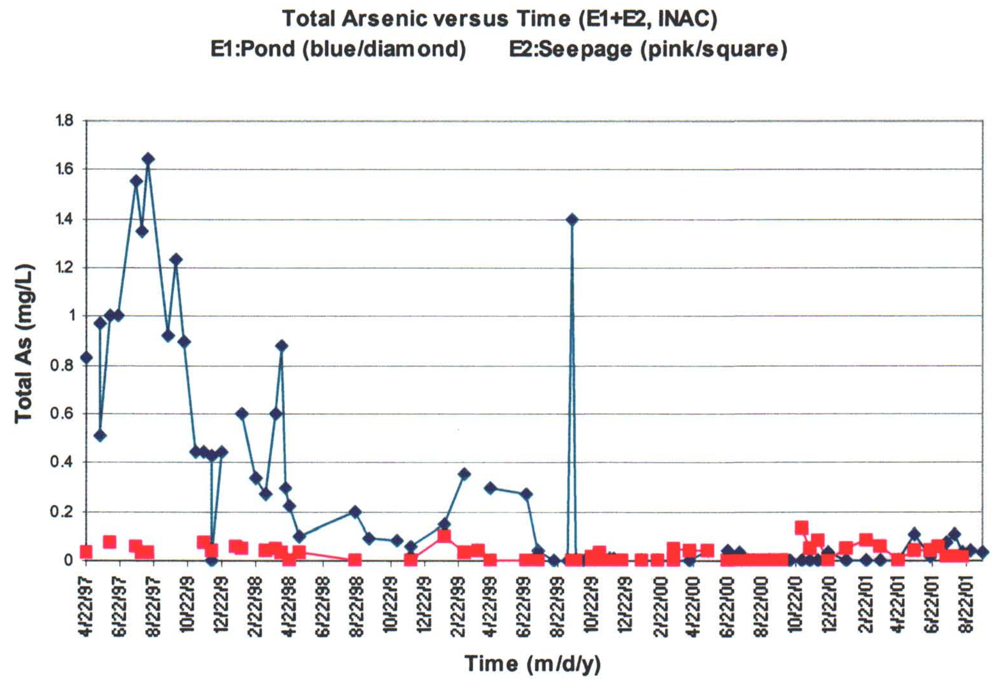
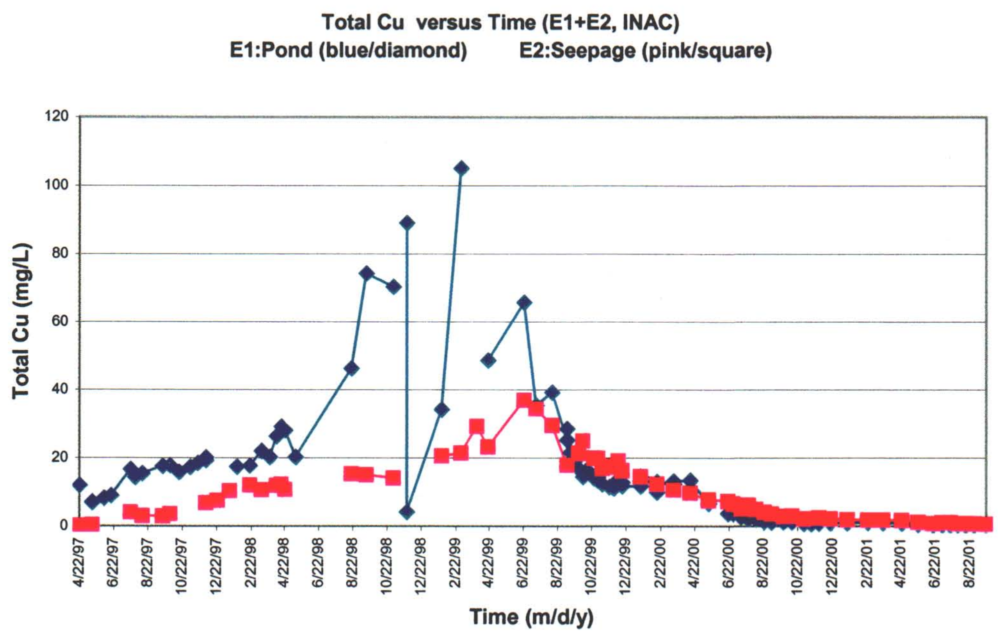


Figure 7. Temporal variation of dissolved ammonia (NH_4-N, upper plot) and total arsenic (Total As, lower plot) in the tailings pond water and seepage return based on INAC monitoring data.



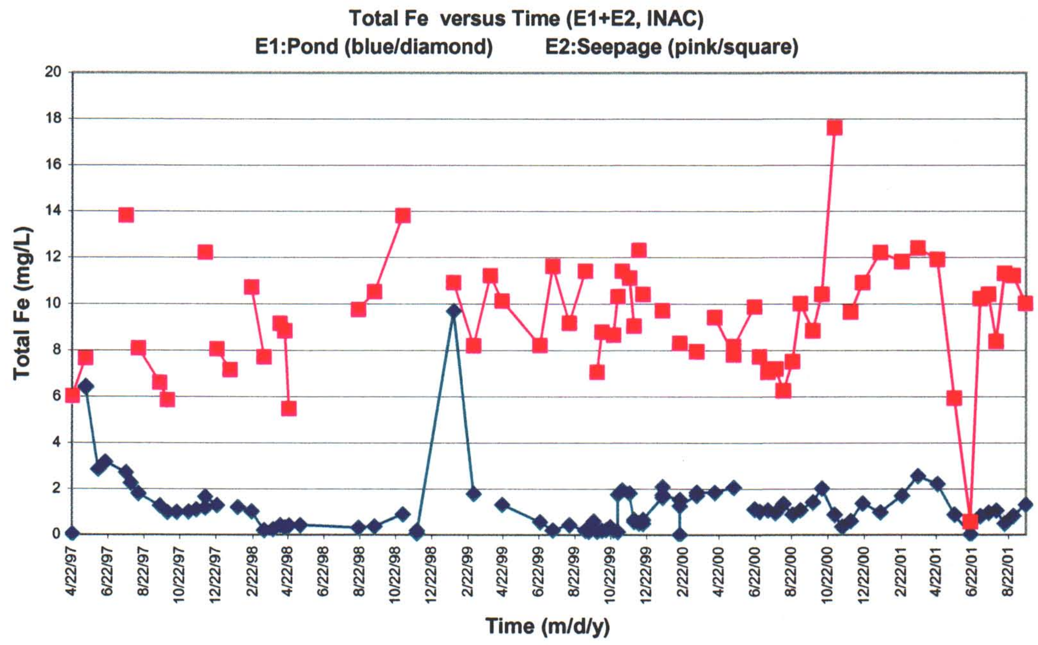


Figure 8. Temporal variations of total copper (Total Cu, upper plot) and total iron (Total Fe, lower plot) in the tailings pond water and seepage return based on INAC monitoring data.

GEOCHEMISTRY AND MINERALOGY

As described in the previous section, based on core logging in the field, tailings impounded at Mount Nansen can be divided into four categories according to apparent sulfide content and grain size variations. These are oxide silt (± sand), oxide clay (± silt), sulfidic silt (± sand) and sulfidic clay (± silt). To ascertain their mineralogical composition, 38 polished thin sections were prepared from individual or composite samples and examined with a petrographic microscope. Twelve of these were selected for further detailed analysis including point counting under a scanning electron microscope (SEM) equipped with an energy-dispersive X-ray (EDX) analyzer. In addition, 36 samples were analyzed by X-ray powder diffractometry (XRD). For geochemistry, 38 individual or composite samples were analyzed for ABA characteristics at BC Research Inc. and 110 for total metals content using four-acid digestion and ICP-AES scan at both CANMET/MMSL and BC Research Inc. Grab samples from the Brown-McDade pit were also subjected to similar analyses. In addition, 58 tailings solids resulting from the field analysis program were analyzed for Total CN. A lesser number of pond and porewater samples were also analyzed for various cyanide-related species and dissolved metals. Salient results and observations are presented below.

Tailings Geochemistry

Residual metals and parameters of environmental concern: The results of geochemical analysis of tailings solids from the impoundment and a few grab rock samples from the Brown-McDade open pit are tabulated in Appendix C. Generally, the tailings are heterogeneous in composition with anomalous contents of As (up to 0.6%), Cu (up to 0.06% and higher if contaminated by process chemicals), Pb (up to 0.6%), Sb (up to 0.1%) and Zn (up to 0.3%). The Ag content varies from 10 to 80 μg/g but Au is generally not detected (i.e., <4 μg/g). The Total CN content of selected samples analyzed ranges from 5 to 165 μg/g with most high values associated with the fine tails. From a geochemical perspective, the tailings can readily be differentiated from the underlying native sediments by an enrichment in Ag, As, Cu, Fe, Mn, Pb, Sb, Zn and Total S as well as a relative depletion in Na, Sr and, to a less extent, Ca and Mg. The contrast is best illustrated by comparing the chemical analyses of composite samples of the four tailings types with those of the native sediments (Table 1).

Nine individual native sediments sampled in the tailings coring program were analyzed to arrive at the average composition given in Table 1. A few other samples collected near the tailings contact and thus contaminated by the tailings to a varied extent were deliberately excluded. The four tailings composite samples were comprised of several samples (5 to 10) of the same type mixed together and subsequently homogenized to give a large bulk sample for various laboratory testing. For two reasons, the clayey composites were analyzed more often. First, the clayey tailings were more difficult to mix than the silty tailings, multiple analyses are required to demonstrate their homogeneity. Second, the two sets of samples have been used as inter-laboratory check samples. The mean and standard deviation shown in Table 1 are derived from analyses produced by both the CANMET-MMSL Analytical Services and BC Research Inc.

Table 1. A comparison of chemistry of the four tailings types and the underlying native sediments at the Mount Nansen tailings impoundment

Parameters	Oxide Silt Composite (MNOMIX)	Sulfidic Silt Composite (MNSMIX)	Oxide Clay Composite (BATCHO)	Sulfidic Clay Composite (BATCHS)	Native Sediments (9 samples)
Samples analysed	1	1	6	4	1 (each)
Ag (μg/g)	36	42	56 ± 3	44 ± 3	2 ± 2
As (μg/g)	2800	2270	4930 ± 383	3590 ± 166	99 ± 94
Ca (%)	0.77	1.43	1.04 ± 0.05	1.36 ± 0.10	2.50 ± 0.64
Cu (μg/g)	290	365	483 ± 225	356 ± 20	42 ± 62
Fe (%)	4.85	5.02	6.66 ± 0.04	6.06 ± 0.17	2.1 ± 0.4
K (%)	1.79	2.02	2.49 ± 0.09	2.28 ± 0.15	1.70 ± 0.18
Mg (%)	0.24	0.37	0.27 ± 0.01	0.33 ± 0.01	0.70 ± 0.18
Mn (μg/g)	1330	2380	1680 ± 94	2250 ± 155	510 ± 100
Na (%)	0.10	0.16	0.13 ± 0.01	0.13 ± 0.01	2.30 ± 0.20
Pb (μg/g)	1470	1800	4510 ± 149	2750 ± 96	49 ± 37
Sb (μg/g)	386	433	847 ± 104	443 ± 55	7 ± 6
Sr (μg/g)	96	125	131 ± 2	127 ± 1	448 ± 47
Zn (μg/g)	1020	1940	1590 ±120	1920 ± 56	92 ± 53
Total S (%)	2.30	2.36	1.38 ± 0.05	1.96 ± 0.16	0.05 ± 0.04

In addition to demonstrating the compositional differences between the tailings and the native sediments, the data shown in Table 1 lead to the following observations with regard to the geochemistry of the four tailings types:

1. The clayey tailings are more enriched in As, Mn, Pb, Zn and, to a lesser extent, in Fe and K as well as slightly impoverished in Total S than the silty varieties.
2. The sulfidic tailings are only marginally higher in Total S content than the oxide tailings regardless of grain size.
3. The oxide clayey tailings appear to be preferentially enriched in Ag, As, Pb and Sb while the oxide silt tailings are apparently depleted in Zn and, to a lesser extent, in Ca and Sr.
4. Regardless of grain size and sulfide content, Mn appears to correlate with Zn.

An odd observation regarding the tailings analyses is that the variation of Cu is significantly higher than those of the other elements. As explained later, this appears to be related to both the mode of occurrence of the prevalent Cu-containing minerals and contamination from process chemicals, especially during water treatment using the INCO-SO_2/Air process.

ABA Characteristics: Forty selected samples were analyzed for various ABA parameters using the modified ABA procedure (MEND, 2001) at BC Research Inc. The detailed data acquired are given in Appendix C. A brief perusal of the appended data readily reveals that the impounded tailings are potentially acid-generating. However, the sulfide-sulfur content does not exceed 4 wt.% in any of the analyzed samples. Thus, the worst net neutralization potential

(NNP) measured is only -82 kg $CaCO_3$/tonne. Although the inorganic carbon analyses indicate the presence of carbonate minerals in most tailings, the fact that the Carbonate NP is often lower than the sample neutralization potential (NP, determined by back titration) suggests that some of the carbonates are Fe- or Mn-bearing. Table 2 summarizes selected ABA parameters of the impounded tailings and the underlying native sediments. These data demonstrate that there are large variations in ABA properties within each tailings grouping such that the four types of tailings are not, statistically speaking, significantly different. However, it is apparent that the oxide tailings, regardless of grain size, are relatively depleted of carbonates while the fine tails, especially the oxide clay tailings, are relatively impoverished in sulfide-S.

In contrast to the tailings, native sediments underlying the impoundment appear to have some inherent acid buffering capacity. This is reflected by the positive NNP values (up to 20 kg $CaCO_3$/tonne) of the few samples analyzed.

Table 2. Summary ABA characteristics of tailings and native sediments sampled from the Mount Nansen tailings impoundment.

Sample Type	Paste pH	Carbonate-NP*	MPA*	NP*	NNP*
Oxide silt tails:					
Composite	7.7	13.2	62.8	11.1	-51.7
8 more samples	7.5 ± 0.5	29.1 ± 20.2	66.6 ±30.7	24.1 ±13.6	-42.6 ± 25.7
Sulfide silt tails:					
Composite	8.0	29.7	58.1	24.9	-33.2
10 more samples	7.9 ± 0.5	29.6 ± 15.9	63.2 ± 31.0	24.1 ± 9.8	-39.1 ± 23.1
Oxide clay tails:					
Composite	8.6	11.6	25.9	14.1	-11.8
3 more samples	8.9 ± 0.3	12.0 ± 2.9	39.2 ± 1.5	16.3 ±1.9	-22.8 ± 1.8
Sulfide clay tails	8.3	21.6	40.6	18.8	-21.8
6 native sediments	7.5 ± 0.8	12.2 ± 10.5	0.4 ± 0.6	12.9 ±11.4	12.6 ± 11.1

*Carbonate-NP=carbonate neutralization potential based on inorganic-C, MPA=maximum potential acidity based on sulfide-S, NP=neutralization potential and NNP=net neutralization potential, all measured in kg $CaCO_3$/tonne.

Tailings Mineralogy

To determine the tailings mineralogy, polished thin sections were made from 36 selected individual and composite tailings samples for petrographic examination. Portions of the same samples were also analyzed by XRD. Based on the results obtained, 12 selected polished thin sections were examined in detail under a SEM equipped with an EDX analyzer to reveal the mineral associations and composition. Salient observations are presented below.

Petrography: Largely due to the fine grain size of the tailings samples, not much detailed mineralogical identification and decipher of textural relationships can be achieved by examination under the petrographic microscope. However, even from a cursory examination of the polished thin sections, it is evident that quartz is the dominant mineral in all of the tailings samples. Alkali feldspar appears to be a subordinate phase in many sections but it is often intensively replaced by sericite ± carbonate ± clay ± epidote. Gypsum or a similar sulfate appears to be a common accessory mineral. Pyrite, generally amounting to less than 5 modal %, is the dominant sulfide identified. While many of the pyrite grains show an oxide rim, the majority of them are fresh, fully liberated grains up to about 100 μm across. In contrast, arsenopyrite is only rarely observed, mostly embedded in larger quartz grains.

XRD results: The analysis of the 36 selected tailings samples confirms that quartz is the dominant mineral in all four tailings types. In addition, muscovite ± illite, gypsum, kaolinite and jarosite are the ubiquitous accessory minerals. Montmorillonite and small amounts of pyrite, alkali feldspar and calcite are also positively identified in some of the samples. Largely due to overlapping reflection peaks, minerals occurring in less than about 5 wt.% cannot be always confirmed by XRD. Based on the XRD analysis, the clayey tails can readily be differentiated from the silty tails by the presence of a greater abundance of clay minerals (Figure 9). The oxide and sulfide varieties of the same grain size group, however, cannot be differentiated based on XRD evidence alone. Additional X-ray diffractograms of representative samples in each tailings type are appended (Appendix D-1).

SEM/EDX analysis: With the supplementary capability of an EDX analyzer for chemical analysis in situ, mineral identification can be performed in the examination of polished thin sections of tailings samples under a SEM. By setting up a grid across the thin section, the traditional point counting technique can be applied to ascertain mineral abundance. This procedure was applied in the examination of 12 selected polished thin sections. The results (Appendix D-2) show that, similar to bulk geochemistry, the tailings are heterogeneous in mineralogical make-up. However, the coarser tails generally contain more quartz (58-69 versus 41-51 modal %) and less sericite (>20 versus <16 modal %) than the fine tails. Alkali feldspar occurs in subordinate amounts (up to 17 modal %), which tends to be more concentrated in the sulfidic tails. The most abundant sulfide mineral observed in the tailings is pyrite (0.2-5 modal %). Most arsenopyrite has been altered to scorodite (Figure 10). Because of the common occurrence of encapsulation of sulfides in coarse quartz particles in all the tailings types (e.g., Figures 10 and 11) the sulfidic tailings show only marginally more sulfides than the oxide tails. In addition to iron oxyhydroxide (3-6 modal %), a common secondary mineral found in the tailings is jarosite (1-7 modal %). Other minor to trace minerals identified in the tailings include kaolinite, gypsum, calcite, ankerite, Mn-rich carbonate, manganese oxide, albite, sphalerite, galena, chalcopyrite, covellite, argentite, bournonite, rutile, ilmenite, apatite, epidote, monazite, zircon and a couple of sulfosalts enriched in Fe and Sb and Pb and Sb, respectively.

Although amorphous iron oxyhydroxide, loosely called goethite in this report, constitutes only a minor component of the tailing solids, it plays a significant role in attenuating the transport of some potentially deleterious metals and trace elements. The sorption of Zn in goethite enriched in Mn is demonstrated by a series of X-ray maps in Figure 11. Other examples of textural features of interest observed during the SEM analysis as well as chemical analyses of rare minerals are illustrated in Appendix D-2.

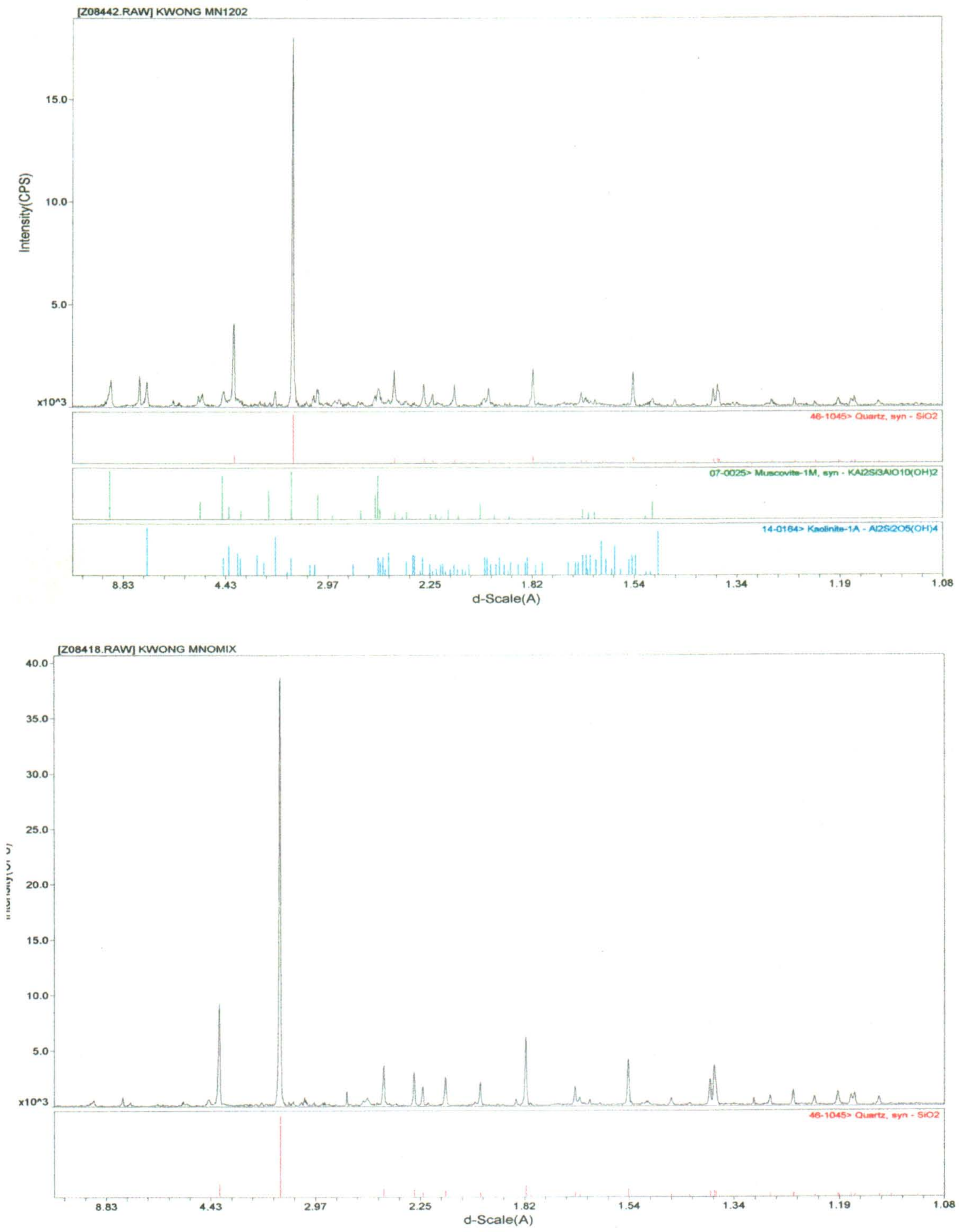


Figure 9. A pair of X-ray diffractograms illustrating that clayey tailings (above) differ from silty tailings (below) by the amount of clay minerals present regardless of sulfide content. Reference XRD patterns of relevant minerals are provided below each diffractogram to demonstrate positive identification.

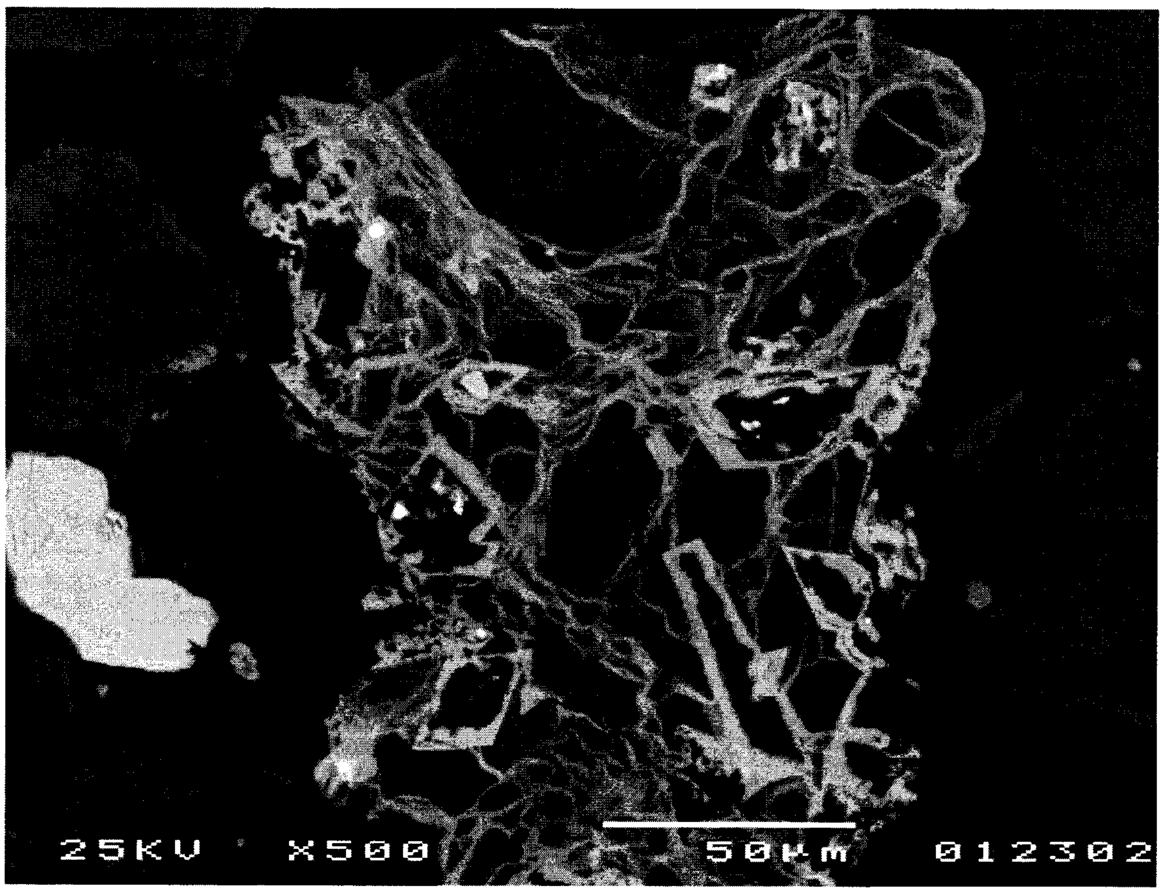


Figure 10. A backscattered electron photomicrograph illustrating complete replacement of arsenopyrite (angular grains with apparent voids in the centre and embedded in a composite grain of quartz) by scorodite. A subhedral pyrite grain (light grey, left edge of picture) is totally devoid of alteration. The small white grain inside one of the weathered-out arsenopyrite is bournonite, a lead antimony sulfide.

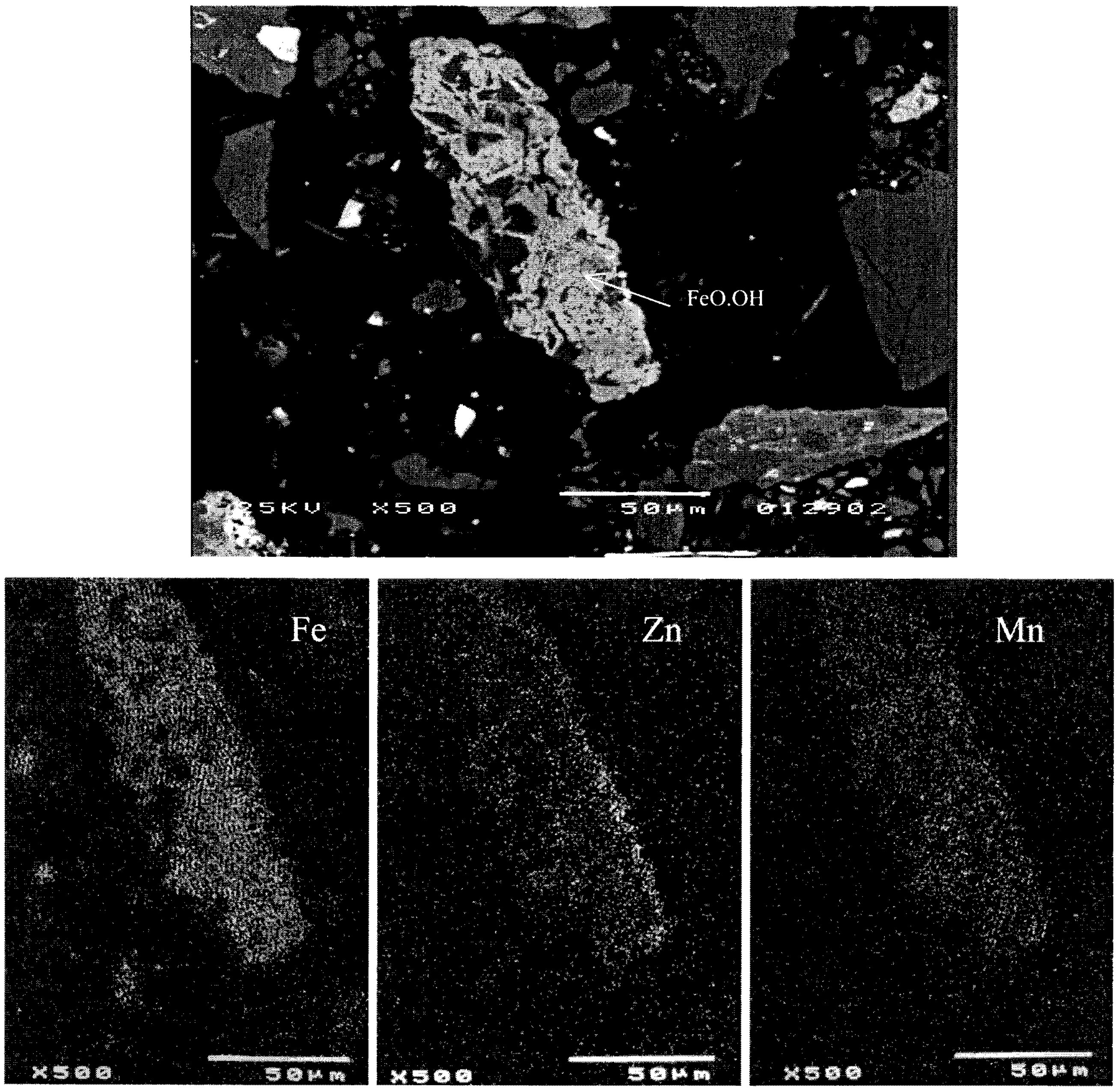


Figure 11. Top: Secondary electron photomicrograph of an aggregated grain of goethite (FeO.OH) with included quartz (dark grey). Bottom: X-ray maps of Fe, Zn and Mn of the aggregated grain above illustrating the sorption of Zn with the iron oxyhydroxide enriched in Mn content. Note also the partial encapsulation of pyrite in quartz (upper left corner in the secondary electron photomicrograph) that has hampered its oxidation to goethite.

Tailings Porewater Chemistry

Most of the core samples acquired in the drill program were saturated tailings. Upon transport from the tailings pond to the field laboratory, compaction often led to the bleeding of porewater to the surface of the tailings in a sample bag. Such porewater was carefully decanted and filtered (0.45 μm) for various analyses. For clayey tailings that did not readily bleed water, centrifuging was required to extract any porewater. Frozen tailings were allowed to thaw before porewater extraction. For samples that did not yield any porewater, leaching with de-ionized distilled water at a 1:1 liquid to solid ratio was conducted to provide a leach water (simulated porewater) for field analysis of cyanide-related species only.

The porewater samples were analyzed for pH, weak acid dissociable cyanide (WAD CN), thiocyanate (CNS), ammonia (NH_4-N), nitrite (NO_2-N) and nitrate (NO_3-N). In the field, WAD CN was measured using a Perstorp analyzer obtained from INAC. The analysis of NH_4-N, NO_3-N, NO_2-N and CNS was conducted using a Hach DR 2010 analyzer. Upon completion of the field analyses, excess porewater samples were preserved and shipped to CANMET/MMSL, Ottawa for further analysis. An aliquot of each sample (~25 mL) was preserved with concentrated nitric acid (one drop per 20 mL of sample) for ICP/MS metal scan and sulfate. The remainder was preserved using 1.0M NaOH (to pH >12) for the analysis of various CN species.

The detailed porewater analyses on each sample and a summary of the CN-related parameters and selected metals are tabulated in Appendix C-3 on a hole-by-hole basis. Briefly, the porewater Total-CN concentration ranged from 0.1 to 65.3 mg/L while the Total CN content of tailings solids ranged from 53 to 145 μg/g. The maximum porewater WAD CN concentration measured, which appeared to be strongly related to dissolved Cu, was 38.3 mg/L. The total CN and WAD CN concentrations increased with depth in Bore Holes 2, 3 and 4 while in the majority of other holes they did not follow any specific pattern with either increasing or decreasing depths. For nine porewater samples the WAD CN values obtained in field were higher than the Total-CN concentrations determined at the CANMET/MMSL laboratory. The Total CN concentration in the majority of these samples was lower than 1 mg/L. The total CN analysis was conducted in Ottawa about two weeks after the field program. Given the low initial concentrations, the time delay and the impact of NaOH addition (for sample preservation) on a variety of metal-CN complexes may have contributed to the observed discrepancies.

While the sulfidic clays contained a higher average amount of Total CN (72.7 μg/g), the oxide tailings, regardless of grain size, were more enriched in both porewater Total CN and WAD CN (Figure 12). Incidentally, the oxide tailings (both silt and clay) were also observed to have the higher average dissolved Cu and Fe concentrations in their porewater samples.

Porewater CNS concentrations ranged from <2 mg/L to a maximum of 315 mg/L. They generally did not show any relationship with either porewater Total CN or WAD CN. The CNS concentration reached 100 mg/L even for porewater samples with Total CN and WAD CN concentrations of less than 1 mg/L. The average CNS concentration for sulfide clay, sulfide silt, oxide clay and oxide silt samples were 168, 104, 118 and 140 mg/L, respectively (Figure 12). Thus sulfide clay tailings are apparently most enriched in CNS.

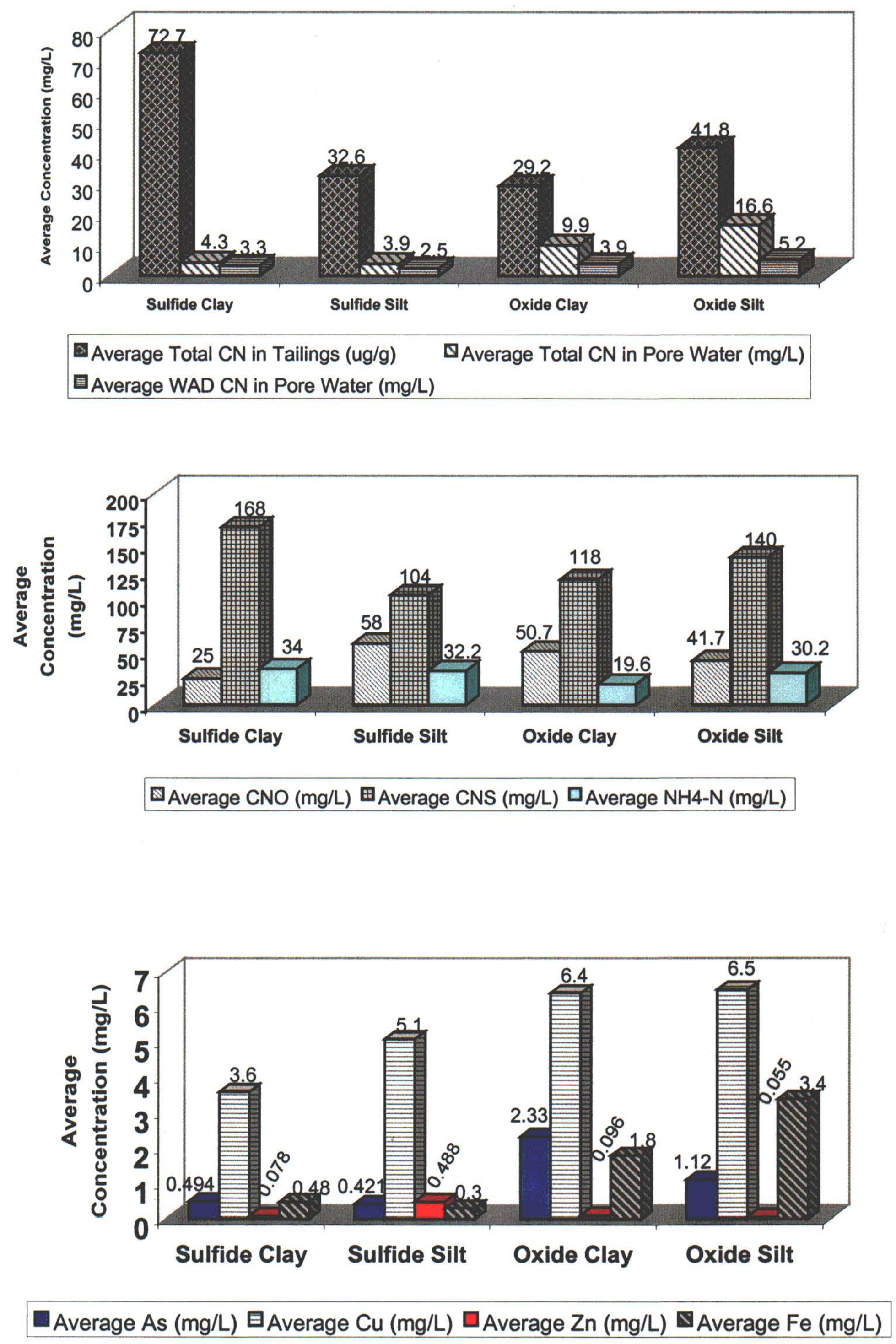


Figure 12. Average concentration of Total CN in tailings solids and various CN-related species and selected metals in porewaters of the four types of tailings identified in the Mount Nansen tailings impoundment.

Porewater CNO values in the Mount Nansen tailings ranged from 3 mg/L to 153 mg/L. Porewater samples with Total CN and WAD CN below 1 mg/L had CNO concentration below 20 mg/L. The thermodynamics of the cyanide-cyanate reaction indicates that cyanate should be the predominant species under natural conditions. However only strong oxidants are capable of directly oxidizing cyanide. Under natural conditions microbial enzymatic reactions and catalytic surfaces of minerals are able to promote this oxidization. Cyanate is also generated by the hydrolysis of thiocyanate. The average CNO concentrations in porewaters associated with the sulfide clay, sulfide silt, oxide clay and oxide silt tailings are shown in Figure 12.

The ammonia concentration in the porewater samples ranged from 1 mg/L to 59 mg/L. Ammonia concentrations in general were higher for samples containing higher amounts of CNS. In the leach water samples (mainly on BH 5 cores that yielded no porewater) the WAD CN, CNS and NH_4-N concentrations were <0.2, 10 and 10 mg/L, respectively. The analysis of frozen ice samples below the snow cover gave <0.1 mg/L WAD CN but the CNS concentrations were between 50 to 65 mg/L and ammonia in the 20 to 25 mg/L range. The variation of average NH_4-N in porewaters of the different tailings types is also shown in Figure 12.

As expected, the average Total S concentration in the porewaters was higher in sulfide silt/clay cores than in oxide clay/silt cores. The dissolved As concentration in porewaters ranged from as low as 1 μg/L to as high as 5,620 μg/L. The maximum Zn concentration in the porewater samples was 5,774 μg/L. The Cu concentration ranged from 0.01 mg/L to 27.7 mg/L. In general, samples with a higher Cu concentration also showed higher WAD CN. The average porewater Zn concentration was higher for sulfide silt cores (Figure 12). The average As concentration in porewater samples was higher for oxide cores than for sulfide cores. The Cu concentration in general was higher in oxide silt (6.5 mg/L) and oxide clay (6.4 mg/L) than in sulfide silt (5.09 mg/L) and sulfide clay (3.6 mg/L). The average porewater Fe concentration in the oxide silt/clay cores was higher than that in the sulfide clay/silt cores.

Analyses of Grab Samples from the Brown-McDade Pit

Samples collected during a brief examination of alteration and remnant mineralization at the Brown-McDade pit and subjected to detailed analysis include the following:

1. Four grab samples of intense alteration at the two adits and a breccia zone in the north wall near the middle of the pit;
2. Two pit water samples from the top and bottom of the pit pond, respectively; and
3. A small sample of sediments accumulated at the bottom of the pit.

The results of XRD, SEM/EDX and geochemical analyses of the grab alteration samples confirm the presence of pyrite as the dominant sulfide and gypsum, jarosite, muscovite/illite and kaolinite the common crystalline alteration products. Two samples submitted for ABA characterization are shown to be potentially acid-generating with NNP values of -92 and -147 kg $CaCO_3$/tonne, respectively. X-Ray diffraction analysis of the pit sediment reveals that it differs from the impounded tailings by the presence of a significant amount of montmorillonite and the absence of gypsum. Quartz, muscovite/illite and kaolinite are the other constituents identified.

The analysis of the pit waters by ICPAES reveals the presence of chemical stratification in the pit pond. The sample collected from just beneath the ice cover, which was used in the column and leaching studies, contained significantly less dissolved metals than the sample collected near the bottom of the pit. Notable contrasts include 0.04 versus 0.35 mg/L Al; 127 versus 426 mg/L Ca; 0.05 versus 0.86 mg/L Fe; 1.25 versus 5.99 mg/L K, 29.0 versus 397 mg/L Mg; <0.006 versus 0.025 mg/L Mn; 7.99 versus 15.8 mg/L Na; 81.7 versus 899 mg/L total S; and, 0.82 versus 1.74 mg/L Zn. Dissolved Si, however, was enriched near the top of the pit (9.84 versus 3.72 mg/L). Dissolved As, Cu, Pb and Sb in both of the water samples were below the ICPAES quantification limits (which is defined as 10X the detection limits) of 0.55, 0.018, 0.52 and 0.32 mg/L, respectively. Supplementary ICPMS analyses gave 0.024 mg/L As and 0.060 mg/L Sb in the surface pit water, 0.014 mg/L As and 0.022 mg/L Sb in the bottom water and <0.020 mg/L Pb in either water. The pit surface water gave a field pH measurement of 7.1 while that of the pit bottom water was pH 7.5. It thus appears that both As and Sb are more soluble in a higher pH medium.

COLUMN TESTING

Purpose of Study

To investigate possible interactions of the impounded tailings with water accumulated in the Brown-McDade pit, eight columns were set up to simulate four disposal scenarios in duplicate (Figure 13). The scenarios are:

1. High sulfide tailings under a water cover;
2. Low sulfide tailing under a water cover;
3. Mixed (high and low sulfide) tailings slurried and placed under a water cover; and
4. Mixed tailings under flow-through conditions.

Figure 13. Eight columns set up to study four disposal scenarios for the Mount Nansen tailings

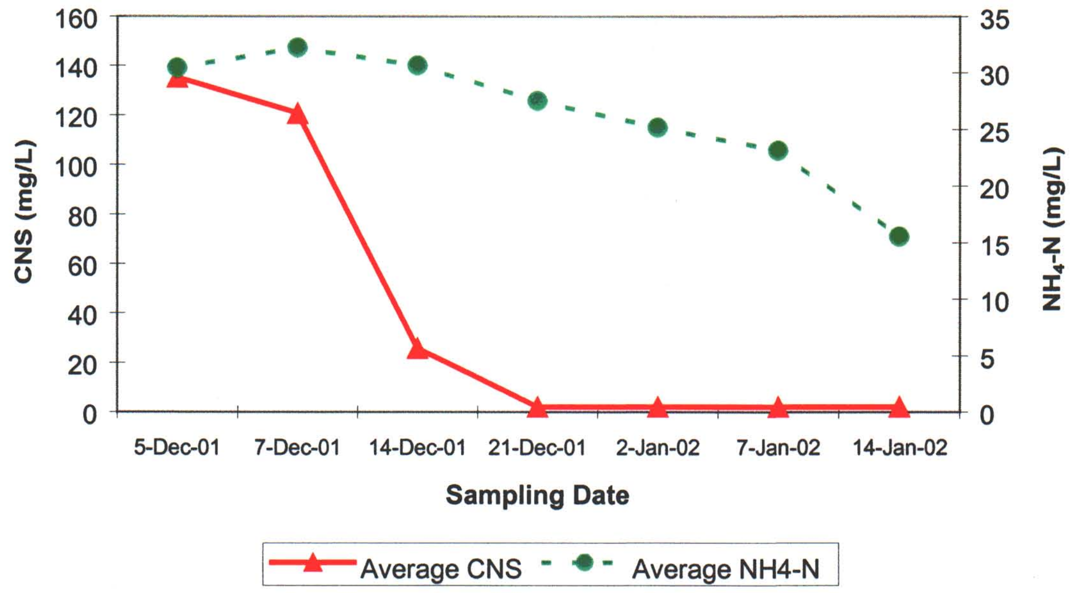
Scenarios 1 and 2 simulate the transfer of tailings with relatively little water followed by placement under a shallow water cover. Scenario 3 simulates transfer of mixed coarse tailings as a slurry, followed by settling under a shallow water cover. Scenario 4 (flow through) simulates leaching of exposed tailings by natural precipitation. For practical reasons (time and permeability of the test solids), only composite samples of the coarser tailings (sulfide and oxide silts) were used in the column testing. The column configuration and set up, test procedures and monitoring data acquired to date are detailed in Appendix E. Between December 2001 and February 2002, the columns with a water cover were sampled four times and the flow-through columns ten times. For the former, samples of the overlying water and porewater at 5 cm below the water/tailings interface were collected in addition to one drawn from the base of the columns. For the latter, sampling was done only from the base of the columns. Salient observations on the water analyses are presented and discussed below.

Results and Observations

Since the commencement of the column testing in December 2001, Total and WAD CN have not been released into the water to any significant degree in all the disposal scenarios studied. Total CN in concentrations ranging from 0.05 to 0.07 mg/L were observed in the last two sampling events at the base of the columns with tailings under a water cover (Scenarios 1 and 2). The high-sulfide columns had the higher CNS concentrations in porewater and at the base of the column. The average CNS concentrations in the porewater and at the base of the high-sulfide column were 39 and 131 mg/L, respectively, at the last sampling event conducted on February 11, 2002. In the low-sulfide columns, CNS was detected only at the base of the columns during the last two sampling events with a concentration range of 9.9 to 12 mg/L. Ammonia was detected in all columns. The NH_4-N concentration in the high-sulfide columns ranged from a minimum of 3.75 mg/L in the water cover to a maximum of 35 mg/L in the porewater. In the low-sulfide columns, the NH_4-N concentration ranged from a minimum of 0.54 mg/L in water cover to a maximum of 24.7 mg/L at the base of the column. The water cover of the mixed slurry columns in general had higher NH_4-N compared to the low- and high-sulfide columns, with a maximum NH_4-N concentration of 21.4 mg/L at the start of the column study. For the columns with a water cover, NH_4-N at the base of the columns was observed to increase with time, whereas porewater NH_4-N was observed to decrease with time. A similar trend was observed for CNS and SO_4 concentrations in the porewater and at the base of the columns with a water cover. The flushing of porewater from the upper regions of the columns through extraction of water samples at the base of the column may have contributed to the observed increase in the NH_4-N at the base of the columns. As ammonia is a degradation product of CN and CNS, its presence indicates that CN/CNS degradation reactions were taking place. Since the column testing is conducted at room temperature (considerably higher than that under field conditions) the CN/CNS degradation rates may have been enhanced. Cyanate was not observed in the columns with the water cover during the first two sampling events. In the high-sulfide tailings, a maximum CNO concentration of 25 mg/L was observed in the tailings porewater and at the base of the columns. Lower CNO concentrations were observed in the low-sulfide, mixed slurried tailings and flow-through columns. The presence of CNO also confirms that CN/CNS degradation reactions were taking place in the columns and possibly the reactions rates were enhanced towards the last two sampling events. It is thus desirable to continue the column testing for at least three additional sampling events to clarify the evolution trends. The oxidation of ammonia to nitrite and nitrate was not observed to any significant levels in any of the columns. The only other ammonia removal mechanisms from water would be by volatilization and/or by ion exchange/sorption with the clay particles in the tailings. Since the pH in the columns was generally below 9.5, ammonia removal by volatilization would not be significant.

Arsenic was observed in the water cover, porewater and base flow of all the columns. The dissolved arsenic concentration in the water cover, porewater and at the base of the high-sulfide and mixed slurry tailings columns increased with time and appeared to have stabilized at concentrations of 1.5 ± 0.2 mg/L. A maximum arsenic concentration of 2.58 mg/L was observed at the base of the low-sulfide columns at the last sampling event. Dissolved zinc in the porewater and at the base of the columns decreased with time to concentrations of less than 0.038 mg/L at the last sampling event. However, zinc was generally present in higher concentrations (0.08 to 0.62 mg/L) in the water cover compared to porewater and at the base of the columns. This can readily be explained by the higher Zn concentration (0.74 mg/L) in the pit water, which was used in the column testing. Lower dissolved Zn in the porewater and at the base of the columns suggests that Zn was removed by precipitation/sorption on mineral surfaces as overlying water was drawn downward during sample collection. A maximum dissolved Cu concentration of 0.194 mg/L was observed at the start of the testing in the flow-through columns. Generally, the dissolved Cu concentrations in the water cover, porewater and at the base of the columns have decreased to levels ranging from 0.03 to 0.05 mg/L by the last sampling event. Dissolved Cu at much higher concentrations was observed in porewater samples collected from the tailings pond. Here the porewater results indicate a strong relationship between Cu and WAD CN concentrations. Dissolved Cu, Total and WAD CN were not found in the column samples at concentrations comparable to the tailings pond porewater results. It is possible that WAD CN (predominantly as copper-cyanide complex) degraded between the time the core samples were extracted from the tailing pond and the set up of the columns. The Cu released from WAD CN degradation could have precipitated or sorbed onto mineral surfaces and the CN could have either volatilized, degraded or formed complexes with Fe and also precipitated among the tailings solids. It is also possible that redox-potential changes and other secondary reactions may have led to the formation of a variety of precipitates such as Cu (I, II) and ferri/ferro cyanide complexes, which are highly insoluble and can remain inert (Smith and Mudder, 1991). Compounds such as hexacyanoferrates are usually tightly bound to the tailings solids. They are thermodynamically stable and do not dissociate readily. In an iron-rich medium containing excess ferric, ferrous and copper ions, an insoluble metal hexacyanoferrate often forms and precipitates out from solution. This could also explain why total CN was not released to any significant degree in the column testing.

While the column test work to date indicated that tailings might not release significant amounts of Total CN and WAD CN to the water cover and base flow, seepage water collected during the drilling program had Total CN and WAD CN contents of approximately 0.3 mg/L. The tailings seepage at the site has been continuously pumped back to the tailing pond. The CNS and NH_4-N concentrations in the tailings pond seepage water were 60 mg/L and 17 mg/L, respectively. The average CNS and NH_4-N concentrations observed in the last sampling event at the base of the mixed slurried tailing columns were 58 mg/L and 21.7 mg/L, respectively. However, in the flow-through columns (simulating a storm accelerated flushing scenario) CNS was no longer detectable at the base approximately two weeks after the column set up. Instead, its degradation product NH_4-N was observed at an average concentration of 15.5 mg/L during the last sampling event. Thiocyanate was present in the base flow of the columns with a water cover at the last sampling event. The average CNS concentrations ranged from 11.5 mg/L in the low-sulfide columns to 131 mg/L in the high-sulfide columns. Figure 14 shows time-series plots of CNS, NH_4-N, SO_4, As and Sb observed at the base of the flow-through columns. The flow-through column results to date show that the release of NH_4-N from the tailings will likely continue to decrease with time in concentration. The concentration of As initially increased and now appears to have stabilized at a concentration of approximately 0.9 mg/L. The leaching of Cu, Zn and Sb appears to have stabilized at approximately <0.03 mg/L, 0.03 mg/L and 0.08 mg/L, respectively. The average dissolved As concentration in the base flow samples of columns with a water cover was approximately 1.6 mg/L in the high-sulfide and mixed slurry tailings columns and 2.58 mg/L in the low-sulfide columns.



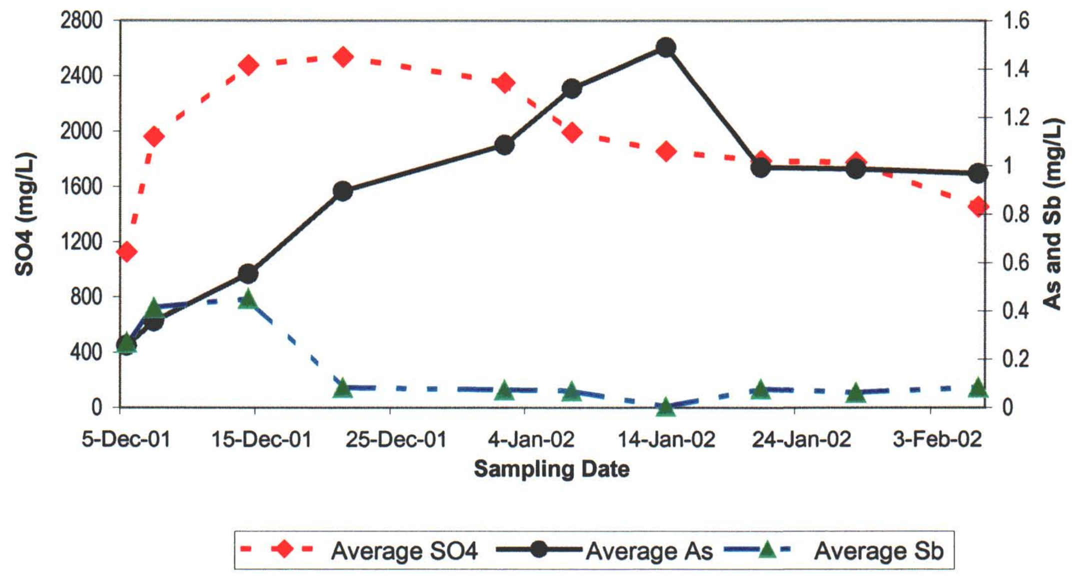


Figure 14. The average concentration of CNS, NH_4-N, SO_4, As and Sb in samples collected at the base of the flow-through columns.

Based on observations made to date in the column study, the method used for moving the tailings from the present location to the pit could also impact the water quality of the resultant water cover and seepage water. The tailings, if slurried and then pumped to the pit, will initially generate higher concentrations of CNS, SO_4, NH_4-N, As and Sb in the water cover. Moving the tailings in a relatively dry form may not have as significant an impact on the water cover quality. At the time of the field sampling campaign, the tailing pond seepage water had dissolved As, Cu, Sb and Zn concentrations of 0.037, 0.389, 0.004 and 0.643 mg/L respectively. In the flow-through columns after approximately three months of pit water application the average concentrations of dissolved As, Cu, Sb, and Zn in the collected samples were 0.969 mg/L, 0.029 mg/L, 0.084 and 0.013 mg/L, respectively. In all of the columns, the base flow samples in general had higher concentrations of dissolved As and Sb and lower concentrations of dissolved Cu and Zn than those measured in the tailings pond seepage return water. The column testing to date shows that, with the exception of overlying water in the low-sulfide columns, dissolved As levels in most samples were higher than the 0.5 mg/L limit of maximum acceptable monthly mean value indicated in the Environment Canada's Metal Mining Liquid Effluent Regulations and Guidelines (1977). Total CN and WAD CN were below the detection limit of 0.05 mg/L in the majority of samples collected. The maximum Total CN and WAD CN concentrations observed in the column study were 0.10 and 0.17 mg/L, respectively. It appears that to date Total CN associated with the tailings in the columns did not leach into the water as Total CN or WAD CN to any significant degree.

SEQUENTIAL BATCH LEACH TESTS

Because of the fine grain size of the clayey tailings and consequently their inherently low permeability, it is not practical to run column testing with them. Instead, the sequential batch test as described by Filipek (1999) is adopted to investigate the impact of varying water to solid ratios on the leaching behaviour of the fine tailings. Two tests were conducted, one on untreated tailings and the other on tailings after treatment with the INCO-SO_2 process. The focus of the former was on metal releases and the latter on the behaviour of CN-related species.

Test with Untreated Tailings

The test procedure is schematically illustrated in Figure 15. The experiment was started with 100 g of fine tailings shaken overnight with 100 mL of the Brown-McDade pit water as the leach medium. An aliquot of the filtered leachate was advanced successively through a new, smaller batch of fresh tailings from left to right while keeping the same liquid to solid ratio. From top to bottom, the residue from the previous leaching step was successively leached with an increasing amount of pit water. In other words, going from left to right, the same batch of pit water encountered more and more fresh tailings while from top to bottom, the same batch of tailings was subjected to repeated leaching by new batches of pit water. Consequently, although the liquid to solid ratio was maintained the same along a horizontal series of batch leaching, the effective liquid to solid ratio at each leach step varied. The latter was calculated and shown in each box pertaining to an individual step in the batch test procedure. Note that there are built-in redundancies in the test procedure such that Leachates A1 and B3 have the same effective liquid to solid ratio and so do Leachates B1 and C2. The agreement between the analyses of a particular constituent in these corresponding leachates indicates if sorption and rapid dissolution control the behaviour of the constituent, or if errors have been made in the test work or in the subsequent chemical analysis.

The ICP-AES analyses of the leachate samples show that As and Sb are the only trace elements that were significantly leached from the tailings. The test results are illustrated in a plot of amount of elements released versus the effective liquid to solid ratio in each leach step (Figure 16). The major cations, K and Ca, are also included in the diagram to illustrate the different processes that could have occurred during the batch leach testing.

Of the four elements depicted, K shows the most significant and consistent decrease in concentration with increasing effective liquid to solid ratio. This reflects that the release of K into the leachates was indeed controlled by sorption or rapid dissolution reactions. The dissolved Ca concentration in the leachates does not appear to vary at all with the effective liquid to solid ratio except for the leaching of the oxide clayey tailings at high dilution. This suggests a solubility control on the Ca release throughout most of the sequential batch testing. Given the notable presence of gypsum in the tailings, it is likely that rapid dissolution of gypsum had maintained a constant Ca concentration in the leachates until it was totally depleted. In other words, the leachates were in equilibrium with gypsum except at very high dilutions. A perusal of the associated sulfate data (Appendix F) provides additional support for the gypsum dissolution hypothesis. Since the oxide tailings contain less gypsum than the sulfide tails, it is logical to expect that gypsum will be depleted sooner in the former, leading to the observed drop in dissolved Ca concentration when the effective liquid to solid ratio approached 6 (Figure 16).

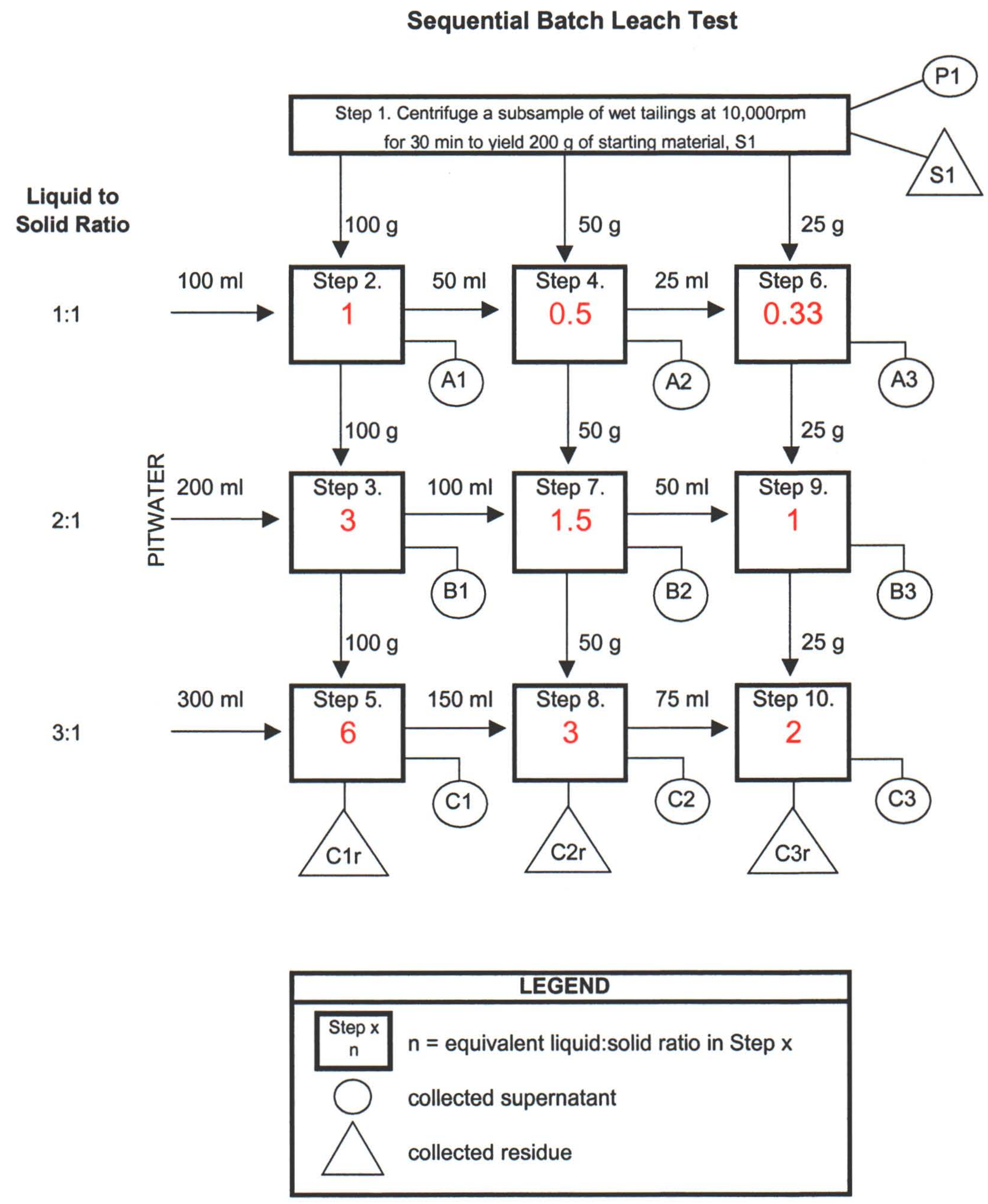


Figure 15. A schematic diagram showing the test procedure for the sequential batch test.

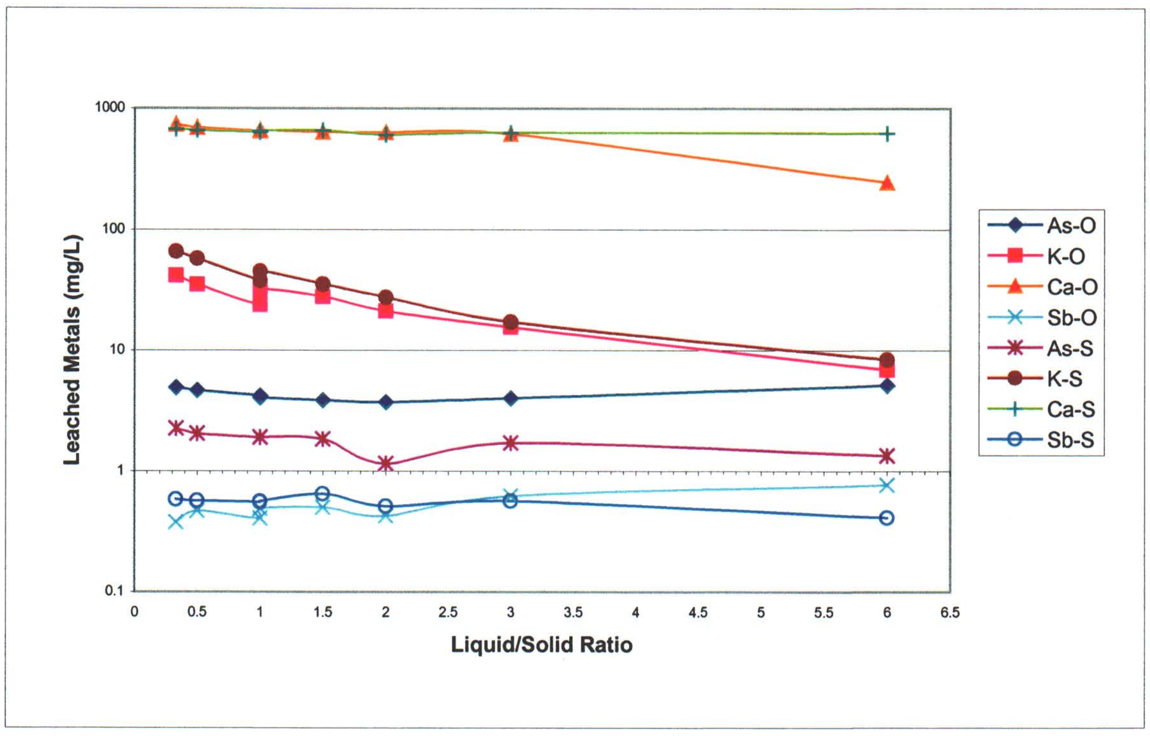


Figure 16. Variation of elements released with effective liquid to solid ratio in a sequential batch leach of clayey tailings with the Brown-McDade pit water. (O in the legend refers to oxide tails and S to sulfide tails.)

The leaching of As and Sb apparently followed a different path depending on the composition of the tailings tested. With the clayey sulfide tailings, both the As and Sb concentrations in the leachates slightly decreased with an increasing effective liquid to solid ratio in the leaching process. With the clayey oxide tailings, however, the leachate Sb concentration showed a slight increasing trend at higher dilution. The leachate As concentration first decreased and then increased with an increasing liquid to solid ratio. These observations suggest that the leaching of As and Sb from the sulfide tails was controlled by slow desorption and dilution reactions. In contrast, ionic exchange probably dominated the As and Sb release from the oxide tailings, especially under high dilution conditions.

Test with INCO SO_2/Air Treated Tailings

The INCO SO_2/Air treatment process is commonly used for the removal of free and complexed cyanide from water and tailings. The process uses a combination of SO_2 plus oxygen in air as an oxidizing agent in the presence of copper as a catalyst. The reaction is normally completed in 5 to 60 minutes. This process has been widely used in the gold mining industry.

The INCO SO_2/Air treatment of the fine sulfide and oxide tailings was conducted separately in a 2 L reaction vessel. Prior to treatment, the tailings were vacuum-filtered to remove the associated porewater. One kg of tailings were thoroughly mixed with 1.5 L of deionized water using a magnetic stirrer bar. One hundred mg of copper sulfate was also added to the reactor. Sulfur dioxide and air were then introduced into the tailings slurry at a flow rate of 20 mL/min and 110 mL/min, respectively. The slurry was continuously mixed and lime was added to maintain the pH at 9.5. The tests were conducted for 45 minutes. In total, 50 g of lime was added during the treatment of the tailings.

The total CN of 63 μg/g in the sulfide tailings solids was reduced to less than 0.2 μg/g after the treatment. The total CN in the oxide tailings solids was reduced from 47 μg/g to <0.2 μg/g. Thus the INCO SO_2/Air treatment was effective in removing the Total CN associated with the tailings. The Total CN concentration in the INCO SO_2/Air process water was detected at 4.05 and 1.0 mg/L for the sulfide and oxide tailings, respectively. The WAD CN, CNS, NH_4-N and SO_4 concentrations in the process water for the sulfide tailings were <0.05, 15, 10.4 and 1,630 mg/L, respectively. The corresponding values for the oxide tailings were <0.05, 22, 6.3 and 494 mg/L, respectively. The dissolved As, Cu, Zn and Sb concentrations in the INCO SO_2/Air process water for the oxide tailings were 1.34, 0.043, 0.016, and 0.260 mg/L, respectively. For the sulfide tailings, the corresponding analyses were 0.438 mg/L As, 0.043 mg/L Cu, 0.052 mg/L Zn, and 0.128 mg/L Sb. Higher concentrations of As and Sb were released during the INCO SO_2/Air treatment of the oxide tailings compared to treating the sulfide tailings.

The tailings after INCO SO_2/Air treatment were subjected to the sequential batch test. The results are shown in Table 3 for the sulfide tailings and in Table 4 for the oxide tailings according to effective liquid to solid ratios. A high degree of variability in the concentration of the measured parameters was observed. In the leaching of the two tailings composites, the maximum concentrations of Total CN, WAD CN, CNS, and NH_4-N released into the water were 3.8, 0.09, 7 and 9.8 mg/L, respectively. Arsenic, Cu, Zn and Sb released into water at maximum concentrations of 3.86, 0.069, 0.187 and 0.403 mg/L, respectively, were also observed.

Table 3. Results of sequential batch test conducted for sulfide tailings after INCO SO_2/Air treatment.

Parameter	Effective Liquid Solid Ratio								
	0.33 (A3)	0.5 (A2)	1 (A1/B3)		1.5 (B2)	2 (C3)	3 (B1/C2)		6 (C1)
pH	8.87	8.16	8.34	9.08	8.42	8.41	8.06	8.34	8.07
Conductivity (μS/cm)	-	2650	2870	2420	2600	2910	2500	2520	2010
Total CN (mg/L)	3.40	<0.05	<0.05	1.50	<0.05	0.50	<0.05	0.06	0.10
WAD CN (mg/L)	<0.05	0.07	<0.05	0.06	0.09	0.05	0.09	0.06	<0.05
CNS (mg/L)	7	6	<1	<1	<1	<1	<1	<1	<1
NH_4-N (mg/L)	1.7	12	8.1	-	6.3	2.9	2.3	2.4	<1
As (mg/L)	3.12	1.10	1.07	2.98	1.06	2.98	0.934	3.83	1.02
Cu (mg/L)	0.063	0.063	0.033	0.035	0.032	0.036	0.069	0.033	0.025
Zn (mg/L)	0.164	0.110	0.034	0.012	0.025	0.026	0.187	0.021	0.017
Sb (mg/L)	0.324	0.242	0.272	0.305	0.233	0.334	0.233	0.240	0.185

Table 4. Results of sequential batch test conducted for oxide tailings after INCO SO_2/Air treatment.

Parameter	Effective Liquid Solid Ratio							
	0.33 (A3)	1 (A1/B3)		1.5 (B2)	2 (C3)	3 (B1/C2)		6 (C1)
pH	8.31	9.50	8.70	9.24	8.4	8.77	8.62	
Conductivity (μS/cm)	2710	1131	2450	1809	2470	1725	2020	1602
Total CN (mg/L)	0.3	3.8	0.2	2.2	0.2	1.5	1.0	0.6
WAD CN (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
CNS (mg/L)	<1	5	<1	<1	<1	<1	<1	<1
NH_4-N (mg/L)	9.8	2.0	4.1	1.4	2.3	1.4	1.0	<1
As (mg/L)	1.18	3.58	1.08	3.86	1.25	3.44	1.32	3.57
Cu (mg/L)	0.046	0.035	0.032	0.030	0.033	0.032	0.033	0.030
Zn (mg/L)	0.040	<0.005	0.024	<0.005	0.020	0.070	0.009	0.009
Sb (mg/L)	0.403	0.263	0.249	0.311	0.309	0.357	0.397	0.312

These results show that treating the tailings with the INCO SO_2/Air process could remove the Total CN associated with the tailings. However, CNS, NH_4-N and sulfate will be generated during the process. Arsenic and antimony will also be released from the tailings into the water during the INCO SO_2/Air treatment. Much of the Total CN released into the process water during the treatment could have been further eliminated by increasing the reaction time from 45 minutes to 60 minutes.

SELECTIVE LEACHING AND FREEZE THAW STUDIES

To complement the column testing and sequential batch leach test work, customized leach tests and freeze thaw studies were conducted on samples representative of the four tailings types to elucidate the impact of changing environmental conditions on the tailings chemical stability. Salient results and observations are presented below.

Selective Leach Tests

a) Partial sequential extraction analysis: The potential for remobilization and hence the bioavailability of trace elements associated with geologic materials like tailings depends on how the elements are distributed among the different components in a typical sample. Hall et al. (1997) have furnished a sequential extraction scheme involving a series of successive chemical treatments of a sample, each being more drastic in nature than the previous step, to determine the relative mobility of trace elements associated with five common components of a geological sample. Exchangeable and adsorbed trace elements and those coprecipitated with carbonates (collectively known as the AEC component) can readily be leached by subtle changes in the composition of a circulating fluid. Trace elements associated with hydrous oxides of Mn and Fe (abbreviated as the amorphous FeO fraction) can readily be remobilized under mildly reducing conditions. Trace elements associated with the other components that can be released with increasing difficulty include those bound by crystalline FeO, sulfides and organics, and a residual fraction usually locked in silicate minerals. The AEC and amorphous FeO bound trace elements thus represent the more readily remobilized and bioavailable fractions in a geologic sample while those bound in other components can only be leached under conditions not readily reached in a natural setting.

To determine the mobile metals and trace elements associated with the impounded tailings at Mount Nansen, a partial sequential extraction procedure of Hall et al. (1997) was adopted. The AEC fraction was determined by extraction with a sodium acetate solution buffered at pH 5.0. Metals and trace elements associated with amorphous and hydrous Fe and Mn oxides (i.e., the amorphous FeO fraction) were extracted with a solution of 0.25 M $NH_2OH.HCl$ in 0.05 M HCl. Six samples of different tailings types were tested. The raw data are tabulated in Appendix F and the derived fractionation results are summarized in Table 5.

Several observations can readily be made from a perusal of the data shown in Table 5. These include the following:

1. Amorphous Fe±Mn oxyhydroxides are a significant host for Cu, Pb, Zn and, to a lesser extent, As, in the Mount Nansen tailings.
2. With about 40% of the total concentration associated with the AEC and amorphous Fe-Mn oxyhydroxides, Zn is understandably the metal most susceptible to remobilization in the impounded tailings.
3. A relatively high proportion (average about 20%) of Cu and Pb in the tailings, regardless of grain size and composition, also occur in readily releasable forms. However, the total Cu concentration in the tailings solids is relatively low and thus

will not give rise to highly concentrated leachates. For Pb, a greater proportion of the releasable component is associated with the amorphous oxyhydroxide. It can be remobilized only under reducing conditions where the oxyhydroxides are no longer stable.

4. The clayey tailings apparently host more AEC As than their silty counterparts. The relatively low proportion of amorphous oxide-bound As in the silty oxide tails suggests that sorption with clay minerals is an important mechanism for attenuating transport of As in the impoundment.
5. With less than 5% of the total concentration occurring in readily releasable forms, most Sb in the Mount Nansen tailings is likely locked up in sulfosalts as observed during SEM examination of selected tailings.

Table 5. Proportion of easily releasable As, Cu, Pb, Sb and Zn in the Mount Nansen tailings as derived from sequential extraction analysis.

Sample Description	*As*	*Cu*	*Pb*	*Sb*	*Zn*
Oxide clay BATCHO					
Total concentration, µg/g	4926	483	4514	847	1588
% AEC	11.4	3.3	4.5	2.0	11.4
% Amorphous FeO-bound	6.5	8.4	20.5	<1	28.3
Sulfide clay BATCHS					
Total concentration, µg/g	3589	356	2745	443	1916
% AEC	10.0	12.3	3.7	2.6	12.0
% amorphous FeO-bound	9.8	14.6	19.6	<2.2	34.4
Sulfide clay MN1102					
Total concentration, µg/g	4070	630	3750	571	2440
% AEC	8.5	6.9	5.0	<1.7	12.0
% amorphous FeO-bound	10.3	10.0	17.5	<1.7	31.7
Oxide silt MN1401					
Total concentration, µg/g	4442	338	2270	460	2100
% AEC	3.5	10.2	5.3	2.2	11.5
% amorphous FeO-bound	3.0	15.1	19.6	<2.1	25.9
Sulfide-Oxide silt (SOMIX)					
Total concentration, µg/g	2468	285	1758	375	1525
% AEC	5.5	11.1	5.0	<2.6	13.3
% amorphous FeO-bound	3.5	11.1	13.2	<2.6	25.5
Sulfide-Oxide silt (Slurry)					
Total concentration, µg/g	2473	312	1644	375	1525
% AEC	5.4	8.0	4.3	<2.6	12.1
% amorphous FeO-bound	3.5	11.8	14.4	<2.6	27.7

It should be noted that the extraction analysis was conducted with vigorous agitation and aggressive digestion. The analyses would thus reflect the worst-case remobilization for the elements analyzed. Under normal field conditions, the release of these elements is expected to occur to a much smaller extent. Leachates obtained at each step of the sequential extraction analysis were also analyzed for Total CN. However, all analyses were below the detection limit of 0.05 mg/L. Therefore WAD CN was not analyzed for these samples.

b) Controlled lime leach: Since both As and CN are parameters of concern at Mount Nansen and the mobility of which are known to vary with pH, it was decided to leach the same selected tailings samples used in the sequential extraction analysis with a 0.1M lime solution. A standard leach protocol with a modified liquid to solid ratio of 5:1 was used as the test procedure. A controlled experiment was also conducted with distilled water as the leach medium. The test results are summarized in Table 6.

A perusal of the data shown in Table 6 reveals a few surprises. Arsenic and antimony were not leached by the lime solution in all samples but were released at low concentration with the distilled water leach. In contrast, the lime leach appeared to have mobilized Pb, Zn and CN in most samples while the control showed insignificant leaching of these species by distilled water. The leaching of CNS is apparently independent of leach media but controlled by the composition of tailings. The mobilization of Pb and Zn appears to be related to the instability of iron oxyhydroxide at very high pH. Further work will be required to fully explain the observed behaviour of the other species analyzed.

Table 6. A comparison of the results of leaching selected tailings with a lime solution and distilled water (control)

Sample	*pH*	*As*	*Pb*	*Sb*	*Zn*	*Total CN*	*CNS*
BATCHO							
Lime	12.3	<0.55	<0.52	<0.32	0.027	2.3	7
Control	8.6	3.22	<0.45	0.36	<0.05	0.60	5
BATCHS							
Lime	12.2	<0.55	<0.52	<0.32	0.137	4.7	6
Control	8.0	1.18	<0.45	0.45	<0.075	0.09	<1
MN1102							
Lime	12.1	<0.55	1.00	<0.32	0.132	4.2	12
Control	8.0	<0.49	<0.45	0.57	<0.075	0.05	11
MN1401							
Lime	12.2	<0.55	1.04	<0.32	0.067	2.5	<1
Control	7.6	<0.49	<0.45	0.69	<0.075	<0.05	<1
SOMIX							
Lime	12.3	<0.55	0.69	<0.32	0.062	2.1	<1
Control	7.8	<0.49	<0.45	0.57	<0.075	<0.05	<1
SLURRY							
Lime	12.2	<0.55	0.57	<0.32	0.204	1.5	<1
Control	7.7	<0.49	<0.45	0.62	<0.075	<0.05	<1

Note: All values in mg/L except for pH.

Freeze Thaw Study

The objective of the freeze-thaw study was to assess the effects of repeated freezing and thawing on the physical and chemical properties (especially grain size distribution and chemical leachability) of the tailings impounded at Mount Nansen. For the study, five different tailings samples or composites representative of the range of tailings found at the site were subjected to three cycles of freezing and thawing from -20°C to 20°C and vice versa at a rate of 2°C/hour.

Leach testing of the tailings with distilled water was conducted both prior to and after the freeze-thaw cycles. The detailed method of investigation and data acquired are described in Appendix G. Salient observations are summarized as follows.

In the study, no trends or major differences were noted in the samples with regard to metal mobility. The liquid to solid ratio used for the leaching test prior to and post-freeze-thaw was 5:1 and the samples were agitated at 150 rpm for 24h to allow the tailings to equilibrate with the leach medium. After the freeze-thaw cycles, the arsenic release slightly decreased for all the samples. Leaching of Ca, Mg and Na was observed but varied in extent among the samples. Overall, the metal leachability remained more or less the same before and after the freeze-thaw study.

Cyanide concentrations measured were usually below the limit of quantification except for the clayey oxide tailings sample (BatchO). As the final leachate pH was below 9.0 after the leaching test, cyanide may have been leached from the solid and then converted into the gaseous form (i.e., HCN). This hypothesis is supported by the test results obtained using a lime solution as the leachant. As described above, the lime leach gave rise to measured cyanide concentrations of between 1.0 and 3.0 mg/L in the leachate.

The initial concentration of cyanide (Total CN) in the sample BatchO was 47 µg/g and only a small fraction of the cyanide was leached from the sample. Before the freeze-thaw study, the leachate pH was above 9.0. Consequently all the cyanide leached from the sample would have remained in solution. The total cyanide concentration in the leachate of the clayey oxide tails was reduced by more than 50% after the freeze-thaw step. However, the final leachate pH measured then was below 9.0. Part of the cyanide released could have been converted to HCN. Thus the reduction in the leachate cyanide concentration is probably not directly related to the effect of freeze-thaw but is most probably pH-dependent. For the other samples, no cyanide was measured in the leachate probably because the leachate pH was below 9.0.

The particle size distribution was different after the freeze-thaw treatment for the clayey sulfide tails (BatchS) and the silty oxide tails (MN1401). The mean diameter increased from 6.21 to 17.32 µm for BatchS and from 29.14 to 64.10 µm for MN1401. Several researchers (Ahukrichs and White, 1962; Anderson and Hoekstra, 1965; Rowell and Dillon, 1972) found that clay aggregates were produced during freezing, resulting in an increase in overall grain size. Further mineralogical analysis should provide more information about the consolidation of the BatchS and MN1401 samples.

Overall, the freeze-thaw cycles did not significantly change the metal leachability of the test samples. The main factor controlling metal leachability appeared to be the pH of the leachate. Samples collected from Mount Nansen might have already been subjected to many freeze-thaw cycles. Consequently, the impact of incremental freezing action is expected to be very small. Results may have been different if fresh tailings that have never been subjected to cold climates were tested. Multiple freeze-thaw cycles seemed to modify the final leachate pH. After freezing and thawing, the pH was systematically lower. The pH decrease could be related to Fe(II) oxidation; the hydrolysis of the Fe(III) ion produced could depress the pH of the solution.

DISCUSSION

In response to the request from INAC, the comprehensive tailings characterization and testing program described in earlier sections was designed to achieve the following two primary objectives:

1. to evaluate the short- and long-term chemical stability of the impounded tailings at Mount Nansen; and,
2. to provide scientific data to aid with making appropriate decisions for the permanent disposal of the problematic tailings.

The ensuing discussion intends to reflect on the implications of the research findings with regard to the chemical stability of the impounded tailings and to suggest how the acquired information may help to develop a proper strategy for final decommissioning of the site.

Tailings Chemical Stability

Geochemical analyses of the tailings solids reveal their anomalous contents of Ag, As, Cu, Pb, Sb, Zn and a few CN-related species. The average Ag content of about 45 μg/g represents the only metal value remaining in the tailings. The other anomalous trace elements and chemical compounds pose potential short- and long-term liabilities, some of which are well reflected by the poor water quality observed in the tailings pond water, tailings porewater and leachates of various laboratory testing. The extent of environmental impacts that the tailings may potentially exert on the local ecosystem depends, in the short term, on the concentrations and rates of release of the contaminants identified and, in the long term, on the mode of occurrence and quantity of the contaminants in the system as well. These are briefly discussed below, taking the observed trends of chemical evolution into consideration.

Although neither the tailings pond water nor the seepage water currently shows excessive dissolved As, both the field porewater chemistry and laboratory leachate analyses suggest potential As mobility. However, the As content in the Mount Nansen tailings is relatively low (on the order of tenths of a per cent) compared to many other gold mines with similar mineralization. With only 10 to 20 per cent of the arsenic occurring in readily releasable forms and the low net acid-generating potential of the impounded tailings, it appears that the threat for long-term As hazard is not significant if the tailings are properly contained. Geochemically, antimony behaves in a similar way as arsenic. In the Mount Nansen tailings, the Sb content is an order of magnitude lower than that of As. Dissolved Sb is rarely detected in the tailings pond water and porewater. Results of the leaching experiments suggest that it may be released only at a limited range of liquid to solid ratio. Consequently, Sb leaching is unlikely to become a significant environmental issue at Mount Nansen.

Among the three base metals occurring in anomalous amounts in the impounded tailings, copper is the least abundant. Its presence in the tailings pond water, porewater and leachates appear to correlate with the WAD CN content. Thus, aqueous Cu in the impounded tailings may have been largely derived from mineral processing and subsequent (including post-mine) water treatment. The decreasing trend in dissolved Cu concentration in the tailings pond water and the seepage return since mine closure supports such a hypothesis. Results of the partial sequential extraction analysis indicate that more than 80% of the Cu in the tailings occurs in less readily leachable forms (mostly as liberated sulfides and sulfosalts or the same minerals encapsulated in quartz). This coupled with its relatively low abundance (a few hundred μg/g Cu) suggest that copper leaching is and will not be a serious threat at Mount Nansen.

Although lead occurs in comparable concentrations in the Mount Nansen tailings as arsenic, dissolved Pb has not been detected in most liquid samples analyzed, except at low concentrations (≤ 1 mg/L) in the lime leachates. Up to about 20% of Pb in the tailings solids are associated with amorphous oxyhydroxides. These are susceptible to remobilization with the dissolution of oxyhydroxides under either acidic or reducing conditions. However, this is unlikely to occur if similar environmental conditions as currently prevailing at the impoundment are maintained. Consequently, the likelihood of Pb leaching is considered as remote for the impounded tailings.

For zinc, about 30% of the average content of approximately 2,000 μg/g in the tailings are found to be associated with the oxyhydroxides and another 10% as sorbed ions and/or carbonate-bound. Results of both the geochemical and SEM analyses have demonstrated the close association of Zn with Mn-rich phases. Therefore, Zn can be more readily mobilized than Pb with slight changes in environmental setting. This is supported in part by the elevated Zn content in water samples of the Brown-McDade pit, where there is evidence of local acid generation during the dry seasons. However, results of the sequential batch leach of the tailings with pit water indicate no significant Zn leaching and those of the column studies show that the tailings serve as a sink to dissolved Zn in the overlying water. These observations suggest that Zn is stabilized in the tailings. Unless acidic or reducing conditions are generated with changes in the disposal settings, Zn leaching from the tailings is unlikely to be significant.

The occurrence of CN and its derivatives (in particular CNO, CNS and ammonia) often at anomalous levels in the tailings pond water and seepage has been a concern and necessitates continuing water treatment since the cessation of mining at Mount Nansen (Higgs, 2000). Chemical analyses of pond and porewater and tailings solids as well as the results of the column and other leach test work suggest strong sorption of the bulk of these CN species with the clay fraction of the tailings. Only a small percentage of the residual CN from milling is partitioned into the liquid phase (i.e., porewater) in the tailings pond. Various CN-related species in the porewater are susceptible to degradation as is evidenced by the observed trend of decreasing concentrations of Total and WAD CN and the abundance of ammonia in the tailings pond water and seepage return. Sorbed CN and related species with the tailings solids are, however, difficult to remove and only decay very slowly as is evident from the column and leach test results. Thus it is expected that as long as there is seepage from the tailings impoundment, the site will see anomalous CNS and NH_4-N until all the CN species in the tailings are degraded. Unfortunately, the short duration of the column testing and the complication of a higher temperature setting in the laboratory experiments have precluded an accurate prediction of when the potentially hazardous products of CN degradation will be reduced to sufficiently low levels to allow direct discharge of excess water from the tailings impoundment.

Results of the cursory freeze-thaw study suggest that multiple cycles of freezing and thawing may lead to some aggregation of fine particles in the tailings but generally do not affect the release of most trace elements. Some CN, however, has apparently been desorbed from the tailings particles in the process. In many ways, the wetting and drying process is similar to freeze thaw and can be expected to affect CN release from the tailings to a limited extent. If the released CN ends up in a liquid phase with pH <9, it is susceptible to loss by volatilization with vigorous agitation. This was observed in the freeze thaw study. Released CN ended up in a quiescent system such as impounded tailings will likely stay in the porewater. This could explain the detected increase in CN concentrations in the tailings seepage following an antecedent drying period produced by drawing down the water level in the tailings pond.

In short, although water treatment is currently required for the discharge of effluents from the tailings impoundment at Mount Nansen because of elevated levels of CN and related species, the tailings contain relatively low concentrations of mobile trace elements. Only As and Zn may be susceptible to remobilization in moderate concentrations with changing environmental settings. Given the relatively small size of the impoundment (about 200x200 m^2) and the amount of contained tailings (~ 250,000 tonnes), it is tempting to devise a one-time solution that will eliminate the need to maintain the site for an extended period of time. Implications of the research findings to the possible options are discussed below.

Decommissioning Options for the Impounded Tailings

As reviewed by Strathcona Mineral Services Ltd. (2000), dictated by the setting of the minesite, there are only two possible options for long-term disposal of the impounded tailings at Mount Nansen. These are (1) retain them at the current impoundment with improvements made to the facility; and, (2) transfer and re-deposit them in the Brown-McDade open pit. Based on the findings of the field and laboratory investigations conducted in this study, the advantages and drawbacks of the two options are discussed. Additional measures that may enhance the performance or functionality of each of the options are also suggested.

Retention in the current impoundment: Largely contained by permafrost except near portions of the tailings dam, the tailings impoundment is apparently isolated from the regional groundwater flow system. Contaminant transport from the impounded tailings is dominated by surface runoff, controlled discharge and limited local seepage. Although anomalous levels of ammonia and thiocyanate in the tailings pond water and seepage currently pose toxicity concerns, historic and on-going monitoring data collecting at the impoundment and the results of various laboratory testing indicate that the system is chemically stable and improving. Concentrations of Total and WAD CN as well as dissolved Cu are decreasing with time. For the two relatively mobile elements, As and Zn, occurring in the tailings based on the laboratory test work, elevated dissolved As concentrations are restricted to tailings porewaters and there is insignificant leaching of Zn in the existing impoundment. If means can be devised to reduce ammonia and CNS to acceptable levels in the tailings seepage, leaving the impounded tailings in place may avoid the risks of contaminant releases resulting from exposing the tailings to significant changes in environmental conditions in a new disposal setting.

The two main concerns with regard to sustaining the existing impoundment are the physical stability of the tailings containment dam and the impact of erosion on the maintenance of the associated diversion ditches (D. Sherstone and B. MacAlpine, personal communication, October 2001). The tailings dam is a compacted earth dam keyed into the underlying frozen ground. To ensure its physical integrity, original design requirements include: initial placement of tailings to press against the low-permeability geomembrane near the centre of the dam, and no water rests directly against the dam structure for 50 m upstream of the dam (Klohn Crippen Consultants Ltd., 1995). Both design criteria were apparently ignored when the tailings were first disposed in the impoundment, leading to partial thawing of permafrost beneath the dam. Nonetheless, recent geotechnical reassessments of the conditions of the tailings dam have suggested that the tailings dam is still safe, except possibly during severe seismic events, if the designed width of the tailing beach is maintained (EBA Engineering Consultants Ltd., 1999; Klohn Crippen Consultants Ltd., 2000). Strathcona Mineral Services Ltd. (2000) suggested redistribution of tailings within the impoundment to achieve the purpose, which might possibly alleviate the extent of diversion ditch maintenance. It may be worthwhile to investigate if the physical integrity of the dam can be improved by installing some sort of reinforcement structure at the downstream base of the dam.

If decisions were made to retain the tailings in the existing impoundment, restoring permafrost in the impoundment area should perhaps be considered to further ensure the chemical stability of the impounded tailings and the physical stability of the impoundment infrastructure. Admittedly, given the partially thawed, relatively "warm" permafrost apparently occurring at the site at present, it may not be easy to kick start the permafrost progradation process. However, if it can be done at all, increasing the permafrost depth in the tailings pond will not only prevent trace element leaching, it may also slow down the CN degradation process and thus the production of ammonia and CNS at acceptable levels. Relocating the seepage return pipe farther upstream of the containment dam may also help to arrest thawing at its base. The eventual conversion of the tailings pond to an oxic, boreal wetland by incorporating native sand and local ground cover into the impoundment may further enhance both the chemical and physical stability of the system.

Transfer of impounded tailings to the Brown-McDade open pit: Relocating the impounded tailings with final deposition in the open pit will obviously eliminate the problem of a potentially unsafe tailings containment dam. The transferred tailings may cover some of the exposed mineralization and alteration in the pit floor and pit walls, thereby reducing the extent of metal leaching (e.g., Zn mobilization) and local acid generation. During tailings transport, agitation and exposure of the tailings to a more oxidizing environment may enhance volatilization and degradation of some of the CN and related species. Other than that, placement of tailings in the open pit will certainly be beset with challenges, some of which are briefly discussed below.

Both the column studies with coarse tailings and batch leach tests with fine clayey tails have demonstrated potential mobilization of As, Sb and selected sorbed CN species with disturbance of the tailings and interaction with the pit water. While some free CN and WAD CN may be eliminated during tailings transport, additional loads of CNS and NH_4-N are likely to be generated at the same time. If the transport medium is eventually contaminated with excessive trace elements and potentially hazardous CN-related compounds and their derivatives, the medium has to be impounded and treated before discharge. Transfer of tailings in a relatively dry form will impose a less significant impact on the quality of the subsequent water cover, if one develops. However, given the fine grain size of the tailings and elevation difference between the tailings impoundment and the open pit, transport of tailings by truck may be challenging.

In the absence of detailed information on the local hydrology and hydrogeology of the open pit, the post-deposition environmental setting for the transferred tailings is largely unknown. If a deep water cover eventually forms on the tailings, reducing conditions will develop in the tailings, leading to potential dissolution of amorphous Fe and Mn oxyhydroxides and the release of the associated trace elements. If unsaturated conditions develop, oxidation of the remnant sulfides may occur, leading to acid generation and metal leaching. In contrast to the tailings impoundment, the open pit appears to be connected to the regional groundwater flow system. The observed seasonal variation in the monitored pit water chemistry appears to have derived from a fluctuating water table. Unless major conduits are somehow blocked, contamination of groundwater with trace metals and CN-related species in the tailings porewater is highly probable. The Total CN occurring in the tailings can effectively be destroyed using the INCO SO_2/Air process prior to transfer to the open pit. However, as mentioned before, this will result in a simultaneous release of significant doses of As, Sb and ammonia. The requirement for treatment of the resultant effluent seems inevitable.

A variation in the theme of transferring the tailings to the Brown-McDade pit is to mix the tailings with cement and dispose of them in a paste form that does not bleed water. This will eliminate the problem of potential flushing of contaminated tailings porewater to the regional groundwater system and also help to reduce the likelihood of acid generation. However, since both arsenic and antimony are mobile under both acidic and alkaline conditions, the effect of lime addition (in the form of cement) on the long-term chemical stability of As- and Sb-containing minerals is uncertain. Although the overnight leach testing with a lime solution conducted in the current study did not yield evidence of significant arsenic leaching, there are indications from other mine sites that elevated calcium, bicarbonate and lime contents in a tailings system reduce the long-term stability of As-containing minerals (Kwong et al., 2000; Soprovich, 2000). In addition, the same leach test with a lime solution gave rise to cyanide release. The results of the freeze-thaw experiments also suggested alkaline condition would enhance the persistence of CN. Furthermore, whether or not the entire tailings mass can be used in paste making with cement is not known. Therefore, much research remains to be done if the paste option is to be pursued further.

Concluding remarks: From the perspective of tailings chemical stability, among the two options considered for permanent disposal of the problematic tailings, retaining the tailings in the existing impoundment appears to be associated with fewer unknown factors than transferring the tailings to the Brown-McDade open pit. To fully evaluate the latter option, a detailed study of the pit hydrology and hydrogeology as well as the distribution of minerals and alteration along the pit walls should be conducted. This will provide the necessary information to compare and contrast the two options, including their variations, using a risk assessment approach. Based on the assessment results, the more cost-effective and environmentally friendly option can be adopted.

CONCLUSIONS

The Mount Nansen tailings chemical stability project aims to characterize the impounded tailings with regard to their chemical and mineralogical composition and assess their short- and long-term behaviour so as to provide scientific data for making decisions on their permanent disposal. Based on observations made and test results obtained in field and laboratory investigations conducted for this project, the following conclusions can be drawn:

1. Tailings impounded in the Mount Nansen tailings pond can be divided into four main types according to grain size and composition, namely, oxide silt, oxide clay, sulfide silt and sulfide clay. The combined sulfide varieties make up about 30% by volume of the impounded tailings and the combined fine-grained varieties slightly less than 50%.

2. Regardless of the detailed type, the impounded tailings are generally enriched in Ag, As, Cu, CN, Pb, Sb and Zn and show a moderate acid-generating potential.

3. Column testing simulating four tailings disposal scenarios demonstrates potential mobilization of CNS, NH_4-N and As in the tailings porewater and overlying water at undesirable concentrations. If the impounded tailings were to be relocated to the open pit, moving the tailings in a relatively dry form will lead to reduced impacts on the water cover quality.

4. The sequential batch leach tests showed that As and Sb are susceptible to leaching from the tailings by the pit water.

5. The INCO SO_2/Air treatment is effective in destroying CN associated with the tailings solids but releases significant amounts of Total CN, CNS, NH_4-N as well as possibly As and Sb to the process water at the same time.

6. The results of partial sequential extraction analysis on selected tailings indicated that As and Zn are the most readily releasable trace elements occurring in the tailings.

7. Multiple freeze-thaw cycles do not generally affect the metal leachability of the test tailings. However, an increase in average grain size may result from the aggregation of clay particles during freezing.

8. The impounded tailings represent a relatively stable chemical system the quality of which is expected to improve with time. However, CNS and NH_4-N levels in tailings pond water and porewater may remain a concern for the medium term unless appropriate technology can be devised to efficiently enhance their removal.

RECOMMENDATIONS FOR FURTHER WORK

Constrained by the limited time frame allowed for this project, both field and laboratory investigations have been designed to render the most useful data in the shortest time possible to aid decision making on developing an appropriate strategy for the long-term disposal of the arsenic- and cyanide-bearing tailings at Mount Nansen. Details are often sacrificed for variety and information gaps are frequently identified upon interpreting the acquired data. To fully address the issues raised by INAC with regard to the tailings behaviour and disposal options, further work in the following areas is recommended.

1. Three months of column testing have proved to be inadequate to render sufficient data to establish the rates of metal leaching and cyanide degradation. Depending on the selection of the preferred long-term disposal option, the corresponding columns, if not the entire column test work, should be run for another three to six months to acquire the relevant rate data.

2. The column test work has been conducted at room temperature; therefore the rate data obtained may not be truly representative of those taking place in the field. If it is decided to retain the tailings in the existing impoundment, it will be instructive to experiment with a scaled model of the impoundment constructed with the remainder of the tailings and native sediments collected. The model would incorporate a frozen layer at depth and a partially thawed tailings dam on one side. The model would be closely monitored for a year for the transfer of trace elements and CN species across the porewater-tailings solids interface as well as the generation and movement of ammonia and thiocyanate in the tailings porewater. Such a model experiment will give a more realistic picture of the water-tailings interactions occurring under field conditions.

3. Regardless of the final option chosen for long-term disposal of the problematic tailings, the generation of ammonia and thiocyanate is likely to continue for some time. It is worthwhile to review and develop new technologies for treating water containing excessive amounts of such potentially toxic, CN degradation products.

4. Insufficient information on the detailed distribution of minerals, hydrology and hydrogeology of the Brown-McDade pit is currently available to fully predict the potential consequences of disposing the impounded tailings there. Efforts should be made to acquire such information and then a risk assessment can be performed and the procedure applied to select the most appropriate long-term disposal options for the impounded tailings.

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APPENDIX A

Tailings Core Logs

Tailings Core Log

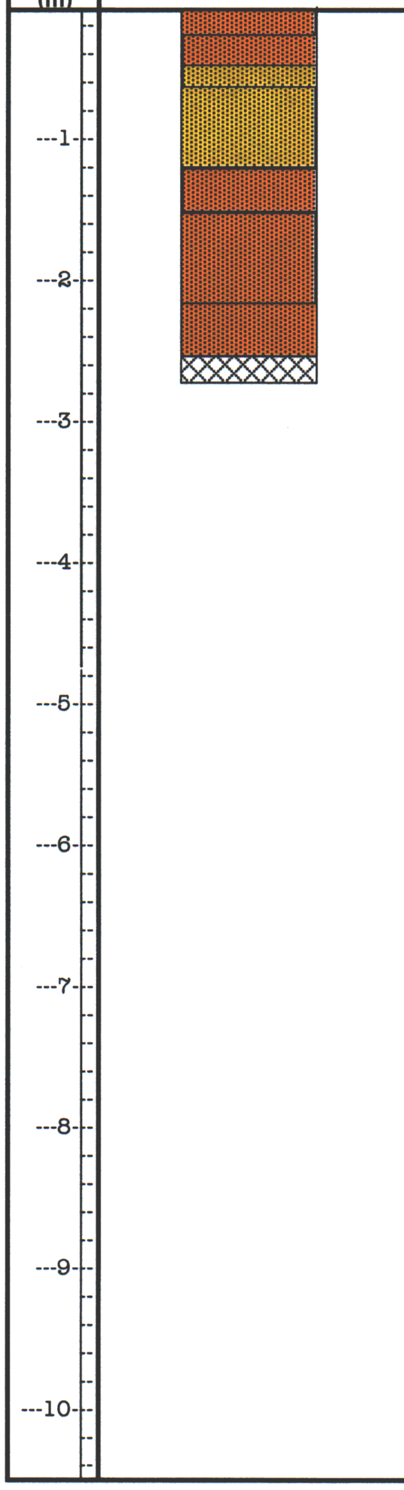
Core No: MN BH 1

Project: Mt. Nansen Tailings Chemical Stability | **Elevation:** 1149.898 m

Location: Mt. Nansen, Yukon Territory | **Sampling Date:** November 14th 2001

Project No: 602345 | **Drilling Method:** Sonic

Depth (m) / **Core Details**



Description	Sample #	Comments
beige frozen silt	MN BH1-01	light grey brown silt (when thawed)
light grey brown silt	MN BH1-02	
grey clayey silt	MN BH1-03	
grey brown sandy silt, moist	MN BH1-04	
light grey brown silt, wet	MN BH1-05	
saturated light brown silt	MN BH1-06	
yellow brown sandy silt with black carbon particles	MN BH1-07	
peat	MN BH1-08	

Tailings Core Log

Core No: MN BH 2

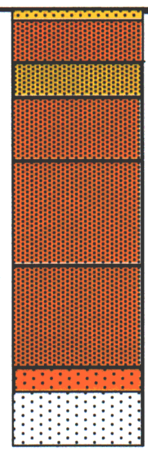
Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1149.523 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 14th 2001

Project No: 602345
Drilling Method: Sonic

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Core Details

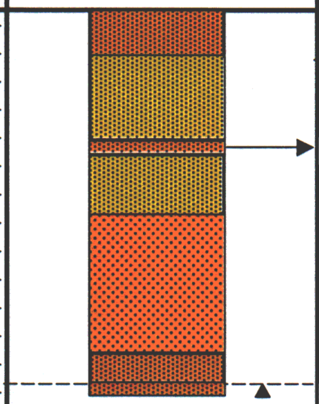


Description	Sample #	Comments
grey beige frozen silt	MN BH2-01	slightly clayey grey brown silt (thawed)
moist brown silt with grey partings	MN BH2-02	
saturated grey yellow silt	MN BH2-03	
saturated light grey brown sandy silt	MN BH2-04	
"soupy" yellow silt	MN BH2-05	light grey clayey silt (upon re-examination in laboratory)
"soupy" yellow silt	MN BH2-06	light grey brown clayey silt (upon re-examination)
light brown silty clay (20% grey streaks)	MN BH2-07	
dense dark grey organic rich silty clay (muck)	MN BH2-08	native sediment

Tailings Core Log

Core No: MN BH 3

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1149.331 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 14th 2001
Project No: 602345
Drilling Method: Sonic

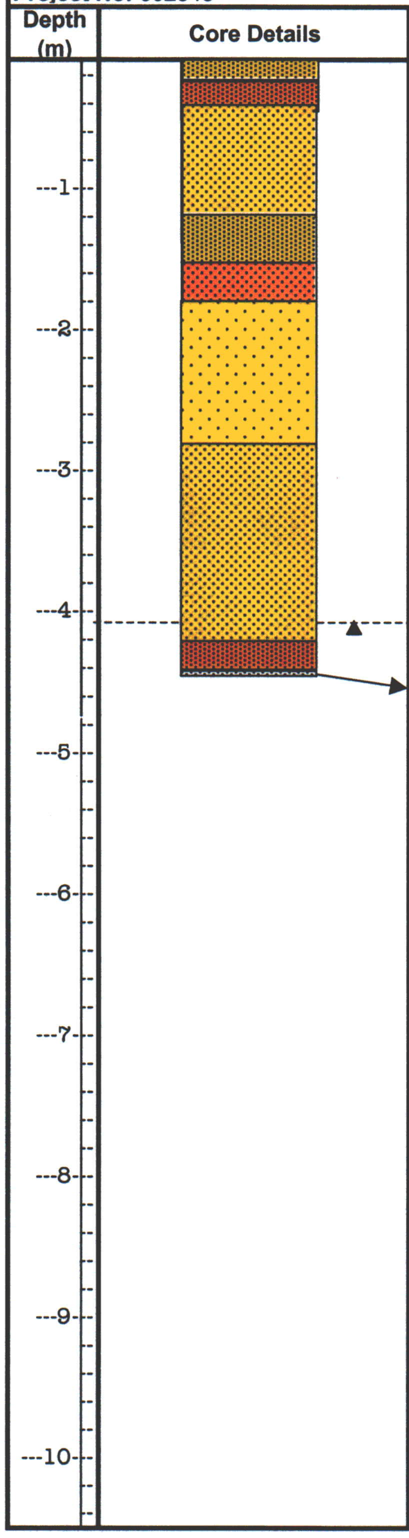


Depth (m)	Core Details	Description	Sample #	Comments
		frozen grey brown silt	MN BH3-01	brown silt with dark red particles (thawed)
		moist grey brown silt, sandy	MN BH3-02	
1		saturated light grey brown silt, sandy	MN BH3-03	
		grey brown sandy silt	MN BH3-04	
2		wet light grey brown clayey silt	MN BH3-05	
		moist brown sandy silt	MN BH3-06	
3		frozen brown sandy silt	MN BH3-07	
4				
5				
6				
7				
8				
9				
10				

Tailings Core Log

Core No: MN BH 4

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1149.493 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 15th 2001
Project No: 602345
Drilling Method: Sonic



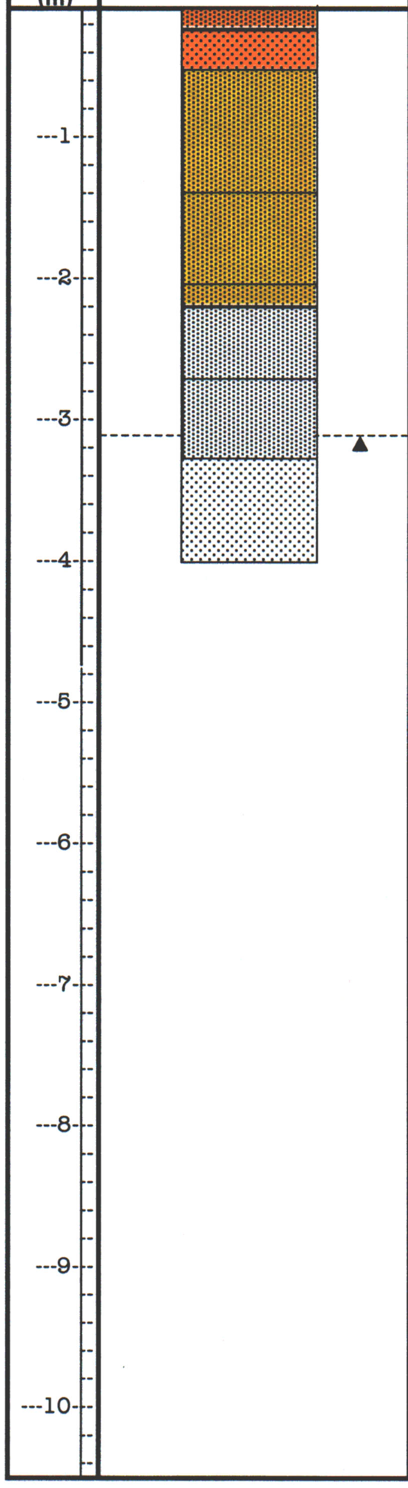
Description	Sample #	Comments
beige frozen silt	MN BH4-01	grey brown silt (thawed)
moist light grey brown silt	MN BH4-02	
saturated grey brown clayey silt	MN BH4-03	
grey brown silt, slushy	MN BH4-04	
light grey clayey silt	MN BH4-05	
dark grey plastic clay	MN BH4-06	
grey brown clayey silt	MN BH4-07	
yellow brown silt slurry	MN BH4-08	
grey native sand at contact		

Tailings Core Log

Core No: **MN BH 5**

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1151.293 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 15th 2001
Project No: 602345
Drilling Method: Sonic

Depth (m) / **Core Details**

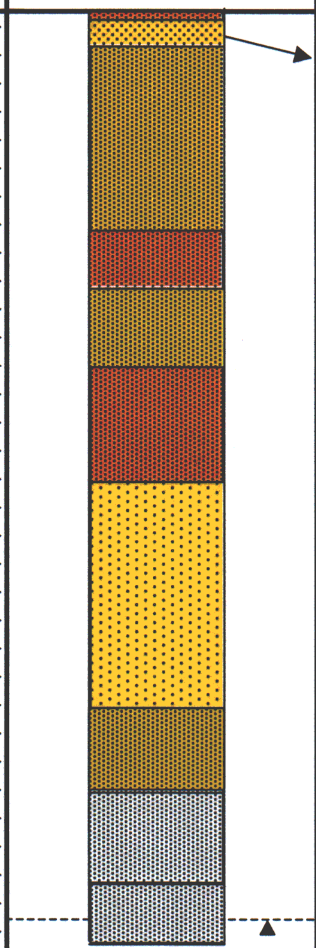


Description	Sample #	Comments
light grey brown silt	MN BH5-01	
dense, light grey brown clayey silt	MN BH5-02	
grey brown sandy silt	MN BH5-03	
wet grey brown sandy silt grading into grey silt	MN BH5-04	
grey native sand	MN BH5-05	tailings-native sand interface
dark grey silty sand with black organic streaks	MN BH5-06	native sediment
dark grey silt, organic rich	MN BH5-07	native sediment
frozen dark grey silt with clay, organic rich	MN BH5-08	native sediment

Tailings Core Log

Core No: MN BH 6

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1149.323 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 15th 2001
Project No: 602345
Drilling Method: Sonic

Depth (m)	Core Details	Description	Sample #	Comments
0–10 (scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10)		frozen light grey brown silt	MN BH6-01	
		moist brown silt with up to 20% sulfide rich pods (4mm thick)	MN BH6-02	grey brown clayey silt (laboratory identification)
		grey brown silt slurry	MN BH6-03	
		saturated light grey brown silt	MN BH6-04	
		grey brown silt, slushy	MN BH6-05	
		wet light grey brown silt	MN BH6-06	
		grey brown silty clay	MN BH6-07	
		contact zone of silty clay with grey native sand	MN BH6-08	
		medium grey organic rich native sand	MN BH6-09	

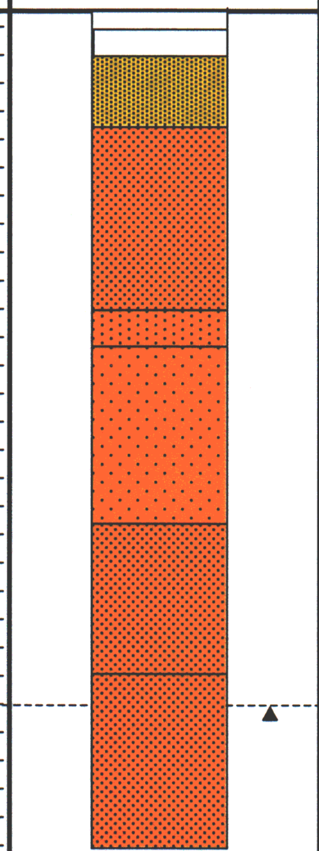
Tailings Core Log

Core No: MN BH 7

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.513 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001
Project No: 602345
Drilling Method: Sonic

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Core Details:

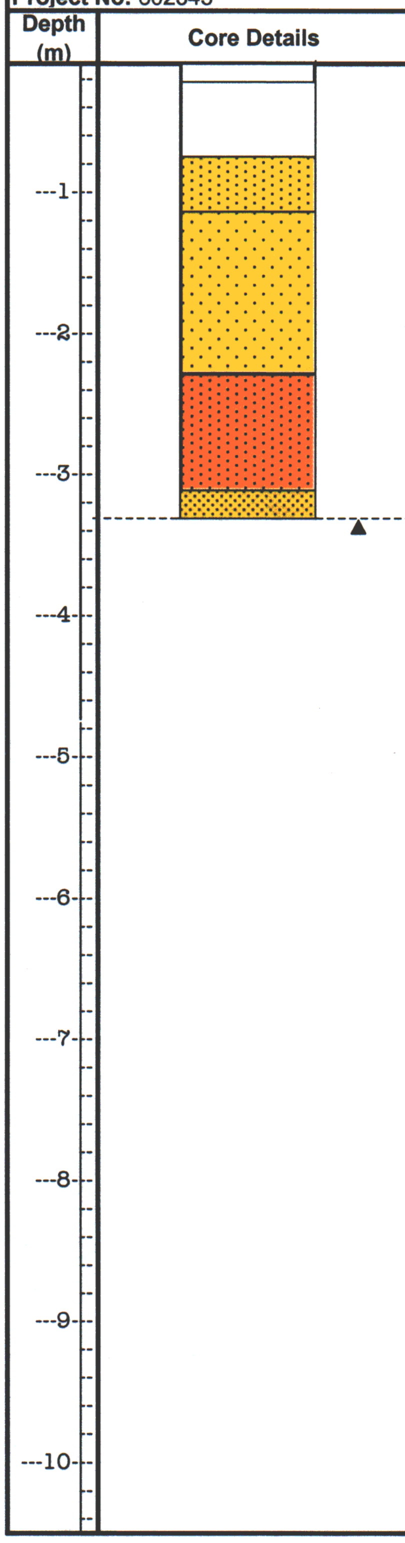


Description	Sample #	Comments
ice		
water	MN BH7-01	
grey brown silt	MN BH7-02	
light grey brown clayey silt	MN BH7-03	
light brown silty clay	MN BH7-04	
brown plastic clay	MN BH7-05	
wet light brown clayey silt	MN BH7-06	
light grey brown clayey silt	MN BH7-07	

Tailings Core Log

Core No: **MN BH 8**

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.501 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 14th 2001
Project No: 602345
Drilling Method: Sonic



Description	Sample #	Comments
ice		
water	MN BH8-01	
grey silty clay, slushy	MN BH8-02	
grey plastic clay	MN BH8-03	
light grey brown silty clay slurry	MN BH8-04	
dense light grey clayey silt with frozen clots	MN BH8-05	

Tailings Core Log

Core No: MN BH 9

Project: Mt. Nansen Tailings Chemical Stability

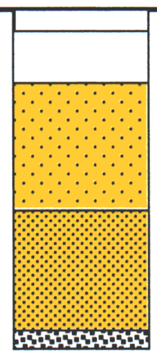
Location: Mt. Nansen, Yukon Territory

Project No: 602345

Elevation: 1148.498 m

Sampling Date: November 14th 2001

Drilling Method: Sonic

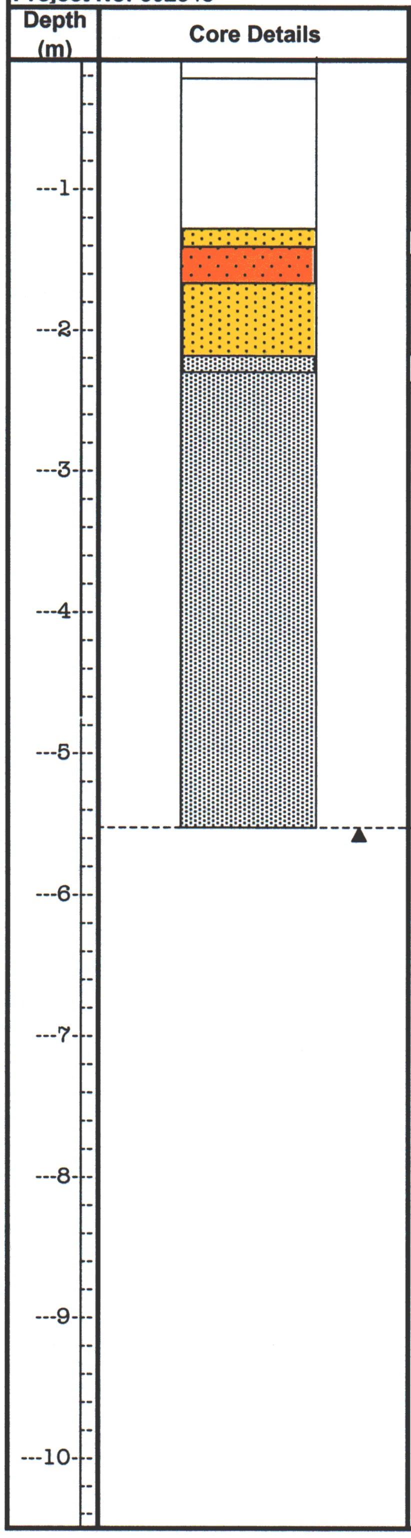


Depth (m)	Description	Sample #	Comments
	ice		
	water	MN BH9-01	
1	brown grey clay	MN BH9-02	
2	brown grey clayey silt terminating in gravel	MN BH9-03	
	gravel		
3			
4			
5			
6			
7			
8			
9			
10			

Tailings Core Log

Core No: MN BH 10

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.514 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001
Project No: 602345
Drilling Method: Sonic

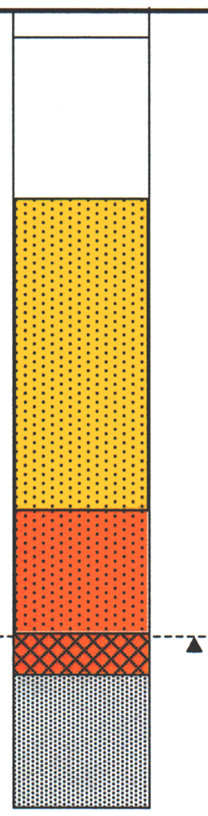


Description	Sample #	Comments
ice		
water	MN BH10-01	
grey brown silty clay	MN BH10-03	
light brown clay interbed	MN BH10-02	
grey brown silty clay	MN BH10-03	
grey native sand at tailings interface	MN BH10-04	
coarse, grey native sand with roots, organics near bottom	MN BH10-05	

Tailings Core Log

Core No: MN BH 11

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.524 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001
Project No: 602345
Drilling Method: Sonic



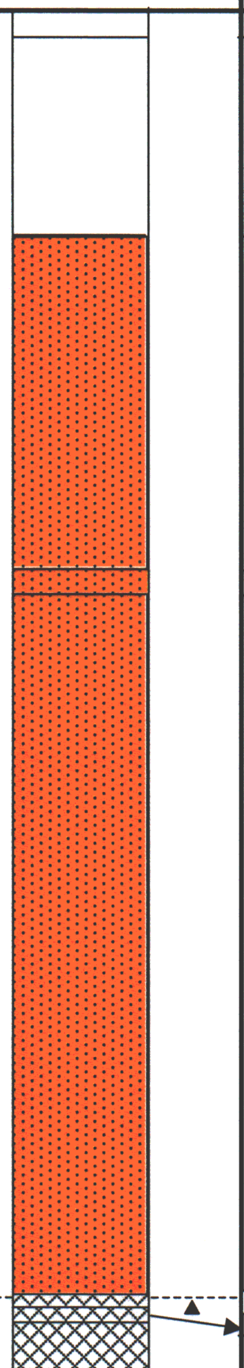
Depth (m)	Core Details	Description	Sample #	Comments
		ice		
1		water	MN BH11-01	
2, 3		grey brown silty clay	MN BH11-02	
4		light grey brown silty clay	MN BH11-03	
		clay/peat interface	MN BH11-04	
5		black organic rich soil (black muck with sandy interval)	MN BH11-05	
6				
7				
8				
9				
10				

Tailings Core Log

Core No: MN BH 12

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.514 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001
Project No: 602345
Drilling Method: Sonic

Core Details



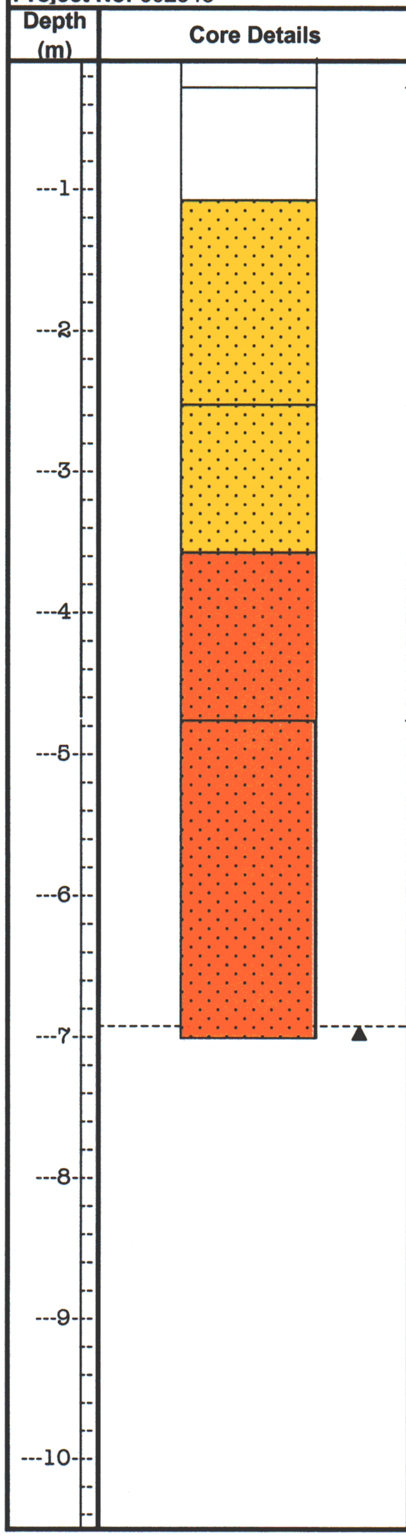
Depth (m) scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Description	Sample #	Comments
ice		
water	MN BH12-01	
light brown clay with <5% grey streaks	MN BH12-02	light grey brown silty clay (laboratory identification)
light brown clay 50% grey streaks	MN BH 12-03	light grey brown plastic clay
brown plastic clay with <2% grey streaks	MN BH12-04	brown silty clay (laboratory identification)
frozen peat grading into grey organic rich soil	MN BH12-05	brown plastic clay in peat
peat	MN BH12-06	
black peat and sand	MN BH12-07	

Tailings Core Log

Core No: MN BH 13

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.513 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001
Project No: 602345
Drilling Method: Sonic

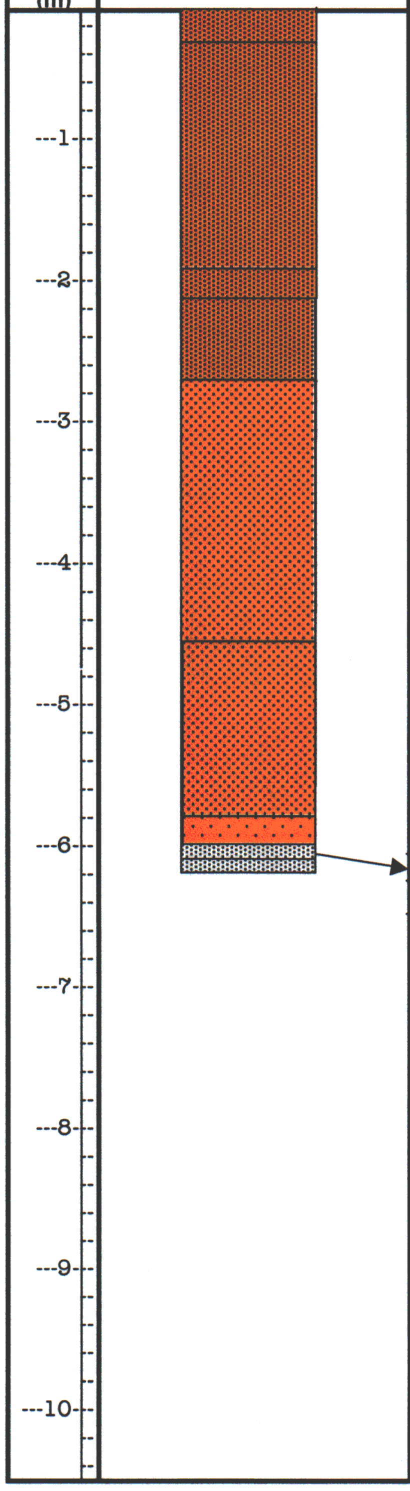


Description	Sample #	Comments
ice		
water	MN BH13-01	
grey plastic clay <40% brown streaks	MN BH13-02	grey brown plastic clay (laboratory classification)
grey brown plastic clay with 50% brown	MN BH13-03	light grey brown plastic clay (laboratory classification)
brown plastic clay with 30% grey	MN BH13-04	brown plastic clay (laboratory classification)
brown plastic clay with <10% grey	MN BH13-05	brown plastic clay (laboratory classification)

Tailings Core Log

Core No: MN BH 14

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1150.103 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001
Project No: 602345
Drilling Method: Sonic



Description	Sample #	Comments
light brown frozen silt		NOT SAMPLED
moist light brown silty sand	MN BH 14-01	yellow brown silt (upon re-examination)
light grey brown clayey silt (20% clay)	MN BH14-02	light grey brown silt
light brown sandy silt	MN BH 14-03	grey brown silt (upon re-examination)
saturated light brown clay with 25% slushy sections	MN BH14-04	light grey brown clayey silt (laboratory classification)
brown silt with 20-30% clay	MN BH14-05	grey brown clayey silt (laboratory classification)
brown plastic clay with 20% grey	MN BH14-06	light brown plastic clay
contact zone with native sand, plant remains	MN BH14-07	dark grey organic soil
native sand	MN BH14-08	

Tailings Core Log

Core No: MN BH 15

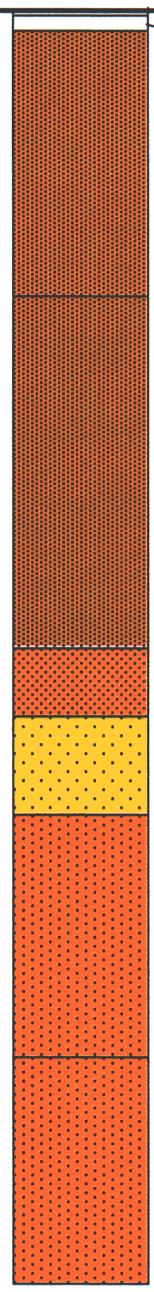
Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.527 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001

Project No: 602345
Drilling Method: Sonic

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Core Details:



Description	Sample #	Comments
ice		
water	MN BH15-01	
saturated brown sand, 1-2% sulfides	MN BH15-02	brown silty sand (laboratory classification)
saturated brown sand 1-2% sulfides	MN BH15-03	light brown silty sand (laboratory classification)
brown clayey silt, 20% grey streaks	MN BH15-04	light grey brown clayey silt
grey brown plastic clay (20-25% grey streaks)	MN BH15-05	light grey brown plastic clay (laboratory classification)
brown silty clay, plastic (10% grey streaks)	MN BH15-06	brown plastic silty clay (laboratory classification)
brown silty clay, plastic (<10% grey streaks)	MN BH 15-07	brown silty clay, plastic (laboratory classification)

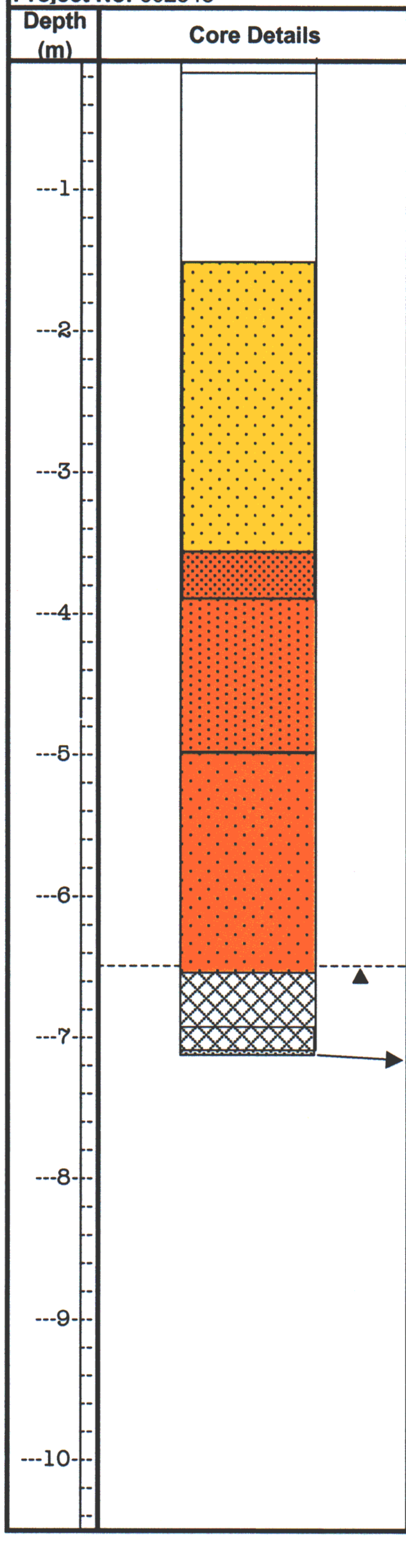
Tailings Core Log

Core No: MN BH 16

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.492 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001

Project No: 602345
Drilling Method: Sonic



Description	Sample #	Comments
ice		
water	MN BH16-01	
grey brown clay ,<40% brown	MN BH16-02	
light grey brown silt (clayey)	MN BH16-03	
light grey brown plastic clay (<30% grey), silty	MN BH16-04	
light grey yellow brown plastic clay (<20% grey), locally silty	MN BH16-05	
peat moss at contact with clay	MN BH16-06	
black organic rich soil and peat	MN BH16-07	
dark grey frozen sand		NOT SAMPLED

Tailings Core Log

Core No: MN BH 17

Project: Mt. Nansen Tailings Chemical Stability

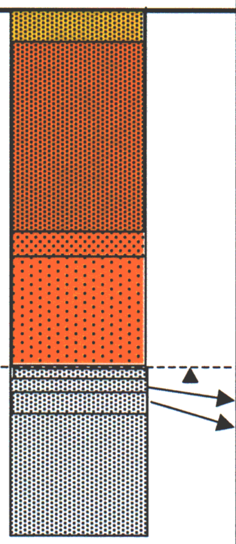
Elevation: 1149.454 m

Location: Mt. Nansen, Yukon Territory

Sampling Date: November 18th 2001

Project No: 602345

Drilling Method: Sonic



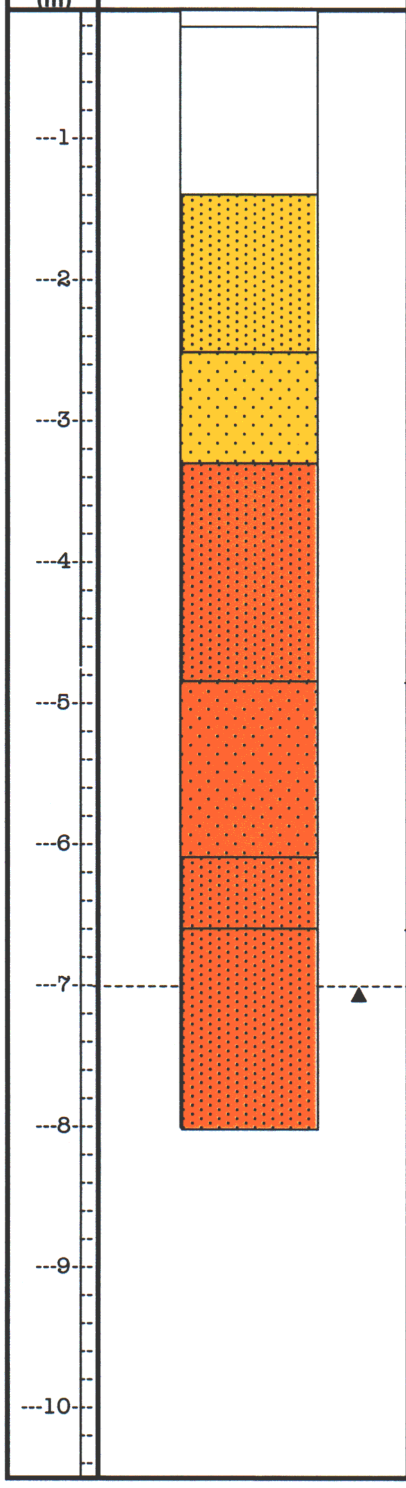
Depth (m)	Core Details	Description	Sample #	Comments
		frozen beige sandy silt	MN BH17-01	grey brown sandy silt (thawed)
1		brown, moist silty sand	MN BH17-02	yellow brown silt, slightly sandy (upon re-examination)
		saturated brown silt (20% grey)	MN BH17-03	light grey brown clayey silt
2		clayey silt, 20% brown, <20% clay	MN BH17-04	light grey brown silty clay (laboratory classification)
		native sand in contact with clayey silt	MN BH17-05	
		grey native sand 10-20 cm below contact	MN BH17-06	
3		grey native sand 20-30 cm below contact	MN BH17-07	
		wet native sand	NOT SAMPLED	
4				
5				
6				
7				
8				
9				
10				

Tailings Core Log

Core No: **MN BH 18**

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.716 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001
Project No: 602345
Drilling Method: Sonic

Depth (m) | **Core Details**



Description	Sample #	Comments
ice		
water	MN BH18-00	
grey brown silty clay	MN BH18-01	
grey brown plastic clay, 50% clay	MN BH18-02	
light grey brown clay (25% grey), slightly silty	MN BH18-03	
brown plastic clay (10% grey)	MN BH18-04	
light grey brown silty clay with brown sand and ice lenses	MN BH18-05	
brown silt with 65% ice crystals	MN BH18-06	brown silty clay slurry (thawed)

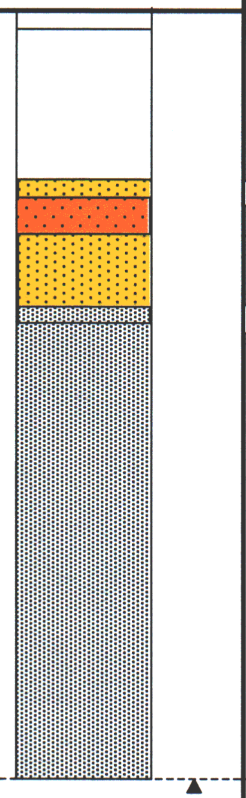
Tailings Core Log

Core No: MN BH 10

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.514 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001

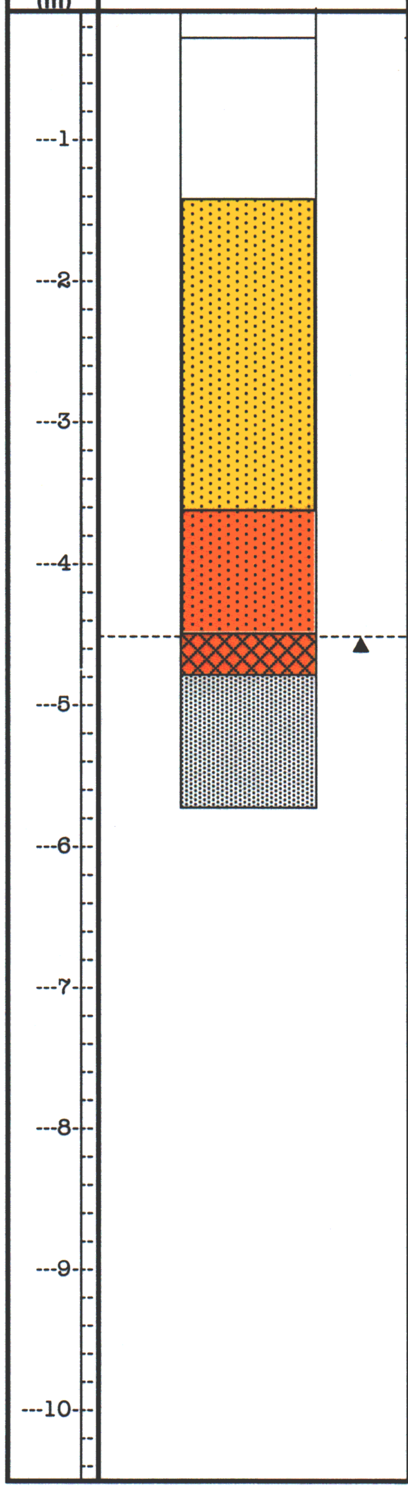
Project No: 602345
Drilling Method: Sonic

Depth (m)	Core Details	Description	Sample #	Comments
0–10		ice		
		water	MN BH10-01	
		grey brown silty clay	MN BH10-03	
		light brown clay interbed	MN BH10-02	
		grey brown silty clay	MN BH10-03	
		grey native sand at tailings interface	MN BH10-04	
		coarse, grey native sand with roots, organics near bottom	MN BH10-05	

Tailings Core Log

Core No: MN BH 11

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.524 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001
Project No: 602345
Drilling Method: Sonic



Description	Sample #	Comments
ice		
water	MN BH11-01	
grey brown silty clay	MN BH11-02	
light grey brown silty clay	MN BH11-03	
clay/peat interface	MN BH11-04	
black organic rich soil (black muck with sandy interval)	MN BH11-05	

Tailings Core Log

Core No: MN BH 12

Project: Mt. Nansen Tailings Chemical Stability

Location: Mt. Nansen, Yukon Territory

Project No: 602345

Elevation: 1148.514 m

Sampling Date: November 16th 2001

Drilling Method: Sonic

Depth (m)	Core Details	Description	Sample #	Comments
		ice		
1		water	MN BH12-01	
2–3		light brown clay with <5% grey streaks	MN BH12-02	light grey brown silty clay (laboratory identification)
4		light brown clay 50% grey streaks	MN BH 12-03	light grey brown plastic clay
5–8		brown plastic clay with <2% grey streaks	MN BH12-04	brown silty clay (laboratory identification)
9		frozen peat grading into grey organic rich soil	MN BH12-05	brown plastic clay in peat
		peat	MN BH12-06	
		black peat and sand	MN BH12-07	
10				

Tailings Core Log

Core No: MN BH 13

Project: Mt. Nansen Tailings Chemical Stability

Elevation: 1148.513 m

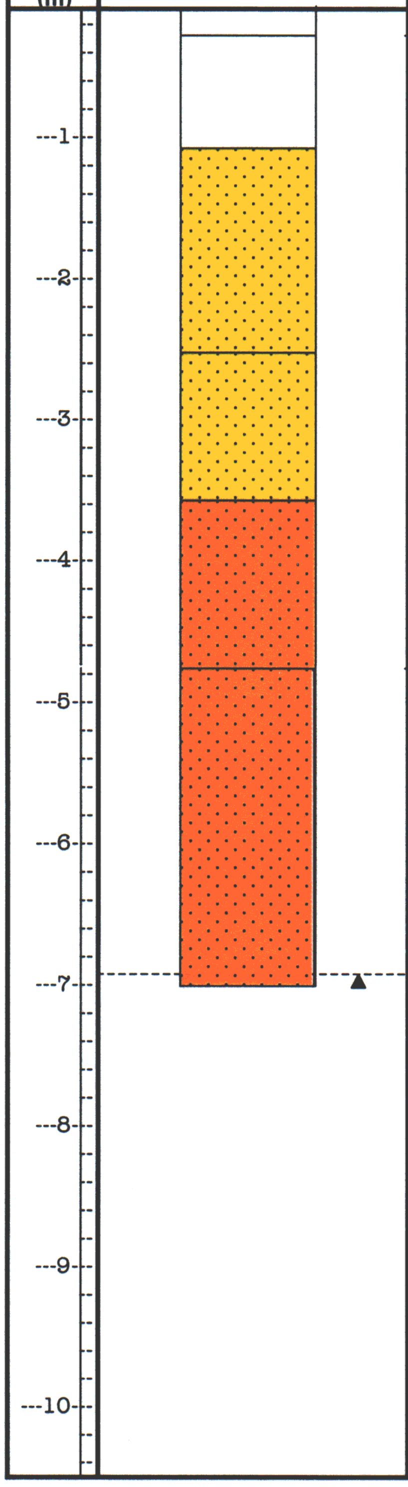
Location: Mt. Nansen, Yukon Territory

Sampling Date: November 17th 2001

Project No: 602345

Drilling Method: Sonic

Depth (m) / Core Details:

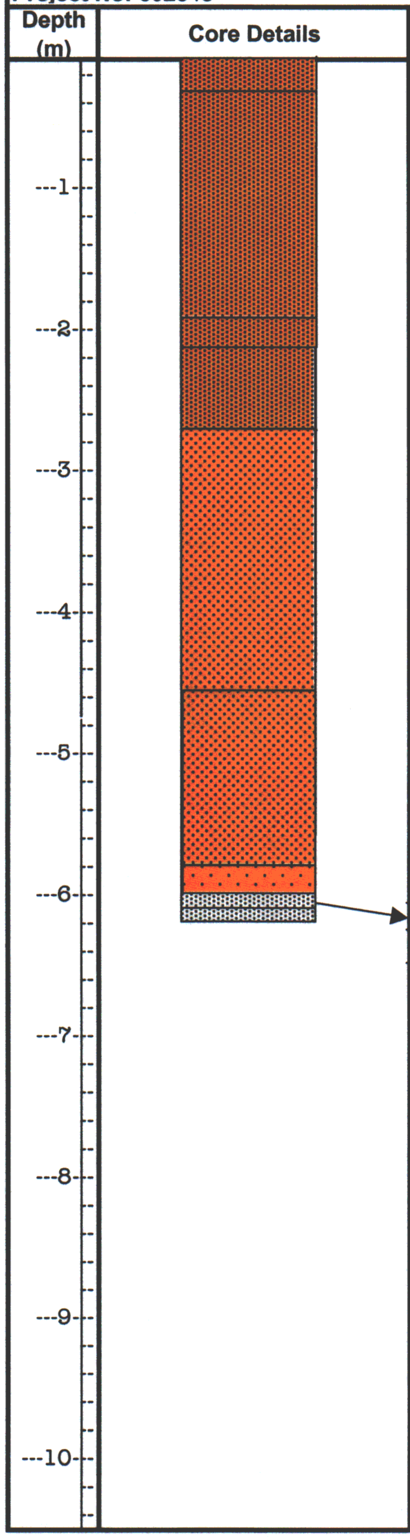


Description	Sample #	Comments
ice		
water	MN BH13-01	
grey plastic clay <40% brown streaks	MN BH13-02	grey brown plastic clay (laboratory classification)
grey brown plastic clay with 50% brown	MN BH13-03	light grey brown plastic clay (laboratory classification)
brown plastic clay with 30% grey	MN BH13-04	brown plastic clay (laboratory classification)
brown plastic clay with <10% grey	MN BH13-05	brown plastic clay (laboratory classification)

Tailings Core Log

Core No: MN BH 14

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1150.103 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001
Project No: 602345
Drilling Method: Sonic

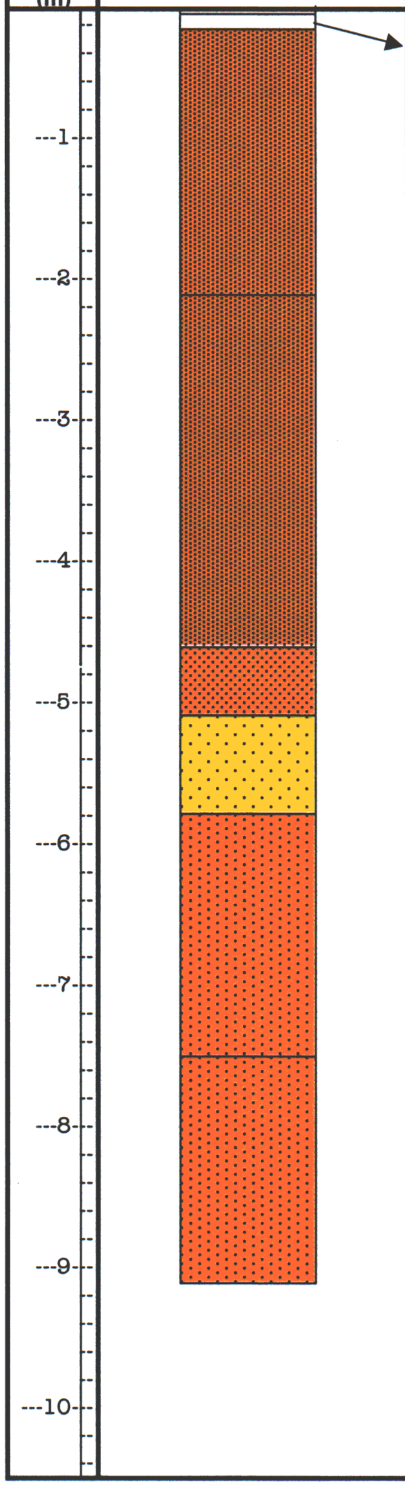


Description	Sample #	Comments
light brown frozen silt		NOT SAMPLED
moist light brown silty sand	MN BH 14-01	yellow brown silt (upon re-examination)
light grey brown clayey silt (20% clay)	MN BH14-02	light grey brown silt
light brown sandy silt	MN BH 14-03	grey brown silt (upon re-examination)
saturated light brown clay with 25% slushy sections	MN BH14-04	light grey brown clayey silt (laboratory classification)
brown silt with 20-30% clay	MN BH14-05	grey brown clayey silt (laboratory classification)
brown plastic clay with 20% grey	MN BH14-06	light brown plastic clay
contact zone with native sand, plant remains	MN BH14-07	dark grey organic soil
native sand	MN BH14-08	

Tailings Core Log

Core No: MN BH 15

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.527 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001
Project No: 602345
Drilling Method: Sonic



Depth (m)	Description	Sample #	Comments
	ice		
	water	MN BH15-01	
1	saturated brown sand, 1-2% sulfides	MN BH15-02	brown silty sand (laboratory classification)
2–4	saturated brown sand 1-2% sulfides	MN BH15-03	light brown silty sand (laboratory classification)
5	brown clayey silt, 20% grey streaks	MN BH15-04	light grey brown clayey silt
	grey brown plastic clay (20-25% grey streaks)	MN BH15-05	light grey brown plastic clay (laboratory classification)
6–7	brown silty clay, plastic (10% grey streaks)	MN BH15-06	brown plastic silty clay (laboratory classification)
8–9	brown silty clay, plastic (<10% grey streaks)	MN BH 15-07	brown silty clay, plastic (laboratory classification)
10			

Tailings Core Log

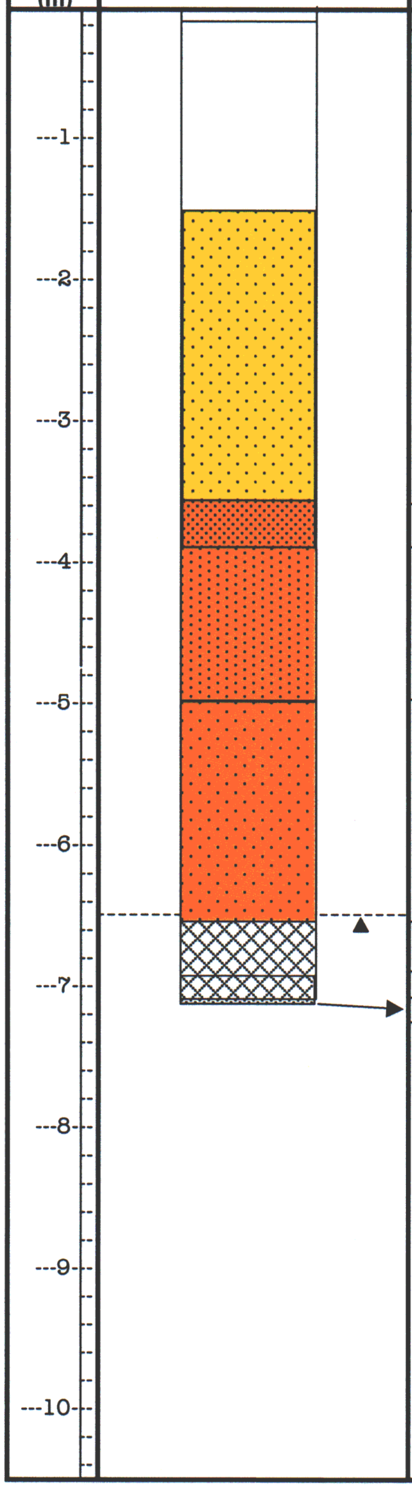
Core No: MN BH 16

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.492 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001

Project No: 602345
Drilling Method: Sonic

Depth (m) / Core Details



Description	Sample #	Comments
ice		
water	MN BH16-01	
grey brown clay ,<40% brown	MN BH16-02	
light grey brown silt (clayey)	MN BH16-03	
light grey brown plastic clay (<30% grey), silty	MN BH16-04	
light grey yellow brown plastic clay (<20% grey), locally silty	MN BH16-05	
peat moss at contact with clay	MN BH16-06	
black organic rich soil and peat	MN BH16-07	
dark grey frozen sand		NOT SAMPLED

Tailings Core Log

Core No: MN BH 17

Project: Mt. Nansen Tailings Chemical Stability

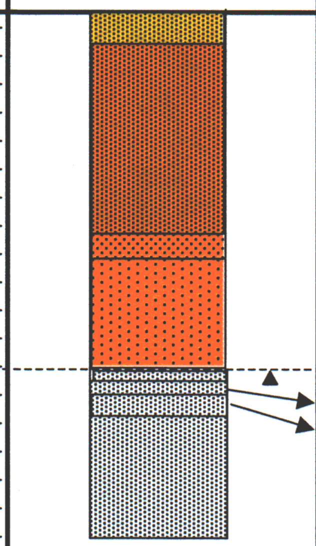
Location: Mt. Nansen, Yukon Territory

Project No: 602345

Elevation: 1149.454 m

Sampling Date: November 18th 2001

Drilling Method: Sonic



Depth (m)	Core Details	Description	Sample #	Comments
		frozen beige sandy silt	MN BH17-01	grey brown sandy silt (thawed)
1		brown, moist silty sand	MN BH17-02	yellow brown silt, slightly sandy (upon re-examination)
		saturated brown silt (20% grey)	MN BH17-03	light grey brown clayey silt
2		clayey silt, 20% brown, <20% clay	MN BH17-04	light grey brown silty clay (laboratory classification)
		native sand in contact with clayey silt	MN BH17-05	
		grey native sand 10-20 cm below contact	MN BH17-06	
3		grey native sand 20-30 cm below contact	MN BH17-07	
		wet native sand	NOT SAMPLED	
4				
5				
6				
7				
8				
9				
10				

Tailings Core Log

Core No: MN BH 18

Project: Mt. Nansen Tailings Chemical Stability

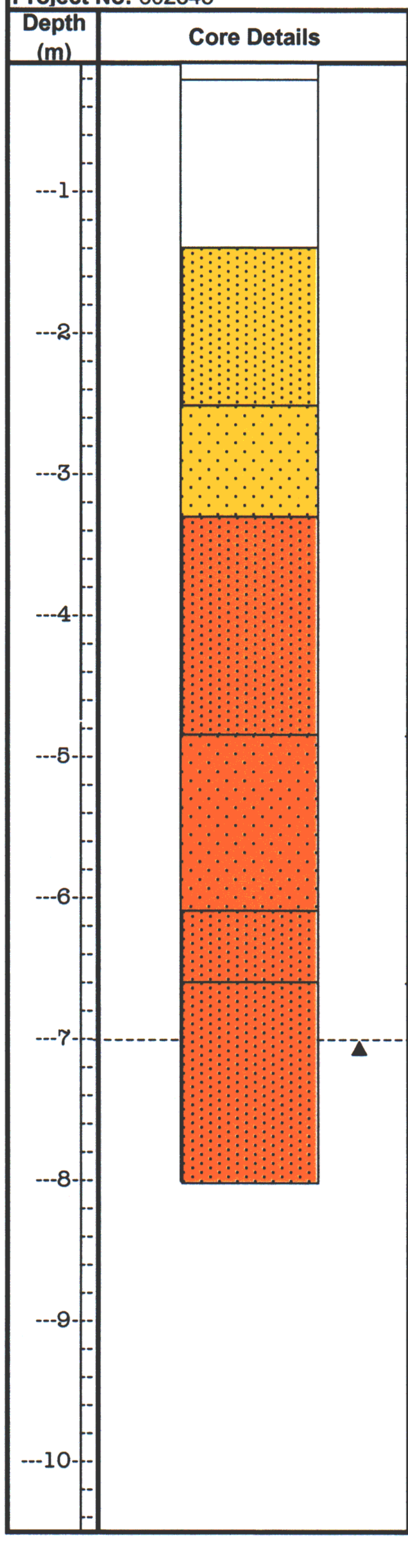
Location: Mt. Nansen, Yukon Territory

Project No: 602345

Elevation: 1148.716 m

Sampling Date: November 18th 2001

Drilling Method: Sonic

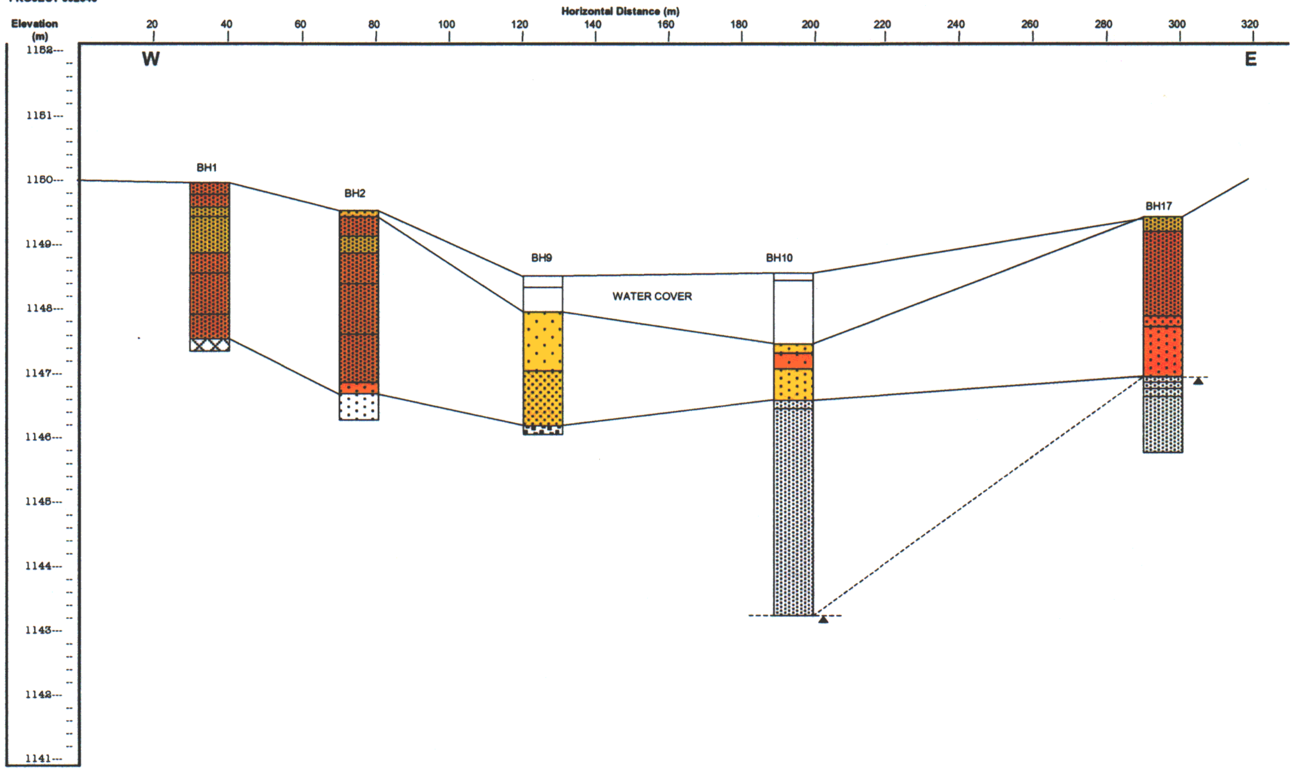


Description	Sample #	Comments
ice		
water	MN BH18-00	
grey brown silty clay	MN BH18-01	
grey brown plastic clay, 50% clay	MN BH18-02	
light grey brown clay (25% grey), slightly silty	MN BH18-03	
brown plastic clay (10% grey)	MN BH18-04	
light grey brown silty clay with brown sand and ice lenses	MN BH18-05	
brown silt with 65% ice crystals	MN BH18-06	brown silty clay slurry (thawed)

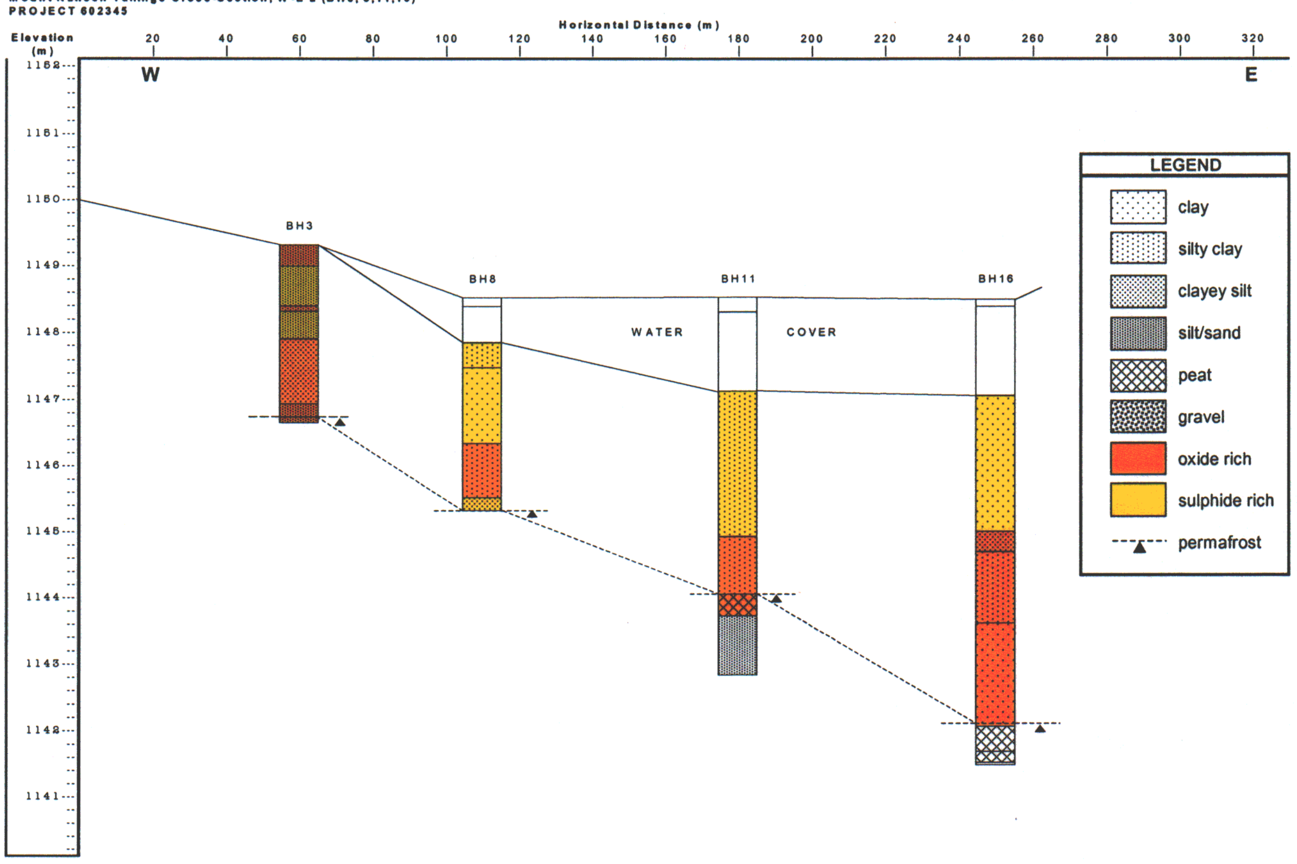
APPENDIX B

Cross Sections of the Tailings Impoundment at Mount Nansen

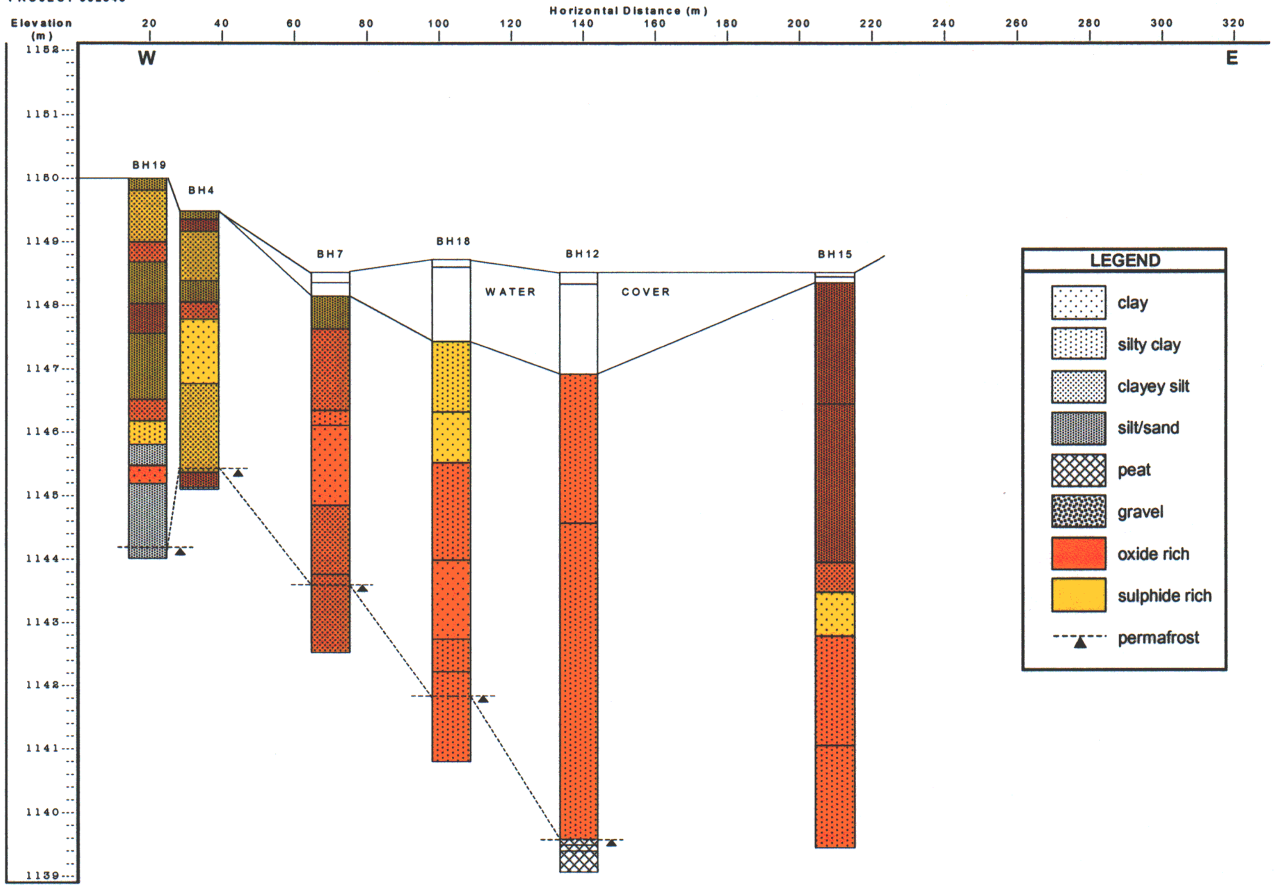
Mount Nansen Tailings Cross-Section, W-E 1 (BH1, 2, 9, 10, 17)
PROJECT 602345



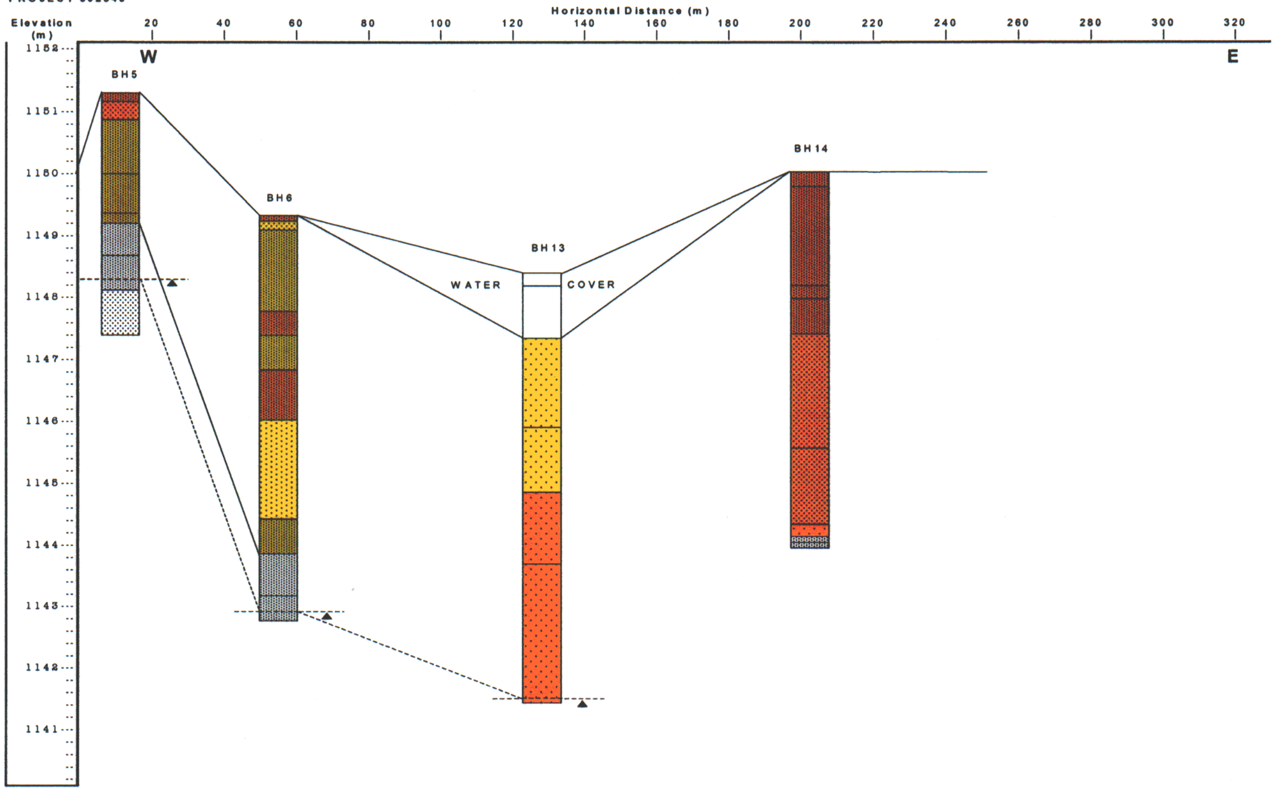
Mount Nansen Tailings Cross-Section, W-E 2 (BH3, 8,11,16)
PROJECT 602345



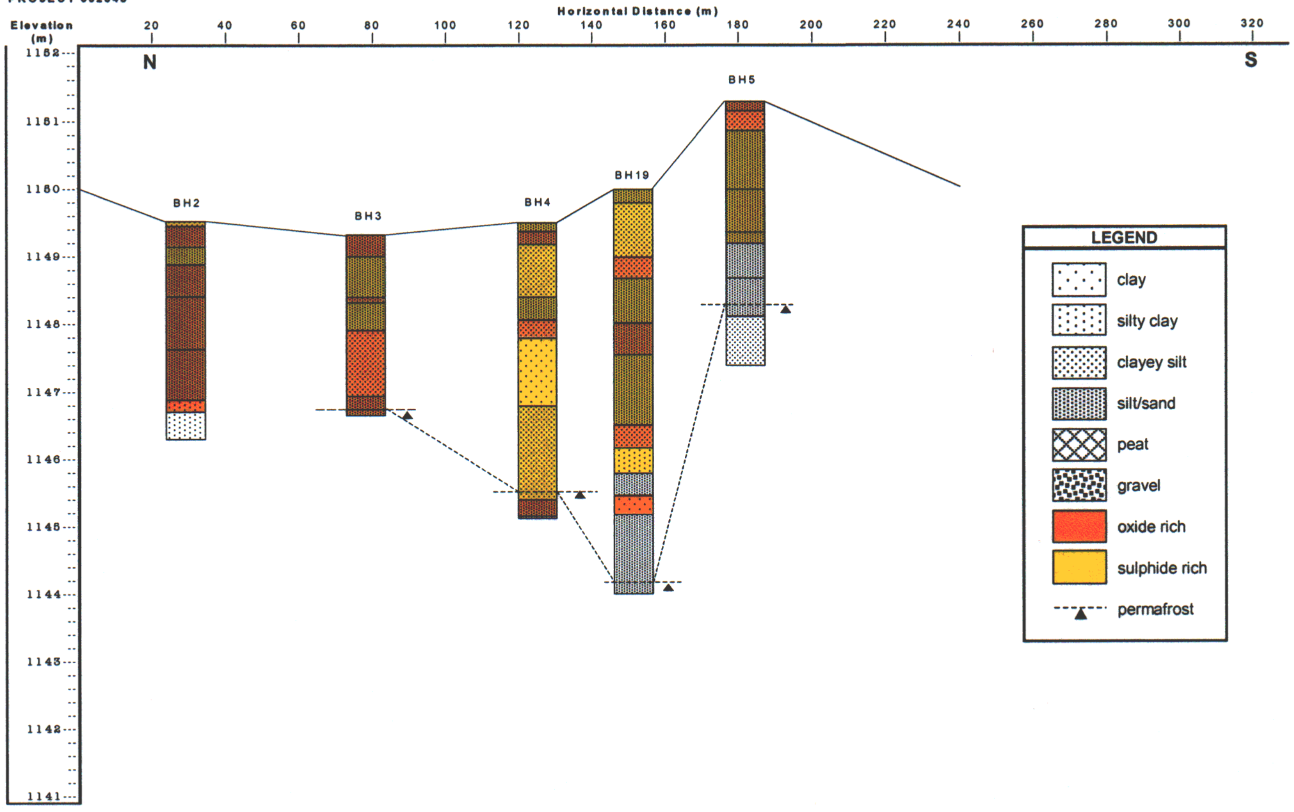
Mount Nansen Tailings Cross-Section, W-E 3 (BH19, 4, 7, 18, 12, 15)
PROJECT 602345



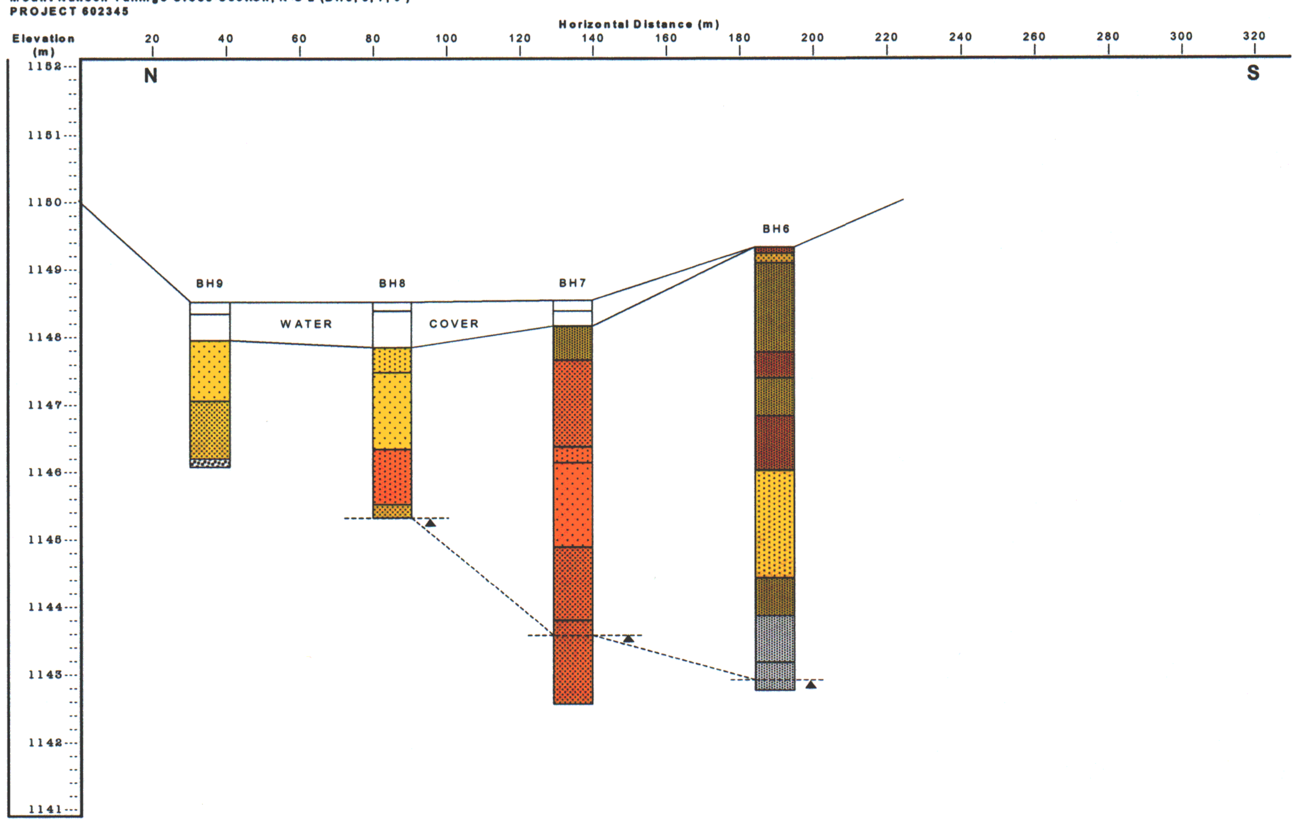
Mount Nansen Tailings Cross-Section, W-E 4 (BH5, 6, 13, 14)
PROJECT 602345



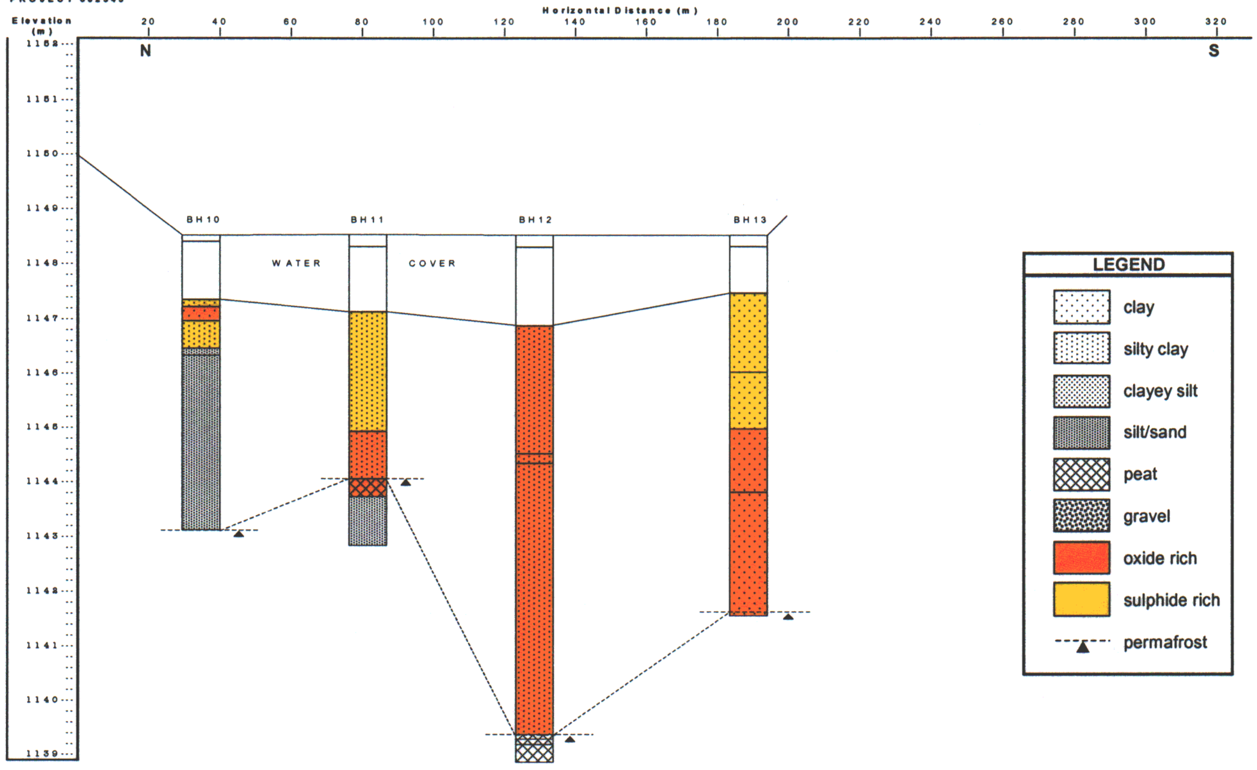
Mount Nansen Tailings Cross-Section, N-S 1 (BH2, 3, 4, 19, 5)
PROJECT 602345



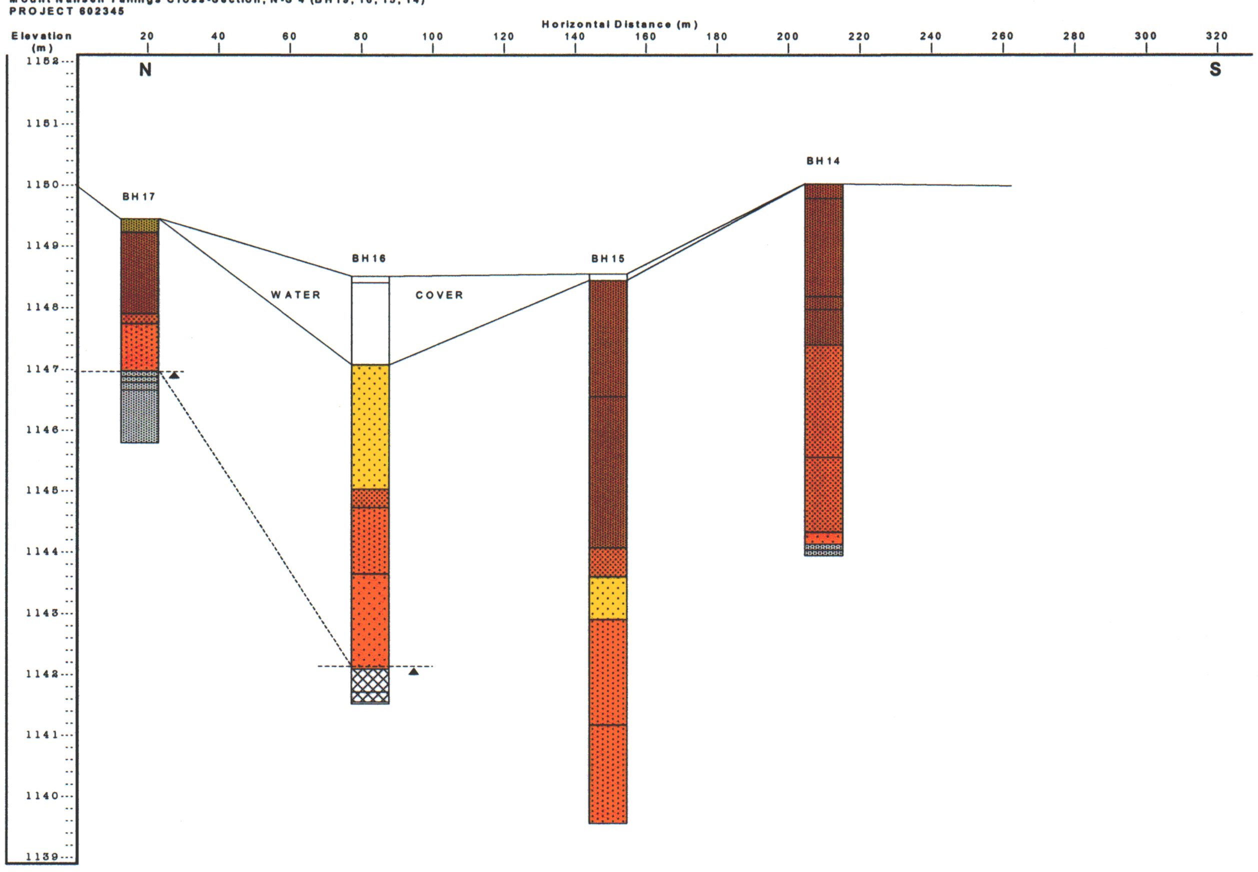
Mount Nansen Tailings Cross-Section, N-S 2 (BH9, 8, 7, 6)
PROJECT 602345



Mount Nansen Tailings Cross-Section, N-S 3 (BH10, 11, 12, 13)
PROJECT 602345



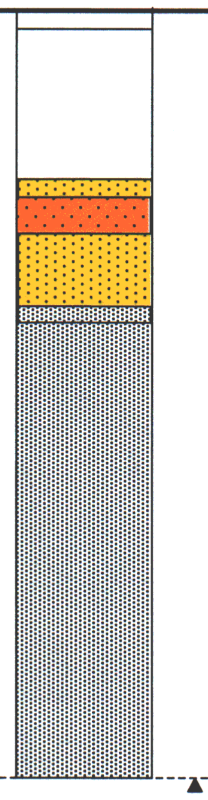
Mount Nansen Tailings Cross-Section, N-S 4 (BH19, 16, 15, 14)
PROJECT 602345



Tailings Core Log

Core No: MN BH 10

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.514 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001
Project No: 602345
Drilling Method: Sonic



Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

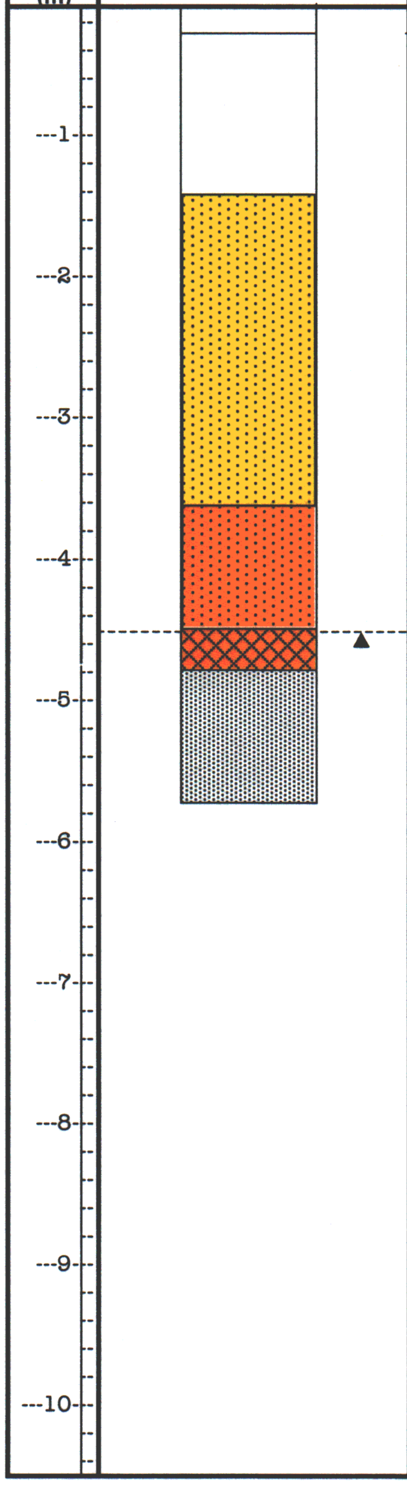
Description	Sample #	Comments
ice		
water	MN BH10-01	
grey brown silty clay	MN BH10-03	
light brown clay interbed	MN BH10-02	
grey brown silty clay	MN BH10-03	
grey native sand at tailings interface	MN BH10-04	
coarse, grey native sand with roots, organics near bottom	MN BH10-05	

Tailings Core Log

Core No: MN BH 11

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.524 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001
Project No: 602345
Drilling Method: Sonic

Core Details



Description	Sample #	Comments
ice		
water	MN BH11-01	
grey brown silty clay	MN BH11-02	
light grey brown silty clay	MN BH11-03	
clay/peat interface	MN BH11-04	
black organic rich soil (black muck with sandy interval)	MN BH11-05	

Tailings Core Log

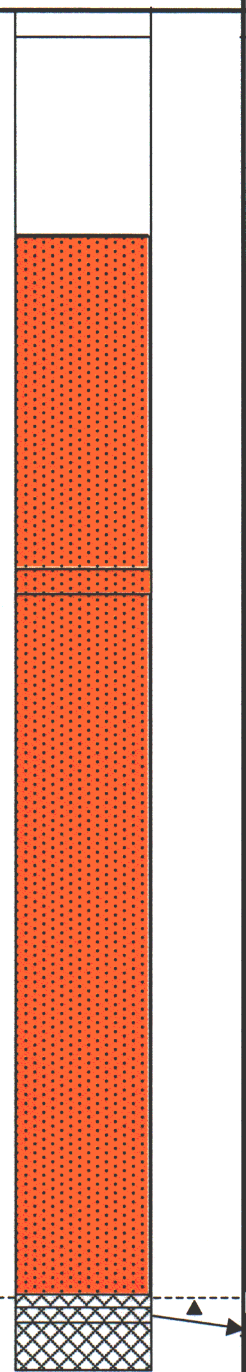
Core No: MN BH 12

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.514 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001

Project No: 602345
Drilling Method: Sonic

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10



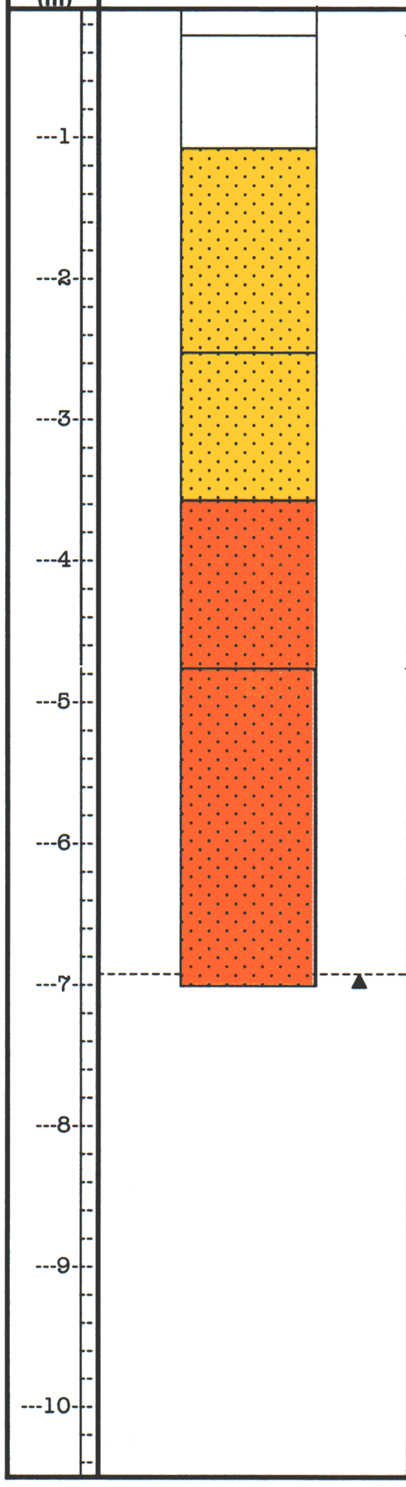
Description	Sample #	Comments
ice		
water	MN BH12-01	
light brown clay with <5% grey streaks	MN BH12-02	light grey brown silty clay (laboratory identification)
light brown clay 50% grey streaks	MN BH 12-03	light grey brown plastic clay
brown plastic clay with <2% grey streaks	MN BH12-04	brown silty clay (laboratory identification)
frozen peat grading into grey organic rich soil	MN BH12-05	brown plastic clay in peat
peat	MN BH12-06	
black peat and sand	MN BH12-07	

Tailings Core Log

Core No: MN BH 13

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.513 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001
Project No: 602345
Drilling Method: Sonic

Depth (m) / Core Details	Description	Sample #	Comments
	ice		
	water	MN BH13-01	
	grey plastic clay <40% brown streaks	MN BH13-02	grey brown plastic clay (laboratory classification)
	grey brown plastic clay with 50% brown	MN BH13-03	light grey brown plastic clay (laboratory classification)
	brown plastic clay with 30% grey	MN BH13-04	brown plastic clay (laboratory classification)
	brown plastic clay with <10% grey	MN BH13-05	brown plastic clay (laboratory classification)



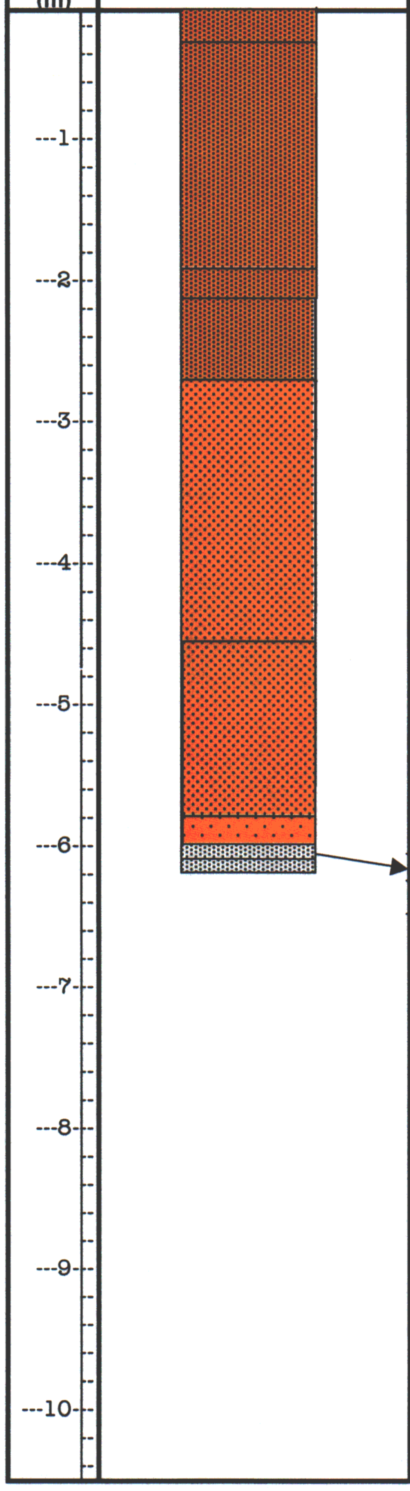
Tailings Core Log

Core No: MN BH 14

Project: Mt. Nansen Tailings Chemical Stability | **Elevation:** 1150.103 m

Location: Mt. Nansen, Yukon Territory | **Sampling Date:** November 17th 2001

Project No: 602345 | **Drilling Method:** Sonic



Description	Sample #	Comments
light brown frozen silt		NOT SAMPLED
moist light brown silty sand	MN BH 14-01	yellow brown silt (upon re-examination)
light grey brown clayey silt (20% clay)	MN BH14-02	light grey brown silt
light brown sandy silt	MN BH 14-03	grey brown silt (upon re-examination)
saturated light brown clay with 25% slushy sections	MN BH14-04	light grey brown clayey silt (laboratory classification)
brown silt with 20-30% clay	MN BH14-05	grey brown clayey silt (laboratory classification)
brown plastic clay with 20% grey	MN BH14-06	light brown plastic clay
contact zone with native sand, plant remains	MN BH14-07	dark grey organic soil
native sand	MN BH14-08	

Depth (m): 1 – 10

Tailings Core Log

Core No: MN BH 15

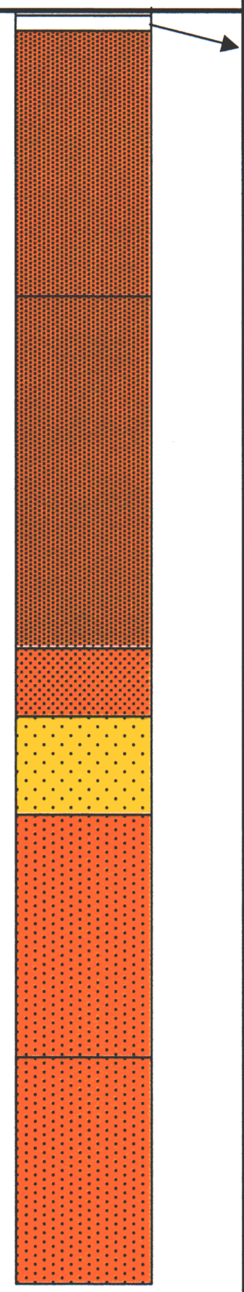
Project: Mt. Nansen Tailings Chemical Stability | **Elevation:** 1148.527 m

Location: Mt. Nansen, Yukon Territory | **Sampling Date:** November 17th 2001

Project No: 602345 | **Drilling Method:** Sonic

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Core Details:



Description	Sample #	Comments
ice		
water	MN BH15-01	
saturated brown sand, 1-2% sulfides	MN BH15-02	brown silty sand (laboratory classification)
saturated brown sand 1-2% sulfides	MN BH15-03	light brown silty sand (laboratory classification)
brown clayey silt, 20% grey streaks	MN BH15-04	light grey brown clayey silt
grey brown plastic clay (20-25% grey streaks)	MN BH15-05	light grey brown plastic clay (laboratory classification)
brown silty clay, plastic (10% grey streaks)	MN BH15-06	brown plastic silty clay (laboratory classification)
brown silty clay, plastic (<10% grey streaks)	MN BH 15-07	brown silty clay, plastic (laboratory classification)

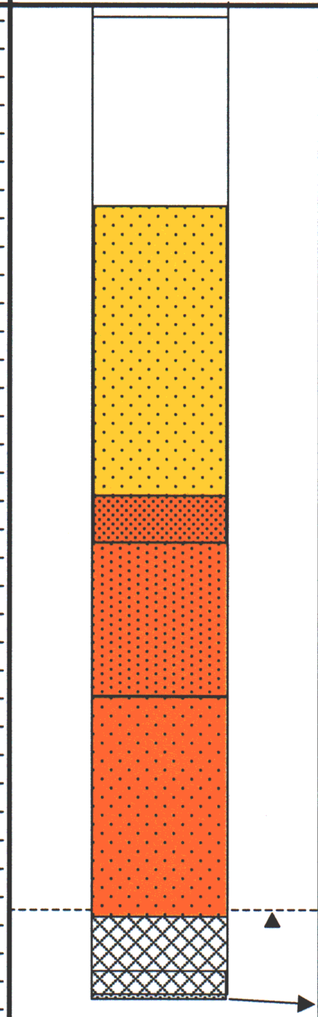
Tailings Core Log

Core No: MN BH 16

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.492 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001

Project No: 602345
Drilling Method: Sonic



Depth (m)	Description	Sample #	Comments
	ice		
1	water	MN BH16-01	
2–3	grey brown clay ,<40% brown	MN BH16-02	
	light grey brown silt (clayey)	MN BH16-03	
4	light grey brown plastic clay (<30% grey), silty	MN BH16-04	
5–6	light grey yellow brown plastic clay (<20% grey), locally silty	MN BH16-05	
	peat moss at contact with clay	MN BH16-06	
7	black organic rich soil and peat	MN BH16-07	
	dark grey frozen sand		NOT SAMPLED
8			
9			
10			

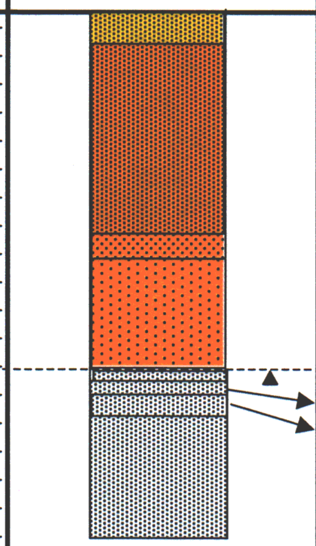
Tailings Core Log

Core No: MN BH 17

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1149.454 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001

Project No: 602345
Drilling Method: Sonic



Depth (m)	Core Details	Description	Sample #	Comments
		frozen beige sandy silt	MN BH17-01	grey brown sandy silt (thawed)
1		brown, moist silty sand	MN BH17-02	yellow brown silt, slightly sandy (upon re-examination)
		saturated brown silt (20% grey)	MN BH17-03	light grey brown clayey silt
2		clayey silt, 20% brown, <20% clay	MN BH17-04	light grey brown silty clay (laboratory classification)
		native sand in contact with clayey silt	MN BH17-05	
		grey native sand 10-20 cm below contact	MN BH17-06	
3		grey native sand 20-30 cm below contact	MN BH17-07	
		wet native sand	NOT SAMPLED	
4				
5				
6				
7				
8				
9				
10				

Tailings Core Log

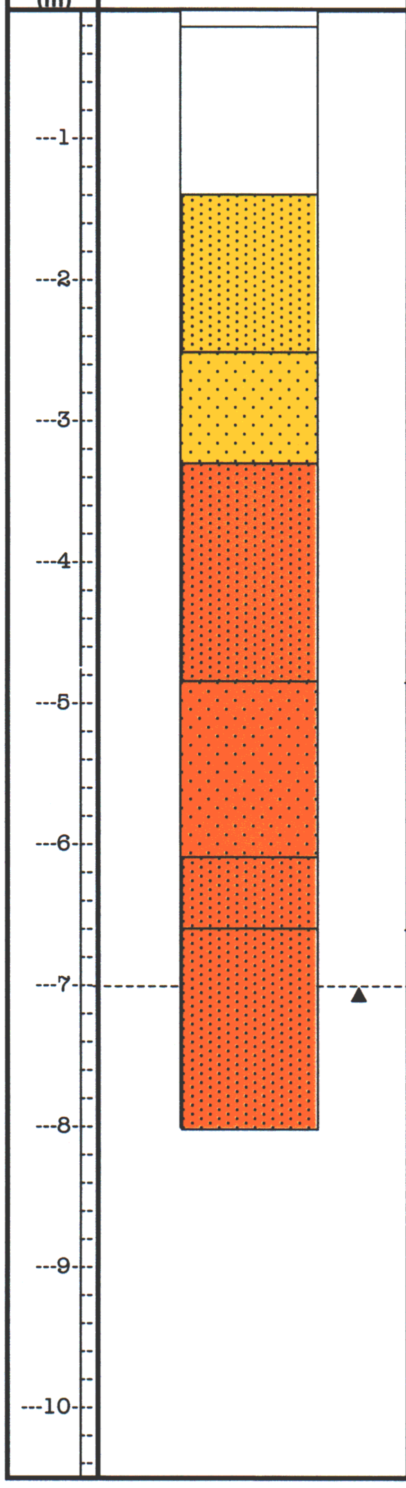
Core No: MN BH 18

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.716 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001

Project No: 602345
Drilling Method: Sonic

Depth (m) | Core Details

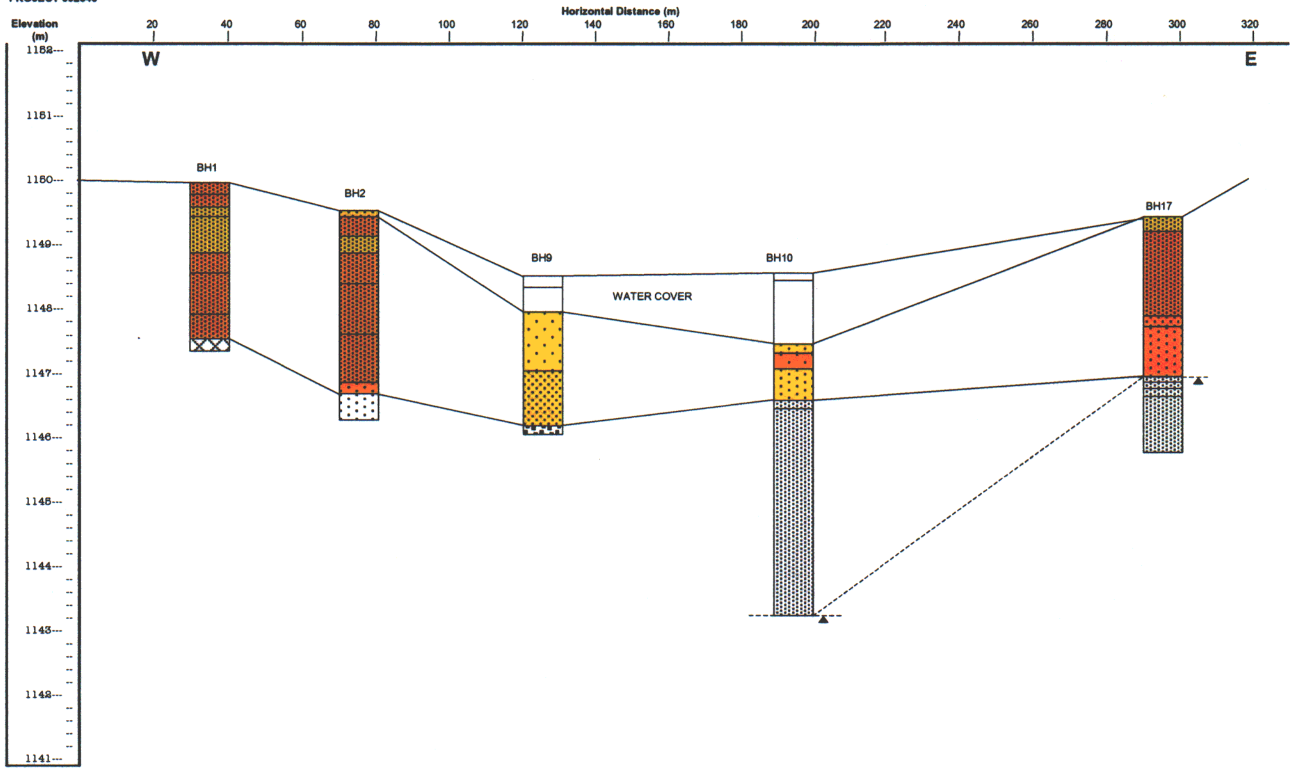


Description	Sample #	Comments
ice		
water	MN BH18-00	
grey brown silty clay	MN BH18-01	
grey brown plastic clay, 50% clay	MN BH18-02	
light grey brown clay (25% grey), slightly silty	MN BH18-03	
brown plastic clay (10% grey)	MN BH18-04	
light grey brown silty clay with brown sand and ice lenses	MN BH18-05	
brown silt with 65% ice crystals	MN BH18-06	brown silty clay slurry (thawed)

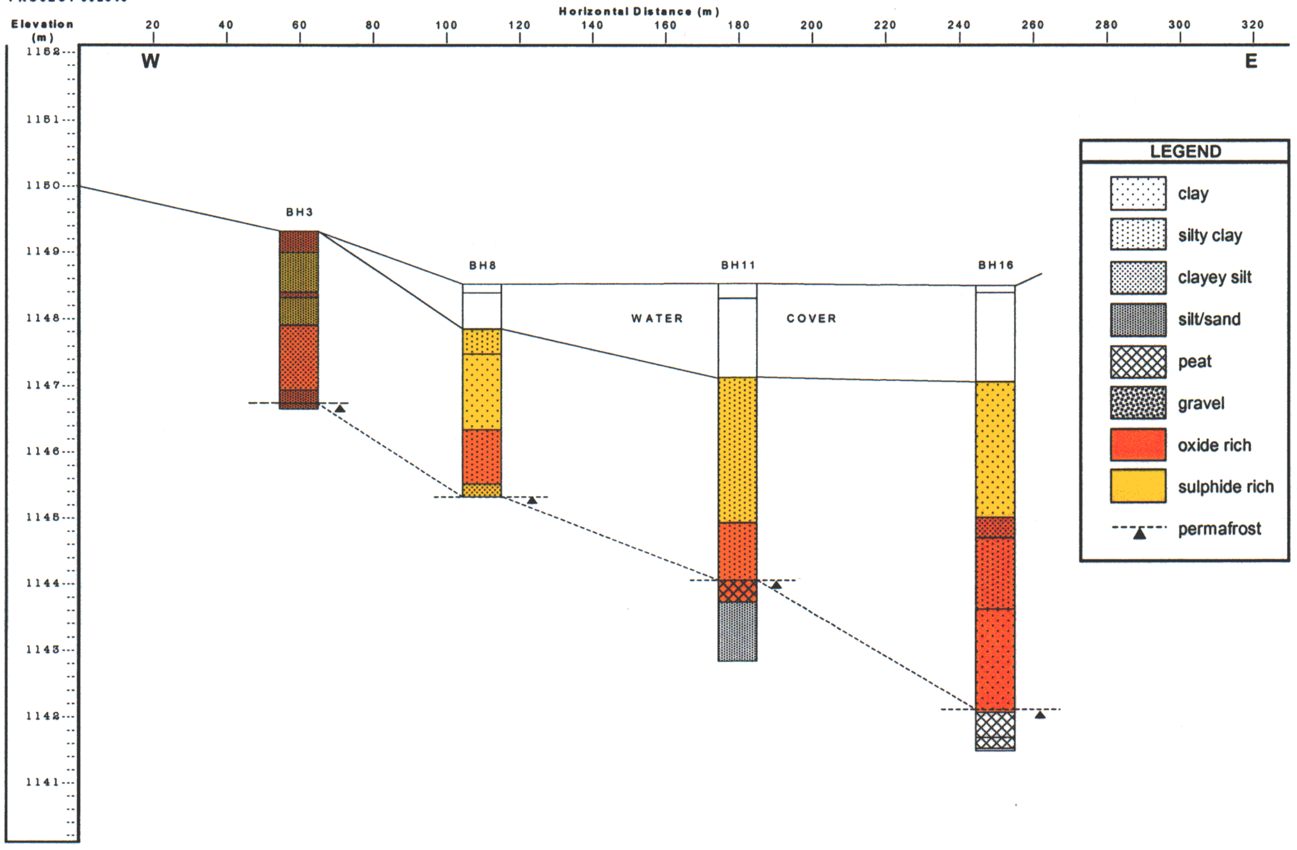
APPENDIX B

Cross Sections of the Tailings Impoundment at Mount Nansen

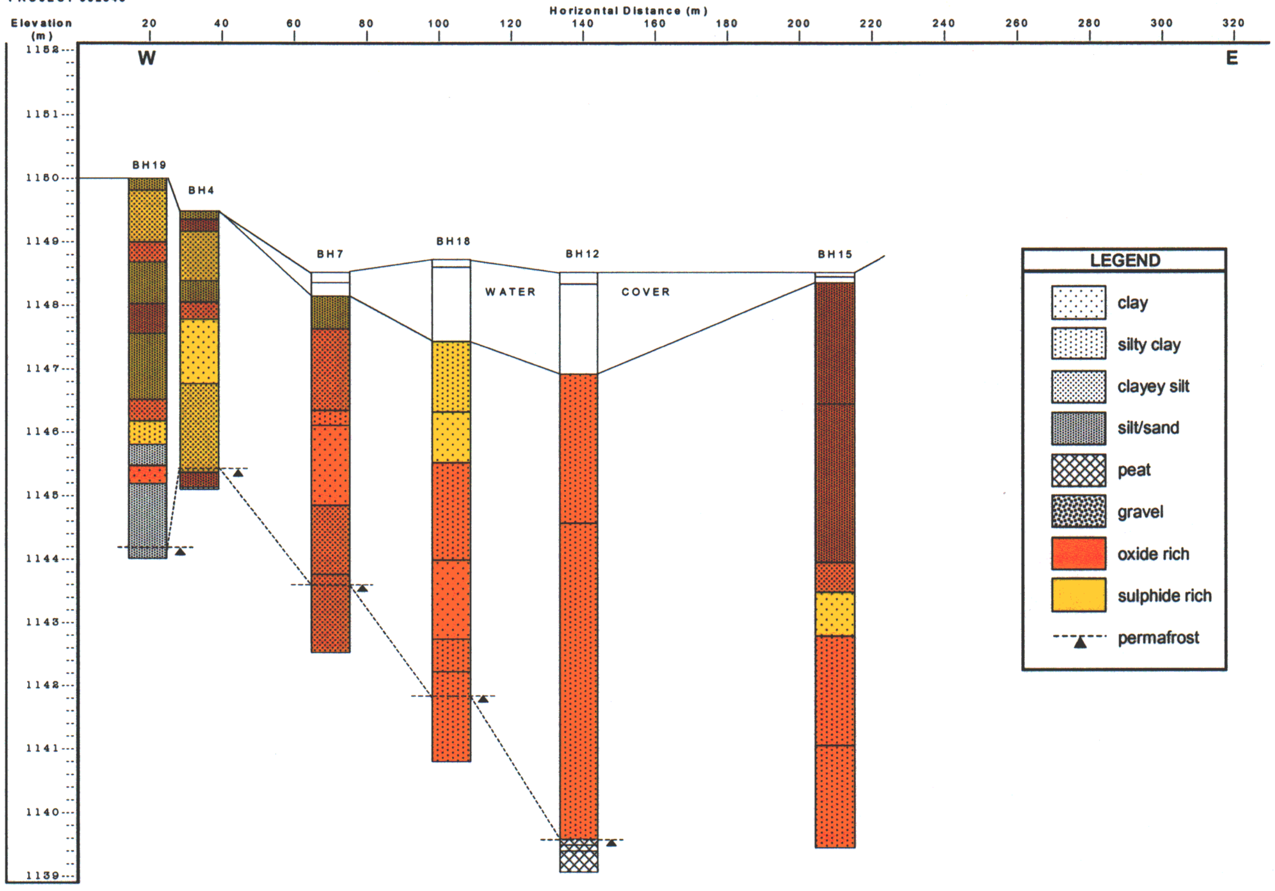
Mount Nansen Tailings Cross-Section, W-E 1 (BH1, 2, 9, 10, 17)
PROJECT 602345



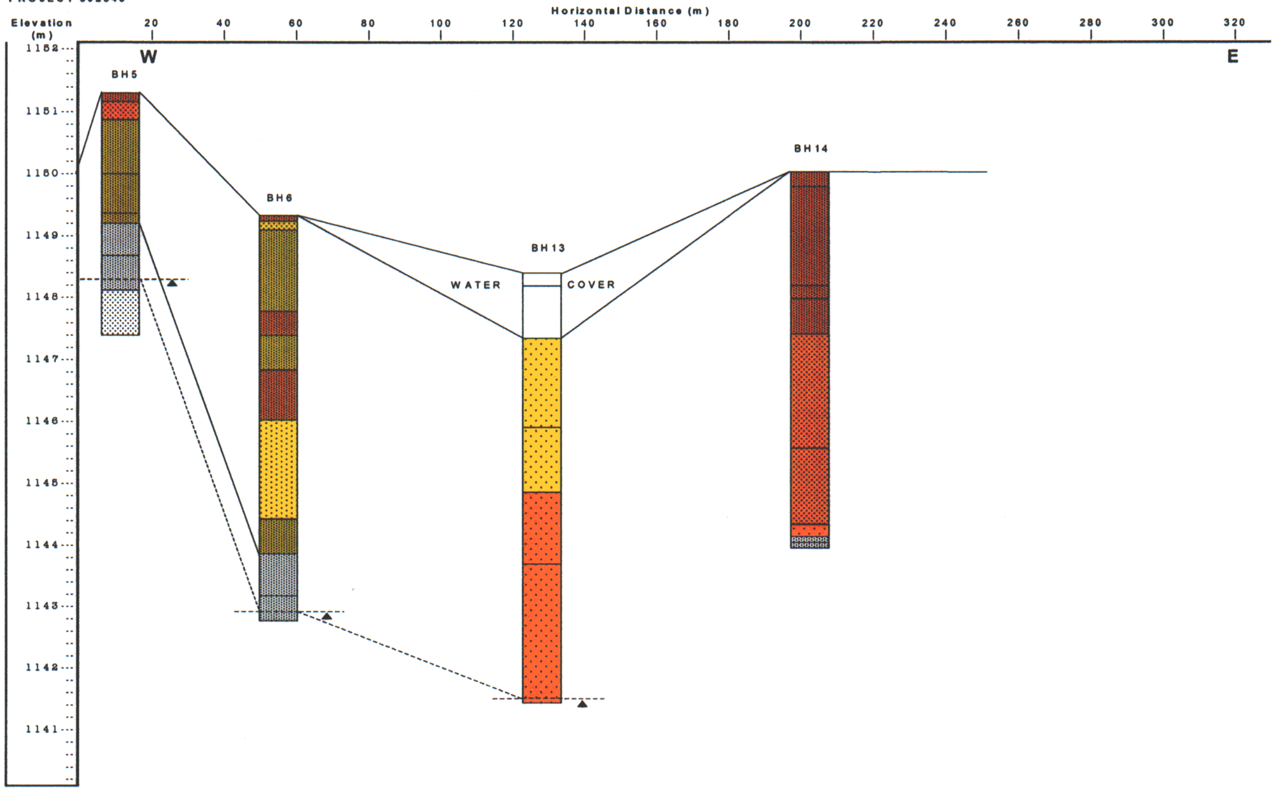
Mount Nansen Tailings Cross-Section, W-E 2 (BH3, 8,11,16)
PROJECT 602345



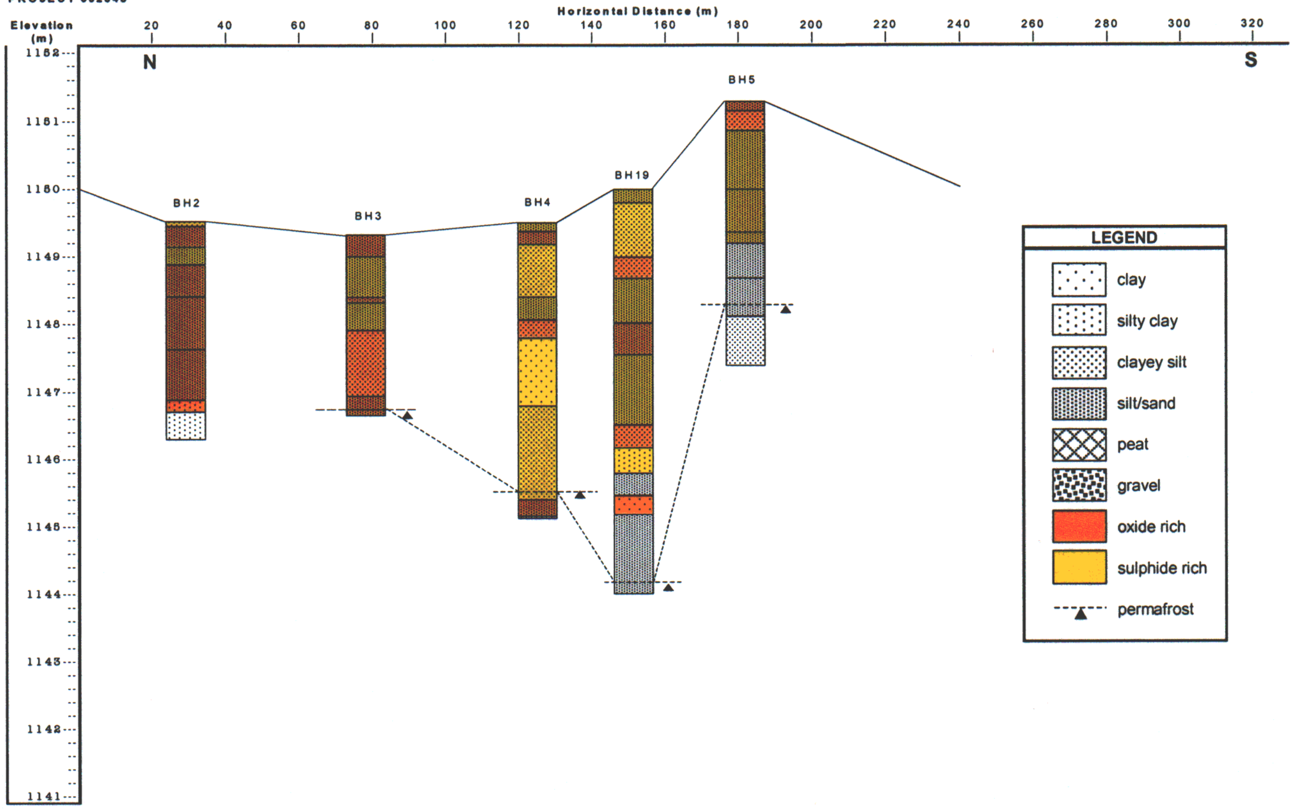
Mount Nansen Tailings Cross-Section, W-E 3 (BH19, 4, 7, 18, 12, 15)
PROJECT 602345



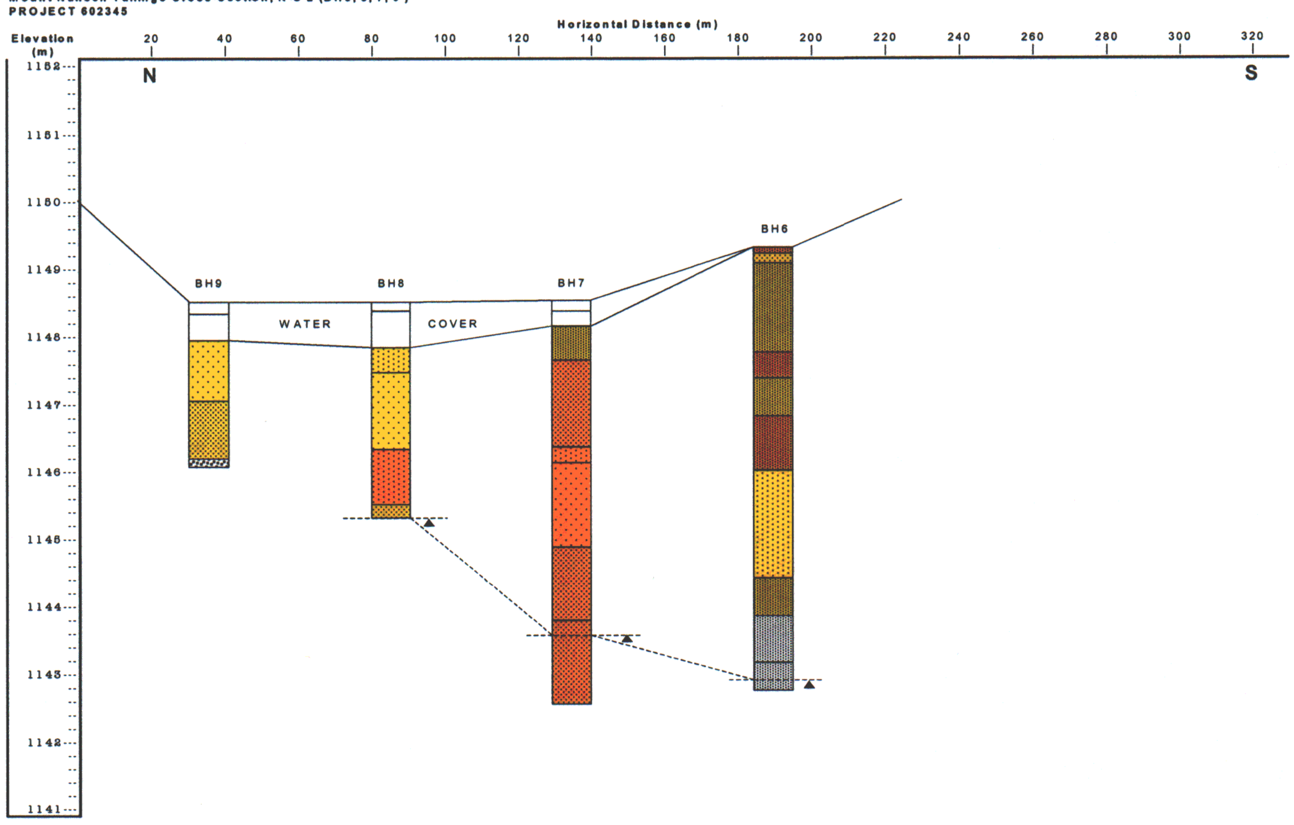
Mount Nansen Tailings Cross-Section, W-E 4 (BH5, 6, 13, 14)
PROJECT 602345



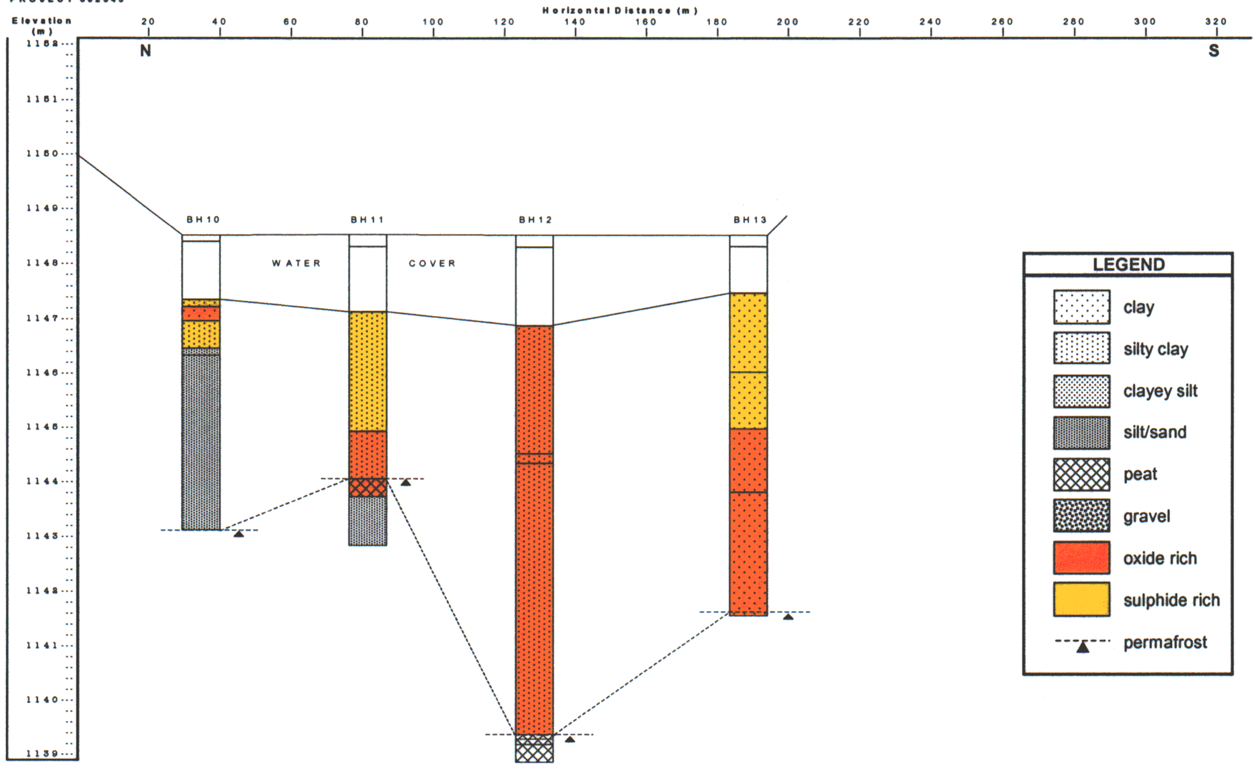
Mount Nansen Tailings Cross-Section, N-S 1 (BH2, 3, 4, 19, 5)
PROJECT 602345



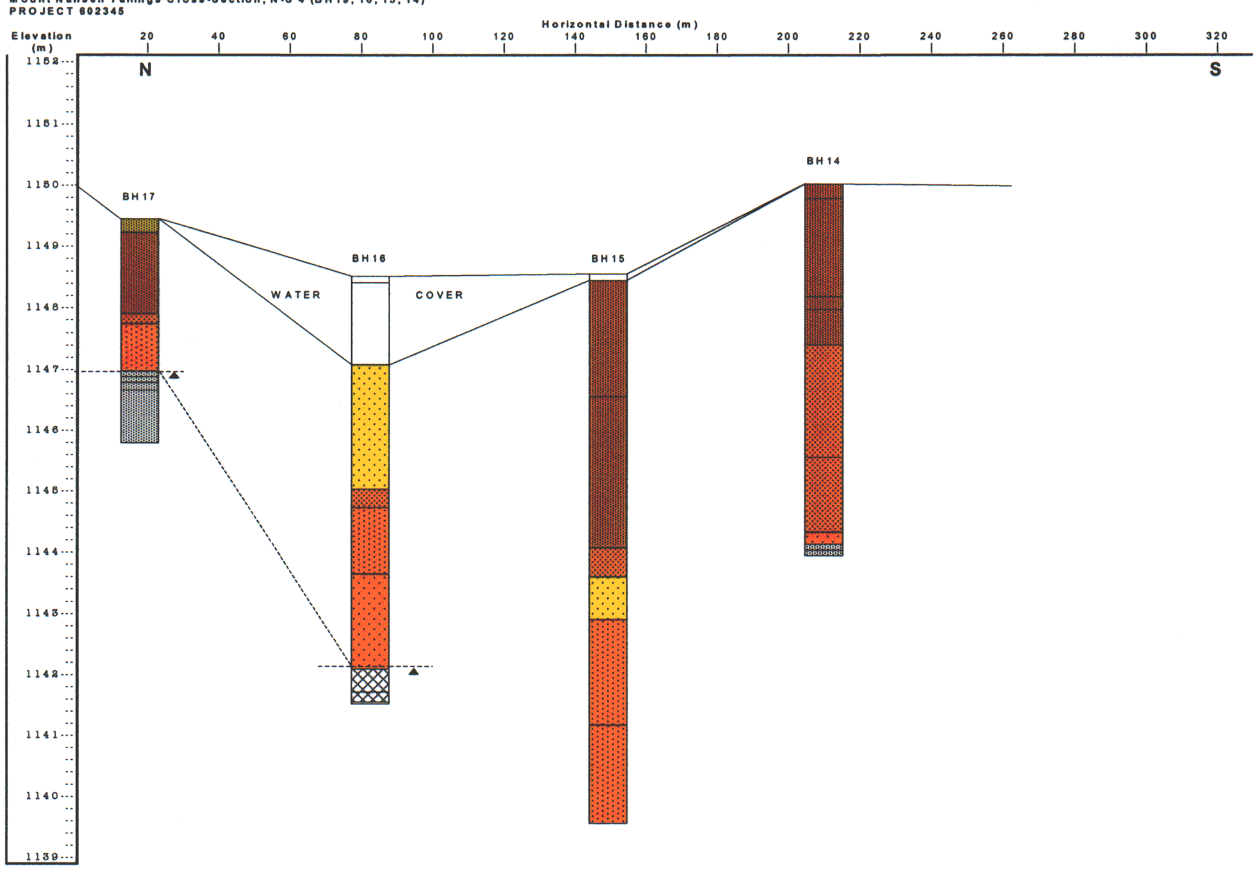
Mount Nansen Tailings Cross-Section, N-S 2 (BH9, 8, 7, 6)
PROJECT 602345



Mount Nansen Tailings Cross-Section, N-S 3 (BH10, 11, 12, 13)
PROJECT 602345



Mount Nansen Tailings Cross-Section, N-S 4 (BH19, 16, 15, 14)
PROJECT 602345



APPENDIX C

Tailings Geochemistry and Particle Size

Appendix C contains the following raw data:

C1. Tailings solids chemistry
  a) Tailings geochemistry as determined by the Analytical Services Group of CANMET-MMSL (**Table C-1a**)
  b) Tailings geochemistry as determined by B.C. Research Inc. (**Table C-1b**)

C2. Acid base accounting analyses of selected tailings solids as determined by B.C. Research Inc. (**Table C-2**)

C3. Porewater chemistry of samples extracted in the field and surface water chemistry at selected locations (Analysis by the Analytical Services Group, CANMET-MMSL) (**Table C-3**).

C4. Detailed particle size analyses of selected samples covering the four varieties of tailings identified (Grain size distribution curves and related data) (**Appendix C-4**)

Table C-1a: Tailings geochemistry as determined by the Analytical Services Group of CANMET-MMSL

	FIELD #	SAMPLE TYPE	Ag µg/g	Al %	As µg/g	B µg/g	Ba µg/g	Bi µg/g	Ca %	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe %	K %
6394 AES-SCAN	MN0101	oxide silt	31	5.56	2700	354	828	<15	2.11	40	7	34	717	5.36	2.03
	MN0103	sulfide silt	24	5.21	2810	557	798	<15	1.96	45	9	26	628	5.88	1.85
	MN0106	oxide silt	20	3.50	2620	165	568	<15	0.623	20	3	17	248	3.65	1.36
	MN0201	sulfide silt	26	5.19	2530	78	832	<15	2.13	39	6	25	880	4.80	1.89
	MN0205	oxide silt	29	4.22	2990	368	699	<15	1.28	34	5	19	529	4.99	1.63
	MN0302	sulfide silt	21	5.15	2020	367	986	<15	1.26	33	7	18	283	4.52	1.90
	DuMN0302	sulfide silt	21	5.23	2020	370	993	<15	1.28	33	7	18	287	4.54	1.91
	MN0304	sulfide silt	27	4.61	2670	373	898	<15	1.19	34	6	23	566	5.10	1.77
	DuMN0304	sulfide silt	n/d	4.64	2670	372	899	<15	1.20	34	7	24	569	5.10	1.78
	MN0402	oxide silt	56	4.07	2650	379	585	<15	2.00	45	5	16	431	4.65	1.43
	MN0405	oxide silt	16	5.53	1440	386	923	<15	1.67	27	8	30	207	4.28	1.76
	DuMN0406	sulfide clay	27	5.05	3080	402	710	<15	2.32	52	10	39	414	5.95	1.76
6395 AES-SCAN	MN0503	sulfide silt	45	4.04	2930	738	628	n/d	1.74	n/d	5	21	455	5.39	1.36
	MN0601	oxide silt	46	5.55	3070	601	818	n/d	2.20	n/d	6	26	745	5.59	1.89
	MN0603	sulfide silt	14	4.58	1950	508	802	15*	1.41	39*	7	26	234	4.95	1.62
	MN0607	sulfide clay	70	7.45	3810	157	1020	26*	1.43	39*	4	36	456	7.31	2.62
	MN0617	sulfide clay	70	7.42	3700	466	1020	6*	1.49	24*	6	36	444	7.31	2.59
	MN0702	sulfide silt	37	4.67	2630	682	698	32*	1.44	33*	4	21	416	5.37	1.71
	DuMN0702	sulfide silt	42	5.26	2760	640	799	32*	1.74	32*	6	29	433	6.04	1.84
	MN0703	oxide silt	41	5.88	2800	425	876	27*	1.60	38*	5	27	577	6.73	2.09
	MN0703F	oxide silt	41	5.89	2970	624	906	26*	1.63	33*	6	29	588	6.77	2.12
	DuMN0703F	oxide silt	41	5.76	2980	625	888	n/d	1.60	n/d	6	29	588	6.64	2.12
	MN0705	oxide clay	40	7.63	4190	239	1020	30*	1.32	27*	6	40	309	6.99	2.65
	MN0705F	oxide clay	42	7.57	4190	468	1020	32*	1.25	27*	5	38	321	7.12	2.72
	DuMN0705F	oxide clay	42	7.24	4200	464	976	n/d	1.20	n/d	5	38	317	6.84	2.66
6396 AES-SCAN	MN0707	oxide silt	23	4.98	3210	580	846	26	0.798	12	6	55	139	4.63	1.73
	DuMN0707	oxide silt	23	5.06	3110	449	854	25	0.792	11	6	70	138	4.55	1.72
	MN0803	sulfide clay	31	6.30	2500	382	860	22	1.62	36	8	20	510	5.82	2.13
	MN0803F	sulfide clay	29	6.08	2440	345	828	23	1.60	35	8	26	469	5.42	2.07
	MN0804	oxide clay	27	6.94	2540	258	969	21	1.57	36	12	30	465	6.21	2.29
	MN0805	sulfide silt	36	4.48	4240	610	712	39	0.567	13	4	32	200	5.54	1.71
	MN0902	sulfide clay	48	5.27	3950	370	834	35	1.39	26	8	18	484	6.65	1.99
	MN0912	sulfide clay	42	5.46	3820	370	836	37	1.40	25	7	22	450	6.70	1.98
	MN0903	sulfide silt	29	4.66	3730	295	815	32	0.657	6	6	41	155	4.84	1.63
	DuMN0903	sulfide silt	29	4.53	3760	298	829	35	0.667	7	7	40	160	4.82	1.67
	MN1002	oxide clay	27	8.46	2460	126	1100	27	1.23	33	9	26	392	6.80	2.84
	MN1003	sulfide clay	60	7.10	4400	264	954	47	1.27	30	8	26	692	7.21	2.61
	DuMN1003	sulfide clay	61	6.97	4400	266	961	51	1.27	29	8	26	720	6.87	2.65
6397 AES-SCAN	MN1003F	sulfide clay	62	7.09	4660	451	1040	77*	1.41	44	8	25	737	7.39	2.68
	DuMN1003F	sulfide clay	62	7.05	4820	393	1030	n/d	1.40	46	8	25	740	7.35	2.68
	MN1004	native sed.	1	6.43	104	296	1210	5*	1.90	2	5	21	202	1.71	1.63
	MN1102	sulfide clay	51	6.62	4070	226	939	41*	1.71	50	9	23	630	7.07	2.42
	MN1103	oxide clay	50	7.58	4120	402	1050	39*	1.27	41	8	21	984	7.85	2.77
	MN1202	oxide clay	28	7.47	2660	378	1080	23*	1.44	46	8	28	372	6.16	2.56
	MN1212	oxide clay	27	7.59	2680	215	1090	22*	1.45	45	10	28	383	6.24	2.59
	MN1204T	oxide clay	56	6.62	5710	456	1040	45*	0.947	41	6	28	238	7.55	2.58
	MN1204B	oxide clay	48	5.59	4830	481	903	41*	0.829	29	5	52	193	6.81	2.20
	DuMN1204B	oxide clay	48	5.57	4860	485	903	n/d	0.829	29	5	52	195	6.78	2.20
	MN1205	native sed.	35	7.21	4060	186	1090	40*	1.01	31	7	66	203	6.03	2.42
	MN1205F	native sed.	35	7.35	3970	382	1100	37*	1.02	31	7	65	212	6.10	2.47
	DuMN1205F	native sed.	35	7.38	3950	381	1100	n/d	1.03	31	n/d	65	210	6.12	2.46
6398 AES-SCAN	MN1206	native sed.	29	6.71	3560	69	1020	28*	1.17	< 1	11	62	421	5.94	2.19
	DuMN1206	native sed.	30	6.75	3280	56	1010	n/d	1.15	n/d	9	61	427	5.95	2.21
	MN1206D	native sed.	28	6.69	3470	192	1020	26*	1.15	101*	9	61	409	5.93	2.19
	MN1207	native sed.	0	6.29	24	91	963	<2*	2.05	< 1*	8	42	27	2.08	1.34
	MN1303	sulfide clay	47	5.84	3240	208	876	27*	1.72	38*	8	32	506	7.00	2.08
	MN1303F	sulfide clay	48	5.83	3380	221	875	28*	1.71	29*	8	31	487	6.99	2.08
	MN1304	oxide clay	58	6.23	4560	254	935	35*	1.47	13*	8	33	367	6.99	2.37
	MN1305	oxide clay	48	6.66	5060	135	1010	36*	1.16	11*	7	35	275	7.30	2.50
	MN1305F	oxide clay	47	6.63	5170	128	1000	37*	1.16	24*	7	36	276	7.28	2.50
	DuMN1305F	oxide clay	47	6.55	5150	127	996	n/d	1.16	n/d	8	36	276	7.29	2.49
	MN1401	oxide silt	35	4.48	3130	258	743	11*	1.45	15*	7	23	339	5.53	1.58
	DuMN1401	oxide silt	35	4.50	3120	258	746	7*	1.45	12*	8	23	337	5.52	1.59
	MN1402	oxide silt	39	4.26	5610	355	749	n/d	1.33	n/d	6	24	238	4.41	1.50
6399 AES-SCAN	MN1406	oxide clay	53	5.38	4920	287	1010	36*	1.06	21*	5	39	260	7.21	2.43
	DuMN1406	oxide clay	54	5.88	4990	159	1050	n/d	1.06	n/d	0	40	256	7.42	2.49
	MN1407	native sed.	3	1.15	275	512	169	<2*	0.585	2*	4	20	13	1.53	0.269
	MN1408	native sed.	1	6.19	30	49	1160	<2*	2.02	< 1*	3	34	11	1.94	1.62
	MN1504	oxide silt	66	4.64	3720	296	719	24*	1.48	30*	6	20	655	5.87	1.92
	MN1506	oxide clay	55	5.56	4480	348	930	27*	1.08	23*	7	22	302	6.22	2.31
	MN1603	oxide silt	38	4.35	2120	259	867	5*	1.13	24*	5	19	188	4.10	1.84
	MN1604	oxide clay	31	5.41	3630	172	921	19*	0.784	12*	2	17	195	5.58	2.32
	MN1605	oxide clay	57	5.55	5380	243	1230	35*	0.865	19*	2	46	367	6.89	2.40
	DuMN1605	oxide clay	58	5.47	5380	243	1230	n/d	0.825	n/d	5	45	364	6.91	2.30

Table C-1a (cont.)

	FIELD #	SAMPLE TYPE	Ag µg/g	Al %	As µg/g	B µg/g	Ba µg/g	Bi µg/kg	Ca %	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe %	K %
6400 AES-SCAN	MN1616	native sed.	73	6.93	4570	180	1080	45.6*	0.699	n/d	2	68	228	8.31	2.56
	DuMN1616	native sed.	74	6.88	4600	168	1060	n/d	0.693	n/d	4	72	224	8.12	2.52
	MN1701	sulfide silt	64	3.65	4480	507	647	18.6*	0.733	n/d	6	19	847	6.18	1.39
	MN1704	oxide silt	40	3.91	3980	550	685	15.6*	0.681	n/d	3	19	354	5.51	1.62
	MN1705F	native sed.	27	6.47	1240	131	1160	4.32*	1.58	n/d	4	28	53	2.86	1.78
	MN1802	sulfide clay	26	6.31	2330	199	955	9.02*	1.35	n/d	7	27	385	5.68	2.16
	MN1802F	sulfide clay	24	6.34	2390	384	969	9.55*	1.36	n/d	6	32	380	5.76	2.17
	MN1804	oxide clay	59	7.28	5460	219	1010	35.7*	1.16	n/d	6	25	485	7.80	2.66
	MN1805	oxide clay	46	5.27	4230	311	832	28.6*	0.652	n/d	2	72	197	6.51	2.07
	DuMN1805	oxide clay	45	5.25	4240	311	826	n/d	0.649	n/d	5	70	197	6.52	2.08
	MN1806	oxide silt	58	6.22	4850	270	924	41.5*	0.903	n/d	6	8	358	0.728	0.228
	MN1806D	oxide silt	59	6.23	4850	200	922	43.9*	0.899	n/d	3	56	497	7.21	2.29
	DuMN1806D	oxide silt	59	6.22	4840	200	919	n/d	0.899	n/d	4	53	494	7.41	2.35
6401 AES-SCAN	MN1901	sulfide silt	54	3.93	3670	534	642	13.5*	1.78	n/d	8	10	709	5.56	1.34
	DuMN1901	sulfide silt	50	3.95	3610	373	650	n/d	1.79	n/d	9	10	695	5.55	1.34
	MN1902	sulfide silt	31	4.96	2580	345	811	9.60*	1.62	n/d	8	11	613	5.06	1.70
	MN1905	oxide silt	20	4.59	1910	296	892	4.77*	1.33	n/d	7	13	323	4.56	1.57
	MN1906	sulfide silt	20	4.61	2210	450	1010	3.46*	1.35	n/d	7	16	455	4.44	1.55
	MN1907	oxide silt	24	4.22	2090	388	839	3.98*	1.15	n/d	5	13	609	3.59	1.46
	MN1908	sulfide silt	25	4.58	2310	452	865	7.55*	1.54	n/d	6	14	472	4.50	1.58
	MN1910	oxide clay	47	5.21	6220	790	850	38.5*	0.944	n/d	5	38	188	6.90	2.06
	NWALL1	pit grab	5	8.43	1240	372	1220	0.00*	0.863	n/d	10	11	477	6.11	3.61
	DuNWALL1	pit grab	5	8.42	1220	368	1220	n/d	0.864	n/d	10	11	477	6.11	3.62
	NWALBX	pit grab	117	1.41	1280	381	128	244*	1.73	n/d	30	5	539	33.8	0.565
	WBH3	pit grab	241	4.43	1670	66	652	11.3*	12.9	n/d	13	38	4130	5.15	1.38
	DuWBH3	pit grab	241	4.45	1660	63	655	n/d	13.0	n/d	13	39	4130	5.17	1.38
6402 AES-SCAN	PITSED	pit grab	10	9.44	1460	12	1360	3.14*	1.90	n/d	17	21	412	6.79	2.07
	DuPITSED	pit grab	10	9.23	1490	13	1380	n/d	1.92	n/d	17	25	376	7.12	2.11
	BATCH01	oxide clay composite	56	6.32	4720	47	961	38.5*	1.02	n/d	5	23	580	6.65	2.46
	BATCH02	oxide clay composite	55	6.35	4720	54	959	36.1*	1.03	n/d	6	16	860	6.69	2.47
	BATCH03	oxide clay composite	56	6.21	4750	71	956	38.4*	1.02	n/d	6	34	249	6.61	2.42
	BATCHS1	sulfide clay composite	42	5.76	3520	73	885	25.3*	1.28	n/d	7	15	344	5.84	2.18
	BATCHS1D	sulfide clay composite	43	5.93	3520	68	881	24.3*	1.32	n/d	7	6	350	6.02	2.23
	BATCHS2	suphide clay composite	43	5.95	3480	61	876	24.9*	1.33	n/d	4	25	345	6.16	2.19
	BATCH1E	composite	55	6.22	4880	63	940	33.5*	1.03	n/d	4	22	491	6.62	2.42
	DuBATCH1E	composite	54	6.15	4790	62	967	n/d	1.01	n/d	5	30	451	6.66	2.27

n/d= not determined
* = MS analysis µg/kg (all other data are AES)

Table C-1a (cont.)

FIELD #	SAMPLE TYPE	Li µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Na µg/g	Ni µg/g	P µg/g	Pb µg/g	S %	Sb µg/g	Sr µg/g	V µg/g	Zn µg/g
MN0101	oxide silt	15	4320	2780	4	1500	13	584	1370	2.69	436	149	49	2100
MN0103	sulfide silt	15	5130	3250	2	1380	14	563	1510	3.52	363	102	55	2650
MN0106	oxide silt	17	1520	924	2	1770	7	425	1660	0.696	368	91	40	649
MN0201	sulfide silt	15	3780	2420	2	1740	16	556	1580	2.30	423	147	52	2030
MN0205	oxide silt	17	2310	1740	2	1360	9	500	1980	2.05	445	104	45	1460
MN0302	sulfide silt	13	2960	2070	3	2810	7	532	1410	1.93	276	131	49	1770
DuMN0302	sulfide silt	13	2970	2080	4	2830	10	542	1410	1.95	265	132	50	1770
MN0304	sulfide silt	13	2730	1880	2	2200	10	528	1970	2.08	377	113	47	1610
DuMN0304	sulfide silt	13	2740	1870	3	2200	10	526	1980	2.07	379	113	47	1610
MN0402	oxide silt	16	3880	2690	6	688	10	442	1450	3.28	560	118	37	2170
MN0405	oxide silt	11	4320	2080	3	6690	14	590	925	1.27	205	190	60	1460
DuMN0406	sulfide clay	10	5530	3370	4	3660	16	521	1890	3.52	433	144	55	2710
MN0503	sulfide silt	23	4170	2770	<5	874	4	n/d	1750	4.15	41500	121	36	2630
MN0601	oxide silt	27	4760	3040	<5	777	5	n/d	2100	3.05	30500	145	49	2940
MN0603	sulfide silt	25	3830	2730	<5	1810	8	70.17*	1150	2.38	23800	111	47	2040
MN0607	sulfide clay	29	3720	2290	<5	1900	6	93.70*	3760	1.99	19900	155	79	2560
MN0617	sulfide clay	31	3780	2290	<5	1910	7	112.4*	3760	1.65	16500	154	79	2670
MN0702	sulfide silt	19	3730	2600	<5	630	5	160.9*	1980	2.74	27400	111	45	2470
DuMN0702	sulfide silt	26	4110	2850	<5	706	6	169.0*	2170	3.10	31000	118	49	2960
MN0703	oxide silt	28	4100	2650	<5	1390	5	147.0*	2700	2.38	23800	124	60	2610
MN0703F	oxide silt	27	4140	2650	<5	1380	6	166.9*	2750	3.69	36900	124	61	2730
DuMN0703F	oxide silt	27	4160	2590	<5	1380	5	n/d	2760	2.39	23900	124	61	2670
MN0705	oxide clay	32	3510	2120	<5	1760	9	157.3*	3750	1.42	14200	146	82	1970
MN0705F	oxide clay	32	3450	2150	<5	1640	7	160.3*	3780	1.38	13800	144	84	1940
DuMN0705F	oxide clay	31	3460	2060	<5	1590	7	n/d	3790	1.59	15900	142	83	1850
MN0707	oxide silt	22	2290	1510	4	2390	4	564	2730	0.619	392	134	55	961
DuMN0707	oxide silt	27	2250	1500	4	2440	5	541	2680	0.607	510	135	55	922
MN0803	sulfide clay	26	4870	2990	2	1180	3	586	1970	2.50	430	116	65	2610
MN0803F	sulfide clay	29	4910	2860	1	1080	1	565	1920	2.40	408	114	64	2480
MN0804	oxide clay	28	4590	3120	1	1350	10	641	2140	2.29	417	124	70	2550
MN0805	sulfide silt	26	1870	1040	3	1230	3	488	3740	1.04	536	102	49	879
MN0902	sulfide clay	27	3230	2070	1	1110	3	610	3140	2.47	436	121	59	1880
MN0912	sulfide clay	21	3210	2060	1	1110	3	585	3060	2.39	594	119	58	1850
MN0903	sulfide silt	18	3220	836	1	4180	13	466	3710	0.784	700	141	64	558
DuMN0903	sulfide silt	19	3200	835	1	4300	14	477	3710	0.794	709	143	64	559
MN1002	oxide clay	28	3660	2900	2	1420	6	732	2350	1.35	358	136	81	2400
MN1003	sulfide clay	30	3840	1860	2	1880	3	651	4480	2.25	746	150	77	1990
DuMN1003	sulfide clay	30	3830	1850	2	1910	4	649	4480	2.25	756	151	77	1990
MN1003F	sulfide clay	27	4040	1940	6	2640	7	719	4520	2.39	831*	147*	76	2110
DuMN1003F	sulfide clay	29	4000	1940	5	2650	7	738	4570	2.37	n/d	n/d	77	2090
MN1004	native sed.	6	4590	361	3	24900	8	323	96	0.0637	330*	438*	44	183
MN1102	sulfide clay	30	4410	2500	3	1810	6	707	3750	2.79	571*	140*	68	2440
MN1103	oxide clay	29	3560	2310	6	1840	7	773	3470	1.86	502*	152*	76	2210
MN1202	oxide clay	28	4370	3210	3	2420	6	728	2060	1.60	312*	120*	73	2580
MN1212	oxide clay	28	4440	3260	4	2410	7	719	2070	1.62	286*	125*	73	2620
MN1204T	oxide clay	31	2850	1680	3	1990	6	786	5700	1.45	912*	128*	71	1510
MN1204B	oxide clay	24	2420	1360	4	2180	7	689	4450	1.30	596*	116*	60	1030
DuMN1003F	oxide clay	25	2410	1360	4	2190	6	691	4450	1.30	n/d	n/d	61	1030
MN1205	native sed.	33	3180	1720	5	3690	8	681	3880	0.932	547*	159	76	1300
MN1205F	native sed.	31	3250	1730	6	3650	8	685	3930	0.945	560*	159	77	1310
DuMN1205F	native sed.	30	3280	1740	5	3660	9	678	3950	0.943	n/d	159	77	1330
MN1206	native sed.	33	3040	1810	<4	2880	12	132*	4130	1.08	681	157	73	1360
DuMN1206	native sed.	32	3000	1810	<4	2900	11	n/d	4110	1.06	706	157	73	1330
MN1206D	native sed.	32	2920	1810	<4	2800	11	148*	3930	1.08	701	157	72	1320
MN1207	native sed.	13	7100	442	<4	19900	15	197*	30	0.147	8	386	72	131
MN1303	sulfide clay	29	3540	2280	4	783	8	104*	3480	3.01	610	125	62	2540
MN1303F	sulfide clay	29	3530	2270	8	774	7	147*	3510	3.04	569	124	62	2530
MN1304	oxide clay	30	3150	2050	<4	1150	6	175*	4550	1.96	812	139	68	2120
MN1305	oxide clay	31	2920	1910	<4	1190	7	171*	4600	1.55	1010	142	74	1670
MN1305F	oxide clay	32	2980	1860	<4	1190	8	256*	4690	1.55	1050	141	74	1660
DuMN1305F	oxide clay	32	2960	1870	<4	1180	8	n/d	4640	1.54	1050	141	74	1650
MN1401	oxide silt	20	3080	2090	<4	1400	6	129*	2260	2.74	398	106	46	2100
DuMN1401	oxide silt	20	3110	2090	<4	1390	7	12.8*	2280	2.74	400	106	47	2100
MN1402	oxide silt	24	2140	1510	<4	2350	6	n/d	2400	1.70	709	130	47	1700
MN1406	oxide clay	36	2890	1550	90	1640	<15	68.5*	5550	1.49	920	128	72	1420
DuMN1406	oxide clay	33	2880	1590	101	1710	<15	n/d	5480	1.53	862	139	73	1410
MN1407	native sed.	6	2920	204	12	1520	7	0.00*	107	0.0717	7	46	42	188
MN1408	native sed.	9	6880	413	112	22300	<15	0.00*	20	0.0356	3	462	59	70
MN1504	oxide silt	30	3070	1980	82	966	<15	23.8*	3270	2.20	735	125	55	2020
MN1506	oxide clay	34	2600	1870	90	897	<15	72.1*	4200	1.23	989	123	68	1610
MN1603	oxide silt	29	2370	2040	69	1470	<15	81.6*	1790	1.07	428	111	54	1620
MN1604	oxide clay	25	2250	1810	89	984	<15	18.3*	1870	0.925	356	107	69	1110
MN1605	oxide clay	32	3000	1120	94	1800	<15	32.9*	5580	1.34	1010	146	70	1030
DuMN1605	oxide clay	31	3040	n/d	94	1720	<15	n/d	5550	1.34	1000	147	71	1040

Table C-1a (cont.)

FIELD #	SAMPLE TYPE	Li µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Na µg/g	Ni µg/g	P µg/kg	Pb µg/g	S %	Sb µg/kg	Sr µg/g	V µg/g	Zn µg/g
MN1616	native sed.	30	2660	1320	123	1650	<7	154*	4780	1.49	546*	154	70	939
DuMN1616	native sed.	29	2600	1340	123	1620	<7	n/d	4770	1.46	n/d	153	71	920
MN1701	sulfide silt	28	2500	1290	66	1170	<7	67.4*	2950	3.78	490*	92	45	1780
MN1704	oxide silt	27	2170	1080	71	1370	<7	460*	2200	2.14	428*	99	51	1230
MN1705F	native sed.	13	4180	532	118	18300	<7	69.6*	1350	0.332	198*	382	49	260
MN1802	sulfide clay	28	3650	3100	114	1550	<7	180*	1850	1.62	256*	123	66	2340
MN1802F	sulfide clay	29	3700	3130	118	1590	<7	144*	1860	1.66	227*	124	65	2360
MN1804	oxide clay	33	3160	1850	136	1200	<7	229*	5460	1.45	791*	140	79	1770
MN1805	oxide clay	32	2210	1430	100	1290	<7	109*	4530	1.15	566*	116	59	1100
DuMN1805	oxide clay	32	2210	1430	98	1280	<7	n/d	4520	1.14	n/d	116	58	1100
MN1806	oxide silt	34	267	1530	113	135	<7	140*	5610	0.140	669*	137	68	132
MN1806D	oxide silt	34	2650	1530	115	1340	<7	80.5*	5530	1.38	500*	137	68	1370
DuMN1806D	oxide silt	34	2710	1530	116	1370	<7	n/d	5550	1.41	n/d	137	68	1410
MN1901	sulfide silt	29	4320	2830	<6	1070	2	56.1*	1760	4.21	575*	116	44	2850
DuMN1901	sulfide silt	30	4360	2840	7	1100	1	n/d	1670	4.19	n/d	117	45	2860
MN1902	sulfide silt	30	4250	2820	<6	1630	1	76.3*	1470	2.76	351*	116	60	2650
MN1905	oxide silt	28	3720	2340	<6	2950	1	85.2*	1090	2.39	224*	121	63	2050
MN1906	sulfide silt	25	3570	1800	<6	4630	4	116*	1140	2.31	232*	152	60	1800
MN1907	oxide silt	26	2960	1690	<6	3800	2	97.2*	1020	1.74	250*	135	52	1670
MN1908	sulfide silt	26	3320	2010	<6	2970	1	21.0*	1300	2.32	263*	129	57	1970
MN1910	oxide clay	30	3070	861	<6	4000	4	131*	6420	1.28	622*	147	69	761
NWALL1	pit grab	12	4100	303	<6	2460	46	168*	721	3.72	121*	116	67	319
DuNWALL1	pit grab	12	4100	304	<6	2470	48	n/d	721	3.73	n/d	116	67	322
NWALBX	pit grab	24	2980	1160	<6	177	1	0.00*	4350	38.0	234*	36	17	2290
WBH3	pit grab	18	7630	3100	10	3520	50	106*	1090	1.29	188*	292	63	2410
DuWBH3	pit grab	18	7650	3120	7	3560	51	n/d	1090	1.28	n/d	290	63	2430
PITSED	pit grab	32	9680	5830	11	4410	10	270*	564	0.815	168*	266	168	3270
DuPITSED	pit grab	29	9360	5900	10	4190	12	n/d	566	0.968	n/d	271	160	3290
BATCH01	oxide clay composite	31	2670	1640	7	1350	8	222*	4470	1.35	860*	132	75	1640
BATCH02	oxide clay composite	30	2670	1670	6	1340	10	103*	4400	1.37	759*	133	76	1790
BATCH03	oxide clay composite	30	2650	1630	7	1340	8	196*	4460	1.37	778*	130	74	1470
BATCHS1	sulfide clay composite	30	3260	2140	5	1380	8	89.3*	2700	1.85	406*	126	69	1850
BATCHS1D	sulfide clay composite	29	3260	2190	6	1320	8	101*	2690	1.88	390*	128	72	1900
BATCHS2	suphide clay composite	29	3210	2200	6	1330	11	77.8*	2700	1.92	468*	127	77	1930
BATCH1E	composite	31	2630	1640	7	1350	7	117*	4530	1.35	816*	130	76	1570
DuBATCH1E	composite	30	2660	1650	7	1200	7	n/d	4420	1.33	n/d	126	76	1590

n/d= not determined

* = MS analysis µg/kg (all other data are AES)

Table C-1b: Tailings Geochmistry of selected samples by B.C. Research Inc.

Metal Contents of tailings solids

Field #	Sample Type	Ag µg/g	Al %	As µg/g	Au µg/g	Ba µg/g	Be µg/g	Bi µg/g	Ca %	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe %	K %	La µg/g	Mg %
ENDADIT	pit grab	7.1	7.33	837	5	847	1	12	2.49	12.0	9	11	44.0	5.88	2.96	8	0.83
NWALLCU	pit grab	45.3	4.93	2536	< 4	252	1	75	1.94	29.3	6	6	7438	5.66	2.02	7	0.29
MNOMIX	oxide silt composite	35.6	4.25	2796	< 4	558	1	20	0.770	14.2	3	13	290	4.85	1.79	11	0.24
MNSMIX	sulfide silt composite	42.3	5.56	2274	< 4	788	1	20	1.43	26.9	6	16	365	5.02	2.02	14	0.37
SOMIX	s-o silt composite	31.8	5.00	2468	< 4	383	2	16	1.23	20.8	4	18	285	4.87	1.96	14	0.33
SLURRY	s-o silt composite	35.6	5.06	2473	< 4	598	1	21	1.18	20.3	3	21	312	4.94	1.94	13	0.33
MN0102	oxide silt	25.0	6.59	2370	< 4	559	2	18	1.71	26.5	6	35	437	5.22	2.32	17	0.41
MN0104	sulfide silt	48.7	5.02	2349	< 4	696	1	8	1.29	25.2	4	15	400	5.14	1.92	16	0.34
MN0203	sulfide silt	23.8	5.25	2174	< 4	657	1	18	1.48	24.8	4	14	256	5.04	1.97	14	0.38
MN0304	sulfide silt	32.0	5.36	2604	< 4	539	1	30	1.30	23.9	4	23	599	5.16	2.07	13	0.33
MN0401	sulfide silt	52.1	5.49	1728	< 4	848	1	18	2.23	36.9	8	13	398	5.81	2.00	18	0.55
MN0402	oxide silt	54.3	4.64	1863	< 4	628	1	21	2.10	32.5	4	10	412	4.56	1.76	14	0.47
MN0404	sulfide silt	16.1	5.75	1285	< 4	322	1	16	1.64	18.7	6	19	199	4.06	2.00	15	0.45
MN0501	oxide silt	52.1	5.49	1637	< 4	820	1	26	2.13	33.2	8	17	679	5.46	1.98	17	0.55
MN0502	oxide silt	53.8	4.89	1888	< 4	715	1	23	1.90	34.2	7	12	512	5.51	1.83	17	0.49
MN0503	sulfide silt	76.9	4.86	1924	< 4	537	1	23	1.83	37.4	7	18	524	5.89	1.77	13	0.47
MN0505	sulfide silt	9.7	6.57	349	< 4	282	1	< 5	2.12	8.00	7	39	86.0	3.18	1.89	15	0.66
MN0506T	native sediments	1.0	7.32	17.0	< 4	1069	2	< 5	2.72	0.70	8	47	9.00	2.57	1.82	25	0.90
MN0506B	native sediments	< 0.5	7.52	14.0	< 4	957	2	< 5	3.64	0.60	9	56	49.0	2.81	1.77	26	1.07
MN0605	sulfide silt	25.1	5.12	1427	< 4	555	1	16	1.54	28.0	7	19	315	5.08	1.94	14	0.47
MN0608	sulfide clay	7.5	7.25	523	< 4	1124	2	< 5	2.97	5.00	7	35	66.0	2.62	1.99	16	0.76
MN0609	native sediments	< 0.5	6.90	21.0	< 4	1138	1	< 5	2.92	0.40	7	35	13.0	1.81	1.92	15	0.76
MN0805	sulfide silt	45.9	5.51	5494	< 4	330	1	46	0.750	12.5	2	33	221	5.94	2.18	16	0.25
MN0903	sulfide silt	36.3	5.36	4634	< 4	656	1	35	0.840	6.40	6	49	172	5.02	2.05	20	0.39
MN1204B	oxide clay	55.4	6.12	5617	< 4	379	1	58	0.930	13.1	2	66	201	6.91	2.48	13	0.27
MN1206	native sediments	37.1	6.92	3847	< 4	297	1	39	1.20	17.1	8	65	428	5.87	2.49	13	0.33
MN1305	oxide clay	61.5	7.13	5961	< 4	272	1	51	1.27	24.3	3	32	288	7.43	2.85	15	0.33
MN1405	oxide silt	28.1	5.27	2554	< 4	465	1	13	1.60	19.5	4	21	163	4.23	2.05	16	0.27
MN1406	oxide clay	57.3	6.81	6106	< 4	226	1	61	1.17	22.5	2	47	227	7.82	2.87	16	0.32
MN1407	native sediments	2.8	6.30	267	< 4	1068	1	< 5	2.25	2.10	7	40	11.0	2.23	1.85	21	0.68
MN1502	oxide silt	25.7	3.98	2158	< 4	169	1	24	0.480	14.9	4	16	264	5.08	1.85	12	0.22
MN1607	native sediments	7.4	5.59	131	< 4	1057	1	8	1.98	0.60	5	40	37.0	1.81	1.80	19	0.59
MN1702	oxide silt	46.7	3.85	3808	< 4	294	1	26	0.790	18.1	3	14	404	5.04	1.77	9	0.26
MN1703	oxide silt	33.7	3.72	4394	< 4	228	1	39	0.570	9.30	2	19	210	4.88	1.86	9	0.21
MN1705	native sediments	27.8	5.26	1330	< 4	843	2	16	1.53	3.60	3	36	53.0	2.60	2.05	12	0.42
MN1706	native sediments	28.6	5.43	911	< 4	1072	1	8	1.63	1.80	4	36	40.0	2.33	2.07	14	0.42
MN1904	sulfide silt	28.3	4.94	1854	< 4	731	1	16	1.61	28.2	5	21	402	4.59	1.91	16	0.40
MN1909	native sediments	1.5	6.83	57.0	< 4	989	1	< 5	3.26	1.00	7	47	20.0	2.23	1.80	22	0.85
BATCHO3	oxide clay composite	61.5	6.64	5698	< 4	277	1	56	1.15	22.2	3	37	268	6.72	2.67	14	0.29
BATCHS3	sulfide clay composite	48.1	6.32	3836	< 4	223	1	46	1.50	27.5	4	23	386	6.23	2.50	14	0.34
DuMN0304	sulfide silt	32.3	5.22	2501	< 4	508	1	18	1.26	21.9	4	18	538	5.02	2.04	13	0.33
DuMN0605	sulfide silt	23.2	5.16	1378	< 4	581	1	13	1.56	26.8	7	20	302	5.15	1.97	14	0.48
DuMN1407	native sediments	2.5	6.54	277	< 4	1113	2	< 5	2.28	2.30	7	40	12.0	2.24	1.88	21	0.70
DuBATCHS3	sulfide clay composite	46.9	6.01	3778	< 4	174	1	45	1.46	26.8	4	25	374	6.10	2.46	13	0.34

Table C-1b (cont.)

Field #	Sample Type	Mn µg/g	Mo µg/g	Na %	Nb µg/g	Ni µg/g	P µg/g	Pb µg/g	Sb µg/g	Sc µg/g	Sn µg/g	Sr µg/g	Th µg/g	Ti µg/g	U µg/g	V µg/g
ENDADIT	pit grab	5484	3	0.03	2	7	310	427	68.0	4	5	55.0	< 2	600	10	34
NWALLCU	pit grab	312	2	0.04	2	< 2	810	5700	990	7	6	113	4	900	< 10	59
MNOMIX	oxide silt composite	1332	2	0.10	4	4	440	1470	386	5	3	96.0	3	1200	< 10	44
MNSMIX	sulfide silt composite	2379	2	0.16	5	4	600	1800	433	6	4	125	3	1400	15	53
SOMIX	s-o silt composite	2071	< 2	0.15	4	6	580	1758	375	5	4	114	4	1500	18	52
SLURRY	s-o silt composite	2059	2	0.15	5	5	530	1644	375	5	4	117	3	1600	< 10	51
MN0102	oxide silt	2601	< 2	0.14	5	6	660	1576	370	6	4	147	3	1400	20	58
MN0104	sulfide silt	2360	2	0.13	6	4	510	1830	542	5	4	117	5	1300	< 10	46
MN0203	sulfide silt	2491	< 2	0.20	5	3	570	1544	320	5	< 2	129	3	1400	< 10	48
MN0304	sulfide silt	2120	2	0.21	5	7	610	2059	412	5	4	126	4	1500	< 10	51
MN0401	sulfide silt	3597	< 2	0.07	5	8	580	1553	617	5	4	122	4	1200	19	41
MN0402	oxide silt	2777	< 2	0.06	5	5	480	1576	629	4	5	134	3	1100	< 10	37
MN0404	sulfide silt	2153	< 2	0.56	6	9	620	962	191	7	3	187	3	2000	12	60
MN0501	oxide silt	3482	2	0.09	5	5	520	1402	518	5	4	128	4	1200	11	41
MN0502	oxide silt	3321	< 2	0.07	5	5	470	1749	685	4	4	123	4	1200	22	39
MN0503	sulfide silt	2909	< 2	0.10	5	5	470	2006	804	4	4	136	3	1000	10	39
MN0505	sulfide silt	1216	2	1.71	6	12	590	419	77	7	3	361	3	2100	< 10	64
MN0506T	native sediments	599	< 2	2.41	7	14	580	21.0	5	10	3	487	6	3400	< 10	85
MN0506B	native sediments	672	< 2	2.43	8	16	650	22.0	< 5	11	< 2	503	5	3600	< 10	95
MN0605	sulfide silt	2993	< 2	0.18	6	7	590	1343	299	5	3	113	4	1500	15	50
MN0608	sulfide clay	758	2	2.17	6	11	550	472	81	8	2	458	3	2400	< 10	66
MN0609	native sediments	467	< 2	2.42	6	12	440	21.0	5	7	2	485	8	2300	< 10	59
MN0805	sulfide silt	1268	3	0.15	5	5	640	4352	773	6	5	123	5	1400	14	59
MN0903	sulfide silt	1018	2	0.45	5	17	590	4180	733	7	3	162	5	1500	< 10	72
MN1204B	oxide clay	1541	4	0.15	4	7	730	4971	882	7	7	139	4	1400	< 10	69
MN1206	native sediments	1971	3	0.30	2	13	800	4351	704	8	6	154	3	1200	< 10	77
MN1305	oxide clay	2124	< 2	0.14	2	8	830	5238	1084	8	5	145	4	1500	10	80
MN1405	oxide silt	2260	2	0.19	6	6	650	1248	262	6	4	128	3	1700	< 10	52
MN1406	oxide clay	1753	3	0.19	2	10	820	6431	1112	7	5	142	4	1500	< 10	80
MN1407	native sediments	523	< 2	2.24	6	11	510	118	19.0	7	< 2	446	5	2500	16	69
MN1502	oxide silt	1470	< 2	0.05	3	5	470	1446	235	4	2	68	4	1500	< 10	46
MN1607	native sediments	534	2	1.91	5	12	540	47.0	8	7	4	361	4	2400	< 10	62
MN1702	oxide silt	1205	< 2	0.10	2	3	440	2052	564	5	4	89.0	3	1500	< 10	45
MN1703	oxide silt	750	2	0.10	3	4	500	2738	450	5	2	103	< 2	1500	< 10	48
MN1705	native sediments	581	2	1.70	5	10	440	1245	248	5	6	343	4	1700	< 10	50
MN1706	native sediments	521	< 2	1.90	4	11	410	893	147	5	9	378	4	1700	< 10	54
MN1904	sulfide silt	2633	< 2	0.18	4	7	560	1420	375	5	4	122	4	1500	< 10	47
MN1909	native sediments	585	< 2	2.19	5	14	500	67.0	13	9	2	462	6	2800	11	73
BATCHO3	oxide clay composite	1875	2	0.11	2	8	740	4804	1020	8	6	133	4	1500	10	74
BATCHS3	sulfide clay composite	2483	2	0.12	2	7	740	2888	507	7	5	128	3	1500	< 10	69
MN0304	sulfide silt	2086	2	0.20	5	6	580	2080	390	5	4	124	3	1300	12	49
MN0605	sulfide silt	3045	2	0.18	5	6	560	1283	270	5	3	114	2	1500	< 10	50
MN1407	native sediments	525	2	2.27	10	9	500	128	19.0	7	< 2	462	4	2600	< 10	67
BATCHS3	sulfide clay composite	2423	< 2	0.12	2	8	730	2818	506	7	4	125	4	1600	< 10	72

Table C-1b (cont.)

Field #	Sample Type	W µg/g	Y µg/g	Zn µg/g	Zr µg/g	TOT/S %	CO_2 %
ENDADIT	pit grab	< 4	6	989	10	5.63	3.89
NWALLCU	pit grab	4	5	306	43	6.33	0.04
MNOMIX	oxide silt composite	< 4	5	1023	34	2.30	0.58
MNSMIX	sulfide silt composite	< 4	7	1937	32	2.36	1.31
SOMIX	s-o silt composite	< 4	6	1525	31	2.23	1.04
SLURRY	s-o silt composite	< 4	6	1525	35	2.28	1.12
MN0102	oxide silt	< 4	7	1977	31	2.06	1.42
MN0104	sulfide silt	< 4	6	1834	32	2.70	1.12
MN0203	sulfide silt	< 4	7	1920	30	2.53	1.23
MN0304	sulfide silt	< 4	6	1755	29	2.24	1.15
MN0401	sulfide silt	< 4	8	2766	38	4.06	2.58
MN0402	oxide silt	< 4	7	2376	32	3.43	2.08
MN0404	sulfide silt	< 4	9	1437	26	1.48	1.00
MN0501	oxide silt	< 4	8	2535	44	3.80	2.62
MN0502	oxide silt	< 4	7	2559	33	4.10	2.08
MN0503	sulfide silt	< 4	6	2607	31	4.33	1.96
MN0505	sulfide silt	< 4	8	634	22	0.96	0.77
MN0506T	native sediments	< 4	14	43.0	34	< .02	< .03
MN0506B	native sediments	< 4	16	48.0	25	0.03	0.77
MN0605	sulfide silt	< 4	8	2189	33	2.76	1.85
MN0608	sulfide clay	< 4	12	355	20	0.30	0.81
MN0609	native sediments	< 4	9	40.0	16	< .02	0.85
MN0805	sulfide silt	< 4	5	915	32	1.19	0.46
MN0903	sulfide silt	< 4	7	504	31	0.84	0.23
MN1204B	oxide clay	< 4	5	1002	29	1.36	0.38
MN1206	native sediments	< 4	8	1251	20	1.16	0.77
MN1305	oxide clay	4	6	1633	29	1.54	0.62
MN1405	oxide silt	< 4	7	1473	28	1.28	0.65
MN1406	oxide clay	< 4	6	1393	27	1.62	0.58
MN1407	native sediments	< 4	11	160	21	0.06	0.04
MN1502	oxide silt	< 4	5	1151	32	2.43	0.59
MN1607	native sediments	< 4	10	70.0	21	0.04	0.04
MN1702	oxide silt	< 4	4	1289	24	3.00	0.51
MN1703	oxide silt	< 4	4	745	25	1.63	0.29
MN1705	native sediments	< 4	6	217	21	0.35	0.11
MN1706	native sediments	< 4	7	163	17	0.24	0.11
MN1904	sulfide silt	< 4	7	2090	32	2.72	1.47
MN1909	native sediments	< 4	12	85.0	20	0.06	0.99
BATCHO3	oxide clay composite	< 4	6	1467	29	1.48	0.51
BATCHS3	sulfide clay composite	< 4	7	1983	32	2.19	0.95
MN0304	sulfide silt	< 4	7	1648	33	2.13	1.12
MN0605	sulfide silt	< 4	8	2110	32	2.69	1.89
MN1407	native sediments	< 4	11	159	20	0.06	0.04
BATCHS3	sulfide clay composite	< 4	6	1940	32	2.15	0.95

Table C-2: Acid base accounting characteristics of selected samples

ABA Results
by BC Research

Field #	Sample Type	Paste pH	CO_2 Inorg. (Wt.%)	$CaCO_3$ Equiv. (Kg $CaCO_3$/ Tonne)	Total Sulfur (Wt.%)	Sulfate Sulfur (Wt.%)	sulfide Sulfur* (Wt.%)	Maximum Potential Acidity** (Kg $CaCO_3$/ Tonne)	Neutralization Potential (Kg $CaCO_3$/ Tonne)
ENDADIT	pit grab	7.0	3.89	88.3	5.63	0.47	5.16	161.3	69.2
NWALLCU	pit grab	3.5	0.04	0.91	6.33	1.76	4.57	142.8	-4.4
MNOMIX	oxide silt composite	7.7	0.58	13.2	2.30	0.29	2.01	62.8	11.1
MNSMIX	sulfide silt composite	8.0	1.31	29.7	2.36	0.50	1.86	58.1	24.9
SOMIX	s-o silt composite	8.1	1.04	23.6	2.23	0.36	1.87	58.4	20.4
SLURRY	s-o silt composite	7.9	1.12	25.4	2.28	0.37	1.91	59.7	19.5
MN0102	oxide silt	7.7	1.42	32.2	2.06	0.63	1.43	44.7	26.8
MN0104	sulfide silt	7.7	1.12	25.4	2.70	0.45	2.25	70.3	19.2
MN0203	sulfide silt	7.4	1.23	27.9	2.53	0.52	2.01	62.8	22.4
MN0304	sulfide silt	8.3	1.15	26.1	2.24	0.39	1.85	57.8	20.9
MN0401	sulfide silt	8.0	2.58	58.6	4.06	0.79	3.27	102.2	39.5
MN0402	oxide silt	8.1	2.08	47.2	3.43	0.81	2.62	81.9	36.6
MN0404	sulfide silt	8.0	1.00	22.7	1.48	0.30	1.18	36.9	22.7
MN0501	oxide silt	7.5	2.62	59.5	3.80	0.84	2.96	92.5	42.9
MN0502	oxide silt	6.8	2.08	47.2	4.10	0.75	3.35	104.7	37.2
MN0503	sulfide silt	6.8	1.96	44.5	4.33	0.69	3.64	113.8	31.7
MN0505	sulfide silt	8.0	0.77	17.5	0.96	0.09	0.87	27.2	16.0
MN0506T	native sediments	7.1	<0.03	<0.7	<0.02	<0.01	<0.02	<0.6	3.0
MN0506B	native sediments	7.6	0.77	17.5	0.03	0.02	0.01	0.3	23.6
MN0605	sulfide silt	8.2	1.85	42.0	2.76	0.37	2.39	74.7	34.7
MN0608	sulfide clay	8.0	0.81	18.4	0.30	0.09	0.21	6.6	20.8
MN0609	native sediments	8.2	0.85	19.3	<0.02	<0.01	<0.02	<0.6	21.3
MN0805	sulfice silt	8.5	0.46	10.4	1.19	0.44	0.75	23.4	12.4
MN0903	sulfide silt	8.2	0.23	5.2	0.84	0.25	0.59	18.4	8.2
MN1204B	oxide clay	9.0	0.38	8.6	1.36	0.13	1.23	38.4	14.1
MN1206	native sediments	7.0	0.77	17.5	1.16	0.15	1.01	31.6	14.9
MN1305	oxide clay	9.1	0.62	14.1	1.54	0.32	1.22	38.1	17.3
MN1405	oxide silt	8.4	0.65	14.8	1.28	0.85	0.43	13.4	17.3
MN1406	oxide clay	8.6	0.58	13.2	1.62	0.31	1.31	40.9	17.6
MN1407	native sediments	7.7	0.04	0.9	0.06	0.06	< 0.02	<0.6	3.0
MN1502	oxide silt	7.4	0.59	13.4	2.43	0.11	2.32	72.5	12.4
MN1607	native sediments	6.1	0.04	0.9	0.04	0.04	0.00	0.0	1.7
MN1702	oxide silt	7.0	0.51	11.6	3.00	0.36	2.64	82.5	12.1
MN1703	oxide silt	7.2	0.29	6.6	1.63	0.32	1.31	40.9	7.4
MN1705	native sediments	8.7	0.11	2.5	0.35	0.12	0.23	7.2	4.2
MN1706	native sediments	8.6	0.11	2.5	0.24	0.17	0.07	2.2	4.5
MN1904	sulfide silt	7.8	1.47	33.4	2.72	0.43	2.29	71.6	29.5
MN1909	native sediments	8.2	0.99	22.5	0.06	0.02	0.04	1.3	24.8
BATCHO3	oxide clay composite	8.6	0.51	11.6	1.48	0.65	0.83	25.9	14.1
BATCHS3	sulfide clay composite	8.3	0.95	21.6	2.19	0.89	1.30	40.6	18.8

*Based on difference between total sulfur and sulfate-sulfur

**Based on sulfide-sulfur

Table C-2 (cont.)

Field #	Sample Type	Net Neutralization Potential (Kg $CaCO_3$/ Tonne)	Fizz Rating	Acid Used (mL/N)
ENDADIT	pit grab	-92.1	none	40/0.1
NWALLCU	pit grab	-147.2	none	20/0.1
MNOMIX	oxide silt composite	-51.7	none	20/0.1
MNSMIX	sulfide silt composite	-33.2	none	20/0.1
SOMIX	s-o silt composite	-38.0	none	20/0.1
SLURRY	s-o silt composite	-40.2	none	20/0.1
MN0102	oxide silt	-17.9	none	20/0.1
MN0104	sulfide silt	-51.1	none	20/0.1
MN0203	sulfide silt	-40.4	none	20/0.1
MN0304	sulfide silt	-36.9	none	20/0.1
MN0401	sulfide silt	-62.7	none	30/0.1
MN0402	oxide silt	-45.3	none	30/0.1
MN0404	sulfide silt	-14.2	none	20/0.1
MN0501	oxide silt	-49.6	slight	40/0.1
MN0502	oxide silt	-67.5	slight	40/0.1
MN0503	sulfide silt	-82.1	none	25/0.1
MN0505	sulfide silt	-11.2	none	20/0.1
MN0506T	native sediments	3.0	none	20/0.1
MN0506B	native sediments	23.3	slight	40/0.1
MN0605	sulfide silt	-40.0	slight	40/0.1
MN0608	sulfide clay	14.2	slight	40/0.1
MN0609	native sediments	21.3	slight	40/0.1
MN0805	sulfide silt	-11.0	none	20/0.1
MN0903	sulfide silt	-10.2	none	20/0.1
MN1204B	oxide clay	-24.3	none	20/0.1
MN1206	native sediments	-16.7	none	20/0.1
MN1305	oxide clay	-20.8	none	20/0.1
MN1405	oxide silt	3.9	none	20/0.1
MN1406	oxide clay	-23.3	none	20/0.1
MN1407	native sediments	3.0	none	20/0.1
MN1502	oxide silt	-60.1	none	20/0.1
MN1607	native sediments	1.7	none	20/0.1
MN1702	oxide silt	-70.4	none	20/0.1
MN1703	oxide silt	-33.5	none	20/0.1
MN1705	native sediments	-3.0	none	20/0.1
MN1706	native sediments	2.3	none	20/0.1
MN1904	sulfide silt	-42.1	none	20/0.1
MN1909	native sediments	23.6	slight	40/0.1
BATCHO3	oxide clay composite	-11.8	none	20/0.1
BATCHS3	sulfide clay composite	-21.8	none	20/0.1

*Based on difference between total sulfur and sulfate-sulfur

**Based on sulfide-sulfur

Table C-2 (cont.)

Table C-2a: QA/QC for NP Determination (Mod. ABA)

Sample	Neutralisation Potential (kgCaCO3/Tonne)	Neutralisation Potential (kgCaCO3/Tonne)
Duplicates - NP		
10	20.9	21.8
20	34.7	35.6
30	3.0	3.2
40	18.8	19.3
NBM-1 Reference (NP = 42)	42.9	-

Table C-2b: QA/QC for Sulphur Speciation

Sample	Sulphur (Wt.%)	Sulphur (Wt.%)
Duplicates - total sulphur		
10	2.24	2.13
20	2.76	2.69
30	0.06	0.06
40	2.19	2.15
Std. CSB (5.2% TS)	5.33	5.30
BCRI Std. (0.11% TS)	0.10	0.10
BCRI Std. (0.53% SO4-S)	0.56	-
BCRI Std. (0.05% SO4-S)	0.05	-

Table C-2c: QA/QC for CO2 Determination

Sample	CO2 (Wt.%)	CO2 (Wt.%)
Duplicates		
10	1.15	1.12
20	1.85	1.89
30	0.04	0.04
40	0.95	0.95

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 1 - 03	45 - 90	Leach Water	S-silt	8.79	17.77	43.7			< 0.02			6		10	
MN BH 1 - 04	60 - 120	Porewater	S-silt	7.91		32.6			0.37		188	299	2239	45	
MN BH 1 - 05	120-150	Leach Water	O-silt	8.65		9.10			0.03			2		1	
MN BH 1 - 06	150 - 217	Porewater	O-silt	9.22		7.50	27.6	11.3	11.9	6	63	95	1646	6	7.0
MN BH 1 - 07	217 - 255	Leach Water	O-silt	8.33	2.61				0.12			< 2		7	
MN BH 1 - 08	255 - 270	Leach Water		7.80	> 19.99				< 0.02			9		9	
MN BH 2 - 01	0 - 17.5	Porewater	S-silt	8.10					< 0.02			24		30	0.8
MN BH 2 - 02	18 - 47	Porewater	O-silt	8.31		17.7	0.1	< 0.05	0.19	3	184	229	2785	41	
MN BH 2 - 03	47 - 70	Porewater	S-silt	8.38		58.6	0.2	0.10	0.32	< 2	238	248	2356	43	
MN BH 2 - 04	70 - 120	Porewater	O-silt	8.44		61.9			0.05			230		49	
MN BH 2 - 05	120 - 200	Porewater	O-silt	8.70		35.4	2.6	0.60	2.64	26	166	204	1987	29	
MN BH 2 - 06	200 - 275	Porewater	O-silt	8.95			23.6	4.2	8.47	45	94	87	1913	12	1.8
MN BH 2 - 07	275 - 290	Leach Water	O-clay	8.12	> 19.99				0.03			3		3	
MN BH 2 - 08	290 - 330	Leach Water		6.63					0.02			< 2		4	
MN BH 3 - 01	0 - 40	Porewater	O-silt	7.77					< 0.02			240		59	0.9
MN BH 3 - 02	40 - 100	Leach Water	S-silt	8.75		31.0			0.02			18		7	
MN BH 3 - 03	100 - 110	Porewater	O-silt	8.85					0.02			316		44	
MN BH 3 - 04	110 - 150	Porewater	S-silt	8.77			7.7	0.10	1.17	64	180	192	2242	27	
MN BH 3 - 05	150 - 250	Porewater	O-silt	8.98			65.3	32.8	23.3	75	115	130	1885	12	
MN BH 3 - 06	250 - 275	Leach Water	O-silt	9.15	2.75		7.1	3.8	3.88	8	141	10	141	5	
MN BH 3 - 07	275 - 280	Porewater	O-silt	8.81		28.8	59.3	32.8	32.0	37	54	43	801	8	1.2
MN BH 4 - 01	0 - 25	Porewater	S-silt	8.60					0.07			41		28	7.3
MN BH 4 - 02	25 - 40	Porewater	O-silt	8.64	16.07				0.14			56		27	
MN BH 4 - 03	40 - 120	Porewater	S-silt	8.87	19.92	54.2			1.76		47	62	1968	29	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 4 - 04	120 - 150	Porewater	S-silt	8.66	> 19.99	14.4	1.6	1.5	2.53	20	125	141	2080	41	
MN BH 4 - 06	180 - 280	Porewater	S-clay	8.65		63.0	2.3	1.8	3.47	72	285	285	2388	46	
MN BH 4 - 08	420 - 440	Porewater	S-silt	9.40	10.56		55.6	25.1	25.5	19	33	84	519	5	1.0
MN BH 5 - 01	0 - 25	Leach Water	O-silt	7.80	13.54	24.3			< 0.02			< 2		5	
MN BH 5 - 02	25 - 50	Leach Water	O-silt	6.97	14.32				< 0.02			8		7	
MN BH 5 - 03	50 - 140	Leach Water	S-silt	7.72	12.76	24.3			< 0.02						
MN BH 5 - 04	140 - 205	Leach Water	S-silt	7.93	8.79				<0.02			3		6	
MN BH 5 - 05	205	Leach Water		7.04					0.02			< 2		5	
MN BH 5 - 06	205 - 270	Leach Water	S-silt	7.58	3.54				<0.02			< 2		7	
MN BH 5 - 07	270 - 330	Leach Water		8.04	> 19.99				0.02			11		2	
MN BH 5 - 08	330 - 400	Leach Water		8.04	> 19.99				0.02			5		< 1	
MN BH 6 - 01	0 - 10	Porewater	S-silt	7.96	> 19.99				< 0.02			< 2		74	
MN BH 6 - 03	30 - 166	Porewater	S-silt	8.60	> 19.99	21.0	12.8	13.2	18.7	72	236	253	2492	40	
MN BH 6 - 04	166 - 206	Porewater	O-silt	8.31		21.0	0.1	< 0.05	8.39	124	194	185	2346	< 1	
MN BH 6 - 05	206 - 262	Porewater	S-silt	8.75		27.6	7.8	8.1	25.7	153	239	224	2374	34	
MN BH 6 - 07	342 - 502	Porewater	S-clay	8.68		111	0.2	< 0.05	1.64	9	152	169	2084	14	
MN BH 6 - 08	502 - 626	Porewater	O-silt	8.36		46.4	0.6	< 0.05	8.26	<2	110	106	2229	12	
MN BH 7 - 01	20 - 40	Water		7.90		42.5	0.1	< 0.05	0.13	4	46	57	1365	24	
MN BH 7 - 02	40 - 90	Porewater	S-silt	8.96	15.4				0.03			53		12	
MN BH 7 - 03	90 - 220	Porewater	O-silt	8.87		165	< 0.05	< 0.05	1.55	20	249	255	2267	41	
MN BH 7 - 05	246 - 377	Porewater	O-clay	8.68		93.1	0.8	1.3	17.1	83	139	148	1998	10	
MN BH 7 - 06	377 - 480	Porewater	O-silt	9.32	13.98	98.8	59.9	8.9	12.4	66	64	94	1262	38	
MN BH 7 - 07	480 - 600	Porewater	O-silt	9.67	16.83	51.8	37.1	7.5	7.95	54	38	31	601	29	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 8 - 01	25 - 75	Porewater	S-clay	7.93					0.12			69		22	
MN BH 8 - 02A	75 - 330	Porewater	S-clay	8.48			30.4	4.8	28.4	35	52	77	1256	12	
MN BH 8 - 02	75 - 330A	Porewater	O-clay	8.56					0.15			262			
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt	8.47			0.3	< 0.05	0.38	22	252	257	2672		
MN BH 8 - 05	75 - 330C	Porewater		9.03			43.5	32.9	38.3	103	104	104	2110		
MN BH 8 - 06	75 - 330D										26		1070		
MN BH 9 - 01	20 - 60	Water		7.84			0.3	0.1	0.16	3	46	64	1370	16	1.0
MN BH 9 - 02	60 - 150	Porewater	S-clay	8.47		99.6	0.5	< 0.05	1.72	18	153	174	2151	42	
MN BH 9 - 03	150 - 240	Porewater	S-silt	7.98		11.1	2.2	1.0	0.86	< 2	76	55	1794	7	1.3
MN BH 9 - 04														43	
MN BH 10 - 01	24 - 130	Water		7.63	> 19.99				0.07		47	65	1404	20	
MN BH 10 - 02	140 - 165	Porewater		8.93	16.61				0.04			106		44	
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	8.60			0.3	< 0.05	0.02	11	175	179	2452	51	
MN BH 10 - 04															
MNBH 10 - 06															
MN BH 11 - 01	24 - 140	Water		7.90	13.56				0.09		43	56	1281	24	
MN BH 11 - 02	140 - 362	Porewater	S-clay	8.75		67.7	0.1	< 0.05	1.55	22	196	221	2114	40	
MN BH 11 - 03	362 - 450	Porewater	O-clay	8.64		36.1	0.3	0.1	0.33	5	127	151	1976	12	
MN BH 11 - 05	480 - 570	Porewater	O-clay	7.14	18.61	0.5			0.02		<5	< 2	79	20	
MN BH 12 - 01	25 - 168	Water		7.87					0.09		40	19	1357	26	
MN BH 12 - 02	168 - 407	Porewater	O-clay	9.07		30.0	0.2	< 0.05	0.02	< 2	169	163	2079	27	
MN BH 12 - 04	417 - 920	Porewater	O-clay	9.09		23.6	5.7	< 0.05	3.18	55	157	143	1964	7	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 13 - 01	25 - 110	Water		7.96					0.09		40	39	1393	26	
MN BH 13 - 02	110 -257	Porewater	S-clay	8.40		73.0			0.05			183		46	
MN BH 13 - 03	257 - 356	Porewater	S-clay	8.60		95.1			0.02			175		35	
MN BH 13 - 04	356 - 470	Porewater	O-clay	8.46		34.3			0.08			146		33	
MN BH 13 - 05	470 - 700	Porewater	O-clay	9.05		19.3	2.4	< 0.05	5.86	59	135	135	1881	8	
MN BH 14 - 04	270 - 455	Porewater	O-silt	9.09		7.3	0.9	< 0.05	<0.02	5	128	170	2279	24	
MN BH 14 - 05	455 - 578	Porewater	O-silt	8.85		17.1			< 0.02			179		29	
MN BH 15 - 01	10 - 25 cm	Water	S-clay	7.70					0.16		47	52	1395	24	
MN BH 15 - 02	25 - 210	Porewater	O-silt	7.87		12.8	0.1	< 0.05	0.35	< 2	50	49	1900	17	
MN BH 15 - 03	210 - 460	Porewater	O-silt	8.86		5.41			0.02		143	221	2225	37	
MN BH 15 - 04	460 - 510	Porewater	O-silt	8.34		18.2			0.10		244	245	2399	48	
MN BH 15 - 06	580 - 750	Porewater	O-clay	9.24		24.6	60.6	< 0.05	5.46	53	145	144	1860	5	
MN BH 15 - 07	750 - 910	Porewater	O-clay	8.90		19.3	18.3	0.3	2.33	29	163	171	1691		
MN BH 16 - 01	13 - 150	Water	S-clay	7.79					0.11		42	37	1321	23	
MN BH 16 - 02	150 - 358	Porewater	O-silt	8.58		145	0.3	0.2	0.46	10	212	233	1879	41	
MN BH 16 - 04	386 - 498	Porewater	O-clay	8.70		19.1	1.7	< 0.05	< 0.02	<2	179	171	2295	13	
MN BH 17 - 04	184 - 260	Porewater	O- Silt	8.33					< 0.02		33	18	2183	21	
MN BH 18 -00	20 - 140	Porewater		7.77					0.05			32			
MN BH 18 -01	140 - 250	Porewater	S-clay	8.72		73.3			< 0.02		105	62	1869	31	
MN BH 18 -02	250 - 331	Porewater	S-clay	8.68		7.8			0.45			171		> 55	
MN BH 18 -03	331 - 485	Porewater	O-clay	8.65		27.8			0.07			124			
MN BH 18 -04	485 - 610	Porewater	O-clay	9.10		31.1	2.1	0.5	12.5	81	154	132	1880	31	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 18 -05	610 - 660	Porewater	O-clay	8.83		24.4	16.5	11.7	22.6	81	125	81	1755		
MN BH 18 -06	660 - 800	Porewater	O-silt	9.12		102	4.4	0.3	1.50	26	16	16	514		
MN BH 19 - 01	0 - 25	Porewater	S-silt	7.57					0.34		<5	25	3008		
MN BH 19 - 02	25 - 103	Porewater	S-silt	8.70		31.1			0.33			17			
MN BH 19 - 03	103 - 140	Porewater	O-silt	8.62		27.8	0.1	0.2	0.72	< 2	31	33	2209	32	
MN BH 19 - 04	140 - 207	Porewater	S-silt	8.85		33.3	0.2	< 0.05	0.02	11	45	36	2175		
MN BH 19 - 05	207 - 251	Porewater		8.26		22.2	0.1	0.1	< 0.02	17		109			
MN BH 19 - 06	251 - 356	Porewater	S-silt	8.38		4.9	0.1	0.08	0.09	16		76		> 55	
MN BH 19 - 07	356 - 389	Porewater		8.35		17.8			< 0.02			15		47	
MN BH 19 - 08	389 - 428	Porewater	S-silt	8.25		37.6			< 0.02		43	42	2215		
MN Seepage Water		Water		7.27			0.3	0.2	0.33	< 2	57	60	1222	17	
MN Pit (Bottom)													2579		
MN Pit (Top)													223		
BLANK 17													<10		
BLANK 18													<10		
BLANK 19													<10		

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_3-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 1 - 03	45 - 90	Leach Water	S-silt	0.1																
MN BH 1 - 04	60 - 120	Porewater	S-silt	3.1	0.056	1.59	0.226	0.052	3.7	540.8	< 0.1	35.9	2.5	1.79	0.049	48.35	2.5	48.17	1.98	1.4
MN BH 1 - 05	120-150	Leach Water	O-silt	0.4																
MN BH 1 - 06	150 - 217	Porewater	O-silt	4.4	0.145	1.22	2.82	0.139	4.7	495.5	< 0.1	22.6	0.2	7.34	4.28	26.24	1.1	1.61	0.036	< 0.1
MN BH 1 - 07	217 - 255	Leach Water	O-silt	0.2																
MN BH 1 - 08	255 - 270	Leach Water		<0.1																
MN BH 2 - 01	0 - 17.5	Porewater	S-silt	4.4																
MN BH 2 - 02	18 - 47	Porewater	O-silt	0.2	0.007	0.609	0.055	0.048	3.7	504.0	5.8	17.9	2.1	0.225	0.104	62.52	1.7	77.89	0.892	< 0.1
MN BH 2 - 03	47 - 70	Porewater	S-silt	0.1	0.031	1.32	0.268	0.050	2.9	531.5	< 0.1	19.8	0.5	0.407	0.143	52.02	1.9	62.07	3.58	< 0.1
MN BH 2 - 04	70 - 120	Porewater	O-silt	< 0.1																
MN BH 2 - 05	120 - 200	Porewater	O-silt	< 0.1						498.0				9.23	1.19	32.70	0.9	31.27	0.373	1.1
MN BH 2 - 06	200 - 275	Porewater	O-silt	< 0.1	0.005	0.426	1.39	0.084	2.1	564.0	< 0.1	35.0	<0.1	0.008	6.69	27.19	0.5	6.19	0.022	2.4
MN BH 2 - 07	275 - 290	Leach Water	O-clay	0.1																
MN BH 2 - 08	290 - 330	Leach Water		< 0.1																
MN BH 3 - 01	0 - 40	Porewater	O-silt	0.4																
MN BH 3 - 02	40 - 100	Leach Water	S-silt	0.2																
MN BH 3 - 03	100 - 110	Porewater	O-silt	0.5																
MN BH 3 - 04	110 - 150	Porewater	S-silt	0.1	0.016	0.713	1.13	0.095	3.7	571.8	< 0.1	38.3	0.5	0.774	1.73	47.41	2.1	20.34	0.092	3.1
MN BH 3 - 05	150 - 250	Porewater	O-silt	0.2	0.062	0.287	1.84	0.050	2.7	564.3	0.3	32.5	<0.1	19.3	12.1	34.04	1.2	3.85	0.011	25.1
MN BH 3 - 06	250 - 275	Leach Water	O-silt	0.2	0.036	0.982	0.667	0.041	4.3	39.25	< 0.1	4.3	0.6	2.68	4.01	6.87	0.5	0.42	0.015	5.9
MN BH 3 - 07	275 - 280	Porewater	O-silt	0.2	0.272	0.888	1.27	0.034	1.6	214.9	< 0.1	24.5	<0.1	16.4	11.5	31.96	0.3	1.55	0.017	7.8
MN BH 4 - 01	0 - 25	Porewater	S-silt	0.2																
MN BH 4 - 02	25 - 40	Porewater	O-silt	0.1																
MN BH 4 - 03	40 - 120	Porewater	S-silt	0.3	0.035	1.27	0.255	0.030	3.2	521.9	1.3	4.5	0.6	2.44	0.167	57.19	0.7	14.49	0.061	8.4

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_3-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 4 - 04	120 - 150	Porewater	S-silt	< 0.1	0.005	0.427	0.082	0.043	3.8	503.1	1.7	7.5	<0.1	3.11	0.087	52.46	0.2	33.19	0.115	< 0.1
MN BH 4 - 06	180 - 280	Porewater	S-clay	< 0.1	0.010	0.913	0.067	0.035	2.1	475.8	1.9	3.8	1.3	2.44	0.082	66.46	1.7	50.47	0.355	10.5
MN BH 4 - 08	420 - 440	Porewater	S-silt	0.2	0.062	0.922	0.439	0.047	1.6	128.5	9.1	9.7	2.6	7.84	10.1	13.93	0.2	1.77	0.027	9.7
MN BH 5 - 01	0 - 25	Leach Water	O-silt	0.1																
MN BH 5 - 02	25 - 50	Leach Water	O-silt	0.1																
MN BH 5 - 03	50 - 140	Leach Water	S-silt																	
MN BH 5 - 04	140 - 205	Leach Water	S-silt	0.2																
MN BH 5 - 05	205	Leach Water		< 0.1																
MN BH 5 - 06	205 - 270	Leach Water	S-silt	0.1																
MN BH 5 - 07	270 - 330	Leach Water		0.1																
MN BH 5 - 08	330 - 400	Leach Water																		
MN BH 6 - 01	0 - 10	Porewater	S-silt																	
MN BH 6 - 03	30 - 166	Porewater	S-silt	< 0.1	0.019	0.816	0.086	0.090	2.1	475.6	2.2	10.3	<0.1	18.1	0.129	60.89	0.5	23.95	0.053	12.3
MN BH 6 - 04	166 - 206	Porewater	O-silt	0.1	< 0.001	0.703	0.219	0.225	6.2	505.9	2.7	20.6	1.2	10.8	0.216	53.58	1.8	24.35	0.238	11.2
MN BH 6 - 05	206 - 262	Porewater	S-silt	< 0.1	0.002	0.600	0.093	0.045	1.1	497.1	0.3	16.5	<0.1	27.8	0.091	62.13	0.5	18.67	0.087	21.4
MN BH 6 - 07	342 - 502	Porewater	S-clay	0.1	0.019	1.08	0.497	0.085	3.4	596.1	< 0.1	14.7	0.7	0.733	0.089	36.77	0.7	37.38	0.845	< 0.1
MN BH 6 - 08	502 - 626	Porewater	O-silt	< 0.1	0.030	1.33	0.174	0.053	27.0	539.4	3.6	19.4	<0.1	8.13	0.114	20.37	1.2	60.56	0.643	13.6
MN BH 7 - 01	20 - 40	Water		0.4	0.008	1.62	0.010	0.070	13.9	333.1	0.4	18.5	1.7	0.238	0.183	14.21	0.8	30.91	1.80	4.7
MN BH 7 - 02	40 - 90	Porewater	S-silt	2.2																
MN BH 7 - 03	90 - 220	Porewater	O-silt	< 0.1	0.004	1.55	0.214	0.044	3.7	526.8	4.0	14.8	37.5	1.54	0.205	51.43	1.1	43.47	0.274	7.1
MN BH 7 - 05	246 - 377	Porewater	O-clay	< 0.1	0.003	0.232	0.992	0.056	2.8	489.2	0.3	27.5	<0.1	18.4	1.00	25.75	0.8	18.20	0.414	4.2
MN BH 7 - 06	377 - 480	Porewater	O-silt	0.1	0.020	0.643	1.53	0.040	7.2	379.1	< 0.1	15.6	<0.1	14.0	20.0	29.01	0.9	2.74	0.015	12.7
MN BH 7 - 07	480 - 600	Porewater	O-silt	0.1	0.024	1.33	0.940	0.047	4.4	161.4	< 0.1	16.4	1.5	8.21	11.2	21.46	1.4	1.09	0.020	15.5

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_3-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 8 - 01	25 - 75	Porewater	S-clay	0.1																
MN BH 8 - 02A	75 - 330	Porewater	S-clay	< 0.1	0.063	1.54	0.952	0.111	5.4	332.1	9.7	23.6	1.7	18.0	3.80	27.60	0.8	6.9	0.088	5.1
MN BH 8 - 02	75 - 330A	Porewater	O-clay																	
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt		0.004	0.301	0.172	0.063	7.6	550.2	< 0.1	17.9	6.0	1.16	0.589	65.83	1.2	57.27	0.882	10.3
MN BH 8 - 05	75 - 330C	Porewater			0.014	0.350	1.98	0.151	3.4	591.6	< 0.1	6.8	1.7	21.6	1.23	31.32	0.4	8.17	0.044	2.0
MN BH 8 - 06	75 - 330D				0.292	1.08	0.879	0.075	8.4	310.5	< 0.1	15.5	4.0	10.6	0.713	30.52	1.3	5.24	0.052	10.4
MN BH 9 - 01	20 - 60	Water		0.2	0.002	0.617	< 0.005	0.035	7.8	332.2	0.1	10.1	<0.1	0.225	0.117	14.89	0.4	30.71	1.17	9.8
MN BH 9 - 02	60 - 150	Porewater	S-clay	< 0.1	< 0.001	0.788	< 0.005	0.044	4.1	521.0	< 0.1	14.1	1.5	1.62	0.121	42.16	1.5	45.54	0.740	10.7
MN BH 9 - 03	150 - 240	Porewater	S-silt	2.5	< 0.001	0.411	0.928	0.157	49.8	616.9	< 0.1	31.1	0.4	0.020	0.382	37.18	1.6	30.20	1.30	12.5
MN BH 9 - 04																				
MN BH 10 - 01	24 - 130	Water		0.1	< 0.001	0.307	0.043	0.079	11.0	329.6	< 0.1	12.9	<0.1	0.266	0.123	13.62	0.2	30.49	1.19	1.2
MN BH 10 - 02	140 - 165	Porewater		0.3																
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	< 0.1	0.003	0.479	0.300	0.098	6.5	524.1	< 0.1	14.2	1.5	0.182	0.071	44.94	2.5	54.82	0.800	15.7
MN BH 10 - 04										540.8					0.049	48.35		48.17		
MNBH 10 - 06										495.5					4.28	26.24		1.61		
MN BH 11 - 01	24 - 140	Water		0.2	0.006	0.526	0.011	0.070	13.2	308.4	< 0.1	16.2	0.7	0.272	0.092	12.89	0.8	28.36	1.66	< 0.1
MN BH 11 - 02	140 - 362	Porewater	S-clay	0.1	0.025	0.501	0.542	0.073	2.1	527.2	3.0	13.9	<0.1	2.39	0.020	40.25	1.2	37.26	0.442	5.8
MN BH 11 - 03	362 - 450	Porewater	O-clay	0.1	< 0.001	0.310	0.654	0.071	3.9	542.0	2.5	15.1	0.8	0.881	0.081	32.53	1.7	36.46	0.656	3.8
MN BH 11 - 05	480 - 570	Porewater	O-clay	< 0.1	0.006	0.478	0.028	0.044	14.9	14.62	< 0.1	0.76	1.3	0.011	4.23	2.150	0.7	3.56	0.053	1.5
MN BH 12 - 01	25 - 168	Water		0.3	< 0.001	0.403	< 0.005	0.068	9.8	314.7	< 0.1	12.8	1.6	0.211	0.112	13.14	1.2	29.15	1.41	< 0.1
MN BH 12 - 02	168 - 407	Porewater	O-clay	2.5	0.002	0.322	0.989	0.077	2.2	550.9	< 0.1	24.9	<0.1	0.012	0.121	42.95	1.3	32.51	0.356	3.8
MN BH 12 - 04	417 - 920	Porewater	O-clay		0.018	0.222	1.44	0.058	2.1	641.6	< 0.1	17.7	1.5	6.63	1.91	27.08	0.8	10.67	0.081	8.2

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 13 - 01	25 - 110	Water		0.1	0.010	0.389	0.074	0.061	12.9	326.8	< 0.1	15.7	2.4	0.204	0.096	13.52	1.0	30.09	1.63	< 0.1
MN BH 13 - 02	110 -257	Porewater	S-clay	< 0.1																
MN BH 13 - 03	257 - 356	Porewater	S-clay	0.1																
MN BH 13 - 04	356 - 470	Porewater	O-clay	0.1																
MN BH 13 - 05	470 - 700	Porewater	O-clay	< 0.1	0.023	0.390	1.86	0.092	2.5	642.3	< 0.1	18.9	0.5	10.4	1.61	28.16	1.8	11.85	0.108	10.5
MN BH 14 - 04	270 - 455	Porewater	O-silt	0.2	0.011	0.319	1.06	0.054	3.9	501.3	< 0.1	43.5	2.2	0.010	0.281	59.02	0.7	16.03	0.016	8.2
MN BH 14 - 05	455 - 578	Porewater	O-silt	0.2																
MN BH 15 - 01	10 - 25 cm	Water	S-clay	0.1	< 0.001	0.344	0.044	0.069	13.0	330.7	< 0.1	15.5	<0.1	0.347	0.112	13.37	0.6	29.50	1.82	< 0.1
MN BH 15 - 02	25 - 210	Porewater	O-silt	0.2	0.001	0.317	0.090	0.093	5.5	509.2	0.8	14.4	1.9	0.061	0.078	20.36	1.7	32.23	1.76	< 0.1
MN BH 15 - 03	210 - 460	Porewater	O-silt	< 0.1	0.005	0.189	0.925	0.017	1.5	539.8	< 0.1	18.3	<0.1	0.064	0.051	39.34	0.4	19.49	0.12	18.5
MN BH 15 - 04	460 - 510	Porewater	O-silt	< 0.1	0.001	0.425	0.421	0.049	4.2	565.4	1.6	27.2	<0.1	0.039	0.099	52.78	2.3	39.34	0.937	4.1
MN BH 15 - 06	580 - 750	Porewater	O-clay	< 0.1	0.004	0.154	1.42	0.057	2.4	606.8	1.0	15.8	0.7	8.63	2.44	25.17	0.3	7.24	0.064	2.8
MN BH 15 - 07	750 - 910	Porewater	O-clay		0.044	0.303	2.35	0.128	3.4	679.9	< 0.1	30.4	<0.1	3.09	7.30	22.21	0.2	6.66	0.033	5.7
MN BH 16 - 01	13 - 150	Water	S-clay	1.5	0.015	0.285	0.110	0.071	10.0	312.8	< 0.1	12.8	0.3	0.231	0.185	12.84	0.2	28.43	1.40	< 0.1
MN BH 16 - 02	150 - 358	Porewater	O-silt		0.029	0.299	0.267	0.030	1.3	515.5	< 0.1	9.8	< 0.1	2.64	0.042	42.43	0.7	33.7	0.325	5.1
MN BH 16 - 04	386 - 498	Porewater	O-clay		0.160	10.0	11.2	0.141	12.9	359.3	1.8	153	4.9	0.070	0.854	31.17	5.3	5.38	0.220	52.2
MN BH 17 - 04	184 - 260	Porewater	O- Silt		0.039	10.4	0.990	0.168	12.0	634.9	< 0.1	53.6	7.1	0.148	0.147	23.71	10.5	31.96	3.11	41.9
MN BH 18 -00	20 - 140	Porewater																		
MN BH 18 -01	140 - 250	Porewater	S-clay		0.012	10.2	1.43	0.103	8.1	566.2	1.7	25.3	5.4	0.036	0.410	52.56	4.3	22.85	0.490	43.4
MN BH 18 -02	250 - 331	Porewater	S-clay																	
MN BH 18 -03	331 - 485	Porewater	O-clay																	
MN BH 18 -04	485 - 610	Porewater	O-clay		0.024	8.54	5.62	0.237	7.5	449.5	3.2	72.9	6.3	14.3	1.75	28.76	4.3	15.04	0.409	47.0

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 18 -05	610 - 660	Porewater	O-clay		0.084	8.69	5.36	0.323	5.9	579.8	2.1	87.0	4.1	23.1	4.02	24.83	13.9	9.69	0.178	37.2
MN BH 18 -06	660 - 800	Porewater	O-silt		0.020	0.84	0.382	0.061	3.5	174.5	1.1	6.5	0.9	3.52	2.23	10.16	0.5	2.88	0.066	1.9
MN BH 19 - 01	0 - 25	Porewater	S-silt		0.001	8.09	0.052	0.084	9.9	374.2	58.0	21.6	7.2	0.065	0.202	47.40	18.8	116.9	29.1	5.6
MN BH 19 - 02	25 - 103	Porewater	S-silt																	
MN BH 19 - 03	103 - 140	Porewater	O-silt		0.006	0.618	0.067	0.046	5.2	367.5	< 0.1	7.7	1.3	0.987	0.122	31.08	0.4	9.37	0.084	< 0.1
MN BH 19 - 04	140 - 207	Porewater	S-silt		0.002	7.75	0.434	0.089	12.1	576.9	14.7	38.8	8.7	0.608	0.072	54.69	6.7	27.82	3.51	29.7
MN BH 19 - 05	207 - 251	Porewater																		
MN BH 19 - 06	251 - 356	Porewater	S-silt																	
MN BH 19 - 07	356 - 389	Porewater																		
MN BH 19 - 08	389 - 428	Porewater	S-silt		0.058	6.77	0.397	0.120	23.1	596.4	28.8	50.5	5.6	3.02	0.071	39.64	8.3	36.48	9.68	17.2
MN Seepage Water		Water		0.7	0.002	6.29	0.037	0.084	45.2	289.3	1.6	49.1	6.2		11.2	11.48	1.3	25.55	7.94	6.2
MN Pit (Bottom)					0.001	0.941	< 0.005	0.019	0.53	443.3	6.2	1.3	6.4	0.043	0.02	6.13	4.0	274.0	1.54	1.8
MN Pit (Top)					0.001	0.573	0.019	0.034	4.5	118.7	1.8	0.34	4.8	0.038	0.16	1.97	1.2	26.84	0.070	< 0.1
BLANK 17					0.011	0.904	< 0.005	0.751	< 0.02	0.188	0.1	< 0.01	1.9	0.005	0.06	<0.27	28.0	0.04	0.005	< 0.1
BLANK 18					0.014	0.745	< 0.005	0.131	< 0.02	0.114	< 0.1	2.8	1.2	0.083	0.04	<0.27	0.4	0.01	0.004	< 0.1
BLANK 19					0.010	0.630	< 0.005	0.042	0.87	0.061	< 0.1	< 0.01	4.2	0.005	0.03	<0.27	<0.1	0.01	0.004	< 0.1

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 1 - 03	45 - 90	Leach Water	S-silt									
MN BH 1 - 04	60 - 120	Porewater	S-silt	412	49.1	188	18.6	888.2	79	5.06		27
MN BH 1 - 05	120-150	Leach Water	O-silt									
MN BH 1 - 06	150 - 217	Porewater	O-silt	241	36.3	193	1.1	550.5	19	27.7		< 1
MN BH 1 - 07	217 - 255	Leach Water	O-silt									
MN BH 1 - 08	255 - 270	Leach Water										
MN BH 2 - 01	0 - 17.5	Porewater	S-silt									
MN BH 2 - 02	18 - 47	Porewater	O-silt	608	<0.1	77	1.2	1115	64	3.55	1.68	8
MN BH 2 - 03	47 - 70	Porewater	S-silt	427	23.0	231	1.3	1007	30	5.12	1.16	20
MN BH 2 - 04	70 - 120	Porewater	O-silt									
MN BH 2 - 05	120 - 200	Porewater	O-silt	376	12.5	198	< 0.2	794.4	37	8.73	1.05	< 1
MN BH 2 - 06	200 - 275	Porewater	O-silt	256	4.1	183	< 0.2	668.8	55	19.0	1.27	< 1
MN BH 2 - 07	275 - 290	Leach Water	O-clay									
MN BH 2 - 08	290 - 330	Leach Water										
MN BH 3 - 01	0 - 40	Porewater	O-silt									
MN BH 3 - 02	40 - 100	Leach Water	S-silt									
MN BH 3 - 03	100 - 110	Porewater	O-silt									
MN BH 3 - 04	110 - 150	Porewater	S-silt	433	4.5	224	0.2	874.3	32	11.1	1.49	< 1
MN BH 3 - 05	150 - 250	Porewater	O-silt	340	22.3	172	3.6	680.2	62	20.0	1.50	7
MN BH 3 - 06	250 - 275	Leach Water	O-silt	42.9	8.2	140	52.2	49.5	45	6.69	0.08	18
MN BH 3 - 07	275 - 280	Porewater	O-silt	225	33.1	118	4.8	288.3	74	12.2	0.48	248
MN BH 4 - 01	0 - 25	Porewater	S-silt									
MN BH 4 - 02	25 - 40	Porewater	O-silt									
MN BH 4 - 03	40 - 120	Porewater	S-silt	248	6.7	201	2.5	695.3	51	1.23	1.38	32

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 4 - 04	120 - 150	Porewater	S-silt	336	12.1	220	11.0	791.9	35	2.46	1.53	< 1
MN BH 4 - 06	180 - 280	Porewater	S-clay	548	20.4	147	8.7	996.2	60	1.54	1.85	51
MN BH 4 - 08	420 - 440	Porewater	S-silt	158	11.2	230	1.3	175.4	28	5.82	0.30	423
MN BH 5 - 01	0 - 25	Leach Water	O-silt									
MN BH 5 - 02	25 - 50	Leach Water	O-silt									
MN BH 5 - 03	50 - 140	Leach Water	S-silt									
MN BH 5 - 04	140 - 205	Leach Water	S-silt									
MN BH 5 - 05	205	Leach Water										
MN BH 5 - 06	205 - 270	Leach Water	S-silt									
MN BH 5 - 07	270 - 330	Leach Water										
MN BH 5 - 08	330 - 400	Leach Water										
MN BH 6 - 01	0 - 10	Porewater	S-silt									
MN BH 6 - 03	30 - 166	Porewater	S-silt	664	28.7	176	1.0	1006	29	2.18	1.45	23
MN BH 6 - 04	166 - 206	Porewater	O-silt	550	38.2	106	2.3	907.2	55	3.38	1.38	< 1
MN BH 6 - 05	206 - 262	Porewater	S-silt	643	41.2	77	1.0	974.6	57	2.64	1.50	10
MN BH 6 - 07	342 - 502	Porewater	S-clay	349	11.4	156	26.4	934.7	46	0.96	1.35	14
MN BH 6 - 08	502 - 626	Porewater	O-silt	459	7.6	158	4.3	852.5	71	5.31	1.51	48
MN BH 7 - 01	20 - 40	Water		229	8.0	89	3.1	475.3	27	3.37	0.96	10
MN BH 7 - 02	40 - 90	Porewater	S-silt									
MN BH 7 - 03	90 - 220	Porewater	O-silt	524	4.6	251	2.4	1055	73	2.11	1.54	< 1
MN BH 7 - 05	246 - 377	Porewater	O-clay	288	37.6	271	6.2	658.8	46	3.98	0.96	8.3
MN BH 7 - 06	377 - 480	Porewater	O-silt	233	16.7	97	3.6	457.0	42	12.9	1.22	< 1
MN BH 7 - 07	480 - 600	Porewater	O-silt	152	28.7	133	191	213.1	34	5.10	0.52	48

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 8 - 01	25 - 75	Porewater	S-clay									
MN BH 8 - 02A	75 - 330	Porewater	S-clay	198	31.8	210	5.5	421.4	36	7.21	0.82	446
MN BH 8 - 02	75 - 330A	Porewater	O-clay									
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt	577	41.3	252	10.1	1143	53	2.63	1.63	73
MN BH 8 - 05	75 - 330C	Porewater		363	31.4	94	12.9	703.1	51	3.99	1.34	4
MN BH 8 - 06	75 - 330D			145	58.4	135	4.5	348.0	32	1.10	0.95	57
MN BH 9 - 01	20 - 60	Water		223	< 0.1	< 10	0.3	476.6	27	3.39	0.95	< 1
MN BH 9 - 02	60 - 150	Porewater	S-clay	331	24.1	110	2.2	822.5	44	5.29	1.23	< 1
MN BH 9 - 03	150 - 240	Porewater	S-silt	213	123	43	9.2	633.1	55	19.3	1.61	6
MN BH 9 - 04												
MN BH 10 - 01	24 - 130	Water		224	7.1	83	11.8	472.8	35	3.31	0.94	6
MN BH 10 - 02	140 - 165	Porewater										
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	430	5.3	41	3.7	919.3	65	2.82	1.38	11
MN BH 10 - 04				412				888.2		5.06	1.24	
MNBH 10 - 06				241				550.5		27.7	1.13	
MN BH 11 - 01	24 - 140	Water		213	9.3	12	16.9	444.3	28	2.88	0.88	16
MN BH 11 - 02	140 - 362	Porewater	S-clay	437	22.8	238	16.0	965.5	71	2.58	1.05	14
MN BH 11 - 03	362 - 450	Porewater	O-clay	317	7.1	178	0.9	823.6	50	3.95	0.99	10
MN BH 11 - 05	480 - 570	Porewater	O-clay	7.3	2.2	98	3.2	18.7	6	2.76	0.08	55
MN BH 12 - 01	25 - 168	Water		212	5.1	121	1.4	452.3	7	2.90	0.89	55
MN BH 12 - 02	168 - 407	Porewater	O-clay	363	3.9	205	2.4	856.4	41	2.72	1.20	90
MN BH 12 - 04	417 - 920	Porewater	O-clay	275	23.0	86	0.6	831.3	27	4.19	1.24	43

Table C-3 - Tailings Porewater Chemistry

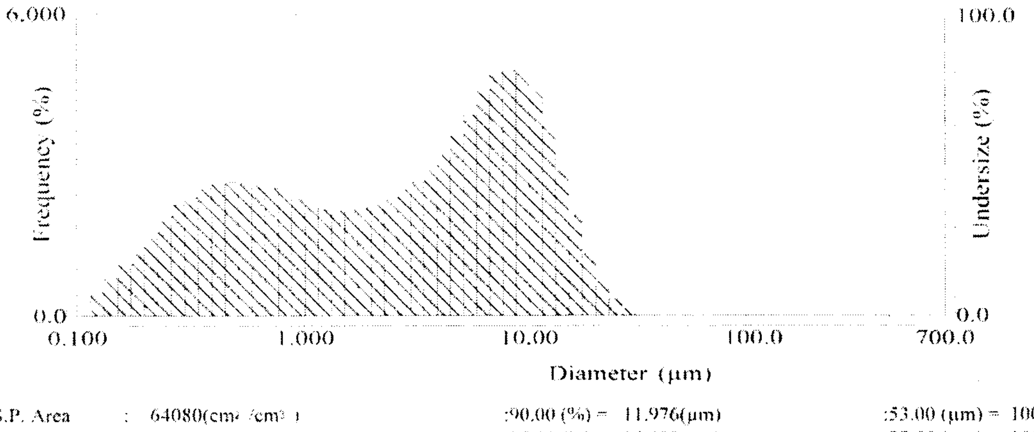
Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 13 - 01	25 - 110	Water		220	7.6	100	0.4	465.8	6	3.04	0.93	3
MN BH 13 - 02	110 -257	Porewater	S-clay									
MN BH 13 - 03	257 - 356	Porewater	S-clay									
MN BH 13 - 04	356 - 470	Porewater	O-clay									
MN BH 13 - 05	470 - 700	Porewater	O-clay	275	31.0	80	19.0	854.0	48	3.48	1.20	46
MN BH 14 - 04	270 - 455	Porewater	O-silt	402	8.0	233	0.9	792.8	32	12.5	1.33	< 1
MN BH 14 - 05	455 - 578	Porewater	O-silt									
MN BH 15 - 01	10 - 25 cm	Water	S-clay	238	6.5	78	0.5	481.8	3	3.59	0.96	3
MN BH 15 - 02	25 - 210	Porewater	O-silt	250	5.8	188	2.3	660.9	34	4.89	1.35	13
MN BH 15 - 03	210 - 460	Porewater	O-silt	403	<0.1	109	3.6	852.0	57	15.4	1.24	19
MN BH 15 - 04	460 - 510	Porewater	O-silt	559	3.2	225	3.1	1047	49	1.65	1.28	18
MN BH 15 - 06	580 - 750	Porewater	O-clay	245	23.8	139	1.6	777.1	22	4.27	1.11	1
MN BH 15 - 07	750 - 910	Porewater	O-clay	229	15.3	120	0.4	820.7	85	8.34	1.34	1
MN BH 16 - 01	13 - 150	Water	S-clay	216	2.8	201	0.4	446.4	15	2.80	0.91	81
MN BH 16 - 02	150 - 358	Porewater	O-silt	490	33.8	132	9.9	966.4	44	3.35	0.95	34
MN BH 16 - 04	386 - 498	Porewater	O-clay	427	34.4	127	44.5	711.5	166	7.77	0.73	161
MN BH 17 - 04	184 - 260	Porewater	O- Silt	256	14.9	101	27.7	780.3	210	5.39	1.27	181
MN BH 18 -00	20 - 140	Porewater										
MN BH 18 -01	140 - 250	Porewater	S-clay	223	17.5	95	28.0	728.4	169	1.92	1.32	146
MN BH 18 -02	250 - 331	Porewater	S-clay									
MN BH 18 -03	331 - 485	Porewater	O-clay									
MN BH 18 -04	485 - 610	Porewater	O-clay	267	157	86	28.0	666.2	142	4.92	0.86	180

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 18 -05	610 - 660	Porewater	O-clay	246	147	173	8.1	696.5	188	8.53	1.25	331
MN BH 18 -06	660 - 800	Porewater	O-silt	69.7	36.9	207	30.8	185.4	11	1.86	0.46	60
MN BH 19 - 01	0 - 25	Porewater	S-silt	442	33.5	122	14.4	854.4	823	2.24	1.75	5774
MN BH 19 - 02	25 - 103	Porewater	S-silt									
MN BH 19 - 03	103 - 140	Porewater	O-silt	170	2.4	213	2.6	475.9	16	1.48	1.14	34
MN BH 19 - 04	140 - 207	Porewater	S-silt	288	23.0	112	8.8	809.8	167	3.33	1.59	304
MN BH 19 - 05	207 - 251	Porewater										
MN BH 19 - 06	251 - 356	Porewater	S-silt									
MN BH 19 - 07	356 - 389	Porewater										
MN BH 19 - 08	389 - 428	Porewater	S-silt	305	47.5	208	37.3	824.2	226	5.45	1.67	351
MN Seepage Water		Water		233	29.0	72	5.1	429.3	4	3.50	0.85	644
MN Pit (Bottom)				17.4	< 0.1	144	0.3	862.7	1	3.04	1.97	550
MN Pit (Top)				7.7	1.0	123	1.1	74.0	14	6.32	0.52	219
BLANK 17				4.8	< 0.1	< 10	4.0	0.1	6	0.833	< 0.03	4
BLANK 18				<0.25	4.2	130	12.8	<0.1	18	0.266	< 0.03	< 1
BLANK 19				<0.25	< 0.1	115	1.2	0.1	4	0.135	< 0.03	< 1

Appendix C-4: Tailings Particle Size Analysis: (8 selected samples)

MNBH 1102 (wet)
Feb 25, 2002

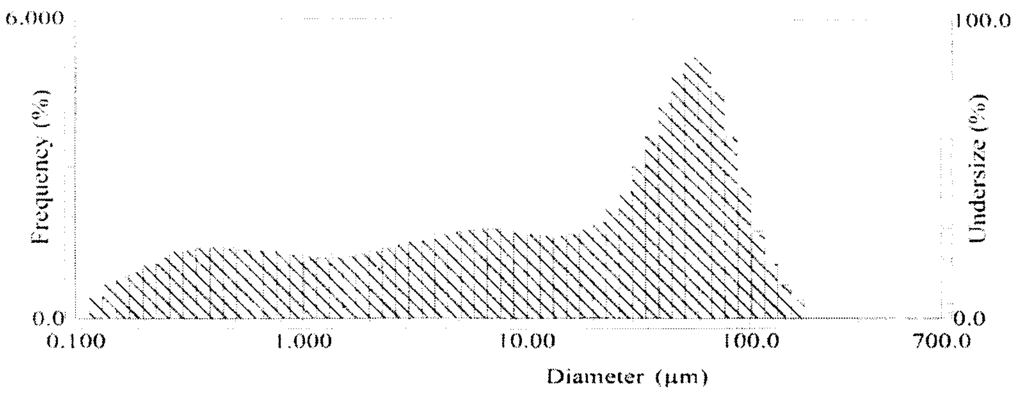


S.P. Area	: 64080(cm²/cm³)			:90.00 (%) = 11.976(µm)			:53.00 (µm) = 100.0
Median	: 3.100(µm)			:95.00 (%) = 14.698(µm)			:38.00 (µm) = 100.0
Diameter on %	:5.000 (%) = 0.227(µm)	% on Diameter	:850.0 (µm) = 100.000(%)		Mean	: 4.841(µm)	
	:10.00 (%) = 0.314(µm)		:600.0 (µm) = 100.000(%)		Variance	: 24.682	
	:20.00 (%) = 0.534(µm)		:425.0 (µm) = 100.000(%)		S.D.	: 4.968(µm)	
	:30.00 (%) = 0.913(µm)		:300.0 (µm) = 100.000(%)		Mode	: 8.235(µm)	
	:40.00 (%) = 1.722(µm)		:212.0 (µm) = 100.000(%)		Span	: 3.762	
	:60.00 (%) = 4.838(µm)		:150.0 (µm) = 100.000(%)				
	:70.00 (%) = 6.725(µm)		:106.0 (µm) = 100.000(%)				
	:80.00 (%) = 8.880(µm)		:75.00 (µm) = 100.000(%)				

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.071	37.980	39	19.904	1.215	98.870	58	262.376	0.000	100.000
2	0.131	0.461	0.461	21	1.729	2.087	40.067	40	22.797	0.663	99.533	59	300.518	0.000	100.000
3	0.150	0.746	1.207	22	1.981	2.138	42.205	41	26.111	0.324	99.857	60	344.206	0.000	100.000
4	0.172	0.996	2.203	23	2.269	2.192	44.398	42	29.907	0.143	100.000	61	394.244	0.000	100.000
5	0.197	1.205	3.409	24	2.599	2.322	46.719	43	34.255	0.000	100.000	62	451.556	0.000	100.000
6	0.226	1.507	4.915	25	2.976	2.487	49.206	44	39.234	0.000	100.000	63	517.200	0.000	100.000
7	0.259	1.856	6.771	26	3.409	2.643	51.849	45	44.938	0.000	100.000	64	592.387	0.000	100.000
8	0.296	2.199	8.970	27	3.905	2.878	54.727	46	51.471	0.000	100.000				
9	0.339	2.352	11.321	28	4.472	3.199	57.926	47	58.953	0.000	100.000				
10	0.389	2.524	13.845	29	5.122	3.580	61.505	48	67.523	0.000	100.000				
11	0.445	2.619	16.464	30	5.867	4.005	65.510	49	77.339	0.000	100.000				
12	0.510	2.646	19.110	31	6.720	4.460	69.970	50	88.583	0.000	100.000				
13	0.584	2.623	21.733	32	7.697	4.859	74.829	51	101.460	0.000	100.000				
14	0.669	2.583	24.316	33	8.816	4.909	79.738	52	116.210	0.000	100.000				
15	0.766	2.528	26.844	34	10.097	4.842	84.581	53	133.103	0.000	100.000				
16	0.877	2.473	29.317	35	11.565	4.452	89.033	54	152.453	0.000	100.000				
17	1.005	2.309	31.626	36	13.246	3.760	92.793	55	174.616	0.000	100.000				
18	1.151	2.183	33.809	37	15.172	2.881	95.674	56	200.000	0.000	100.000				
19	1.318	2.100	35.909	38	17.377	1.981	97.656	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251413761	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:29	Axis Selection	:LogX-LinY
Laser T%	: 78.2(%)		

MNBH 1401 (wet)
Feb 25, 2002

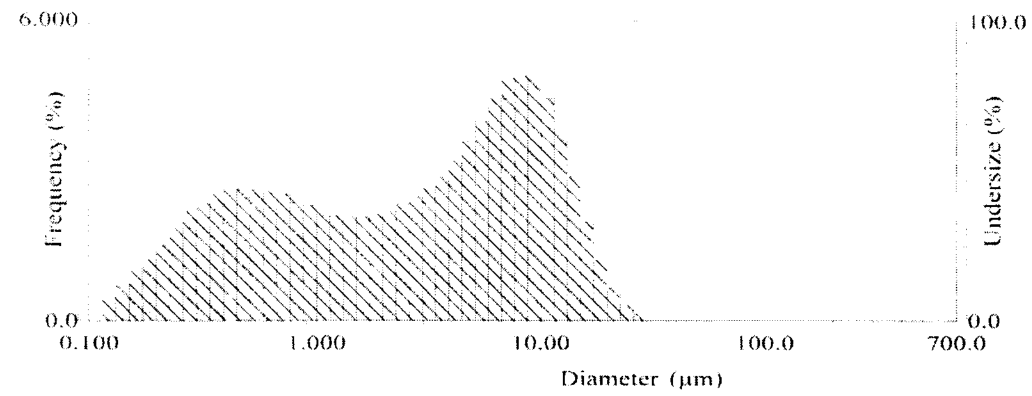


S.P. Area	: 40656(cm²/cm³)		:90.00 (%) = 77.657(μm)			:53.00 (μm) = 76.09
Median	: 16.406(μm)		:95.00 (%) = 95.680(μm)			:38.00 (μm) = 64.88
Diameter on %	:5.000 (%) = 0.255(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 30.200(μm)	
	:10.00 (%) = 0.420(μm)		:600.0 (μm) = 100.000(%)	Variance	: 1115.943	
	:20.00 (%) = 1.177(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 33.406(μm)	
	:30.00 (%) = 3.293(μm)		:300.0 (μm) = 100.000(%)	Mode	: 55.248(μm)	
	:40.00 (%) = 7.319(μm)		:212.0 (μm) = 100.000(%)	Span	: 4.708	
	:60.00 (%) = 31.176(μm)		:150.0 (μm) = 99.550(%)			
	:70.00 (%) = 44.870(μm)		:106.0 (μm) = 96.692(%)			
	:80.00 (%) = 58.644(μm)		:75.00 (μm) = 88.861(%)			

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.207	22.209	39	19.904	1.755	52.462	58	262.376	0.000	100.000
2	0.131	0.444	0.444	21	1.729	1.234	23.443	40	22.797	1.914	54.376	59	300.518	0.000	100.000
3	0.150	0.677	1.121	22	1.981	1.273	24.717	41	26.111	2.166	56.542	60	344.206	0.000	100.000
4	0.172	0.822	1.943	23	2.269	1.315	26.032	42	29.907	2.531	59.074	61	394.244	0.000	100.000
5	0.197	0.910	2.853	24	2.599	1.382	27.414	43	34.255	3.025	62.099	62	451.556	0.000	100.000
6	0.226	1.052	3.905	25	2.976	1.453	28.867	44	39.234	3.638	65.737	63	517.200	0.000	100.000
7	0.259	1.202	5.107	26	3.409	1.522	30.388	45	44.938	4.311	70.048	64	592.387	0.000	100.000
8	0.296	1.330	6.437	27	3.905	1.585	31.973	46	51.471	4.910	74.958				
9	0.339	1.358	7.795	28	4.472	1.656	33.629	47	58.953	5.245	80.203				
10	0.389	1.395	9.189	29	5.122	1.716	35.345	48	67.523	5.138	85.341				
11	0.445	1.402	10.591	30	5.867	1.757	37.101	49	77.339	4.549	89.891				
12	0.510	1.387	11.978	31	6.720	1.781	38.882	50	88.583	3.624	93.515				
13	0.584	1.362	13.341	32	7.697	1.777	40.659	51	101.460	2.616	96.130				
14	0.669	1.341	14.682	33	8.816	1.733	42.392	52	116.210	1.740	97.870				
15	0.766	1.324	16.006	34	10.097	1.704	44.096	53	133.103	1.093	98.964				
16	0.877	1.314	17.320	35	11.565	1.668	45.764	54	152.453	0.666	99.630				
17	1.005	1.261	18.581	36	13.246	1.640	47.404	55	174.616	0.370	100.000				
18	1.151	1.221	19.802	37	15.172	1.635	49.039	56	200.000	0.000	100.000				
19	1.318	1.200	21.002	38	17.377	1.668	50.707	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251426762	Calc. Level	:30
Circulation Speed	:14	R.R.Index	:1.16-0.10i
Ultra sonic	:01:41	Axis Selection	:LogX-LinY
Laser T%	: 79.0(%)		

MNBH 1102 (wet)
Feb 25, 2002

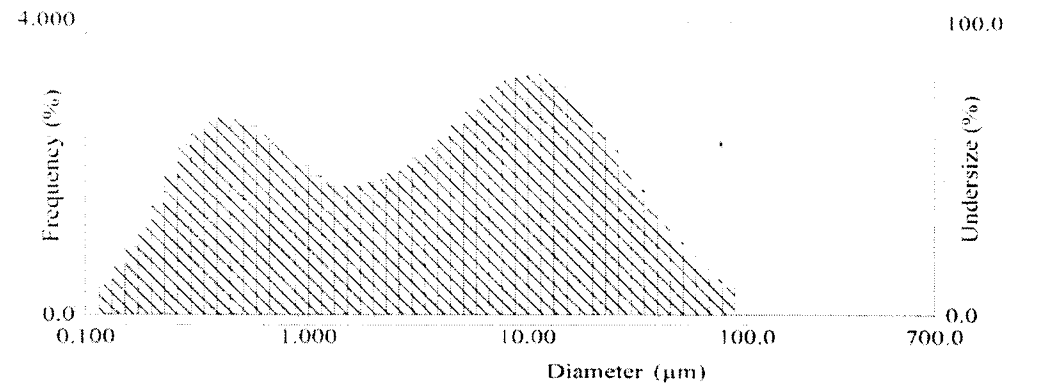


S.P. Area	: 64080(cm²/cm³)	:90.00 (%) = 11.976(μm)		:53.00 (μm) = 100.0
Median	: 3.100(μm)	:95.00 (%) = 14.698(μm)		:38.00 (μm) = 100.0
Diameter on %	:5.000 (%) = 0.227(μm)	% on Diameter :850.0 (μm) = 100.000(%)	Mean	: 4.841(μm)
	:10.00 (%) = 0.314(μm)	:600.0 (μm) = 100.000(%)	Variance	: 24.682
	:20.00 (%) = 0.534(μm)	:425.0 (μm) = 100.000(%)	S.D.	: 4.968(μm)
	:30.00 (%) = 0.913(μm)	:300.0 (μm) = 100.000(%)	Mode	: 8.235(μm)
	:40.00 (%) = 1.722(μm)	:212.0 (μm) = 100.000(%)	Span	: 3.762
	:60.00 (%) = 4.838(μm)	:150.0 (μm) = 100.000(%)		
	:70.00 (%) = 6.725(μm)	:106.0 (μm) = 100.000(%)		
	:80.00 (%) = 8.880(μm)	:75.00 (μm) = 100.000(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.071	37.980	39	19.904	1.215	98.870	58	262.376	0.000	100.000
2	0.131	0.461	0.461	21	1.729	2.087	40.067	40	22.797	0.663	99.533	59	300.518	0.000	100.000
3	0.150	0.746	1.207	22	1.981	2.138	42.205	41	26.111	0.324	99.857	60	344.206	0.000	100.000
4	0.172	0.996	2.203	23	2.269	2.192	44.398	42	29.907	0.143	100.000	61	394.244	0.000	100.000
5	0.197	1.205	3.409	24	2.599	2.322	46.719	43	34.255	0.000	100.000	62	451.556	0.000	100.000
6	0.226	1.507	4.915	25	2.976	2.487	49.206	44	39.234	0.000	100.000	63	517.200	0.000	100.000
7	0.259	1.856	6.771	26	3.409	2.643	51.849	45	44.938	0.000	100.000	64	592.387	0.000	100.000
8	0.296	2.199	8.970	27	3.905	2.878	54.727	46	51.471	0.000	100.000				
9	0.339	2.352	11.321	28	4.472	3.199	57.926	47	58.953	0.000	100.000				
10	0.389	2.524	13.845	29	5.122	3.580	61.505	48	67.523	0.000	100.000				
11	0.445	2.619	16.464	30	5.867	4.005	65.510	49	77.339	0.000	100.000				
12	0.510	2.646	19.110	31	6.720	4.460	69.970	50	88.583	0.000	100.000				
13	0.584	2.623	21.733	32	7.697	4.859	74.829	51	101.460	0.000	100.000				
14	0.669	2.583	24.316	33	8.816	4.909	79.738	52	116.210	0.000	100.000				
15	0.766	2.528	26.844	34	10.097	4.842	84.581	53	133.103	0.000	100.000				
16	0.877	2.473	29.317	35	11.565	4.452	89.033	54	152.453	0.000	100.000				
17	1.005	2.309	31.626	36	13.246	3.760	92.793	55	174.616	0.000	100.000				
18	1.151	2.183	33.809	37	15.172	2.881	95.674	56	200.000	0.000	100.000				
19	1.318	2.100	35.909	38	17.377	1.981	97.656	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251413761	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:29	Axis Selection	:LogX-LinY
Laser T%	: 78.2(%)		

Batch O (wet)
Feb 25, 2002

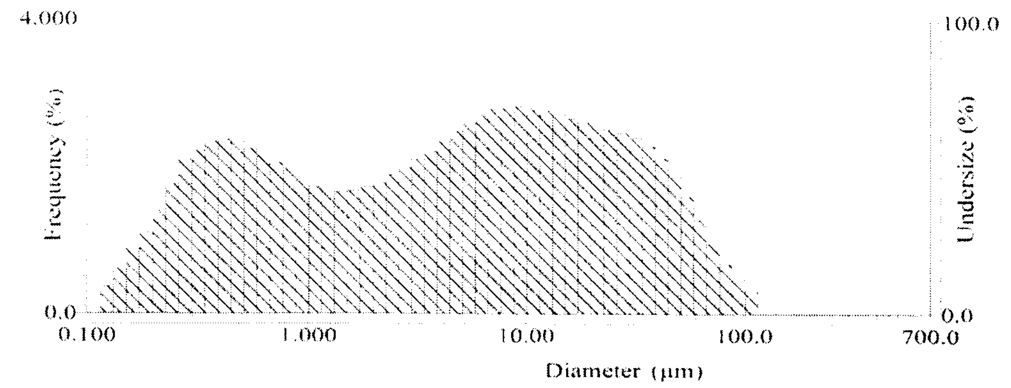


S.P. Area	: 61123(cm² /cm³)		:90.00 (%) = 25.521(μm)			:53.00 (μm) =	97.88
Median	: 3.898(μm)		:95.00 (%) = 37.415(μm)			:38.00 (μm) =	95.16
Diameter on %	:5.000 (%) = 0.232(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 9.296(μm)		
	:10.00 (%) = 0.316(μm)		:600.0 (μm) = 100.000(%)	Variance	: 178.331		
	:20.00 (%) = 0.531(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 13.354(μm)		
	:30.00 (%) = 0.951(μm)		:300.0 (μm) = 100.000(%)	Mode	: 10.796(μm)		
	:40.00 (%) = 2.007(μm)		:212.0 (μm) = 100.000(%)	Span	: 6.467		
	:60.00 (%) = 6.483(μm)		:150.0 (μm) = 100.000(%)				
	:70.00 (%) = 9.952(μm)		:106.0 (μm) = 100.000(%)				
	:80.00 (%) = 15.195(μm)		:75.00 (μm) = 99.516(%)				

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.758	36.270	39	19.904	2.734	85.645	58	262.376	0.000	100.000
2	0.131	0.388	0.388	21	1.729	1.760	38.030	40	22.797	2.494	88.140	59	300.518	0.000	100.000
3	0.150	0.646	1.033	22	1.981	1.793	39.823	41	26.111	2.237	90.376	60	344.206	0.000	100.000
4	0.172	0.917	1.951	23	2.269	1.835	41.658	42	29.907	1.972	92.348	61	394.244	0.000	100.000
5	0.197	1.167	3.118	24	2.599	1.927	43.585	43	34.255	1.708	94.056	62	451.556	0.000	100.000
6	0.226	1.500	4.618	25	2.976	2.035	45.620	44	39.234	1.453	95.508	63	517.200	0.000	100.000
7	0.259	1.901	6.519	26	3.409	2.142	47.762	45	44.938	1.212	96.721	64	592.387	0.000	100.000
8	0.296	2.298	8.817	27	3.905	2.267	50.029	46	51.471	0.993	97.713				
9	0.339	2.453	11.270	28	4.472	2.428	52.457	47	58.953	0.797	98.510				
10	0.389	2.624	13.893	29	5.122	2.599	55.055	48	67.523	0.628	99.139				
11	0.445	2.688	16.581	30	5.867	2.772	57.827	49	77.339	0.488	99.626				
12	0.510	2.659	19.240	31	6.720	2.952	60.779	50	88.583	0.374	100.000				
13	0.584	2.565	21.805	32	7.697	3.105	63.884	51	101.460	0.000	100.000				
14	0.669	2.451	24.257	33	8.816	3.194	67.078	52	116.210	0.000	100.000				
15	0.766	2.329	26.586	34	10.097	3.270	70.348	53	133.103	0.000	100.000				
16	0.877	2.218	28.803	35	11.565	3.281	73.630	54	152.453	0.000	100.000				
17	1.005	2.026	30.829	36	13.246	3.226	76.856	55	174.616	0.000	100.000				
18	1.151	1.886	32.715	37	15.172	3.111	79.967	56	200.000	0.000	100.000				
19	1.318	1.796	34.511	38	17.377	2.944	82.911	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251442763	Caic. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:29	Axis Selection	:LogX-LinY
Laser T%	: 75.2(%)		

Batch S (wet)
Feb 25, 2002

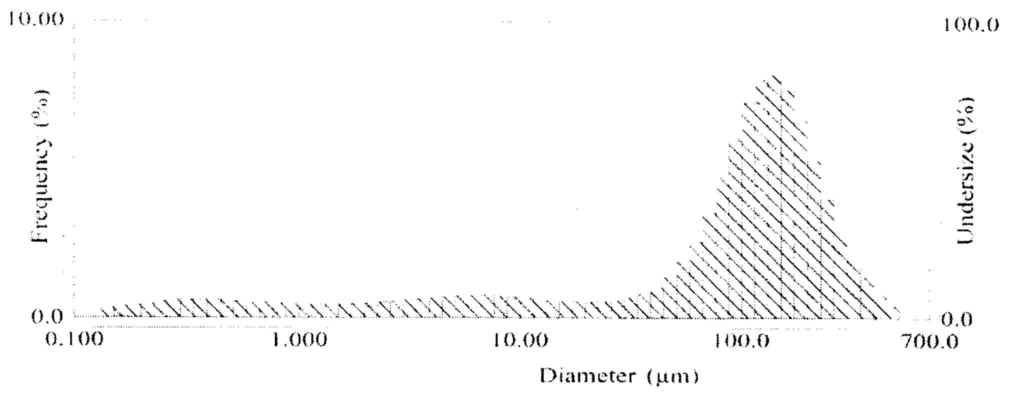


S.P. Area	: 56066(cm²/cm³)		:90.00 (%) = 37.766(μm)		:53.00 (μm) = 95.01	
Median	: 4.834(μm)		:95.00 (%) = 52.930(μm)		:38.00 (μm) = 90.10	
Diameter on %	:5.000 (%) = 0.238(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 12.732(μm)	
	:10.00 (%) = 0.331(μm)		:600.0 (μm) = 100.000(%)	Variance	: 335.877	
	:20.00 (%) = 0.593(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 18.327(μm)	
	:30.00 (%) = 1.199(μm)		:300.0 (μm) = 100.000(%)	Mode	: 9.436(μm)	
	:40.00 (%) = 2.617(μm)		:212.0 (μm) = 100.000(%)	Span	: 7.744	
	:60.00 (%) = 8.011(μm)		:150.0 (μm) = 100.000(%)			
	:70.00 (%) = 12.989(μm)		:106.0 (μm) = 99.791(%)			
	:80.00 (%) = 21.665(μm)		:75.00 (μm) = 98.314(%)			

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.657	32.824	39	19.904	2.611	78.399	58	262.376	0.000	100.000
2	0.131	0.363	0.363	21	1.729	1.678	34.502	40	22.797	2.563	80.962	59	300.518	0.000	100.000
3	0.150	0.608	0.971	22	1.981	1.727	36.230	41	26.111	2.519	83.481	60	344.206	0.000	100.000
4	0.172	0.869	1.840	23	2.269	1.785	38.014	42	29.907	2.470	85.951	61	394.244	0.000	100.000
5	0.197	1.101	2.941	24	2.599	1.884	39.899	43	34.255	2.401	88.352	62	451.556	0.000	100.000
6	0.226	1.398	4.339	25	2.976	1.995	41.894	44	39.234	2.292	90.644	63	517.200	0.000	100.000
7	0.259	1.757	6.096	26	3.409	2.107	44.001	45	44.938	2.127	92.772	64	592.387	0.000	100.000
8	0.296	2.102	8.198	27	3.905	2.219	46.220	46	51.471	1.897	94.669				
9	0.339	2.218	10.416	28	4.472	2.355	48.575	47	58.953	1.608	96.277				
10	0.389	2.349	12.765	29	5.122	2.486	51.061	48	67.523	1.287	97.564				
11	0.445	2.384	15.149	30	5.867	2.605	53.666	49	77.339	0.969	98.533				
12	0.510	2.344	17.493	31	6.720	2.715	56.381	50	88.583	0.689	99.223				
13	0.584	2.254	19.748	32	7.697	2.790	59.171	51	101.460	0.469	99.691				
14	0.669	2.157	21.905	33	8.816	2.810	61.980	52	116.210	0.309	100.000				
15	0.766	2.059	23.964	34	10.097	2.830	64.811	53	133.103	0.000	100.000				
16	0.877	1.978	25.942	35	11.565	2.816	67.626	54	152.453	0.000	100.000				
17	1.005	1.829	27.771	36	13.246	2.775	70.401	55	174.616	0.000	100.000				
18	1.151	1.727	29.498	37	15.172	2.722	73.123	56	200.000	0.000	100.000				
19	1.318	1.669	31.167	38	17.377	2.665	75.788	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251402760	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:40	Axis Selection	:LogX-LinY
Laser T%	: 73.4(%)		

OMIX (wet)
Feb 25, 2002



S.P. Area	: 16846(cm² /cm³)		:90.00 (%) = 241.022(µm)		:53.00 (µm) = 26.80
Median	: 110.915(µm)		:95.00 (%) = 295.057(µm)		:38.00 (µm) = 23.78
Diameter on %	:5.000 (%) = 0.490(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 118.796(µm)
	:10.00 (%) = 1.992(µm)		:600.0 (µm) = 100.000(%)	Variance	: 8819.891
	:20.00 (%) = 16.199(µm)		:425.0 (µm) = 99.225(%)	S.D.	: 93.914(µm)
	:30.00 (%) = 64.549(µm)		:300.0 (µm) = 95.353(%)	Mode	: 142.039(µm)
	:40.00 (%) = 90.262(µm)		:212.0 (µm) = 85.461(%)	Span	: 2.155
	:60.00 (%) = 131.840(µm)		:150.0 (µm) = 67.819(%)		
	:70.00 (%) = 155.696(µm)		:106.0 (µm) = 47.572(%)		
	:80.00 (%) = 187.454(µm)		:75.00 (µm) = 33.607(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	0.438	9.061	39	19.904	0.531	20.817	58	262.376	4.007	92.506
2	0.131	0.000	0.000	21	1.729	0.450	9.510	40	22.797	0.527	21.345	59	300.518	2.884	95.390
3	0.150	0.322	0.322	22	1.981	0.469	9.979	41	26.111	0.545	21.890	60	344.206	2.017	97.406
4	0.172	0.379	0.701	23	2.269	0.490	10.469	42	29.907	0.592	22.481	61	394.244	1.391	98.798
5	0.197	0.422	1.123	24	2.599	0.522	10.991	43	34.255	0.678	23.159	62	451.556	0.773	99.571
6	0.226	0.483	1.606	25	2.976	0.557	11.549	44	39.234	0.819	23.978	63	517.200	0.429	100.000
7	0.259	0.544	2.150	26	3.409	0.593	12.142	45	44.938	1.040	25.018	64	592.387	0.000	100.000
8	0.296	0.597	2.747	27	3.905	0.631	12.773	46	51.471	1.377	26.395				
9	0.339	0.605	3.352	28	4.472	0.672	13.445	47	58.953	1.876	28.271				
10	0.389	0.615	3.967	29	5.122	0.710	14.155	48	67.523	2.588	30.859				
11	0.445	0.610	4.577	30	5.867	0.740	14.895	49	77.339	3.552	34.411				
12	0.510	0.592	5.170	31	6.720	0.759	15.654	50	88.583	4.749	39.160				
13	0.584	0.566	5.736	32	7.697	0.762	16.416	51	101.460	6.067	45.227				
14	0.669	0.539	6.275	33	8.816	0.732	17.148	52	116.210	7.271	52.498				
15	0.766	0.513	6.788	34	10.097	0.705	17.853	53	133.103	8.069	60.567				
16	0.877	0.491	7.280	35	11.565	0.668	18.521	54	152.453	8.236	68.803				
17	1.005	0.463	7.743	36	13.246	0.626	19.148	55	174.616	7.719	76.522				
18	1.151	0.444	8.187	37	15.172	0.586	19.733	56	200.000	6.654	83.176				
19	1.318	0.435	8.623	38	17.377	0.552	20.286	57	229.075	5.323	88.499				

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ID#	:200202251516768	Calc. Level	:30
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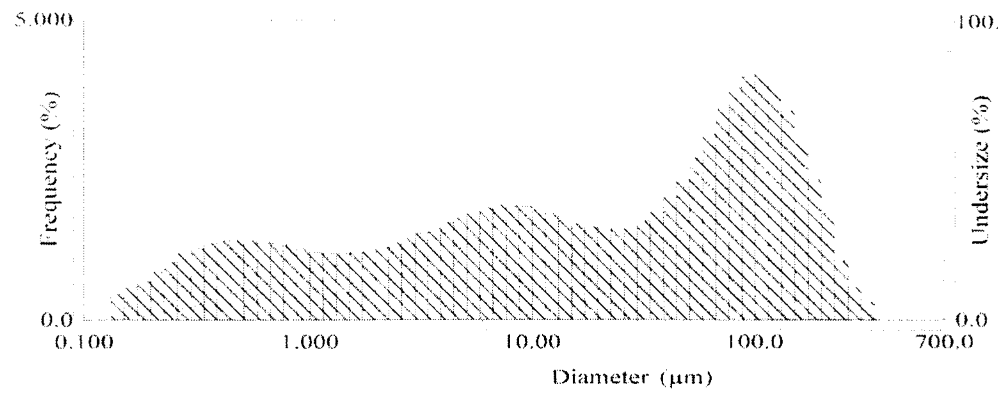
Ultra sonic	:02:34	Axis Selection	:LogX-LinY
Laser T%	: 76.1(%)		

SMIX (wet)
Feb 25, 2002



S.P. Area	: 32318(cm² /cm³)		:90.00 (%) = 146.294(µm)		:53.00 (µm) = 62.71
Median	: 20.560(µm)		:95.00 (%) = 184.842(µm)		:38.00 (µm) = 57.30
Diameter on %	:5.000 (%) = 0.315(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 52.218(µm)
	:10.00 (%) = 0.532(µm)		:600.0 (µm) = 100.000(%)	Variance	: 4062.040
	:20.00 (%) = 1.656(µm)		:425.0 (µm) = 100.000(%)	S.D.	: 63.734(µm)
	:30.00 (%) = 4.478(µm)		:300.0 (µm) = 99.687(%)	Mode	: 108.247(µm)
	:40.00 (%) = 9.303(µm)		:212.0 (µm) = 97.131(%)	Span	: 7.090
	:60.00 (%) = 45.503(µm)		:150.0 (µm) = 90.646(%)		
	:70.00 (%) = 72.992(µm)		:106.0 (µm) = 80.841(%)		
	:80.00 (%) = 103.110(µm)		:75.00 (µm) = 70.707(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.101	19.234	39	19.904	1.556	49.636	58	262.376	0.992	99.143
2	0.131	0.000	0.000	21	1.729	1.127	20.361	40	22.797	1.521	51.157	59	300.518	0.551	99.694
3	0.150	0.427	0.427	22	1.981	1.168	21.529	41	26.111	1.522	52.679	60	344.206	0.306	100.000
4	0.172	0.540	0.967	23	2.269	1.213	22.742	42	29.907	1.567	54.247	61	394.244	0.000	100.000
5	0.197	0.638	1.605	24	2.599	1.286	24.028	43	34.255	1.664	55.911	62	451.556	0.000	100.000
6	0.226	0.789	2.394	25	2.976	1.364	25.392	44	39.234	1.823	57.734	63	517.200	0.000	100.000
7	0.259	0.954	3.348	26	3.409	1.442	26.833	45	44.938	2.050	59.784	64	592.387	0.000	100.000
8	0.296	1.116	4.465	27	3.905	1.525	28.358	46	51.471	2.349	62.132				
9	0.339	1.190	5.655	28	4.472	1.625	29.983	47	58.953	2.714	64.846				
10	0.389	1.273	6.928	29	5.122	1.723	31.706	48	67.523	3.124	67.970				
11	0.445	1.321	8.248	30	5.867	1.810	33.517	49	77.339	3.537	71.508				
12	0.510	1.334	9.582	31	6.720	1.886	35.402	50	88.583	3.891	75.399				
13	0.584	1.321	10.903	32	7.697	1.931	37.334	51	101.460	4.110	79.509				
14	0.669	1.301	12.204	33	8.816	1.914	39.247	52	116.210	4.130	83.639				
15	0.766	1.274	13.478	34	10.097	1.897	41.145	53	133.103	3.921	87.560				
16	0.877	1.249	14.726	35	11.565	1.848	42.993	54	152.453	3.505	91.065				
17	1.005	1.179	15.905	36	13.246	1.776	44.768	55	174.616	2.950	94.015				
18	1.151	1.128	17.033	37	15.172	1.695	46.463	56	200.000	2.349	96.364				
19	1.318	1.100	18.133	38	17.377	1.617	48.081	57	229.075	1.786	98.150				

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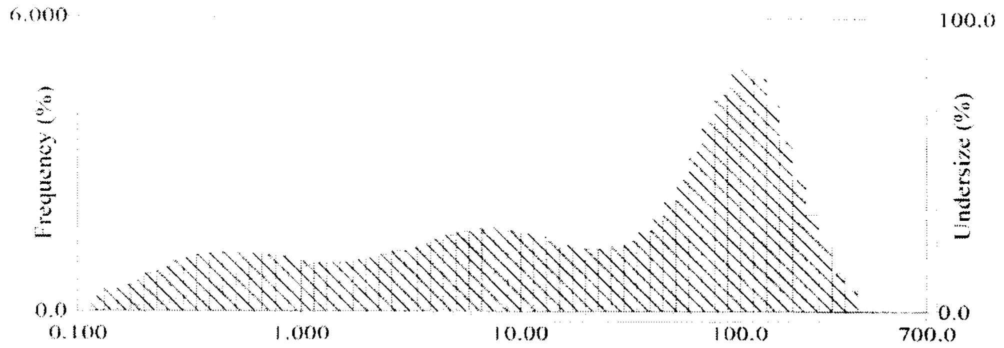
Laser T%	: 82.4(%)		

SOMIX (wet)
Feb 25, 2002



S.P. Area	: 31579(cm²/cm³)		:90.00 (%) = 157.446(μm)		:53.00 (μm) = 56.49
Median	: 33.831(μm)		:95.00 (%) = 196.128(μm)		:38.00 (μm) = 51.37
Diameter on %	:5.000 (%) = 0.311(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 60.210(μm)
	:10.00 (%) = 0.556(μm)		:600.0 (μm) = 100.000(%)	Variance	: 4596.574
	:20.00 (%) = 1.980(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 67.798(μm)
	:30.00 (%) = 5.475(μm)		:300.0 (μm) = 99.556(%)	Mode	: 108.457(μm)
	:40.00 (%) = 12.446(μm)		:212.0 (μm) = 96.245(%)	Span	: 4.637
	:60.00 (%) = 62.405(μm)		:150.0 (μm) = 88.659(%)		
	:70.00 (%) = 87.888(μm)		:106.0 (μm) = 76.743(%)		
	:80.00 (%) = 115.794(μm)		:75.00 (μm) = 64.917(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	0.992	17.936	39	19.904	1.303	44.793	58	262.376	1.405	98.786
2	0.131	0.302	0.302	21	1.729	1.015	18.950	40	22.797	1.274	46.067	59	300.518	0.781	99.566
3	0.150	0.446	0.748	22	1.981	1.052	20.002	41	26.111	1.282	47.350	60	344.206	0.434	100.000
4	0.172	0.543	1.291	23	2.269	1.092	21.095	42	29.907	1.336	48.686	61	394.244	0.000	100.000
5	0.197	0.624	1.915	24	2.599	1.159	22.254	43	34.255	1.447	50.133	62	451.556	0.000	100.000
6	0.226	0.756	2.671	25	2.976	1.231	23.485	44	39.234	1.626	51.759	63	517.200	0.000	100.000
7	0.259	0.896	3.567	26	3.409	1.303	24.788	45	44.938	1.890	53.649	64	592.387	0.000	100.000
8	0.296	1.030	4.597	27	3.905	1.380	26.168	46	51.471	2.253	55.903				
9	0.339	1.089	5.687	28	4.472	1.471	27.639	47	58.953	2.721	58.624				
10	0.389	1.156	6.842	29	5.122	1.559	29.198	48	67.523	3.282	61.906				
11	0.445	1.193	8.036	30	5.867	1.633	30.831	49	77.339	3.891	65.797				
12	0.510	1.202	9.238	31	6.720	1.692	32.523	50	88.583	4.461	70.259				
13	0.584	1.190	10.428	32	7.697	1.721	34.244	51	101.460	4.872	75.130				
14	0.669	1.172	11.600	33	8.816	1.686	35.930	52	116.210	5.001	80.132				
15	0.766	1.147	12.747	34	10.097	1.655	37.584	53	133.103	4.785	84.917				
16	0.877	1.125	13.872	35	11.565	1.595	39.179	54	152.453	4.250	89.167				
17	1.005	1.063	14.935	36	13.246	1.517	40.696	55	174.616	3.510	92.677				
18	1.151	1.017	15.953	37	15.172	1.434	42.130	56	200.000	2.714	95.391				
19	1.318	0.991	16.944	38	17.377	1.360	43.490	57	229.075	1.989	97.380				

Filename	:	Form of Distribution	:Standard
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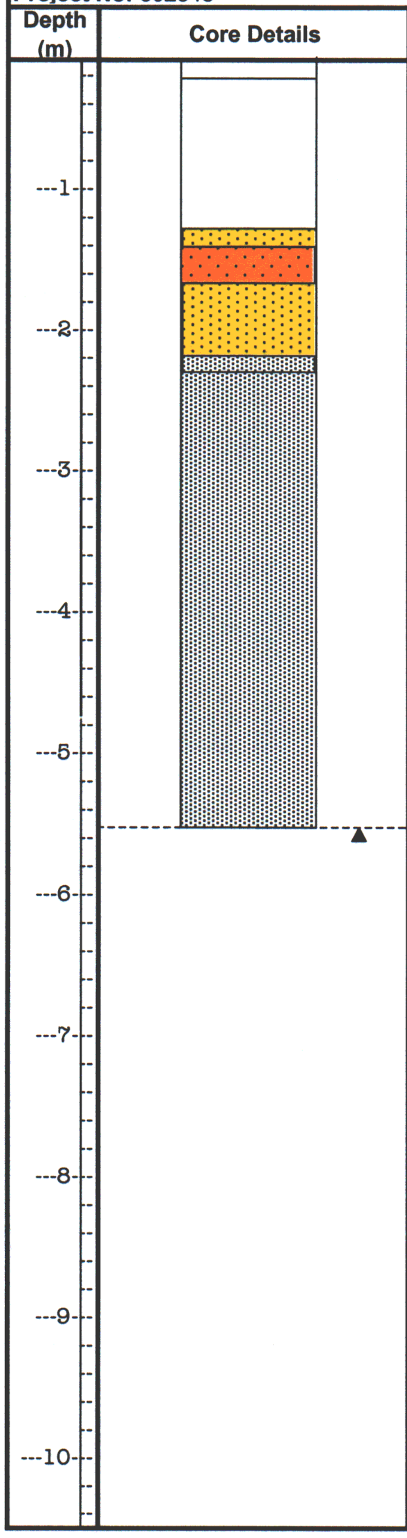
Circulation Speed	:13	R.R.Index	:1.16-0.10i
Ultra sonic	:01:08	Axis Selection	:LogX-LinY
Laser T%	: 82.9(%)		

Tailings Core Log

Core No: MN BH 10

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.514 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001
Project No: 602345
Drilling Method: Sonic



Description	Sample #	Comments
ice		
water	MN BH10-01	
grey brown silty clay	MN BH10-03	
light brown clay interbed	MN BH10-02	
grey brown silty clay	MN BH10-03	
grey native sand at tailings interface	MN BH10-04	
coarse, grey native sand with roots, organics near bottom	MN BH10-05	

Tailings Core Log

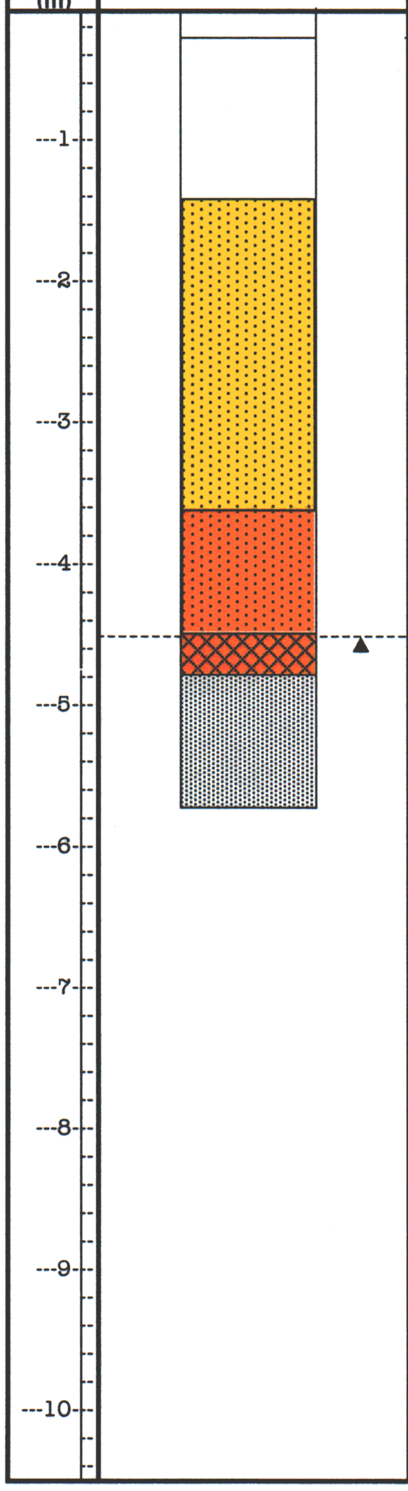
Core No: **MN BH 11**

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.524 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001

Project No: 602345
Drilling Method: Sonic

Depth (m) / Core Details



Description	Sample #	Comments
ice		
water	MN BH11-01	
grey brown silty clay	MN BH11-02	
light grey brown silty clay	MN BH11-03	
clay/peat interface	MN BH11-04	
black organic rich soil (black muck with sandy interval)	MN BH11-05	

Tailings Core Log

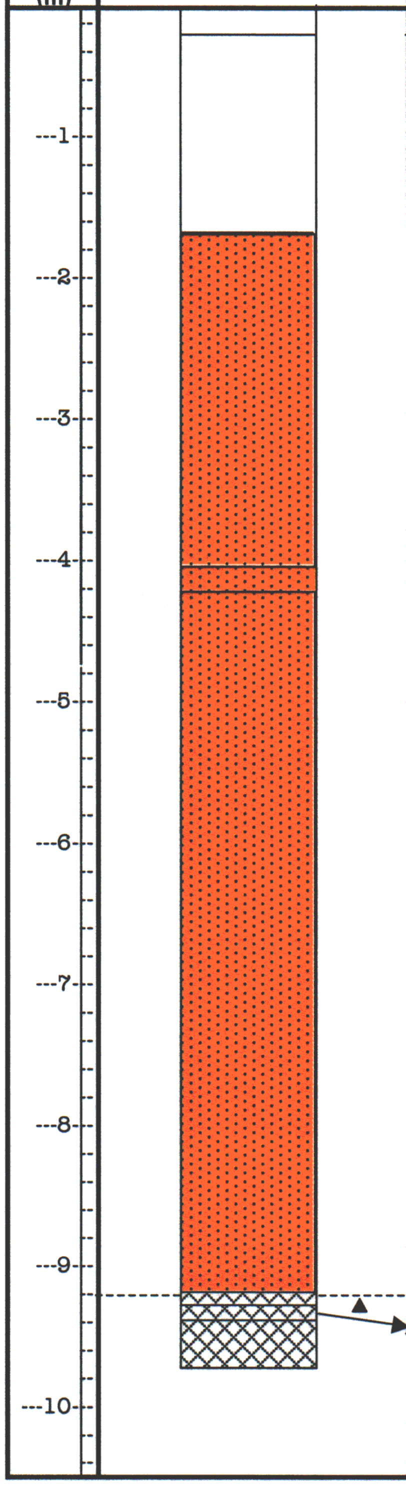
Core No: MN BH 12

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.514 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001

Project No: 602345
Drilling Method: Sonic

Depth (m) / **Core Details**



Description	Sample #	Comments
ice		
water	MN BH12-01	
light brown clay with <5% grey streaks	MN BH12-02	light grey brown silty clay (laboratory identification)
light brown clay 50% grey streaks	MN BH 12-03	light grey brown plastic clay
brown plastic clay with <2% grey streaks	MN BH12-04	brown silty clay (laboratory identification)
frozen peat grading into grey organic rich soil	MN BH12-05	brown plastic clay in peat
peat	MN BH12-06	
black peat and sand	MN BH12-07	

Tailings Core Log

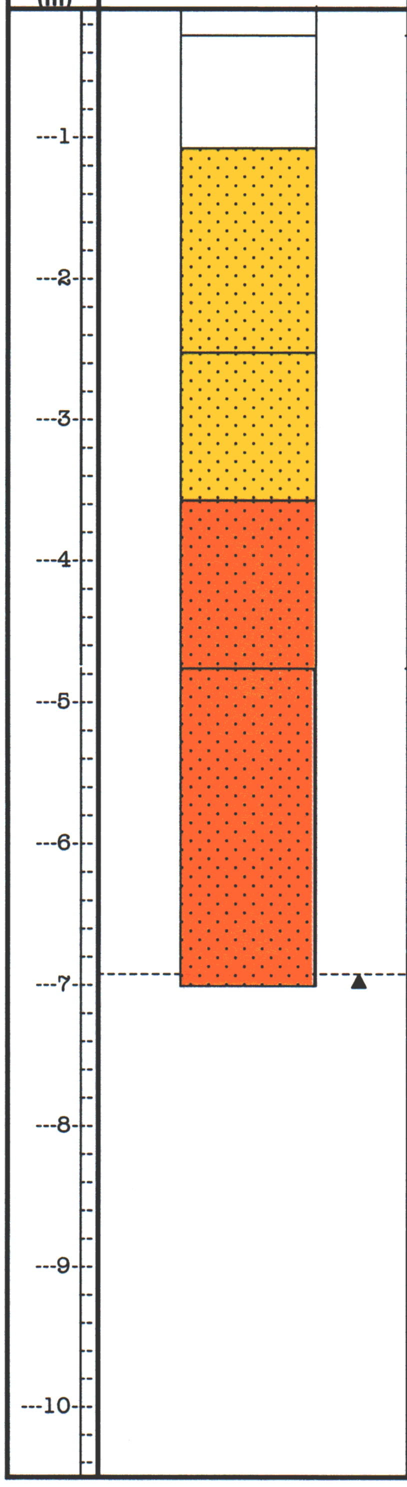
Core No: MN BH 13

Project: Mt. Nansen Tailings Chemical Stability | **Elevation:** 1148.513 m

Location: Mt. Nansen, Yukon Territory | **Sampling Date:** November 17th 2001

Project No: 602345 | **Drilling Method:** Sonic

Depth (m) | Core Details



Description	Sample #	Comments
ice		
water	MN BH13-01	
grey plastic clay <40% brown streaks	MN BH13-02	grey brown plastic clay (laboratory classification)
grey brown plastic clay with 50% brown	MN BH13-03	light grey brown plastic clay (laboratory classification)
brown plastic clay with 30% grey	MN BH13-04	brown plastic clay (laboratory classification)
brown plastic clay with <10% grey	MN BH13-05	brown plastic clay (laboratory classification)

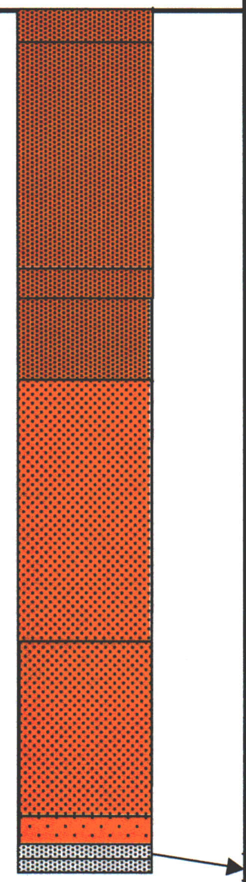
Tailings Core Log

Core No: MN BH 14

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1150.103 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001

Project No: 602345
Drilling Method: Sonic



Depth (m)	Description	Sample #	Comments
0	light brown frozen silt		NOT SAMPLED
1	moist light brown silty sand	MN BH 14-01	yellow brown silt (upon re-examination)
2	light grey brown clayey silt (20% clay)	MN BH14-02	light grey brown silt
	light brown sandy silt	MN BH 14-03	grey brown silt (upon re-examination)
3–4	saturated light brown clay with 25% slushy sections	MN BH14-04	light grey brown clayey silt (laboratory classification)
5	brown silt with 20-30% clay	MN BH14-05	grey brown clayey silt (laboratory classification)
6	brown plastic clay with 20% grey	MN BH14-06	light brown plastic clay
	contact zone with native sand, plant remains	MN BH14-07	dark grey organic soil
	native sand	MN BH14-08	

Depth scale (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

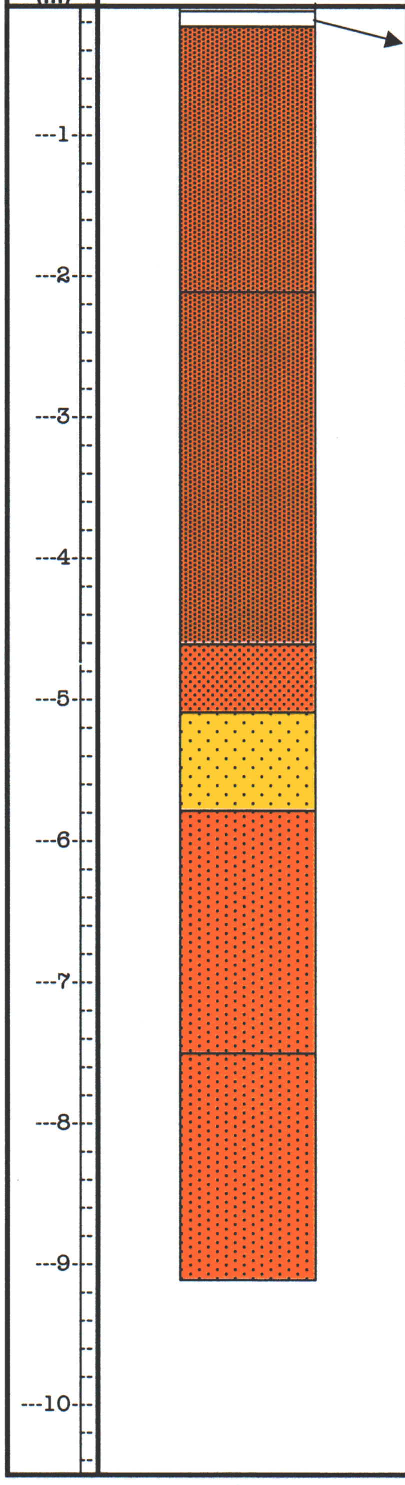
Tailings Core Log

Core No: MN BH 15

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.527 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001

Project No: 602345
Drilling Method: Sonic

Depth (m) / Core Details	Description	Sample #	Comments
	ice		
	water	MN BH15-01	
	saturated brown sand, 1-2% sulfides	MN BH15-02	brown silty sand (laboratory classification)
	saturated brown sand 1-2% sulfides	MN BH15-03	light brown silty sand (laboratory classification)
	brown clayey silt, 20% grey streaks	MN BH15-04	light grey brown clayey silt
	grey brown plastic clay (20-25% grey streaks)	MN BH15-05	light grey brown plastic clay (laboratory classification)
	brown silty clay, plastic (10% grey streaks)	MN BH15-06	brown plastic silty clay (laboratory classification)
	brown silty clay, plastic (<10% grey streaks)	MN BH 15-07	brown silty clay, plastic (laboratory classification)

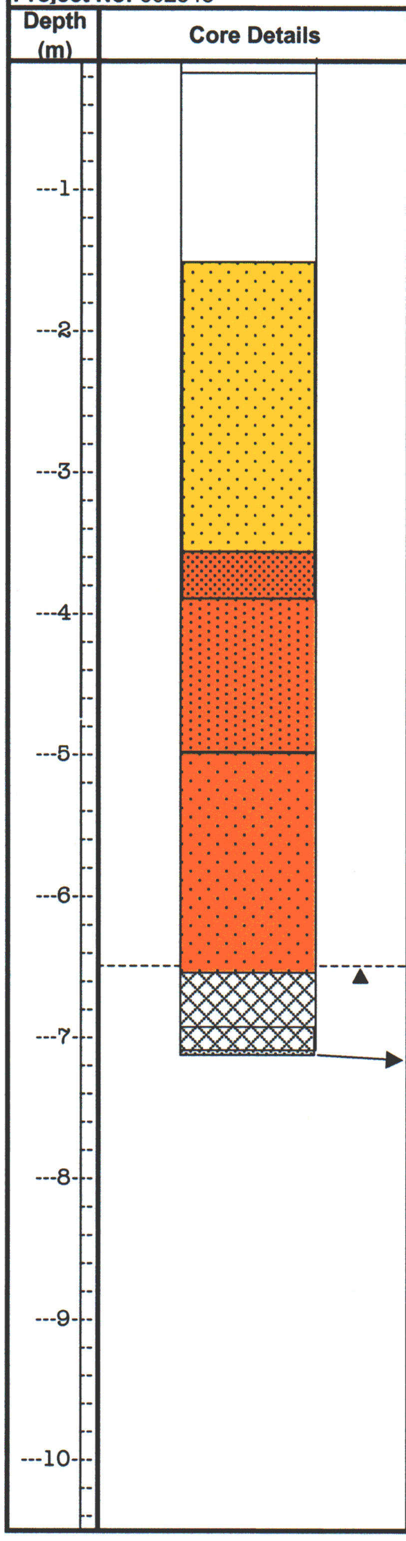
Tailings Core Log

Core No: MN BH 16

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.492 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001

Project No: 602345
Drilling Method: Sonic



Description	Sample #	Comments
ice		
water	MN BH16-01	
grey brown clay ,<40% brown	MN BH16-02	
light grey brown silt (clayey)	MN BH16-03	
light grey brown plastic clay (<30% grey), silty	MN BH16-04	
light grey yellow brown plastic clay (<20% grey), locally silty	MN BH16-05	
peat moss at contact with clay	MN BH16-06	
black organic rich soil and peat	MN BH16-07	
dark grey frozen sand		NOT SAMPLED

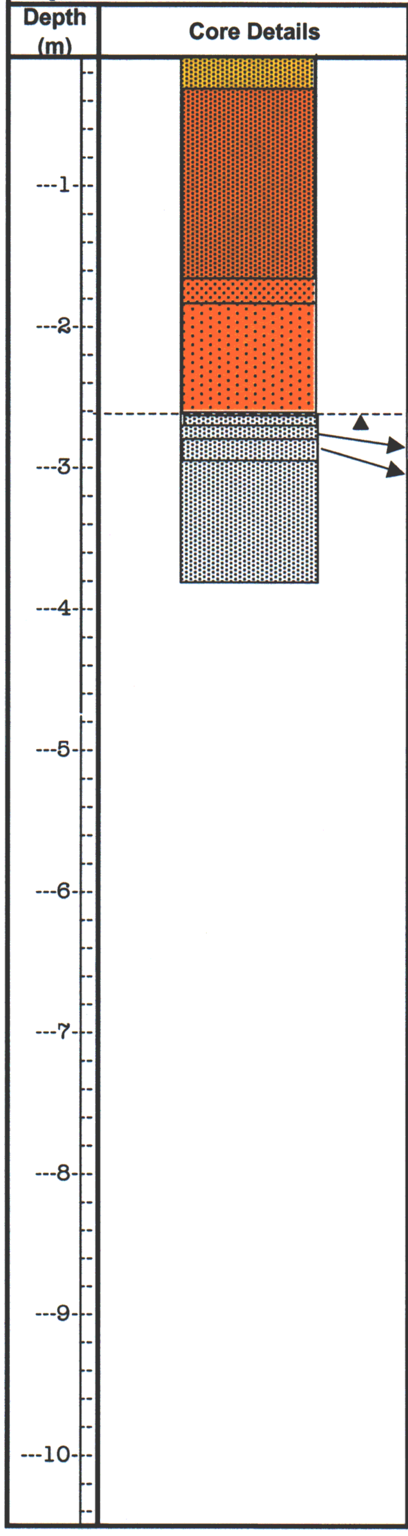
Tailings Core Log

Core No: MN BH 17

Project: Mt. Nansen Tailings Chemical Stability | **Elevation:** 1149.454 m

Location: Mt. Nansen, Yukon Territory | **Sampling Date:** November 18th 2001

Project No: 602345 | **Drilling Method:** Sonic



Description	Sample #	Comments
frozen beige sandy silt	MN BH17-01	grey brown sandy silt (thawed)
brown, moist silty sand	MN BH17-02	yellow brown silt, slightly sandy (upon re-examination)
saturated brown silt (20% grey)	MN BH17-03	light grey brown clayey silt
clayey silt, 20% brown, <20% clay	MN BH17-04	light grey brown silty clay (laboratory classification)
native sand in contact with clayey silt	MN BH17-05	
grey native sand 10-20 cm below contact	MN BH17-06	
grey native sand 20-30 cm below contact	MN BH17-07	
wet native sand	NOT SAMPLED	

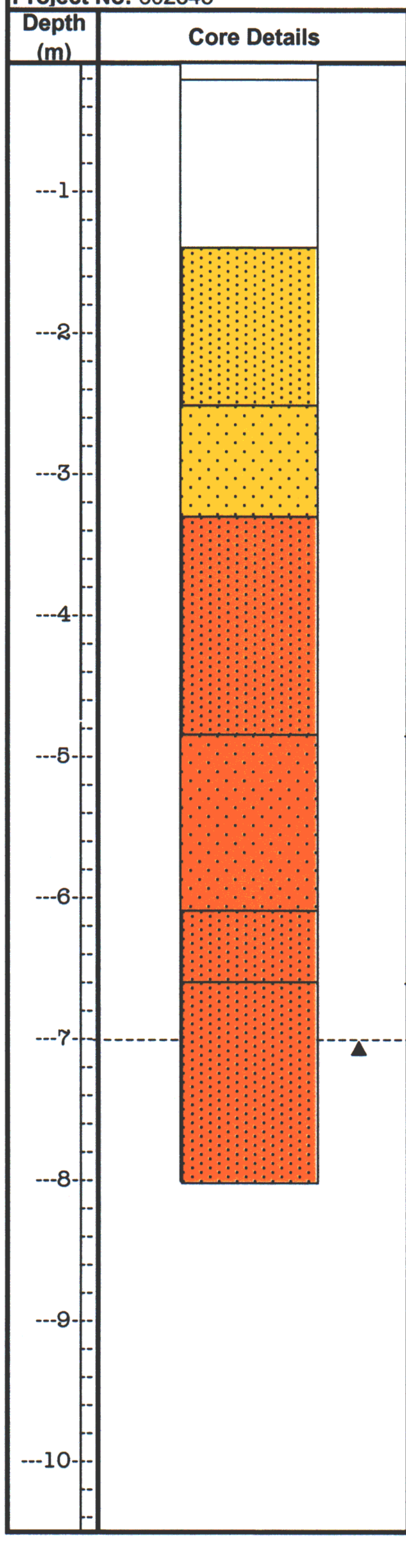
Tailings Core Log

Core No: MN BH 18

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.716 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001

Project No: 602345
Drilling Method: Sonic

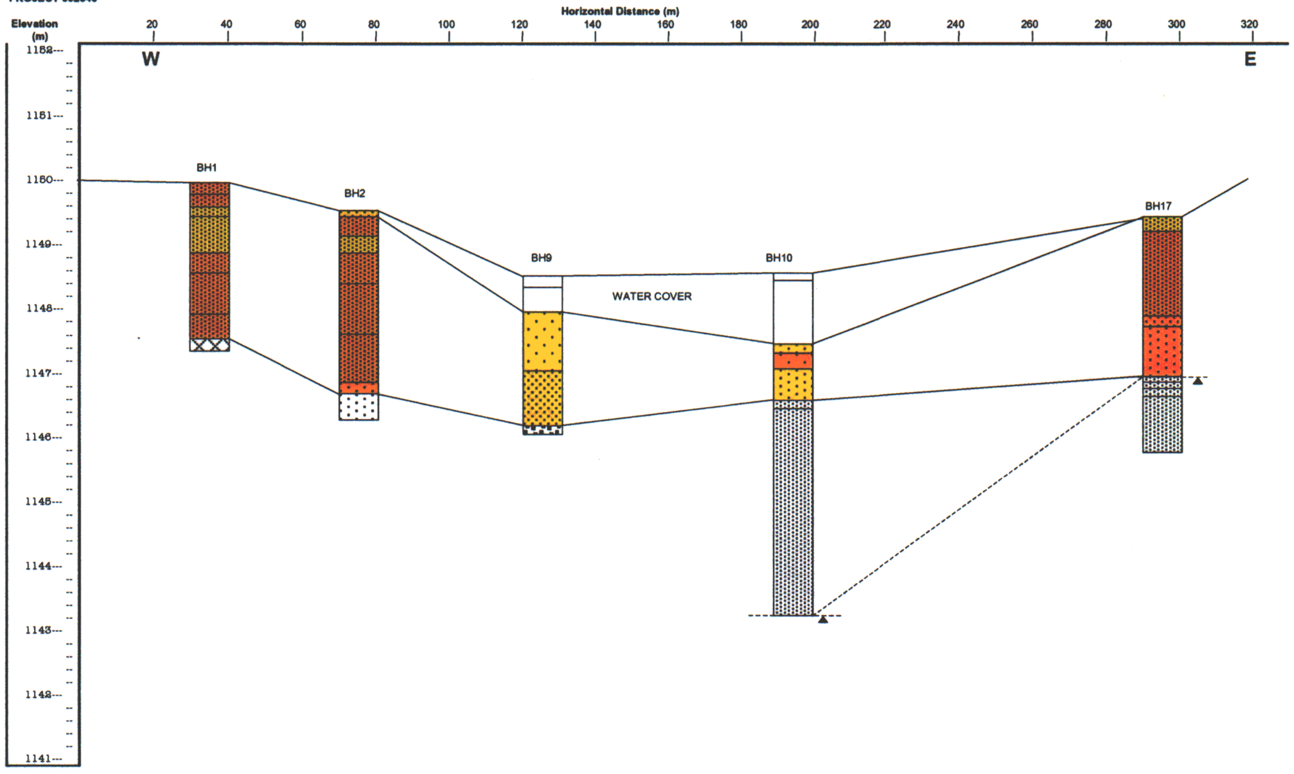


Description	Sample #	Comments
ice		
water	MN BH18-00	
grey brown silty clay	MN BH18-01	
grey brown plastic clay, 50% clay	MN BH18-02	
light grey brown clay (25% grey), slightly silty	MN BH18-03	
brown plastic clay (10% grey)	MN BH18-04	
light grey brown silty clay with brown sand and ice lenses	MN BH18-05	
brown silt with 65% ice crystals	MN BH18-06	brown silty clay slurry (thawed)

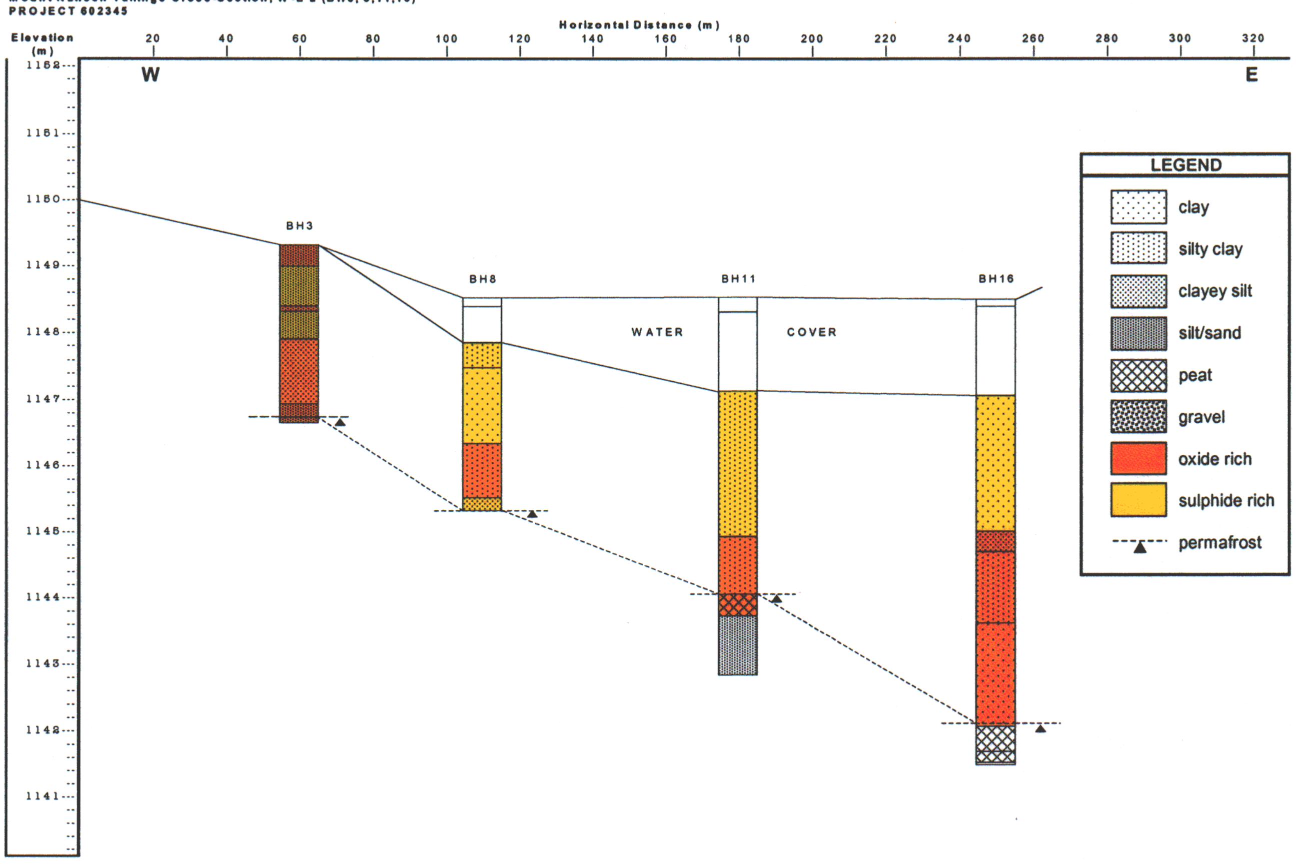
APPENDIX B

Cross Sections of the Tailings Impoundment at Mount Nansen

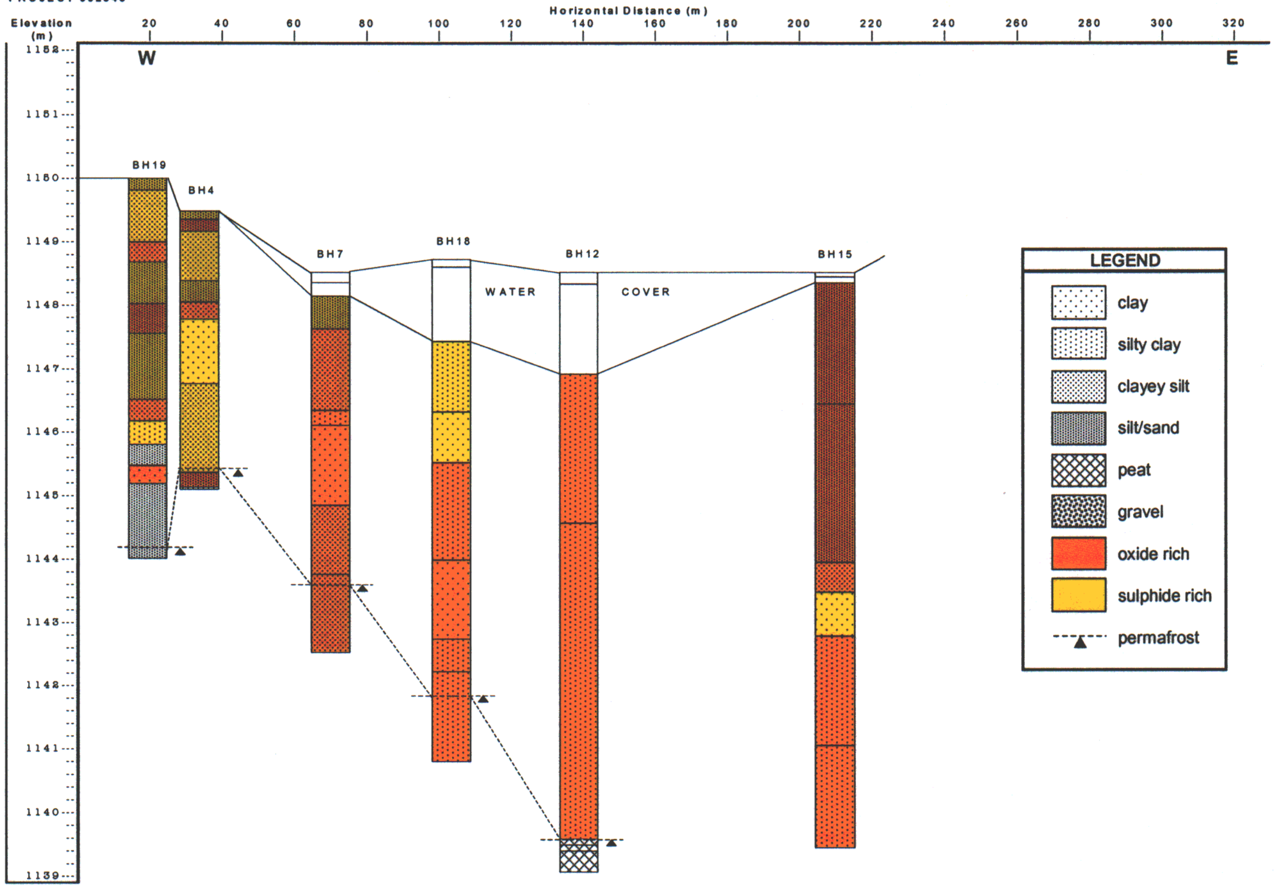
Mount Nansen Tailings Cross-Section, W-E 1 (BH1, 2, 9, 10, 17)
PROJECT 602345



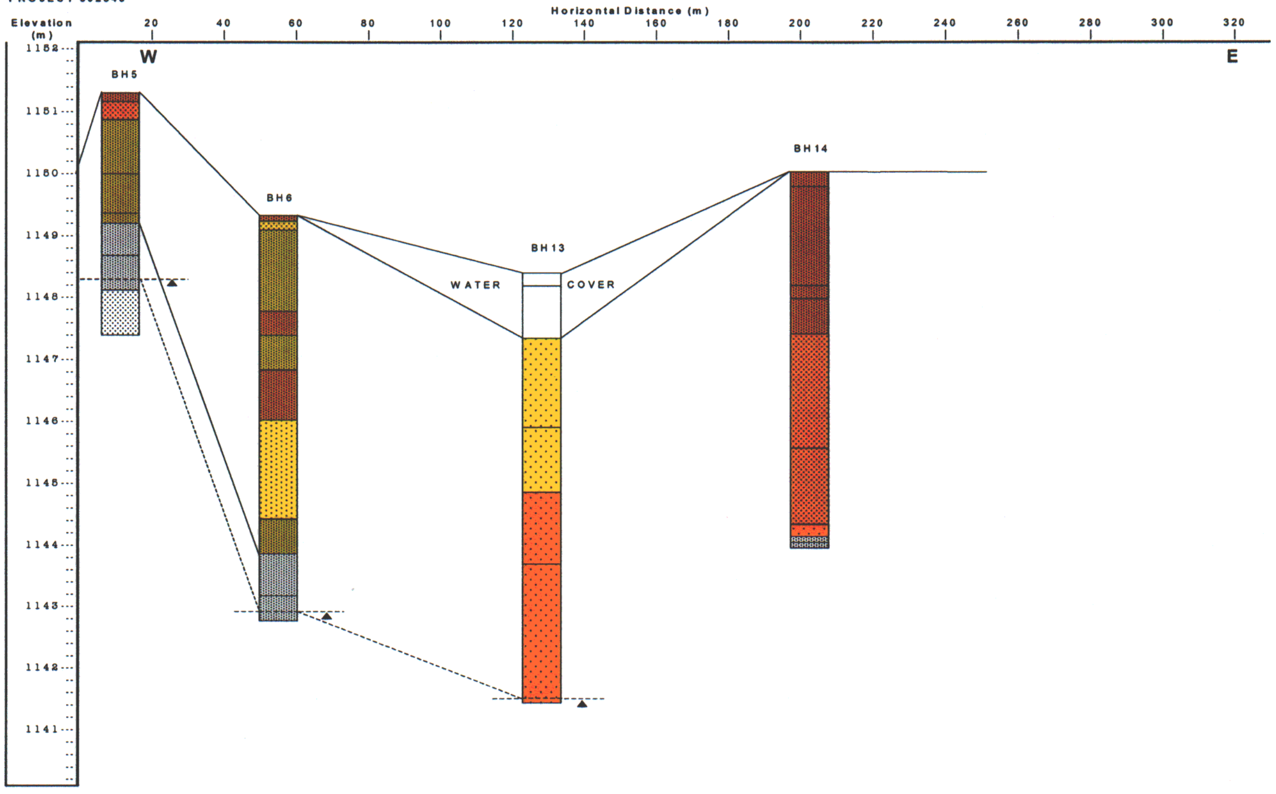
Mount Nansen Tailings Cross-Section, W-E 2 (BH3, 8,11,16)
PROJECT 602345



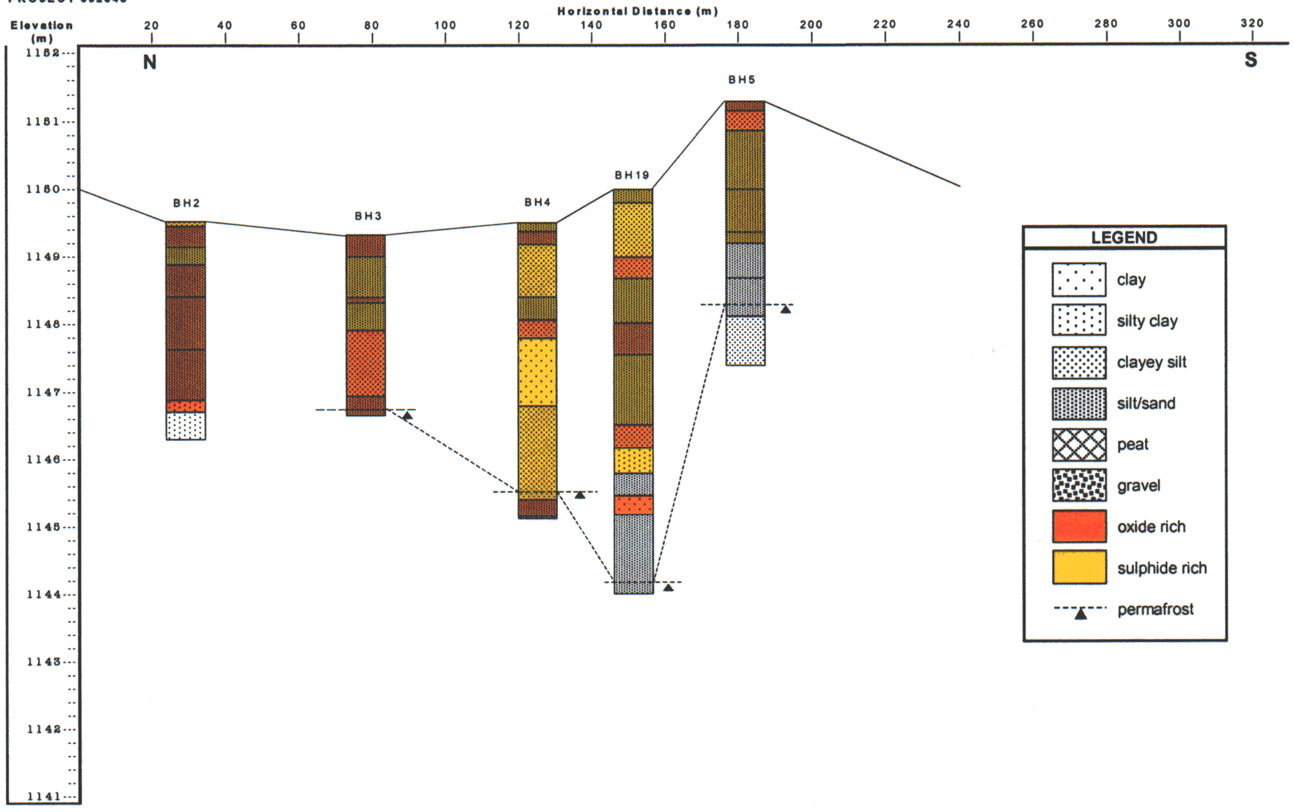
Mount Nansen Tailings Cross-Section, W-E 3 (BH19, 4, 7, 18, 12, 15)
PROJECT 602345



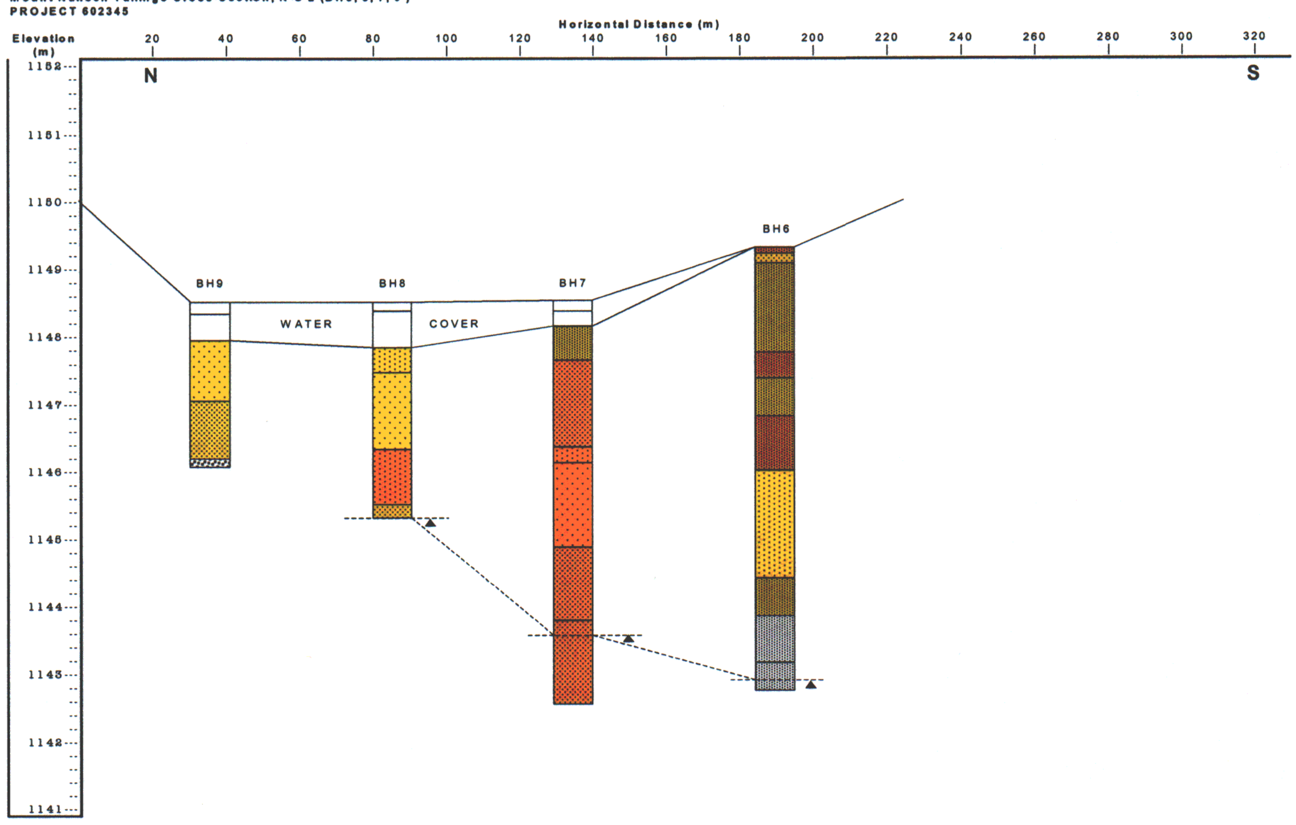
Mount Nansen Tailings Cross-Section, W-E 4 (BH5, 6, 13, 14)
PROJECT 602345



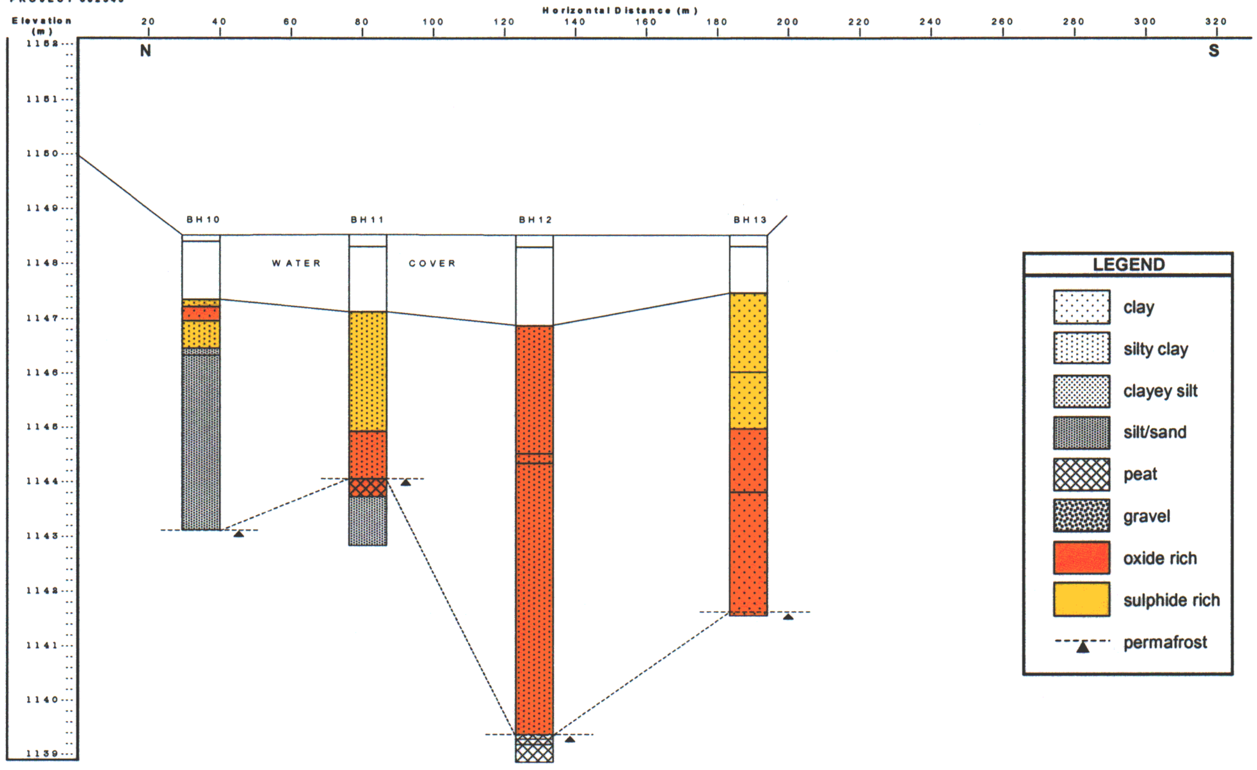
Mount Nansen Tailings Cross-Section, N-S 1 (BH2, 3, 4, 19, 5)
PROJECT 602345



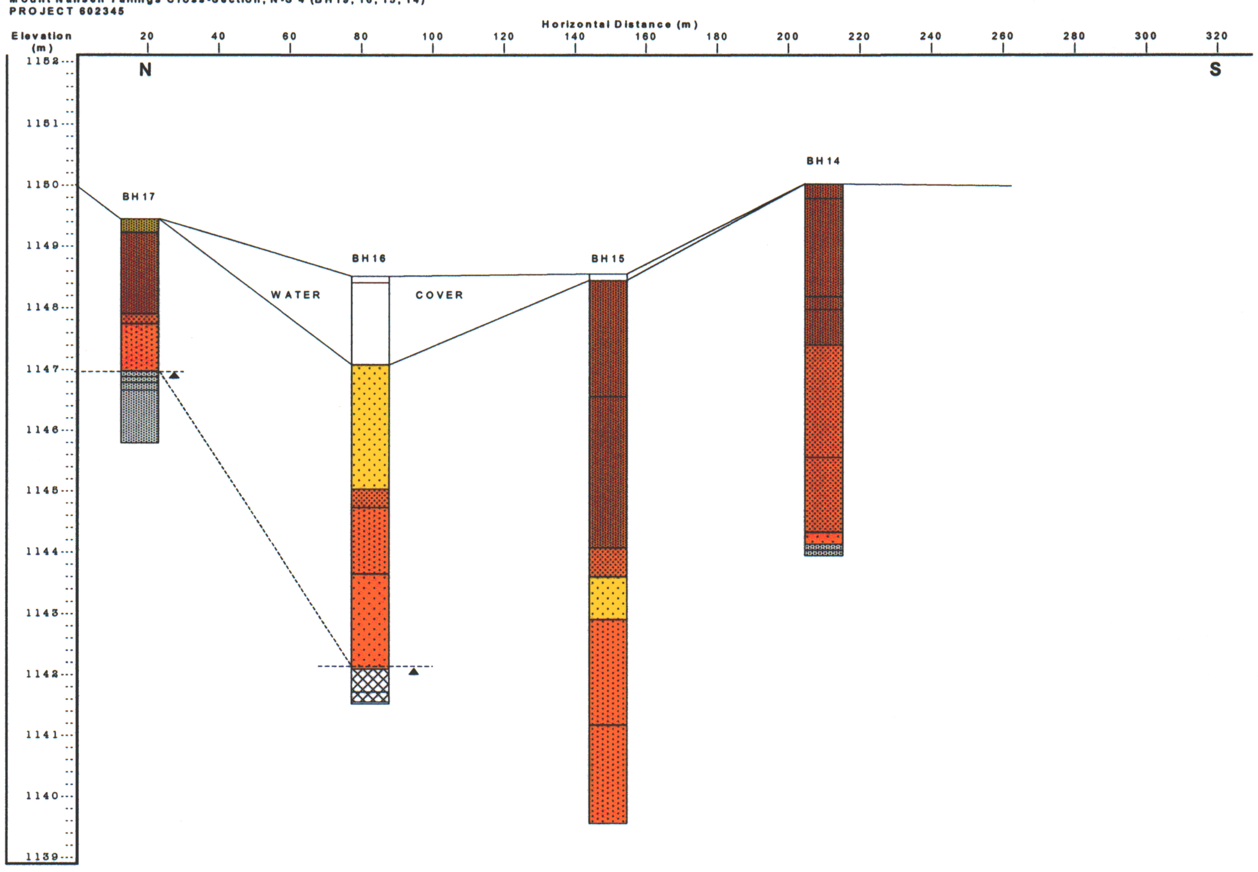
Mount Nansen Tailings Cross-Section, N-S 2 (BH9, 8, 7, 6)
PROJECT 602345



Mount Nansen Tailings Cross-Section, N-S 3 (BH10, 11, 12, 13)
PROJECT 602345



Mount Nansen Tailings Cross-Section, N-S 4 (BH19, 16, 15, 14)
PROJECT 602345



APPENDIX C

Tailings Geochemistry and Particle Size

Appendix C contains the following raw data:

C1. Tailings solids chemistry
   a) Tailings geochemistry as determined by the Analytical Services Group of CANMET-MMSL (**Table C-1a**)
   b) Tailings geochemistry as determined by B.C. Research Inc. (**Table C-1b**)

C2. Acid base accounting analyses of selected tailings solids as determined by B.C. Research Inc. (**Table C-2**)

C3. Porewater chemistry of samples extracted in the field and surface water chemistry at selected locations (Analysis by the Analytical Services Group, CANMET-MMSL) (**Table C-3**).

C4. Detailed particle size analyses of selected samples covering the four varieties of tailings identified (Grain size distribution curves and related data) (**Appendix C-4**)

Table C-1a: Tailings geochemistry as determined by the Analytical Services Group of CANMET-MMSL

	FIELD #	SAMPLE TYPE	Ag µg/g	Al %	As µg/g	B µg/g	Ba µg/g	Bi µg/g	Ca %	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe %	K %
6394 AES-SCAN	MN0101	oxide silt	31	5.56	2700	354	828	<15	2.11	40	7	34	717	5.36	2.03
	MN0103	sulfide silt	24	5.21	2810	557	798	<15	1.96	45	9	26	628	5.88	1.85
	MN0106	oxide silt	20	3.50	2620	165	568	<15	0.623	20	3	17	248	3.65	1.36
	MN0201	sulfide silt	26	5.19	2530	78	832	<15	2.13	39	6	25	880	4.80	1.89
	MN0205	oxide silt	29	4.22	2990	368	699	<15	1.28	34	5	19	529	4.99	1.63
	MN0302	sulfide silt	21	5.15	2020	367	986	<15	1.26	33	7	18	283	4.52	1.90
	DuMN0302	sulfide silt	21	5.23	2020	370	993	<15	1.28	33	7	18	287	4.54	1.91
	MN0304	sulfide silt	27	4.61	2670	373	898	<15	1.19	34	6	23	566	5.10	1.77
	DuMN0304	sulfide silt	n/d	4.64	2670	372	899	<15	1.20	34	7	24	569	5.10	1.78
	MN0402	oxide silt	56	4.07	2650	379	585	<15	2.00	45	5	16	431	4.65	1.43
	MN0405	oxide silt	16	5.53	1440	386	923	<15	1.67	27	8	30	207	4.28	1.76
	DuMN0406	sulfide clay	27	5.05	3080	402	710	<15	2.32	52	10	39	414	5.95	1.76
6395 AES-SCAN	MN0503	sulfide silt	45	4.04	2930	738	628	n/d	1.74	n/d	5	21	455	5.39	1.36
	MN0601	oxide silt	46	5.55	3070	601	818	n/d	2.20	n/d	6	26	745	5.59	1.89
	MN0603	sulfide silt	14	4.58	1950	508	802	15*	1.41	39*	7	26	234	4.95	1.62
	MN0607	sulfide clay	70	7.45	3810	157	1020	26*	1.43	39*	4	36	456	7.31	2.62
	MN0617	sulfide clay	70	7.42	3700	466	1020	6*	1.49	24*	6	36	444	7.31	2.59
	MN0702	sulfide silt	37	4.67	2630	682	698	32*	1.44	33*	4	21	416	5.37	1.71
	DuMN0702	sulfide silt	42	5.26	2760	640	799	32*	1.74	32*	6	29	433	6.04	1.84
	MN0703	oxide silt	41	5.88	2800	425	876	27*	1.60	38*	5	27	577	6.73	2.09
	MN0703F	oxide silt	41	5.89	2970	624	906	26*	1.63	33*	6	29	588	6.77	2.12
	DuMN0703F	oxide silt	41	5.76	2980	625	888	n/d	1.60	n/d	6	29	588	6.64	2.12
	MN0705	oxide clay	40	7.63	4190	239	1020	30*	1.32	27*	6	40	309	6.99	2.65
	MN0705F	oxide clay	42	7.57	4190	468	1020	32*	1.25	27*	5	38	321	7.12	2.72
	DuMN0705F	oxide clay	42	7.24	4200	464	976	n/d	1.20	n/d	5	38	317	6.84	2.66
6396 AES-SCAN	MN0707	oxide silt	23	4.98	3210	580	846	26	0.798	12	6	55	139	4.63	1.73
	DuMN0707	oxide silt	23	5.06	3110	449	854	25	0.792	11	6	70	138	4.55	1.72
	MN0803	sulfide clay	31	6.30	2500	382	860	22	1.62	36	8	20	510	5.82	2.13
	MN0803F	sulfide clay	29	6.08	2440	345	828	23	1.60	35	8	26	469	5.42	2.07
	MN0804	oxide clay	27	6.94	2540	258	969	21	1.57	36	12	30	465	6.21	2.29
	MN0805	sulfide silt	36	4.48	4240	610	712	39	0.567	13	4	32	200	5.54	1.71
	MN0902	sulfide clay	48	5.27	3950	370	834	35	1.39	26	8	18	484	6.65	1.99
	MN0912	sulfide clay	42	5.46	3820	370	836	37	1.40	25	7	22	450	6.70	1.98
	MN0903	sulfide silt	29	4.66	3730	295	815	32	0.657	6	6	41	155	4.84	1.63
	DuMN0903	sulfide silt	29	4.53	3760	298	829	35	0.667	7	7	40	160	4.82	1.67
	MN1002	oxide clay	27	8.46	2460	126	1100	27	1.23	33	9	26	392	6.80	2.84
	MN1003	sulfide clay	60	7.10	4400	264	954	47	1.27	30	8	26	692	7.21	2.61
	DuMN1003	sulfide clay	61	6.97	4400	266	961	51	1.27	29	8	26	720	6.87	2.65
6397 AES-SCAN	MN1003F	sulfide clay	62	7.09	4660	451	1040	77*	1.41	44	8	25	737	7.39	2.68
	DuMN1003F	sulfide clay	62	7.05	4820	393	1030	n/d	1.40	46	8	25	740	7.35	2.68
	MN1004	native sed.	1	6.43	104	296	1210	5*	1.90	2	5	21	202	1.71	1.63
	MN1102	sulfide clay	51	6.62	4070	226	939	41*	1.71	50	9	23	630	7.07	2.42
	MN1103	oxide clay	50	7.58	4120	402	1050	39*	1.27	41	8	21	984	7.85	2.77
	MN1202	oxide clay	28	7.47	2660	378	1080	23*	1.44	46	8	28	372	6.16	2.56
	MN1212	oxide clay	27	7.59	2680	215	1090	22*	1.45	45	10	28	383	6.24	2.59
	MN1204T	oxide clay	56	6.62	5710	456	1040	45*	0.947	41	6	28	238	7.55	2.58
	MN1204B	oxide clay	48	5.59	4830	481	903	41*	0.829	29	5	52	193	6.81	2.20
	DuMN1204B	oxide clay	48	5.57	4860	485	903	n/d	0.829	29	5	52	195	6.78	2.20
	MN1205	native sed.	35	7.21	4060	186	1090	40*	1.01	31	7	66	203	6.03	2.42
	MN1205F	native sed.	35	7.35	3970	382	1100	37*	1.02	31	7	65	212	6.10	2.47
	DuMN1205F	native sed.	35	7.38	3950	381	1100	n/d	1.03	31	n/d	65	210	6.12	2.46
6398 AES-SCAN	MN1206	native sed.	29	6.71	3560	69	1020	28*	1.17	< 1	11	62	421	5.94	2.19
	DuMN1206	native sed.	30	6.75	3280	56	1010	n/d	1.15	n/d	9	61	427	5.95	2.21
	MN1206D	native sed.	28	6.69	3470	192	1020	26*	1.15	101*	9	61	409	5.93	2.19
	MN1207	native sed.	0	6.29	24	91	963	<2*	2.05	< 1*	8	42	27	2.08	1.34
	MN1303	sulfide clay	47	5.84	3240	208	876	27*	1.72	38*	8	32	506	7.00	2.08
	MN1303F	sulfide clay	48	5.83	3380	221	875	28*	1.71	29*	8	31	487	6.99	2.08
	MN1304	oxide clay	58	6.23	4560	254	935	35*	1.47	13*	8	33	367	6.99	2.37
	MN1305	oxide clay	48	6.66	5060	135	1010	36*	1.16	11*	7	35	275	7.30	2.50
	MN1305F	oxide clay	47	6.63	5170	128	1000	37*	1.16	24*	7	36	276	7.28	2.50
	DuMN1305F	oxide clay	47	6.55	5150	127	996	n/d	1.16	n/d	8	36	276	7.29	2.49
	MN1401	oxide silt	35	4.48	3130	258	743	11*	1.45	15*	7	23	339	5.53	1.58
	DuMN1401	oxide silt	35	4.50	3120	258	746	7*	1.45	12*	8	23	337	5.52	1.59
	MN1402	oxide silt	39	4.26	5610	355	749	n/d	1.33	n/d	6	24	238	4.41	1.50
6399 AES-SCAN	MN1406	oxide clay	53	5.38	4920	287	1010	36*	1.06	21*	5	39	260	7.21	2.43
	DuMN1406	oxide clay	54	5.88	4990	159	1050	n/d	1.06	n/d	0	40	256	7.42	2.49
	MN1407	native sed.	3	1.15	275	512	169	<2*	0.585	2*	4	20	13	1.53	0.269
	MN1408	native sed.	1	6.19	30	49	1160	<2*	2.02	< 1*	3	34	11	1.94	1.62
	MN1504	oxide silt	66	4.64	3720	296	719	24*	1.48	30*	6	20	655	5.87	1.92
	MN1506	oxide clay	55	5.56	4480	348	930	27*	1.08	23*	7	22	302	6.22	2.31
	MN1603	oxide silt	38	4.35	2120	259	867	5*	1.13	24*	5	19	188	4.10	1.84
	MN1604	oxide clay	31	5.41	3630	172	921	19*	0.784	12*	2	17	195	5.58	2.32
	MN1605	oxide clay	57	5.55	5380	243	1230	35*	0.865	19*	2	46	367	6.89	2.40
	DuMN1605	oxide clay	58	5.47	5380	243	1230	n/d	0.825	n/d	5	45	364	6.91	2.30

Table C-1a (cont.)

	FIELD #	SAMPLE TYPE	Ag μg/g	Al %	As μg/g	B μg/g	Ba μg/g	Bi μg/kg	Ca %	Cd μg/g	Co μg/g	Cr μg/g	Cu μg/g	Fe %	K %
6400 AES-SCAN	MN1616	native sed.	73	6.93	4570	180	1080	45.6*	0.699	n/d	2	68	228	8.31	2.56
	DuMN1616	native sed.	74	6.88	4600	168	1060	n/d	0.693	n/d	4	72	224	8.12	2.52
	MN1701	sulfide silt	64	3.65	4480	507	647	18.6*	0.733	n/d	6	19	847	6.18	1.39
	MN1704	oxide silt	40	3.91	3980	550	685	15.6*	0.681	n/d	3	19	354	5.51	1.62
	MN1705F	native sed.	27	6.47	1240	131	1160	4.32*	1.58	n/d	4	28	53	2.86	1.78
	MN1802	sulfide clay	26	6.31	2330	199	955	9.02*	1.35	n/d	7	27	385	5.68	2.16
	MN1802F	sulfide clay	24	6.34	2390	384	969	9.55*	1.36	n/d	6	32	380	5.76	2.17
	MN1804	oxide clay	59	7.28	5460	219	1010	35.7*	1.16	n/d	6	25	485	7.80	2.66
	MN1805	oxide clay	46	5.27	4230	311	832	28.6*	0.652	n/d	2	72	197	6.51	2.07
	DuMN1805	oxide clay	45	5.25	4240	311	826	n/d	0.649	n/d	5	70	197	6.52	2.08
	MN1806	oxide silt	58	6.22	4850	270	924	41.5*	0.903	n/d	6	8	358	0.728	0.228
	MN1806D	oxide silt	59	6.23	4850	200	922	43.9*	0.899	n/d	3	56	497	7.21	2.29
	DuMN1806D	oxide silt	59	6.22	4840	200	919	n/d	0.899	n/d	4	53	494	7.41	2.35
6401 AES-SCAN	MN1901	sulfide silt	54	3.93	3670	534	642	13.5*	1.78	n/d	8	10	709	5.56	1.34
	DuMN1901	sulfide silt	50	3.95	3610	373	650	n/d	1.79	n/d	9	10	695	5.55	1.34
	MN1902	sulfide silt	31	4.96	2580	345	811	9.60*	1.62	n/d	8	11	613	5.06	1.70
	MN1905	oxide silt	20	4.59	1910	296	892	4.77*	1.33	n/d	7	13	323	4.56	1.57
	MN1906	sulfide silt	20	4.61	2210	450	1010	3.46*	1.35	n/d	7	16	455	4.44	1.55
	MN1907	oxide silt	24	4.22	2090	388	839	3.98*	1.15	n/d	5	13	609	3.59	1.46
	MN1908	sulfide silt	25	4.58	2310	452	865	7.55*	1.54	n/d	6	14	472	4.50	1.58
	MN1910	oxide clay	47	5.21	6220	790	850	38.5*	0.944	n/d	5	38	188	6.90	2.06
	NWALL1	pit grab	5	8.43	1240	372	1220	0.00*	0.863	n/d	10	11	477	6.11	3.61
	DuNWALL1	pit grab	5	8.42	1220	368	1220	n/d	0.864	n/d	10	11	477	6.11	3.62
	NWALBX	pit grab	117	1.41	1280	381	128	244*	1.73	n/d	30	5	539	33.8	0.565
	WBH3	pit grab	241	4.43	1670	66	652	11.3*	12.9	n/d	13	38	4130	5.15	1.38
	DuWBH3	pit grab	241	4.45	1660	63	655	n/d	13.0	n/d	13	39	4130	5.17	1.38
6402 AES-SCAN	PITSED	pit grab	10	9.44	1460	12	1360	3.14*	1.90	n/d	17	21	412	6.79	2.07
	DuPITSED	pit grab	10	9.23	1490	13	1380	n/d	1.92	n/d	17	25	376	7.12	2.11
	BATCH01	oxide clay composite	56	6.32	4720	47	961	38.5*	1.02	n/d	5	23	580	6.65	2.46
	BATCH02	oxide clay composite	55	6.35	4720	54	959	36.1*	1.03	n/d	6	16	860	6.69	2.47
	BATCH03	oxide clay composite	56	6.21	4750	71	956	38.4*	1.02	n/d	6	34	249	6.61	2.42
	BATCHS1	sulfide clay composite	42	5.76	3520	73	885	25.3*	1.28	n/d	7	15	344	5.84	2.18
	BATCHS1D	sulfide clay composite	43	5.93	3520	68	881	24.3*	1.32	n/d	7	6	350	6.02	2.23
	BATCHS2	suphide clay composite	43	5.95	3480	61	876	24.9*	1.33	n/d	4	25	345	6.16	2.19
	BATCH1E	composite	55	6.22	4880	63	940	33.5*	1.03	n/d	4	22	491	6.62	2.42
	DuBATCH1E	composite	54	6.15	4790	62	967	n/d	1.01	n/d	5	30	451	6.66	2.27

n/d= not determined

* = MS analysis μg/kg (all other data are AES)

Table C-1a (cont.)

FIELD #	SAMPLE TYPE	Li µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Na µg/g	Ni µg/g	P µg/g	Pb µg/g	S %	Sb µg/g	Sr µg/g	V µg/g	Zn µg/g
MN0101	oxide silt	15	4320	2780	4	1500	13	584	1370	2.69	436	149	49	2100
MN0103	sulfide silt	15	5130	3250	2	1380	14	563	1510	3.52	363	102	55	2650
MN0106	oxide silt	17	1520	924	2	1770	7	425	1660	0.696	368	91	40	649
MN0201	sulfide silt	15	3780	2420	2	1740	16	556	1580	2.30	423	147	52	2030
MN0205	oxide silt	17	2310	1740	2	1360	9	500	1980	2.05	445	104	45	1460
MN0302	sulfide silt	13	2960	2070	3	2810	7	532	1410	1.93	276	131	49	1770
DuMN0302	sulfide silt	13	2970	2080	4	2830	10	542	1410	1.95	265	132	50	1770
MN0304	sulfide silt	13	2730	1880	2	2200	10	528	1970	2.08	377	113	47	1610
DuMN0304	sulfide silt	13	2740	1870	3	2200	10	526	1980	2.07	379	113	47	1610
MN0402	oxide silt	16	3880	2690	6	688	10	442	1450	3.28	560	118	37	2170
MN0405	oxide silt	11	4320	2080	3	6690	14	590	925	1.27	205	190	60	1460
DuMN0406	sulfide clay	10	5530	3370	4	3660	16	521	1890	3.52	433	144	55	2710
MN0503	sulfide silt	23	4170	2770	<5	874	4	n/d	1750	4.15	41500	121	36	2630
MN0601	oxide silt	27	4760	3040	<5	777	5	n/d	2100	3.05	30500	145	49	2940
MN0603	sulfide silt	25	3830	2730	<5	1810	8	70.17*	1150	2.38	23800	111	47	2040
MN0607	sulfide clay	29	3720	2290	<5	1900	6	93.70*	3760	1.99	19900	155	79	2560
MN0617	sulfide clay	31	3780	2290	<5	1910	7	112.4*	3760	1.65	16500	154	79	2670
MN0702	sulfide silt	19	3730	2600	<5	630	5	160.9*	1980	2.74	27400	111	45	2470
DuMN0702	sulfide silt	26	4110	2850	<5	706	6	169.0*	2170	3.10	31000	118	49	2960
MN0703	oxide silt	28	4100	2650	<5	1390	5	147.0*	2700	2.38	23800	124	60	2610
MN0703F	oxide silt	27	4140	2650	<5	1380	6	166.9*	2750	3.69	36900	124	61	2730
DuMN0703F	oxide silt	27	4160	2590	<5	1380	5	n/d	2760	2.39	23900	124	61	2670
MN0705	oxide clay	32	3510	2120	<5	1760	9	157.3*	3750	1.42	14200	146	82	1970
MN0705F	oxide clay	32	3450	2150	<5	1640	7	160.3*	3780	1.38	13800	144	84	1940
DuMN0705F	oxide clay	31	3460	2060	<5	1590	7	n/d	3790	1.59	15900	142	83	1850
MN0707	oxide silt	22	2290	1510	4	2390	4	564	2730	0.619	392	134	55	961
DuMN0707	oxide silt	27	2250	1500	4	2440	5	541	2680	0.607	510	135	55	922
MN0803	sulfide clay	26	4870	2990	2	1180	3	586	1970	2.50	430	116	65	2610
MN0803F	sulfide clay	29	4910	2860	1	1080	1	565	1920	2.40	408	114	64	2480
MN0804	oxide clay	28	4590	3120	1	1350	10	641	2140	2.29	417	124	70	2550
MN0805	sulfide silt	26	1870	1040	3	1230	3	488	3740	1.04	536	102	49	879
MN0902	sulfide clay	27	3230	2070	1	1110	3	610	3140	2.47	436	121	59	1880
MN0912	sulfide clay	21	3210	2060	1	1110	3	585	3060	2.39	594	119	58	1850
MN0903	sulfide silt	18	3220	836	1	4180	13	466	3710	0.784	700	141	64	558
DuMN0903	sulfide silt	19	3200	835	1	4300	14	477	3710	0.794	709	143	64	559
MN1002	oxide clay	28	3660	2900	2	1420	6	732	2350	1.35	358	136	81	2400
MN1003	sulfide clay	30	3840	1860	2	1880	3	651	4480	2.25	746	150	77	1990
DuMN1003	sulfide clay	30	3830	1850	2	1910	4	649	4480	2.25	756	151	77	1990
MN1003F	sulfide clay	27	4040	1940	6	2640	7	719	4520	2.39	831*	147*	76	2110
DuMN1003F	sulfide clay	29	4000	1940	5	2650	7	738	4570	2.37	n/d	n/d	77	2090
MN1004	native sed.	6	4590	361	3	24900	8	323	96	0.0637	330*	438*	44	183
MN1102	sulfide clay	30	4410	2500	3	1810	6	707	3750	2.79	571*	140*	68	2440
MN1103	oxide clay	29	3560	2310	6	1840	7	773	3470	1.86	502*	152*	76	2210
MN1202	oxide clay	28	4370	3210	3	2420	6	728	2060	1.60	312*	120*	73	2580
MN1212	oxide clay	28	4440	3260	4	2410	7	719	2070	1.62	286*	125*	73	2620
MN1204T	oxide clay	31	2850	1680	3	1990	6	786	5700	1.45	912*	128*	71	1510
MN1204B	oxide clay	24	2420	1360	4	2180	7	689	4450	1.30	596*	116*	60	1030
DuMN1003F	oxide clay	25	2410	1360	4	2190	6	691	4450	1.30	n/d	n/d	61	1030
MN1205	native sed.	33	3180	1720	5	3690	8	681	3880	0.932	547*	159	76	1300
MN1205F	native sed.	31	3250	1730	6	3650	8	685	3930	0.945	560*	159	77	1310
DuMN1205F	native sed.	30	3280	1740	5	3660	9	678	3950	0.943	n/d	159	77	1330
MN1206	native sed.	33	3040	1810	<4	2880	12	132*	4130	1.08	681	157	73	1360
DuMN1206	native sed.	32	3000	1810	<4	2900	11	n/d	4110	1.06	706	157	73	1330
MN1206D	native sed.	32	2920	1810	<4	2800	11	148*	3930	1.08	701	157	72	1320
MN1207	native sed.	13	7100	442	<4	19900	15	197*	30	0.147	8	386	72	131
MN1303	sulfide clay	29	3540	2280	4	783	8	104*	3480	3.01	610	125	62	2540
MN1303F	sulfide clay	29	3530	2270	8	774	7	147*	3510	3.04	569	124	62	2530
MN1304	oxide clay	30	3150	2050	<4	1150	6	175*	4550	1.96	812	139	68	2120
MN1305	oxide clay	31	2920	1910	<4	1190	7	171*	4600	1.55	1010	142	74	1670
MN1305F	oxide clay	32	2980	1860	<4	1190	8	256*	4690	1.55	1050	141	74	1660
DuMN1305F	oxide clay	32	2960	1870	<4	1180	8	n/d	4640	1.54	1050	141	74	1650
MN1401	oxide silt	20	3080	2090	<4	1400	6	129*	2260	2.74	398	106	46	2100
DuMN1401	oxide silt	20	3110	2090	<4	1390	7	12.8*	2280	2.74	400	106	47	2100
MN1402	oxide silt	24	2140	1510	<4	2350	6	n/d	2400	1.70	709	130	47	1700
MN1406	oxide clay	36	2890	1550	90	1640	<15	68.5*	5550	1.49	920	128	72	1420
DuMN1406	oxide clay	33	2880	1590	101	1710	<15	n/d	5480	1.53	862	139	73	1410
MN1407	native sed.	6	2920	204	12	1520	7	0.00*	107	0.0717	7	46	42	188
MN1408	native sed.	9	6880	413	112	22300	<15	0.00*	20	0.0356	3	462	59	70
MN1504	oxide silt	30	3070	1980	82	966	<15	23.8*	3270	2.20	735	125	55	2020
MN1506	oxide clay	34	2600	1870	90	897	<15	72.1*	4200	1.23	989	123	68	1610
MN1603	oxide silt	29	2370	2040	69	1470	<15	81.6*	1790	1.07	428	111	54	1620
MN1604	oxide clay	25	2250	1810	89	984	<15	18.3*	1870	0.925	356	107	69	1110
MN1605	oxide clay	32	3000	1120	94	1800	<15	32.9*	5580	1.34	1010	146	70	1030
DuMN1605	oxide clay	31	3040	n/d	94	1720	<15	n/d	5550	1.34	1000	147	71	1040

Table C-1a (cont.)

FIELD #	SAMPLE TYPE	Li µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Na µg/g	Ni µg/g	P µg/kg	Pb µg/g	S %	Sb µg/kg	Sr µg/g	V µg/g	Zn µg/g
MN1616	native sed.	30	2660	1320	123	1650	<7	154*	4780	1.49	546*	154	70	939
DuMN1616	native sed.	29	2600	1340	123	1620	<7	n/d	4770	1.46	n/d	153	71	920
MN1701	sulfide silt	28	2500	1290	66	1170	<7	67.4*	2950	3.78	490*	92	45	1780
MN1704	oxide silt	27	2170	1080	71	1370	<7	460*	2200	2.14	428*	99	51	1230
MN1705F	native sed.	13	4180	532	118	18300	<7	69.6*	1350	0.332	198*	382	49	260
MN1802	sulfide clay	28	3650	3100	114	1550	<7	180*	1850	1.62	256*	123	66	2340
MN1802F	sulfide clay	29	3700	3130	118	1590	<7	144*	1860	1.66	227*	124	65	2360
MN1804	oxide clay	33	3160	1850	136	1200	<7	229*	5460	1.45	791*	140	79	1770
MN1805	oxide clay	32	2210	1430	100	1290	<7	109*	4530	1.15	566*	116	59	1100
DuMN1805	oxide clay	32	2210	1430	98	1280	<7	n/d	4520	1.14	n/d	116	58	1100
MN1806	oxide silt	34	267	1530	113	135	<7	140*	5610	0.140	669*	137	68	132
MN1806D	oxide silt	34	2650	1530	115	1340	<7	80.5*	5530	1.38	500*	137	68	1370
DuMN1806D	oxide silt	34	2710	1530	116	1370	<7	n/d	5550	1.41	n/d	137	68	1410
MN1901	sulfide silt	29	4320	2830	<6	1070	2	56.1*	1760	4.21	575*	116	44	2850
DuMN1901	sulfide silt	30	4360	2840	7	1100	1	n/d	1670	4.19	n/d	117	45	2860
MN1902	sulfide silt	30	4250	2820	<6	1630	1	76.3*	1470	2.76	351*	116	60	2650
MN1905	oxide silt	28	3720	2340	<6	2950	1	85.2*	1090	2.39	224*	121	63	2050
MN1906	sulfide silt	25	3570	1800	<6	4630	4	116*	1140	2.31	232*	152	60	1800
MN1907	oxide silt	26	2960	1690	<6	3800	2	97.2*	1020	1.74	250*	135	52	1670
MN1908	sulfide silt	26	3320	2010	<6	2970	1	21.0*	1300	2.32	263*	129	57	1970
MN1910	oxide clay	30	3070	861	<6	4000	4	131*	6420	1.28	622*	147	69	761
NWALL1	pit grab	12	4100	303	<6	2460	46	168*	721	3.72	121*	116	67	319
DuNWALL1	pit grab	12	4100	304	<6	2470	48	n/d	721	3.73	n/d	116	67	322
NWALBX	pit grab	24	2980	1160	<6	177	1	0.00*	4350	38.0	234*	36	17	2290
WBH3	pit grab	18	7630	3100	10	3520	50	106*	1090	1.29	188*	292	63	2410
DuWBH3	pit grab	18	7650	3120	7	3560	51	n/d	1090	1.28	n/d	290	63	2430
PITSED	pit grab	32	9680	5830	11	4410	10	270*	564	0.815	168*	266	168	3270
DuPITSED	pit grab	29	9360	5900	10	4190	12	n/d	566	0.968	n/d	271	160	3290
BATCH01	oxide clay composite	31	2670	1640	7	1350	8	222*	4470	1.35	860*	132	75	1640
BATCH02	oxide clay composite	30	2670	1670	6	1340	10	103*	4400	1.37	759*	133	76	1790
BATCH03	oxide clay composite	30	2650	1630	7	1340	8	196*	4460	1.37	778*	130	74	1470
BATCHS1	sulfide clay composite	30	3260	2140	5	1380	8	89.3*	2700	1.85	406*	126	69	1850
BATCHS1D	sulfide clay composite	29	3260	2190	6	1320	8	101*	2690	1.88	390*	128	72	1900
BATCHS2	suphide clay composite	29	3210	2200	6	1330	11	77.8*	2700	1.92	468*	127	77	1930
BATCH1E	composite	31	2630	1640	7	1350	7	117*	4530	1.35	816*	130	76	1570
DuBATCH1E	composite	30	2660	1650	7	1200	7	n/d	4420	1.33	n/d	126	76	1590

n/d= not determined
* = MS analysis µg/kg (all other data are AES)

Table C-1b: Tailings Geochmistry of selected samples by B.C. Research Inc.

Metal Contents of tailings solids

Field #	Sample Type	Ag µg/g	Al %	As µg/g	Au µg/g	Ba µg/g	Be µg/g	Bi µg/g	Ca %	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe %	K %	La µg/g	Mg %
ENDADIT	pit grab	7.1	7.33	837	5	847	1	12	2.49	12.0	9	11	44.0	5.88	2.96	8	0.83
NWALLCU	pit grab	45.3	4.93	2536	< 4	252	1	75	1.94	29.3	6	6	7438	5.66	2.02	7	0.29
MNOMIX	oxide silt composite	35.6	4.25	2796	< 4	558	1	20	0.770	14.2	3	13	290	4.85	1.79	11	0.24
MNSMIX	sulfide silt composite	42.3	5.56	2274	< 4	788	1	20	1.43	26.9	6	16	365	5.02	2.02	14	0.37
SOMIX	s-o silt composite	31.8	5.00	2468	< 4	383	2	16	1.23	20.8	4	18	285	4.87	1.96	14	0.33
SLURRY	s-o silt composite	35.6	5.06	2473	< 4	598	1	21	1.18	20.3	3	21	312	4.94	1.94	13	0.33
MN0102	oxide silt	25.0	6.59	2370	< 4	559	2	18	1.71	26.5	6	35	437	5.22	2.32	17	0.41
MN0104	sulfide silt	48.7	5.02	2349	< 4	696	1	8	1.29	25.2	4	15	400	5.14	1.92	16	0.34
MN0203	sulfide silt	23.8	5.25	2174	< 4	657	1	18	1.48	24.8	4	14	256	5.04	1.97	14	0.38
MN0304	sulfide silt	32.0	5.36	2604	< 4	539	1	30	1.30	23.9	4	23	599	5.16	2.07	13	0.33
MN0401	sulfide silt	52.1	5.49	1728	< 4	848	1	18	2.23	36.9	8	13	398	5.81	2.00	18	0.55
MN0402	oxide silt	54.3	4.64	1863	< 4	628	1	21	2.10	32.5	4	10	412	4.56	1.76	14	0.47
MN0404	sulfide silt	16.1	5.75	1285	< 4	322	1	16	1.64	18.7	6	19	199	4.06	2.00	15	0.45
MN0501	oxide silt	52.1	5.49	1637	< 4	820	1	26	2.13	33.2	8	17	679	5.46	1.98	17	0.55
MN0502	oxide silt	53.8	4.89	1888	< 4	715	1	23	1.90	34.2	7	12	512	5.51	1.83	17	0.49
MN0503	sulfide silt	76.9	4.86	1924	< 4	537	1	23	1.83	37.4	7	18	524	5.89	1.77	13	0.47
MN0505	sulfide silt	9.7	6.57	349	< 4	282	1	< 5	2.12	8.00	7	39	86.0	3.18	1.89	15	0.66
MN0506T	native sediments	1.0	7.32	17.0	< 4	1069	2	< 5	2.72	0.70	8	47	9.00	2.57	1.82	25	0.90
MN0506B	native sediments	< 0.5	7.52	14.0	< 4	957	2	< 5	3.64	0.60	9	56	49.0	2.81	1.77	26	1.07
MN0605	sulfide silt	25.1	5.12	1427	< 4	555	1	16	1.54	28.0	7	19	315	5.08	1.94	14	0.47
MN0608	sulfide clay	7.5	7.25	523	< 4	1124	2	< 5	2.97	5.00	7	35	66.0	2.62	1.99	16	0.76
MN0609	native sediments	< 0.5	6.90	21.0	< 4	1138	1	< 5	2.92	0.40	7	35	13.0	1.81	1.92	15	0.76
MN0805	sulfide silt	45.9	5.51	5494	< 4	330	1	46	0.750	12.5	2	33	221	5.94	2.18	16	0.25
MN0903	sulfide silt	36.3	5.36	4634	< 4	656	1	35	0.840	6.40	6	49	172	5.02	2.05	20	0.39
MN1204B	oxide clay	55.4	6.12	5617	< 4	379	1	58	0.930	13.1	2	66	201	6.91	2.48	13	0.27
MN1206	native sediments	37.1	6.92	3847	< 4	297	1	39	1.20	17.1	8	65	428	5.87	2.49	13	0.33
MN1305	oxide clay	61.5	7.13	5961	< 4	272	1	51	1.27	24.3	3	32	288	7.43	2.85	15	0.33
MN1405	oxide silt	28.1	5.27	2554	< 4	465	1	13	1.60	19.5	4	21	163	4.23	2.05	16	0.27
MN1406	oxide clay	57.3	6.81	6106	< 4	226	1	61	1.17	22.5	2	47	227	7.82	2.87	16	0.32
MN1407	native sediments	2.8	6.30	267	< 4	1068	1	< 5	2.25	2.10	7	40	11.0	2.23	1.85	21	0.68
MN1502	oxide silt	25.7	3.98	2158	< 4	169	1	24	0.480	14.9	4	16	264	5.08	1.85	12	0.22
MN1607	native sediments	7.4	5.59	131	< 4	1057	1	8	1.98	0.60	5	40	37.0	1.81	1.80	19	0.59
MN1702	oxide silt	46.7	3.85	3808	< 4	294	1	26	0.790	18.1	3	14	404	5.04	1.77	9	0.26
MN1703	oxide silt	33.7	3.72	4394	< 4	228	1	39	0.570	9.30	2	19	210	4.88	1.86	9	0.21
MN1705	native sediments	27.8	5.26	1330	< 4	843	2	16	1.53	3.60	3	36	53.0	2.60	2.05	12	0.42
MN1706	native sediments	28.6	5.43	911	< 4	1072	1	8	1.63	1.80	4	36	40.0	2.33	2.07	14	0.42
MN1904	sulfide silt	28.3	4.94	1854	< 4	731	1	16	1.61	28.2	5	21	402	4.59	1.91	16	0.40
MN1909	native sediments	1.5	6.83	57.0	< 4	989	1	< 5	3.26	1.00	7	47	20.0	2.23	1.80	22	0.85
BATCHO3	oxide clay composite	61.5	6.64	5698	< 4	277	1	56	1.15	22.2	3	37	268	6.72	2.67	14	0.29
BATCHS3	sulfide clay composite	48.1	6.32	3836	< 4	223	1	46	1.50	27.5	4	23	386	6.23	2.50	14	0.34
DuMN0304	sulfide silt	32.3	5.22	2501	< 4	508	1	18	1.26	21.9	4	18	538	5.02	2.04	13	0.33
DuMN0605	sulfide silt	23.2	5.16	1378	< 4	581	1	13	1.56	26.8	7	20	302	5.15	1.97	14	0.48
DuMN1407	native sediments	2.5	6.54	277	< 4	1113	2	< 5	2.28	2.30	7	40	12.0	2.24	1.88	21	0.70
DuBATCHS3	sulfide clay composite	46.9	6.01	3778	< 4	174	1	45	1.46	26.8	4	25	374	6.10	2.46	13	0.34

Table C-1b (cont.)

Field #	Sample Type	Mn µg/g	Mo µg/g	Na %	Nb µg/g	Ni µg/g	P µg/g	Pb µg/g	Sb µg/g	Sc µg/g	Sn µg/g	Sr µg/g	Th µg/g	Ti µg/g	U µg/g	V µg/g
ENDADIT	pit grab	5484	3	0.03	2	7	310	427	68.0	4	5	55.0	< 2	600	10	34
NWALLCU	pit grab	312	2	0.04	2	< 2	810	5700	990	7	6	113	4	900	< 10	59
MNOMIX	oxide silt composite	1332	2	0.10	4	4	440	1470	386	5	3	96.0	3	1200	< 10	44
MNSMIX	sulfide silt composite	2379	2	0.16	5	4	600	1800	433	6	4	125	3	1400	15	53
SOMIX	s-o silt composite	2071	< 2	0.15	4	6	580	1758	375	5	4	114	4	1500	18	52
SLURRY	s-o silt composite	2059	2	0.15	5	5	530	1644	375	5	4	117	3	1600	< 10	51
MN0102	oxide silt	2601	< 2	0.14	5	6	660	1576	370	6	4	147	3	1400	20	58
MN0104	sulfide silt	2360	2	0.13	6	4	510	1830	542	5	4	117	5	1300	< 10	46
MN0203	sulfide silt	2491	< 2	0.20	5	3	570	1544	320	5	< 2	129	3	1400	< 10	48
MN0304	sulfide silt	2120	2	0.21	5	7	610	2059	412	5	4	126	4	1500	< 10	51
MN0401	sulfide silt	3597	< 2	0.07	5	8	580	1553	617	5	4	122	4	1200	19	41
MN0402	oxide silt	2777	< 2	0.06	5	5	480	1576	629	4	5	134	3	1100	< 10	37
MN0404	sulfide silt	2153	< 2	0.56	6	9	620	962	191	7	3	187	3	2000	12	60
MN0501	oxide silt	3482	2	0.09	5	5	520	1402	518	5	4	128	4	1200	11	41
MN0502	oxide silt	3321	< 2	0.07	5	5	470	1749	685	4	4	123	4	1200	22	39
MN0503	sulfide silt	2909	< 2	0.10	5	5	470	2006	804	4	4	136	3	1000	10	39
MN0505	sulfide silt	1216	2	1.71	6	12	590	419	77	7	3	361	3	2100	< 10	64
MN0506T	native sediments	599	< 2	2.41	7	14	580	21.0	5	10	3	487	6	3400	< 10	85
MN0506B	native sediments	672	< 2	2.43	8	16	650	22.0	< 5	11	< 2	503	5	3600	< 10	95
MN0605	sulfide silt	2993	< 2	0.18	6	7	590	1343	299	5	3	113	4	1500	15	50
MN0608	sulfide clay	758	2	2.17	6	11	550	472	81	8	2	458	3	2400	< 10	66
MN0609	native sediments	467	< 2	2.42	6	12	440	21.0	5	7	2	485	8	2300	< 10	59
MN0805	sulfide silt	1268	3	0.15	5	5	640	4352	773	6	5	123	5	1400	14	59
MN0903	sulfide silt	1018	2	0.45	5	17	590	4180	733	7	3	162	5	1500	< 10	72
MN1204B	oxide clay	1541	4	0.15	4	7	730	4971	882	7	7	139	4	1400	< 10	69
MN1206	native sediments	1971	3	0.30	2	13	800	4351	704	8	6	154	3	1200	< 10	77
MN1305	oxide clay	2124	< 2	0.14	2	8	830	5238	1084	8	5	145	4	1500	10	80
MN1405	oxide silt	2260	2	0.19	6	6	650	1248	262	6	4	128	3	1700	< 10	52
MN1406	oxide clay	1753	3	0.19	2	10	820	6431	1112	7	5	142	4	1500	< 10	80
MN1407	native sediments	523	< 2	2.24	6	11	510	118	19.0	7	< 2	446	5	2500	16	69
MN1502	oxide silt	1470	< 2	0.05	3	5	470	1446	235	4	2	68	4	1500	< 10	46
MN1607	native sediments	534	2	1.91	5	12	540	47.0	8	7	4	361	4	2400	< 10	62
MN1702	oxide silt	1205	< 2	0.10	2	3	440	2052	564	5	4	89.0	3	1500	< 10	45
MN1703	oxide silt	750	2	0.10	3	4	500	2738	450	5	2	103	< 2	1500	< 10	48
MN1705	native sediments	581	2	1.70	5	10	440	1245	248	5	6	343	4	1700	< 10	50
MN1706	native sediments	521	< 2	1.90	4	11	410	893	147	5	9	378	4	1700	< 10	54
MN1904	sulfide silt	2633	< 2	0.18	4	7	560	1420	375	5	4	122	4	1500	< 10	47
MN1909	native sediments	585	< 2	2.19	5	14	500	67.0	13	9	2	462	6	2800	11	73
BATCHO3	oxide clay composite	1875	2	0.11	2	8	740	4804	1020	8	6	133	4	1500	10	74
BATCHS3	sulfide clay composite	2483	2	0.12	2	7	740	2888	507	7	5	128	3	1500	< 10	69
MN0304	sulfide silt	2086	2	0.20	5	6	580	2080	390	5	4	124	3	1300	12	49
MN0605	sulfide silt	3045	2	0.18	5	6	560	1283	270	5	3	114	2	1500	< 10	50
MN1407	native sediments	525	2	2.27	10	9	500	128	19.0	7	< 2	462	4	2600	< 10	67
BATCHS3	sulfide clay composite	2423	< 2	0.12	2	8	730	2818	506	7	4	125	4	1600	< 10	72

Table C-1b (cont.)

Field #	Sample Type	W µg/g	Y µg/g	Zn µg/g	Zr µg/g	TOT/S %	CO_2 %
ENDADIT	pit grab	< 4	6	989	10	5.63	3.89
NWALLCU	pit grab	4	5	306	43	6.33	0.04
MNOMIX	oxide silt composite	< 4	5	1023	34	2.30	0.58
MNSMIX	sulfide silt composite	< 4	7	1937	32	2.36	1.31
SOMIX	s-o silt composite	< 4	6	1525	31	2.23	1.04
SLURRY	s-o silt composite	< 4	6	1525	35	2.28	1.12
MN0102	oxide silt	< 4	7	1977	31	2.06	1.42
MN0104	sulfide silt	< 4	6	1834	32	2.70	1.12
MN0203	sulfide silt	< 4	7	1920	30	2.53	1.23
MN0304	sulfide silt	< 4	6	1755	29	2.24	1.15
MN0401	sulfide silt	< 4	8	2766	38	4.06	2.58
MN0402	oxide silt	< 4	7	2376	32	3.43	2.08
MN0404	sulfide silt	< 4	9	1437	26	1.48	1.00
MN0501	oxide silt	< 4	8	2535	44	3.80	2.62
MN0502	oxide silt	< 4	7	2559	33	4.10	2.08
MN0503	sulfide silt	< 4	6	2607	31	4.33	1.96
MN0505	sulfide silt	< 4	8	634	22	0.96	0.77
MN0506T	native sediments	< 4	14	43.0	34	< .02	< .03
MN0506B	native sediments	< 4	16	48.0	25	0.03	0.77
MN0605	sulfide silt	< 4	8	2189	33	2.76	1.85
MN0608	sulfide clay	< 4	12	355	20	0.30	0.81
MN0609	native sediments	< 4	9	40.0	16	< .02	0.85
MN0805	sulfide silt	< 4	5	915	32	1.19	0.46
MN0903	sulfide silt	< 4	7	504	31	0.84	0.23
MN1204B	oxide clay	< 4	5	1002	29	1.36	0.38
MN1206	native sediments	< 4	8	1251	20	1.16	0.77
MN1305	oxide clay	4	6	1633	29	1.54	0.62
MN1405	oxide silt	< 4	7	1473	28	1.28	0.65
MN1406	oxide clay	< 4	6	1393	27	1.62	0.58
MN1407	native sediments	< 4	11	160	21	0.06	0.04
MN1502	oxide silt	< 4	5	1151	32	2.43	0.59
MN1607	native sediments	< 4	10	70.0	21	0.04	0.04
MN1702	oxide silt	< 4	4	1289	24	3.00	0.51
MN1703	oxide silt	< 4	4	745	25	1.63	0.29
MN1705	native sediments	< 4	6	217	21	0.35	0.11
MN1706	native sediments	< 4	7	163	17	0.24	0.11
MN1904	sulfide silt	< 4	7	2090	32	2.72	1.47
MN1909	native sediments	< 4	12	85.0	20	0.06	0.99
BATCHO3	oxide clay composite	< 4	6	1467	29	1.48	0.51
BATCHS3	sulfide clay composite	< 4	7	1983	32	2.19	0.95
MN0304	sulfide silt	< 4	7	1648	33	2.13	1.12
MN0605	sulfide silt	< 4	8	2110	32	2.69	1.89
MN1407	native sediments	< 4	11	159	20	0.06	0.04
BATCHS3	sulfide clay composite	< 4	6	1940	32	2.15	0.95

Table C-2: Acid base accounting characteristics of selected samples

ABA Results
by BC Research

Field #	Sample Type	Paste pH	CO_2 Inorg. (Wt.%)	$CaCO_3$ Equiv. (Kg $CaCO_3$/ Tonne)	Total Sulfur (Wt.%)	Sulfate Sulfur (Wt.%)	sulfide Sulfur* (Wt.%)	Maximum Potential Acidity** (Kg $CaCO_3$/ Tonne)	Neutralization Potential (Kg $CaCO_3$/ Tonne)
ENDADIT	pit grab	7.0	3.89	88.3	5.63	0.47	5.16	161.3	69.2
NWALLCU	pit grab	3.5	0.04	0.91	6.33	1.76	4.57	142.8	-4.4
MNOMIX	oxide silt composite	7.7	0.58	13.2	2.30	0.29	2.01	62.8	11.1
MNSMIX	sulfide silt composite	8.0	1.31	29.7	2.36	0.50	1.86	58.1	24.9
SOMIX	s-o silt composite	8.1	1.04	23.6	2.23	0.36	1.87	58.4	20.4
SLURRY	s-o silt composite	7.9	1.12	25.4	2.28	0.37	1.91	59.7	19.5
MN0102	oxide silt	7.7	1.42	32.2	2.06	0.63	1.43	44.7	26.8
MN0104	sulfide silt	7.7	1.12	25.4	2.70	0.45	2.25	70.3	19.2
MN0203	sulfide silt	7.4	1.23	27.9	2.53	0.52	2.01	62.8	22.4
MN0304	sulfide silt	8.3	1.15	26.1	2.24	0.39	1.85	57.8	20.9
MN0401	sulfide silt	8.0	2.58	58.6	4.06	0.79	3.27	102.2	39.5
MN0402	oxide silt	8.1	2.08	47.2	3.43	0.81	2.62	81.9	36.6
MN0404	sulfide silt	8.0	1.00	22.7	1.48	0.30	1.18	36.9	22.7
MN0501	oxide silt	7.5	2.62	59.5	3.80	0.84	2.96	92.5	42.9
MN0502	oxide silt	6.8	2.08	47.2	4.10	0.75	3.35	104.7	37.2
MN0503	sulfide silt	6.8	1.96	44.5	4.33	0.69	3.64	113.8	31.7
MN0505	sulfide silt	8.0	0.77	17.5	0.96	0.09	0.87	27.2	16.0
MN0506T	native sediments	7.1	<0.03	<0.7	<0.02	<0.01	<0.02	<0.6	3.0
MN0506B	native sediments	7.6	0.77	17.5	0.03	0.02	0.01	0.3	23.6
MN0605	sulfide silt	8.2	1.85	42.0	2.76	0.37	2.39	74.7	34.7
MN0608	sulfide clay	8.0	0.81	18.4	0.30	0.09	0.21	6.6	20.8
MN0609	native sediments	8.2	0.85	19.3	<0.02	<0.01	<0.02	<0.6	21.3
MN0805	sulfide silt	8.5	0.46	10.4	1.19	0.44	0.75	23.4	12.4
MN0903	sulfide silt	8.2	0.23	5.2	0.84	0.25	0.59	18.4	8.2
MN1204B	oxide clay	9.0	0.38	8.6	1.36	0.13	1.23	38.4	14.1
MN1206	native sediments	7.0	0.77	17.5	1.16	0.15	1.01	31.6	14.9
MN1305	oxide clay	9.1	0.62	14.1	1.54	0.32	1.22	38.1	17.3
MN1405	oxide silt	8.4	0.65	14.8	1.28	0.85	0.43	13.4	17.3
MN1406	oxide clay	8.6	0.58	13.2	1.62	0.31	1.31	40.9	17.6
MN1407	native sediments	7.7	0.04	0.9	0.06	0.06	< 0.02	<0.6	3.0
MN1502	oxide silt	7.4	0.59	13.4	2.43	0.11	2.32	72.5	12.4
MN1607	native sediments	6.1	0.04	0.9	0.04	0.04	0.00	0.0	1.7
MN1702	oxide silt	7.0	0.51	11.6	3.00	0.36	2.64	82.5	12.1
MN1703	oxide silt	7.2	0.29	6.6	1.63	0.32	1.31	40.9	7.4
MN1705	native sediments	8.7	0.11	2.5	0.35	0.12	0.23	7.2	4.2
MN1706	native sediments	8.6	0.11	2.5	0.24	0.17	0.07	2.2	4.5
MN1904	sulfide silt	7.8	1.47	33.4	2.72	0.43	2.29	71.6	29.5
MN1909	native sediments	8.2	0.99	22.5	0.06	0.02	0.04	1.3	24.8
BATCHO3	oxide clay composite	8.6	0.51	11.6	1.48	0.65	0.83	25.9	14.1
BATCHS3	sulfide clay composite	8.3	0.95	21.6	2.19	0.89	1.30	40.6	18.8

*Based on difference between total sulfur and sulfate-sulfur

**Based on sulfide-sulfur

Table C-2 (cont.)

Field #	Sample Type	Net Neutralization Potential (Kg $CaCO_3$/ Tonne)	Fizz Rating	Acid Used (mL/N)
ENDADIT	pit grab	-92.1	none	40/0.1
NWALLCU	pit grab	-147.2	none	20/0.1
MNOMIX	oxide silt composite	-51.7	none	20/0.1
MNSMIX	sulfide silt composite	-33.2	none	20/0.1
SOMIX	s-o silt composite	-38.0	none	20/0.1
SLURRY	s-o silt composite	-40.2	none	20/0.1
MN0102	oxide silt	-17.9	none	20/0.1
MN0104	sulfide silt	-51.1	none	20/0.1
MN0203	sulfide silt	-40.4	none	20/0.1
MN0304	sulfide silt	-36.9	none	20/0.1
MN0401	sulfide silt	-62.7	none	30/0.1
MN0402	oxide silt	-45.3	none	30/0.1
MN0404	sulfide silt	-14.2	none	20/0.1
MN0501	oxide silt	-49.6	slight	40/0.1
MN0502	oxide silt	-67.5	slight	40/0.1
MN0503	sulfide silt	-82.1	none	25/0.1
MN0505	sulfide silt	-11.2	none	20/0.1
MN0506T	native sediments	3.0	none	20/0.1
MN0506B	native sediments	23.3	slight	40/0.1
MN0605	sulfide silt	-40.0	slight	40/0.1
MN0608	sulfide clay	14.2	slight	40/0.1
MN0609	native sediments	21.3	slight	40/0.1
MN0805	sulfide silt	-11.0	none	20/0.1
MN0903	sulfide silt	-10.2	none	20/0.1
MN1204B	oxide clay	-24.3	none	20/0.1
MN1206	native sediments	-16.7	none	20/0.1
MN1305	oxide clay	-20.8	none	20/0.1
MN1405	oxide silt	3.9	none	20/0.1
MN1406	oxide clay	-23.3	none	20/0.1
MN1407	native sediments	3.0	none	20/0.1
MN1502	oxide silt	-60.1	none	20/0.1
MN1607	native sediments	1.7	none	20/0.1
MN1702	oxide silt	-70.4	none	20/0.1
MN1703	oxide silt	-33.5	none	20/0.1
MN1705	native sediments	-3.0	none	20/0.1
MN1706	native sediments	2.3	none	20/0.1
MN1904	sulfide silt	-42.1	none	20/0.1
MN1909	native sediments	23.6	slight	40/0.1
BATCHO3	oxide clay composite	-11.8	none	20/0.1
BATCHS3	sulfide clay composite	-21.8	none	20/0.1

*Based on difference between total sulfur and sulfate-sulfur

**Based on sulfide-sulfur

Table C-2 (cont.)

Table C-2a: QA/QC for NP Determination (Mod. ABA)

Sample	Neutralisation Potential (kgCaCO3/Tonne)	Neutralisation Potential (kgCaCO3/Tonne)
Duplicates - NP		
10	20.9	21.8
20	34.7	35.6
30	3.0	3.2
40	18.8	19.3
NBM-1 Reference (NP = 42)	42.9	-

Table C-2b: QA/QC for Sulphur Speciation

Sample	Sulphur (Wt.%)	Sulphur (Wt.%)
Duplicates - total sulphur		
10	2.24	2.13
20	2.76	2.69
30	0.06	0.06
40	2.19	2.15
Std. CSB (5.2% TS)	5.33	5.30
BCRI Std. (0.11% TS)	0.10	0.10
BCRI Std. (0.53% SO4-S)	0.56	-
BCRI Std. (0.05% SO4-S)	0.05	-

Table C-2c: QA/QC for CO2 Determination

Sample	CO2 (Wt.%)	CO2 (Wt.%)
Duplicates		
10	1.15	1.12
20	1.85	1.89
30	0.04	0.04
40	0.95	0.95

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 1 - 03	45 - 90	Leach Water	S-silt	8.79	17.77	43.7			< 0.02			6		10	
MN BH 1 - 04	60 - 120	Porewater	S-silt	7.91		32.6			0.37		188	299	2239	45	
MN BH 1 - 05	120-150	Leach Water	O-silt	8.65		9.10			0.03			2		1	
MN BH 1 - 06	150 - 217	Porewater	O-silt	9.22		7.50	27.6	11.3	11.9	6	63	95	1646	6	7.0
MN BH 1 - 07	217 - 255	Leach Water	O-silt	8.33	2.61				0.12			< 2		7	
MN BH 1 - 08	255 - 270	Leach Water		7.80	> 19.99				< 0.02			9		9	
MN BH 2 - 01	0 - 17.5	Porewater	S-silt	8.10					< 0.02			24		30	0.8
MN BH 2 - 02	18 - 47	Porewater	O-silt	8.31		17.7	0.1	< 0.05	0.19	3	184	229	2785	41	
MN BH 2 - 03	47 - 70	Porewater	S-silt	8.38		58.6	0.2	0.10	0.32	< 2	238	248	2356	43	
MN BH 2 - 04	70 - 120	Porewater	O-silt	8.44		61.9			0.05			230		49	
MN BH 2 - 05	120 - 200	Porewater	O-silt	8.70		35.4	2.6	0.60	2.64	26	166	204	1987	29	
MN BH 2 - 06	200 - 275	Porewater	O-silt	8.95			23.6	4.2	8.47	45	94	87	1913	12	1.8
MN BH 2 - 07	275 - 290	Leach Water	O-clay	8.12	> 19.99				0.03			3		3	
MN BH 2 - 08	290 - 330	Leach Water		6.63					0.02			< 2		4	
MN BH 3 - 01	0 - 40	Porewater	O-silt	7.77					< 0.02			240		59	0.9
MN BH 3 - 02	40 - 100	Leach Water	S-silt	8.75		31.0			0.02			18		7	
MN BH 3 - 03	100 - 110	Porewater	O-silt	8.85					0.02			316		44	
MN BH 3 - 04	110 - 150	Porewater	S-silt	8.77			7.7	0.10	1.17	64	180	192	2242	27	
MN BH 3 - 05	150 - 250	Porewater	O-silt	8.98			65.3	32.8	23.3	75	115	130	1885	12	
MN BH 3 - 06	250 - 275	Leach Water	O-silt	9.15	2.75		7.1	3.8	3.88	8	141	10	141	5	
MN BH 3 - 07	275 - 280	Porewater	O-silt	8.81		28.8	59.3	32.8	32.0	37	54	43	801	8	1.2
MN BH 4 - 01	0 - 25	Porewater	S-silt	8.60					0.07			41		28	7.3
MN BH 4 - 02	25 - 40	Porewater	O-silt	8.64	16.07				0.14			56		27	
MN BH 4 - 03	40 - 120	Porewater	S-silt	8.87	19.92	54.2			1.76		47	62	1968	29	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 4 - 04	120 - 150	Porewater	S-silt	8.66	> 19.99	14.4	1.6	1.5	2.53	20	125	141	2080	41	
MN BH 4 - 06	180 - 280	Porewater	S-clay	8.65		63.0	2.3	1.8	3.47	72	285	285	2388	46	
MN BH 4 - 08	420 - 440	Porewater	S-silt	9.40	10.56		55.6	25.1	25.5	19	33	84	519	5	1.0
MN BH 5 - 01	0 - 25	Leach Water	O-silt	7.80	13.54	24.3			< 0.02			< 2		5	
MN BH 5 - 02	25 - 50	Leach Water	O-silt	6.97	14.32				< 0.02			8		7	
MN BH 5 - 03	50 - 140	Leach Water	S-silt	7.72	12.76	24.3			< 0.02						
MN BH 5 - 04	140 - 205	Leach Water	S-silt	7.93	8.79				<0.02			3		6	
MN BH 5 - 05	205	Leach Water		7.04					0.02			< 2		5	
MN BH 5 - 06	205 - 270	Leach Water	S-silt	7.58	3.54				<0.02			< 2		7	
MN BH 5 - 07	270 - 330	Leach Water		8.04	> 19.99				0.02			11		2	
MN BH 5 - 08	330 - 400	Leach Water		8.04	> 19.99				0.02			5		< 1	
MN BH 6 - 01	0 - 10	Porewater	S-silt	7.96	> 19.99				< 0.02			< 2		74	
MN BH 6 - 03	30 - 166	Porewater	S-silt	8.60	> 19.99	21.0	12.8	13.2	18.7	72	236	253	2492	40	
MN BH 6 - 04	166 - 206	Porewater	O-silt	8.31		21.0	0.1	< 0.05	8.39	124	194	185	2346	< 1	
MN BH 6 - 05	206 - 262	Porewater	S-silt	8.75		27.6	7.8	8.1	25.7	153	239	224	2374	34	
MN BH 6 - 07	342 - 502	Porewater	S-clay	8.68		111	0.2	< 0.05	1.64	9	152	169	2084	14	
MN BH 6 - 08	502 - 626	Porewater	O-silt	8.36		46.4	0.6	< 0.05	8.26	<2	110	106	2229	12	
MN BH 7 - 01	20 - 40	Water		7.90		42.5	0.1	< 0.05	0.13	4	46	57	1365	24	
MN BH 7 - 02	40 - 90	Porewater	S-silt	8.96	15.4				0.03			53		12	
MN BH 7 - 03	90 - 220	Porewater	O-silt	8.87		165	< 0.05	< 0.05	1.55	20	249	255	2267	41	
MN BH 7 - 05	246 - 377	Porewater	O-clay	8.68		93.1	0.8	1.3	17.1	83	139	148	1998	10	
MN BH 7 - 06	377 - 480	Porewater	O-silt	9.32	13.98	98.8	59.9	8.9	12.4	66	64	94	1262	38	
MN BH 7 - 07	480 - 600	Porewater	O-silt	9.67	16.83	51.8	37.1	7.5	7.95	54	38	31	601	29	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 8 - 01	25 - 75	Porewater	S-clay	7.93					0.12			69		22	
MN BH 8 - 02A	75 - 330	Porewater	S-clay	8.48			30.4	4.8	28.4	35	52	77	1256	12	
MN BH 8 - 02	75 - 330A	Porewater	O-clay	8.56					0.15			262			
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt	8.47			0.3	< 0.05	0.38	22	252	257	2672		
MN BH 8 - 05	75 - 330C	Porewater		9.03			43.5	32.9	38.3	103	104	104	2110		
MN BH 8 - 06	75 - 330D										26		1070		
MN BH 9 - 01	20 - 60	Water		7.84			0.3	0.1	0.16	3	46	64	1370	16	1.0
MN BH 9 - 02	60 - 150	Porewater	S-clay	8.47		99.6	0.5	< 0.05	1.72	18	153	174	2151	42	
MN BH 9 - 03	150 - 240	Porewater	S-silt	7.98		11.1	2.2	1.0	0.86	< 2	76	55	1794	7	1.3
MN BH 9 - 04														43	
MN BH 10 - 01	24 - 130	Water		7.63	> 19.99				0.07		47	65	1404	20	
MN BH 10 - 02	140 - 165	Porewater		8.93	16.61				0.04			106		44	
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	8.60			0.3	< 0.05	0.02	11	175	179	2452	51	
MN BH 10 - 04															
MNBH 10 - 06															
MN BH 11 - 01	24 - 140	Water		7.90	13.56				0.09		43	56	1281	24	
MN BH 11 - 02	140 - 362	Porewater	S-clay	8.75		67.7	0.1	< 0.05	1.55	22	196	221	2114	40	
MN BH 11 - 03	362 - 450	Porewater	O-clay	8.64		36.1	0.3	0.1	0.33	5	127	151	1976	12	
MN BH 11 - 05	480 - 570	Porewater	O-clay	7.14	18.61	0.5			0.02		<5	< 2	79	20	
MN BH 12 - 01	25 - 168	Water		7.87					0.09		40	19	1357	26	
MN BH 12 - 02	168 - 407	Porewater	O-clay	9.07		30.0	0.2	< 0.05	0.02	< 2	169	163	2079	27	
MN BH 12 - 04	417 - 920	Porewater	O-clay	9.09		23.6	5.7	< 0.05	3.18	55	157	143	1964	7	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 13 - 01	25 - 110	Water		7.96					0.09		40	39	1393	26	
MN BH 13 - 02	110 -257	Porewater	S-clay	8.40		73.0			0.05			183		46	
MN BH 13 - 03	257 - 356	Porewater	S-clay	8.60		95.1			0.02			175		35	
MN BH 13 - 04	356 - 470	Porewater	O-clay	8.46		34.3			0.08			146		33	
MN BH 13 - 05	470 - 700	Porewater	O-clay	9.05		19.3	2.4	< 0.05	5.86	59	135	135	1881	8	
MN BH 14 - 04	270 - 455	Porewater	O-silt	9.09		7.3	0.9	< 0.05	<0.02	5	128	170	2279	24	
MN BH 14 - 05	455 - 578	Porewater	O-silt	8.85		17.1			< 0.02			179		29	
MN BH 15 - 01	10 - 25 cm	Water	S-clay	7.70					0.16		47	52	1395	24	
MN BH 15 - 02	25 - 210	Porewater	O-silt	7.87		12.8	0.1	< 0.05	0.35	< 2	50	49	1900	17	
MN BH 15 - 03	210 - 460	Porewater	O-silt	8.86		5.41			0.02		143	221	2225	37	
MN BH 15 - 04	460 - 510	Porewater	O-silt	8.34		18.2			0.10		244	245	2399	48	
MN BH 15 - 06	580 - 750	Porewater	O-clay	9.24		24.6	60.6	< 0.05	5.46	53	145	144	1860	5	
MN BH 15 - 07	750 - 910	Porewater	O-clay	8.90		19.3	18.3	0.3	2.33	29	163	171	1691		
MN BH 16 - 01	13 - 150	Water	S-clay	7.79					0.11		42	37	1321	23	
MN BH 16 - 02	150 - 358	Porewater	O-silt	8.58		145	0.3	0.2	0.46	10	212	233	1879	41	
MN BH 16 - 04	386 - 498	Porewater	O-clay	8.70		19.1	1.7	< 0.05	< 0.02	<2	179	171	2295	13	
MN BH 17 - 04	184 - 260	Porewater	O- Silt	8.33					< 0.02		33	18	2183	21	
MN BH 18 -00	20 - 140	Porewater		7.77					0.05			32			
MN BH 18 -01	140 - 250	Porewater	S-clay	8.72		73.3			< 0.02		105	62	1869	31	
MN BH 18 -02	250 - 331	Porewater	S-clay	8.68		7.8			0.45			171		> 55	
MN BH 18 -03	331 - 485	Porewater	O-clay	8.65		27.8			0.07			124			
MN BH 18 -04	485 - 610	Porewater	O-clay	9.10		31.1	2.1	0.5	12.5	81	154	132	1880	31	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 18 -05	610 - 660	Porewater	O-clay	8.83		24.4	16.5	11.7	22.6	81	125	81	1755		
MN BH 18 -06	660 - 800	Porewater	O-silt	9.12		102	4.4	0.3	1.50	26	16	16	514		
MN BH 19 - 01	0 - 25	Porewater	S-silt	7.57					0.34		<5	25	3008		
MN BH 19 - 02	25 - 103	Porewater	S-silt	8.70		31.1			0.33			17			
MN BH 19 - 03	103 - 140	Porewater	O-silt	8.62		27.8	0.1	0.2	0.72	< 2	31	33	2209	32	
MN BH 19 - 04	140 - 207	Porewater	S-silt	8.85		33.3	0.2	< 0.05	0.02	11	45	36	2175		
MN BH 19 - 05	207 - 251	Porewater		8.26		22.2	0.1	0.1	< 0.02	17		109			
MN BH 19 - 06	251 - 356	Porewater	S-silt	8.38		4.9	0.1	0.08	0.09	16		76		> 55	
MN BH 19 - 07	356 - 389	Porewater		8.35		17.8			< 0.02			15		47	
MN BH 19 - 08	389 - 428	Porewater	S-silt	8.25		37.6			< 0.02		43	42	2215		
MN Seepage Water		Water		7.27			0.3	0.2	0.33	< 2	57	60	1222	17	
MN Pit (Bottom)													2579		
MN Pit (Top)													223		
BLANK 17													<10		
BLANK 18													<10		
BLANK 19													<10		

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 1 - 03	45 - 90	Leach Water	S-silt	0.1																
MN BH 1 - 04	60 - 120	Porewater	S-silt	3.1	0.056	1.59	0.226	0.052	3.7	540.8	< 0.1	35.9	2.5	1.79	0.049	48.35	2.5	48.17	1.98	1.4
MN BH 1 - 05	120-150	Leach Water	O-silt	0.4																
MN BH 1 - 06	150 - 217	Porewater	O-silt	4.4	0.145	1.22	2.82	0.139	4.7	495.5	< 0.1	22.6	0.2	7.34	4.28	26.24	1.1	1.61	0.036	< 0.1
MN BH 1 - 07	217 - 255	Leach Water	O-silt	0.2																
MN BH 1 - 08	255 - 270	Leach Water		<0.1																
MN BH 2 - 01	0 - 17.5	Porewater	S-silt	4.4																
MN BH 2 - 02	18 - 47	Porewater	O-silt	0.2	0.007	0.609	0.055	0.048	3.7	504.0	5.8	17.9	2.1	0.225	0.104	62.52	1.7	77.89	0.892	< 0.1
MN BH 2 - 03	47 - 70	Porewater	S-silt	0.1	0.031	1.32	0.268	0.050	2.9	531.5	< 0.1	19.8	0.5	0.407	0.143	52.02	1.9	62.07	3.58	< 0.1
MN BH 2 - 04	70 - 120	Porewater	O-silt	< 0.1																
MN BH 2 - 05	120 - 200	Porewater	O-silt	< 0.1						498.0				9.23	1.19	32.70	0.9	31.27	0.373	1.1
MN BH 2 - 06	200 - 275	Porewater	O-silt	< 0.1	0.005	0.426	1.39	0.084	2.1	564.0	< 0.1	35.0	<0.1	0.008	6.69	27.19	0.5	6.19	0.022	2.4
MN BH 2 - 07	275 - 290	Leach Water	O-clay	0.1																
MN BH 2 - 08	290 - 330	Leach Water		< 0.1																
MN BH 3 - 01	0 - 40	Porewater	O-silt	0.4																
MN BH 3 - 02	40 - 100	Leach Water	S-silt	0.2																
MN BH 3 - 03	100 - 110	Porewater	O-silt	0.5																
MN BH 3 - 04	110 - 150	Porewater	S-silt	0.1	0.016	0.713	1.13	0.095	3.7	571.8	< 0.1	38.3	0.5	0.774	1.73	47.41	2.1	20.34	0.092	3.1
MN BH 3 - 05	150 - 250	Porewater	O-silt	0.2	0.062	0.287	1.84	0.050	2.7	564.3	0.3	32.5	<0.1	19.3	12.1	34.04	1.2	3.85	0.011	25.1
MN BH 3 - 06	250 - 275	Leach Water	O-silt	0.2	0.036	0.982	0.667	0.041	4.3	39.25	< 0.1	4.3	0.6	2.68	4.01	6.87	0.5	0.42	0.015	5.9
MN BH 3 - 07	275 - 280	Porewater	O-silt	0.2	0.272	0.888	1.27	0.034	1.6	214.9	< 0.1	24.5	<0.1	16.4	11.5	31.96	0.3	1.55	0.017	7.8
MN BH 4 - 01	0 - 25	Porewater	S-silt	0.2																
MN BH 4 - 02	25 - 40	Porewater	O-silt	0.1																
MN BH 4 - 03	40 - 120	Porewater	S-silt	0.3	0.035	1.27	0.255	0.030	3.2	521.9	1.3	4.5	0.6	2.44	0.167	57.19	0.7	14.49	0.061	8.4

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_3-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 4 - 04	120 - 150	Porewater	S-silt	< 0.1	0.005	0.427	0.082	0.043	3.8	503.1	1.7	7.5	<0.1	3.11	0.087	52.46	0.2	33.19	0.115	< 0.1
MN BH 4 - 06	180 - 280	Porewater	S-clay	< 0.1	0.010	0.913	0.067	0.035	2.1	475.8	1.9	3.8	1.3	2.44	0.082	66.46	1.7	50.47	0.355	10.5
MN BH 4 - 08	420 - 440	Porewater	S-silt	0.2	0.062	0.922	0.439	0.047	1.6	128.5	9.1	9.7	2.6	7.84	10.1	13.93	0.2	1.77	0.027	9.7
MN BH 5 - 01	0 - 25	Leach Water	O-silt	0.1																
MN BH 5 - 02	25 - 50	Leach Water	O-silt	0.1																
MN BH 5 - 03	50 - 140	Leach Water	S-silt																	
MN BH 5 - 04	140 - 205	Leach Water	S-silt	0.2																
MN BH 5 - 05	205	Leach Water		< 0.1																
MN BH 5 - 06	205 - 270	Leach Water	S-silt	0.1																
MN BH 5 - 07	270 - 330	Leach Water		0.1																
MN BH 5 - 08	330 - 400	Leach Water																		
MN BH 6 - 01	0 - 10	Porewater	S-silt																	
MN BH 6 - 03	30 - 166	Porewater	S-silt	< 0.1	0.019	0.816	0.086	0.090	2.1	475.6	2.2	10.3	<0.1	18.1	0.129	60.89	0.5	23.95	0.053	12.3
MN BH 6 - 04	166 - 206	Porewater	O-silt	0.1	< 0.001	0.703	0.219	0.225	6.2	505.9	2.7	20.6	1.2	10.8	0.216	53.58	1.8	24.35	0.238	11.2
MN BH 6 - 05	206 - 262	Porewater	S-silt	< 0.1	0.002	0.600	0.093	0.045	1.1	497.1	0.3	16.5	<0.1	27.8	0.091	62.13	0.5	18.67	0.087	21.4
MN BH 6 - 07	342 - 502	Porewater	S-clay	0.1	0.019	1.08	0.497	0.085	3.4	596.1	< 0.1	14.7	0.7	0.733	0.089	36.77	0.7	37.38	0.845	< 0.1
MN BH 6 - 08	502 - 626	Porewater	O-silt	< 0.1	0.030	1.33	0.174	0.053	27.0	539.4	3.6	19.4	<0.1	8.13	0.114	20.37	1.2	60.56	0.643	13.6
MN BH 7 - 01	20 - 40	Water		0.4	0.008	1.62	0.010	0.070	13.9	333.1	0.4	18.5	1.7	0.238	0.183	14.21	0.8	30.91	1.80	4.7
MN BH 7 - 02	40 - 90	Porewater	S-silt	2.2																
MN BH 7 - 03	90 - 220	Porewater	O-silt	< 0.1	0.004	1.55	0.214	0.044	3.7	526.8	4.0	14.8	37.5	1.54	0.205	51.43	1.1	43.47	0.274	7.1
MN BH 7 - 05	246 - 377	Porewater	O-clay	< 0.1	0.003	0.232	0.992	0.056	2.8	489.2	0.3	27.5	<0.1	18.4	1.00	25.75	0.8	18.20	0.414	4.2
MN BH 7 - 06	377 - 480	Porewater	O-silt	0.1	0.020	0.643	1.53	0.040	7.2	379.1	< 0.1	15.6	<0.1	14.0	20.0	29.01	0.9	2.74	0.015	12.7
MN BH 7 - 07	480 - 600	Porewater	O-silt	0.1	0.024	1.33	0.940	0.047	4.4	161.4	< 0.1	16.4	1.5	8.21	11.2	21.46	1.4	1.09	0.020	15.5

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 8 - 01	25 - 75	Porewater	S-clay	0.1																
MN BH 8 - 02A	75 - 330	Porewater	S-clay	< 0.1	0.063	1.54	0.952	0.111	5.4	332.1	9.7	23.6	1.7	18.0	3.80	27.60	0.8	6.9	0.088	5.1
MN BH 8 - 02	75 - 330A	Porewater	O-clay																	
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt		0.004	0.301	0.172	0.063	7.6	550.2	< 0.1	17.9	6.0	1.16	0.589	65.83	1.2	57.27	0.882	10.3
MN BH 8 - 05	75 - 330C	Porewater			0.014	0.350	1.98	0.151	3.4	591.6	< 0.1	6.8	1.7	21.6	1.23	31.32	0.4	8.17	0.044	2.0
MN BH 8 - 06	75 - 330D				0.292	1.08	0.879	0.075	8.4	310.5	< 0.1	15.5	4.0	10.6	0.713	30.52	1.3	5.24	0.052	10.4
MN BH 9 - 01	20 - 60	Water		0.2	0.002	0.617	< 0.005	0.035	7.8	332.2	0.1	10.1	<0.1	0.225	0.117	14.89	0.4	30.71	1.17	9.8
MN BH 9 - 02	60 - 150	Porewater	S-clay	< 0.1	< 0.001	0.788	< 0.005	0.044	4.1	521.0	< 0.1	14.1	1.5	1.62	0.121	42.16	1.5	45.54	0.740	10.7
MN BH 9 - 03	150 - 240	Porewater	S-silt	2.5	< 0.001	0.411	0.928	0.157	49.8	616.9	< 0.1	31.1	0.4	0.020	0.382	37.18	1.6	30.20	1.30	12.5
MN BH 9 - 04																				
MN BH 10 - 01	24 - 130	Water		0.1	< 0.001	0.307	0.043	0.079	11.0	329.6	< 0.1	12.9	<0.1	0.266	0.123	13.62	0.2	30.49	1.19	1.2
MN BH 10 - 02	140 - 165	Porewater		0.3																
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	< 0.1	0.003	0.479	0.300	0.098	6.5	524.1	< 0.1	14.2	1.5	0.182	0.071	44.94	2.5	54.82	0.800	15.7
MN BH 10 - 04										540.8					0.049	48.35		48.17		
MNBH 10 - 06										495.5					4.28	26.24		1.61		
MN BH 11 - 01	24 - 140	Water		0.2	0.006	0.526	0.011	0.070	13.2	308.4	< 0.1	16.2	0.7	0.272	0.092	12.89	0.8	28.36	1.66	< 0.1
MN BH 11 - 02	140 - 362	Porewater	S-clay	0.1	0.025	0.501	0.542	0.073	2.1	527.2	3.0	13.9	<0.1	2.39	0.020	40.25	1.2	37.26	0.442	5.8
MN BH 11 - 03	362 - 450	Porewater	O-clay	0.1	< 0.001	0.310	0.654	0.071	3.9	542.0	2.5	15.1	0.8	0.881	0.081	32.53	1.7	36.46	0.656	3.8
MN BH 11 - 05	480 - 570	Porewater	O-clay	< 0.1	0.006	0.478	0.028	0.044	14.9	14.62	< 0.1	0.76	1.3	0.011	4.23	2.150	0.7	3.56	0.053	1.5
MN BH 12 - 01	25 - 168	Water		0.3	< 0.001	0.403	< 0.005	0.068	9.8	314.7	< 0.1	12.8	1.6	0.211	0.112	13.14	1.2	29.15	1.41	< 0.1
MN BH 12 - 02	168 - 407	Porewater	O-clay	2.5	0.002	0.322	0.989	0.077	2.2	550.9	< 0.1	24.9	<0.1	0.012	0.121	42.95	1.3	32.51	0.356	3.8
MN BH 12 - 04	417 - 920	Porewater	O-clay		0.018	0.222	1.44	0.058	2.1	641.6	< 0.1	17.7	1.5	6.63	1.91	27.08	0.8	10.67	0.081	8.2

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 13 - 01	25 - 110	Water		0.1	0.010	0.389	0.074	0.061	12.9	326.8	< 0.1	15.7	2.4	0.204	0.096	13.52	1.0	30.09	1.63	< 0.1
MN BH 13 - 02	110 -257	Porewater	S-clay	< 0.1																
MN BH 13 - 03	257 - 356	Porewater	S-clay	0.1																
MN BH 13 - 04	356 - 470	Porewater	O-clay	0.1																
MN BH 13 - 05	470 - 700	Porewater	O-clay	< 0.1	0.023	0.390	1.86	0.092	2.5	642.3	< 0.1	18.9	0.5	10.4	1.61	28.16	1.8	11.85	0.108	10.5
MN BH 14 - 04	270 - 455	Porewater	O-silt	0.2	0.011	0.319	1.06	0.054	3.9	501.3	< 0.1	43.5	2.2	0.010	0.281	59.02	0.7	16.03	0.016	8.2
MN BH 14 - 05	455 - 578	Porewater	O-silt	0.2																
MN BH 15 - 01	10 - 25 cm	Water	S-clay	0.1	< 0.001	0.344	0.044	0.069	13.0	330.7	< 0.1	15.5	<0.1	0.347	0.112	13.37	0.6	29.50	1.82	< 0.1
MN BH 15 - 02	25 - 210	Porewater	O-silt	0.2	0.001	0.317	0.090	0.093	5.5	509.2	0.8	14.4	1.9	0.061	0.078	20.36	1.7	32.23	1.76	< 0.1
MN BH 15 - 03	210 - 460	Porewater	O-silt	< 0.1	0.005	0.189	0.925	0.017	1.5	539.8	< 0.1	18.3	<0.1	0.064	0.051	39.34	0.4	19.49	0.12	18.5
MN BH 15 - 04	460 - 510	Porewater	O-silt	< 0.1	0.001	0.425	0.421	0.049	4.2	565.4	1.6	27.2	<0.1	0.039	0.099	52.78	2.3	39.34	0.937	4.1
MN BH 15 - 06	580 - 750	Porewater	O-clay	< 0.1	0.004	0.154	1.42	0.057	2.4	606.8	1.0	15.8	0.7	8.63	2.44	25.17	0.3	7.24	0.064	2.8
MN BH 15 - 07	750 - 910	Porewater	O-clay		0.044	0.303	2.35	0.128	3.4	679.9	< 0.1	30.4	<0.1	3.09	7.30	22.21	0.2	6.66	0.033	5.7
MN BH 16 - 01	13 - 150	Water	S-clay	1.5	0.015	0.285	0.110	0.071	10.0	312.8	< 0.1	12.8	0.3	0.231	0.185	12.84	0.2	28.43	1.40	< 0.1
MN BH 16 - 02	150 - 358	Porewater	O-silt		0.029	0.299	0.267	0.030	1.3	515.5	< 0.1	9.8	< 0.1	2.64	0.042	42.43	0.7	33.7	0.325	5.1
MN BH 16 - 04	386 - 498	Porewater	O-clay		0.160	10.0	11.2	0.141	12.9	359.3	1.8	153	4.9	0.070	0.854	31.17	5.3	5.38	0.220	52.2
MN BH 17 - 04	184 - 260	Porewater	O- Silt		0.039	10.4	0.990	0.168	12.0	634.9	< 0.1	53.6	7.1	0.148	0.147	23.71	10.5	31.96	3.11	41.9
MN BH 18 -00	20 - 140	Porewater																		
MN BH 18 -01	140 - 250	Porewater	S-clay		0.012	10.2	1.43	0.103	8.1	566.2	1.7	25.3	5.4	0.036	0.410	52.56	4.3	22.85	0.490	43.4
MN BH 18 -02	250 - 331	Porewater	S-clay																	
MN BH 18 -03	331 - 485	Porewater	O-clay																	
MN BH 18 -04	485 - 610	Porewater	O-clay		0.024	8.54	5.62	0.237	7.5	449.5	3.2	72.9	6.3	14.3	1.75	28.76	4.3	15.04	0.409	47.0

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 18 -05	610 - 660	Porewater	O-clay		0.084	8.69	5.36	0.323	5.9	579.8	2.1	87.0	4.1	23.1	4.02	24.83	13.9	9.69	0.178	37.2
MN BH 18 -06	660 - 800	Porewater	O-silt		0.020	0.84	0.382	0.061	3.5	174.5	1.1	6.5	0.9	3.52	2.23	10.16	0.5	2.88	0.066	1.9
MN BH 19 - 01	0 - 25	Porewater	S-silt		0.001	8.09	0.052	0.084	9.9	374.2	58.0	21.6	7.2	0.065	0.202	47.40	18.8	116.9	29.1	5.6
MN BH 19 - 02	25 - 103	Porewater	S-silt																	
MN BH 19 - 03	103 - 140	Porewater	O-silt		0.006	0.618	0.067	0.046	5.2	367.5	< 0.1	7.7	1.3	0.987	0.122	31.08	0.4	9.37	0.084	< 0.1
MN BH 19 - 04	140 - 207	Porewater	S-silt		0.002	7.75	0.434	0.089	12.1	576.9	14.7	38.8	8.7	0.608	0.072	54.69	6.7	27.82	3.51	29.7
MN BH 19 - 05	207 - 251	Porewater																		
MN BH 19 - 06	251 - 356	Porewater	S-silt																	
MN BH 19 - 07	356 - 389	Porewater																		
MN BH 19 - 08	389 - 428	Porewater	S-silt		0.058	6.77	0.397	0.120	23.1	596.4	28.8	50.5	5.6	3.02	0.071	39.64	8.3	36.48	9.68	17.2
MN Seepage Water		Water		0.7	0.002	6.29	0.037	0.084	45.2	289.3	1.6	49.1	6.2		11.2	11.48	1.3	25.55	7.94	6.2
MN Pit (Bottom)					0.001	0.941	< 0.005	0.019	0.53	443.3	6.2	1.3	6.4	0.043	0.02	6.13	4.0	274.0	1.54	1.8
MN Pit (Top)					0.001	0.573	0.019	0.034	4.5	118.7	1.8	0.34	4.8	0.038	0.16	1.97	1.2	26.84	0.070	< 0.1
BLANK 17					0.011	0.904	< 0.005	0.751	< 0.02	0.188	0.1	< 0.01	1.9	0.005	0.06	<0.27	28.0	0.04	0.005	< 0.1
BLANK 18					0.014	0.745	< 0.005	0.131	< 0.02	0.114	< 0.1	2.8	1.2	0.083	0.04	<0.27	0.4	0.01	0.004	< 0.1
BLANK 19					0.010	0.630	< 0.005	0.042	0.87	0.061	< 0.1	< 0.01	4.2	0.005	0.03	<0.27	<0.1	0.01	0.004	< 0.1

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 1 - 03	45 - 90	Leach Water	S-silt									
MN BH 1 - 04	60 - 120	Porewater	S-silt	412	49.1	188	18.6	888.2	79	5.06		27
MN BH 1 - 05	120-150	Leach Water	O-silt									
MN BH 1 - 06	150 - 217	Porewater	O-silt	241	36.3	193	1.1	550.5	19	27.7		< 1
MN BH 1 - 07	217 - 255	Leach Water	O-silt									
MN BH 1 - 08	255 - 270	Leach Water										
MN BH 2 - 01	0 - 17.5	Porewater	S-silt									
MN BH 2 - 02	18 - 47	Porewater	O-silt	608	<0.1	77	1.2	1115	64	3.55	1.68	8
MN BH 2 - 03	47 - 70	Porewater	S-silt	427	23.0	231	1.3	1007	30	5.12	1.16	20
MN BH 2 - 04	70 - 120	Porewater	O-silt									
MN BH 2 - 05	120 - 200	Porewater	O-silt	376	12.5	198	< 0.2	794.4	37	8.73	1.05	< 1
MN BH 2 - 06	200 - 275	Porewater	O-silt	256	4.1	183	< 0.2	668.8	55	19.0	1.27	< 1
MN BH 2 - 07	275 - 290	Leach Water	O-clay									
MN BH 2 - 08	290 - 330	Leach Water										
MN BH 3 - 01	0 - 40	Porewater	O-silt									
MN BH 3 - 02	40 - 100	Leach Water	S-silt									
MN BH 3 - 03	100 - 110	Porewater	O-silt									
MN BH 3 - 04	110 - 150	Porewater	S-silt	433	4.5	224	0.2	874.3	32	11.1	1.49	< 1
MN BH 3 - 05	150 - 250	Porewater	O-silt	340	22.3	172	3.6	680.2	62	20.0	1.50	7
MN BH 3 - 06	250 - 275	Leach Water	O-silt	42.9	8.2	140	52.2	49.5	45	6.69	0.08	18
MN BH 3 - 07	275 - 280	Porewater	O-silt	225	33.1	118	4.8	288.3	74	12.2	0.48	248
MN BH 4 - 01	0 - 25	Porewater	S-silt									
MN BH 4 - 02	25 - 40	Porewater	O-silt									
MN BH 4 - 03	40 - 120	Porewater	S-silt	248	6.7	201	2.5	695.3	51	1.23	1.38	32

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 4 - 04	120 - 150	Porewater	S-silt	336	12.1	220	11.0	791.9	35	2.46	1.53	< 1
MN BH 4 - 06	180 - 280	Porewater	S-clay	548	20.4	147	8.7	996.2	60	1.54	1.85	51
MN BH 4 - 08	420 - 440	Porewater	S-silt	158	11.2	230	1.3	175.4	28	5.82	0.30	423
MN BH 5 - 01	0 - 25	Leach Water	O-silt									
MN BH 5 - 02	25 - 50	Leach Water	O-silt									
MN BH 5 - 03	50 - 140	Leach Water	S-silt									
MN BH 5 - 04	140 - 205	Leach Water	S-silt									
MN BH 5 - 05	205	Leach Water										
MN BH 5 - 06	205 - 270	Leach Water	S-silt									
MN BH 5 - 07	270 - 330	Leach Water										
MN BH 5 - 08	330 - 400	Leach Water										
MN BH 6 - 01	0 - 10	Porewater	S-silt									
MN BH 6 - 03	30 - 166	Porewater	S-silt	664	28.7	176	1.0	1006	29	2.18	1.45	23
MN BH 6 - 04	166 - 206	Porewater	O-silt	550	38.2	106	2.3	907.2	55	3.38	1.38	< 1
MN BH 6 - 05	206 - 262	Porewater	S-silt	643	41.2	77	1.0	974.6	57	2.64	1.50	10
MN BH 6 - 07	342 - 502	Porewater	S-clay	349	11.4	156	26.4	934.7	46	0.96	1.35	14
MN BH 6 - 08	502 - 626	Porewater	O-silt	459	7.6	158	4.3	852.5	71	5.31	1.51	48
MN BH 7 - 01	20 - 40	Water		229	8.0	89	3.1	475.3	27	3.37	0.96	10
MN BH 7 - 02	40 - 90	Porewater	S-silt									
MN BH 7 - 03	90 - 220	Porewater	O-silt	524	4.6	251	2.4	1055	73	2.11	1.54	< 1
MN BH 7 - 05	246 - 377	Porewater	O-clay	288	37.6	271	6.2	658.8	46	3.98	0.96	8.3
MN BH 7 - 06	377 - 480	Porewater	O-silt	233	16.7	97	3.6	457.0	42	12.9	1.22	< 1
MN BH 7 - 07	480 - 600	Porewater	O-silt	152	28.7	133	191	213.1	34	5.10	0.52	48

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 8 - 01	25 - 75	Porewater	S-clay									
MN BH 8 - 02A	75 - 330	Porewater	S-clay	198	31.8	210	5.5	421.4	36	7.21	0.82	446
MN BH 8 - 02	75 - 330A	Porewater	O-clay									
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt	577	41.3	252	10.1	1143	53	2.63	1.63	73
MN BH 8 - 05	75 - 330C	Porewater		363	31.4	94	12.9	703.1	51	3.99	1.34	4
MN BH 8 - 06	75 - 330D			145	58.4	135	4.5	348.0	32	1.10	0.95	57
MN BH 9 - 01	20 - 60	Water		223	< 0.1	< 10	0.3	476.6	27	3.39	0.95	< 1
MN BH 9 - 02	60 - 150	Porewater	S-clay	331	24.1	110	2.2	822.5	44	5.29	1.23	< 1
MN BH 9 - 03	150 - 240	Porewater	S-silt	213	123	43	9.2	633.1	55	19.3	1.61	6
MN BH 9 - 04												
MN BH 10 - 01	24 - 130	Water		224	7.1	83	11.8	472.8	35	3.31	0.94	6
MN BH 10 - 02	140 - 165	Porewater										
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	430	5.3	41	3.7	919.3	65	2.82	1.38	11
MN BH 10 - 04				412				888.2		5.06	1.24	
MNBH 10 - 06				241				550.5		27.7	1.13	
MN BH 11 - 01	24 - 140	Water		213	9.3	12	16.9	444.3	28	2.88	0.88	16
MN BH 11 - 02	140 - 362	Porewater	S-clay	437	22.8	238	16.0	965.5	71	2.58	1.05	14
MN BH 11 - 03	362 - 450	Porewater	O-clay	317	7.1	178	0.9	823.6	50	3.95	0.99	10
MN BH 11 - 05	480 - 570	Porewater	O-clay	7.3	2.2	98	3.2	18.7	6	2.76	0.08	55
MN BH 12 - 01	25 - 168	Water		212	5.1	121	1.4	452.3	7	2.90	0.89	55
MN BH 12 - 02	168 - 407	Porewater	O-clay	363	3.9	205	2.4	856.4	41	2.72	1.20	90
MN BH 12 - 04	417 - 920	Porewater	O-clay	275	23.0	86	0.6	831.3	27	4.19	1.24	43

Table C-3 - Tailings Porewater Chemistry

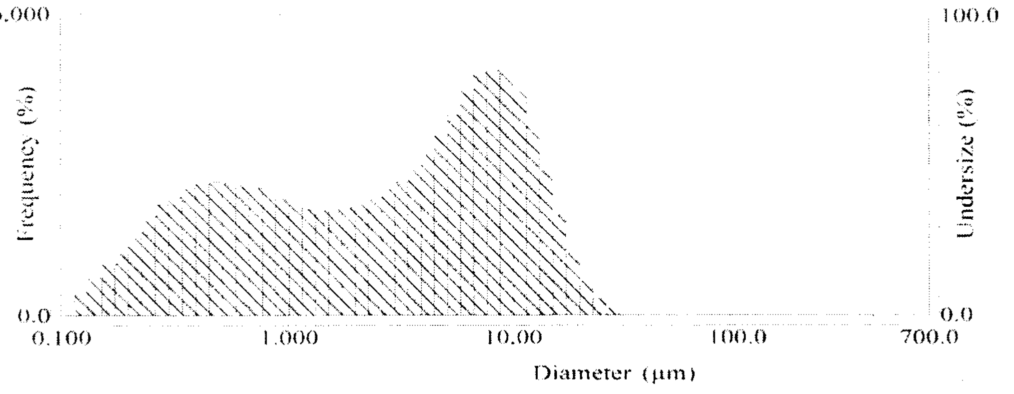
Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 13 - 01	25 - 110	Water		220	7.6	100	0.4	465.8	6	3.04	0.93	3
MN BH 13 - 02	110 -257	Porewater	S-clay									
MN BH 13 - 03	257 - 356	Porewater	S-clay									
MN BH 13 - 04	356 - 470	Porewater	O-clay									
MN BH 13 - 05	470 - 700	Porewater	O-clay	275	31.0	80	19.0	854.0	48	3.48	1.20	46
MN BH 14 - 04	270 - 455	Porewater	O-silt	402	8.0	233	0.9	792.8	32	12.5	1.33	< 1
MN BH 14 - 05	455 - 578	Porewater	O-silt									
MN BH 15 - 01	10 - 25 cm	Water	S-clay	238	6.5	78	0.5	481.8	3	3.59	0.96	3
MN BH 15 - 02	25 - 210	Porewater	O-silt	250	5.8	188	2.3	660.9	34	4.89	1.35	13
MN BH 15 - 03	210 - 460	Porewater	O-silt	403	<0.1	109	3.6	852.0	57	15.4	1.24	19
MN BH 15 - 04	460 - 510	Porewater	O-silt	559	3.2	225	3.1	1047	49	1.65	1.28	18
MN BH 15 - 06	580 - 750	Porewater	O-clay	245	23.8	139	1.6	777.1	22	4.27	1.11	1
MN BH 15 - 07	750 - 910	Porewater	O-clay	229	15.3	120	0.4	820.7	85	8.34	1.34	1
MN BH 16 - 01	13 - 150	Water	S-clay	216	2.8	201	0.4	446.4	15	2.80	0.91	81
MN BH 16 - 02	150 - 358	Porewater	O-silt	490	33.8	132	9.9	966.4	44	3.35	0.95	34
MN BH 16 - 04	386 - 498	Porewater	O-clay	427	34.4	127	44.5	711.5	166	7.77	0.73	161
MN BH 17 - 04	184 - 260	Porewater	O- Silt	256	14.9	101	27.7	780.3	210	5.39	1.27	181
MN BH 18 -00	20 - 140	Porewater										
MN BH 18 -01	140 - 250	Porewater	S-clay	223	17.5	95	28.0	728.4	169	1.92	1.32	146
MN BH 18 -02	250 - 331	Porewater	S-clay									
MN BH 18 -03	331 - 485	Porewater	O-clay									
MN BH 18 -04	485 - 610	Porewater	O-clay	267	157	86	28.0	666.2	142	4.92	0.86	180

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 18 -05	610 - 660	Porewater	O-clay	246	147	173	8.1	696.5	188	8.53	1.25	331
MN BH 18 -06	660 - 800	Porewater	O-silt	69.7	36.9	207	30.8	185.4	11	1.86	0.46	60
MN BH 19 - 01	0 - 25	Porewater	S-silt	442	33.5	122	14.4	854.4	823	2.24	1.75	5774
MN BH 19 - 02	25 - 103	Porewater	S-silt									
MN BH 19 - 03	103 - 140	Porewater	O-silt	170	2.4	213	2.6	475.9	16	1.48	1.14	34
MN BH 19 - 04	140 - 207	Porewater	S-silt	288	23.0	112	8.8	809.8	167	3.33	1.59	304
MN BH 19 - 05	207 - 251	Porewater										
MN BH 19 - 06	251 - 356	Porewater	S-silt									
MN BH 19 - 07	356 - 389	Porewater										
MN BH 19 - 08	389 - 428	Porewater	S-silt	305	47.5	208	37.3	824.2	226	5.45	1.67	351
MN Seepage Water		Water		233	29.0	72	5.1	429.3	4	3.50	0.85	644
MN Pit (Bottom)				17.4	< 0.1	144	0.3	862.7	1	3.04	1.97	550
MN Pit (Top)				7.7	1.0	123	1.1	74.0	14	6.32	0.52	219
BLANK 17				4.8	< 0.1	< 10	4.0	0.1	6	0.833	< 0.03	4
BLANK 18				<0.25	4.2	130	12.8	<0.1	18	0.266	< 0.03	< 1
BLANK 19				<0.25	< 0.1	115	1.2	0.1	4	0.135	< 0.03	< 1

Appendix C-4: Tailings Particle Size Analysis: (8 selected samples)

MNBH 1102 (wet)
Feb 25, 2002

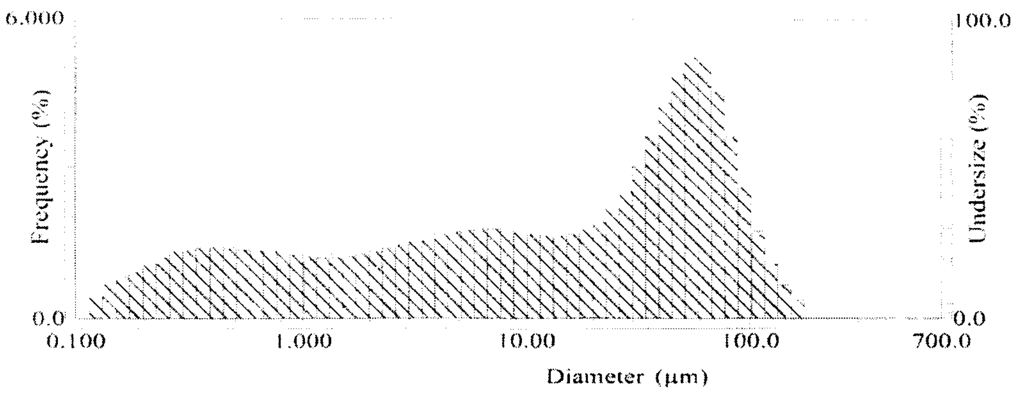


S.P. Area	: 64080(cm²/cm³)	:90.00 (%) = 11.976(μm)		:53.00 (μm) = 100.0	
Median	: 3.100(μm)	:95.00 (%) = 14.698(μm)		:38.00 (μm) = 100.0	
Diameter on %	:5.000 (%) = 0.227(μm)	% on Diameter :850.0 (μm) = 100.000(%)	Mean	: 4.841(μm)	
	:10.00 (%) = 0.314(μm)	:600.0 (μm) = 100.000(%)	Variance	: 24.682	
	:20.00 (%) = 0.534(μm)	:425.0 (μm) = 100.000(%)	S.D.	: 4.968(μm)	
	:30.00 (%) = 0.913(μm)	:300.0 (μm) = 100.000(%)	Mode	: 8.235(μm)	
	:40.00 (%) = 1.722(μm)	:212.0 (μm) = 100.000(%)	Span	: 3.762	
	:60.00 (%) = 4.838(μm)	:150.0 (μm) = 100.000(%)			
	:70.00 (%) = 6.725(μm)	:106.0 (μm) = 100.000(%)			
	:80.00 (%) = 8.880(μm)	:75.00 (μm) = 100.000(%)			

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.071	37.980	39	19.904	1.215	98.870	58	262.376	0.000	100.000
2	0.131	0.461	0.461	21	1.729	2.087	40.067	40	22.797	0.663	99.533	59	300.518	0.000	100.000
3	0.150	0.746	1.207	22	1.981	2.138	42.205	41	26.111	0.324	99.857	60	344.206	0.000	100.000
4	0.172	0.996	2.203	23	2.269	2.192	44.398	42	29.907	0.143	100.000	61	394.244	0.000	100.000
5	0.197	1.205	3.409	24	2.599	2.322	46.719	43	34.255	0.000	100.000	62	451.556	0.000	100.000
6	0.226	1.507	4.915	25	2.976	2.487	49.206	44	39.234	0.000	100.000	63	517.200	0.000	100.000
7	0.259	1.856	6.771	26	3.409	2.643	51.849	45	44.938	0.000	100.000	64	592.387	0.000	100.000
8	0.296	2.199	8.970	27	3.905	2.878	54.727	46	51.471	0.000	100.000				
9	0.339	2.352	11.321	28	4.472	3.199	57.926	47	58.953	0.000	100.000				
10	0.389	2.524	13.845	29	5.122	3.580	61.505	48	67.523	0.000	100.000				
11	0.445	2.619	16.464	30	5.867	4.005	65.510	49	77.339	0.000	100.000				
12	0.510	2.646	19.110	31	6.720	4.460	69.970	50	88.583	0.000	100.000				
13	0.584	2.623	21.733	32	7.697	4.859	74.829	51	101.460	0.000	100.000				
14	0.669	2.583	24.316	33	8.816	4.909	79.738	52	116.210	0.000	100.000				
15	0.766	2.528	26.844	34	10.097	4.842	84.581	53	133.103	0.000	100.000				
16	0.877	2.473	29.317	35	11.565	4.452	89.033	54	152.453	0.000	100.000				
17	1.005	2.309	31.626	36	13.246	3.760	92.793	55	174.616	0.000	100.000				
18	1.151	2.183	33.809	37	15.172	2.881	95.674	56	200.000	0.000	100.000				
19	1.318	2.100	35.909	38	17.377	1.981	97.656	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251413761	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:29	Axis Selection	:LogX-LinY
Laser T%	: 78.2(%)		

MNBH 1401 (wet)
Feb 25, 2002

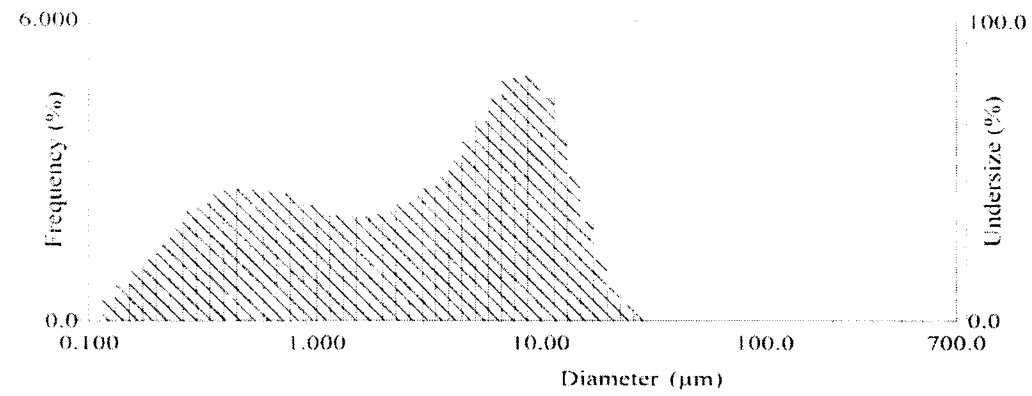


S.P. Area	: 40656(cm²/cm³)		:90.00 (%) = 77.657(µm)		:53.00 (µm) = 76.09
Median	: 16.406(µm)		:95.00 (%) = 95.680(µm)		:38.00 (µm) = 64.88
Diameter on %	:5.000 (%) = 0.255(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 30.200(µm)
	:10.00 (%) = 0.420(µm)		:600.0 (µm) = 100.000(%)	Variance	: 1115.943
	:20.00 (%) = 1.177(µm)		:425.0 (µm) = 100.000(%)	S.D.	: 33.406(µm)
	:30.00 (%) = 3.293(µm)		:300.0 (µm) = 100.000(%)	Mode	: 55.248(µm)
	:40.00 (%) = 7.319(µm)		:212.0 (µm) = 100.000(%)	Span	: 4.708
	:60.00 (%) = 31.176(µm)		:150.0 (µm) = 99.550(%)		
	:70.00 (%) = 44.870(µm)		:106.0 (µm) = 96.692(%)		
	:80.00 (%) = 58.644(µm)		:75.00 (µm) = 88.861(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.207	22.209	39	19.904	1.755	52.462	58	262.376	0.000	100.000
2	0.131	0.444	0.444	21	1.729	1.234	23.443	40	22.797	1.914	54.376	59	300.518	0.000	100.000
3	0.150	0.677	1.121	22	1.981	1.273	24.717	41	26.111	2.166	56.542	60	344.206	0.000	100.000
4	0.172	0.822	1.943	23	2.269	1.315	26.032	42	29.907	2.531	59.074	61	394.244	0.000	100.000
5	0.197	0.910	2.853	24	2.599	1.382	27.414	43	34.255	3.025	62.099	62	451.556	0.000	100.000
6	0.226	1.052	3.905	25	2.976	1.453	28.867	44	39.234	3.638	65.737	63	517.200	0.000	100.000
7	0.259	1.202	5.107	26	3.409	1.522	30.388	45	44.938	4.311	70.048	64	592.387	0.000	100.000
8	0.296	1.330	6.437	27	3.905	1.585	31.973	46	51.471	4.910	74.958				
9	0.339	1.358	7.795	28	4.472	1.656	33.629	47	58.953	5.245	80.203				
10	0.389	1.395	9.189	29	5.122	1.716	35.345	48	67.523	5.138	85.341				
11	0.445	1.402	10.591	30	5.867	1.757	37.101	49	77.339	4.549	89.891				
12	0.510	1.387	11.978	31	6.720	1.781	38.882	50	88.583	3.624	93.515				
13	0.584	1.362	13.341	32	7.697	1.777	40.659	51	101.460	2.616	96.130				
14	0.669	1.341	14.682	33	8.816	1.733	42.392	52	116.210	1.740	97.870				
15	0.766	1.324	16.006	34	10.097	1.704	44.096	53	133.103	1.093	98.964				
16	0.877	1.314	17.320	35	11.565	1.668	45.764	54	152.453	0.666	99.630				
17	1.005	1.261	18.581	36	13.246	1.640	47.404	55	174.616	0.370	100.000				
18	1.151	1.221	19.802	37	15.172	1.635	49.039	56	200.000	0.000	100.000				
19	1.318	1.200	21.002	38	17.377	1.668	50.707	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251426762	Calc. Level	:30
Circulation Speed	:14	R.R.Index	:1.16-0.10i
Ultra sonic	:01:41	Axis Selection	:LogX-LinY
Laser T%	: 79.0(%)		

MNBH 1102 (wet)
Feb 25, 2002

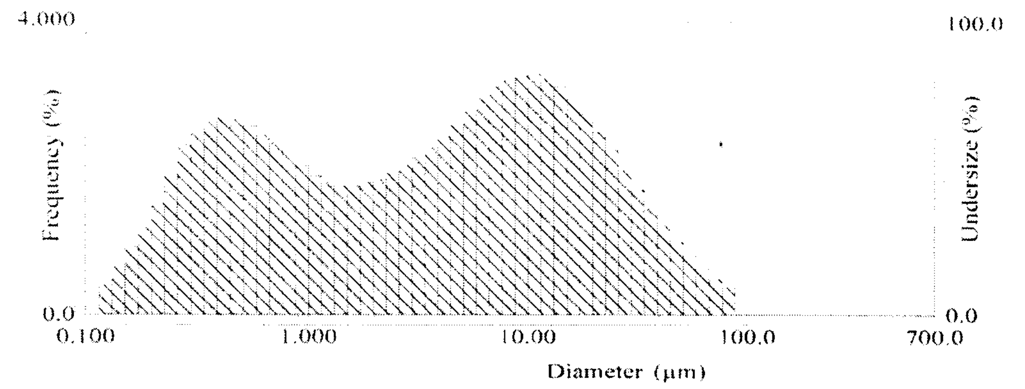


S.P. Area	: 64080(cm²/cm³)		:90.00 (%) = 11.976(µm)			:53.00 (µm) = 100.0
Median	: 3.100(µm)		:95.00 (%) = 14.698(µm)			:38.00 (µm) = 100.0
Diameter on %	:5.000 (%) = 0.227(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 4.841(µm)	
	:10.00 (%) = 0.314(µm)		:600.0 (µm) = 100.000(%)	Variance	: 24.682	
	:20.00 (%) = 0.534(µm)		:425.0 (µm) = 100.000(%)	S.D.	: 4.968(µm)	
	:30.00 (%) = 0.913(µm)		:300.0 (µm) = 100.000(%)	Mode	: 8.235(µm)	
	:40.00 (%) = 1.722(µm)		:212.0 (µm) = 100.000(%)	Span	: 3.762	
	:60.00 (%) = 4.838(µm)		:150.0 (µm) = 100.000(%)			
	:70.00 (%) = 6.725(µm)		:106.0 (µm) = 100.000(%)			
	:80.00 (%) = 8.880(µm)		:75.00 (µm) = 100.000(%)			

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.071	37.980	39	19.904	1.215	98.870	58	262.376	0.000	100.000
2	0.131	0.461	0.461	21	1.729	2.087	40.067	40	22.797	0.663	99.533	59	300.518	0.000	100.000
3	0.150	0.746	1.207	22	1.981	2.138	42.205	41	26.111	0.324	99.857	60	344.206	0.000	100.000
4	0.172	0.996	2.203	23	2.269	2.192	44.398	42	29.907	0.143	100.000	61	394.244	0.000	100.000
5	0.197	1.205	3.409	24	2.599	2.322	46.719	43	34.255	0.000	100.000	62	451.556	0.000	100.000
6	0.226	1.507	4.915	25	2.976	2.487	49.206	44	39.234	0.000	100.000	63	517.200	0.000	100.000
7	0.259	1.856	6.771	26	3.409	2.643	51.849	45	44.938	0.000	100.000	64	592.387	0.000	100.000
8	0.296	2.199	8.970	27	3.905	2.878	54.727	46	51.471	0.000	100.000				
9	0.339	2.352	11.321	28	4.472	3.199	57.926	47	58.953	0.000	100.000				
10	0.389	2.524	13.845	29	5.122	3.580	61.505	48	67.523	0.000	100.000				
11	0.445	2.619	16.464	30	5.867	4.005	65.510	49	77.339	0.000	100.000				
12	0.510	2.646	19.110	31	6.720	4.460	69.970	50	88.583	0.000	100.000				
13	0.584	2.623	21.733	32	7.697	4.859	74.829	51	101.460	0.000	100.000				
14	0.669	2.583	24.316	33	8.816	4.909	79.738	52	116.210	0.000	100.000				
15	0.766	2.528	26.844	34	10.097	4.842	84.581	53	133.103	0.000	100.000				
16	0.877	2.473	29.317	35	11.565	4.452	89.033	54	152.453	0.000	100.000				
17	1.005	2.309	31.626	36	13.246	3.760	92.793	55	174.616	0.000	100.000				
18	1.151	2.183	33.809	37	15.172	2.881	95.674	56	200.000	0.000	100.000				
19	1.318	2.100	35.909	38	17.377	1.981	97.656	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251413761	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:29	Axis Selection	:LogX-LinY
Laser T%	: 78.2(%)		

Batch O (wet)
Feb 25, 2002

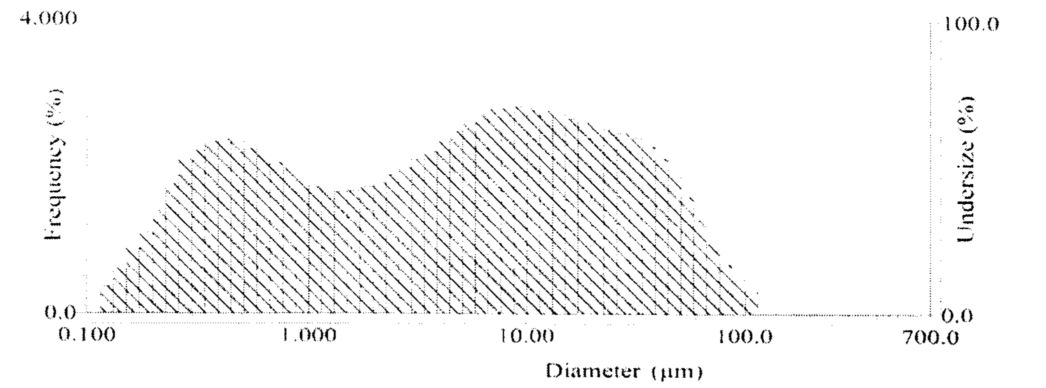


S.P. Area	: 61123(cm²/cm³)		:90.00 (%) = 25.521(µm)			:53.00 (µm) = 97.88
Median	: 3.898(µm)		:95.00 (%) = 37.415(µm)			:38.00 (µm) = 95.16
Diameter on %	:5.000 (%) = 0.232(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 9.296(µm)	
	:10.00 (%) = 0.316(µm)		:600.0 (µm) = 100.000(%)	Variance	: 178.331	
	:20.00 (%) = 0.531(µm)		:425.0 (µm) = 100.000(%)	S.D.	: 13.354(µm)	
	:30.00 (%) = 0.951(µm)		:300.0 (µm) = 100.000(%)	Mode	: 10.796(µm)	
	:40.00 (%) = 2.007(µm)		:212.0 (µm) = 100.000(%)	Span	: 6.467	
	:60.00 (%) = 6.483(µm)		:150.0 (µm) = 100.000(%)			
	:70.00 (%) = 9.952(µm)		:106.0 (µm) = 100.000(%)			
	:80.00 (%) = 15.195(µm)		:75.00 (µm) = 99.516(%)			

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.758	36.270	39	19.904	2.734	85.645	58	262.376	0.000	100.000
2	0.131	0.388	0.388	21	1.729	1.760	38.030	40	22.797	2.494	88.140	59	300.518	0.000	100.000
3	0.150	0.646	1.033	22	1.981	1.793	39.823	41	26.111	2.237	90.376	60	344.206	0.000	100.000
4	0.172	0.917	1.951	23	2.269	1.835	41.658	42	29.907	1.972	92.348	61	394.244	0.000	100.000
5	0.197	1.167	3.118	24	2.599	1.927	43.585	43	34.255	1.708	94.056	62	451.556	0.000	100.000
6	0.226	1.500	4.618	25	2.976	2.035	45.620	44	39.234	1.453	95.508	63	517.200	0.000	100.000
7	0.259	1.901	6.519	26	3.409	2.142	47.762	45	44.938	1.212	96.721	64	592.387	0.000	100.000
8	0.296	2.298	8.817	27	3.905	2.267	50.029	46	51.471	0.993	97.713				
9	0.339	2.453	11.270	28	4.472	2.428	52.457	47	58.953	0.797	98.510				
10	0.389	2.624	13.893	29	5.122	2.599	55.055	48	67.523	0.628	99.139				
11	0.445	2.688	16.581	30	5.867	2.772	57.827	49	77.339	0.488	99.626				
12	0.510	2.659	19.240	31	6.720	2.952	60.779	50	88.583	0.374	100.000				
13	0.584	2.565	21.805	32	7.697	3.105	63.884	51	101.460	0.000	100.000				
14	0.669	2.451	24.257	33	8.816	3.194	67.078	52	116.210	0.000	100.000				
15	0.766	2.329	26.586	34	10.097	3.270	70.348	53	133.103	0.000	100.000				
16	0.877	2.218	28.803	35	11.565	3.281	73.630	54	152.453	0.000	100.000				
17	1.005	2.026	30.829	36	13.246	3.226	76.856	55	174.616	0.000	100.000				
18	1.151	1.886	32.715	37	15.172	3.111	79.967	56	200.000	0.000	100.000				
19	1.318	1.796	34.511	38	17.377	2.944	82.911	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:20020225144276З	Caic. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:29	Axis Selection	:LogX-LinY
Laser T%	: 75.2(%)		

Batch S (wet)
Feb 25, 2002

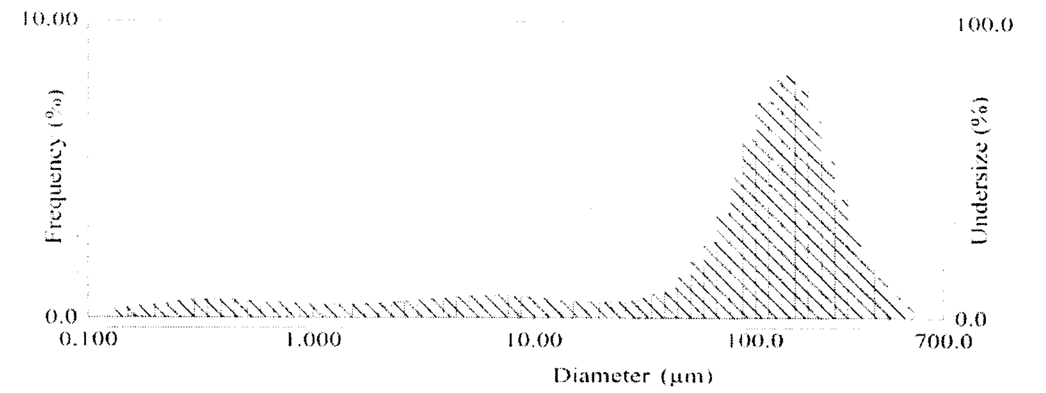


S.P. Area	: 56066(cm²/cm³)		:90.00 (%) = 37.766(μm)		:53.00 (μm) = 95.01
Median	: 4.834(μm)		:95.00 (%) = 52.930(μm)		:38.00 (μm) = 90.10
Diameter on %	:5.000 (%) = 0.238(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 12.732(μm)
	:10.00 (%) = 0.331(μm)		:600.0 (μm) = 100.000(%)	Variance	: 335.877
	:20.00 (%) = 0.593(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 18.327(μm)
	:30.00 (%) = 1.199(μm)		:300.0 (μm) = 100.000(%)	Mode	: 9.436(μm)
	:40.00 (%) = 2.617(μm)		:212.0 (μm) = 100.000(%)	Span	: 7.744
	:60.00 (%) = 8.011(μm)		:150.0 (μm) = 100.000(%)		
	:70.00 (%) = 12.989(μm)		:106.0 (μm) = 99.791(%)		
	:80.00 (%) = 21.665(μm)		:75.00 (μm) = 98.314(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.657	32.824	39	19.904	2.611	78.399	58	262.376	0.000	100.000
2	0.131	0.363	0.363	21	1.729	1.678	34.502	40	22.797	2.563	80.962	59	300.518	0.000	100.000
3	0.150	0.608	0.971	22	1.981	1.727	36.230	41	26.111	2.519	83.481	60	344.206	0.000	100.000
4	0.172	0.869	1.840	23	2.269	1.785	38.014	42	29.907	2.470	85.951	61	394.244	0.000	100.000
5	0.197	1.101	2.941	24	2.599	1.884	39.899	43	34.255	2.401	88.352	62	451.556	0.000	100.000
6	0.226	1.398	4.339	25	2.976	1.995	41.894	44	39.234	2.292	90.644	63	517.200	0.000	100.000
7	0.259	1.757	6.096	26	3.409	2.107	44.001	45	44.938	2.127	92.772	64	592.387	0.000	100.000
8	0.296	2.102	8.198	27	3.905	2.219	46.220	46	51.471	1.897	94.669				
9	0.339	2.218	10.416	28	4.472	2.355	48.575	47	58.953	1.608	96.277				
10	0.389	2.349	12.765	29	5.122	2.486	51.061	48	67.523	1.287	97.564				
11	0.445	2.384	15.149	30	5.867	2.605	53.666	49	77.339	0.969	98.533				
12	0.510	2.344	17.493	31	6.720	2.715	56.381	50	88.583	0.689	99.223				
13	0.584	2.254	19.748	32	7.697	2.790	59.171	51	101.460	0.469	99.691				
14	0.669	2.157	21.905	33	8.816	2.810	61.980	52	116.210	0.309	100.000				
15	0.766	2.059	23.964	34	10.097	2.830	64.811	53	133.103	0.000	100.000				
16	0.877	1.978	25.942	35	11.565	2.816	67.626	54	152.453	0.000	100.000				
17	1.005	1.829	27.771	36	13.246	2.775	70.401	55	174.616	0.000	100.000				
18	1.151	1.727	29.498	37	15.172	2.722	73.123	56	200.000	0.000	100.000				
19	1.318	1.669	31.167	38	17.377	2.665	75.788	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251402760	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:40	Axis Selection	:LogX-LinY
Laser T%	: 73.4(%)		

OMIX (wet)
Feb 25, 2002



S.P. Area : 16846(cm² /cm³)
Median : 110.915(μm)
Diameter on % :5.000 (%) = 0.490(μm)
:10.00 (%) = 1.992(μm)
:20.00 (%) = 16.199(μm)
:30.00 (%) = 64.549(μm)
:40.00 (%) = 90.262(μm)
:60.00 (%) = 131.840(μm)
:70.00 (%) = 155.696(μm)
:80.00 (%) = 187.454(μm)
:90.00 (%) = 241.022(μm)
:95.00 (%) = 295.057(μm)

% on Diameter :850.0 (μm) = 100.000(%)
:600.0 (μm) = 100.000(%)
:425.0 (μm) = 99.225(%)
:300.0 (μm) = 95.353(%)
:212.0 (μm) = 85.461(%)
:150.0 (μm) = 67.819(%)
:106.0 (μm) = 47.572(%)
:75.00 (μm) = 33.607(%)
:53.00 (μm) = 26.80
:38.00 (μm) = 23.78

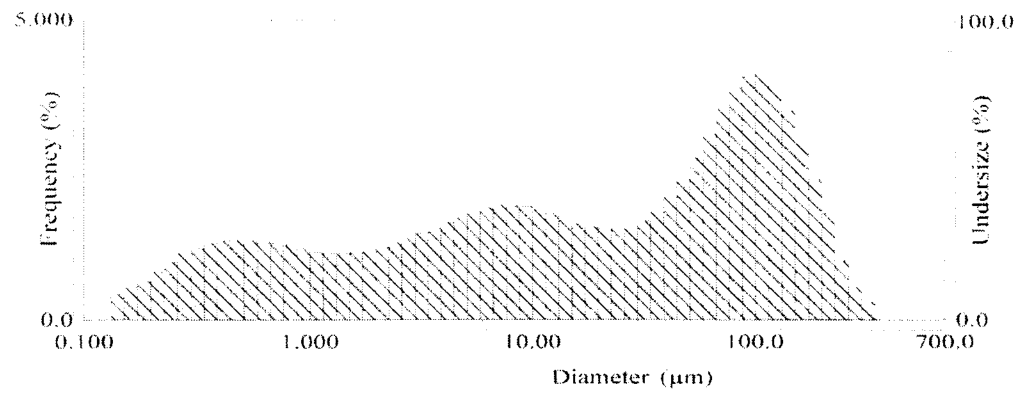
Mean : 118.796(μm)
Variance : 8819.891
S.D. : 93.914(μm)
Mode : 142.039(μm)
Span : 2.155

No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000
2	0.131	0.000	0.000
3	0.150	0.322	0.322
4	0.172	0.379	0.701
5	0.197	0.422	1.123
6	0.226	0.483	1.606
7	0.259	0.544	2.150
8	0.296	0.597	2.747
9	0.339	0.605	3.352
10	0.389	0.615	3.967
11	0.445	0.610	4.577
12	0.510	0.592	5.170
13	0.584	0.566	5.736
14	0.669	0.539	6.275
15	0.766	0.513	6.788
16	0.877	0.491	7.280
17	1.005	0.463	7.743
18	1.151	0.444	8.187
19	1.318	0.435	8.623
20	1.510	0.438	9.061
21	1.729	0.450	9.510
22	1.981	0.469	9.979
23	2.269	0.490	10.469
24	2.599	0.522	10.991
25	2.976	0.557	11.549
26	3.409	0.593	12.142
27	3.905	0.631	12.773
28	4.472	0.672	13.445
29	5.122	0.710	14.155
30	5.867	0.740	14.895
31	6.720	0.759	15.654
32	7.697	0.762	16.416
33	8.816	0.732	17.148
34	10.097	0.705	17.853
35	11.565	0.668	18.521
36	13.246	0.626	19.148
37	15.172	0.586	19.733
38	17.377	0.552	20.286
39	19.904	0.531	20.817
40	22.797	0.527	21.345
41	26.111	0.545	21.890
42	29.907	0.592	22.481
43	34.255	0.678	23.159
44	39.234	0.819	23.978
45	44.938	1.040	25.018
46	51.471	1.377	26.395
47	58.953	1.876	28.271
48	67.523	2.588	30.859
49	77.339	3.552	34.411
50	88.583	4.749	39.160
51	101.460	6.067	45.227
52	116.210	7.271	52.498
53	133.103	8.069	60.567
54	152.453	8.236	68.803
55	174.616	7.719	76.522
56	200.000	6.654	83.176
57	229.075	5.323	88.499
58	262.376	4.007	92.506
59	300.518	2.884	95.390
60	344.206	2.017	97.406
61	394.244	1.391	98.798
62	451.556	0.773	99.571
63	517.200	0.429	100.000
64	592.387	0.000	100.000

Filename :
ID# :200202251516768
Circulation Speed :14
Ultra sonic :02:34
Laser T% : 76.1(%)

Form of Distribution :Standard
Calc. Level :30
R.R.Index :1.16-0.10i
Axis Selection :LogX-LinY

SMIX (wet)
Feb 25, 2002

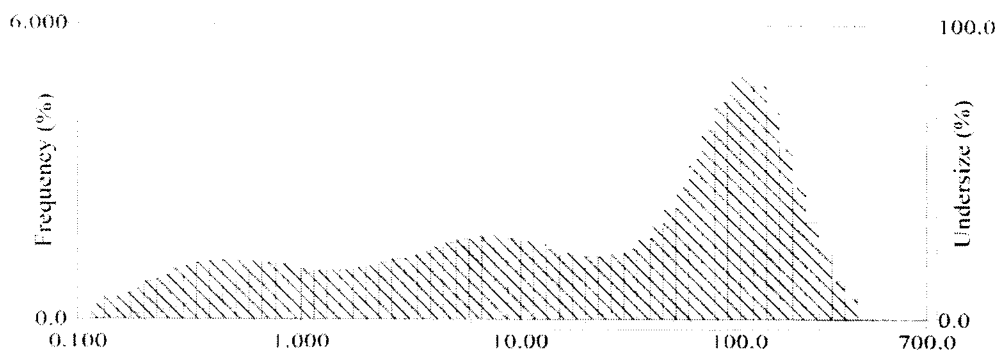


S.P. Area	: 32318(cm² /cm³)		:90.00 (%) = 146.294(µm)		:53.00 (µm) = 62.71
Median	: 20.560(µm)		:95.00 (%) = 184.842(µm)		:38.00 (µm) = 57.30
Diameter on %	:5.000 (%) = 0.315(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 52.218(µm)
	:10.00 (%) = 0.532(µm)		:600.0 (µm) = 100.000(%)	Variance	: 4062.040
	:20.00 (%) = 1.656(µm)		:425.0 (µm) = 100.000(%)	S.D.	: 63.734(µm)
	:30.00 (%) = 4.478(µm)		:300.0 (µm) = 99.687(%)	Mode	: 108.247(µm)
	:40.00 (%) = 9.303(µm)		:212.0 (µm) = 97.131(%)	Span	: 7.090
	:60.00 (%) = 45.503(µm)		:150.0 (µm) = 90.646(%)		
	:70.00 (%) = 72.992(µm)		:106.0 (µm) = 80.841(%)		
	:80.00 (%) = 103.110(µm)		:75.00 (µm) = 70.707(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.101	19.234	39	19.904	1.556	49.636	58	262.376	0.992	99.143
2	0.131	0.000	0.000	21	1.729	1.127	20.361	40	22.797	1.521	51.157	59	300.518	0.551	99.694
3	0.150	0.427	0.427	22	1.981	1.168	21.529	41	26.111	1.522	52.679	60	344.206	0.306	100.000
4	0.172	0.540	0.967	23	2.269	1.213	22.742	42	29.907	1.567	54.247	61	394.244	0.000	100.000
5	0.197	0.638	1.605	24	2.599	1.286	24.028	43	34.255	1.664	55.911	62	451.556	0.000	100.000
6	0.226	0.789	2.394	25	2.976	1.364	25.392	44	39.234	1.823	57.734	63	517.200	0.000	100.000
7	0.259	0.954	3.348	26	3.409	1.442	26.833	45	44.938	2.050	59.784	64	592.387	0.000	100.000
8	0.296	1.116	4.465	27	3.905	1.525	28.358	46	51.471	2.349	62.132				
9	0.339	1.190	5.655	28	4.472	1.625	29.983	47	58.953	2.714	64.846				
10	0.389	1.273	6.928	29	5.122	1.723	31.706	48	67.523	3.124	67.970				
11	0.445	1.321	8.248	30	5.867	1.810	33.517	49	77.339	3.537	71.508				
12	0.510	1.334	9.582	31	6.720	1.886	35.402	50	88.583	3.891	75.399				
13	0.584	1.321	10.903	32	7.697	1.931	37.334	51	101.460	4.110	79.509				
14	0.669	1.301	12.204	33	8.816	1.914	39.247	52	116.210	4.130	83.639				
15	0.766	1.274	13.478	34	10.097	1.897	41.145	53	133.103	3.921	87.560				
16	0.877	1.249	14.726	35	11.565	1.848	42.993	54	152.453	3.505	91.065				
17	1.005	1.179	15.905	36	13.246	1.776	44.768	55	174.616	2.950	94.015				
18	1.151	1.128	17.033	37	15.172	1.695	46.463	56	200.000	2.349	96.364				
19	1.318	1.100	18.133	38	17.377	1.617	48.081	57	229.075	1.786	98.150				

Filename	:	Form of Distribution	:Standard
ID#	:200202251332759	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:00:45	Axis Selection	:LogX-LinY
Laser T%	: 82.4(%)		

SOMIX (wet)
Feb 25, 2002



S.P. Area	: 31579(cm²/cm³)		:90.00 (%) = 157.446(μm)		:53.00 (μm) = 56.49
Median	: 33.831(μm)		:95.00 (%) = 196.128(μm)		:38.00 (μm) = 51.37
Diameter on %	:5.000 (%) = 0.311(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 60.210(μm)
	:10.00 (%) = 0.556(μm)		:600.0 (μm) = 100.000(%)	Variance	: 4596.574
	:20.00 (%) = 1.980(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 67.798(μm)
	:30.00 (%) = 5.475(μm)		:300.0 (μm) = 99.556(%)	Mode	: 108.457(μm)
	:40.00 (%) = 12.446(μm)		:212.0 (μm) = 96.245(%)	Span	: 4.637
	:60.00 (%) = 62.405(μm)		:150.0 (μm) = 88.659(%)		
	:70.00 (%) = 87.888(μm)		:106.0 (μm) = 76.743(%)		
	:80.00 (%) = 115.794(μm)		:75.00 (μm) = 64.917(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	0.992	17.936	39	19.904	1.303	44.793	58	262.376	1.405	98.786
2	0.131	0.302	0.302	21	1.729	1.015	18.950	40	22.797	1.274	46.067	59	300.518	0.781	99.566
3	0.150	0.446	0.748	22	1.981	1.052	20.002	41	26.111	1.282	47.350	60	344.206	0.434	100.000
4	0.172	0.543	1.291	23	2.269	1.092	21.095	42	29.907	1.336	48.686	61	394.244	0.000	100.000
5	0.197	0.624	1.915	24	2.599	1.159	22.254	43	34.255	1.447	50.133	62	451.556	0.000	100.000
6	0.226	0.756	2.671	25	2.976	1.231	23.485	44	39.234	1.626	51.759	63	517.200	0.000	100.000
7	0.259	0.896	3.567	26	3.409	1.303	24.788	45	44.938	1.890	53.649	64	592.387	0.000	100.000
8	0.296	1.030	4.597	27	3.905	1.380	26.168	46	51.471	2.253	55.903				
9	0.339	1.089	5.687	28	4.472	1.471	27.639	47	58.953	2.721	58.624				
10	0.389	1.156	6.842	29	5.122	1.559	29.198	48	67.523	3.282	61.906				
11	0.445	1.193	8.036	30	5.867	1.633	30.831	49	77.339	3.891	65.797				
12	0.510	1.202	9.238	31	6.720	1.692	32.523	50	88.583	4.461	70.259				
13	0.584	1.190	10.428	32	7.697	1.721	34.244	51	101.460	4.872	75.130				
14	0.669	1.172	11.600	33	8.816	1.686	35.930	52	116.210	5.001	80.132				
15	0.766	1.147	12.747	34	10.097	1.655	37.584	53	133.103	4.785	84.917				
16	0.877	1.125	13.872	35	11.565	1.595	39.179	54	152.453	4.250	89.167				
17	1.005	1.063	14.935	36	13.246	1.517	40.696	55	174.616	3.510	92.677				
18	1.151	1.017	15.953	37	15.172	1.434	42.130	56	200.000	2.714	95.391				
19	1.318	0.991	16.944	38	17.377	1.360	43.490	57	229.075	1.989	97.380				

Filename	:	Form of Distribution	:Standard
ID#	:200202251509765	Calc. Level	:30
Circulation Speed	:13	R.R.Index	:1.16-0.10i
Ultra sonic	:01:08	Axis Selection	:LogX-LinY
Laser T%	: 82.9(%)		

APPENDIX D

Results of Mineralogical Analysis

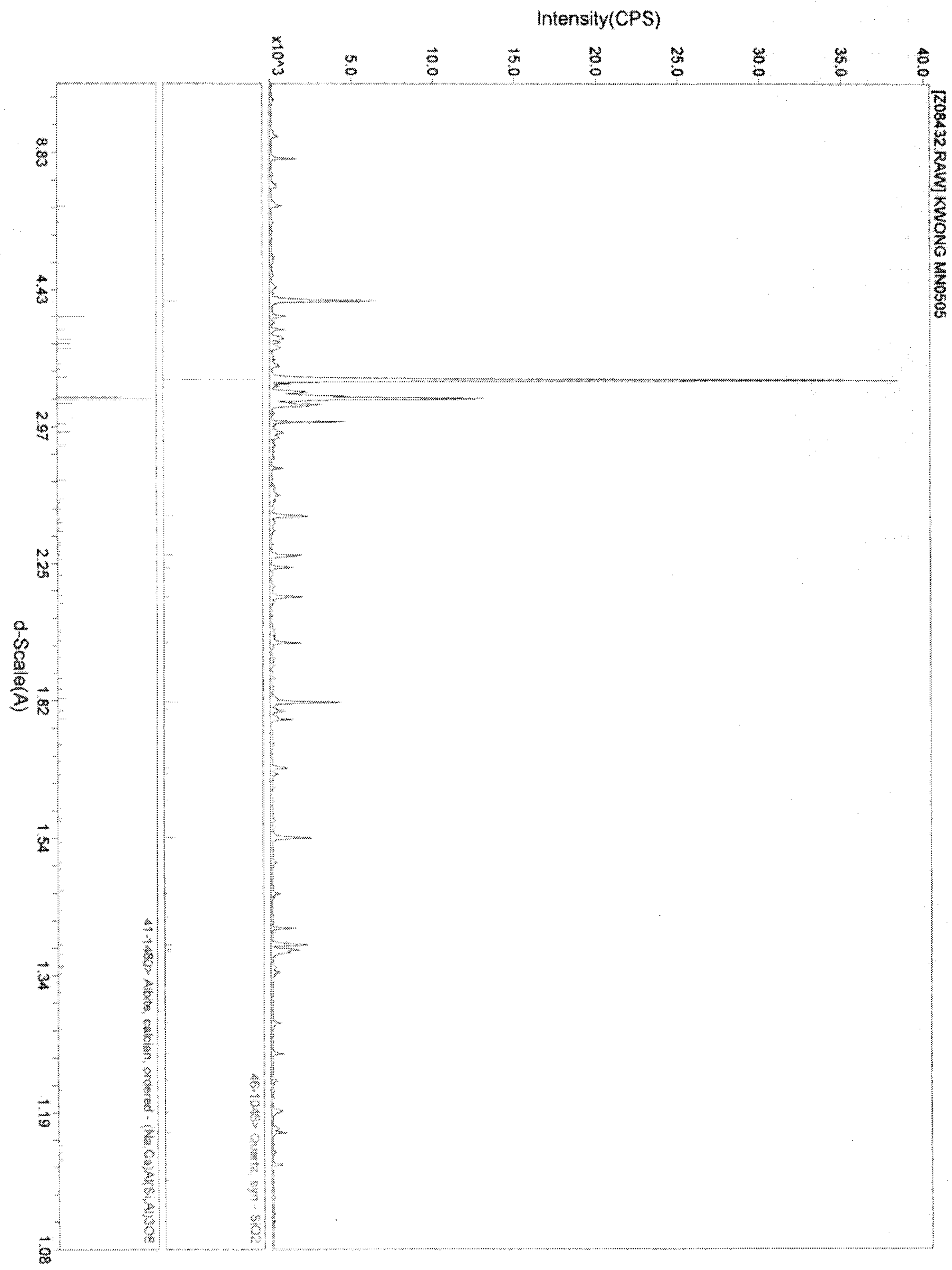
Appendix D-1: X-Ray Diffraction Analysis

This appendix contains selected X-ray diffractograms illustrating the mineralogy of the four types of tailings and native sediments identified in the tailings impoundment as well as grab samples from the Brown-McDade open pit at Mount Nansen. Only reference diffraction patterns for the major components are given below each individual diffractogram. Other minerals identified in the selected samples are tabulated below:

Table D-1. Minerals identified by X-ray diffraction in selected samples from Mount Nansen

Sample #	***Sample Type***	***Minerals Identified****
MN0505	Native sediment	Q > plag >> minor amp, Ksp > trace ms, kao
MN0607	Clayey sulfide tails	Q >> minor ms, kao, gyp, ja > trace py, fels
MN1003	Clayey sulfide tails	Q >> minor ms, gyp, kao, ja, py, Ksp
MN1202	Clayey oxide tails	Q >> minor ms, kao, gyp, ja >trace py
MN1804	Clayey oxide tails	Q >> minor ms, mont, kao, ja
MNSMIX	Silty sulfide tails	Q >> minor kao > trace ms, gyp, ja, fel, py
SOMIX	Mixed oxide-sulfide silty tails	Q >> minor gyp, ms, kao, ja > trace fels, py
WBH3	Alteration on surface tailings	Q ~ cc >> minor gyp, kao,ms, ja
PITSED	Pit sediment	Q > mont > kao > minor ms, ja, Ksp, plag
NWALBX	Pit grab, breccia	Py >> Q ~ gyp > minor ja, ms, kao

*amp=amphibole; cc=calcite; fels=feldspar, undifferentiated; gyp=gypsum; ja=jarosite; kao=kaolinite; Ksp=potassic feldspar; mont=montmorillonite; ms=muscovite/illite; plag=plagioclase; py=pyrite; Q=quartz


Intensity(CPS)
x10^3
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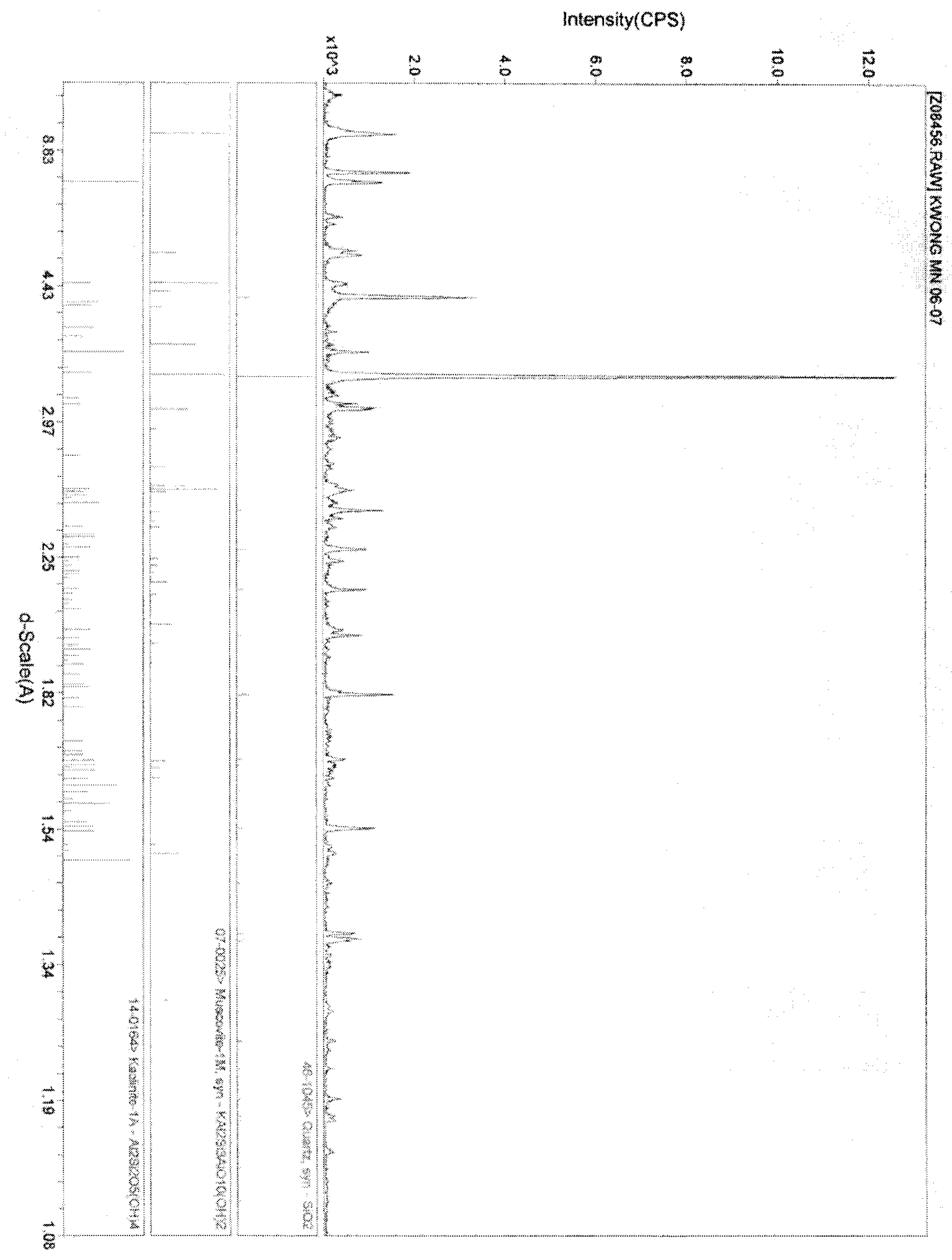
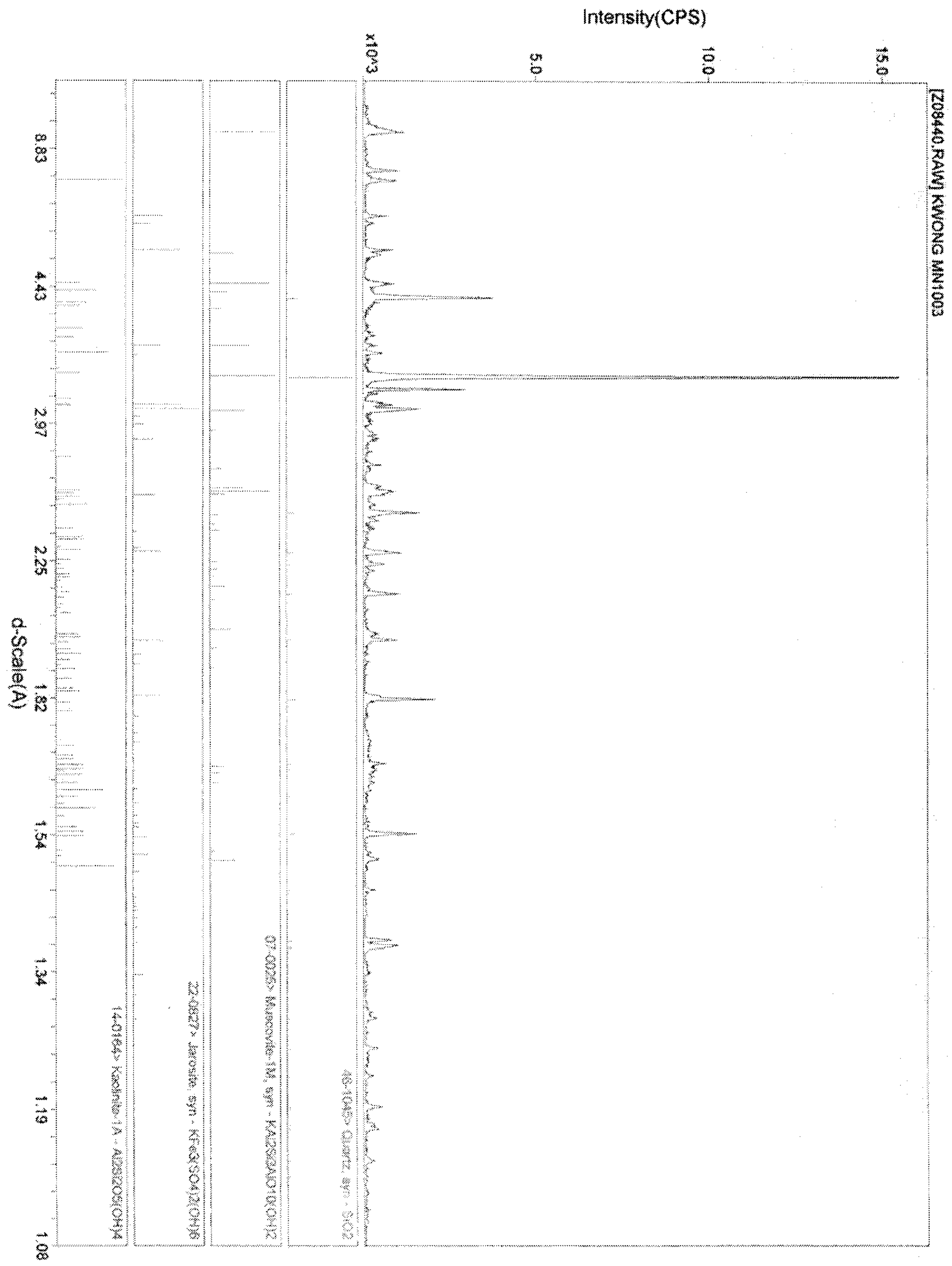
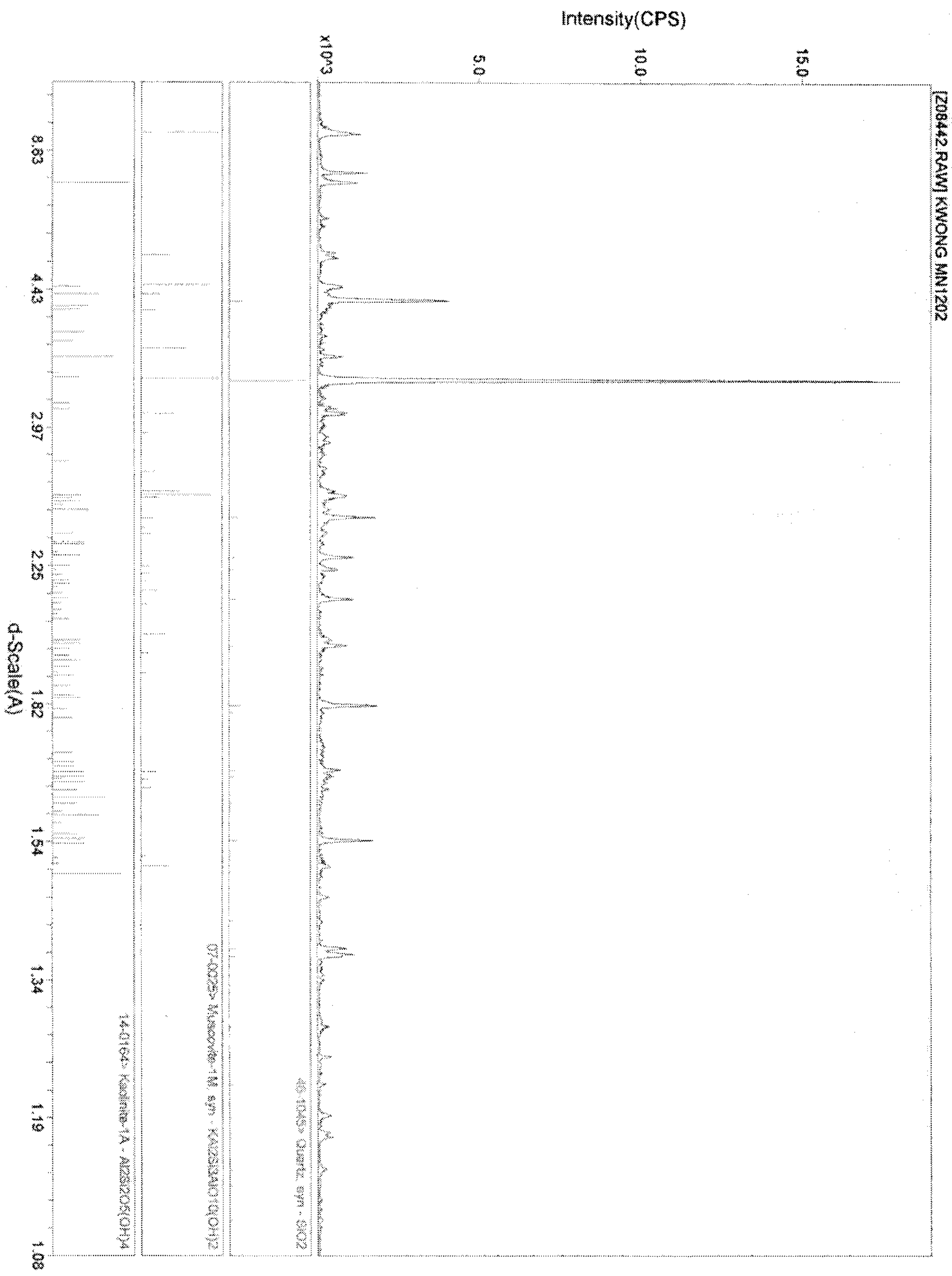
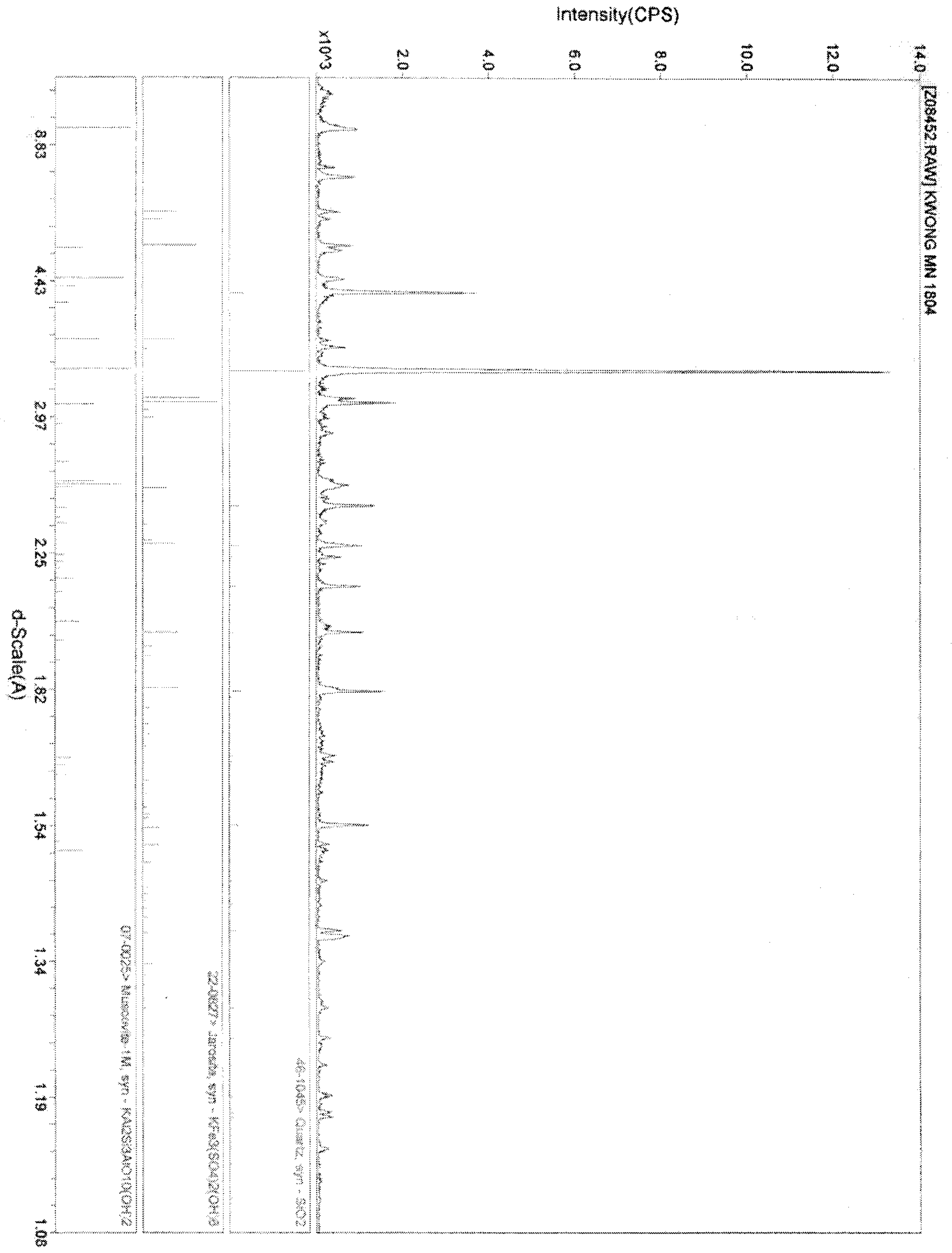
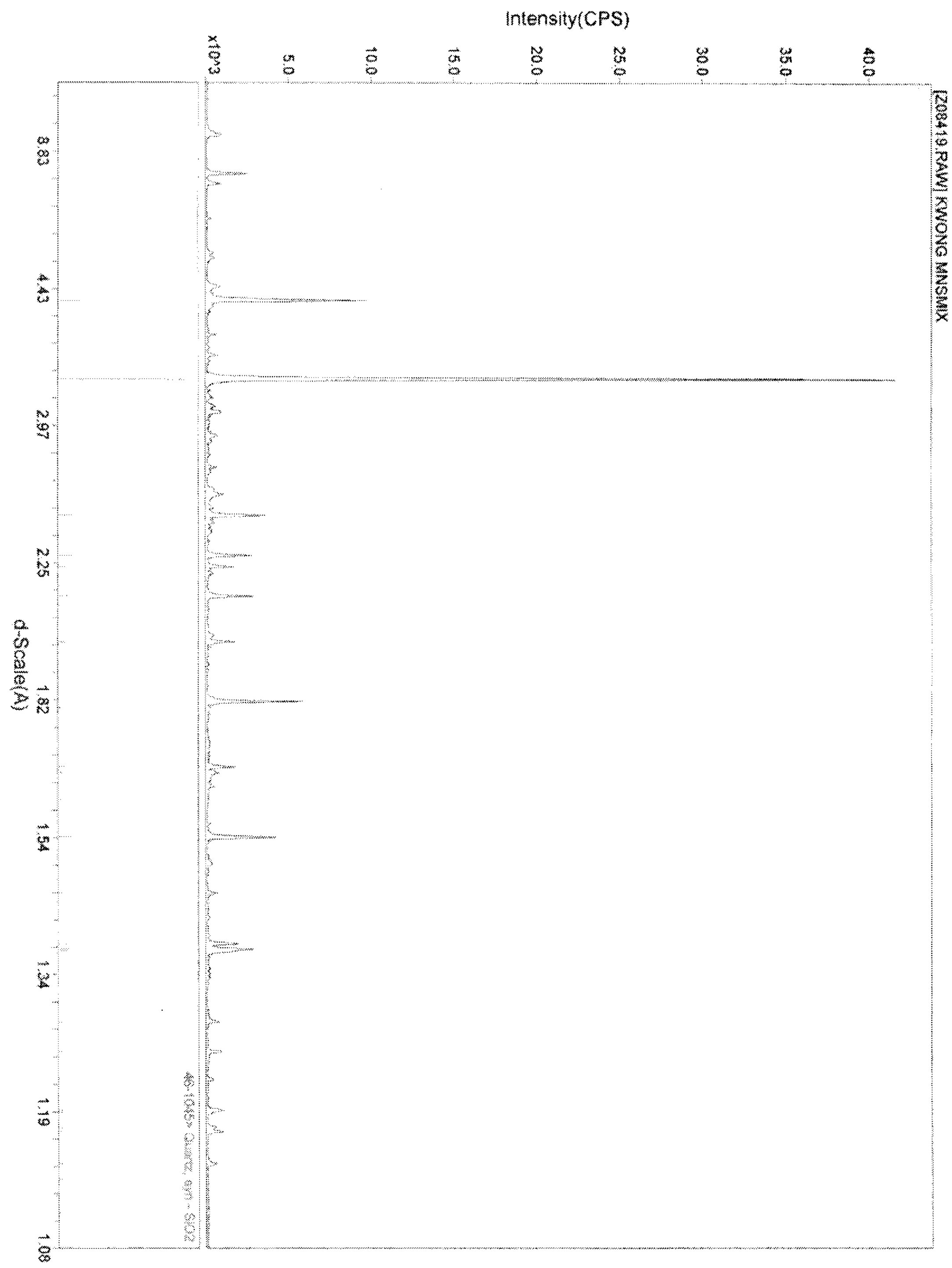
10.0
15.0
20.0
25.0
30.0
35.0
40.0
[Z08432.RAW] KWONG MN0505
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
46-1045> Quartz, syn - SiO2
41-1480> Albite, calcian, ordered - (Na,Ca)Al(Si,Al)3O8

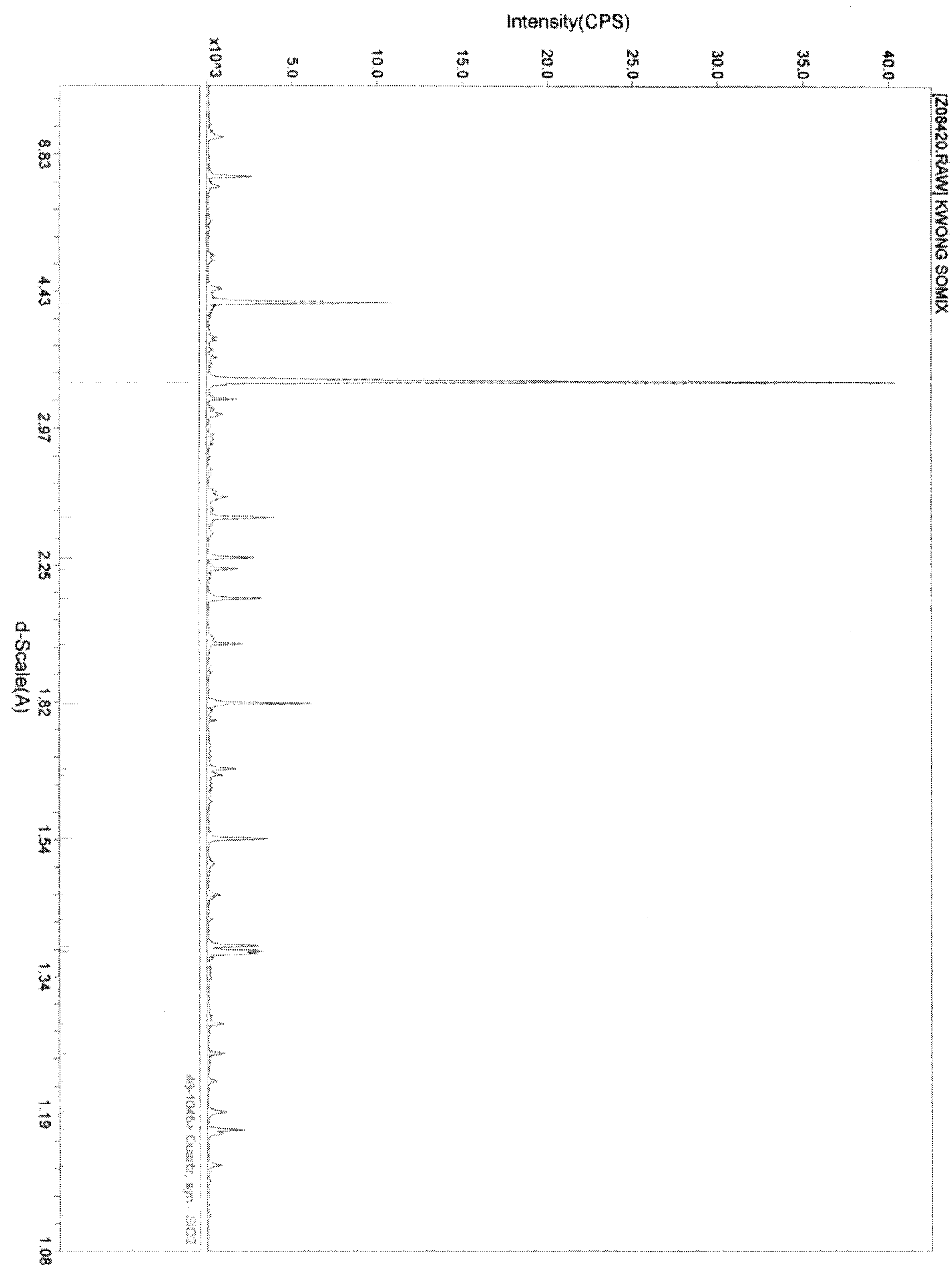

Intensity(CPS)
x10^3
2.0
4.0
6.0
8.0
10.0
12.0
[Z08456.RAW] KWONG MN 06-07
46-1045> Quartz, syn - SiO2
07-0025> Muscovite-1M, syn - KAl2Si3AlO10(OH)2
14-0164> Kaolinite-1A - Al2Si2O5(OH)4
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)

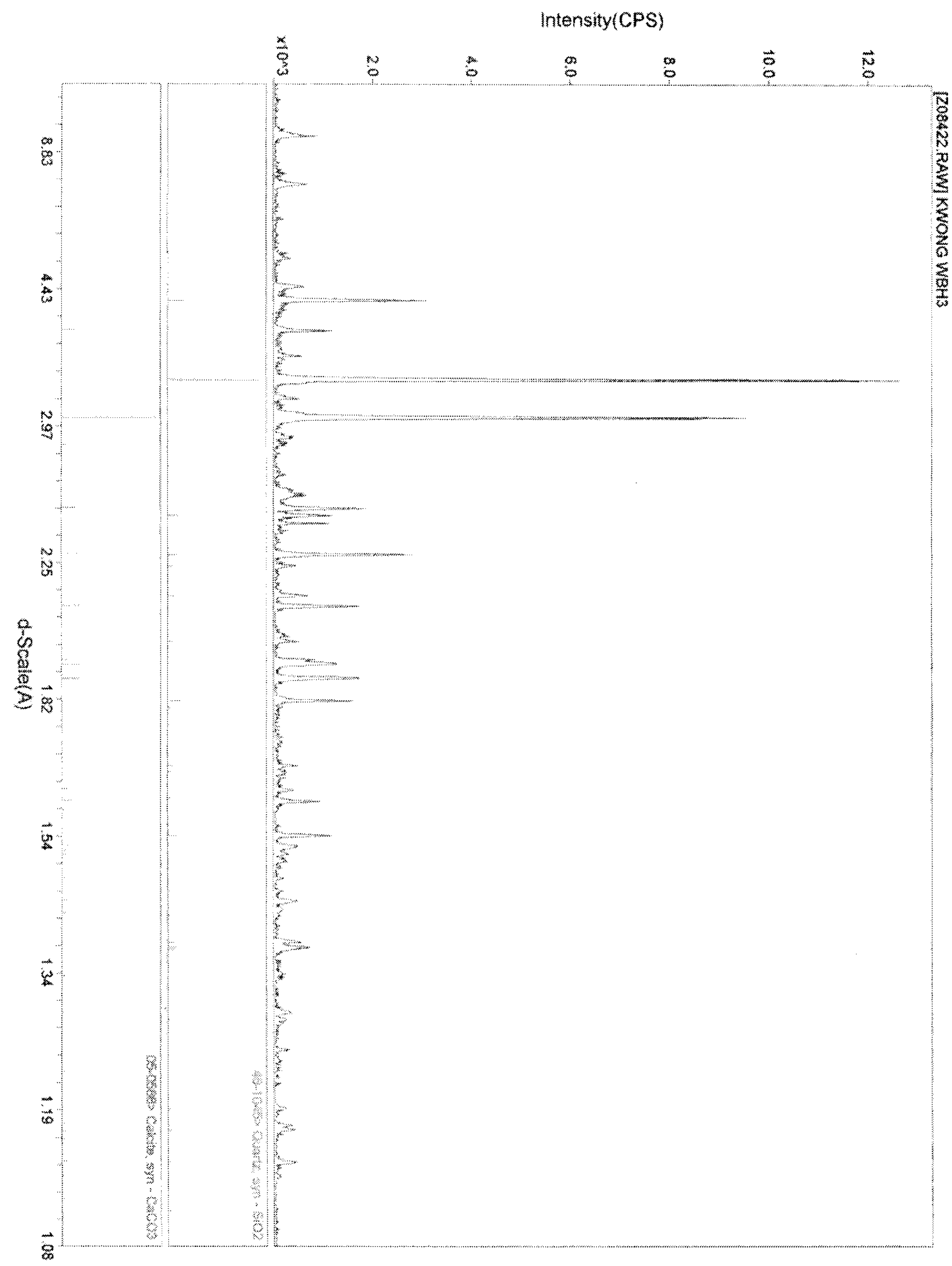

[Z08440.RAW] KWONG MN1003
Intensity(CPS)
x10^3
5.0
10.0
15.0
d-Scale(A)
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
46-1045> Quartz, syn - SiO2
07-0025> Muscovite-1M, syn - KAl2Si3AlO10(OH)2
22-0827> Jarosite, syn - KFe3(SO4)2(OH)6
14-0164> Kaolinite-1A - Al2Si2O5(OH)4

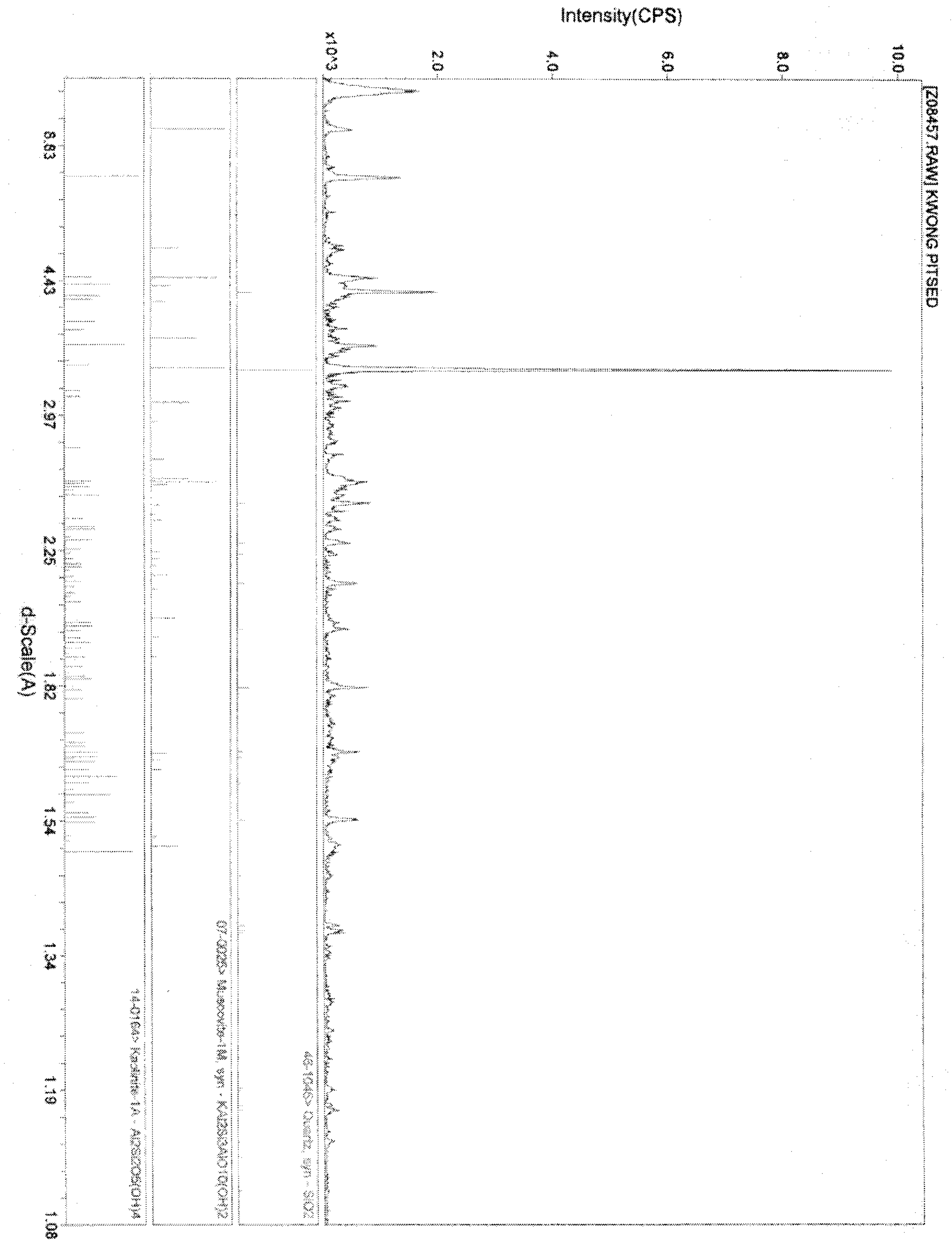

[Z08442.RAW] KWONG MN1202
Intensity(CPS)
x10^3
5.0
10.0
15.0
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
14-0164> Kaolinite-1A - Al2Si2O5(OH)4
07-0025> Muscovite-1M, syn - KAl2Si3AlO10(OH)2
46-1045> Quartz, syn - SiO2


Intensity(CPS)
x10^3
2.0
4.0
6.0
8.0
10.0
12.0
14.0
[Z08452.RAW] KWONG MN 1804
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
46-1045> Quartz, syn - SiO2
22-0827> Jarosite, syn - KFe3(SO4)2(OH)6
07-0025> Muscovite-1M, syn - KAl2(Si3Al)O10(OH)2

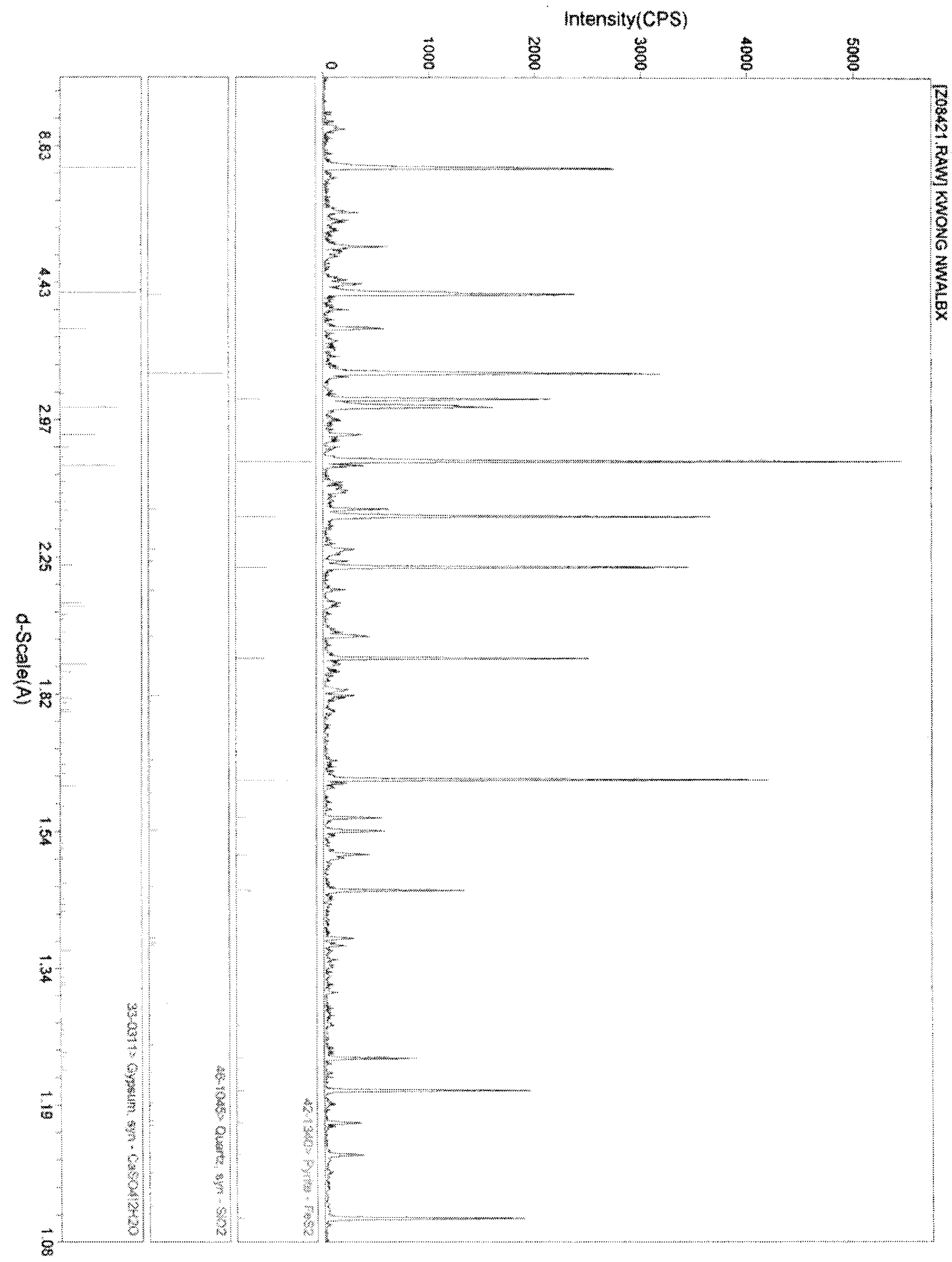

Intensity(CPS)
x10^3
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
[Z08419.RAW] KWONG MNSMIX
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
46-1045> Quartz, syn - SiO2


[Z08420.RAW] KWONG SOMIX
Intensity(CPS)
x10^3
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
d-Scale(A)
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
46-1045> Quartz, syn - SiO2


Intensity(CPS)
x10^3
2.0
4.0
6.0
8.0
10.0
12.0
[Z08422.RAW] KWONG WBH3
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
46-1045> Quartz, syn - SiO2
05-0586> Calcite, syn - CaCO3



[Z08457.RAW] KWONG PITSED
Intensity(CPS)
x10^3
2.0
4.0
6.0
8.0
10.0
d-Scale(A)
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
46-1045> Quartz, syn - SiO2
07-0025> Muscovite-1M, syn - KAl2Si3AlO10(OH)2
14-0164> Kaolinite 1A - Al2Si2O5(OH)4



Intensity(CPS)
0
1000
2000
3000
4000
5000
[Z08421.RAW] KWONG NWALBX
d-Scale(A)
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
33-0311> Gypsum, syn - CaSO4!2H2O
46-1045> Quartz, syn - SiO2
42-1340> Pyrite - FeS2

Appendix D-2: SEM-EDX Analysis

In this appendix, data on mineral abundance in selected tailings samples as determined by point counting under a scanning electron microscope are tabulated (Table D-2). Electron micrographs as well as energy-dispersive X-ray spectra of selected grains of interest are also furnished.

Table D-2. Mineral abundance in selected Mount Nansen tailings by point counting under a scanning electron microscope. (Note that hits on voids in the polished sections are excluded in the tally; minerals in composite grains are proportionally counted in fractions/decimals.)

OMIX (oxide silt composite)

Mineral	*Count*	*%*
Quartz	189	69.7
Muscovite	28.5	10.5
Kaolinite	7	2.6
Biotite	5.5	2
FeO.OH	14	5.2
Pyrite	14	5.2
Jarosite	4.5	1.7
Ca-albite	2	0.7
K-feldspar	1	0.4
Amphibole	1	0.4
Calcite	2	0.7
Ankerite	1	0.4
Gypsum	1	0.4
Scorodite	0.5	0.2
Total	271	100.1

SMIX (sulfide silt composite)

Mineral	*Count*	*%*
Quartz	187	59.6
Muscovite	51.5	16.4
Kaolinite	13.5	4.3
Aspy	1	0.3
FeO.OH	13	4.1
Pyrite	3.5	1.1
Jarosite	8	2.6
Plag.	0.5	0.2
K-feldspar	24.5	7.8
Mn-carb	0.5	0.2
Calcite	5	1.6
Gypsum	3	1
Scorodite	3	1
Total	314	100.2

SOMIX (mixed silt composite)

Mineral	*Count*	*%*
Quartz	208.9	58.2
Muscovite	41.6	11.6
Kaolinite	17.7	4.9
Rutile	1.3	0.4
FeO.OH	18.4	5.1
Pyrite	2.8	0.8
Jarosite	10.2	2.8
Gibbsite	0.5	0.1
K-feldspar	45.3	12.6
Calcite	7.8	2.2
Ankerite	0.5	0.1
Gypsum	0.5	0.1
Scorodite	1	0.3
MnZnO	2.5	0.7
Total	359	99.9

MN0406 (clayey sulfide tails)

Mineral	*Count*	*%*
Quartz	139.2	45.3
Muscovite	61.6	20.1
Kaolinite	8.3	2.7
Sphalerite	0.5	0.2
FeO.OH	8	2.6
Pyrite	7.7	2.5
Jarosite	5.3	1.7
Ca-albite	4.5	1.5
K-feldspar	50.7	16.5
Aspy	3.8	1.2
Calcite	7.8	2.5
Ankerite	1.5	0.5
Gypsum	5	1.6
Scorodite	1.3	0.4
MnZnO	2	0.7
Total	307	100

MN0603 (silty sulfide tails)

Mineral	*Count*	*%*
Quartz	140	58.8
Muscovite	35.9	15.1
Kaolinite	7.5	3.2
Rutile	0.5	0.2
FeO.OH	8.2	3.5
Pyrite	2.5	1.1
Jarosite	2.5	1.1
Ca-albite	0	
K-feldspar	32.9	13.8
Aspy	0	
Calcite	5.3	2.2
Ankerite	0	
Gypsum	1.8	0.7
Scorodite	0	
MnZnO	1	0.4
Total	238	100.1

MN0703 (clayey sulfide tails)

Mineral	*Count*	*%*
Quartz	147.1	42.6
Muscovite	88.8	25.7
Kaolinite	5.3	1.5
Sphalerite	0	0
FeO.OH	18.7	5.4
Pyrite	9.6	2.8
Jarosite	12.7	3.7
Ca-albite	1	0.3
K-feldspar	50.5	14.6
Aspy	0	0
Calcite	6.1	1.8
Ankerite	1	0.3
Gypsum	4.6	1.3
Total	345.3	100

Note: 1 grain of scorodite with remnant Aspy observed but not hit by grid.

Table D-2 (cont.)

MN0803 (clay-silt sulfide tails)

Mineral	*Count*	*%*
Quartz	148.8	41.2
Muscovite	86.6	24
Kaolinite	24.3	6.7
Rutile	0.3	0.1
FeO.OH	17.8	4.9
Pyrite	11.8	3.3
Jarosite	6.9	1.9
Ca-albite	0.7	0.2
K-feldspar	50.8	14
FeSbAsS	1	0.3
Calcite	8.8	2.4
Ankerite	0.5	0.1
Gypsum	2.3	0.6
Scorodite	0	0
MnZnO	1	0.3
Total	361.5	100.0

MN0903 (oxide silt tailings)

Mineral	*Count*	*%*
Quartz	214.1	57.7
Muscovite	40.3	10.9
Kaolinite	13.1	3.5
Rutile	0.5	0.1
FeO.OH	18.4	5
Pyrite	0.7	0.2
Jarosite	20.8	5.6
Ca-albite	0	0
K-feldspar	55.1	14.8
Calcite	4.3	1.1
Ankerite	1	0.3
Gypsum	1	0.3
Scorodite	1.5	0.4
Apatite	0.5	0.1
Total	371.3	100.0

*Other minerals observed: zircon

MN1202 (clayey oxide tails)

Mineral	*Count*	*%*
Quartz	164.2	47.4
Muscovite	85.2	24.6
Kaolinite	22.4	6.5
Ilmenite	0.5	0.1
FeO.OH	17.8	5.2
Pyrite	2.3	0.7
Jarosite	7.4	2.1
MnO	0.5	0.1
K-feldspar	32.8	9.5
Native Fe	1	0.3
Calcite	3.2	0.9
Ankerite	1.7	0.5
Gypsum	4.5	1.3
Kutnohorit	1	0.3
FeMnZnO	2.1	0.6
Total	346.5	100.1

MN1502 (silty oxide tails)

Mineral	*Count*	*%*
Quartz	202.7	67.3
Muscovite	32.7	10.9
Kaolinite	9.8	3.3
Rutile	0	0
FeO.OH	18.8	6.3
Pyrite	3	1
Jarosite	7.2	2.4
Ca-albite	0	0
K-feldspar	21.8	7.2
FeSbAsS	0	0
Calcite	2.8	0.9
Ankerite	0.5	0.2
Gypsum	0.8	0.3
Scorodite	1	0.3
Total	301.0	100.1

*Other minerals observed: zircon, covellite, galena and arsenopyrite.

MN1701 (sulfidic silt tails)

Mineral	*Count*	*%*
Quartz	191.1	64
Muscovite	30.2	10.1
Kaolinite	7.5	2.5
Rutile	2	0.7
FeO.OH	11.2	3.7
Pyrite	5.5	1.8
Jarosite	10.5	3.5
Ilmenite	1	0.3
K-feldspar	28.9	9.7
Aspy	0.5	0.2
Calcite	1.3	0.4
Ankerite	1	0.3
Gypsum	2.3	0.8
Scorodite	1.7	0.6
Kutnohorit	1.5	0.5
Sphalerite	0.5	0.2
Plag	2	0.7
Total	298.5	100.0

MN1804 (clayey oxide tails)

Mineral	*Count*	*%*
Quartz	186.2	51.4
Muscovite	49.8	13.8
Kaolinite	27.3	7.5
Ilmenite	0.5	0.1
FeO.OH	20.3	5.6
Pyrite	1.5	0.4
Jarosite	27.2	7.5
Ca-albite	0	0
K-feldspar	43.4	12
Native Fe	1	0.3
Calcite	4.3	1.2
Ankerite	0	0
Gypsum	0.5	0.1
Scorodite	0	0
Total	361.9	99.9

*Other minerals observed: scorodite

OMIX (supplementary analysis)

Mineral	*Count*	*%*
Quartz	54.2	66.9
Muscovite	11.6	14.3
Kaolinite	4.7	5.8
Biotite	0	0
FeO.OH	3.9	4.8
Pyrite	1	1.2
Jarosite	1.2	1.4
Ca-albite	1	1.2
K-feldspar	2.2	2.7
Amphibole	0	0
Calcite	0	0
Ankerite	0	0
Gypsum	1.3	1.7
Scorodite	0	0
Total	81.0	100

SMIX (supplementary analysis)

Mineral	*Count*	*%*
Quartz	50.4	62.2
Muscovite	14.3	17.6
Kaolinite	3	3.7
Aspy	0	0
FeO.OH	3.5	4.3
Pyrite	0	0
Jarosite	1.8	2.3
Plag.	0	0
K-feldspar	3.8	4.6
Mn-carb	1	1.2
Calcite	1	1.2
Ankerite	1	1.2
Gypsum	0.8	0.9
Rutile	0.5	0.6
Total	81.0	99.8

SOMIX (supplementary analysis)

Mineral	*Count*	*%*
Quartz	53.3	60.6
Muscovite	14.2	16.1
Kaolinite	6.8	7.7
Sphene	1	1.1
FeO.OH	2.4	2.8
Pyrite	0.8	0.9
Jarosite	2.8	3.2
Gibbsite	0	0
K-feldspar	4.7	5.3
FeSbAsS	0	0
Calcite	0	0
Ankerite	1	1.1
Gypsum	1	1.1
Scorodite	0	0
Total	88.0	99.9

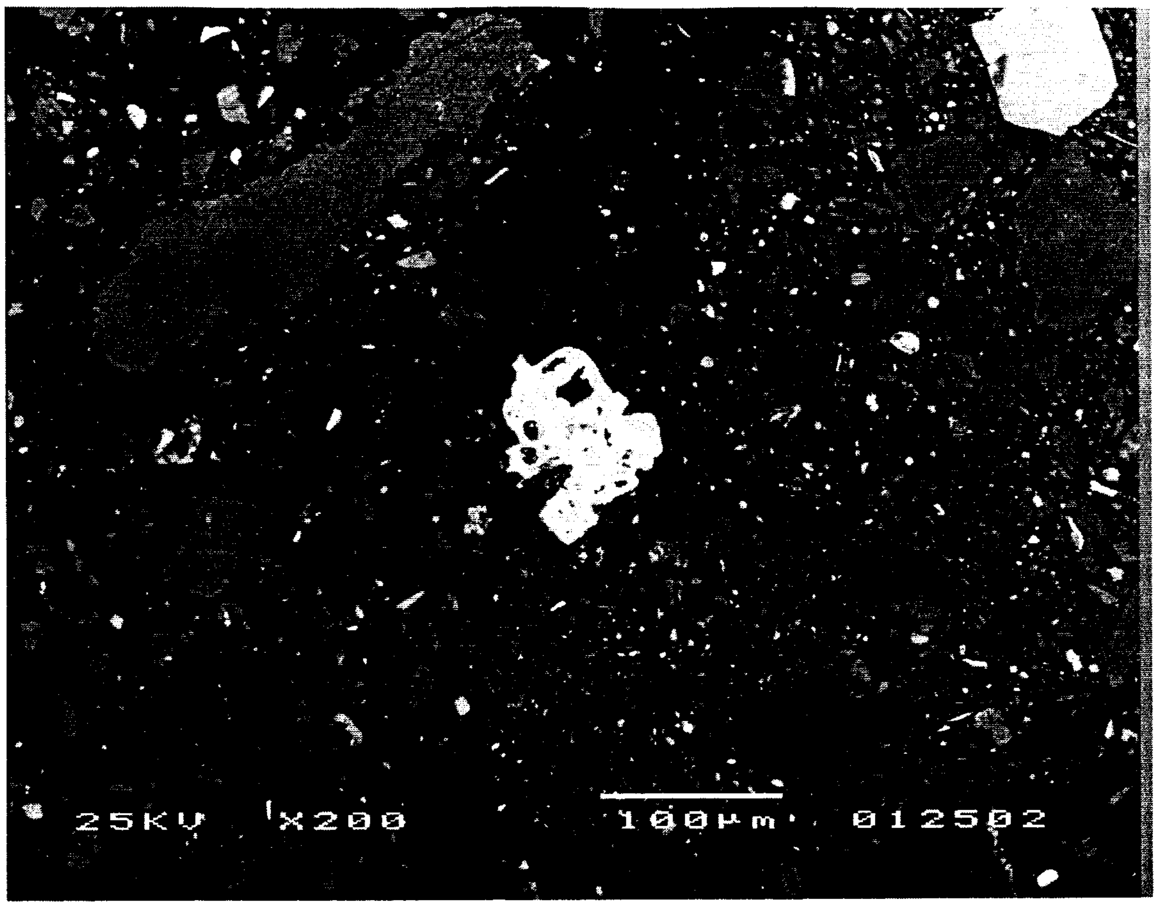


Figure D2-1a. Backscattered electron micrograph of Sample MN0703 showing a scorodite ($FeAsO_4.2H_2O$) grain at the center (greyish white) and an apatite [$Ca_5(PO_4)_3(OH,F,Cl)$] at the top right hand corner (light grey). Energy-dispersive X-ray spectra of the two grains are shown in Figure D2-1b.

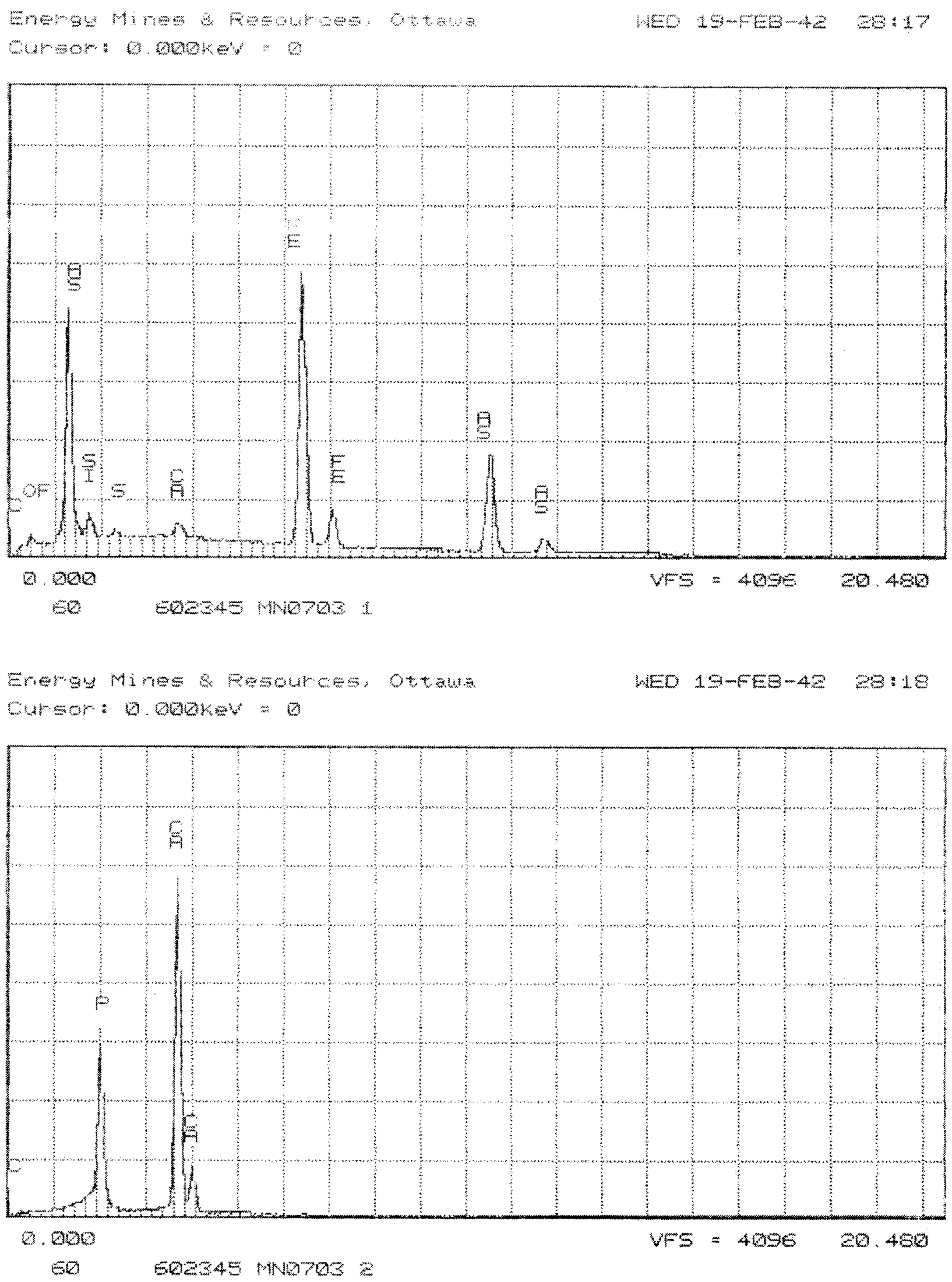


Figure D2-1b. Energy-dispersive X-ray spectra of scorodite (top) and apatite (bottom).

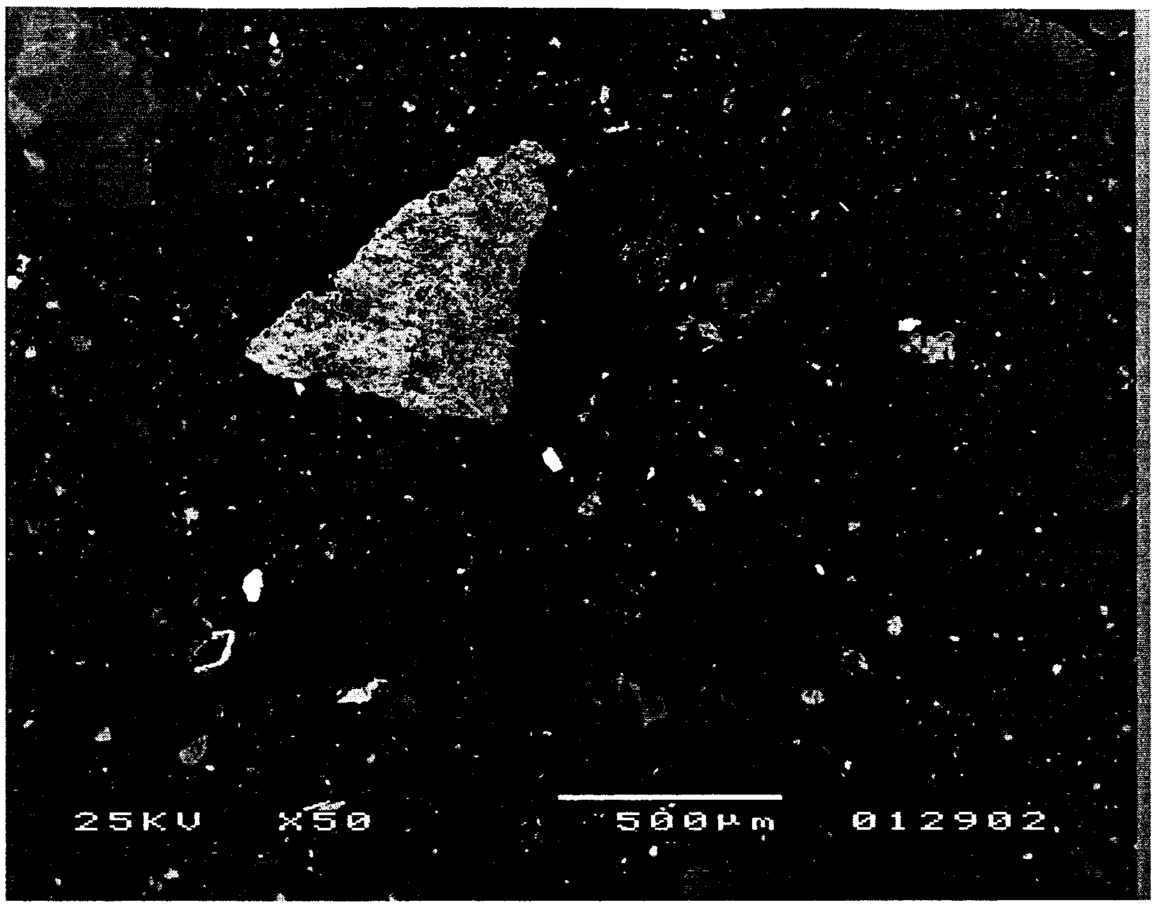
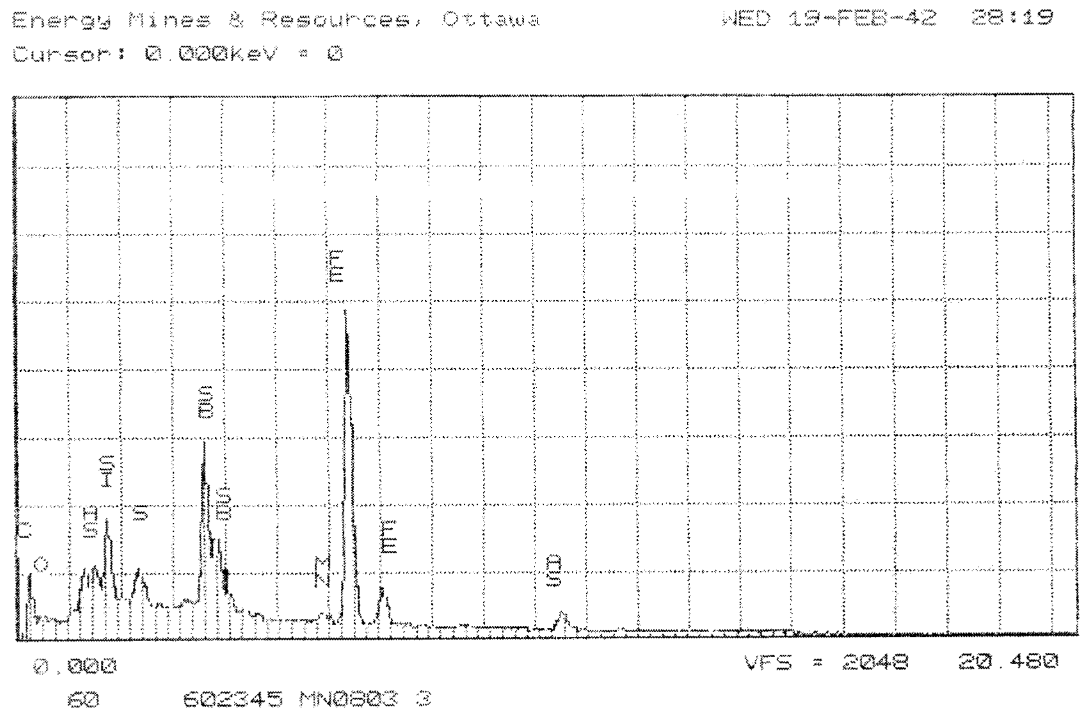


Figure D2-2a. Backscattered electron micrograph of Sample MN0903 showing a triangular, composite grain of goethite (grey, near center). The small, white rectangular grain at the center and the curved white grain at the lower left corner are unidentified sulfosalts, the energy-dispersive X-ray spectra of which are shown in Figure D2-2b. Other scattered, small greyish white grains are mostly pyrite.



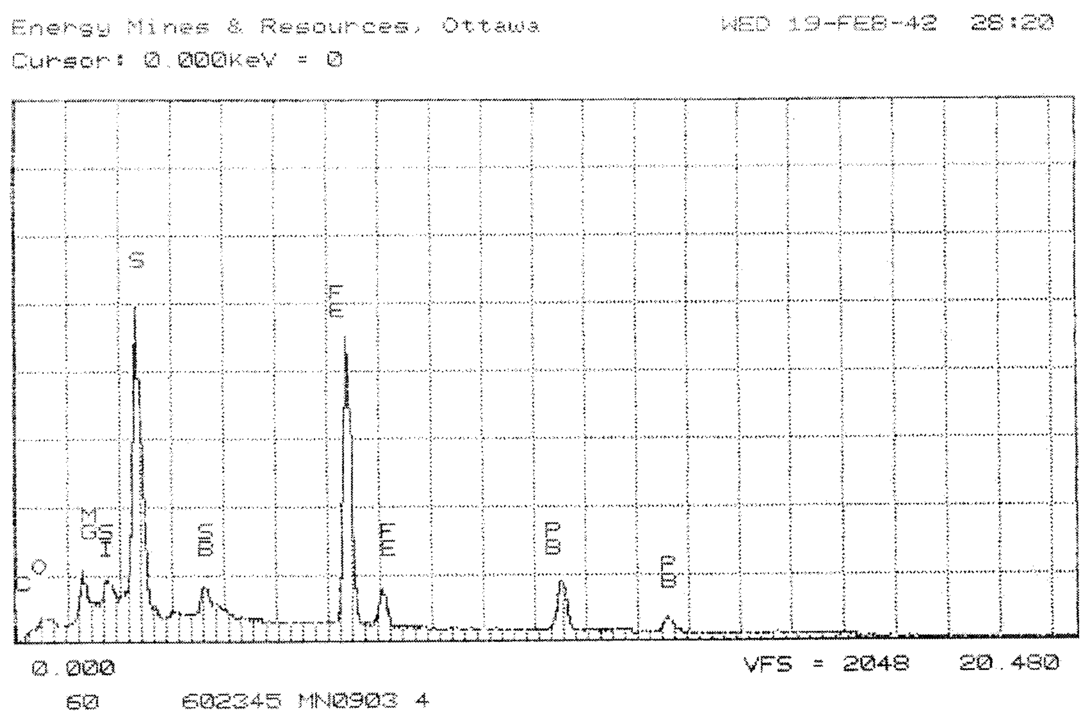


Figure D2-2b. Energy-dispersive X-ray spectra of unidentified sulfosalts observed in Sample MN0903.

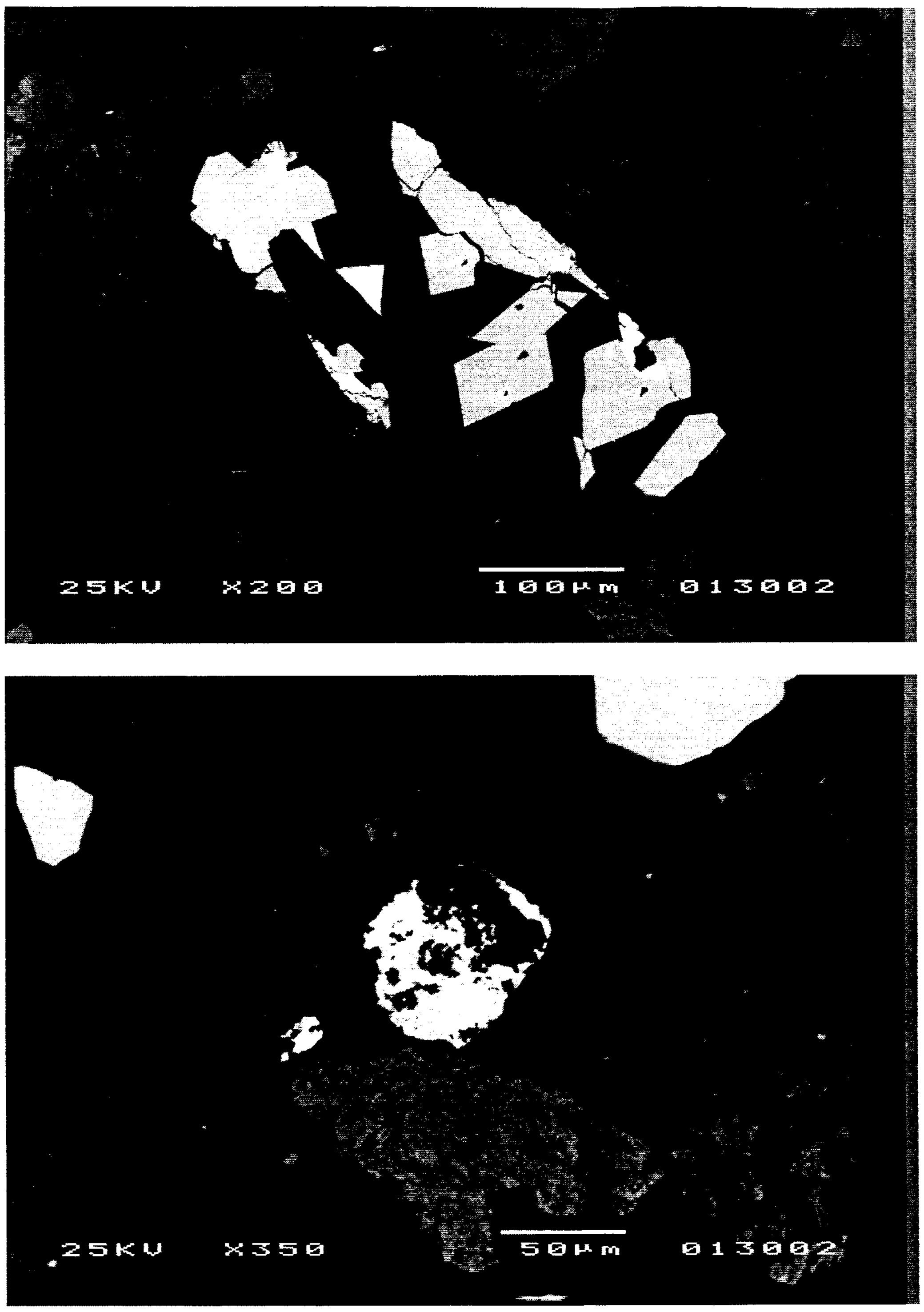


Figure D2-3. Backscattered electron micrographs of Sample MN1502. Top: A quartz grain (dark grey) with included arsenopyrite (grey) and unidentified sulfosalts (white, triangular). Bottom: A composite grain of unidentified sulfosalts (whitish grey, center) surrounded by goethite (dark grey, bottom) and subhedral pyrite (grey, top left and right hand corners).

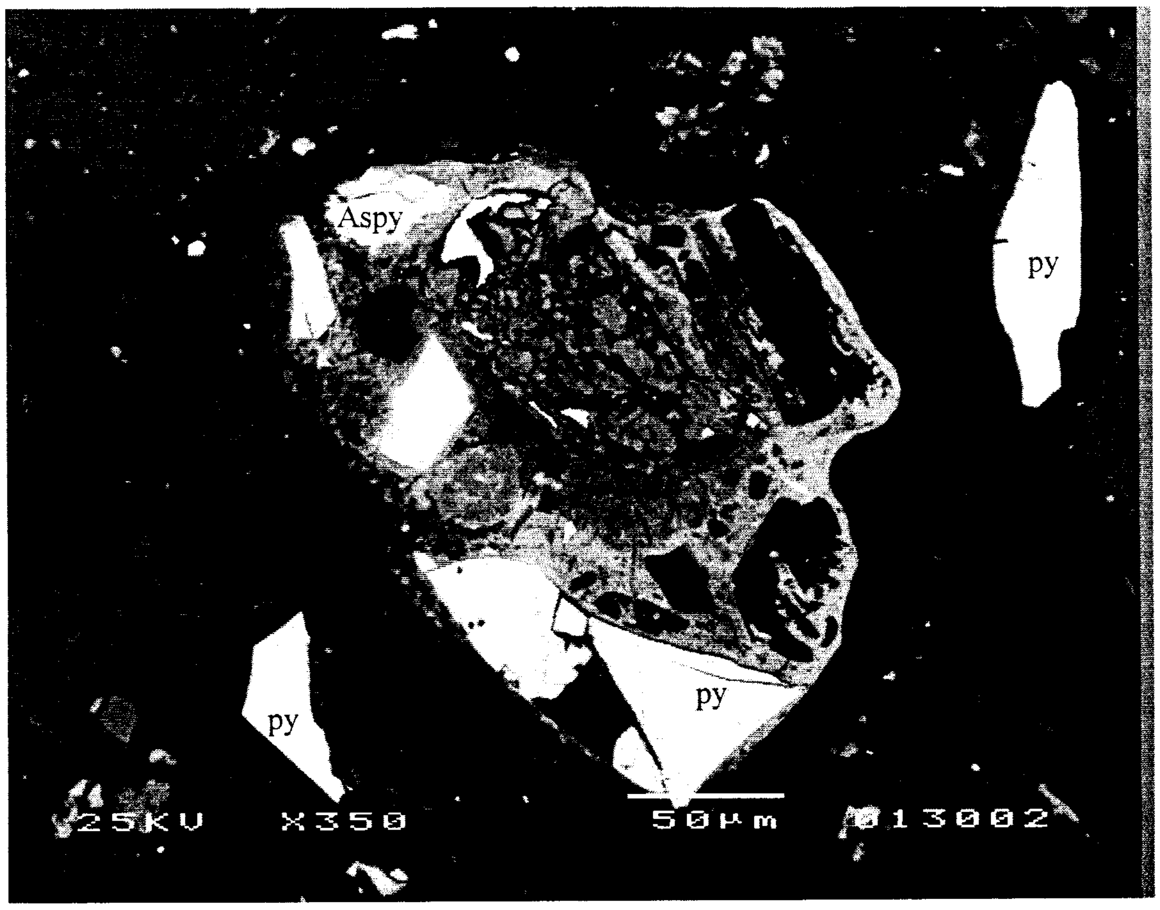


Figure D2-4. A backscattered electron micrograph of Sample MN1701 showing an goethite aggregate with included pyrite (py), arsenopyrite (Aspy) and native iron (white, irregular grain to the right of arsenopyrite).

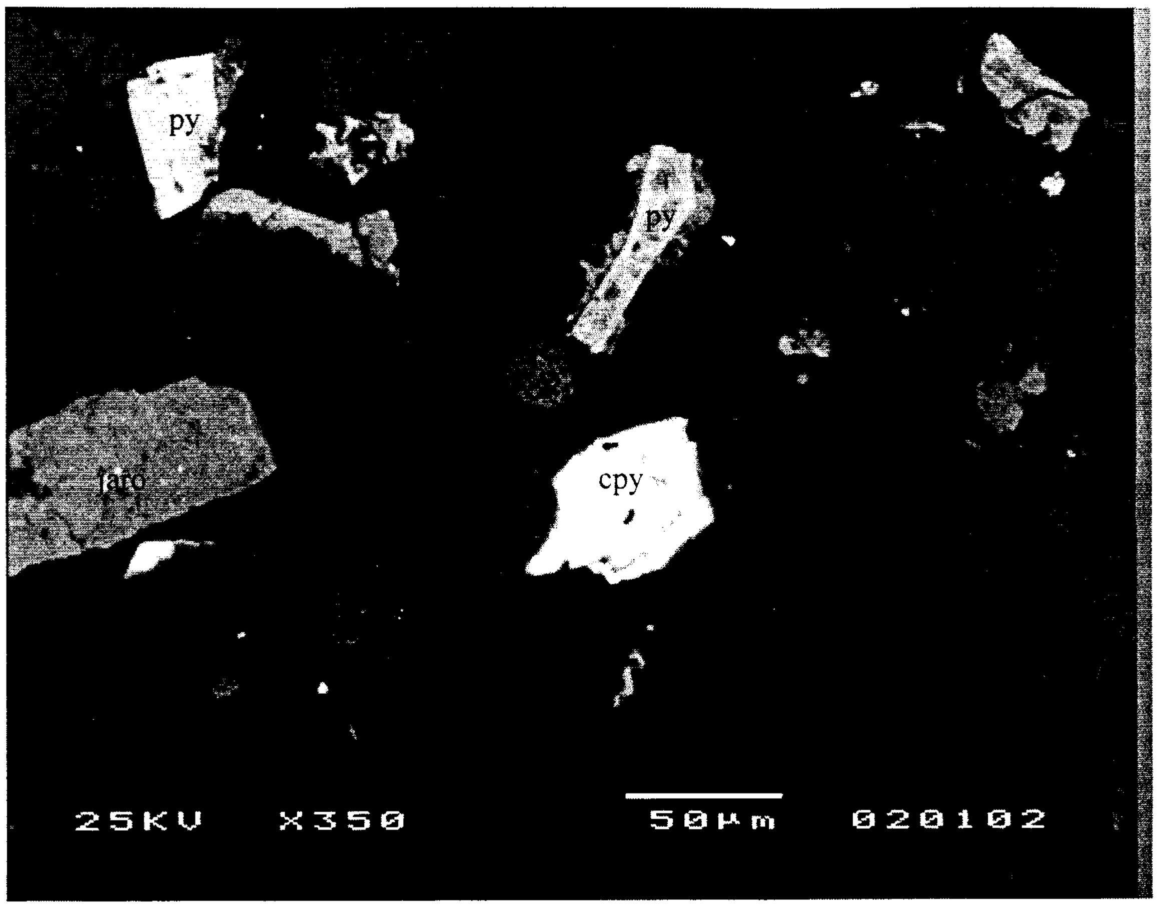


Figure D2-5. A backscattered electron micrograph of Sample MNOMIX showing the occurrence of chalcopyrite (cpy), jarosite (jaro), pyrite (py). Note that the elongated pyrite grain above the chalcopyrite grain is surrounded by goethite.

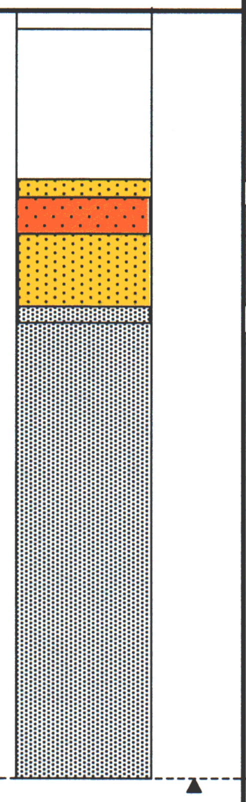
Tailings Core Log

Core No: MN BH 10

Project: Mt. Nansen Tailings Chemical Stability | **Elevation:** 1148.514 m

Location: Mt. Nansen, Yukon Territory | **Sampling Date:** November 16th 2001

Project No: 602345 | **Drilling Method:** Sonic



Depth (m)	Core Details	Description	Sample #	Comments
		ice		
1		water	MN BH10-01	
		grey brown silty clay	MN BH10-03	
		light brown clay interbed	MN BH10-02	
2		grey brown silty clay	MN BH10-03	
		grey native sand at tailings interface	MN BH10-04	
3–5		coarse, grey native sand with roots, organics near bottom	MN BH10-05	
6				
7				
8				
9				
10				

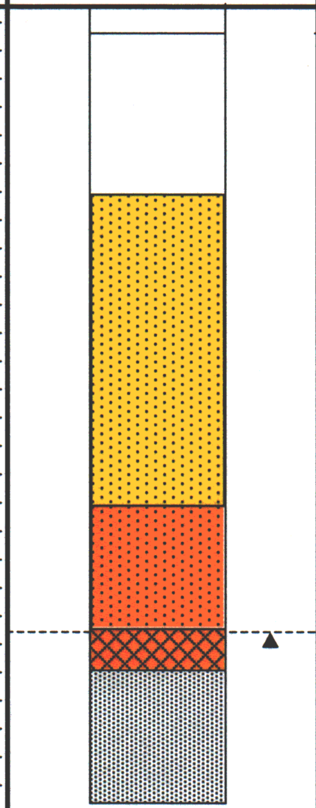
Tailings Core Log

Core No: MN BH 11

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.524 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001

Project No: 602345
Drilling Method: Sonic



Depth (m)	Core Details	Description	Sample #	Comments
		ice		
1		water	MN BH11-01	
2–3		grey brown silty clay	MN BH11-02	
4		light grey brown silty clay	MN BH11-03	
		clay/peat interface	MN BH11-04	
5		black organic rich soil (black muck with sandy interval)	MN BH11-05	
6				
7				
8				
9				
10				

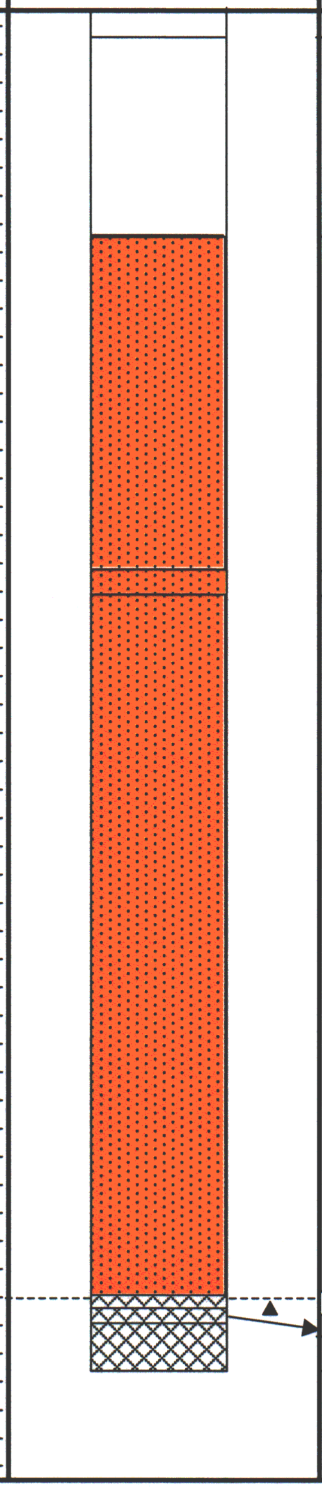
Tailings Core Log

Core No: MN BH 12

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.514 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001

Project No: 602345
Drilling Method: Sonic



Depth (m)	Description	Sample #	Comments
	ice		
---1---	water	MN BH12-01	
---2--- to ---4---	light brown clay with <5% grey streaks	MN BH12-02	light grey brown silty clay (laboratory identification)
	light brown clay 50% grey streaks	MN BH 12-03	light grey brown plastic clay
---5--- to ---9---	brown plastic clay with <2% grey streaks	MN BH12-04	brown silty clay (laboratory identification)
	frozen peat grading into grey organic rich soil	MN BH12-05	brown plastic clay in peat
	peat	MN BH12-06	
	black peat and sand	MN BH12-07	
---10---			

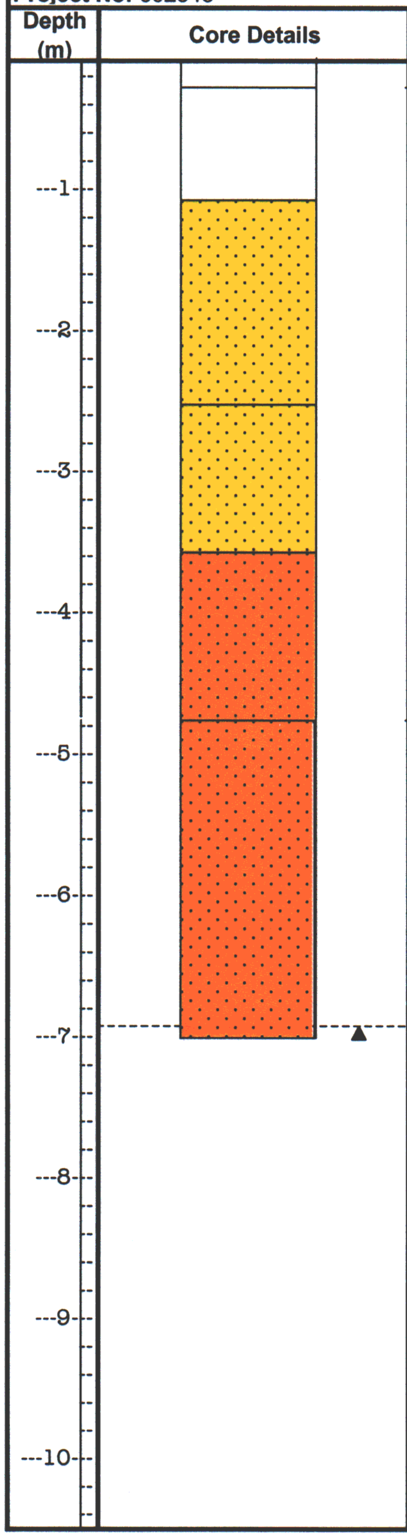
Tailings Core Log

Core No: MN BH 13

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.513 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001

Project No: 602345
Drilling Method: Sonic



Description	Sample #	Comments
ice		
water	MN BH13-01	
grey plastic clay <40% brown streaks	MN BH13-02	grey brown plastic clay (laboratory classification)
grey brown plastic clay with 50% brown	MN BH13-03	light grey brown plastic clay (laboratory classification)
brown plastic clay with 30% grey	MN BH13-04	brown plastic clay (laboratory classification)
brown plastic clay with <10% grey	MN BH13-05	brown plastic clay (laboratory classification)

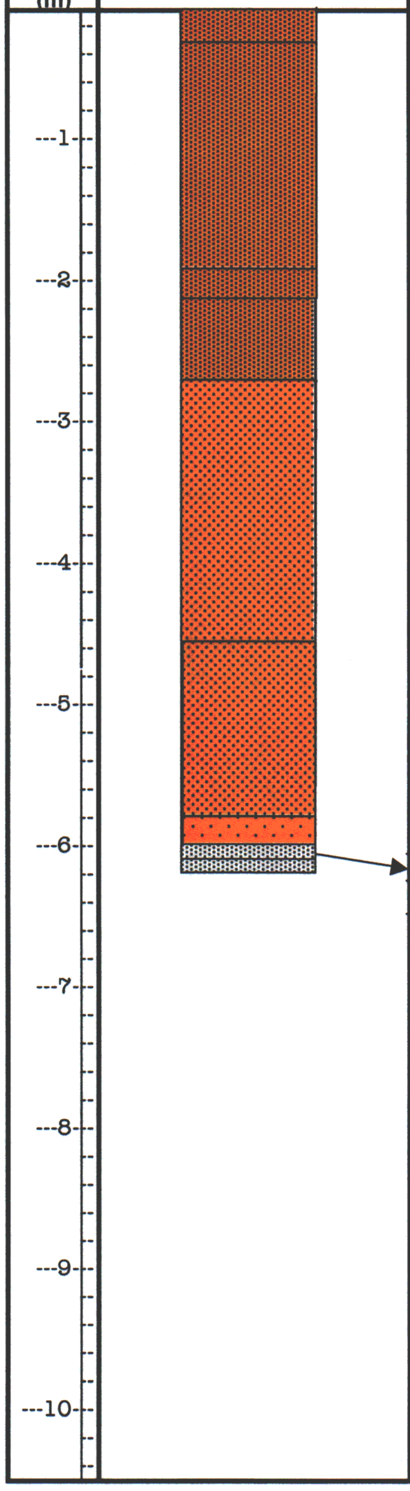
Tailings Core Log

Core No: MN BH 14

Project: Mt. Nansen Tailings Chemical Stability | **Elevation:** 1150.103 m

Location: Mt. Nansen, Yukon Territory | **Sampling Date:** November 17th 2001

Project No: 602345 | **Drilling Method:** Sonic

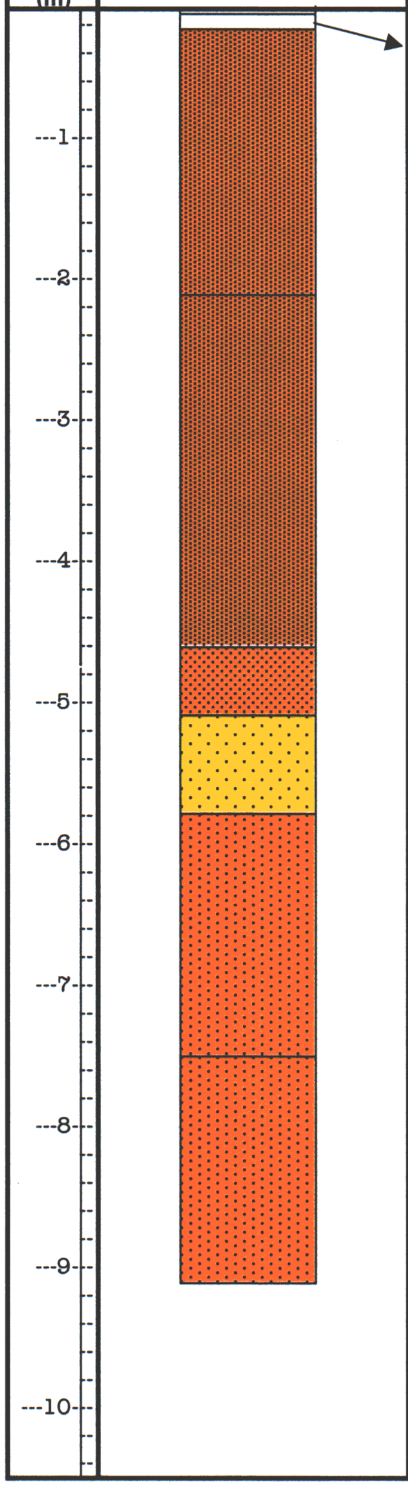


Description	Sample #	Comments
light brown frozen silt		NOT SAMPLED
moist light brown silty sand	MN BH 14-01	yellow brown silt (upon re-examination)
light grey brown clayey silt (20% clay)	MN BH14-02	light grey brown silt
light brown sandy silt	MN BH 14-03	grey brown silt (upon re-examination)
saturated light brown clay with 25% slushy sections	MN BH14-04	light grey brown clayey silt (laboratory classification)
brown silt with 20-30% clay	MN BH14-05	grey brown clayey silt (laboratory classification)
brown plastic clay with 20% grey	MN BH14-06	light brown plastic clay
contact zone with native sand, plant remains	MN BH14-07	dark grey organic soil
native sand	MN BH14-08	

Tailings Core Log

Core No: MN BH 15

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.527 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001
Project No: 602345
Drilling Method: Sonic

Depth (m)	Core Details
1–10	

Description	Sample #	Comments
ice		
water	MN BH15-01	
saturated brown sand, 1-2% sulfides	MN BH15-02	brown silty sand (laboratory classification)
saturated brown sand 1-2% sulfides	MN BH15-03	light brown silty sand (laboratory classification)
brown clayey silt, 20% grey streaks	MN BH15-04	light grey brown clayey silt
grey brown plastic clay (20-25% grey streaks)	MN BH15-05	light grey brown plastic clay (laboratory classification)
brown silty clay, plastic (10% grey streaks)	MN BH15-06	brown plastic silty clay (laboratory classification)
brown silty clay, plastic (<10% grey streaks)	MN BH 15-07	brown silty clay, plastic (laboratory classification)

Tailings Core Log

Core No: MN BH 16

Project: Mt. Nansen Tailings Chemical Stability

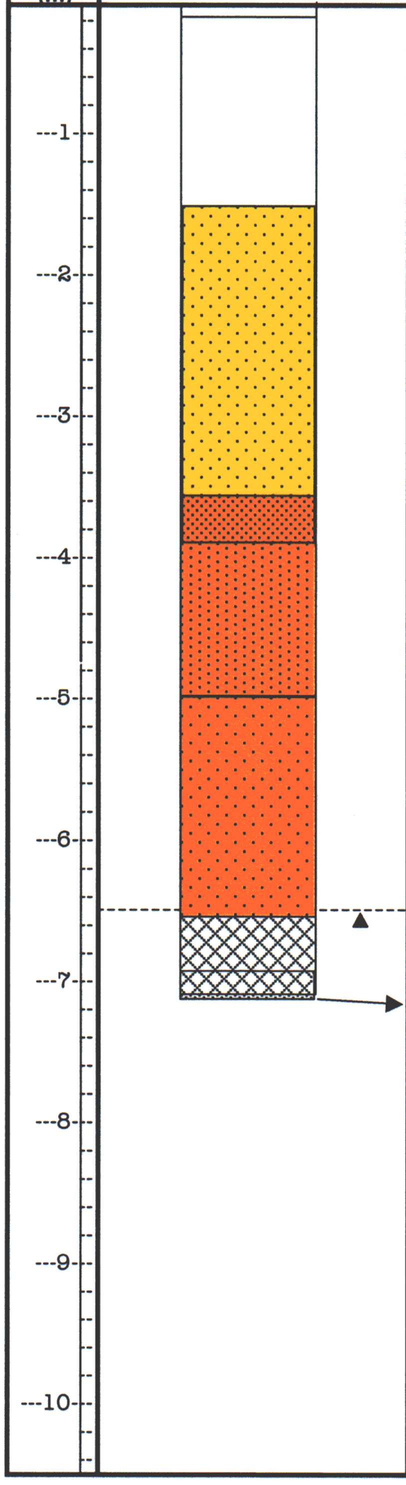
Elevation: 1148.492 m

Location: Mt. Nansen, Yukon Territory

Sampling Date: November 18th 2001

Project No: 602345

Drilling Method: Sonic



Depth (m)	Core Details	Description	Sample #	Comments
		ice		
1		water	MN BH16-01	
2–3		grey brown clay ,<40% brown	MN BH16-02	
		light grey brown silt (clayey)	MN BH16-03	
4		light grey brown plastic clay (<30% grey), silty	MN BH16-04	
5–6		light grey yellow brown plastic clay (<20% grey), locally silty	MN BH16-05	
		peat moss at contact with clay	MN BH16-06	
7		black organic rich soil and peat	MN BH16-07	
		dark grey frozen sand		NOT SAMPLED
8				
9				
10				

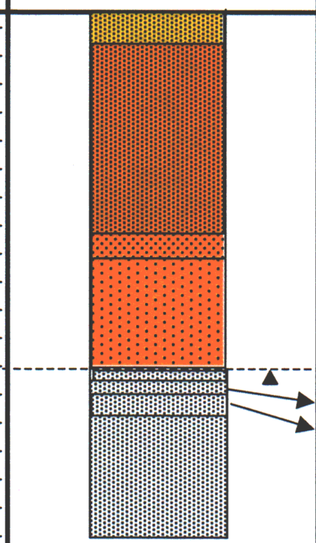
Tailings Core Log

Core No: MN BH 17

Project: Mt. Nansen Tailings Chemical Stability | **Elevation:** 1149.454 m

Location: Mt. Nansen, Yukon Territory | **Sampling Date:** November 18th 2001

Project No: 602345 | **Drilling Method:** Sonic



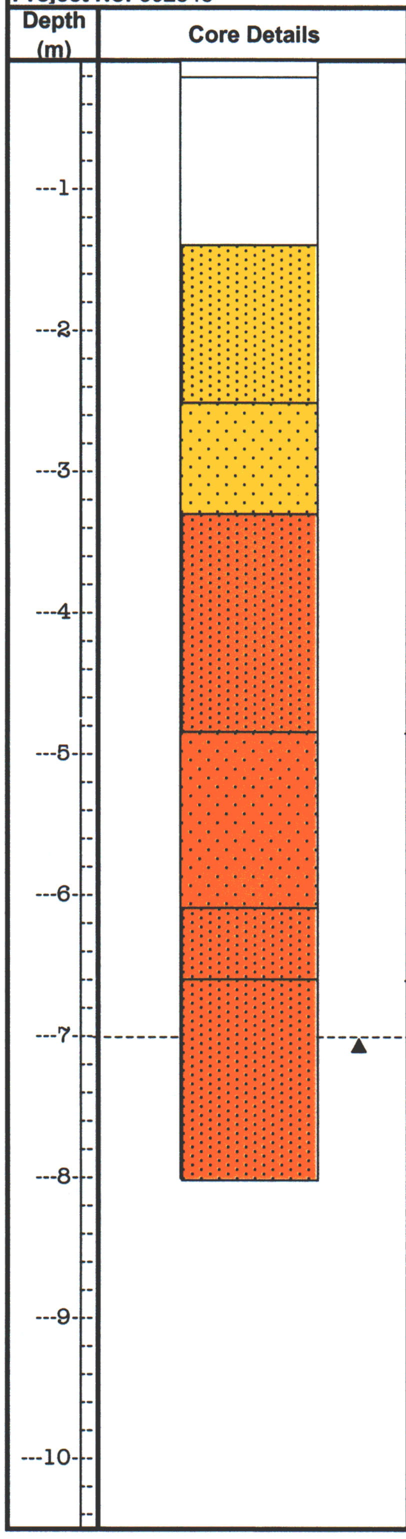
Depth (m)	Description	Sample #	Comments
	frozen beige sandy silt	MN BH17-01	grey brown sandy silt (thawed)
1	brown, moist silty sand	MN BH17-02	yellow brown silt, slightly sandy (upon re-examination)
	saturated brown silt (20% grey)	MN BH17-03	light grey brown clayey silt
2	clayey silt, 20% brown, <20% clay	MN BH17-04	light grey brown silty clay (laboratory classification)
	native sand in contact with clayey silt	MN BH17-05	
	grey native sand 10-20 cm below contact	MN BH17-06	
3	grey native sand 20-30 cm below contact	MN BH17-07	
	wet native sand	NOT SAMPLED	

Depth scale (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Tailings Core Log

Core No: MN BH 18

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.716 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001
Project No: 602345
Drilling Method: Sonic

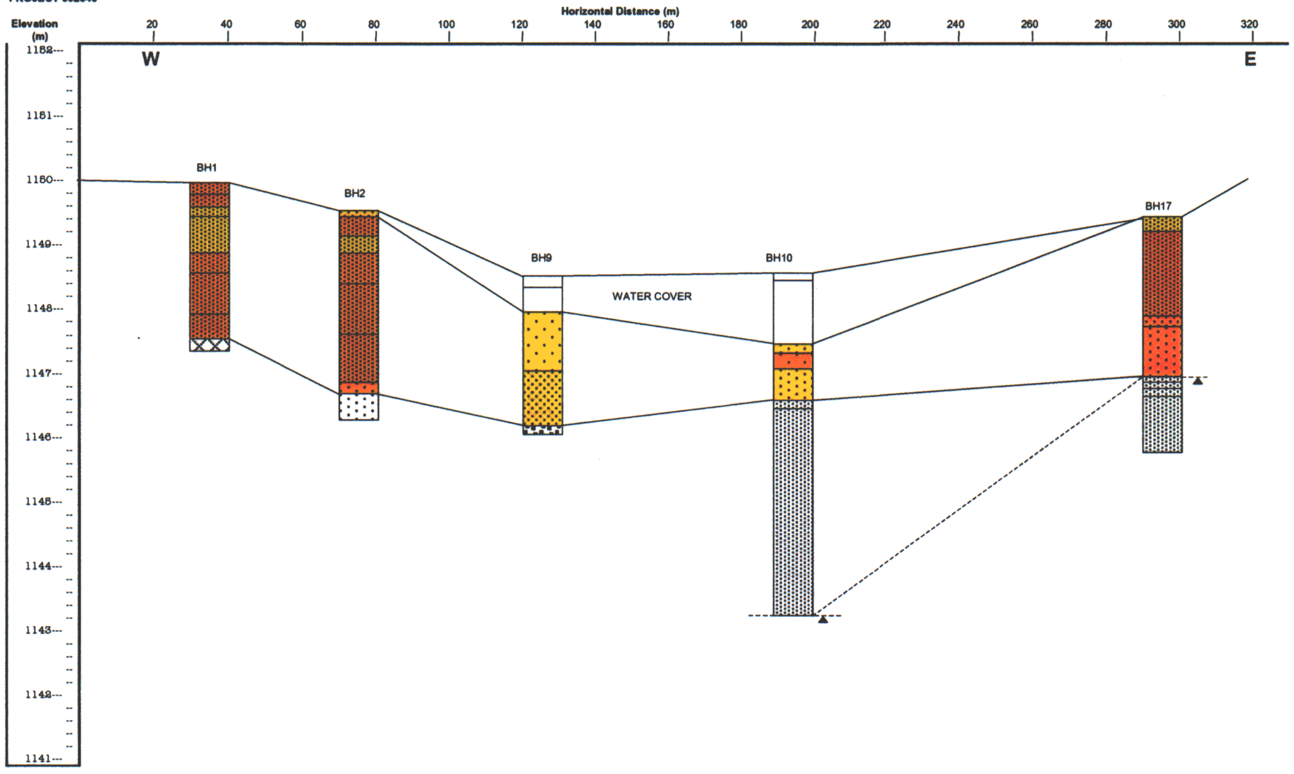


Description	Sample #	Comments
ice		
water	MN BH18-00	
grey brown silty clay	MN BH18-01	
grey brown plastic clay, 50% clay	MN BH18-02	
light grey brown clay (25% grey), slightly silty	MN BH18-03	
brown plastic clay (10% grey)	MN BH18-04	
light grey brown silty clay with brown sand and ice lenses	MN BH18-05	
brown silt with 65% ice crystals	MN BH18-06	brown silty clay slurry (thawed)

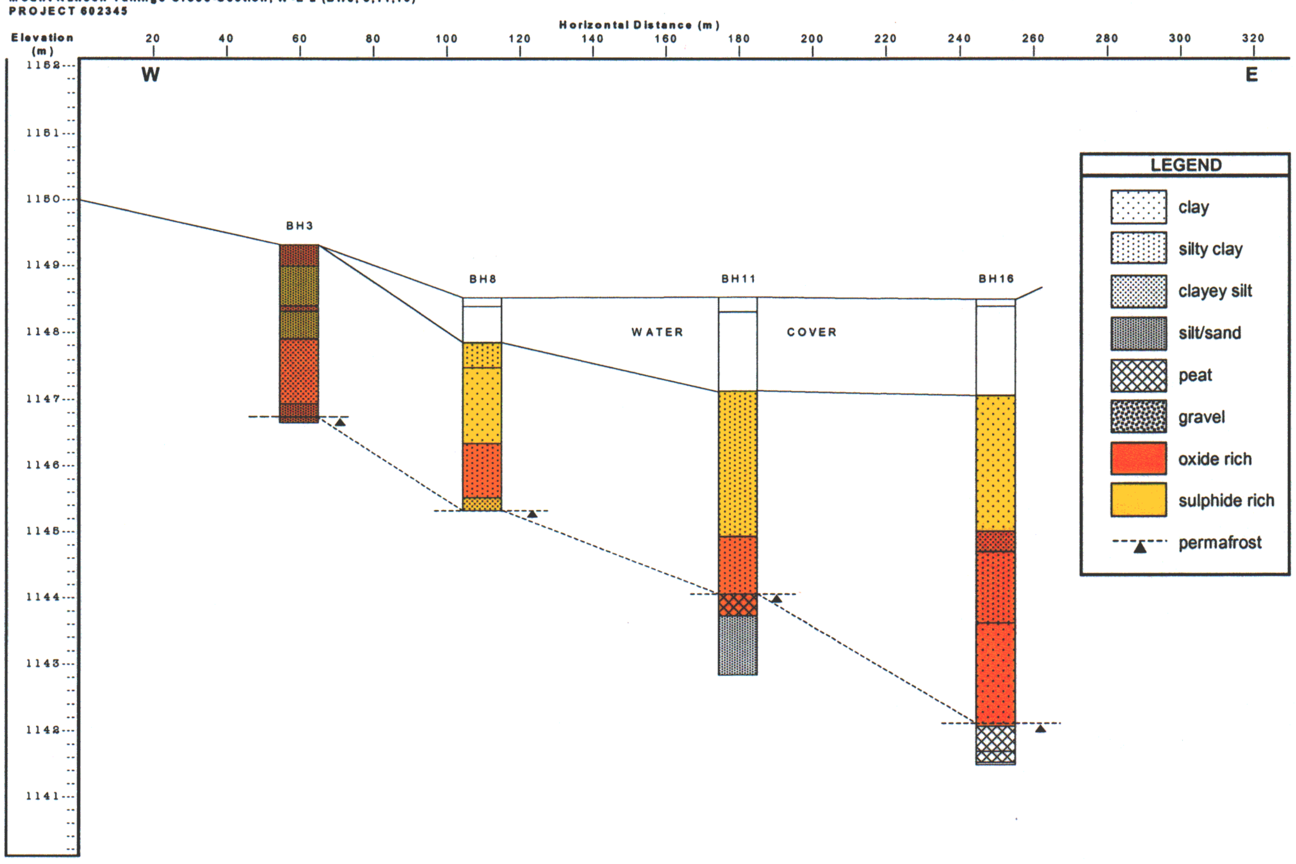
APPENDIX B

Cross Sections of the Tailings Impoundment at Mount Nansen

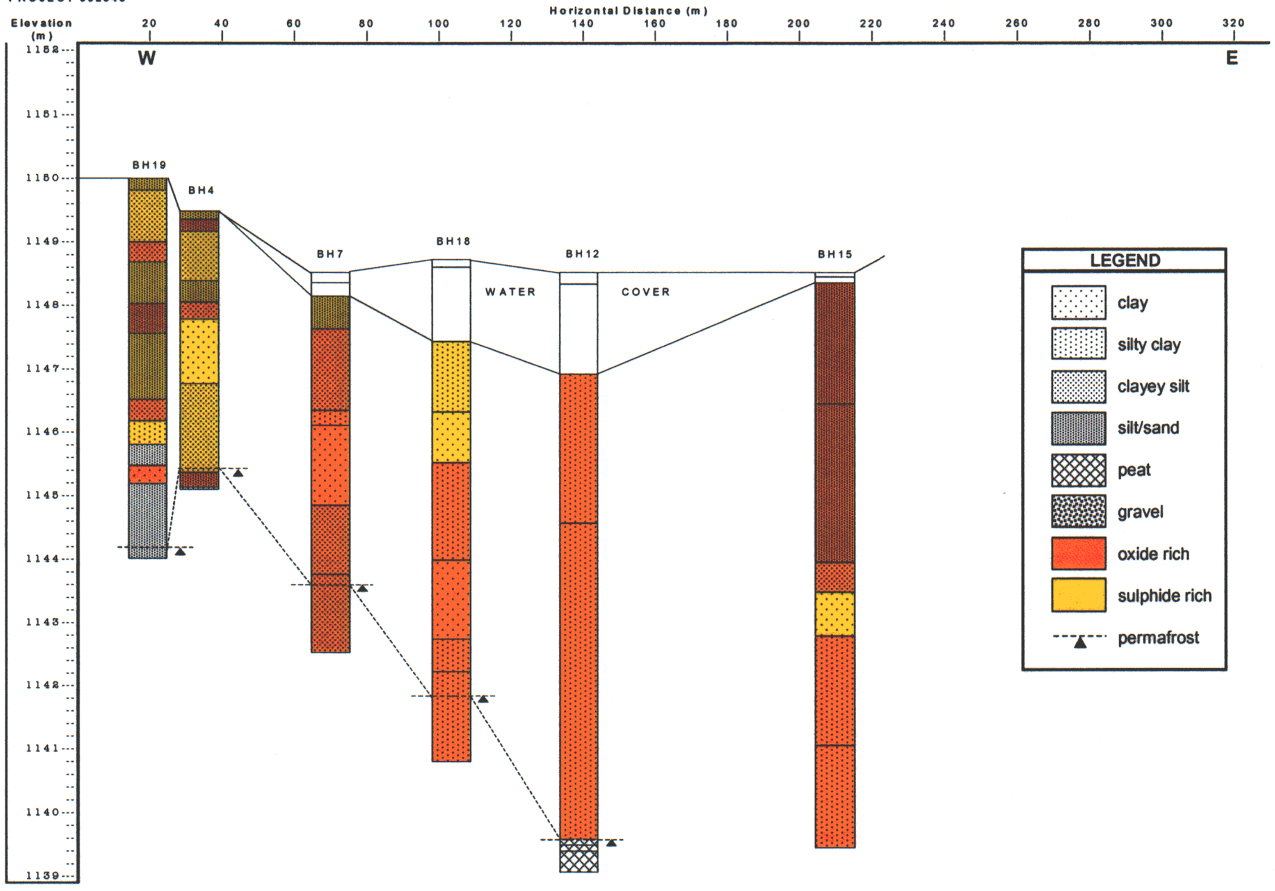
Mount Nansen Tailings Cross-Section, W-E 1 (BH1, 2, 9, 10, 17)
PROJECT 602345



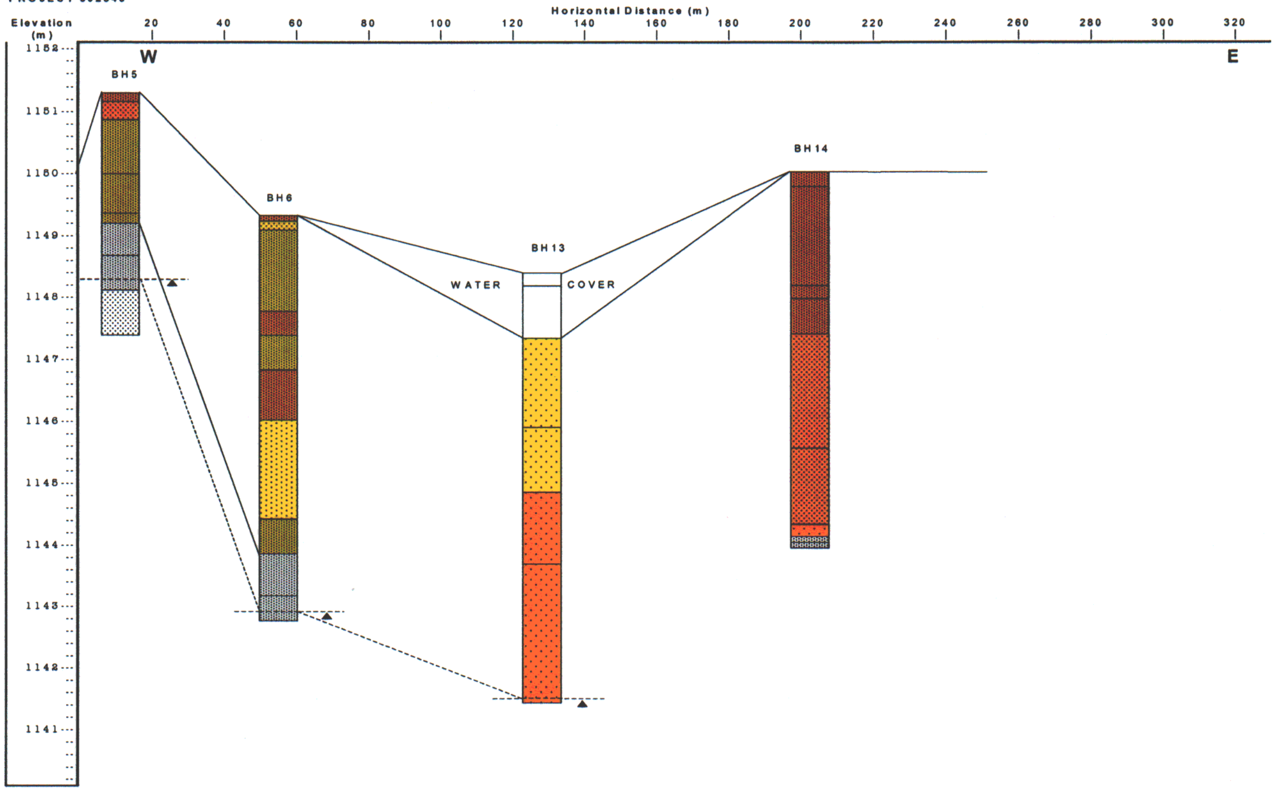
Mount Nansen Tailings Cross-Section, W-E 2 (BH3, 8,11,16)
PROJECT 602345



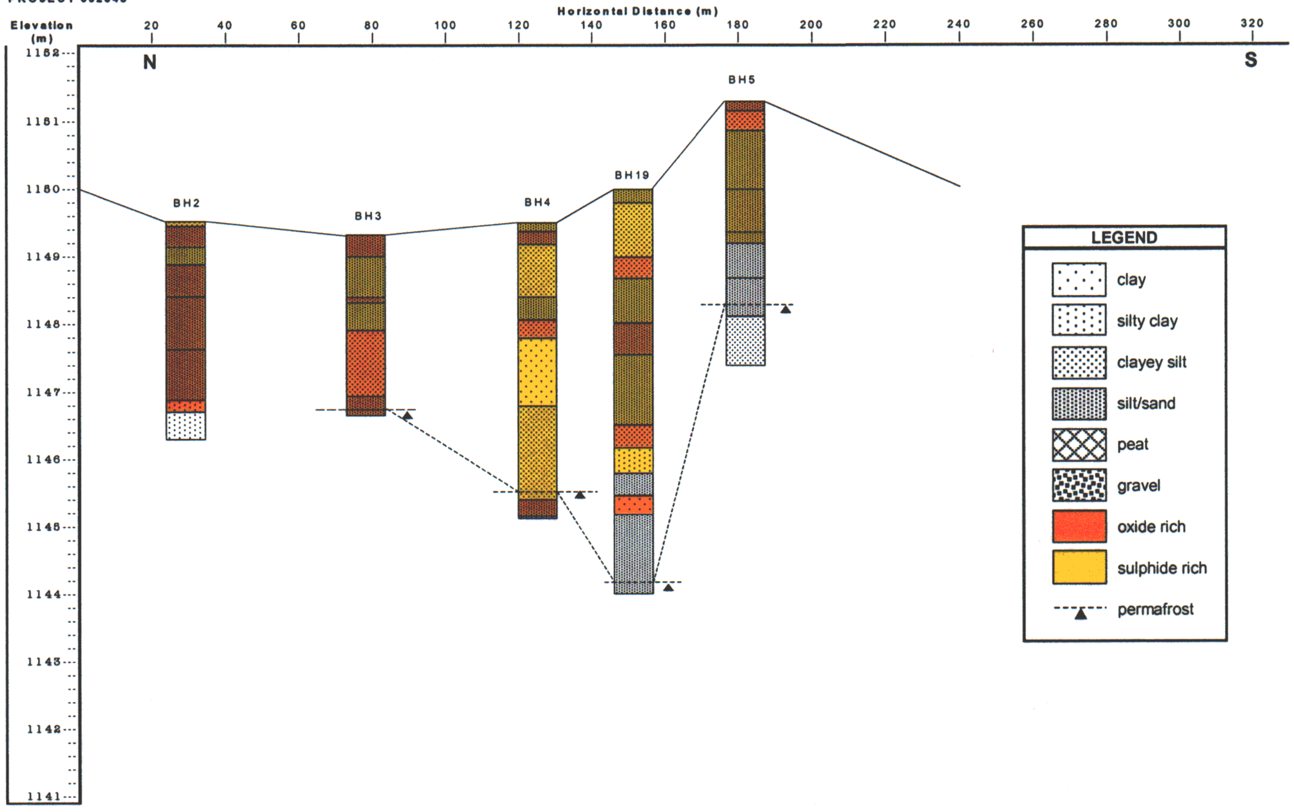
Mount Nansen Tailings Cross-Section, W-E 3 (BH19, 4, 7, 18, 12, 15)
PROJECT 602345



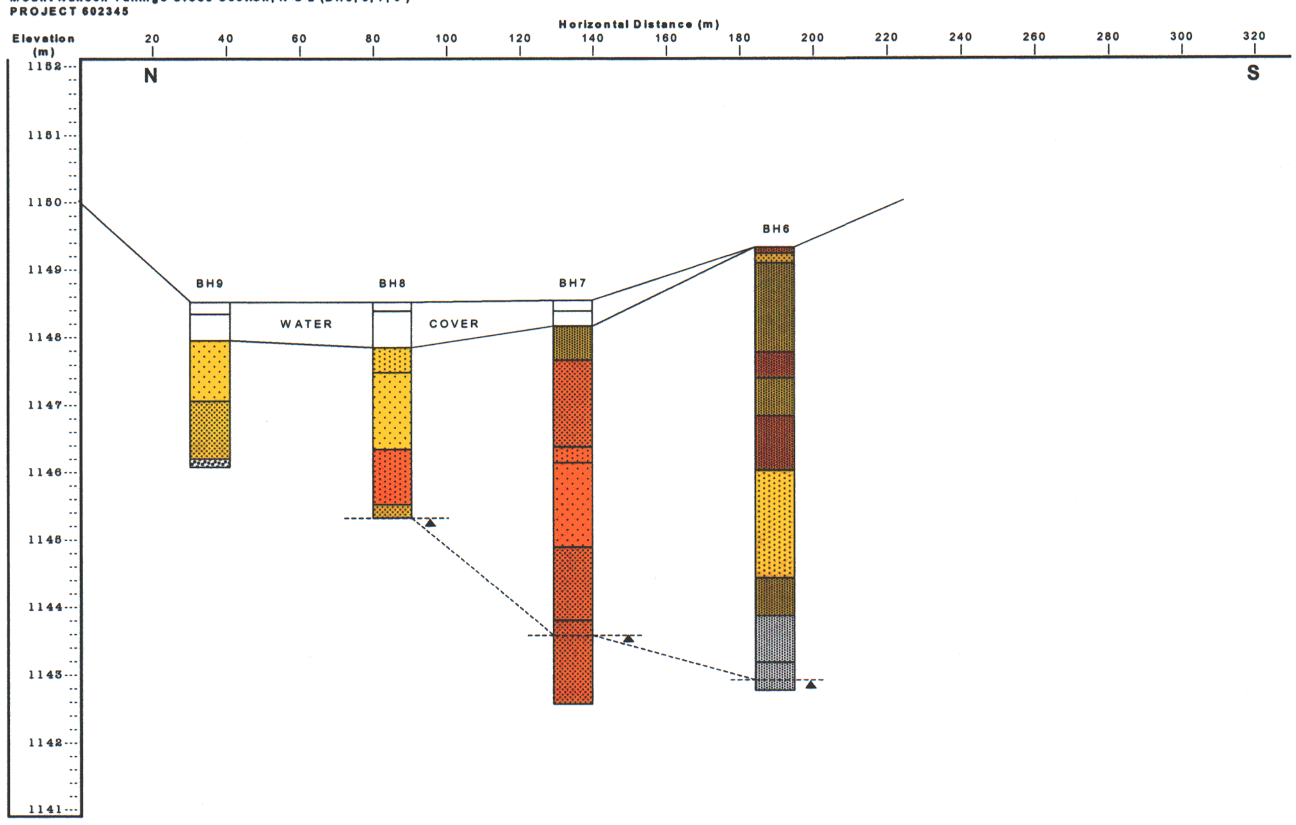
Mount Nansen Tailings Cross-Section, W-E 4 (BH5, 6, 13, 14)
PROJECT 602345



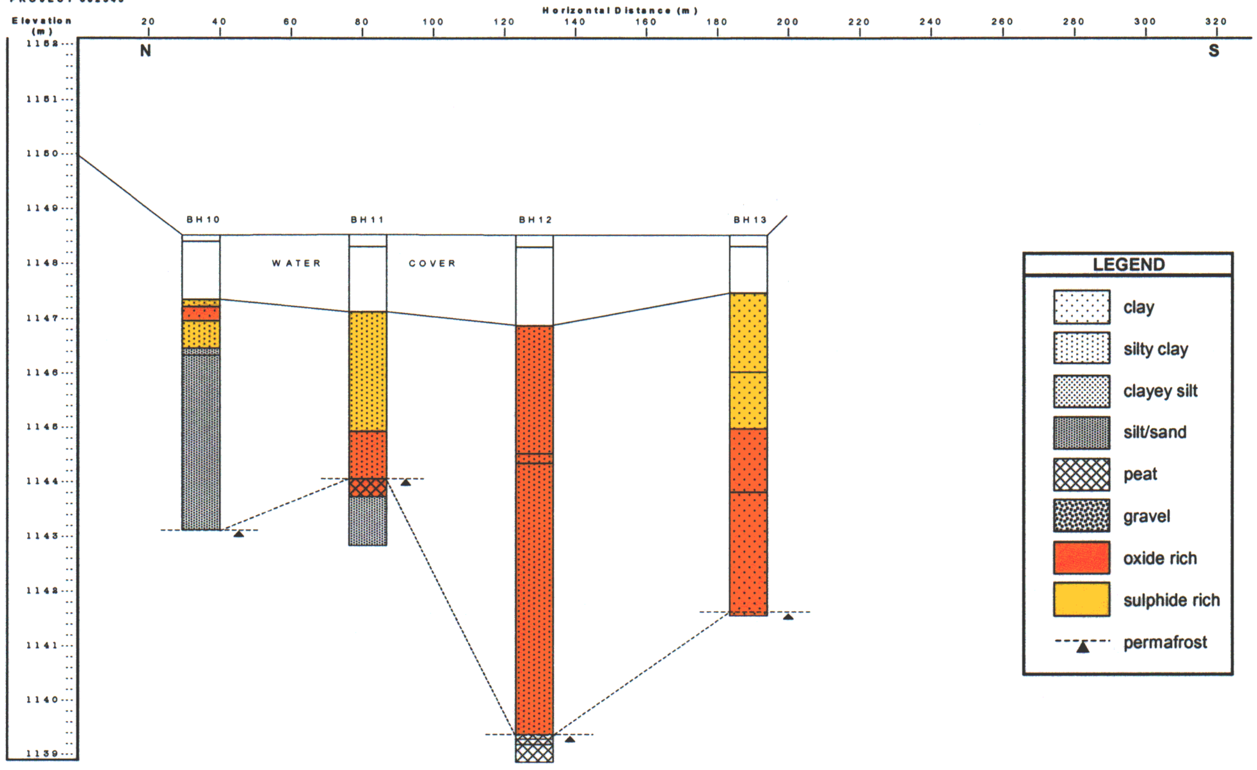
Mount Nansen Tailings Cross-Section, N-S 1 (BH2, 3, 4, 19, 5)
PROJECT 602345



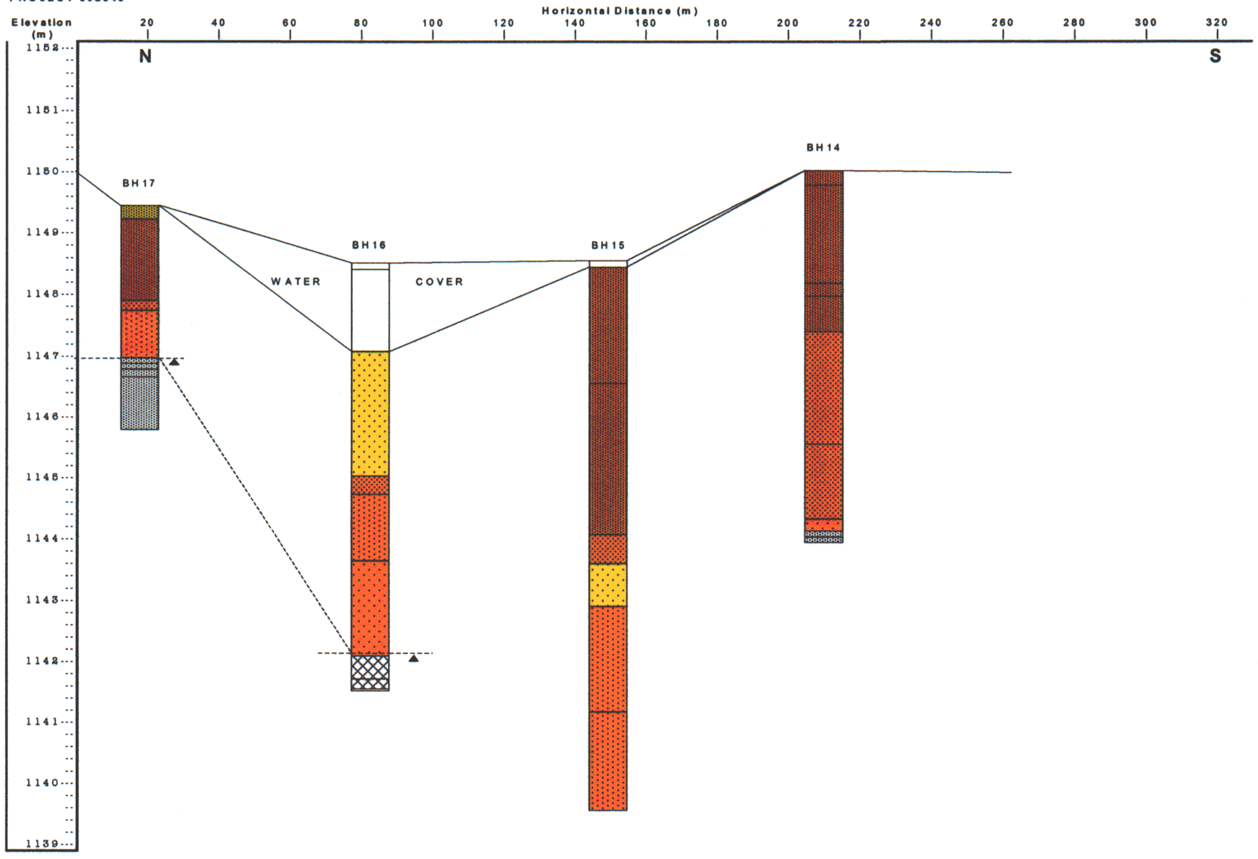
Mount Nansen Tailings Cross-Section, N-S 2 (BH9, 8, 7, 6)
PROJECT 602345



Mount Nansen Tailings Cross-Section, N-S 3 (BH10, 11, 12, 13)
PROJECT 602345



Mount Nansen Tailings Cross-Section, N-S 4 (BH19, 16, 15, 14)
PROJECT 602345



APPENDIX C

Tailings Geochemistry and Particle Size

Appendix C contains the following raw data:

C1. Tailings solids chemistry
   a) Tailings geochemistry as determined by the Analytical Services Group of CANMET-MMSL (**Table C-1a**)
   b) Tailings geochemistry as determined by B.C. Research Inc. (**Table C-1b**)

C2. Acid base accounting analyses of selected tailings solids as determined by B.C. Research Inc. (**Table C-2**)

C3. Porewater chemistry of samples extracted in the field and surface water chemistry at selected locations (Analysis by the Analytical Services Group, CANMET-MMSL) (**Table C-3**).

C4. Detailed particle size analyses of selected samples covering the four varieties of tailings identified (Grain size distribution curves and related data) (**Appendix C-4**)

Table C-1a: Tailings geochemistry as determined by the Analytical Services Group of CANMET-MMSL

	FIELD #	SAMPLE TYPE	Ag µg/g	Al %	As µg/g	B µg/g	Ba µg/g	Bi µg/g	Ca %	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe %	K %
6394 AES-SCAN	MN0101	oxide silt	31	5.56	2700	354	828	<15	2.11	40	7	34	717	5.36	2.03
	MN0103	sulfide silt	24	5.21	2810	557	798	<15	1.96	45	9	26	628	5.88	1.85
	MN0106	oxide silt	20	3.50	2620	165	568	<15	0.623	20	3	17	248	3.65	1.36
	MN0201	sulfide silt	26	5.19	2530	78	832	<15	2.13	39	6	25	880	4.80	1.89
	MN0205	oxide silt	29	4.22	2990	368	699	<15	1.28	34	5	19	529	4.99	1.63
	MN0302	sulfide silt	21	5.15	2020	367	986	<15	1.26	33	7	18	283	4.52	1.90
	DuMN0302	sulfide silt	21	5.23	2020	370	993	<15	1.28	33	7	18	287	4.54	1.91
	MN0304	sulfide silt	27	4.61	2670	373	898	<15	1.19	34	6	23	566	5.10	1.77
	DuMN0304	sulfide silt	n/d	4.64	2670	372	899	<15	1.20	34	7	24	569	5.10	1.78
	MN0402	oxide silt	56	4.07	2650	379	585	<15	2.00	45	5	16	431	4.65	1.43
	MN0405	oxide silt	16	5.53	1440	386	923	<15	1.67	27	8	30	207	4.28	1.76
	DuMN0406	sulfide clay	27	5.05	3080	402	710	<15	2.32	52	10	39	414	5.95	1.76
6395 AES-SCAN	MN0503	sulfide silt	45	4.04	2930	738	628	n/d	1.74	n/d	5	21	455	5.39	1.36
	MN0601	oxide silt	46	5.55	3070	601	818	n/d	2.20	n/d	6	26	745	5.59	1.89
	MN0603	sulfide silt	14	4.58	1950	508	802	15*	1.41	39*	7	26	234	4.95	1.62
	MN0607	sulfide clay	70	7.45	3810	157	1020	26*	1.43	39*	4	36	456	7.31	2.62
	MN0617	sulfide clay	70	7.42	3700	466	1020	6*	1.49	24*	6	36	444	7.31	2.59
	MN0702	sulfide silt	37	4.67	2630	682	698	32*	1.44	33*	4	21	416	5.37	1.71
	DuMN0702	sulfide silt	42	5.26	2760	640	799	32*	1.74	32*	6	29	433	6.04	1.84
	MN0703	oxide silt	41	5.88	2800	425	876	27*	1.60	38*	5	27	577	6.73	2.09
	MN0703F	oxide silt	41	5.89	2970	624	906	26*	1.63	33*	6	29	588	6.77	2.12
	DuMN0703F	oxide silt	41	5.76	2980	625	888	n/d	1.60	n/d	6	29	588	6.64	2.12
	MN0705	oxide clay	40	7.63	4190	239	1020	30*	1.32	27*	6	40	309	6.99	2.65
	MN0705F	oxide clay	42	7.57	4190	468	1020	32*	1.25	27*	5	38	321	7.12	2.72
	DuMN0705F	oxide clay	42	7.24	4200	464	976	n/d	1.20	n/d	5	38	317	6.84	2.66
6396 AES-SCAN	MN0707	oxide silt	23	4.98	3210	580	846	26	0.798	12	6	55	139	4.63	1.73
	DuMN0707	oxide silt	23	5.06	3110	449	854	25	0.792	11	6	70	138	4.55	1.72
	MN0803	sulfide clay	31	6.30	2500	382	860	22	1.62	36	8	20	510	5.82	2.13
	MN0803F	sulfide clay	29	6.08	2440	345	828	23	1.60	35	8	26	469	5.42	2.07
	MN0804	oxide clay	27	6.94	2540	258	969	21	1.57	36	12	30	465	6.21	2.29
	MN0805	sulfide silt	36	4.48	4240	610	712	39	0.567	13	4	32	200	5.54	1.71
	MN0902	sulfide clay	48	5.27	3950	370	834	35	1.39	26	8	18	484	6.65	1.99
	MN0912	sulfide clay	42	5.46	3820	370	836	37	1.40	25	7	22	450	6.70	1.98
	MN0903	sulfide silt	29	4.66	3730	295	815	32	0.657	6	6	41	155	4.84	1.63
	DuMN0903	sulfide silt	29	4.53	3760	298	829	35	0.667	7	7	40	160	4.82	1.67
	MN1002	oxide clay	27	8.46	2460	126	1100	27	1.23	33	9	26	392	6.80	2.84
	MN1003	sulfide clay	60	7.10	4400	264	954	47	1.27	30	8	26	692	7.21	2.61
	DuMN1003	sulfide clay	61	6.97	4400	266	961	51	1.27	29	8	26	720	6.87	2.65
6397 AES-SCAN	MN1003F	sulfide clay	62	7.09	4660	451	1040	77*	1.41	44	8	25	737	7.39	2.68
	DuMN1003F	sulfide clay	62	7.05	4820	393	1030	n/d	1.40	46	8	25	740	7.35	2.68
	MN1004	native sed.	1	6.43	104	296	1210	5*	1.90	2	5	21	202	1.71	1.63
	MN1102	sulfide clay	51	6.62	4070	226	939	41*	1.71	50	9	23	630	7.07	2.42
	MN1103	oxide clay	50	7.58	4120	402	1050	39*	1.27	41	8	21	984	7.85	2.77
	MN1202	oxide clay	28	7.47	2660	378	1080	23*	1.44	46	8	28	372	6.16	2.56
	MN1212	oxide clay	27	7.59	2680	215	1090	22*	1.45	45	10	28	383	6.24	2.59
	MN1204T	oxide clay	56	6.62	5710	456	1040	45*	0.947	41	6	28	238	7.55	2.58
	MN1204B	oxide clay	48	5.59	4830	481	903	41*	0.829	29	5	52	193	6.81	2.20
	DuMN1204B	oxide clay	48	5.57	4860	485	903	n/d	0.829	29	5	52	195	6.78	2.20
	MN1205	native sed.	35	7.21	4060	186	1090	40*	1.01	31	7	66	203	6.03	2.42
	MN1205F	native sed.	35	7.35	3970	382	1100	37*	1.02	31	7	65	212	6.10	2.47
	DuMN1205F	native sed.	35	7.38	3950	381	1100	n/d	1.03	31	n/d	65	210	6.12	2.46
6398 AES-SCAN	MN1206	native sed.	29	6.71	3560	69	1020	28*	1.17	< 1	11	62	421	5.94	2.19
	DuMN1206	native sed.	30	6.75	3280	56	1010	n/d	1.15	n/d	9	61	427	5.95	2.21
	MN1206D	native sed.	28	6.69	3470	192	1020	26*	1.15	101*	9	61	409	5.93	2.19
	MN1207	native sed.	0	6.29	24	91	963	<2*	2.05	< 1*	8	42	27	2.08	1.34
	MN1303	sulfide clay	47	5.84	3240	208	876	27*	1.72	38*	8	32	506	7.00	2.08
	MN1303F	sulfide clay	48	5.83	3380	221	875	28*	1.71	29*	8	31	487	6.99	2.08
	MN1304	oxide clay	58	6.23	4560	254	935	35*	1.47	13*	8	33	367	6.99	2.37
	MN1305	oxide clay	48	6.66	5060	135	1010	36*	1.16	11*	7	35	275	7.30	2.50
	MN1305F	oxide clay	47	6.63	5170	128	1000	37*	1.16	24*	7	36	276	7.28	2.50
	DuMN1305F	oxide clay	47	6.55	5150	127	996	n/d	1.16	n/d	8	36	276	7.29	2.49
	MN1401	oxide silt	35	4.48	3130	258	743	11*	1.45	15*	7	23	339	5.53	1.58
	DuMN1401	oxide silt	35	4.50	3120	258	746	7*	1.45	12*	8	23	337	5.52	1.59
	MN1402	oxide silt	39	4.26	5610	355	749	n/d	1.33	n/d	6	24	238	4.41	1.50
6399 AES-SCAN	MN1406	oxide clay	53	5.38	4920	287	1010	36*	1.06	21*	5	39	260	7.21	2.43
	DuMN1406	oxide clay	54	5.88	4990	159	1050	n/d	1.06	n/d	0	40	256	7.42	2.49
	MN1407	native sed.	3	1.15	275	512	169	<2*	0.585	2*	4	20	13	1.53	0.269
	MN1408	native sed.	1	6.19	30	49	1160	<2*	2.02	< 1*	3	34	11	1.94	1.62
	MN1504	oxide silt	66	4.64	3720	296	719	24*	1.48	30*	6	20	655	5.87	1.92
	MN1506	oxide clay	55	5.56	4480	348	930	27*	1.08	23*	7	22	302	6.22	2.31
	MN1603	oxide silt	38	4.35	2120	259	867	5*	1.13	24*	5	19	188	4.10	1.84
	MN1604	oxide clay	31	5.41	3630	172	921	19*	0.784	12*	2	17	195	5.58	2.32
	MN1605	oxide clay	57	5.55	5380	243	1230	35*	0.865	19*	2	46	367	6.89	2.40
	DuMN1605	oxide clay	58	5.47	5380	243	1230	n/d	0.825	n/d	5	45	364	6.91	2.30

Table C-1a (cont.)

	FIELD #	SAMPLE TYPE	Ag μg/g	Al %	As μg/g	B μg/g	Ba μg/g	Bi μg/kg	Ca %	Cd μg/g	Co μg/g	Cr μg/g	Cu μg/g	Fe %	K %
6400 AES-SCAN	MN1616	native sed.	73	6.93	4570	180	1080	45.6*	0.699	n/d	2	68	228	8.31	2.56
	DuMN1616	native sed.	74	6.88	4600	168	1060	n/d	0.693	n/d	4	72	224	8.12	2.52
	MN1701	sulfide silt	64	3.65	4480	507	647	18.6*	0.733	n/d	6	19	847	6.18	1.39
	MN1704	oxide silt	40	3.91	3980	550	685	15.6*	0.681	n/d	3	19	354	5.51	1.62
	MN1705F	native sed.	27	6.47	1240	131	1160	4.32*	1.58	n/d	4	28	53	2.86	1.78
	MN1802	sulfide clay	26	6.31	2330	199	955	9.02*	1.35	n/d	7	27	385	5.68	2.16
	MN1802F	sulfide clay	24	6.34	2390	384	969	9.55*	1.36	n/d	6	32	380	5.76	2.17
	MN1804	oxide clay	59	7.28	5460	219	1010	35.7*	1.16	n/d	6	25	485	7.80	2.66
	MN1805	oxide clay	46	5.27	4230	311	832	28.6*	0.652	n/d	2	72	197	6.51	2.07
	DuMN1805	oxide clay	45	5.25	4240	311	826	n/d	0.649	n/d	5	70	197	6.52	2.08
	MN1806	oxide silt	58	6.22	4850	270	924	41.5*	0.903	n/d	6	8	358	0.728	0.228
	MN1806D	oxide silt	59	6.23	4850	200	922	43.9*	0.899	n/d	3	56	497	7.21	2.29
	DuMN1806D	oxide silt	59	6.22	4840	200	919	n/d	0.899	n/d	4	53	494	7.41	2.35
6401 AES-SCAN	MN1901	sulfide silt	54	3.93	3670	534	642	13.5*	1.78	n/d	8	10	709	5.56	1.34
	DuMN1901	sulfide silt	50	3.95	3610	373	650	n/d	1.79	n/d	9	10	695	5.55	1.34
	MN1902	sulfide silt	31	4.96	2580	345	811	9.60*	1.62	n/d	8	11	613	5.06	1.70
	MN1905	oxide silt	20	4.59	1910	296	892	4.77*	1.33	n/d	7	13	323	4.56	1.57
	MN1906	sulfide silt	20	4.61	2210	450	1010	3.46*	1.35	n/d	7	16	455	4.44	1.55
	MN1907	oxide silt	24	4.22	2090	388	839	3.98*	1.15	n/d	5	13	609	3.59	1.46
	MN1908	sulfide silt	25	4.58	2310	452	865	7.55*	1.54	n/d	6	14	472	4.50	1.58
	MN1910	oxide clay	47	5.21	6220	790	850	38.5*	0.944	n/d	5	38	188	6.90	2.06
	NWALL1	pit grab	5	8.43	1240	372	1220	0.00*	0.863	n/d	10	11	477	6.11	3.61
	DuNWALL1	pit grab	5	8.42	1220	368	1220	n/d	0.864	n/d	10	11	477	6.11	3.62
	NWALBX	pit grab	117	1.41	1280	381	128	244*	1.73	n/d	30	5	539	33.8	0.565
	WBH3	pit grab	241	4.43	1670	66	652	11.3*	12.9	n/d	13	38	4130	5.15	1.38
	DuWBH3	pit grab	241	4.45	1660	63	655	n/d	13.0	n/d	13	39	4130	5.17	1.38
6402 AES-SCAN	PITSED	pit grab	10	9.44	1460	12	1360	3.14*	1.90	n/d	17	21	412	6.79	2.07
	DuPITSED	pit grab	10	9.23	1490	13	1380	n/d	1.92	n/d	17	25	376	7.12	2.11
	BATCH01	oxide clay composite	56	6.32	4720	47	961	38.5*	1.02	n/d	5	23	580	6.65	2.46
	BATCH02	oxide clay composite	55	6.35	4720	54	959	36.1*	1.03	n/d	6	16	860	6.69	2.47
	BATCH03	oxide clay composite	56	6.21	4750	71	956	38.4*	1.02	n/d	6	34	249	6.61	2.42
	BATCHS1	sulfide clay composite	42	5.76	3520	73	885	25.3*	1.28	n/d	7	15	344	5.84	2.18
	BATCHS1D	sulfide clay composite	43	5.93	3520	68	881	24.3*	1.32	n/d	7	6	350	6.02	2.23
	BATCHS2	suphide clay composite	43	5.95	3480	61	876	24.9*	1.33	n/d	4	25	345	6.16	2.19
	BATCH1E	composite	55	6.22	4880	63	940	33.5*	1.03	n/d	4	22	491	6.62	2.42
	DuBATCH1E	composite	54	6.15	4790	62	967	n/d	1.01	n/d	5	30	451	6.66	2.27

n/d= not determined
* = MS analysis μg/kg (all other data are AES)

Table C-1a (cont.)

FIELD #	SAMPLE TYPE	Li µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Na µg/g	Ni µg/g	P µg/g	Pb µg/g	S %	Sb µg/g	Sr µg/g	V µg/g	Zn µg/g
MN0101	oxide silt	15	4320	2780	4	1500	13	584	1370	2.69	436	149	49	2100
MN0103	sulfide silt	15	5130	3250	2	1380	14	563	1510	3.52	363	102	55	2650
MN0106	oxide silt	17	1520	924	2	1770	7	425	1660	0.696	368	91	40	649
MN0201	sulfide silt	15	3780	2420	2	1740	16	556	1580	2.30	423	147	52	2030
MN0205	oxide silt	17	2310	1740	2	1360	9	500	1980	2.05	445	104	45	1460
MN0302	sulfide silt	13	2960	2070	3	2810	7	532	1410	1.93	276	131	49	1770
DuMN0302	sulfide silt	13	2970	2080	4	2830	10	542	1410	1.95	265	132	50	1770
MN0304	sulfide silt	13	2730	1880	2	2200	10	528	1970	2.08	377	113	47	1610
DuMN0304	sulfide silt	13	2740	1870	3	2200	10	526	1980	2.07	379	113	47	1610
MN0402	oxide silt	16	3880	2690	6	688	10	442	1450	3.28	560	118	37	2170
MN0405	oxide silt	11	4320	2080	3	6690	14	590	925	1.27	205	190	60	1460
DuMN0406	sulfide clay	10	5530	3370	4	3660	16	521	1890	3.52	433	144	55	2710
MN0503	sulfide silt	23	4170	2770	<5	874	4	n/d	1750	4.15	41500	121	36	2630
MN0601	oxide silt	27	4760	3040	<5	777	5	n/d	2100	3.05	30500	145	49	2940
MN0603	sulfide silt	25	3830	2730	<5	1810	8	70.17*	1150	2.38	23800	111	47	2040
MN0607	sulfide clay	29	3720	2290	<5	1900	6	93.70*	3760	1.99	19900	155	79	2560
MN0617	sulfide clay	31	3780	2290	<5	1910	7	112.4*	3760	1.65	16500	154	79	2670
MN0702	sulfide silt	19	3730	2600	<5	630	5	160.9*	1980	2.74	27400	111	45	2470
DuMN0702	sulfide silt	26	4110	2850	<5	706	6	169.0*	2170	3.10	31000	118	49	2960
MN0703	oxide silt	28	4100	2650	<5	1390	5	147.0*	2700	2.38	23800	124	60	2610
MN0703F	oxide silt	27	4140	2650	<5	1380	6	166.9*	2750	3.69	36900	124	61	2730
DuMN0703F	oxide silt	27	4160	2590	<5	1380	5	n/d	2760	2.39	23900	124	61	2670
MN0705	oxide clay	32	3510	2120	<5	1760	9	157.3*	3750	1.42	14200	146	82	1970
MN0705F	oxide clay	32	3450	2150	<5	1640	7	160.3*	3780	1.38	13800	144	84	1940
DuMN0705F	oxide clay	31	3460	2060	<5	1590	7	n/d	3790	1.59	15900	142	83	1850
MN0707	oxide silt	22	2290	1510	4	2390	4	564	2730	0.619	392	134	55	961
DuMN0707	oxide silt	27	2250	1500	4	2440	5	541	2680	0.607	510	135	55	922
MN0803	sulfide clay	26	4870	2990	2	1180	3	586	1970	2.50	430	116	65	2610
MN0803F	sulfide clay	29	4910	2860	1	1080	1	565	1920	2.40	408	114	64	2480
MN0804	oxide clay	28	4590	3120	1	1350	10	641	2140	2.29	417	124	70	2550
MN0805	sulfide silt	26	1870	1040	3	1230	3	488	3740	1.04	536	102	49	879
MN0902	sulfide clay	27	3230	2070	1	1110	3	610	3140	2.47	436	121	59	1880
MN0912	sulfide clay	21	3210	2060	1	1110	3	585	3060	2.39	594	119	58	1850
MN0903	sulfide silt	18	3220	836	1	4180	13	466	3710	0.784	700	141	64	558
DuMN0903	sulfide silt	19	3200	835	1	4300	14	477	3710	0.794	709	143	64	559
MN1002	oxide clay	28	3660	2900	2	1420	6	732	2350	1.35	358	136	81	2400
MN1003	sulfide clay	30	3840	1860	2	1880	3	651	4480	2.25	746	150	77	1990
DuMN1003	sulfide clay	30	3830	1850	2	1910	4	649	4480	2.25	756	151	77	1990
MN1003F	sulfide clay	27	4040	1940	6	2640	7	719	4520	2.39	831*	147*	76	2110
DuMN1003F	sulfide clay	29	4000	1940	5	2650	7	738	4570	2.37	n/d	n/d	77	2090
MN1004	native sed.	6	4590	361	3	24900	8	323	96	0.0637	330*	438*	44	183
MN1102	sulfide clay	30	4410	2500	3	1810	6	707	3750	2.79	571*	140*	68	2440
MN1103	oxide clay	29	3560	2310	6	1840	7	773	3470	1.86	502*	152*	76	2210
MN1202	oxide clay	28	4370	3210	3	2420	6	728	2060	1.60	312*	120*	73	2580
MN1212	oxide clay	28	4440	3260	4	2410	7	719	2070	1.62	286*	125*	73	2620
MN1204T	oxide clay	31	2850	1680	3	1990	6	786	5700	1.45	912*	128*	71	1510
MN1204B	oxide clay	24	2420	1360	4	2180	7	689	4450	1.30	596*	116*	60	1030
DuMN1003F	oxide clay	25	2410	1360	4	2190	6	691	4450	1.30	n/d	n/d	61	1030
MN1205	native sed.	33	3180	1720	5	3690	8	681	3880	0.932	547*	159	76	1300
MN1205F	native sed.	31	3250	1730	6	3650	8	685	3930	0.945	560*	159	77	1310
DuMN1205F	native sed.	30	3280	1740	5	3660	9	678	3950	0.943	n/d	159	77	1330
MN1206	native sed.	33	3040	1810	<4	2880	12	132*	4130	1.08	681	157	73	1360
DuMN1206	native sed.	32	3000	1810	<4	2900	11	n/d	4110	1.06	706	157	73	1330
MN1206D	native sed.	32	2920	1810	<4	2800	11	148*	3930	1.08	701	157	72	1320
MN1207	native sed.	13	7100	442	<4	19900	15	197*	30	0.147	8	386	72	131
MN1303	sulfide clay	29	3540	2280	4	783	8	104*	3480	3.01	610	125	62	2540
MN1303F	sulfide clay	29	3530	2270	8	774	7	147*	3510	3.04	569	124	62	2530
MN1304	oxide clay	30	3150	2050	<4	1150	6	175*	4550	1.96	812	139	68	2120
MN1305	oxide clay	31	2920	1910	<4	1190	7	171*	4600	1.55	1010	142	74	1670
MN1305F	oxide clay	32	2980	1860	<4	1190	8	256*	4690	1.55	1050	141	74	1660
DuMN1305F	oxide clay	32	2960	1870	<4	1180	8	n/d	4640	1.54	1050	141	74	1650
MN1401	oxide silt	20	3080	2090	<4	1400	6	129*	2260	2.74	398	106	46	2100
DuMN1401	oxide silt	20	3110	2090	<4	1390	7	12.8*	2280	2.74	400	106	47	2100
MN1402	oxide silt	24	2140	1510	<4	2350	6	n/d	2400	1.70	709	130	47	1700
MN1406	oxide clay	36	2890	1550	90	1640	<15	68.5*	5550	1.49	920	128	72	1420
DuMN1406	oxide clay	33	2880	1590	101	1710	<15	n/d	5480	1.53	862	139	73	1410
MN1407	native sed.	6	2920	204	12	1520	7	0.00*	107	0.0717	7	46	42	188
MN1408	native sed.	9	6880	413	112	22300	<15	0.00*	20	0.0356	3	462	59	70
MN1504	oxide silt	30	3070	1980	82	966	<15	23.8*	3270	2.20	735	125	55	2020
MN1506	oxide clay	34	2600	1870	90	897	<15	72.1*	4200	1.23	989	123	68	1610
MN1603	oxide silt	29	2370	2040	69	1470	<15	81.6*	1790	1.07	428	111	54	1620
MN1604	oxide clay	25	2250	1810	89	984	<15	18.3*	1870	0.925	356	107	69	1110
MN1605	oxide clay	32	3000	1120	94	1800	<15	32.9*	5580	1.34	1010	146	70	1030
DuMN1605	oxide clay	31	3040	n/d	94	1720	<15	n/d	5550	1.34	1000	147	71	1040

Table C-1a (cont.)

FIELD #	SAMPLE TYPE	Li µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Na µg/g	Ni µg/g	P µg/kg	Pb µg/g	S %	Sb µg/kg	Sr µg/g	V µg/g	Zn µg/g
MN1616	native sed.	30	2660	1320	123	1650	<7	154*	4780	1.49	546*	154	70	939
DuMN1616	native sed.	29	2600	1340	123	1620	<7	n/d	4770	1.46	n/d	153	71	920
MN1701	sulfide silt	28	2500	1290	66	1170	<7	67.4*	2950	3.78	490*	92	45	1780
MN1704	oxide silt	27	2170	1080	71	1370	<7	460*	2200	2.14	428*	99	51	1230
MN1705F	native sed.	13	4180	532	118	18300	<7	69.6*	1350	0.332	198*	382	49	260
MN1802	sulfide clay	28	3650	3100	114	1550	<7	180*	1850	1.62	256*	123	66	2340
MN1802F	sulfide clay	29	3700	3130	118	1590	<7	144*	1860	1.66	227*	124	65	2360
MN1804	oxide clay	33	3160	1850	136	1200	<7	229*	5460	1.45	791*	140	79	1770
MN1805	oxide clay	32	2210	1430	100	1290	<7	109*	4530	1.15	566*	116	59	1100
DuMN1805	oxide clay	32	2210	1430	98	1280	<7	n/d	4520	1.14	n/d	116	58	1100
MN1806	oxide silt	34	267	1530	113	135	<7	140*	5610	0.140	669*	137	68	132
MN1806D	oxide silt	34	2650	1530	115	1340	<7	80.5*	5530	1.38	500*	137	68	1370
DuMN1806D	oxide silt	34	2710	1530	116	1370	<7	n/d	5550	1.41	n/d	137	68	1410
MN1901	sulfide silt	29	4320	2830	<6	1070	2	56.1*	1760	4.21	575*	116	44	2850
DuMN1901	sulfide silt	30	4360	2840	7	1100	1	n/d	1670	4.19	n/d	117	45	2860
MN1902	sulfide silt	30	4250	2820	<6	1630	1	76.3*	1470	2.76	351*	116	60	2650
MN1905	oxide silt	28	3720	2340	<6	2950	1	85.2*	1090	2.39	224*	121	63	2050
MN1906	sulfide silt	25	3570	1800	<6	4630	4	116*	1140	2.31	232*	152	60	1800
MN1907	oxide silt	26	2960	1690	<6	3800	2	97.2*	1020	1.74	250*	135	52	1670
MN1908	sulfide silt	26	3320	2010	<6	2970	1	21.0*	1300	2.32	263*	129	57	1970
MN1910	oxide clay	30	3070	861	<6	4000	4	131*	6420	1.28	622*	147	69	761
NWALL1	pit grab	12	4100	303	<6	2460	46	168*	721	3.72	121*	116	67	319
DuNWALL1	pit grab	12	4100	304	<6	2470	48	n/d	721	3.73	n/d	116	67	322
NWALBX	pit grab	24	2980	1160	<6	177	1	0.00*	4350	38.0	234*	36	17	2290
WBH3	pit grab	18	7630	3100	10	3520	50	106*	1090	1.29	188*	292	63	2410
DuWBH3	pit grab	18	7650	3120	7	3560	51	n/d	1090	1.28	n/d	290	63	2430
PITSED	pit grab	32	9680	5830	11	4410	10	270*	564	0.815	168*	266	168	3270
DuPITSED	pit grab	29	9360	5900	10	4190	12	n/d	566	0.968	n/d	271	160	3290
BATCH01	oxide clay composite	31	2670	1640	7	1350	8	222*	4470	1.35	860*	132	75	1640
BATCH02	oxide clay composite	30	2670	1670	6	1340	10	103*	4400	1.37	759*	133	76	1790
BATCH03	oxide clay composite	30	2650	1630	7	1340	8	196*	4460	1.37	778*	130	74	1470
BATCHS1	sulfide clay composite	30	3260	2140	5	1380	8	89.3*	2700	1.85	406*	126	69	1850
BATCHS1D	sulfide clay composite	29	3260	2190	6	1320	8	101*	2690	1.88	390*	128	72	1900
BATCHS2	suphide clay composite	29	3210	2200	6	1330	11	77.8*	2700	1.92	468*	127	77	1930
BATCH1E	composite	31	2630	1640	7	1350	7	117*	4530	1.35	816*	130	76	1570
DuBATCH1E	composite	30	2660	1650	7	1200	7	n/d	4420	1.33	n/d	126	76	1590

n/d= not determined

* = MS analysis µg/kg (all other data are AES)

Table C-1b: Tailings Geochmistry of selected samples by B.C. Research Inc.

Metal Contents of tailings solids

Field #	Sample Type	Ag µg/g	Al %	As µg/g	Au µg/g	Ba µg/g	Be µg/g	Bi µg/g	Ca %	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe %	K %	La µg/g	Mg %
ENDADIT	pit grab	7.1	7.33	837	5	847	1	12	2.49	12.0	9	11	44.0	5.88	2.96	8	0.83
NWALLCU	pit grab	45.3	4.93	2536	< 4	252	1	75	1.94	29.3	6	6	7438	5.66	2.02	7	0.29
MNOMIX	oxide silt composite	35.6	4.25	2796	< 4	558	1	20	0.770	14.2	3	13	290	4.85	1.79	11	0.24
MNSMIX	sulfide silt composite	42.3	5.56	2274	< 4	788	1	20	1.43	26.9	6	16	365	5.02	2.02	14	0.37
SOMIX	s-o silt composite	31.8	5.00	2468	< 4	383	2	16	1.23	20.8	4	18	285	4.87	1.96	14	0.33
SLURRY	s-o silt composite	35.6	5.06	2473	< 4	598	1	21	1.18	20.3	3	21	312	4.94	1.94	13	0.33
MN0102	oxide silt	25.0	6.59	2370	< 4	559	2	18	1.71	26.5	6	35	437	5.22	2.32	17	0.41
MN0104	sulfide silt	48.7	5.02	2349	< 4	696	1	8	1.29	25.2	4	15	400	5.14	1.92	16	0.34
MN0203	sulfide silt	23.8	5.25	2174	< 4	657	1	18	1.48	24.8	4	14	256	5.04	1.97	14	0.38
MN0304	sulfide silt	32.0	5.36	2604	< 4	539	1	30	1.30	23.9	4	23	599	5.16	2.07	13	0.33
MN0401	sulfide silt	52.1	5.49	1728	< 4	848	1	18	2.23	36.9	8	13	398	5.81	2.00	18	0.55
MN0402	oxide silt	54.3	4.64	1863	< 4	628	1	21	2.10	32.5	4	10	412	4.56	1.76	14	0.47
MN0404	sulfide silt	16.1	5.75	1285	< 4	322	1	16	1.64	18.7	6	19	199	4.06	2.00	15	0.45
MN0501	oxide silt	52.1	5.49	1637	< 4	820	1	26	2.13	33.2	8	17	679	5.46	1.98	17	0.55
MN0502	oxide silt	53.8	4.89	1888	< 4	715	1	23	1.90	34.2	7	12	512	5.51	1.83	17	0.49
MN0503	sulfide silt	76.9	4.86	1924	< 4	537	1	23	1.83	37.4	7	18	524	5.89	1.77	13	0.47
MN0505	sulfide silt	9.7	6.57	349	< 4	282	1	< 5	2.12	8.00	7	39	86.0	3.18	1.89	15	0.66
MN0506T	native sediments	1.0	7.32	17.0	< 4	1069	2	< 5	2.72	0.70	8	47	9.00	2.57	1.82	25	0.90
MN0506B	native sediments	< 0.5	7.52	14.0	< 4	957	2	< 5	3.64	0.60	9	56	49.0	2.81	1.77	26	1.07
MN0605	sulfide silt	25.1	5.12	1427	< 4	555	1	16	1.54	28.0	7	19	315	5.08	1.94	14	0.47
MN0608	sulfide clay	7.5	7.25	523	< 4	1124	2	< 5	2.97	5.00	7	35	66.0	2.62	1.99	16	0.76
MN0609	native sediments	< 0.5	6.90	21.0	< 4	1138	1	< 5	2.92	0.40	7	35	13.0	1.81	1.92	15	0.76
MN0805	sulfide silt	45.9	5.51	5494	< 4	330	1	46	0.750	12.5	2	33	221	5.94	2.18	16	0.25
MN0903	sulfide silt	36.3	5.36	4634	< 4	656	1	35	0.840	6.40	6	49	172	5.02	2.05	20	0.39
MN1204B	oxide clay	55.4	6.12	5617	< 4	379	1	58	0.930	13.1	2	66	201	6.91	2.48	13	0.27
MN1206	native sediments	37.1	6.92	3847	< 4	297	1	39	1.20	17.1	8	65	428	5.87	2.49	13	0.33
MN1305	oxide clay	61.5	7.13	5961	< 4	272	1	51	1.27	24.3	3	32	288	7.43	2.85	15	0.33
MN1405	oxide silt	28.1	5.27	2554	< 4	465	1	13	1.60	19.5	4	21	163	4.23	2.05	16	0.27
MN1406	oxide clay	57.3	6.81	6106	< 4	226	1	61	1.17	22.5	2	47	227	7.82	2.87	16	0.32
MN1407	native sediments	2.8	6.30	267	< 4	1068	1	< 5	2.25	2.10	7	40	11.0	2.23	1.85	21	0.68
MN1502	oxide silt	25.7	3.98	2158	< 4	169	1	24	0.480	14.9	4	16	264	5.08	1.85	12	0.22
MN1607	native sediments	7.4	5.59	131	< 4	1057	1	8	1.98	0.60	5	40	37.0	1.81	1.80	19	0.59
MN1702	oxide silt	46.7	3.85	3808	< 4	294	1	26	0.790	18.1	3	14	404	5.04	1.77	9	0.26
MN1703	oxide silt	33.7	3.72	4394	< 4	228	1	39	0.570	9.30	2	19	210	4.88	1.86	9	0.21
MN1705	native sediments	27.8	5.26	1330	< 4	843	2	16	1.53	3.60	3	36	53.0	2.60	2.05	12	0.42
MN1706	native sediments	28.6	5.43	911	< 4	1072	1	8	1.63	1.80	4	36	40.0	2.33	2.07	14	0.42
MN1904	sulfide silt	28.3	4.94	1854	< 4	731	1	16	1.61	28.2	5	21	402	4.59	1.91	16	0.40
MN1909	native sediments	1.5	6.83	57.0	< 4	989	1	< 5	3.26	1.00	7	47	20.0	2.23	1.80	22	0.85
BATCHO3	oxide clay composite	61.5	6.64	5698	< 4	277	1	56	1.15	22.2	3	37	268	6.72	2.67	14	0.29
BATCHS3	sulfide clay composite	48.1	6.32	3836	< 4	223	1	46	1.50	27.5	4	23	386	6.23	2.50	14	0.34
DuMN0304	sulfide silt	32.3	5.22	2501	< 4	508	1	18	1.26	21.9	4	18	538	5.02	2.04	13	0.33
DuMN0605	sulfide silt	23.2	5.16	1378	< 4	581	1	13	1.56	26.8	7	20	302	5.15	1.97	14	0.48
DuMN1407	native sediments	2.5	6.54	277	< 4	1113	2	< 5	2.28	2.30	7	40	12.0	2.24	1.88	21	0.70
DuBATCHS3	sulfide clay composite	46.9	6.01	3778	< 4	174	1	45	1.46	26.8	4	25	374	6.10	2.46	13	0.34

Table C-1b (cont.)

Field #	Sample Type	Mn µg/g	Mo µg/g	Na %	Nb µg/g	Ni µg/g	P µg/g	Pb µg/g	Sb µg/g	Sc µg/g	Sn µg/g	Sr µg/g	Th µg/g	Ti µg/g	U µg/g	V µg/g
ENDADIT	pit grab	5484	3	0.03	2	7	310	427	68.0	4	5	55.0	< 2	600	10	34
NWALLCU	pit grab	312	2	0.04	2	< 2	810	5700	990	7	6	113	4	900	< 10	59
MNOMIX	oxide silt composite	1332	2	0.10	4	4	440	1470	386	5	3	96.0	3	1200	< 10	44
MNSMIX	sulfide silt composite	2379	2	0.16	5	4	600	1800	433	6	4	125	3	1400	15	53
SOMIX	s-o silt composite	2071	< 2	0.15	4	6	580	1758	375	5	4	114	4	1500	18	52
SLURRY	s-o silt composite	2059	2	0.15	5	5	530	1644	375	5	4	117	3	1600	< 10	51
MN0102	oxide silt	2601	< 2	0.14	5	6	660	1576	370	6	4	147	3	1400	20	58
MN0104	sulfide silt	2360	2	0.13	6	4	510	1830	542	5	4	117	5	1300	< 10	46
MN0203	sulfide silt	2491	< 2	0.20	5	3	570	1544	320	5	< 2	129	3	1400	< 10	48
MN0304	sulfide silt	2120	2	0.21	5	7	610	2059	412	5	4	126	4	1500	< 10	51
MN0401	sulfide silt	3597	< 2	0.07	5	8	580	1553	617	5	4	122	4	1200	19	41
MN0402	oxide silt	2777	< 2	0.06	5	5	480	1576	629	4	5	134	3	1100	< 10	37
MN0404	sulfide silt	2153	< 2	0.56	6	9	620	962	191	7	3	187	3	2000	12	60
MN0501	oxide silt	3482	2	0.09	5	5	520	1402	518	5	4	128	4	1200	11	41
MN0502	oxide silt	3321	< 2	0.07	5	5	470	1749	685	4	4	123	4	1200	22	39
MN0503	sulfide silt	2909	< 2	0.10	5	5	470	2006	804	4	4	136	3	1000	10	39
MN0505	sulfide silt	1216	2	1.71	6	12	590	419	77	7	3	361	3	2100	< 10	64
MN0506T	native sediments	599	< 2	2.41	7	14	580	21.0	5	10	3	487	6	3400	< 10	85
MN0506B	native sediments	672	< 2	2.43	8	16	650	22.0	< 5	11	< 2	503	5	3600	< 10	95
MN0605	sulfide silt	2993	< 2	0.18	6	7	590	1343	299	5	3	113	4	1500	15	50
MN0608	sulfide clay	758	2	2.17	6	11	550	472	81	8	2	458	3	2400	< 10	66
MN0609	native sediments	467	< 2	2.42	6	12	440	21.0	5	7	2	485	8	2300	< 10	59
MN0805	sulfide silt	1268	3	0.15	5	5	640	4352	773	6	5	123	5	1400	14	59
MN0903	sulfide silt	1018	2	0.45	5	17	590	4180	733	7	3	162	5	1500	< 10	72
MN1204B	oxide clay	1541	4	0.15	4	7	730	4971	882	7	7	139	4	1400	< 10	69
MN1206	native sediments	1971	3	0.30	2	13	800	4351	704	8	6	154	3	1200	< 10	77
MN1305	oxide clay	2124	< 2	0.14	2	8	830	5238	1084	8	5	145	4	1500	10	80
MN1405	oxide silt	2260	2	0.19	6	6	650	1248	262	6	4	128	3	1700	< 10	52
MN1406	oxide clay	1753	3	0.19	2	10	820	6431	1112	7	5	142	4	1500	< 10	80
MN1407	native sediments	523	< 2	2.24	6	11	510	118	19.0	7	< 2	446	5	2500	16	69
MN1502	oxide silt	1470	< 2	0.05	3	5	470	1446	235	4	2	68	4	1500	< 10	46
MN1607	native sediments	534	2	1.91	5	12	540	47.0	8	7	4	361	4	2400	< 10	62
MN1702	oxide silt	1205	< 2	0.10	2	3	440	2052	564	5	4	89.0	3	1500	< 10	45
MN1703	oxide silt	750	2	0.10	3	4	500	2738	450	5	2	103	< 2	1500	< 10	48
MN1705	native sediments	581	2	1.70	5	10	440	1245	248	5	6	343	4	1700	< 10	50
MN1706	native sediments	521	< 2	1.90	4	11	410	893	147	5	9	378	4	1700	< 10	54
MN1904	sulfide silt	2633	< 2	0.18	4	7	560	1420	375	5	4	122	4	1500	< 10	47
MN1909	native sediments	585	< 2	2.19	5	14	500	67.0	13	9	2	462	6	2800	11	73
BATCHO3	oxide clay composite	1875	2	0.11	2	8	740	4804	1020	8	6	133	4	1500	10	74
BATCHS3	sulfide clay composite	2483	2	0.12	2	7	740	2888	507	7	5	128	3	1500	< 10	69
MN0304	sulfide silt	2086	2	0.20	5	6	580	2080	390	5	4	124	3	1300	12	49
MN0605	sulfide silt	3045	2	0.18	5	6	560	1283	270	5	3	114	2	1500	< 10	50
MN1407	native sediments	525	2	2.27	10	9	500	128	19.0	7	< 2	462	4	2600	< 10	67
BATCHS3	sulfide clay composite	2423	< 2	0.12	2	8	730	2818	506	7	4	125	4	1600	< 10	72

Table C-1b (cont.)

Field #	Sample Type	W $\mu g/g$	Y $\mu g/g$	Zn $\mu g/g$	Zr $\mu g/g$	TOT/S %	CO_2 %
ENDADIT	pit grab	< 4	6	989	10	5.63	3.89
NWALLCU	pit grab	4	5	306	43	6.33	0.04
MNOMIX	oxide silt composite	< 4	5	1023	34	2.30	0.58
MNSMIX	sulfide silt composite	< 4	7	1937	32	2.36	1.31
SOMIX	s-o silt composite	< 4	6	1525	31	2.23	1.04
SLURRY	s-o silt composite	< 4	6	1525	35	2.28	1.12
MN0102	oxide silt	< 4	7	1977	31	2.06	1.42
MN0104	sulfide silt	< 4	6	1834	32	2.70	1.12
MN0203	sulfide silt	< 4	7	1920	30	2.53	1.23
MN0304	sulfide silt	< 4	6	1755	29	2.24	1.15
MN0401	sulfide silt	< 4	8	2766	38	4.06	2.58
MN0402	oxide silt	< 4	7	2376	32	3.43	2.08
MN0404	sulfide silt	< 4	9	1437	26	1.48	1.00
MN0501	oxide silt	< 4	8	2535	44	3.80	2.62
MN0502	oxide silt	< 4	7	2559	33	4.10	2.08
MN0503	sulfide silt	< 4	6	2607	31	4.33	1.96
MN0505	sulfide silt	< 4	8	634	22	0.96	0.77
MN0506T	native sediments	< 4	14	43.0	34	< .02	< .03
MN0506B	native sediments	< 4	16	48.0	25	0.03	0.77
MN0605	sulfide silt	< 4	8	2189	33	2.76	1.85
MN0608	sulfide clay	< 4	12	355	20	0.30	0.81
MN0609	native sediments	< 4	9	40.0	16	< .02	0.85
MN0805	sulfide silt	< 4	5	915	32	1.19	0.46
MN0903	sulfide silt	< 4	7	504	31	0.84	0.23
MN1204B	oxide clay	< 4	5	1002	29	1.36	0.38
MN1206	native sediments	< 4	8	1251	20	1.16	0.77
MN1305	oxide clay	4	6	1633	29	1.54	0.62
MN1405	oxide silt	< 4	7	1473	28	1.28	0.65
MN1406	oxide clay	< 4	6	1393	27	1.62	0.58
MN1407	native sediments	< 4	11	160	21	0.06	0.04
MN1502	oxide silt	< 4	5	1151	32	2.43	0.59
MN1607	native sediments	< 4	10	70.0	21	0.04	0.04
MN1702	oxide silt	< 4	4	1289	24	3.00	0.51
MN1703	oxide silt	< 4	4	745	25	1.63	0.29
MN1705	native sediments	< 4	6	217	21	0.35	0.11
MN1706	native sediments	< 4	7	163	17	0.24	0.11
MN1904	sulfide silt	< 4	7	2090	32	2.72	1.47
MN1909	native sediments	< 4	12	85.0	20	0.06	0.99
BATCHO3	oxide clay composite	< 4	6	1467	29	1.48	0.51
BATCHS3	sulfide clay composite	< 4	7	1983	32	2.19	0.95
MN0304	sulfide silt	< 4	7	1648	33	2.13	1.12
MN0605	sulfide silt	< 4	8	2110	32	2.69	1.89
MN1407	native sediments	< 4	11	159	20	0.06	0.04
BATCHS3	sulfide clay composite	< 4	6	1940	32	2.15	0.95

Table C-2: Acid base accounting characteristics of selected samples

ABA Results
by BC Research

Field #	Sample Type	Paste pH	CO_2 Inorg. (Wt.%)	$CaCO_3$ Equiv. (Kg $CaCO_3$/ Tonne)	Total Sulfur (Wt.%)	Sulfate Sulfur (Wt.%)	sulfide Sulfur* (Wt.%)	Maximum Potential Acidity** (Kg $CaCO_3$/ Tonne)	Neutralization Potential (Kg $CaCO_3$/ Tonne)
ENDADIT	pit grab	7.0	3.89	88.3	5.63	0.47	5.16	161.3	69.2
NWALLCU	pit grab	3.5	0.04	0.91	6.33	1.76	4.57	142.8	-4.4
MNOMIX	oxide silt composite	7.7	0.58	13.2	2.30	0.29	2.01	62.8	11.1
MNSMIX	sulfide silt composite	8.0	1.31	29.7	2.36	0.50	1.86	58.1	24.9
SOMIX	s-o silt composite	8.1	1.04	23.6	2.23	0.36	1.87	58.4	20.4
SLURRY	s-o silt composite	7.9	1.12	25.4	2.28	0.37	1.91	59.7	19.5
MN0102	oxide silt	7.7	1.42	32.2	2.06	0.63	1.43	44.7	26.8
MN0104	sulfide silt	7.7	1.12	25.4	2.70	0.45	2.25	70.3	19.2
MN0203	sulfide silt	7.4	1.23	27.9	2.53	0.52	2.01	62.8	22.4
MN0304	sulfide silt	8.3	1.15	26.1	2.24	0.39	1.85	57.8	20.9
MN0401	sulfide silt	8.0	2.58	58.6	4.06	0.79	3.27	102.2	39.5
MN0402	oxide silt	8.1	2.08	47.2	3.43	0.81	2.62	81.9	36.6
MN0404	sulfide silt	8.0	1.00	22.7	1.48	0.30	1.18	36.9	22.7
MN0501	oxide silt	7.5	2.62	59.5	3.80	0.84	2.96	92.5	42.9
MN0502	oxide silt	6.8	2.08	47.2	4.10	0.75	3.35	104.7	37.2
MN0503	sulfide silt	6.8	1.96	44.5	4.33	0.69	3.64	113.8	31.7
MN0505	sulfide silt	8.0	0.77	17.5	0.96	0.09	0.87	27.2	16.0
MN0506T	native sediments	7.1	<0.03	<0.7	<0.02	<0.01	<0.02	<0.6	3.0
MN0506B	native sediments	7.6	0.77	17.5	0.03	0.02	0.01	0.3	23.6
MN0605	sulfide silt	8.2	1.85	42.0	2.76	0.37	2.39	74.7	34.7
MN0608	sulfide clay	8.0	0.81	18.4	0.30	0.09	0.21	6.6	20.8
MN0609	native sediments	8.2	0.85	19.3	<0.02	<0.01	<0.02	<0.6	21.3
MN0805	sulfide silt	8.5	0.46	10.4	1.19	0.44	0.75	23.4	12.4
MN0903	sulfide silt	8.2	0.23	5.2	0.84	0.25	0.59	18.4	8.2
MN1204B	oxide clay	9.0	0.38	8.6	1.36	0.13	1.23	38.4	14.1
MN1206	native sediments	7.0	0.77	17.5	1.16	0.15	1.01	31.6	14.9
MN1305	oxide clay	9.1	0.62	14.1	1.54	0.32	1.22	38.1	17.3
MN1405	oxide silt	8.4	0.65	14.8	1.28	0.85	0.43	13.4	17.3
MN1406	oxide clay	8.6	0.58	13.2	1.62	0.31	1.31	40.9	17.6
MN1407	native sediments	7.7	0.04	0.9	0.06	0.06	< 0.02	<0.6	3.0
MN1502	oxide silt	7.4	0.59	13.4	2.43	0.11	2.32	72.5	12.4
MN1607	native sediments	6.1	0.04	0.9	0.04	0.04	0.00	0.0	1.7
MN1702	oxide silt	7.0	0.51	11.6	3.00	0.36	2.64	82.5	12.1
MN1703	oxide silt	7.2	0.29	6.6	1.63	0.32	1.31	40.9	7.4
MN1705	native sediments	8.7	0.11	2.5	0.35	0.12	0.23	7.2	4.2
MN1706	native sediments	8.6	0.11	2.5	0.24	0.17	0.07	2.2	4.5
MN1904	sulfide silt	7.8	1.47	33.4	2.72	0.43	2.29	71.6	29.5
MN1909	native sediments	8.2	0.99	22.5	0.06	0.02	0.04	1.3	24.8
BATCHO3	oxide clay composite	8.6	0.51	11.6	1.48	0.65	0.83	25.9	14.1
BATCHS3	sulfide clay composite	8.3	0.95	21.6	2.19	0.89	1.30	40.6	18.8

*Based on difference between total sulfur and sulfate-sulfur

**Based on sulfide-sulfur

Table C-2 (cont.)

Field #	Sample Type	Net Neutralization Potential (Kg $CaCO_3$/ Tonne)	Fizz Rating	Acid Used (mL/N)
ENDADIT	pit grab	-92.1	none	40/0.1
NWALLCU	pit grab	-147.2	none	20/0.1
MNOMIX	oxide silt composite	-51.7	none	20/0.1
MNSMIX	sulfide silt composite	-33.2	none	20/0.1
SOMIX	s-o silt composite	-38.0	none	20/0.1
SLURRY	s-o silt composite	-40.2	none	20/0.1
MN0102	oxide silt	-17.9	none	20/0.1
MN0104	sulfide silt	-51.1	none	20/0.1
MN0203	sulfide silt	-40.4	none	20/0.1
MN0304	sulfide silt	-36.9	none	20/0.1
MN0401	sulfide silt	-62.7	none	30/0.1
MN0402	oxide silt	-45.3	none	30/0.1
MN0404	sulfide silt	-14.2	none	20/0.1
MN0501	oxide silt	-49.6	slight	40/0.1
MN0502	oxide silt	-67.5	slight	40/0.1
MN0503	sulfide silt	-82.1	none	25/0.1
MN0505	sulfide silt	-11.2	none	20/0.1
MN0506T	native sediments	3.0	none	20/0.1
MN0506B	native sediments	23.3	slight	40/0.1
MN0605	sulfide silt	-40.0	slight	40/0.1
MN0608	sulfide clay	14.2	slight	40/0.1
MN0609	native sediments	21.3	slight	40/0.1
MN0805	sulfide silt	-11.0	none	20/0.1
MN0903	sulfide silt	-10.2	none	20/0.1
MN1204B	oxide clay	-24.3	none	20/0.1
MN1206	native sediments	-16.7	none	20/0.1
MN1305	oxide clay	-20.8	none	20/0.1
MN1405	oxide silt	3.9	none	20/0.1
MN1406	oxide clay	-23.3	none	20/0.1
MN1407	native sediments	3.0	none	20/0.1
MN1502	oxide silt	-60.1	none	20/0.1
MN1607	native sediments	1.7	none	20/0.1
MN1702	oxide silt	-70.4	none	20/0.1
MN1703	oxide silt	-33.5	none	20/0.1
MN1705	native sediments	-3.0	none	20/0.1
MN1706	native sediments	2.3	none	20/0.1
MN1904	sulfide silt	-42.1	none	20/0.1
MN1909	native sediments	23.6	slight	40/0.1
BATCHO3	oxide clay composite	-11.8	none	20/0.1
BATCHS3	sulfide clay composite	-21.8	none	20/0.1

*Based on difference between total sulfur and sulfate-sulfur

**Based on sulfide-sulfur

Table C-2 (cont.)

Table C-2a: QA/QC for NP Determination (Mod. ABA)

Sample	Neutralisation Potential (kgCaCO3/Tonne)	Neutralisation Potential (kgCaCO3/Tonne)
Duplicates - NP		
10	20.9	21.8
20	34.7	35.6
30	3.0	3.2
40	18.8	19.3
NBM-1 Reference (NP = 42)	42.9	-

Table C-2b: QA/QC for Sulphur Speciation

Sample	Sulphur (Wt.%)	Sulphur (Wt.%)
Duplicates - total sulphur		
10	2.24	2.13
20	2.76	2.69
30	0.06	0.06
40	2.19	2.15
Std. CSB (5.2% TS)	5.33	5.30
BCRI Std. (0.11% TS)	0.10	0.10
BCRI Std. (0.53% SO4-S)	0.56	-
BCRI Std. (0.05% SO4-S)	0.05	-

Table C-2c: QA/QC for CO2 Determination

Sample	CO2 (Wt.%)	CO2 (Wt.%)
Duplicates		
10	1.15	1.12
20	1.85	1.89
30	0.04	0.04
40	0.95	0.95

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 1 - 03	45 - 90	Leach Water	S-silt	8.79	17.77	43.7			< 0.02			6		10	
MN BH 1 - 04	60 - 120	Porewater	S-silt	7.91		32.6			0.37		188	299	2239	45	
MN BH 1 - 05	120-150	Leach Water	O-silt	8.65		9.10			0.03			2		1	
MN BH 1 - 06	150 - 217	Porewater	O-silt	9.22		7.50	27.6	11.3	11.9	6	63	95	1646	6	7.0
MN BH 1 - 07	217 - 255	Leach Water	O-silt	8.33	2.61				0.12			< 2		7	
MN BH 1 - 08	255 - 270	Leach Water		7.80	> 19.99				< 0.02			9		9	
MN BH 2 - 01	0 - 17.5	Porewater	S-silt	8.10					< 0.02			24		30	0.8
MN BH 2 - 02	18 - 47	Porewater	O-silt	8.31		17.7	0.1	< 0.05	0.19	3	184	229	2785	41	
MN BH 2 - 03	47 - 70	Porewater	S-silt	8.38		58.6	0.2	0.10	0.32	< 2	238	248	2356	43	
MN BH 2 - 04	70 - 120	Porewater	O-silt	8.44		61.9			0.05			230		49	
MN BH 2 - 05	120 - 200	Porewater	O-silt	8.70		35.4	2.6	0.60	2.64	26	166	204	1987	29	
MN BH 2 - 06	200 - 275	Porewater	O-silt	8.95			23.6	4.2	8.47	45	94	87	1913	12	1.8
MN BH 2 - 07	275 - 290	Leach Water	O-clay	8.12	> 19.99				0.03			3		3	
MN BH 2 - 08	290 - 330	Leach Water		6.63					0.02			< 2		4	
MN BH 3 - 01	0 - 40	Porewater	O-silt	7.77					< 0.02			240		59	0.9
MN BH 3 - 02	40 - 100	Leach Water	S-silt	8.75		31.0			0.02			18		7	
MN BH 3 - 03	100 - 110	Porewater	O-silt	8.85					0.02			316		44	
MN BH 3 - 04	110 - 150	Porewater	S-silt	8.77			7.7	0.10	1.17	64	180	192	2242	27	
MN BH 3 - 05	150 - 250	Porewater	O-silt	8.98			65.3	32.8	23.3	75	115	130	1885	12	
MN BH 3 - 06	250 - 275	Leach Water	O-silt	9.15	2.75		7.1	3.8	3.88	8	141	10	141	5	
MN BH 3 - 07	275 - 280	Porewater	O-silt	8.81		28.8	59.3	32.8	32.0	37	54	43	801	8	1.2
MN BH 4 - 01	0 - 25	Porewater	S-silt	8.60					0.07			41		28	7.3
MN BH 4 - 02	25 - 40	Porewater	O-silt	8.64	16.07				0.14			56		27	
MN BH 4 - 03	40 - 120	Porewater	S-silt	8.87	19.92	54.2			1.76		47	62	1968	29	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 4 - 04	120 - 150	Porewater	S-silt	8.66	> 19.99	14.4	1.6	1.5	2.53	20	125	141	2080	41	
MN BH 4 - 06	180 - 280	Porewater	S-clay	8.65		63.0	2.3	1.8	3.47	72	285	285	2388	46	
MN BH 4 - 08	420 - 440	Porewater	S-silt	9.40	10.56		55.6	25.1	25.5	19	33	84	519	5	1.0
MN BH 5 - 01	0 - 25	Leach Water	O-silt	7.80	13.54	24.3			< 0.02			< 2		5	
MN BH 5 - 02	25 - 50	Leach Water	O-silt	6.97	14.32				< 0.02			8		7	
MN BH 5 - 03	50 - 140	Leach Water	S-silt	7.72	12.76	24.3			< 0.02						
MN BH 5 - 04	140 - 205	Leach Water	S-silt	7.93	8.79				<0.02			3		6	
MN BH 5 - 05	205	Leach Water		7.04					0.02			< 2		5	
MN BH 5 - 06	205 - 270	Leach Water	S-silt	7.58	3.54				<0.02			< 2		7	
MN BH 5 - 07	270 - 330	Leach Water		8.04	> 19.99				0.02			11		2	
MN BH 5 - 08	330 - 400	Leach Water		8.04	> 19.99				0.02			5		< 1	
MN BH 6 - 01	0 - 10	Porewater	S-silt	7.96	> 19.99				< 0.02			< 2		74	
MN BH 6 - 03	30 - 166	Porewater	S-silt	8.60	> 19.99	21.0	12.8	13.2	18.7	72	236	253	2492	40	
MN BH 6 - 04	166 - 206	Porewater	O-silt	8.31		21.0	0.1	< 0.05	8.39	124	194	185	2346	< 1	
MN BH 6 - 05	206 - 262	Porewater	S-silt	8.75		27.6	7.8	8.1	25.7	153	239	224	2374	34	
MN BH 6 - 07	342 - 502	Porewater	S-clay	8.68		111	0.2	< 0.05	1.64	9	152	169	2084	14	
MN BH 6 - 08	502 - 626	Porewater	O-silt	8.36		46.4	0.6	< 0.05	8.26	<2	110	106	2229	12	
MN BH 7 - 01	20 - 40	Water		7.90		42.5	0.1	< 0.05	0.13	4	46	57	1365	24	
MN BH 7 - 02	40 - 90	Porewater	S-silt	8.96	15.4				0.03			53		12	
MN BH 7 - 03	90 - 220	Porewater	O-silt	8.87		165	< 0.05	< 0.05	1.55	20	249	255	2267	41	
MN BH 7 - 05	246 - 377	Porewater	O-clay	8.68		93.1	0.8	1.3	17.1	83	139	148	1998	10	
MN BH 7 - 06	377 - 480	Porewater	O-silt	9.32	13.98	98.8	59.9	8.9	12.4	66	64	94	1262	38	
MN BH 7 - 07	480 - 600	Porewater	O-silt	9.67	16.83	51.8	37.1	7.5	7.95	54	38	31	601	29	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 8 - 01	25 - 75	Porewater	S-clay	7.93					0.12			69		22	
MN BH 8 - 02A	75 - 330	Porewater	S-clay	8.48			30.4	4.8	28.4	35	52	77	1256	12	
MN BH 8 - 02	75 - 330A	Porewater	O-clay	8.56					0.15			262			
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt	8.47			0.3	< 0.05	0.38	22	252	257	2672		
MN BH 8 - 05	75 - 330C	Porewater		9.03			43.5	32.9	38.3	103	104	104	2110		
MN BH 8 - 06	75 - 330D										26		1070		
MN BH 9 - 01	20 - 60	Water		7.84			0.3	0.1	0.16	3	46	64	1370	16	1.0
MN BH 9 - 02	60 - 150	Porewater	S-clay	8.47		99.6	0.5	< 0.05	1.72	18	153	174	2151	42	
MN BH 9 - 03	150 - 240	Porewater	S-silt	7.98		11.1	2.2	1.0	0.86	< 2	76	55	1794	7	1.3
MN BH 9 - 04														43	
MN BH 10 - 01	24 - 130	Water		7.63	> 19.99				0.07		47	65	1404	20	
MN BH 10 - 02	140 - 165	Porewater		8.93	16.61				0.04			106		44	
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	8.60			0.3	< 0.05	0.02	11	175	179	2452	51	
MN BH 10 - 04															
MNBH 10 - 06															
MN BH 11 - 01	24 - 140	Water		7.90	13.56				0.09		43	56	1281	24	
MN BH 11 - 02	140 - 362	Porewater	S-clay	8.75		67.7	0.1	< 0.05	1.55	22	196	221	2114	40	
MN BH 11 - 03	362 - 450	Porewater	O-clay	8.64		36.1	0.3	0.1	0.33	5	127	151	1976	12	
MN BH 11 - 05	480 - 570	Porewater	O-clay	7.14	18.61	0.5			0.02		<5	< 2	79	20	
MN BH 12 - 01	25 - 168	Water		7.87					0.09		40	19	1357	26	
MN BH 12 - 02	168 - 407	Porewater	O-clay	9.07		30.0	0.2	< 0.05	0.02	< 2	169	163	2079	27	
MN BH 12 - 04	417 - 920	Porewater	O-clay	9.09		23.6	5.7	< 0.05	3.18	55	157	143	1964	7	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 13 - 01	25 - 110	Water		7.96					0.09		40	39	1393	26	
MN BH 13 - 02	110 -257	Porewater	S-clay	8.40		73.0			0.05			183		46	
MN BH 13 - 03	257 - 356	Porewater	S-clay	8.60		95.1			0.02			175		35	
MN BH 13 - 04	356 - 470	Porewater	O-clay	8.46		34.3			0.08			146		33	
MN BH 13 - 05	470 - 700	Porewater	O-clay	9.05		19.3	2.4	< 0.05	5.86	59	135	135	1881	8	
MN BH 14 - 04	270 - 455	Porewater	O-silt	9.09		7.3	0.9	< 0.05	<0.02	5	128	170	2279	24	
MN BH 14 - 05	455 - 578	Porewater	O-silt	8.85		17.1			< 0.02			179		29	
MN BH 15 - 01	10 - 25 cm	Water	S-clay	7.70					0.16		47	52	1395	24	
MN BH 15 - 02	25 - 210	Porewater	O-silt	7.87		12.8	0.1	< 0.05	0.35	< 2	50	49	1900	17	
MN BH 15 - 03	210 - 460	Porewater	O-silt	8.86		5.41			0.02		143	221	2225	37	
MN BH 15 - 04	460 - 510	Porewater	O-silt	8.34		18.2			0.10		244	245	2399	48	
MN BH 15 - 06	580 - 750	Porewater	O-clay	9.24		24.6	60.6	< 0.05	5.46	53	145	144	1860	5	
MN BH 15 - 07	750 - 910	Porewater	O-clay	8.90		19.3	18.3	0.3	2.33	29	163	171	1691		
MN BH 16 - 01	13 - 150	Water	S-clay	7.79					0.11		42	37	1321	23	
MN BH 16 - 02	150 - 358	Porewater	O-silt	8.58		145	0.3	0.2	0.46	10	212	233	1879	41	
MN BH 16 - 04	386 - 498	Porewater	O-clay	8.70		19.1	1.7	< 0.05	< 0.02	<2	179	171	2295	13	
MN BH 17 - 04	184 - 260	Porewater	O- Silt	8.33					< 0.02		33	18	2183	21	
MN BH 18 -00	20 - 140	Porewater		7.77					0.05			32			
MN BH 18 -01	140 - 250	Porewater	S-clay	8.72		73.3			< 0.02		105	62	1869	31	
MN BH 18 -02	250 - 331	Porewater	S-clay	8.68		7.8			0.45			171		> 55	
MN BH 18 -03	331 - 485	Porewater	O-clay	8.65		27.8			0.07			124			
MN BH 18 -04	485 - 610	Porewater	O-clay	9.10		31.1	2.1	0.5	12.5	81	154	132	1880	31	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 18 -05	610 - 660	Porewater	O-clay	8.83		24.4	16.5	11.7	22.6	81	125	81	1755		
MN BH 18 -06	660 - 800	Porewater	O-silt	9.12		102	4.4	0.3	1.50	26	16	16	514		
MN BH 19 - 01	0 - 25	Porewater	S-silt	7.57					0.34		<5	25	3008		
MN BH 19 - 02	25 - 103	Porewater	S-silt	8.70		31.1			0.33			17			
MN BH 19 - 03	103 - 140	Porewater	O-silt	8.62		27.8	0.1	0.2	0.72	< 2	31	33	2209	32	
MN BH 19 - 04	140 - 207	Porewater	S-silt	8.85		33.3	0.2	< 0.05	0.02	11	45	36	2175		
MN BH 19 - 05	207 - 251	Porewater		8.26		22.2	0.1	0.1	< 0.02	17		109			
MN BH 19 - 06	251 - 356	Porewater	S-silt	8.38		4.9	0.1	0.08	0.09	16		76		> 55	
MN BH 19 - 07	356 - 389	Porewater		8.35		17.8			< 0.02			15		47	
MN BH 19 - 08	389 - 428	Porewater	S-silt	8.25		37.6			< 0.02		43	42	2215		
MN Seepage Water		Water		7.27			0.3	0.2	0.33	< 2	57	60	1222	17	
MN Pit (Bottom)													2579		
MN Pit (Top)													223		
BLANK 17													<10		
BLANK 18													<10		
BLANK 19													<10		

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_3-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 1 - 03	45 - 90	Leach Water	S-silt	0.1																
MN BH 1 - 04	60 - 120	Porewater	S-silt	3.1	0.056	1.59	0.226	0.052	3.7	540.8	< 0.1	35.9	2.5	1.79	0.049	48.35	2.5	48.17	1.98	1.4
MN BH 1 - 05	120-150	Leach Water	O-silt	0.4																
MN BH 1 - 06	150 - 217	Porewater	O-silt	4.4	0.145	1.22	2.82	0.139	4.7	495.5	< 0.1	22.6	0.2	7.34	4.28	26.24	1.1	1.61	0.036	< 0.1
MN BH 1 - 07	217 - 255	Leach Water	O-silt	0.2																
MN BH 1 - 08	255 - 270	Leach Water		<0.1																
MN BH 2 - 01	0 - 17.5	Porewater	S-silt	4.4																
MN BH 2 - 02	18 - 47	Porewater	O-silt	0.2	0.007	0.609	0.055	0.048	3.7	504.0	5.8	17.9	2.1	0.225	0.104	62.52	1.7	77.89	0.892	< 0.1
MN BH 2 - 03	47 - 70	Porewater	S-silt	0.1	0.031	1.32	0.268	0.050	2.9	531.5	< 0.1	19.8	0.5	0.407	0.143	52.02	1.9	62.07	3.58	< 0.1
MN BH 2 - 04	70 - 120	Porewater	O-silt	< 0.1																
MN BH 2 - 05	120 - 200	Porewater	O-silt	< 0.1						498.0				9.23	1.19	32.70	0.9	31.27	0.373	1.1
MN BH 2 - 06	200 - 275	Porewater	O-silt	< 0.1	0.005	0.426	1.39	0.084	2.1	564.0	< 0.1	35.0	<0.1	0.008	6.69	27.19	0.5	6.19	0.022	2.4
MN BH 2 - 07	275 - 290	Leach Water	O-clay	0.1																
MN BH 2 - 08	290 - 330	Leach Water		< 0.1																
MN BH 3 - 01	0 - 40	Porewater	O-silt	0.4																
MN BH 3 - 02	40 - 100	Leach Water	S-silt	0.2																
MN BH 3 - 03	100 - 110	Porewater	O-silt	0.5																
MN BH 3 - 04	110 - 150	Porewater	S-silt	0.1	0.016	0.713	1.13	0.095	3.7	571.8	< 0.1	38.3	0.5	0.774	1.73	47.41	2.1	20.34	0.092	3.1
MN BH 3 - 05	150 - 250	Porewater	O-silt	0.2	0.062	0.287	1.84	0.050	2.7	564.3	0.3	32.5	<0.1	19.3	12.1	34.04	1.2	3.85	0.011	25.1
MN BH 3 - 06	250 - 275	Leach Water	O-silt	0.2	0.036	0.982	0.667	0.041	4.3	39.25	< 0.1	4.3	0.6	2.68	4.01	6.87	0.5	0.42	0.015	5.9
MN BH 3 - 07	275 - 280	Porewater	O-silt	0.2	0.272	0.888	1.27	0.034	1.6	214.9	< 0.1	24.5	<0.1	16.4	11.5	31.96	0.3	1.55	0.017	7.8
MN BH 4 - 01	0 - 25	Porewater	S-silt	0.2																
MN BH 4 - 02	25 - 40	Porewater	O-silt	0.1																
MN BH 4 - 03	40 - 120	Porewater	S-silt	0.3	0.035	1.27	0.255	0.030	3.2	521.9	1.3	4.5	0.6	2.44	0.167	57.19	0.7	14.49	0.061	8.4

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_3-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 4 - 04	120 - 150	Porewater	S-silt	< 0.1	0.005	0.427	0.082	0.043	3.8	503.1	1.7	7.5	<0.1	3.11	0.087	52.46	0.2	33.19	0.115	< 0.1
MN BH 4 - 06	180 - 280	Porewater	S-clay	< 0.1	0.010	0.913	0.067	0.035	2.1	475.8	1.9	3.8	1.3	2.44	0.082	66.46	1.7	50.47	0.355	10.5
MN BH 4 - 08	420 - 440	Porewater	S-silt	0.2	0.062	0.922	0.439	0.047	1.6	128.5	9.1	9.7	2.6	7.84	10.1	13.93	0.2	1.77	0.027	9.7
MN BH 5 - 01	0 - 25	Leach Water	O-silt	0.1																
MN BH 5 - 02	25 - 50	Leach Water	O-silt	0.1																
MN BH 5 - 03	50 - 140	Leach Water	S-silt																	
MN BH 5 - 04	140 - 205	Leach Water	S-silt	0.2																
MN BH 5 - 05	205	Leach Water		< 0.1																
MN BH 5 - 06	205 - 270	Leach Water	S-silt	0.1																
MN BH 5 - 07	270 - 330	Leach Water		0.1																
MN BH 5 - 08	330 - 400	Leach Water																		
MN BH 6 - 01	0 - 10	Porewater	S-silt																	
MN BH 6 - 03	30 - 166	Porewater	S-silt	< 0.1	0.019	0.816	0.086	0.090	2.1	475.6	2.2	10.3	<0.1	18.1	0.129	60.89	0.5	23.95	0.053	12.3
MN BH 6 - 04	166 - 206	Porewater	O-silt	0.1	< 0.001	0.703	0.219	0.225	6.2	505.9	2.7	20.6	1.2	10.8	0.216	53.58	1.8	24.35	0.238	11.2
MN BH 6 - 05	206 - 262	Porewater	S-silt	< 0.1	0.002	0.600	0.093	0.045	1.1	497.1	0.3	16.5	<0.1	27.8	0.091	62.13	0.5	18.67	0.087	21.4
MN BH 6 - 07	342 - 502	Porewater	S-clay	0.1	0.019	1.08	0.497	0.085	3.4	596.1	< 0.1	14.7	0.7	0.733	0.089	36.77	0.7	37.38	0.845	< 0.1
MN BH 6 - 08	502 - 626	Porewater	O-silt	< 0.1	0.030	1.33	0.174	0.053	27.0	539.4	3.6	19.4	<0.1	8.13	0.114	20.37	1.2	60.56	0.643	13.6
MN BH 7 - 01	20 - 40	Water		0.4	0.008	1.62	0.010	0.070	13.9	333.1	0.4	18.5	1.7	0.238	0.183	14.21	0.8	30.91	1.80	4.7
MN BH 7 - 02	40 - 90	Porewater	S-silt	2.2																
MN BH 7 - 03	90 - 220	Porewater	O-silt	< 0.1	0.004	1.55	0.214	0.044	3.7	526.8	4.0	14.8	37.5	1.54	0.205	51.43	1.1	43.47	0.274	7.1
MN BH 7 - 05	246 - 377	Porewater	O-clay	< 0.1	0.003	0.232	0.992	0.056	2.8	489.2	0.3	27.5	<0.1	18.4	1.00	25.75	0.8	18.20	0.414	4.2
MN BH 7 - 06	377 - 480	Porewater	O-silt	0.1	0.020	0.643	1.53	0.040	7.2	379.1	< 0.1	15.6	<0.1	14.0	20.0	29.01	0.9	2.74	0.015	12.7
MN BH 7 - 07	480 - 600	Porewater	O-silt	0.1	0.024	1.33	0.940	0.047	4.4	161.4	< 0.1	16.4	1.5	8.21	11.2	21.46	1.4	1.09	0.020	15.5

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 8 - 01	25 - 75	Porewater	S-clay	0.1																
MN BH 8 - 02A	75 - 330	Porewater	S-clay	< 0.1	0.063	1.54	0.952	0.111	5.4	332.1	9.7	23.6	1.7	18.0	3.80	27.60	0.8	6.9	0.088	5.1
MN BH 8 - 02	75 - 330A	Porewater	O-clay																	
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt		0.004	0.301	0.172	0.063	7.6	550.2	< 0.1	17.9	6.0	1.16	0.589	65.83	1.2	57.27	0.882	10.3
MN BH 8 - 05	75 - 330C	Porewater			0.014	0.350	1.98	0.151	3.4	591.6	< 0.1	6.8	1.7	21.6	1.23	31.32	0.4	8.17	0.044	2.0
MN BH 8 - 06	75 - 330D				0.292	1.08	0.879	0.075	8.4	310.5	< 0.1	15.5	4.0	10.6	0.713	30.52	1.3	5.24	0.052	10.4
MN BH 9 - 01	20 - 60	Water		0.2	0.002	0.617	< 0.005	0.035	7.8	332.2	0.1	10.1	<0.1	0.225	0.117	14.89	0.4	30.71	1.17	9.8
MN BH 9 - 02	60 - 150	Porewater	S-clay	< 0.1	< 0.001	0.788	< 0.005	0.044	4.1	521.0	< 0.1	14.1	1.5	1.62	0.121	42.16	1.5	45.54	0.740	10.7
MN BH 9 - 03	150 - 240	Porewater	S-silt	2.5	< 0.001	0.411	0.928	0.157	49.8	616.9	< 0.1	31.1	0.4	0.020	0.382	37.18	1.6	30.20	1.30	12.5
MN BH 9 - 04																				
MN BH 10 - 01	24 - 130	Water		0.1	< 0.001	0.307	0.043	0.079	11.0	329.6	< 0.1	12.9	<0.1	0.266	0.123	13.62	0.2	30.49	1.19	1.2
MN BH 10 - 02	140 - 165	Porewater		0.3																
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	< 0.1	0.003	0.479	0.300	0.098	6.5	524.1	< 0.1	14.2	1.5	0.182	0.071	44.94	2.5	54.82	0.800	15.7
MN BH 10 - 04										540.8					0.049	48.35		48.17		
MNBH 10 - 06										495.5					4.28	26.24		1.61		
MN BH 11 - 01	24 - 140	Water		0.2	0.006	0.526	0.011	0.070	13.2	308.4	< 0.1	16.2	0.7	0.272	0.092	12.89	0.8	28.36	1.66	< 0.1
MN BH 11 - 02	140 - 362	Porewater	S-clay	0.1	0.025	0.501	0.542	0.073	2.1	527.2	3.0	13.9	<0.1	2.39	0.020	40.25	1.2	37.26	0.442	5.8
MN BH 11 - 03	362 - 450	Porewater	O-clay	0.1	< 0.001	0.310	0.654	0.071	3.9	542.0	2.5	15.1	0.8	0.881	0.081	32.53	1.7	36.46	0.656	3.8
MN BH 11 - 05	480 - 570	Porewater	O-clay	< 0.1	0.006	0.478	0.028	0.044	14.9	14.62	< 0.1	0.76	1.3	0.011	4.23	2.150	0.7	3.56	0.053	1.5
MN BH 12 - 01	25 - 168	Water		0.3	< 0.001	0.403	< 0.005	0.068	9.8	314.7	< 0.1	12.8	1.6	0.211	0.112	13.14	1.2	29.15	1.41	< 0.1
MN BH 12 - 02	168 - 407	Porewater	O-clay	2.5	0.002	0.322	0.989	0.077	2.2	550.9	< 0.1	24.9	<0.1	0.012	0.121	42.95	1.3	32.51	0.356	3.8
MN BH 12 - 04	417 - 920	Porewater	O-clay		0.018	0.222	1.44	0.058	2.1	641.6	< 0.1	17.7	1.5	6.63	1.91	27.08	0.8	10.67	0.081	8.2

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 13 - 01	25 - 110	Water		0.1	0.010	0.389	0.074	0.061	12.9	326.8	< 0.1	15.7	2.4	0.204	0.096	13.52	1.0	30.09	1.63	< 0.1
MN BH 13 - 02	110 -257	Porewater	S-clay	< 0.1																
MN BH 13 - 03	257 - 356	Porewater	S-clay	0.1																
MN BH 13 - 04	356 - 470	Porewater	O-clay	0.1																
MN BH 13 - 05	470 - 700	Porewater	O-clay	< 0.1	0.023	0.390	1.86	0.092	2.5	642.3	< 0.1	18.9	0.5	10.4	1.61	28.16	1.8	11.85	0.108	10.5
MN BH 14 - 04	270 - 455	Porewater	O-silt	0.2	0.011	0.319	1.06	0.054	3.9	501.3	< 0.1	43.5	2.2	0.010	0.281	59.02	0.7	16.03	0.016	8.2
MN BH 14 - 05	455 - 578	Porewater	O-silt	0.2																
MN BH 15 - 01	10 - 25 cm	Water	S-clay	0.1	< 0.001	0.344	0.044	0.069	13.0	330.7	< 0.1	15.5	<0.1	0.347	0.112	13.37	0.6	29.50	1.82	< 0.1
MN BH 15 - 02	25 - 210	Porewater	O-silt	0.2	0.001	0.317	0.090	0.093	5.5	509.2	0.8	14.4	1.9	0.061	0.078	20.36	1.7	32.23	1.76	< 0.1
MN BH 15 - 03	210 - 460	Porewater	O-silt	< 0.1	0.005	0.189	0.925	0.017	1.5	539.8	< 0.1	18.3	<0.1	0.064	0.051	39.34	0.4	19.49	0.12	18.5
MN BH 15 - 04	460 - 510	Porewater	O-silt	< 0.1	0.001	0.425	0.421	0.049	4.2	565.4	1.6	27.2	<0.1	0.039	0.099	52.78	2.3	39.34	0.937	4.1
MN BH 15 - 06	580 - 750	Porewater	O-clay	< 0.1	0.004	0.154	1.42	0.057	2.4	606.8	1.0	15.8	0.7	8.63	2.44	25.17	0.3	7.24	0.064	2.8
MN BH 15 - 07	750 - 910	Porewater	O-clay		0.044	0.303	2.35	0.128	3.4	679.9	< 0.1	30.4	<0.1	3.09	7.30	22.21	0.2	6.66	0.033	5.7
MN BH 16 - 01	13 - 150	Water	S-clay	1.5	0.015	0.285	0.110	0.071	10.0	312.8	< 0.1	12.8	0.3	0.231	0.185	12.84	0.2	28.43	1.40	< 0.1
MN BH 16 - 02	150 - 358	Porewater	O-silt		0.029	0.299	0.267	0.030	1.3	515.5	< 0.1	9.8	< 0.1	2.64	0.042	42.43	0.7	33.7	0.325	5.1
MN BH 16 - 04	386 - 498	Porewater	O-clay		0.160	10.0	11.2	0.141	12.9	359.3	1.8	153	4.9	0.070	0.854	31.17	5.3	5.38	0.220	52.2
MN BH 17 - 04	184 - 260	Porewater	O- Silt		0.039	10.4	0.990	0.168	12.0	634.9	< 0.1	53.6	7.1	0.148	0.147	23.71	10.5	31.96	3.11	41.9
MN BH 18 -00	20 - 140	Porewater																		
MN BH 18 -01	140 - 250	Porewater	S-clay		0.012	10.2	1.43	0.103	8.1	566.2	1.7	25.3	5.4	0.036	0.410	52.56	4.3	22.85	0.490	43.4
MN BH 18 -02	250 - 331	Porewater	S-clay																	
MN BH 18 -03	331 - 485	Porewater	O-clay																	
MN BH 18 -04	485 - 610	Porewater	O-clay		0.024	8.54	5.62	0.237	7.5	449.5	3.2	72.9	6.3	14.3	1.75	28.76	4.3	15.04	0.409	47.0

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 18 -05	610 - 660	Porewater	O-clay		0.084	8.69	5.36	0.323	5.9	579.8	2.1	87.0	4.1	23.1	4.02	24.83	13.9	9.69	0.178	37.2
MN BH 18 -06	660 - 800	Porewater	O-silt		0.020	0.84	0.382	0.061	3.5	174.5	1.1	6.5	0.9	3.52	2.23	10.16	0.5	2.88	0.066	1.9
MN BH 19 - 01	0 - 25	Porewater	S-silt		0.001	8.09	0.052	0.084	9.9	374.2	58.0	21.6	7.2	0.065	0.202	47.40	18.8	116.9	29.1	5.6
MN BH 19 - 02	25 - 103	Porewater	S-silt																	
MN BH 19 - 03	103 - 140	Porewater	O-silt		0.006	0.618	0.067	0.046	5.2	367.5	< 0.1	7.7	1.3	0.987	0.122	31.08	0.4	9.37	0.084	< 0.1
MN BH 19 - 04	140 - 207	Porewater	S-silt		0.002	7.75	0.434	0.089	12.1	576.9	14.7	38.8	8.7	0.608	0.072	54.69	6.7	27.82	3.51	29.7
MN BH 19 - 05	207 - 251	Porewater																		
MN BH 19 - 06	251 - 356	Porewater	S-silt																	
MN BH 19 - 07	356 - 389	Porewater																		
MN BH 19 - 08	389 - 428	Porewater	S-silt		0.058	6.77	0.397	0.120	23.1	596.4	28.8	50.5	5.6	3.02	0.071	39.64	8.3	36.48	9.68	17.2
MN Seepage Water		Water		0.7	0.002	6.29	0.037	0.084	45.2	289.3	1.6	49.1	6.2		11.2	11.48	1.3	25.55	7.94	6.2
MN Pit (Bottom)					0.001	0.941	< 0.005	0.019	0.53	443.3	6.2	1.3	6.4	0.043	0.02	6.13	4.0	274.0	1.54	1.8
MN Pit (Top)					0.001	0.573	0.019	0.034	4.5	118.7	1.8	0.34	4.8	0.038	0.16	1.97	1.2	26.84	0.070	< 0.1
BLANK 17					0.011	0.904	< 0.005	0.751	< 0.02	0.188	0.1	< 0.01	1.9	0.005	0.06	<0.27	28.0	0.04	0.005	< 0.1
BLANK 18					0.014	0.745	< 0.005	0.131	< 0.02	0.114	< 0.1	2.8	1.2	0.083	0.04	<0.27	0.4	0.01	0.004	< 0.1
BLANK 19					0.010	0.630	< 0.005	0.042	0.87	0.061	< 0.1	< 0.01	4.2	0.005	0.03	<0.27	<0.1	0.01	0.004	< 0.1

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 1 - 03	45 - 90	Leach Water	S-silt									
MN BH 1 - 04	60 - 120	Porewater	S-silt	412	49.1	188	18.6	888.2	79	5.06		27
MN BH 1 - 05	120-150	Leach Water	O-silt									
MN BH 1 - 06	150 - 217	Porewater	O-silt	241	36.3	193	1.1	550.5	19	27.7		< 1
MN BH 1 - 07	217 - 255	Leach Water	O-silt									
MN BH 1 - 08	255 - 270	Leach Water										
MN BH 2 - 01	0 - 17.5	Porewater	S-silt									
MN BH 2 - 02	18 - 47	Porewater	O-silt	608	<0.1	77	1.2	1115	64	3.55	1.68	8
MN BH 2 - 03	47 - 70	Porewater	S-silt	427	23.0	231	1.3	1007	30	5.12	1.16	20
MN BH 2 - 04	70 - 120	Porewater	O-silt									
MN BH 2 - 05	120 - 200	Porewater	O-silt	376	12.5	198	< 0.2	794.4	37	8.73	1.05	< 1
MN BH 2 - 06	200 - 275	Porewater	O-silt	256	4.1	183	< 0.2	668.8	55	19.0	1.27	< 1
MN BH 2 - 07	275 - 290	Leach Water	O-clay									
MN BH 2 - 08	290 - 330	Leach Water										
MN BH 3 - 01	0 - 40	Porewater	O-silt									
MN BH 3 - 02	40 - 100	Leach Water	S-silt									
MN BH 3 - 03	100 - 110	Porewater	O-silt									
MN BH 3 - 04	110 - 150	Porewater	S-silt	433	4.5	224	0.2	874.3	32	11.1	1.49	< 1
MN BH 3 - 05	150 - 250	Porewater	O-silt	340	22.3	172	3.6	680.2	62	20.0	1.50	7
MN BH 3 - 06	250 - 275	Leach Water	O-silt	42.9	8.2	140	52.2	49.5	45	6.69	0.08	18
MN BH 3 - 07	275 - 280	Porewater	O-silt	225	33.1	118	4.8	288.3	74	12.2	0.48	248
MN BH 4 - 01	0 - 25	Porewater	S-silt									
MN BH 4 - 02	25 - 40	Porewater	O-silt									
MN BH 4 - 03	40 - 120	Porewater	S-silt	248	6.7	201	2.5	695.3	51	1.23	1.38	32

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 4 - 04	120 - 150	Porewater	S-silt	336	12.1	220	11.0	791.9	35	2.46	1.53	< 1
MN BH 4 - 06	180 - 280	Porewater	S-clay	548	20.4	147	8.7	996.2	60	1.54	1.85	51
MN BH 4 - 08	420 - 440	Porewater	S-silt	158	11.2	230	1.3	175.4	28	5.82	0.30	423
MN BH 5 - 01	0 - 25	Leach Water	O-silt									
MN BH 5 - 02	25 - 50	Leach Water	O-silt									
MN BH 5 - 03	50 - 140	Leach Water	S-silt									
MN BH 5 - 04	140 - 205	Leach Water	S-silt									
MN BH 5 - 05	205	Leach Water										
MN BH 5 - 06	205 - 270	Leach Water	S-silt									
MN BH 5 - 07	270 - 330	Leach Water										
MN BH 5 - 08	330 - 400	Leach Water										
MN BH 6 - 01	0 - 10	Porewater	S-silt									
MN BH 6 - 03	30 - 166	Porewater	S-silt	664	28.7	176	1.0	1006	29	2.18	1.45	23
MN BH 6 - 04	166 - 206	Porewater	O-silt	550	38.2	106	2.3	907.2	55	3.38	1.38	< 1
MN BH 6 - 05	206 - 262	Porewater	S-silt	643	41.2	77	1.0	974.6	57	2.64	1.50	10
MN BH 6 - 07	342 - 502	Porewater	S-clay	349	11.4	156	26.4	934.7	46	0.96	1.35	14
MN BH 6 - 08	502 - 626	Porewater	O-silt	459	7.6	158	4.3	852.5	71	5.31	1.51	48
MN BH 7 - 01	20 - 40	Water		229	8.0	89	3.1	475.3	27	3.37	0.96	10
MN BH 7 - 02	40 - 90	Porewater	S-silt									
MN BH 7 - 03	90 - 220	Porewater	O-silt	524	4.6	251	2.4	1055	73	2.11	1.54	< 1
MN BH 7 - 05	246 - 377	Porewater	O-clay	288	37.6	271	6.2	658.8	46	3.98	0.96	8.3
MN BH 7 - 06	377 - 480	Porewater	O-silt	233	16.7	97	3.6	457.0	42	12.9	1.22	< 1
MN BH 7 - 07	480 - 600	Porewater	O-silt	152	28.7	133	191	213.1	34	5.10	0.52	48

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 8 - 01	25 - 75	Porewater	S-clay									
MN BH 8 - 02A	75 - 330	Porewater	S-clay	198	31.8	210	5.5	421.4	36	7.21	0.82	446
MN BH 8 - 02	75 - 330A	Porewater	O-clay									
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt	577	41.3	252	10.1	1143	53	2.63	1.63	73
MN BH 8 - 05	75 - 330C	Porewater		363	31.4	94	12.9	703.1	51	3.99	1.34	4
MN BH 8 - 06	75 - 330D			145	58.4	135	4.5	348.0	32	1.10	0.95	57
MN BH 9 - 01	20 - 60	Water		223	< 0.1	< 10	0.3	476.6	27	3.39	0.95	< 1
MN BH 9 - 02	60 - 150	Porewater	S-clay	331	24.1	110	2.2	822.5	44	5.29	1.23	< 1
MN BH 9 - 03	150 - 240	Porewater	S-silt	213	123	43	9.2	633.1	55	19.3	1.61	6
MN BH 9 - 04												
MN BH 10 - 01	24 - 130	Water		224	7.1	83	11.8	472.8	35	3.31	0.94	6
MN BH 10 - 02	140 - 165	Porewater										
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	430	5.3	41	3.7	919.3	65	2.82	1.38	11
MN BH 10 - 04				412				888.2		5.06	1.24	
MNBH 10 - 06				241				550.5		27.7	1.13	
MN BH 11 - 01	24 - 140	Water		213	9.3	12	16.9	444.3	28	2.88	0.88	16
MN BH 11 - 02	140 - 362	Porewater	S-clay	437	22.8	238	16.0	965.5	71	2.58	1.05	14
MN BH 11 - 03	362 - 450	Porewater	O-clay	317	7.1	178	0.9	823.6	50	3.95	0.99	10
MN BH 11 - 05	480 - 570	Porewater	O-clay	7.3	2.2	98	3.2	18.7	6	2.76	0.08	55
MN BH 12 - 01	25 - 168	Water		212	5.1	121	1.4	452.3	7	2.90	0.89	55
MN BH 12 - 02	168 - 407	Porewater	O-clay	363	3.9	205	2.4	856.4	41	2.72	1.20	90
MN BH 12 - 04	417 - 920	Porewater	O-clay	275	23.0	86	0.6	831.3	27	4.19	1.24	43

Table C-3 - Tailings Porewater Chemistry

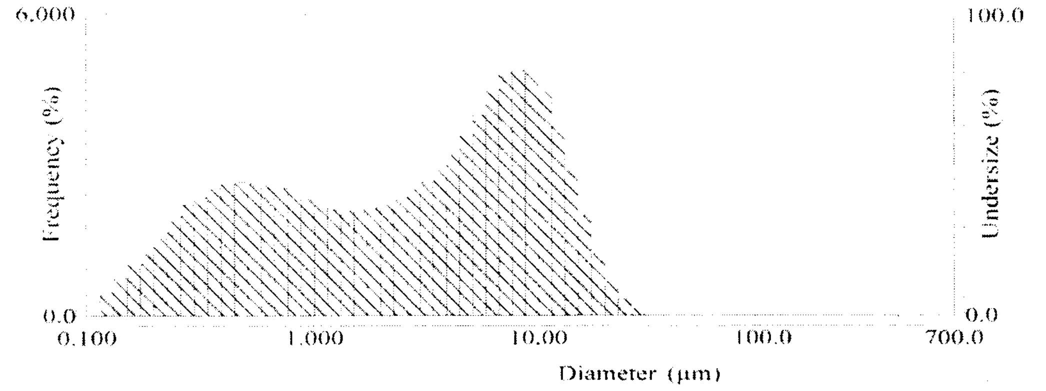
Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 13 - 01	25 - 110	Water		220	7.6	100	0.4	465.8	6	3.04	0.93	3
MN BH 13 - 02	110 -257	Porewater	S-clay									
MN BH 13 - 03	257 - 356	Porewater	S-clay									
MN BH 13 - 04	356 - 470	Porewater	O-clay									
MN BH 13 - 05	470 - 700	Porewater	O-clay	275	31.0	80	19.0	854.0	48	3.48	1.20	46
MN BH 14 - 04	270 - 455	Porewater	O-silt	402	8.0	233	0.9	792.8	32	12.5	1.33	< 1
MN BH 14 - 05	455 - 578	Porewater	O-silt									
MN BH 15 - 01	10 - 25 cm	Water	S-clay	238	6.5	78	0.5	481.8	3	3.59	0.96	3
MN BH 15 - 02	25 - 210	Porewater	O-silt	250	5.8	188	2.3	660.9	34	4.89	1.35	13
MN BH 15 - 03	210 - 460	Porewater	O-silt	403	<0.1	109	3.6	852.0	57	15.4	1.24	19
MN BH 15 - 04	460 - 510	Porewater	O-silt	559	3.2	225	3.1	1047	49	1.65	1.28	18
MN BH 15 - 06	580 - 750	Porewater	O-clay	245	23.8	139	1.6	777.1	22	4.27	1.11	1
MN BH 15 - 07	750 - 910	Porewater	O-clay	229	15.3	120	0.4	820.7	85	8.34	1.34	1
MN BH 16 - 01	13 - 150	Water	S-clay	216	2.8	201	0.4	446.4	15	2.80	0.91	81
MN BH 16 - 02	150 - 358	Porewater	O-silt	490	33.8	132	9.9	966.4	44	3.35	0.95	34
MN BH 16 - 04	386 - 498	Porewater	O-clay	427	34.4	127	44.5	711.5	166	7.77	0.73	161
MN BH 17 - 04	184 - 260	Porewater	O- Silt	256	14.9	101	27.7	780.3	210	5.39	1.27	181
MN BH 18 -00	20 - 140	Porewater										
MN BH 18 -01	140 - 250	Porewater	S-clay	223	17.5	95	28.0	728.4	169	1.92	1.32	146
MN BH 18 -02	250 - 331	Porewater	S-clay									
MN BH 18 -03	331 - 485	Porewater	O-clay									
MN BH 18 -04	485 - 610	Porewater	O-clay	267	157	86	28.0	666.2	142	4.92	0.86	180

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 18 -05	610 - 660	Porewater	O-clay	246	147	173	8.1	696.5	188	8.53	1.25	331
MN BH 18 -06	660 - 800	Porewater	O-silt	69.7	36.9	207	30.8	185.4	11	1.86	0.46	60
MN BH 19 - 01	0 - 25	Porewater	S-silt	442	33.5	122	14.4	854.4	823	2.24	1.75	5774
MN BH 19 - 02	25 - 103	Porewater	S-silt									
MN BH 19 - 03	103 - 140	Porewater	O-silt	170	2.4	213	2.6	475.9	16	1.48	1.14	34
MN BH 19 - 04	140 - 207	Porewater	S-silt	288	23.0	112	8.8	809.8	167	3.33	1.59	304
MN BH 19 - 05	207 - 251	Porewater										
MN BH 19 - 06	251 - 356	Porewater	S-silt									
MN BH 19 - 07	356 - 389	Porewater										
MN BH 19 - 08	389 - 428	Porewater	S-silt	305	47.5	208	37.3	824.2	226	5.45	1.67	351
MN Seepage Water		Water		233	29.0	72	5.1	429.3	4	3.50	0.85	644
MN Pit (Bottom)				17.4	< 0.1	144	0.3	862.7	1	3.04	1.97	550
MN Pit (Top)				7.7	1.0	123	1.1	74.0	14	6.32	0.52	219
BLANK 17				4.8	< 0.1	< 10	4.0	0.1	6	0.833	< 0.03	4
BLANK 18				<0.25	4.2	130	12.8	<0.1	18	0.266	< 0.03	< 1
BLANK 19				<0.25	< 0.1	115	1.2	0.1	4	0.135	< 0.03	< 1

Appendix C-4: Tailings Particle Size Analysis: (8 selected samples)

MNBH 1102 (wet)
Feb 25, 2002



S.P. Area : 64080(cm²/cm³)
Median : 3.100(µm)

Diameter on % :5.000 (%) = 0.227(µm)
:10.00 (%) = 0.314(µm)
:20.00 (%) = 0.534(µm)
:30.00 (%) = 0.913(µm)
:40.00 (%) = 1.722(µm)
:60.00 (%) = 4.838(µm)
:70.00 (%) = 6.725(µm)
:80.00 (%) = 8.880(µm)
:90.00 (%) = 11.976(µm)
:95.00 (%) = 14.698(µm)

% on Diameter :850.0 (µm) = 100.000(%)
:600.0 (µm) = 100.000(%)
:425.0 (µm) = 100.000(%)
:300.0 (µm) = 100.000(%)
:212.0 (µm) = 100.000(%)
:150.0 (µm) = 100.000(%)
:106.0 (µm) = 100.000(%)
:75.00 (µm) = 100.000(%)
:53.00 (µm) = 100.0
:38.00 (µm) = 100.0

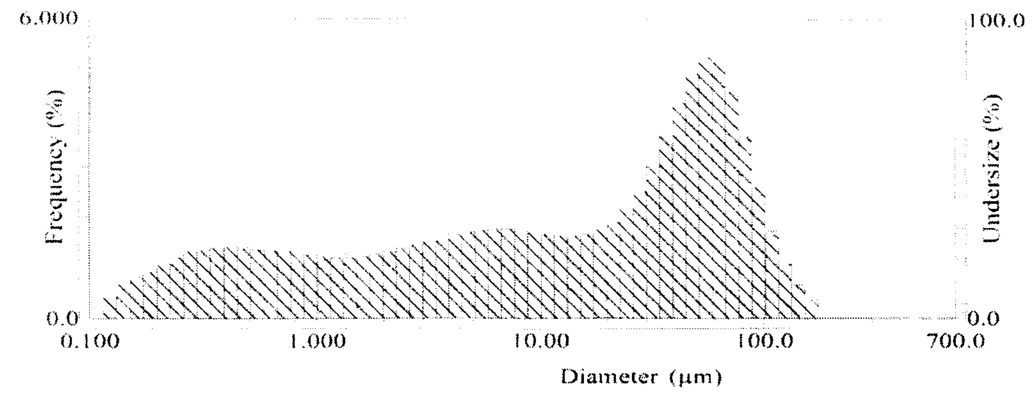
Mean : 4.841(µm)
Variance : 24.682
S.D. : 4.968(µm)
Mode : 8.235(µm)
Span : 3.762

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.071	37.980	39	19.904	1.215	98.870	58	262.376	0.000	100.000
2	0.131	0.461	0.461	21	1.729	2.087	40.067	40	22.797	0.663	99.533	59	300.518	0.000	100.000
3	0.150	0.746	1.207	22	1.981	2.138	42.205	41	26.111	0.324	99.857	60	344.206	0.000	100.000
4	0.172	0.996	2.203	23	2.269	2.192	44.398	42	29.907	0.143	100.000	61	394.244	0.000	100.000
5	0.197	1.205	3.409	24	2.599	2.322	46.719	43	34.255	0.000	100.000	62	451.556	0.000	100.000
6	0.226	1.507	4.915	25	2.976	2.487	49.206	44	39.234	0.000	100.000	63	517.200	0.000	100.000
7	0.259	1.856	6.771	26	3.409	2.643	51.849	45	44.938	0.000	100.000	64	592.387	0.000	100.000
8	0.296	2.199	8.970	27	3.905	2.878	54.727	46	51.471	0.000	100.000				
9	0.339	2.352	11.321	28	4.472	3.199	57.926	47	58.953	0.000	100.000				
10	0.389	2.524	13.845	29	5.122	3.580	61.505	48	67.523	0.000	100.000				
11	0.445	2.619	16.464	30	5.867	4.005	65.510	49	77.339	0.000	100.000				
12	0.510	2.646	19.110	31	6.720	4.460	69.970	50	88.583	0.000	100.000				
13	0.584	2.623	21.733	32	7.697	4.859	74.829	51	101.460	0.000	100.000				
14	0.669	2.583	24.316	33	8.816	4.909	79.738	52	116.210	0.000	100.000				
15	0.766	2.528	26.844	34	10.097	4.842	84.581	53	133.103	0.000	100.000				
16	0.877	2.473	29.317	35	11.565	4.452	89.033	54	152.453	0.000	100.000				
17	1.005	2.309	31.626	36	13.246	3.760	92.793	55	174.616	0.000	100.000				
18	1.151	2.183	33.809	37	15.172	2.881	95.674	56	200.000	0.000	100.000				
19	1.318	2.100	35.909	38	17.377	1.981	97.656	57	229.075	0.000	100.000				

Filename :
ID# :200202251413761
Circulation Speed :12
Ultra sonic :01:29
Laser T% : 78.2(%)

Form of Distribution :Standard
Calc. Level :30
R.R.Index :1.16-0.10i
Axis Selection :LogX-LinY

MNBH 1401 (wet)
Feb 25, 2002

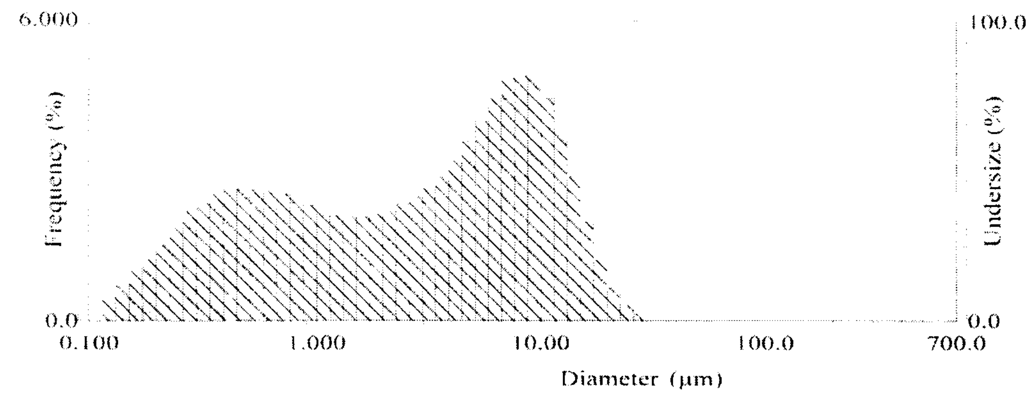


S.P. Area	: 40656(cm²/cm³)		:90.00 (%) = 77.657(μm)			:53.00 (μm) = 76.09
Median	: 16.406(μm)		:95.00 (%) = 95.680(μm)			:38.00 (μm) = 64.88
Diameter on %	:5.000 (%) = 0.255(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 30.200(μm)	
	:10.00 (%) = 0.420(μm)		:600.0 (μm) = 100.000(%)	Variance	: 1115.943	
	:20.00 (%) = 1.177(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 33.406(μm)	
	:30.00 (%) = 3.293(μm)		:300.0 (μm) = 100.000(%)	Mode	: 55.248(μm)	
	:40.00 (%) = 7.319(μm)		:212.0 (μm) = 100.000(%)	Span	: 4.708	
	:60.00 (%) = 31.176(μm)		:150.0 (μm) = 99.550(%)			
	:70.00 (%) = 44.870(μm)		:106.0 (μm) = 96.692(%)			
	:80.00 (%) = 58.644(μm)		:75.00 (μm) = 88.861(%)			

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.207	22.209	39	19.904	1.755	52.462	58	262.376	0.000	100.000
2	0.131	0.444	0.444	21	1.729	1.234	23.443	40	22.797	1.914	54.376	59	300.518	0.000	100.000
3	0.150	0.677	1.121	22	1.981	1.273	24.717	41	26.111	2.166	56.542	60	344.206	0.000	100.000
4	0.172	0.822	1.943	23	2.269	1.315	26.032	42	29.907	2.531	59.074	61	394.244	0.000	100.000
5	0.197	0.910	2.853	24	2.599	1.382	27.414	43	34.255	3.025	62.099	62	451.556	0.000	100.000
6	0.226	1.052	3.905	25	2.976	1.453	28.867	44	39.234	3.638	65.737	63	517.200	0.000	100.000
7	0.259	1.202	5.107	26	3.409	1.522	30.388	45	44.938	4.311	70.048	64	592.387	0.000	100.000
8	0.296	1.330	6.437	27	3.905	1.585	31.973	46	51.471	4.910	74.958				
9	0.339	1.358	7.795	28	4.472	1.656	33.629	47	58.953	5.245	80.203				
10	0.389	1.395	9.189	29	5.122	1.716	35.345	48	67.523	5.138	85.341				
11	0.445	1.402	10.591	30	5.867	1.757	37.101	49	77.339	4.549	89.891				
12	0.510	1.387	11.978	31	6.720	1.781	38.882	50	88.583	3.624	93.515				
13	0.584	1.362	13.341	32	7.697	1.777	40.659	51	101.460	2.616	96.130				
14	0.669	1.341	14.682	33	8.816	1.733	42.392	52	116.210	1.740	97.870				
15	0.766	1.324	16.006	34	10.097	1.704	44.096	53	133.103	1.093	98.964				
16	0.877	1.314	17.320	35	11.565	1.668	45.764	54	152.453	0.666	99.630				
17	1.005	1.261	18.581	36	13.246	1.640	47.404	55	174.616	0.370	100.000				
18	1.151	1.221	19.802	37	15.172	1.635	49.039	56	200.000	0.000	100.000				
19	1.318	1.200	21.002	38	17.377	1.668	50.707	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251426762	Calc. Level	:30
Circulation Speed	:14	R.R.Index	:1.16-0.10i
Ultra sonic	:01:41	Axis Selection	:LogX-LinY
Laser T%	: 79.0(%)		

MNBH 1102 (wet)
Feb 25, 2002

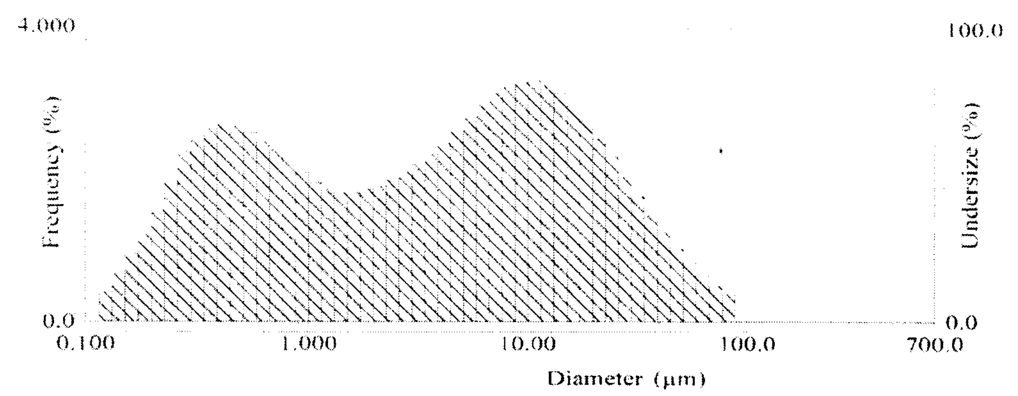


S.P. Area	: 64080(cm² /cm³)		:90.00 (%) = 11.976(μm)			:53.00 (μm) = 100.0
Median	: 3.100(μm)		:95.00 (%) = 14.698(μm)			:38.00 (μm) = 100.0
Diameter on %	:5.000 (%) = 0.227(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 4.841(μm)	
	:10.00 (%) = 0.314(μm)		:600.0 (μm) = 100.000(%)	Variance	: 24.682	
	:20.00 (%) = 0.534(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 4.968(μm)	
	:30.00 (%) = 0.913(μm)		:300.0 (μm) = 100.000(%)	Mode	: 8.235(μm)	
	:40.00 (%) = 1.722(μm)		:212.0 (μm) = 100.000(%)	Span	: 3.762	
	:60.00 (%) = 4.838(μm)		:150.0 (μm) = 100.000(%)			
	:70.00 (%) = 6.725(μm)		:106.0 (μm) = 100.000(%)			
	:80.00 (%) = 8.880(μm)		:75.00 (μm) = 100.000(%)			

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.071	37.980	39	19.904	1.215	98.870	58	262.376	0.000	100.000
2	0.131	0.461	0.461	21	1.729	2.087	40.067	40	22.797	0.663	99.533	59	300.518	0.000	100.000
3	0.150	0.746	1.207	22	1.981	2.138	42.205	41	26.111	0.324	99.857	60	344.206	0.000	100.000
4	0.172	0.996	2.203	23	2.269	2.192	44.398	42	29.907	0.143	100.000	61	394.244	0.000	100.000
5	0.197	1.205	3.409	24	2.599	2.322	46.719	43	34.255	0.000	100.000	62	451.556	0.000	100.000
6	0.226	1.507	4.915	25	2.976	2.487	49.206	44	39.234	0.000	100.000	63	517.200	0.000	100.000
7	0.259	1.856	6.771	26	3.409	2.643	51.849	45	44.938	0.000	100.000	64	592.387	0.000	100.000
8	0.296	2.199	8.970	27	3.905	2.878	54.727	46	51.471	0.000	100.000				
9	0.339	2.352	11.321	28	4.472	3.199	57.926	47	58.953	0.000	100.000				
10	0.389	2.524	13.845	29	5.122	3.580	61.505	48	67.523	0.000	100.000				
11	0.445	2.619	16.464	30	5.867	4.005	65.510	49	77.339	0.000	100.000				
12	0.510	2.646	19.110	31	6.720	4.460	69.970	50	88.583	0.000	100.000				
13	0.584	2.623	21.733	32	7.697	4.859	74.829	51	101.460	0.000	100.000				
14	0.669	2.583	24.316	33	8.816	4.909	79.738	52	116.210	0.000	100.000				
15	0.766	2.528	26.844	34	10.097	4.842	84.581	53	133.103	0.000	100.000				
16	0.877	2.473	29.317	35	11.565	4.452	89.033	54	152.453	0.000	100.000				
17	1.005	2.309	31.626	36	13.246	3.760	92.793	55	174.616	0.000	100.000				
18	1.151	2.183	33.809	37	15.172	2.881	95.674	56	200.000	0.000	100.000				
19	1.318	2.100	35.909	38	17.377	1.981	97.656	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251413761	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:29	Axis Selection	:LogX-LinY
Laser T%	: 78.2(%)		

Batch O (wet)
Feb 25, 2002

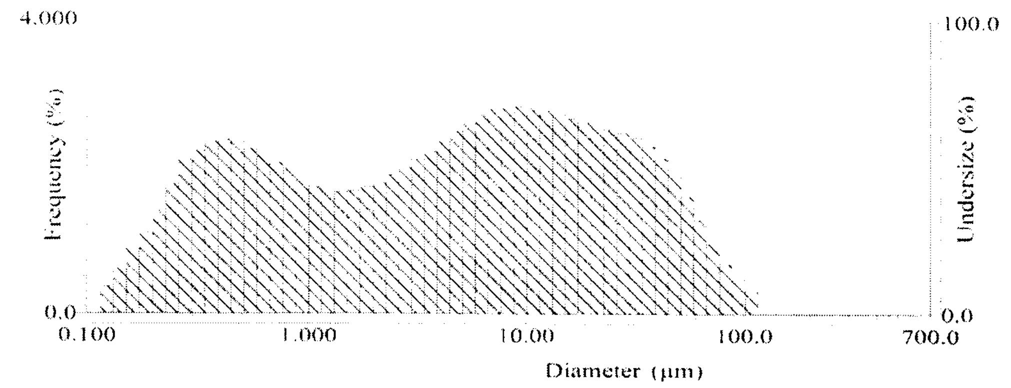


S.P. Area	: 61123(cm²/cm³)		:90.00 (%) = 25.521(μm)		:53.00 (μm) = 97.88
Median	: 3.898(μm)		:95.00 (%) = 37.415(μm)		:38.00 (μm) = 95.16
Diameter on %	:5.000 (%) = 0.232(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 9.296(μm)
	:10.00 (%) = 0.316(μm)		:600.0 (μm) = 100.000(%)	Variance	: 178.331
	:20.00 (%) = 0.531(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 13.354(μm)
	:30.00 (%) = 0.951(μm)		:300.0 (μm) = 100.000(%)	Mode	: 10.796(μm)
	:40.00 (%) = 2.007(μm)		:212.0 (μm) = 100.000(%)	Span	: 6.467
	:60.00 (%) = 6.483(μm)		:150.0 (μm) = 100.000(%)		
	:70.00 (%) = 9.952(μm)		:106.0 (μm) = 100.000(%)		
	:80.00 (%) = 15.195(μm)		:75.00 (μm) = 99.516(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.758	36.270	39	19.904	2.734	85.645	58	262.376	0.000	100.000
2	0.131	0.388	0.388	21	1.729	1.760	38.030	40	22.797	2.494	88.140	59	300.518	0.000	100.000
3	0.150	0.646	1.033	22	1.981	1.793	39.823	41	26.111	2.237	90.376	60	344.206	0.000	100.000
4	0.172	0.917	1.951	23	2.269	1.835	41.658	42	29.907	1.972	92.348	61	394.244	0.000	100.000
5	0.197	1.167	3.118	24	2.599	1.927	43.585	43	34.255	1.708	94.056	62	451.556	0.000	100.000
6	0.226	1.500	4.618	25	2.976	2.035	45.620	44	39.234	1.453	95.508	63	517.200	0.000	100.000
7	0.259	1.901	6.519	26	3.409	2.142	47.762	45	44.938	1.212	96.721	64	592.387	0.000	100.000
8	0.296	2.298	8.817	27	3.905	2.267	50.029	46	51.471	0.993	97.713				
9	0.339	2.453	11.270	28	4.472	2.428	52.457	47	58.953	0.797	98.510				
10	0.389	2.624	13.893	29	5.122	2.599	55.055	48	67.523	0.628	99.139				
11	0.445	2.688	16.581	30	5.867	2.772	57.827	49	77.339	0.488	99.626				
12	0.510	2.659	19.240	31	6.720	2.952	60.779	50	88.583	0.374	100.000				
13	0.584	2.565	21.805	32	7.697	3.105	63.884	51	101.460	0.000	100.000				
14	0.669	2.451	24.257	33	8.816	3.194	67.078	52	116.210	0.000	100.000				
15	0.766	2.329	26.586	34	10.097	3.270	70.348	53	133.103	0.000	100.000				
16	0.877	2.218	28.803	35	11.565	3.281	73.630	54	152.453	0.000	100.000				
17	1.005	2.026	30.829	36	13.246	3.226	76.856	55	174.616	0.000	100.000				
18	1.151	1.886	32.715	37	15.172	3.111	79.967	56	200.000	0.000	100.000				
19	1.318	1.796	34.511	38	17.377	2.944	82.911	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:20020225144276З	Caic. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:29	Axis Selection	:LogX-LinY
Laser T%	: 75.2(%)		

Batch S (wet)
Feb 25, 2002

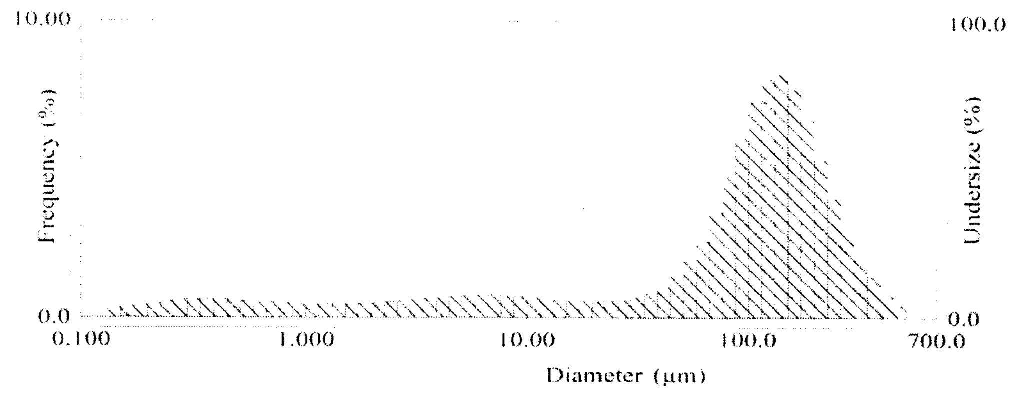


S.P. Area	: 56066(cm² /cm³)		:90.00 (%) = 37.766(μm)				:53.00 (μm) = 95.01
Median	: 4.834(μm)		:95.00 (%) = 52.930(μm)				:38.00 (μm) = 90.10
Diameter on %	:5.000 (%) = 0.238(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 12.732(μm)		
	:10.00 (%) = 0.331(μm)		:600.0 (μm) = 100.000(%)	Variance	: 335.877		
	:20.00 (%) = 0.593(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 18.327(μm)		
	:30.00 (%) = 1.199(μm)		:300.0 (μm) = 100.000(%)	Mode	: 9.436(μm)		
	:40.00 (%) = 2.617(μm)		:212.0 (μm) = 100.000(%)	Span	: 7.744		
	:60.00 (%) = 8.011(μm)		:150.0 (μm) = 100.000(%)				
	:70.00 (%) = 12.989(μm)		:106.0 (μm) = 99.791(%)				
	:80.00 (%) = 21.665(μm)		:75.00 (μm) = 98.314(%)				

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.657	32.824	39	19.904	2.611	78.399	58	262.376	0.000	100.000
2	0.131	0.363	0.363	21	1.729	1.678	34.502	40	22.797	2.563	80.962	59	300.518	0.000	100.000
3	0.150	0.608	0.971	22	1.981	1.727	36.230	41	26.111	2.519	83.481	60	344.206	0.000	100.000
4	0.172	0.869	1.840	23	2.269	1.785	38.014	42	29.907	2.470	85.951	61	394.244	0.000	100.000
5	0.197	1.101	2.941	24	2.599	1.884	39.899	43	34.255	2.401	88.352	62	451.556	0.000	100.000
6	0.226	1.398	4.339	25	2.976	1.995	41.894	44	39.234	2.292	90.644	63	517.200	0.000	100.000
7	0.259	1.757	6.096	26	3.409	2.107	44.001	45	44.938	2.127	92.772	64	592.387	0.000	100.000
8	0.296	2.102	8.198	27	3.905	2.219	46.220	46	51.471	1.897	94.669				
9	0.339	2.218	10.416	28	4.472	2.355	48.575	47	58.953	1.608	96.277				
10	0.389	2.349	12.765	29	5.122	2.486	51.061	48	67.523	1.287	97.564				
11	0.445	2.384	15.149	30	5.867	2.605	53.666	49	77.339	0.969	98.533				
12	0.510	2.344	17.493	31	6.720	2.715	56.381	50	88.583	0.689	99.223				
13	0.584	2.254	19.748	32	7.697	2.790	59.171	51	101.460	0.469	99.691				
14	0.669	2.157	21.905	33	8.816	2.810	61.980	52	116.210	0.309	100.000				
15	0.766	2.059	23.964	34	10.097	2.830	64.811	53	133.103	0.000	100.000				
16	0.877	1.978	25.942	35	11.565	2.816	67.626	54	152.453	0.000	100.000				
17	1.005	1.829	27.771	36	13.246	2.775	70.401	55	174.616	0.000	100.000				
18	1.151	1.727	29.498	37	15.172	2.722	73.123	56	200.000	0.000	100.000				
19	1.318	1.669	31.167	38	17.377	2.665	75.788	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251402760	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:40	Axis Selection	:LogX-LinY
Laser T%	: 73.4(%)		

OMIX (wet)
Feb 25, 2002

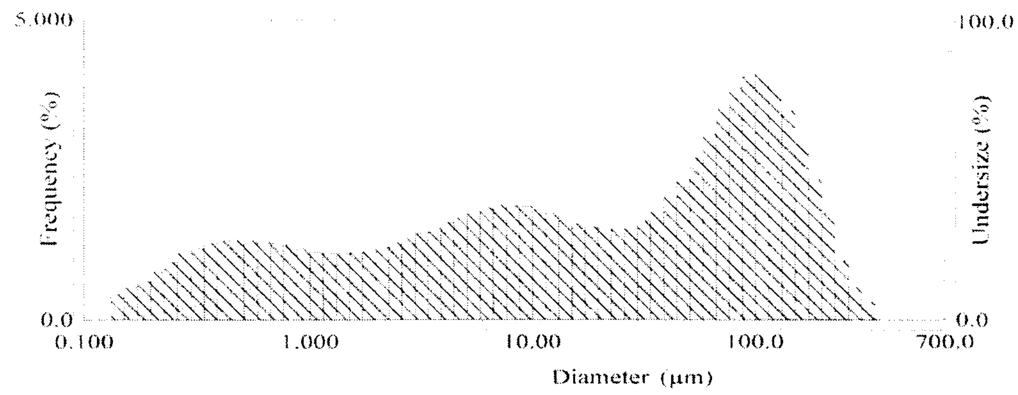


S.P. Area	: 16846(cm²/cm³)		:90.00 (%) = 241.022(µm)		:53.00 (µm) = 26.80
Median	: 110.915(µm)		:95.00 (%) = 295.057(µm)		:38.00 (µm) = 23.78
Diameter on %	:5.000 (%) = 0.490(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 118.796(µm)
	:10.00 (%) = 1.992(µm)		:600.0 (µm) = 100.000(%)	Variance	: 8819.891
	:20.00 (%) = 16.199(µm)		:425.0 (µm) = 99.225(%)	S.D.	: 93.914(µm)
	:30.00 (%) = 64.549(µm)		:300.0 (µm) = 95.353(%)	Mode	: 142.039(µm)
	:40.00 (%) = 90.262(µm)		:212.0 (µm) = 85.461(%)	Span	: 2.155
	:60.00 (%) = 131.840(µm)		:150.0 (µm) = 67.819(%)		
	:70.00 (%) = 155.696(µm)		:106.0 (µm) = 47.572(%)		
	:80.00 (%) = 187.454(µm)		:75.00 (µm) = 33.607(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	0.438	9.061	39	19.904	0.531	20.817	58	262.376	4.007	92.506
2	0.131	0.000	0.000	21	1.729	0.450	9.510	40	22.797	0.527	21.345	59	300.518	2.884	95.390
3	0.150	0.322	0.322	22	1.981	0.469	9.979	41	26.111	0.545	21.890	60	344.206	2.017	97.406
4	0.172	0.379	0.701	23	2.269	0.490	10.469	42	29.907	0.592	22.481	61	394.244	1.391	98.798
5	0.197	0.422	1.123	24	2.599	0.522	10.991	43	34.255	0.678	23.159	62	451.556	0.773	99.571
6	0.226	0.483	1.606	25	2.976	0.557	11.549	44	39.234	0.819	23.978	63	517.200	0.429	100.000
7	0.259	0.544	2.150	26	3.409	0.593	12.142	45	44.938	1.040	25.018	64	592.387	0.000	100.000
8	0.296	0.597	2.747	27	3.905	0.631	12.773	46	51.471	1.377	26.395				
9	0.339	0.605	3.352	28	4.472	0.672	13.445	47	58.953	1.876	28.271				
10	0.389	0.615	3.967	29	5.122	0.710	14.155	48	67.523	2.588	30.859				
11	0.445	0.610	4.577	30	5.867	0.740	14.895	49	77.339	3.552	34.411				
12	0.510	0.592	5.170	31	6.720	0.759	15.654	50	88.583	4.749	39.160				
13	0.584	0.566	5.736	32	7.697	0.762	16.416	51	101.460	6.067	45.227				
14	0.669	0.539	6.275	33	8.816	0.732	17.148	52	116.210	7.271	52.498				
15	0.766	0.513	6.788	34	10.097	0.705	17.853	53	133.103	8.069	60.567				
16	0.877	0.491	7.280	35	11.565	0.668	18.521	54	152.453	8.236	68.803				
17	1.005	0.463	7.743	36	13.246	0.626	19.148	55	174.616	7.719	76.522				
18	1.151	0.444	8.187	37	15.172	0.586	19.733	56	200.000	6.654	83.176				
19	1.318	0.435	8.623	38	17.377	0.552	20.286	57	229.075	5.323	88.499				

Filename	:	Form of Distribution	:Standard
ID#	:200202251516768	Calc. Level	:30
Circulation Speed	:14	R.R.Index	:1.16-0.10i
Ultra sonic	:02:34	Axis Selection	:LogX-LinY
Laser T%	: 76.1(%)		

SMIX (wet)
Feb 25, 2002

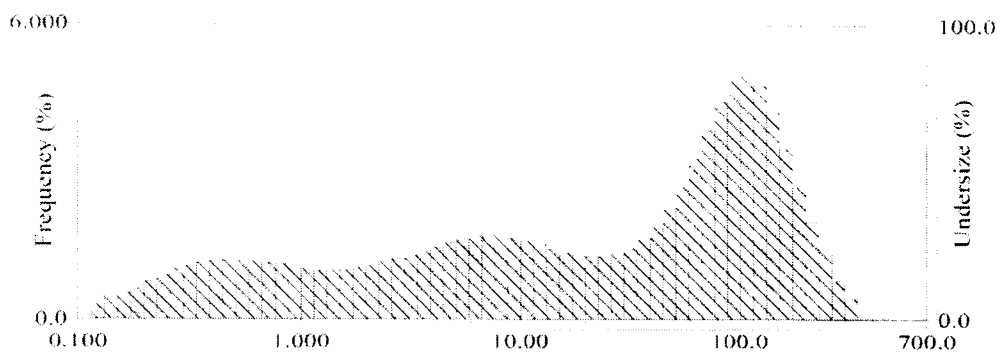


S.P. Area	: 32318(cm²/cm³)		:90.00 (%) = 146.294(μm)		:53.00 (μm) = 62.71
Median	: 20.560(μm)		:95.00 (%) = 184.842(μm)		:38.00 (μm) = 57.30
Diameter on %	:5.000 (%) = 0.315(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 52.218(μm)
	:10.00 (%) = 0.532(μm)		:600.0 (μm) = 100.000(%)	Variance	: 4062.040
	:20.00 (%) = 1.656(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 63.734(μm)
	:30.00 (%) = 4.478(μm)		:300.0 (μm) = 99.687(%)	Mode	: 108.247(μm)
	:40.00 (%) = 9.303(μm)		:212.0 (μm) = 97.131(%)	Span	: 7.090
	:60.00 (%) = 45.503(μm)		:150.0 (μm) = 90.646(%)		
	:70.00 (%) = 72.992(μm)		:106.0 (μm) = 80.841(%)		
	:80.00 (%) = 103.110(μm)		:75.00 (μm) = 70.707(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.101	19.234	39	19.904	1.556	49.636	58	262.376	0.992	99.143
2	0.131	0.000	0.000	21	1.729	1.127	20.361	40	22.797	1.521	51.157	59	300.518	0.551	99.694
3	0.150	0.427	0.427	22	1.981	1.168	21.529	41	26.111	1.522	52.679	60	344.206	0.306	100.000
4	0.172	0.540	0.967	23	2.269	1.213	22.742	42	29.907	1.567	54.247	61	394.244	0.000	100.000
5	0.197	0.638	1.605	24	2.599	1.286	24.028	43	34.255	1.664	55.911	62	451.556	0.000	100.000
6	0.226	0.789	2.394	25	2.976	1.364	25.392	44	39.234	1.823	57.734	63	517.200	0.000	100.000
7	0.259	0.954	3.348	26	3.409	1.442	26.833	45	44.938	2.050	59.784	64	592.387	0.000	100.000
8	0.296	1.116	4.465	27	3.905	1.525	28.358	46	51.471	2.349	62.132				
9	0.339	1.190	5.655	28	4.472	1.625	29.983	47	58.953	2.714	64.846				
10	0.389	1.273	6.928	29	5.122	1.723	31.706	48	67.523	3.124	67.970				
11	0.445	1.321	8.248	30	5.867	1.810	33.517	49	77.339	3.537	71.508				
12	0.510	1.334	9.582	31	6.720	1.886	35.402	50	88.583	3.891	75.399				
13	0.584	1.321	10.903	32	7.697	1.931	37.334	51	101.460	4.110	79.509				
14	0.669	1.301	12.204	33	8.816	1.914	39.247	52	116.210	4.130	83.639				
15	0.766	1.274	13.478	34	10.097	1.897	41.145	53	133.103	3.921	87.560				
16	0.877	1.249	14.726	35	11.565	1.848	42.993	54	152.453	3.505	91.065				
17	1.005	1.179	15.905	36	13.246	1.776	44.768	55	174.616	2.950	94.015				
18	1.151	1.128	17.033	37	15.172	1.695	46.463	56	200.000	2.349	96.364				
19	1.318	1.100	18.133	38	17.377	1.617	48.081	57	229.075	1.786	98.150				

Filename	:	Form of Distribution	:Standard
ID#	:200202251332759	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:00:45	Axis Selection	:LogX-LinY
Laser T%	: 82.4(%)		

SOMIX (wet)
Feb 25, 2002



S.P. Area	: 31579(cm² /cm³)		:90.00 (%) = 157.446(μm)		:53.00 (μm) = 56.49
Median	: 33.831(μm)		:95.00 (%) = 196.128(μm)		:38.00 (μm) = 51.37
Diameter on %	:5.000 (%) = 0.311(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 60.210(μm)
	:10.00 (%) = 0.556(μm)		:600.0 (μm) = 100.000(%)	Variance	: 4596.574
	:20.00 (%) = 1.980(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 67.798(μm)
	:30.00 (%) = 5.475(μm)		:300.0 (μm) = 99.556(%)	Mode	: 108.457(μm)
	:40.00 (%) = 12.446(μm)		:212.0 (μm) = 96.245(%)	Span	: 4.637
	:60.00 (%) = 62.405(μm)		:150.0 (μm) = 88.659(%)		
	:70.00 (%) = 87.888(μm)		:106.0 (μm) = 76.743(%)		
	:80.00 (%) = 115.794(μm)		:75.00 (μm) = 64.917(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	0.992	17.936	39	19.904	1.303	44.793	58	262.376	1.405	98.786
2	0.131	0.302	0.302	21	1.729	1.015	18.950	40	22.797	1.274	46.067	59	300.518	0.781	99.566
3	0.150	0.446	0.748	22	1.981	1.052	20.002	41	26.111	1.282	47.350	60	344.206	0.434	100.000
4	0.172	0.543	1.291	23	2.269	1.092	21.095	42	29.907	1.336	48.686	61	394.244	0.000	100.000
5	0.197	0.624	1.915	24	2.599	1.159	22.254	43	34.255	1.447	50.133	62	451.556	0.000	100.000
6	0.226	0.756	2.671	25	2.976	1.231	23.485	44	39.234	1.626	51.759	63	517.200	0.000	100.000
7	0.259	0.896	3.567	26	3.409	1.303	24.788	45	44.938	1.890	53.649	64	592.387	0.000	100.000
8	0.296	1.030	4.597	27	3.905	1.380	26.168	46	51.471	2.253	55.903				
9	0.339	1.089	5.687	28	4.472	1.471	27.639	47	58.953	2.721	58.624				
10	0.389	1.156	6.842	29	5.122	1.559	29.198	48	67.523	3.282	61.906				
11	0.445	1.193	8.036	30	5.867	1.633	30.831	49	77.339	3.891	65.797				
12	0.510	1.202	9.238	31	6.720	1.692	32.523	50	88.583	4.461	70.259				
13	0.584	1.190	10.428	32	7.697	1.721	34.244	51	101.460	4.872	75.130				
14	0.669	1.172	11.600	33	8.816	1.686	35.930	52	116.210	5.001	80.132				
15	0.766	1.147	12.747	34	10.097	1.655	37.584	53	133.103	4.785	84.917				
16	0.877	1.125	13.872	35	11.565	1.595	39.179	54	152.453	4.250	89.167				
17	1.005	1.063	14.935	36	13.246	1.517	40.696	55	174.616	3.510	92.677				
18	1.151	1.017	15.953	37	15.172	1.434	42.130	56	200.000	2.714	95.391				
19	1.318	0.991	16.944	38	17.377	1.360	43.490	57	229.075	1.989	97.380				

Filename	:	Form of Distribution	:Standard
ID#	:200202251509765	Calc. Level	:30
Circulation Speed	:13	R.R.Index	:1.16-0.10i
Ultra sonic	:01:08	Axis Selection	:LogX-LinY
Laser T%	: 82.9(%)		

APPENDIX D

Results of Mineralogical Analysis

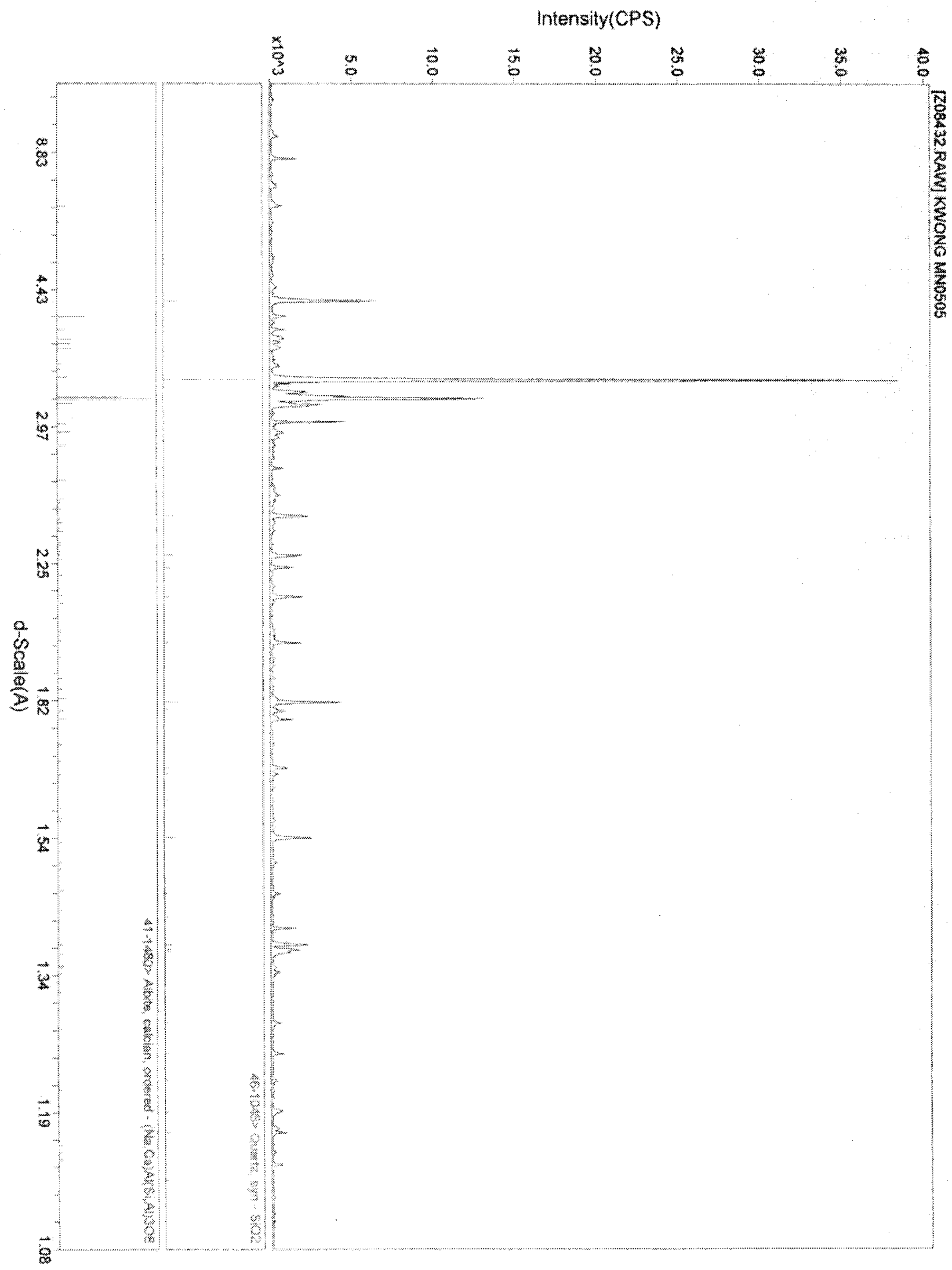
Appendix D-1: X-Ray Diffraction Analysis

This appendix contains selected X-ray diffractograms illustrating the mineralogy of the four types of tailings and native sediments identified in the tailings impoundment as well as grab samples from the Brown-McDade open pit at Mount Nansen. Only reference diffraction patterns for the major components are given below each individual diffractogram. Other minerals identified in the selected samples are tabulated below:

Table D-1. Minerals identified by X-ray diffraction in selected samples from Mount Nansen

Sample #	***Sample Type***	***Minerals Identified****
MN0505	Native sediment	Q > plag >> minor amp, Ksp > trace ms, kao
MN0607	Clayey sulfide tails	Q >> minor ms, kao, gyp, ja > trace py, fels
MN1003	Clayey sulfide tails	Q >> minor ms, gyp, kao, ja, py, Ksp
MN1202	Clayey oxide tails	Q >> minor ms, kao, gyp, ja >trace py
MN1804	Clayey oxide tails	Q >> minor ms, mont, kao, ja
MNSMIX	Silty sulfide tails	Q >> minor kao > trace ms, gyp, ja, fel, py
SOMIX	Mixed oxide-sulfide silty tails	Q >> minor gyp, ms, kao, ja > trace fels, py
WBH3	Alteration on surface tailings	Q ~ cc >> minor gyp, kao,ms, ja
PITSED	Pit sediment	Q > mont > kao > minor ms, ja, Ksp, plag
NWALBX	Pit grab, breccia	Py >> Q ~ gyp > minor ja, ms, kao

*amp=amphibole; cc=calcite; fels=feldspar, undifferentiated; gyp=gypsum; ja=jarosite; kao=kaolinite; Ksp=potassic feldspar; mont=montmorillonite; ms=muscovite/illite; plag=plagioclase; py=pyrite; Q=quartz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4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
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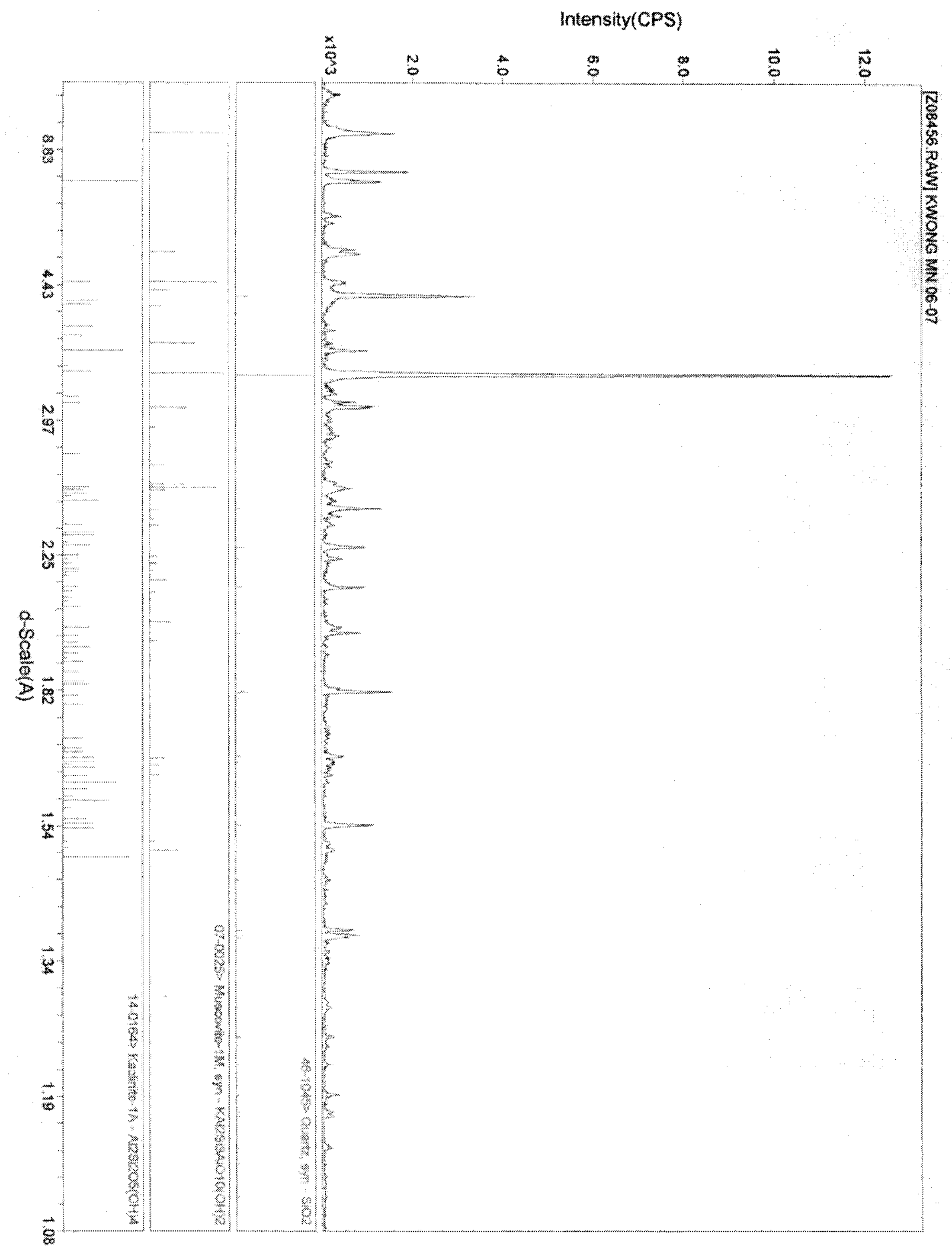
41-1480> Albite, calcian, ordered - (Na,Ca)Al(Si,Al)3O8



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14-0164> Kaolinite-1A - Al2Si2O5(OH)4
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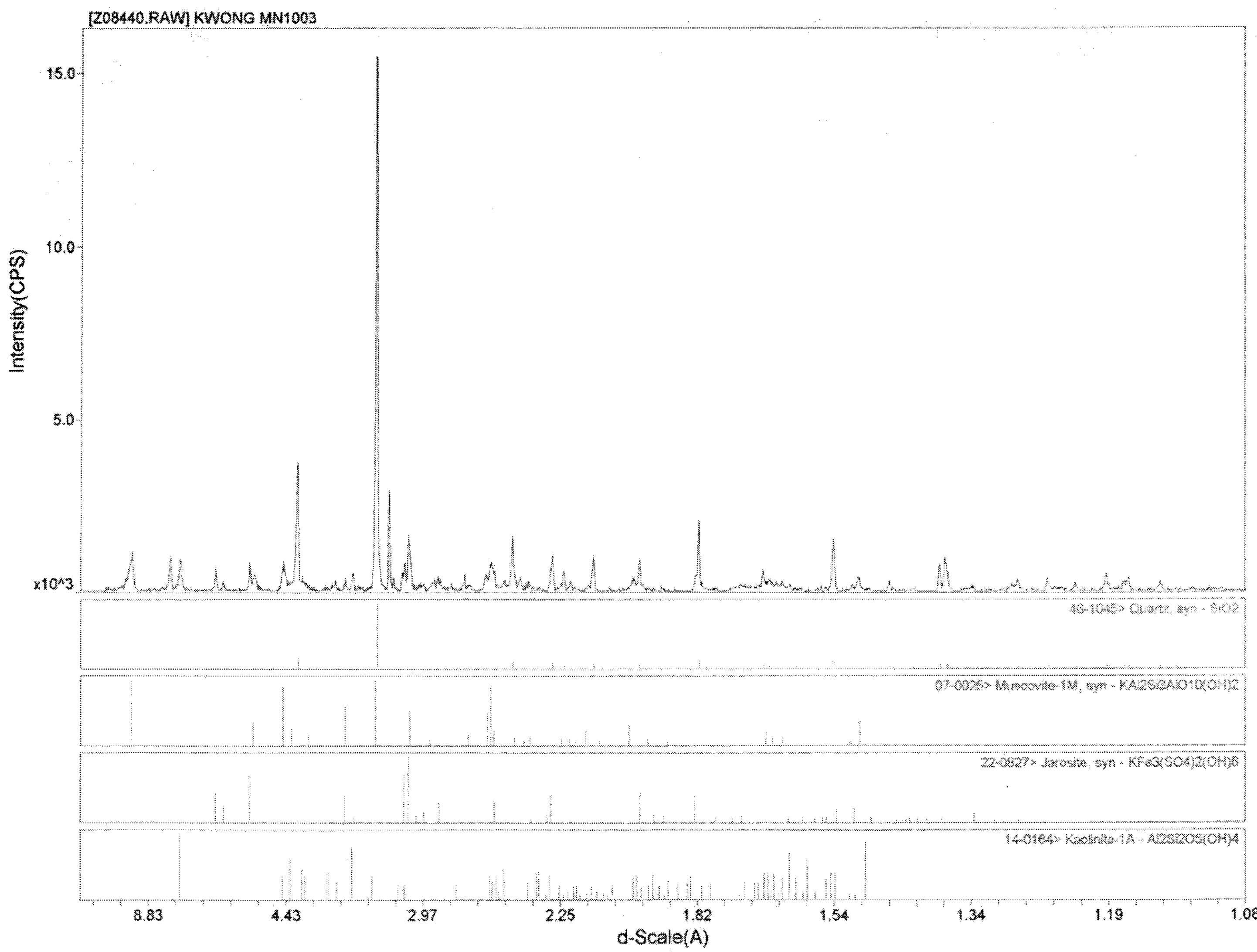
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)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22-0827> Jarosite, syn - KFe3(SO4)2(OH)6
14-0164> Kaolinite-1A - Al2Si2O5(OH)4
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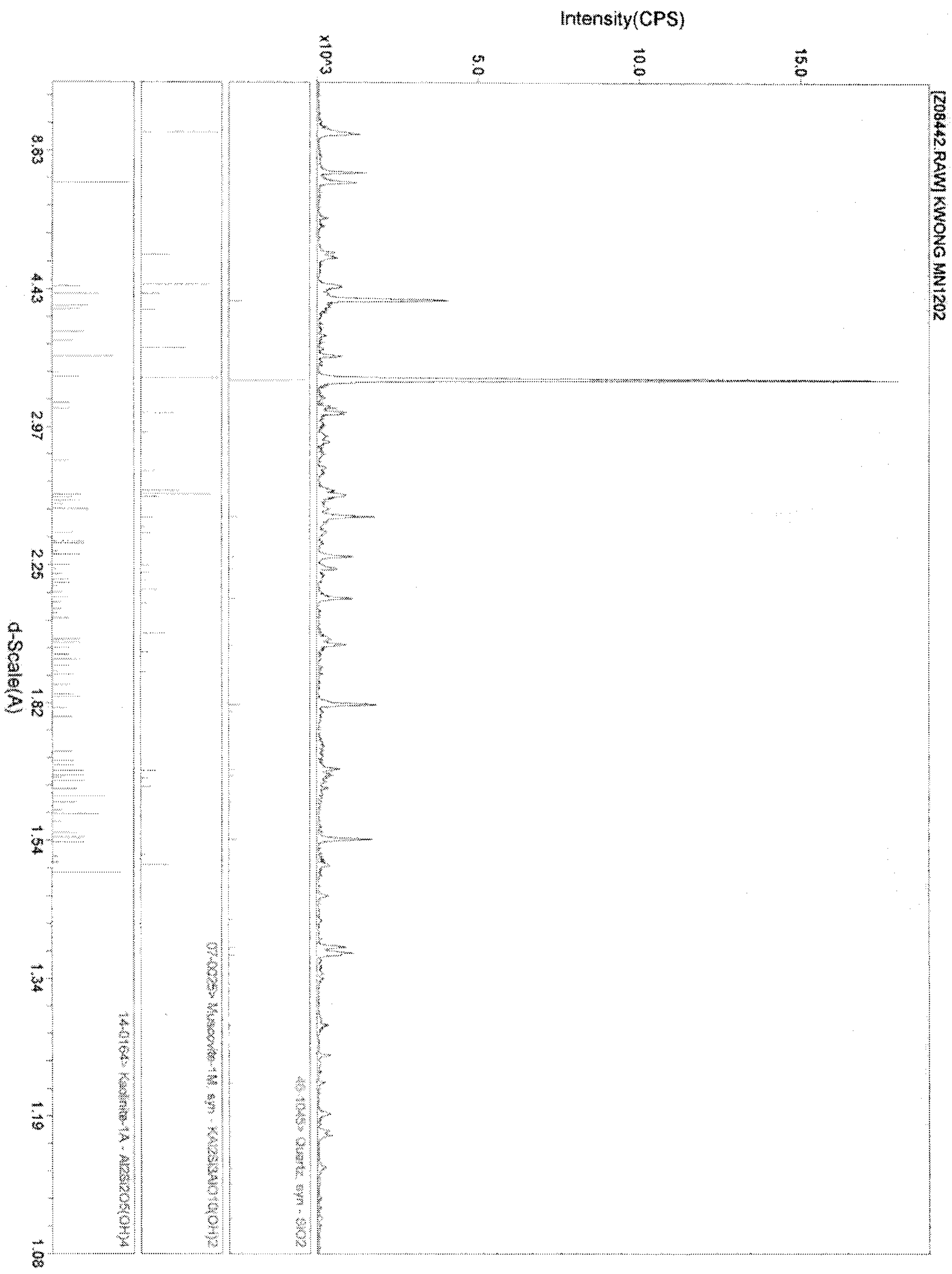
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)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d-Scale(A)
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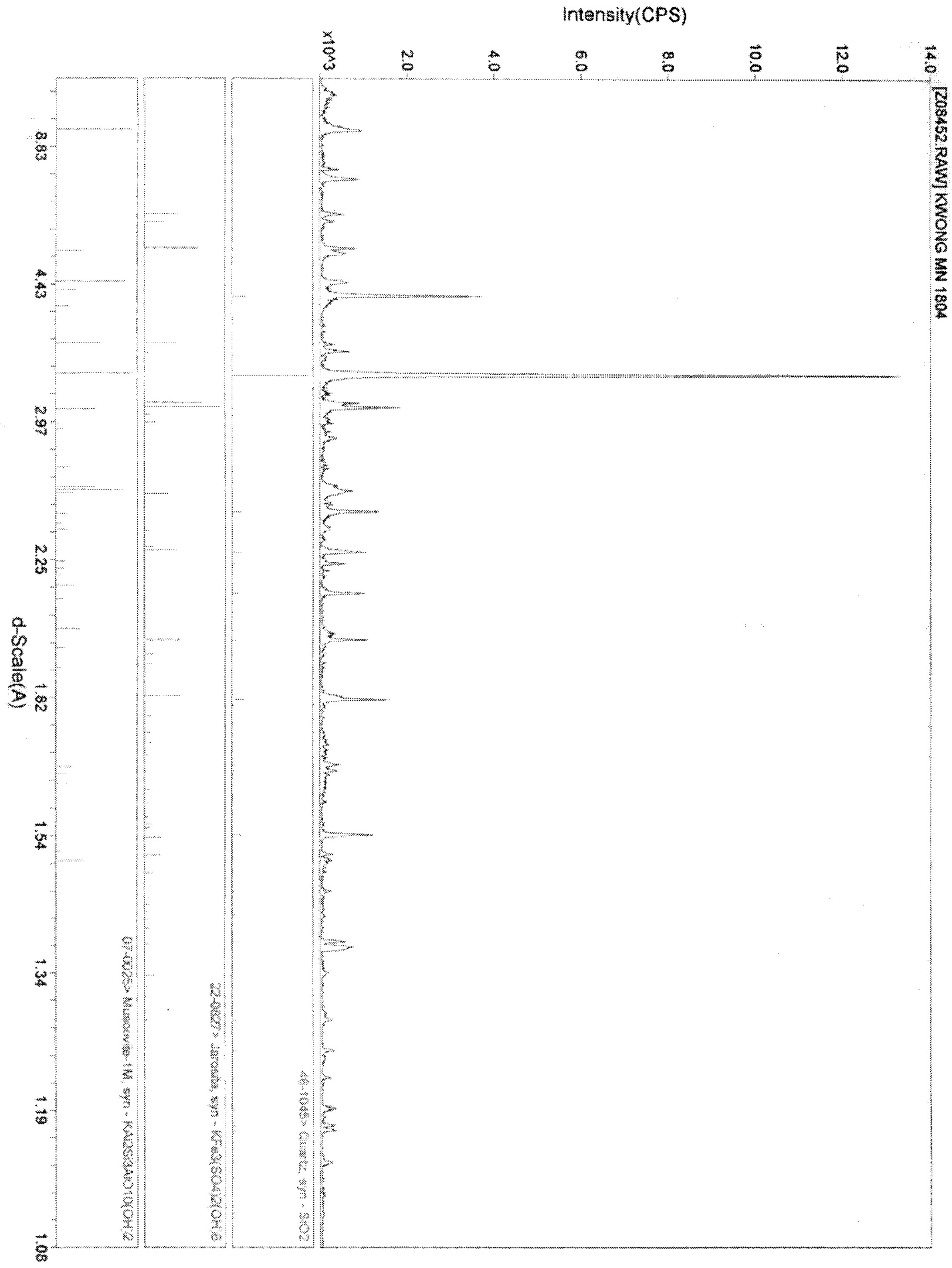
2.97
2.25
1.82
1.54
1.34
1.19
1.08
14-0164> Kaolinite-1A - Al2Si2O5(OH)4
07-0025> Muscovite-1M, syn - KAl2Si3AlO10(OH)2
46-1045> Quartz, syn - SiO2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10.0
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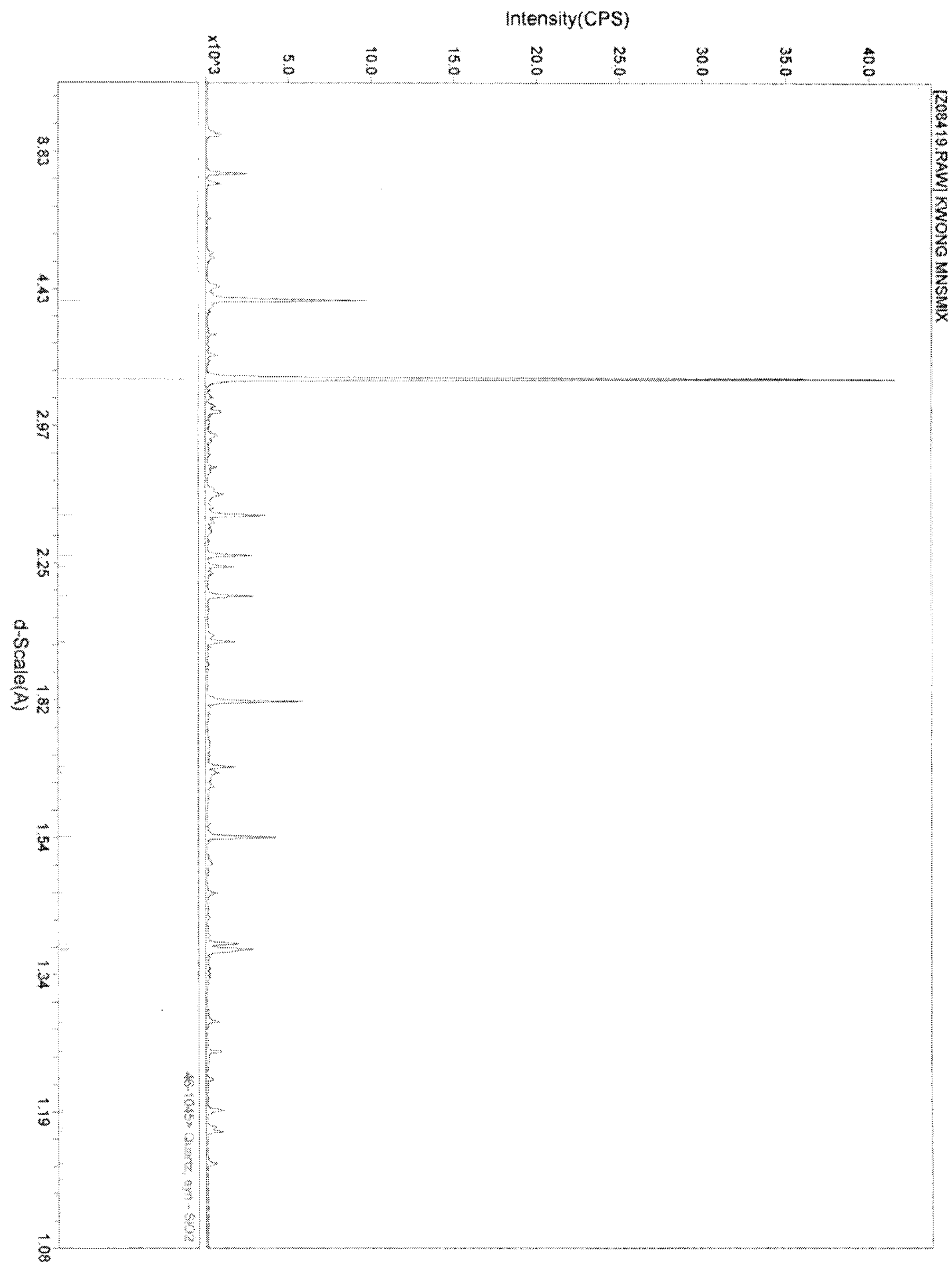
2.97
2.25
1.82
1.54
1.34
1.19
1.08
46-1045> Quartz, syn - SiO2
22-0827> Jarosite, syn - KFe3(SO4)2(OH)6
07-0025> Muscovite-1M, syn - KAl2(Si3Al)O10(OH)2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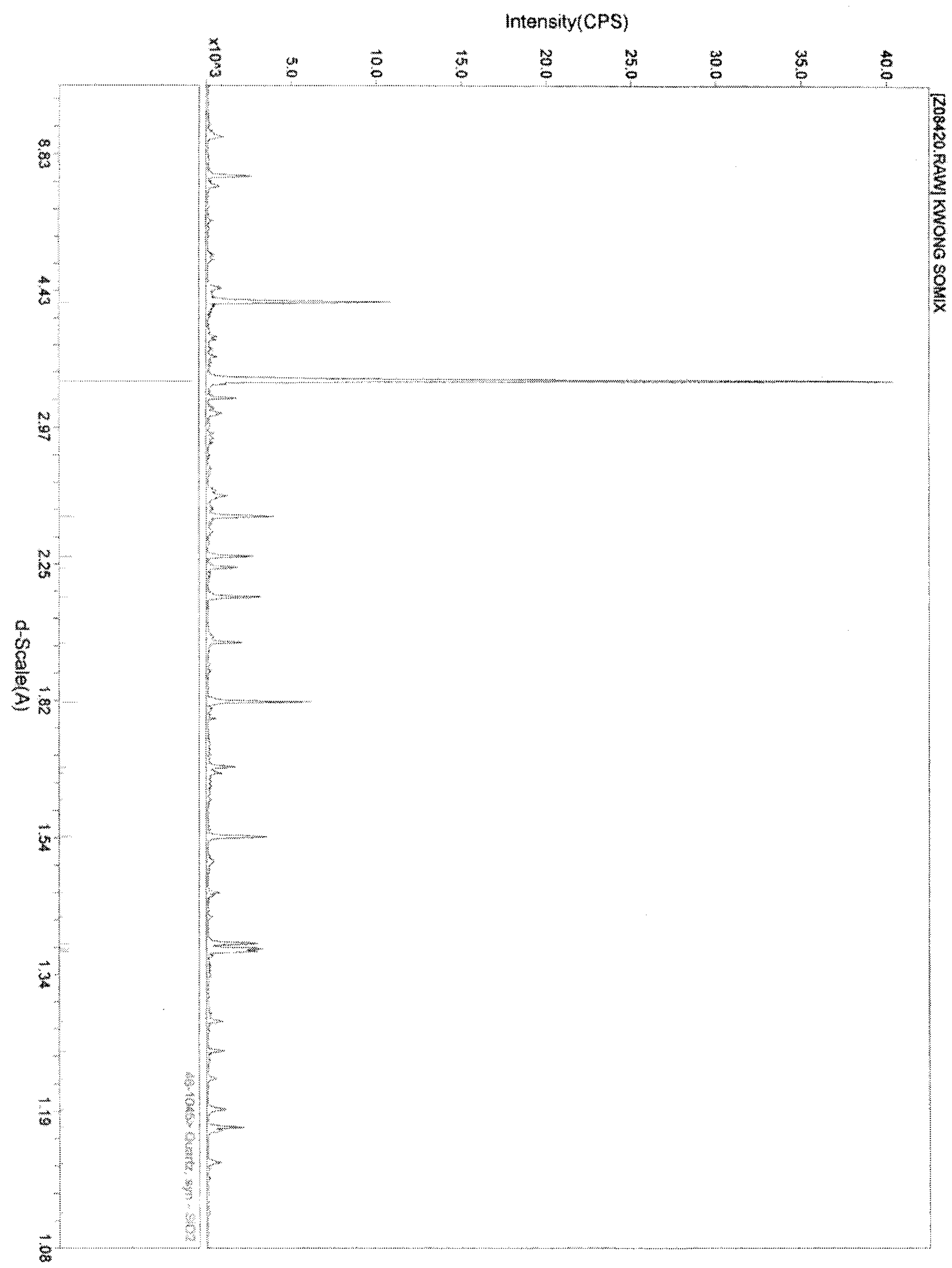
1.08
d-Scale(A)
46-1045> Quartz, syn - SiO2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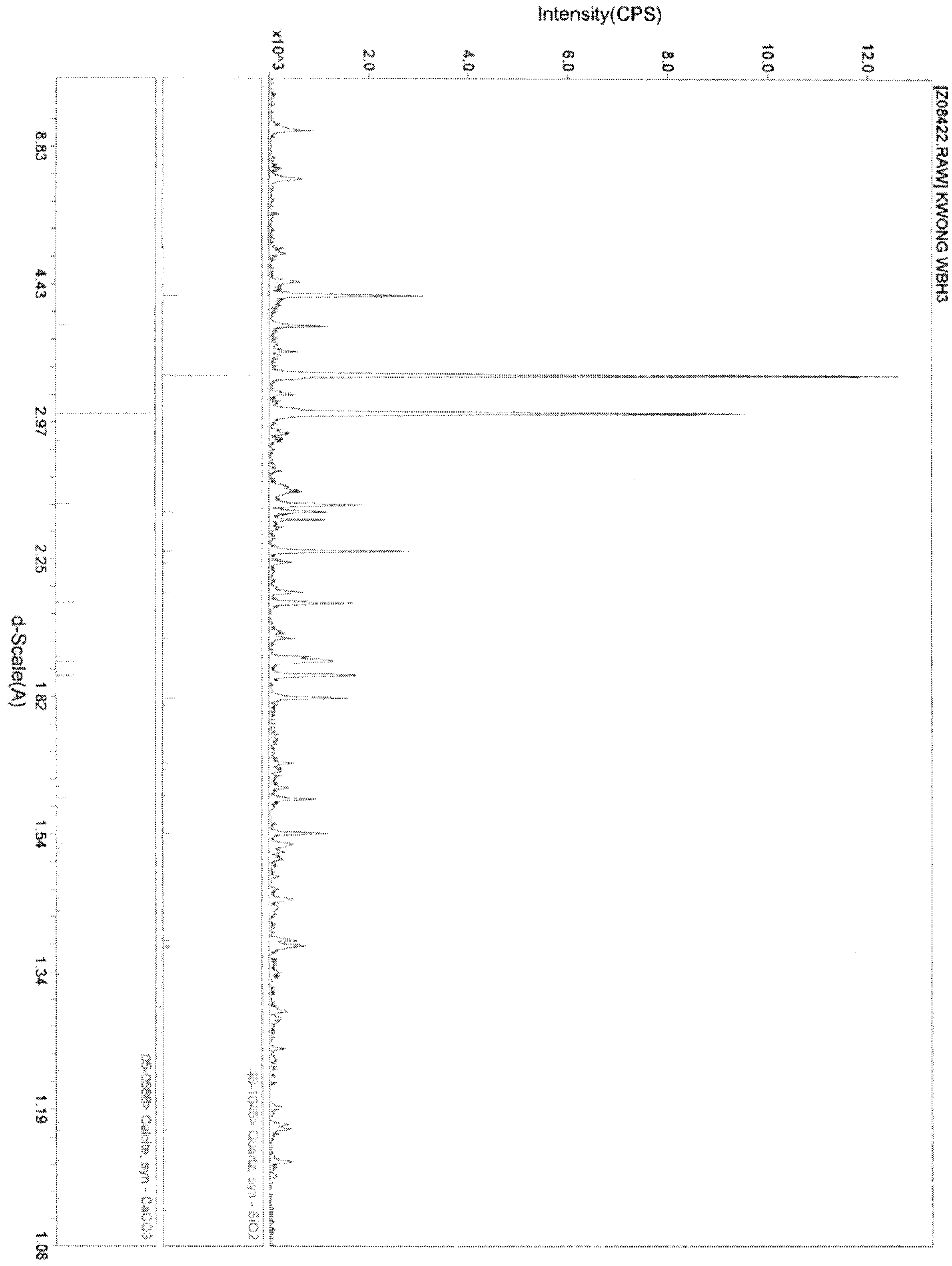
40.0
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
46-1045> Quartz, syn - SiO2



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8.0
10.0
12.0
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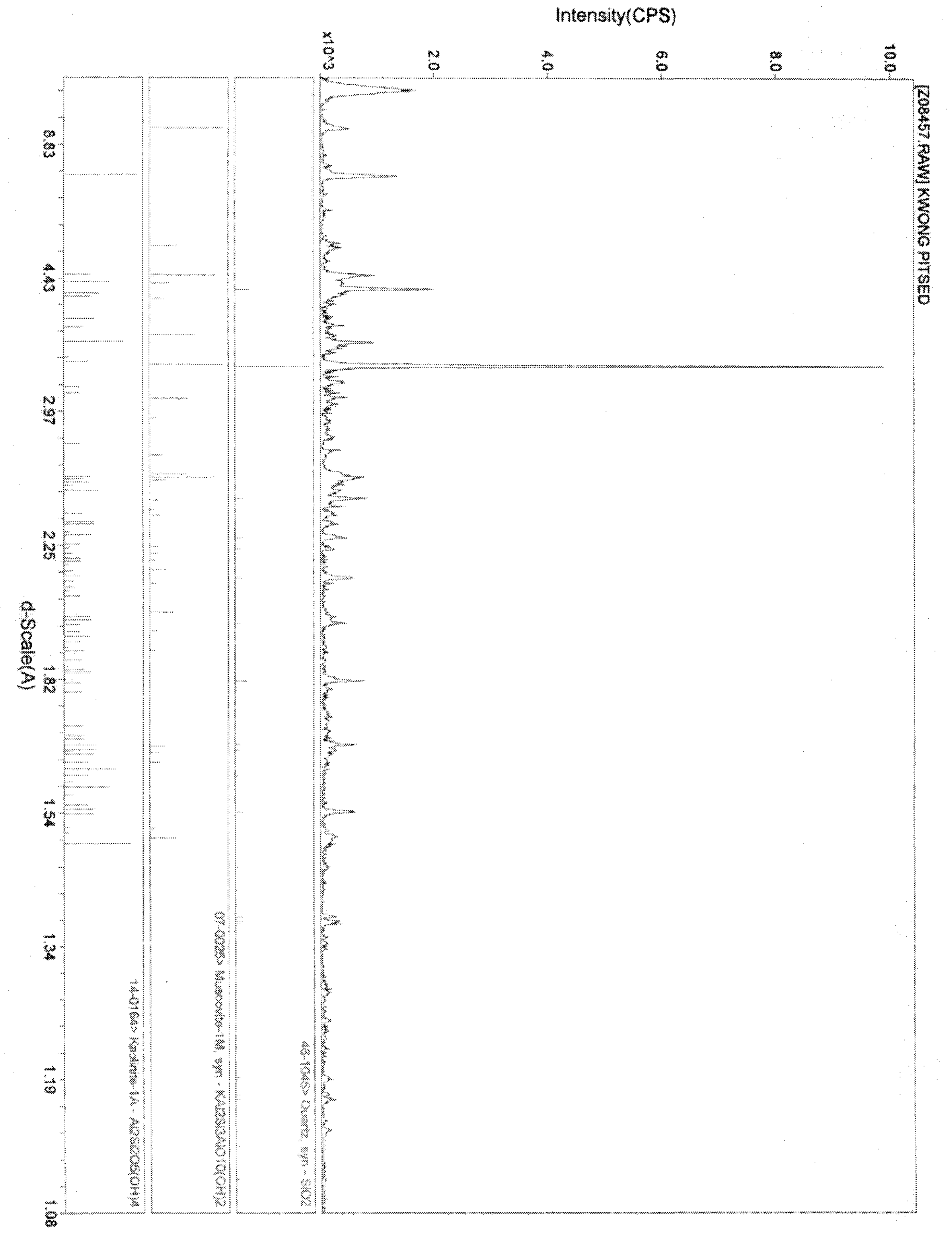
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
Quartz, syn - SiO2
05-0586> Calcite, syn - CaCO3



[Z08457.RAW] KWONG PITSED
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6.0
8.0
10.0
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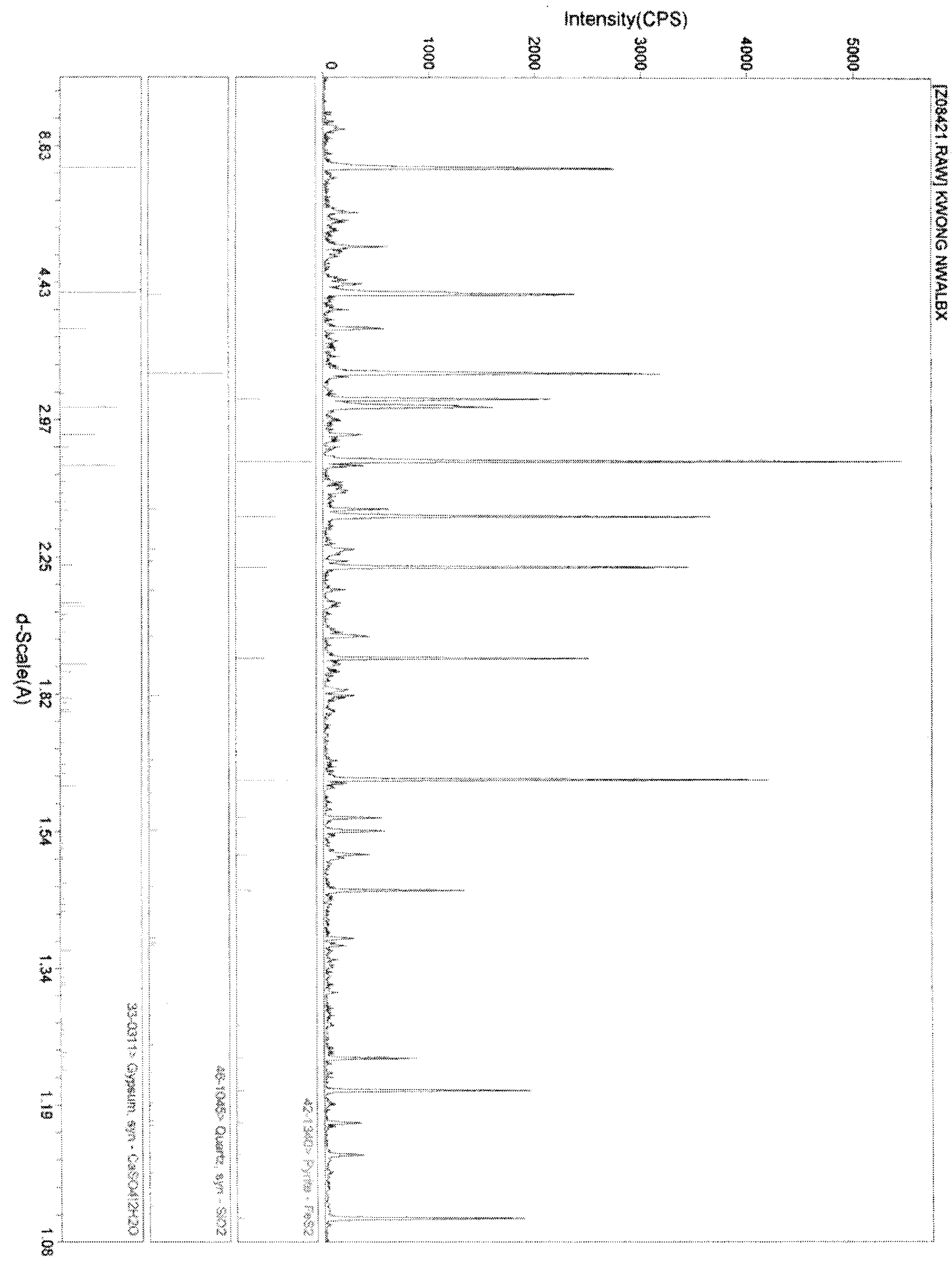
07-0025> Muscovite-1M, syn - KAl2Si3AlO10(OH)2
14-0164> Kaolinite-1A - Al2Si2O5(OH)4
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)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2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
33-0311> Gypsum, syn - CaSO4!2H2O
46-1045> Quartz, syn - SiO2
42-1340> Pyrite - FeS2

Appendix D-2: SEM-EDX Analysis

In this appendix, data on mineral abundance in selected tailings samples as determined by point counting under a scanning electron microscope are tabulated (Table D-2). Electron micrographs as well as energy-dispersive X-ray spectra of selected grains of interest are also furnished.

Table D-2. Mineral abundance in selected Mount Nansen tailings by point counting under a scanning electron microscope. (Note that hits on voids in the polished sections are excluded in the tally; minerals in composite grains are proportionally counted in fractions/decimals.)

OMIX (oxide silt composite)

Mineral	*Count*	*%*
Quartz	189	69.7
Muscovite	28.5	10.5
Kaolinite	7	2.6
Biotite	5.5	2
FeO.OH	14	5.2
Pyrite	14	5.2
Jarosite	4.5	1.7
Ca-albite	2	0.7
K-feldspar	1	0.4
Amphibole	1	0.4
Calcite	2	0.7
Ankerite	1	0.4
Gypsum	1	0.4
Scorodite	0.5	0.2
Total	271	100.1

SMIX (sulfide silt composite)

Mineral	*Count*	*%*
Quartz	187	59.6
Muscovite	51.5	16.4
Kaolinite	13.5	4.3
Aspy	1	0.3
FeO.OH	13	4.1
Pyrite	3.5	1.1
Jarosite	8	2.6
Plag.	0.5	0.2
K-feldspar	24.5	7.8
Mn-carb	0.5	0.2
Calcite	5	1.6
Gypsum	3	1
Scorodite	3	1
Total	314	100.2

SOMIX (mixed silt composite)

Mineral	*Count*	*%*
Quartz	208.9	58.2
Muscovite	41.6	11.6
Kaolinite	17.7	4.9
Rutile	1.3	0.4
FeO.OH	18.4	5.1
Pyrite	2.8	0.8
Jarosite	10.2	2.8
Gibbsite	0.5	0.1
K-feldspar	45.3	12.6
Calcite	7.8	2.2
Ankerite	0.5	0.1
Gypsum	0.5	0.1
Scorodite	1	0.3
MnZnO	2.5	0.7
Total	359	99.9

MN0406 (clayey sulfide tails)

Mineral	*Count*	*%*
Quartz	139.2	45.3
Muscovite	61.6	20.1
Kaolinite	8.3	2.7
Sphalerite	0.5	0.2
FeO.OH	8	2.6
Pyrite	7.7	2.5
Jarosite	5.3	1.7
Ca-albite	4.5	1.5
K-feldspar	50.7	16.5
Aspy	3.8	1.2
Calcite	7.8	2.5
Ankerite	1.5	0.5
Gypsum	5	1.6
Scorodite	1.3	0.4
MnZnO	2	0.7
Total	307	100

MN0603 (silty sulfide tails)

Mineral	*Count*	*%*
Quartz	140	58.8
Muscovite	35.9	15.1
Kaolinite	7.5	3.2
Rutile	0.5	0.2
FeO.OH	8.2	3.5
Pyrite	2.5	1.1
Jarosite	2.5	1.1
Ca-albite	0	
K-feldspar	32.9	13.8
Aspy	0	
Calcite	5.3	2.2
Ankerite	0	
Gypsum	1.8	0.7
Scorodite	0	
MnZnO	1	0.4
Total	238	100.1

MN0703 (clayey sulfide tails)

Mineral	*Count*	*%*
Quartz	147.1	42.6
Muscovite	88.8	25.7
Kaolinite	5.3	1.5
Sphalerite	0	0
FeO.OH	18.7	5.4
Pyrite	9.6	2.8
Jarosite	12.7	3.7
Ca-albite	1	0.3
K-feldspar	50.5	14.6
Aspy	0	0
Calcite	6.1	1.8
Ankerite	1	0.3
Gypsum	4.6	1.3
Total	345.3	100

Note: 1 grain of scorodite with remnant Aspy observed but not hit by grid.

Table D-2 (cont.)

MN0803 (clay-silt sulfide tails)

Mineral	*Count*	*%*
Quartz	148.8	41.2
Muscovite	86.6	24
Kaolinite	24.3	6.7
Rutile	0.3	0.1
FeO.OH	17.8	4.9
Pyrite	11.8	3.3
Jarosite	6.9	1.9
Ca-albite	0.7	0.2
K-feldspar	50.8	14
FeSbAsS	1	0.3
Calcite	8.8	2.4
Ankerite	0.5	0.1
Gypsum	2.3	0.6
Scorodite	0	0
MnZnO	1	0.3
Total	361.5	100.0

MN0903 (oxide silt tailings)

Mineral	*Count*	*%*
Quartz	214.1	57.7
Muscovite	40.3	10.9
Kaolinite	13.1	3.5
Rutile	0.5	0.1
FeO.OH	18.4	5
Pyrite	0.7	0.2
Jarosite	20.8	5.6
Ca-albite	0	0
K-feldspar	55.1	14.8
Calcite	4.3	1.1
Ankerite	1	0.3
Gypsum	1	0.3
Scorodite	1.5	0.4
Apatite	0.5	0.1
Total	371.3	100.0

*Other minerals observed: zircon

MN1202 (clayey oxide tails)

Mineral	*Count*	*%*
Quartz	164.2	47.4
Muscovite	85.2	24.6
Kaolinite	22.4	6.5
Ilmenite	0.5	0.1
FeO.OH	17.8	5.2
Pyrite	2.3	0.7
Jarosite	7.4	2.1
MnO	0.5	0.1
K-feldspar	32.8	9.5
Native Fe	1	0.3
Calcite	3.2	0.9
Ankerite	1.7	0.5
Gypsum	4.5	1.3
Kutnohorit	1	0.3
FeMnZnO	2.1	0.6
Total	346.5	100.1

MN1502 (silty oxide tails)

Mineral	*Count*	*%*
Quartz	202.7	67.3
Muscovite	32.7	10.9
Kaolinite	9.8	3.3
Rutile	0	0
FeO.OH	18.8	6.3
Pyrite	3	1
Jarosite	7.2	2.4
Ca-albite	0	0
K-feldspar	21.8	7.2
FeSbAsS	0	0
Calcite	2.8	0.9
Ankerite	0.5	0.2
Gypsum	0.8	0.3
Scorodite	1	0.3
Total	301.0	100.1

*Other minerals observed: zircon, covellite, galena and arsenopyrite.

MN1701 (sulfidic silt tails)

Mineral	*Count*	*%*
Quartz	191.1	64
Muscovite	30.2	10.1
Kaolinite	7.5	2.5
Rutile	2	0.7
FeO.OH	11.2	3.7
Pyrite	5.5	1.8
Jarosite	10.5	3.5
Ilmenite	1	0.3
K-feldspar	28.9	9.7
Aspy	0.5	0.2
Calcite	1.3	0.4
Ankerite	1	0.3
Gypsum	2.3	0.8
Scorodite	1.7	0.6
Kutnohorit	1.5	0.5
Sphalerite	0.5	0.2
Plag	2	0.7
Total	298.5	100.0

MN1804 (clayey oxide tails)

Mineral	*Count*	*%*
Quartz	186.2	51.4
Muscovite	49.8	13.8
Kaolinite	27.3	7.5
Ilmenite	0.5	0.1
FeO.OH	20.3	5.6
Pyrite	1.5	0.4
Jarosite	27.2	7.5
Ca-albite	0	0
K-feldspar	43.4	12
Native Fe	1	0.3
Calcite	4.3	1.2
Ankerite	0	0
Gypsum	0.5	0.1
Scorodite	0	0
Total	361.9	99.9

*Other minerals observed: scorodite

OMIX (supplementary analysis)

Mineral	*Count*	*%*
Quartz	54.2	66.9
Muscovite	11.6	14.3
Kaolinite	4.7	5.8
Biotite	0	0
FeO.OH	3.9	4.8
Pyrite	1	1.2
Jarosite	1.2	1.4
Ca-albite	1	1.2
K-feldspar	2.2	2.7
Amphibole	0	0
Calcite	0	0
Ankerite	0	0
Gypsum	1.3	1.7
Scorodite	0	0
Total	81.0	100

SMIX (supplementary analysis)

Mineral	*Count*	*%*
Quartz	50.4	62.2
Muscovite	14.3	17.6
Kaolinite	3	3.7
Aspy	0	0
FeO.OH	3.5	4.3
Pyrite	0	0
Jarosite	1.8	2.3
Plag.	0	0
K-feldspar	3.8	4.6
Mn-carb	1	1.2
Calcite	1	1.2
Ankerite	1	1.2
Gypsum	0.8	0.9
Rutile	0.5	0.6
Total	81.0	99.8

SOMIX (supplementary analysis)

Mineral	*Count*	*%*
Quartz	53.3	60.6
Muscovite	14.2	16.1
Kaolinite	6.8	7.7
Sphene	1	1.1
FeO.OH	2.4	2.8
Pyrite	0.8	0.9
Jarosite	2.8	3.2
Gibbsite	0	0
K-feldspar	4.7	5.3
FeSbAsS	0	0
Calcite	0	0
Ankerite	1	1.1
Gypsum	1	1.1
Scorodite	0	0
Total	88.0	99.9

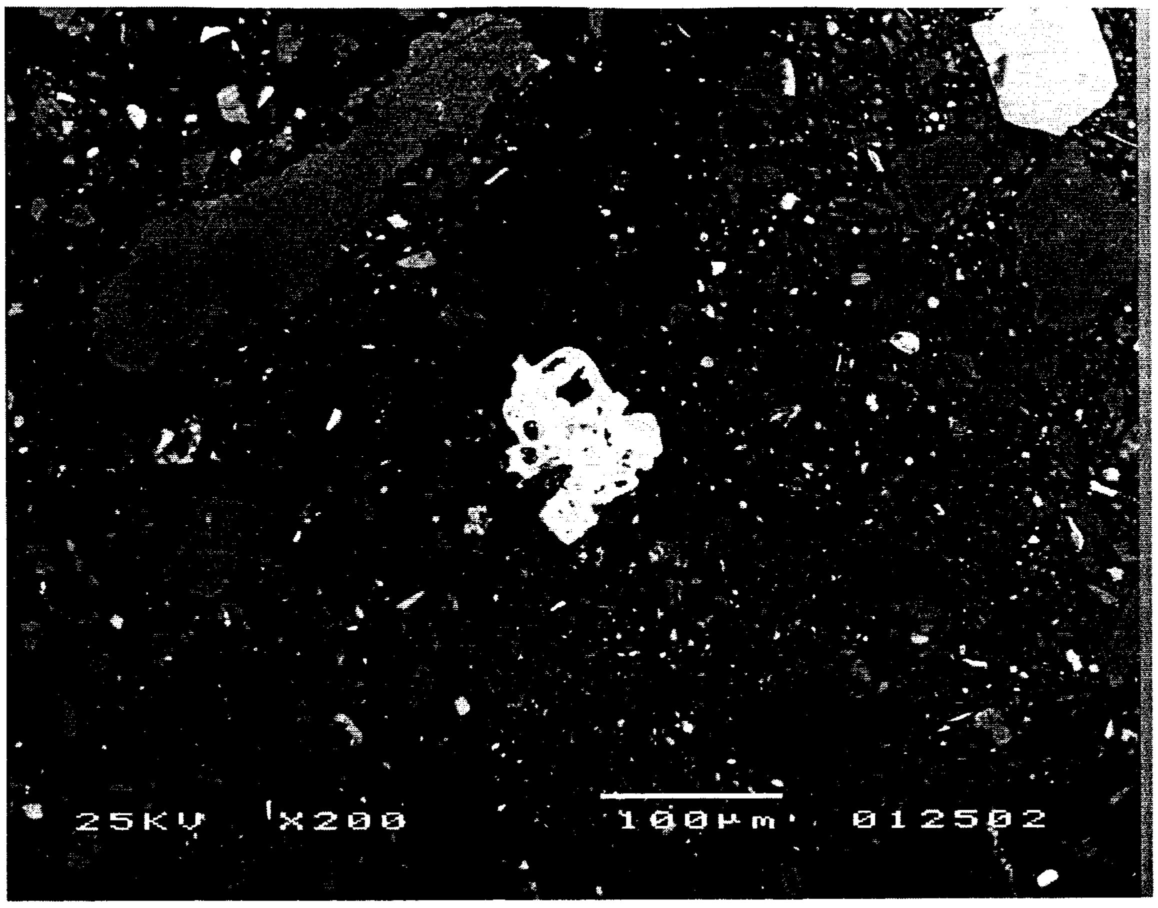
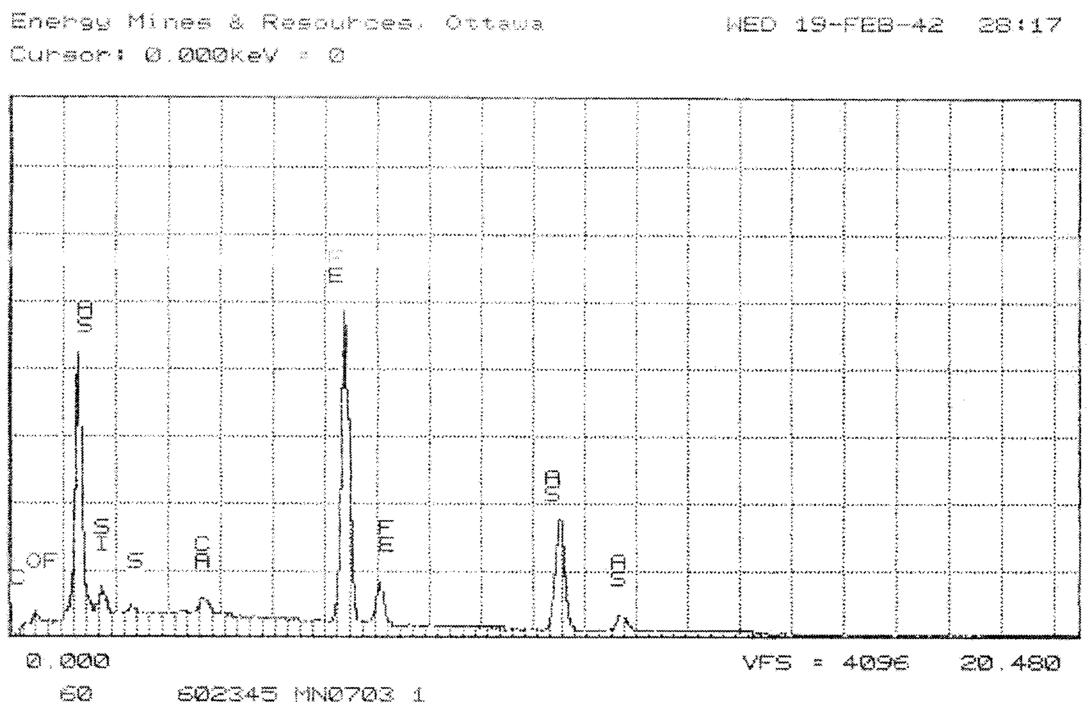


Figure D2-1a. Backscattered electron micrograph of Sample MN0703 showing a scorodite ($FeAsO_4.2H_2O$) grain at the center (greyish white) and an apatite [$Ca_5(PO_4)_3(OH,F,Cl)$] at the top right hand corner (light grey). Energy-dispersive X-ray spectra of the two grains are shown in Figure D2-1b.



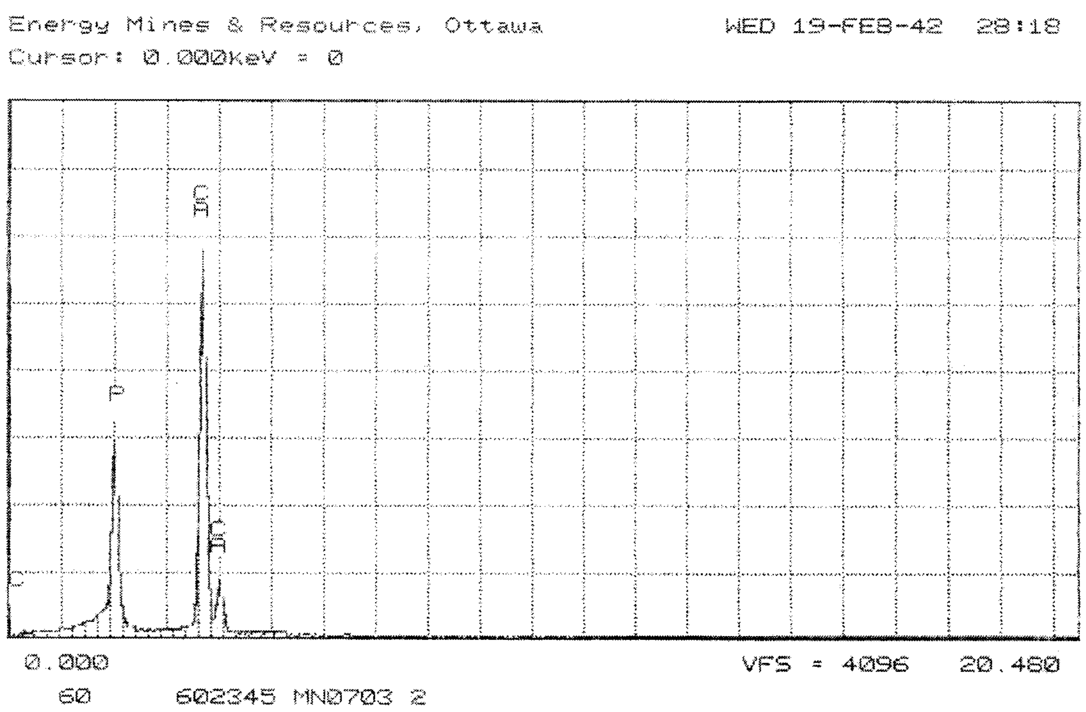


Figure D2-1b. Energy-dispersive X-ray spectra of scorodite (top) and apatite (bottom).

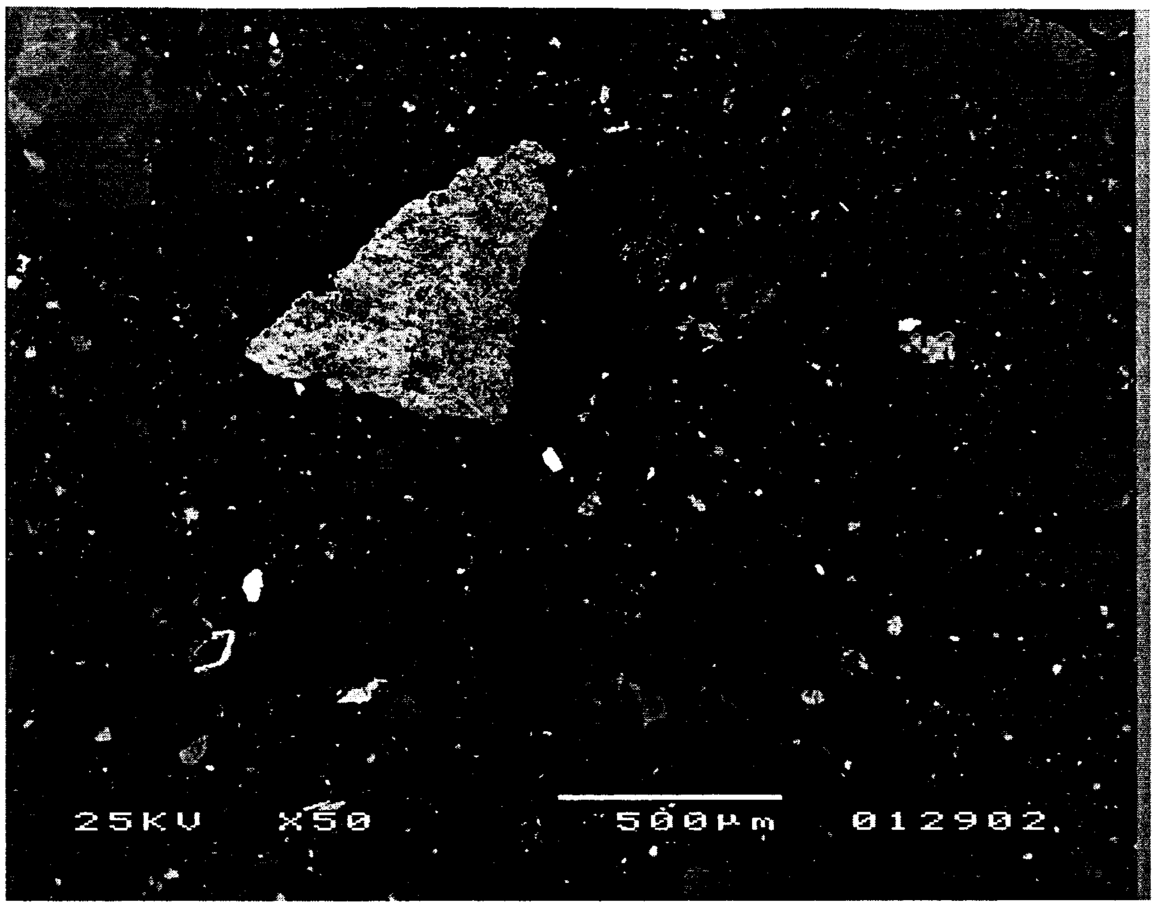
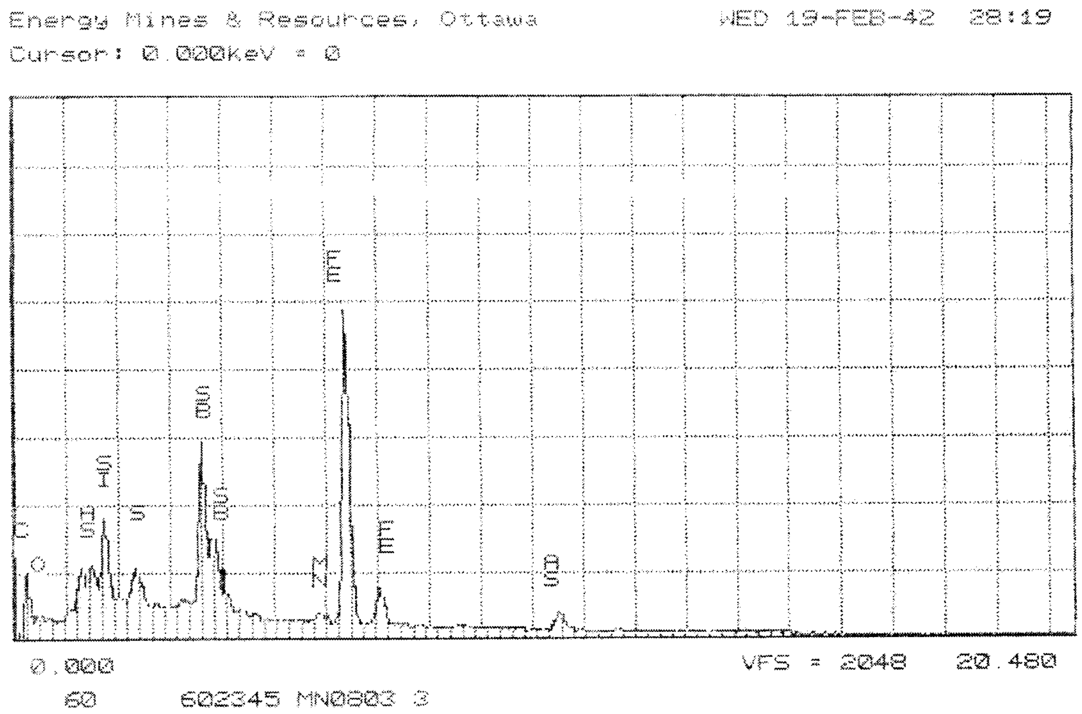


Figure D2-2a. Backscattered electron micrograph of Sample MN0903 showing a triangular, composite grain of goethite (grey, near center). The small, white rectangular grain at the center and the curved white grain at the lower left corner are unidentified sulfosalts, the energy-dispersive X-ray spectra of which are shown in Figure D2-2b. Other scattered, small greyish white grains are mostly pyrite.



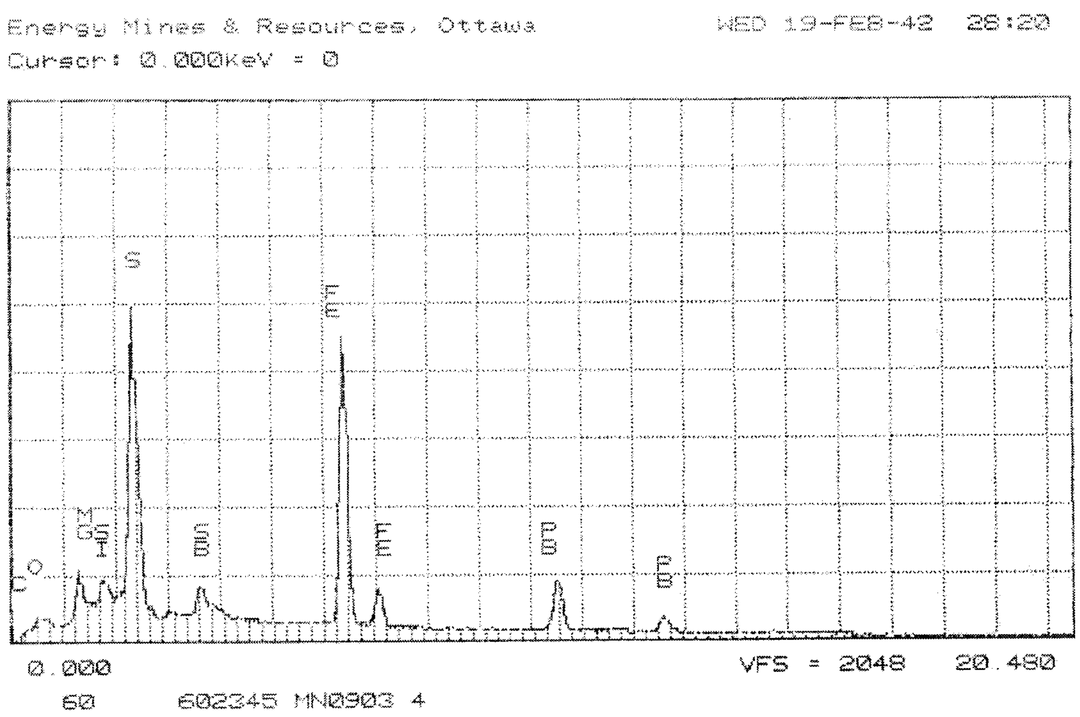


Figure D2-2b. Energy-dispersive X-ray spectra of unidentified sulfosalts observed in Sample MN0903.

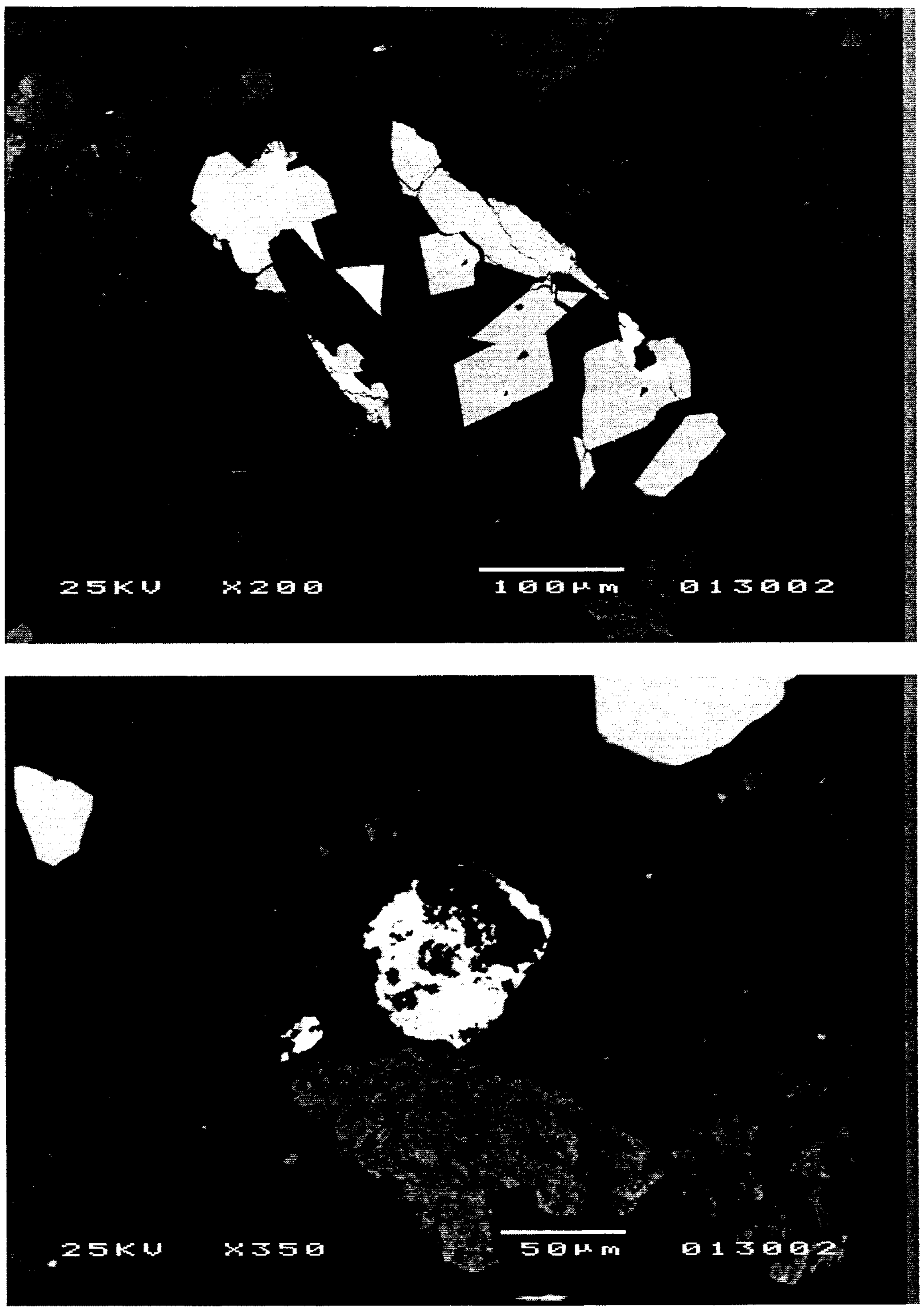


Figure D2-3. Backscattered electron micrographs of Sample MN1502. Top: A quartz grain (dark grey) with included arsenopyrite (grey) and unidentified sulfosalts (white, triangular). Bottom: A composite grain of unidentified sulfosalts (whitish grey, center) surrounded by goethite (dark grey, bottom) and subhedral pyrite (grey, top left and right hand corners).

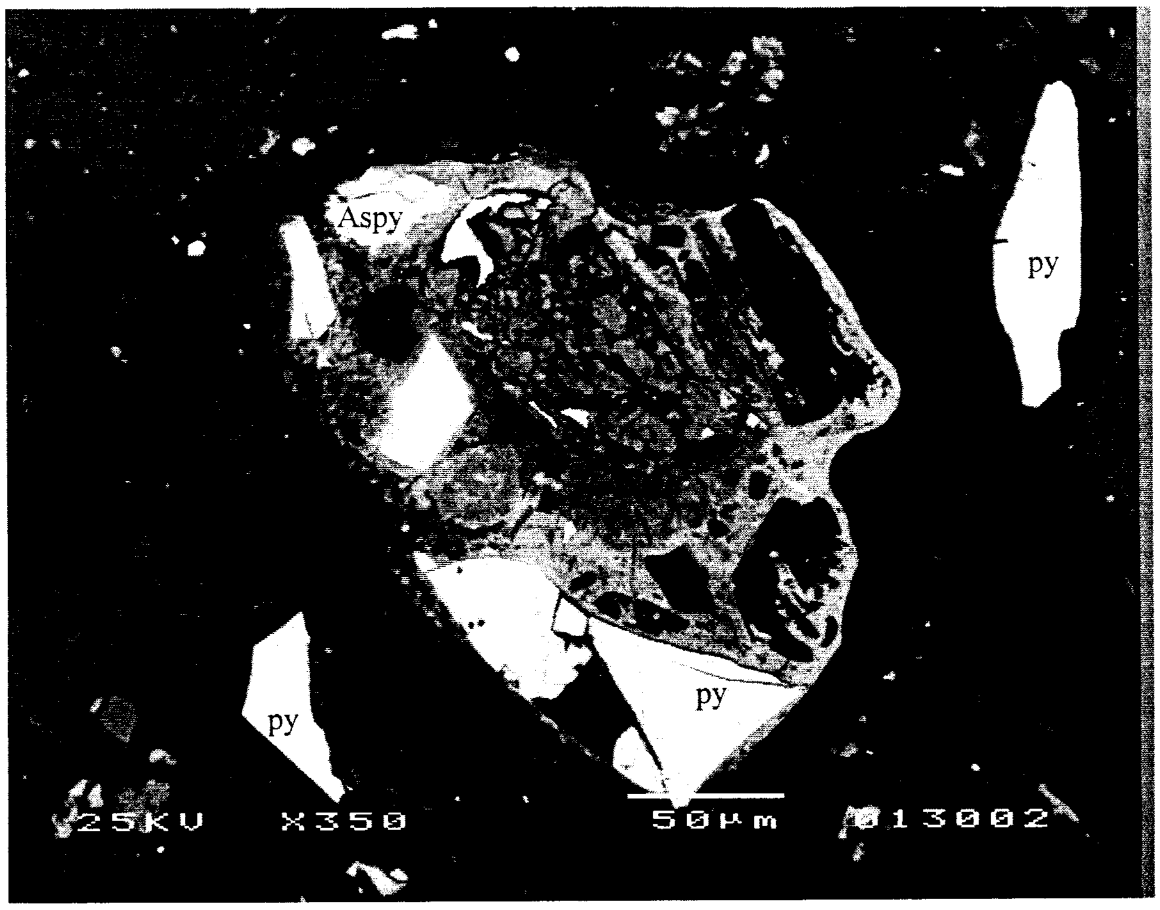


Figure D2-4. A backscattered electron micrograph of Sample MN1701 showing an goethite aggregate with included pyrite (py), arsenopyrite (Aspy) and native iron (white, irregular grain to the right of arsenopyrite).

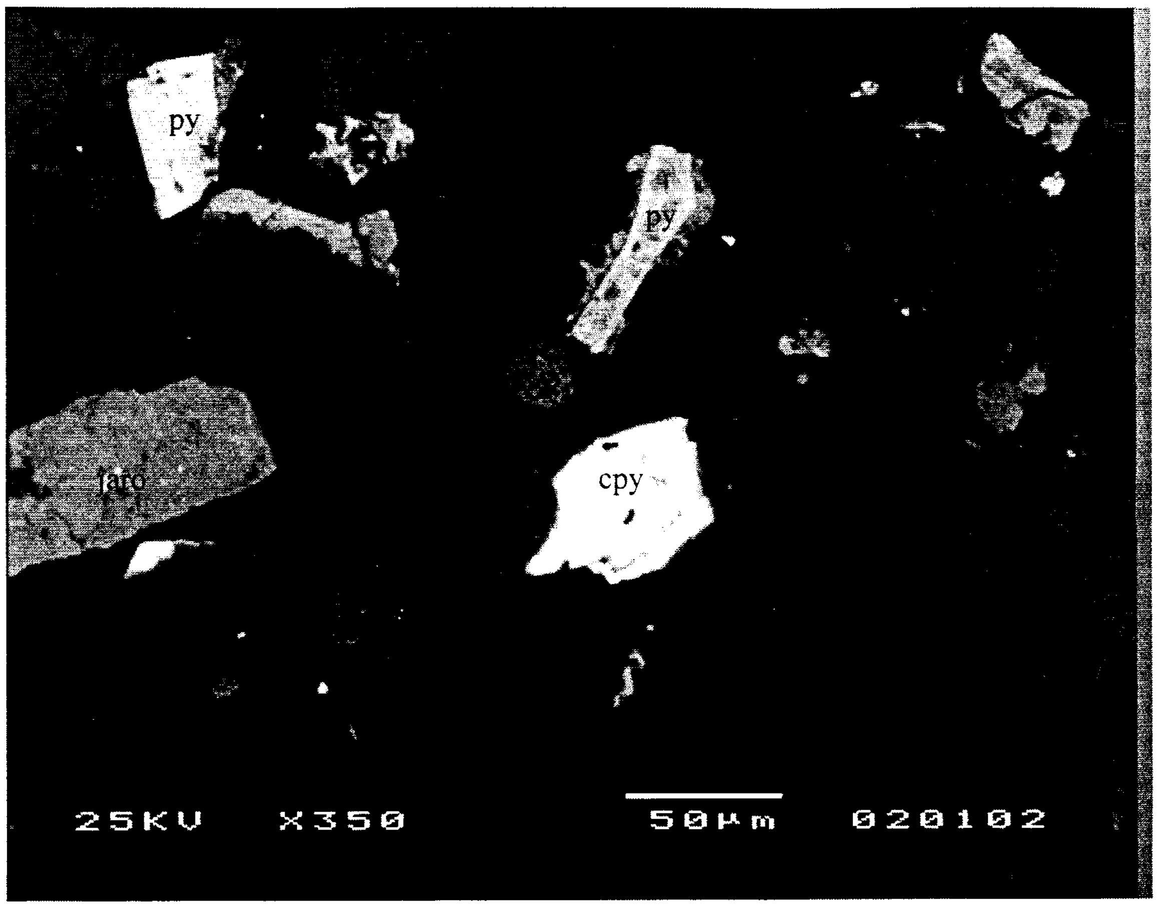


Figure D2-5. A backscattered electron micrograph of Sample MNOMIX showing the occurrence of chalcopyrite (cpy), jarosite (jaro), pyrite (py). Note that the elongated pyrite grain above the chalcopyrite grain is surrounded by goethite.

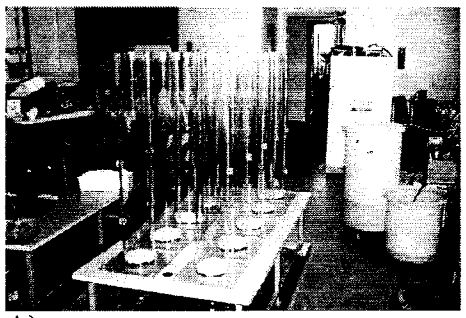
APPENDIX E

Column Set Up, Test Procedure and Results

COLUMNS SET–UP

Eight plexi-glass columns (15.2 cm inside diameter) were set up to investigate the following disposal scenarios in duplicate:

1. High sulfide tailings under a water cover;
2. Low sulfide tailing under a water cover;
3. Mixed (mixture of high and low sulfide) tailings slurried and placed under a water cover; and
4. Mixed tailings under flow through conditions.


A)

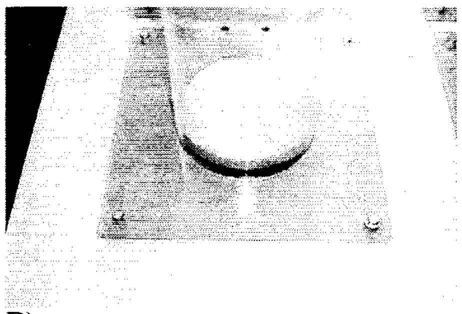
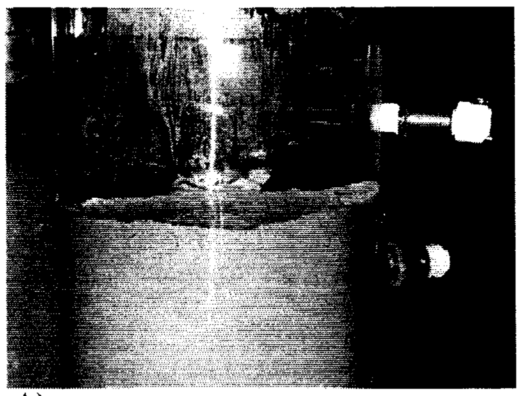

B)

Figure E1: A) The layout of the columns, and B) The drainage layer at the bottom of the column.

Prior to placing the tailings in the columns, a layer of glass wool was placed at the base of all the columns. On top of the glass wool layer, a one-inch layer of acid washed (10% HCl) quartz with an effective size of 1 mm was placed. The columns were secured on a 45 cm high table. Figure E1 shows the layout of the columns placed on the table with the quartz layer overlying the glass wool. The height of the tailings bed in the columns was approximately 23 cm. The columns with tailings under a water cover were sampled at the water cover, porewater and at the base of the column. The water cover samples were collected at 5 cm above the water/tailing interface and the porewater samples were collected at 5 cm below the water/tailing interface. Figure E2 shows the location of the sampling ports.


A)

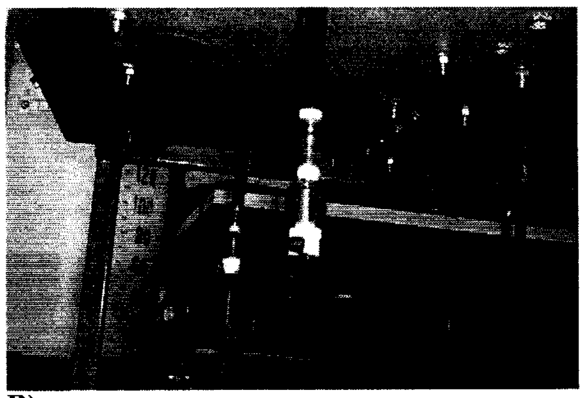

B)

Figure E2: A) The sampling port in the water cover and in the tailings for porewater, and B) The sampling ports at the base of the columns.

Only coarse tailings were used in the columns to study their interaction with the Brown-McDade pit water. The interaction of fine tailings with the Brown-McDade pit water was studied by sequential batch leaching. The coarser tailings were visually inspected and classified as high and low sulfide for use in this study. The coarse tailings suitable for the column study were in limited quantity. The high sulfide tailings from core samples BH 1 – 03, – 04; BH 2 – 02, 03, 04, 05; BH 3 – 02; BH 4 – 04; BH 5 – 03; BH 6 – 04, – 06; BH 7 – 07; BH 12 – 02; BH 14 – 03; and BH 17 – 01 were placed in a large bucket and thoroughly mixed by hand to prepare a composite of high sulfide tailings. Similarly, low sulfide tailings from core samples BH 1 – 06, BH 3 – 03, BH 15 – 02, 03, and BH 17 – 02 were used to prepare a composite of low sulphide tailings. Before the tailings were placed in the column a layer of approximately 2.5 cm of pit water was transferred to the columns. The tailings were then placed in a 5 to 7.5 cm layer at a time and compacted using a plexi-glass rod to displace air pockets from the tailings bed. When the tailings bed reached the location of porewater sampling ports, the sampling ports were inserted into the columns (Figure E3) and additional tailings were placed on top of the sampling ports to achieve a tailings bed of approximately 23 cm in height. A similar procedure was used for the set up of the columns containing low sulfide tailings. The two high sulfide tailings columns contained 8.02 and 8.1 kg of tailings. The two low sulfide tailings columns contained 7.24 and 7.14 kg of tailings. After the tailings were placed in the columns, Brown-McDade pit water was pumped in the columns to obtain a water cover of 7.5 cm in depth. The individual high sulfide columns required approximately 1400 mL of pit water for 7.5 cm of water cover. The individual low sulfide columns required approximately 1650 mL of pit water for 7.5 cm of water cover. The moisture contents of the high and low sulfide tailings composite samples were 21.2% and 18% respectively.

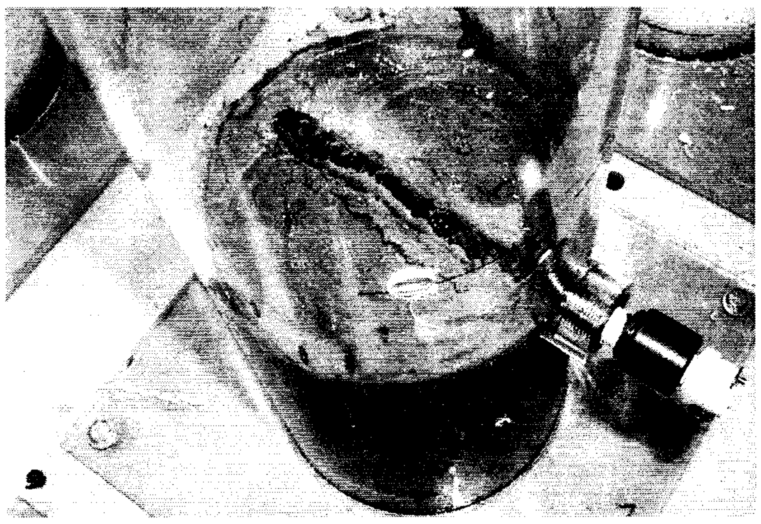


Figure E3: The sampling port for tailing porewater samples.

The remaining high and low sulfide tailings were mixed for use in the set up of additional columns. The mixed tailings were slurried by placing 18.4 kg of tailings in 3.6 L of Brown-McDade pit water. The slurry was then poured into the two columns. The tailings in the columns were allowed to settle and the water cover height was adjusted to 7.5 cm. The height of tailings bed in the mixed slurried columns was approximately 25 cm. The high sulfide, low sulfide and mixed columns under water cover were sampled approximately every three weeks at the water cover, porewater and the base of the respective column.

The remaining mixed tailings were used in the columns to simulate flow-through conditions. The two flow-through columns contained 6.2 kg of mixed tailings each. The tailings bed in each of the columns was approximately 18 cm. To ensure even distribution of pit water subsequently applied to the columns, a layer of glass wool covered by a filter paper was placed on the tailings. The Brown-McDade pit water was applied to columns at the rate of five times the average annual precipitation of 25 cm per year at Mount Nansen. The pit water was applied twice a week (190 mL each time @ 6 mL/min) and the samples were collected at the base of the columns. The water samples collected during the week were mixed together and the composite samples analyzed for the various parameters. Figure E4 shows all eight columns set up to study the four disposal scenarios. The water samples collected were analyzed for pH, conductivity, Total and WAD CN, CNS, CNO, NH_4-N, NO_3-N, NO_2-N, SO_4, and dissolved metals by ICP AES/MS metal scans. 100 mL of sample was collected from each sampling port for the analysis of parameters listed above.

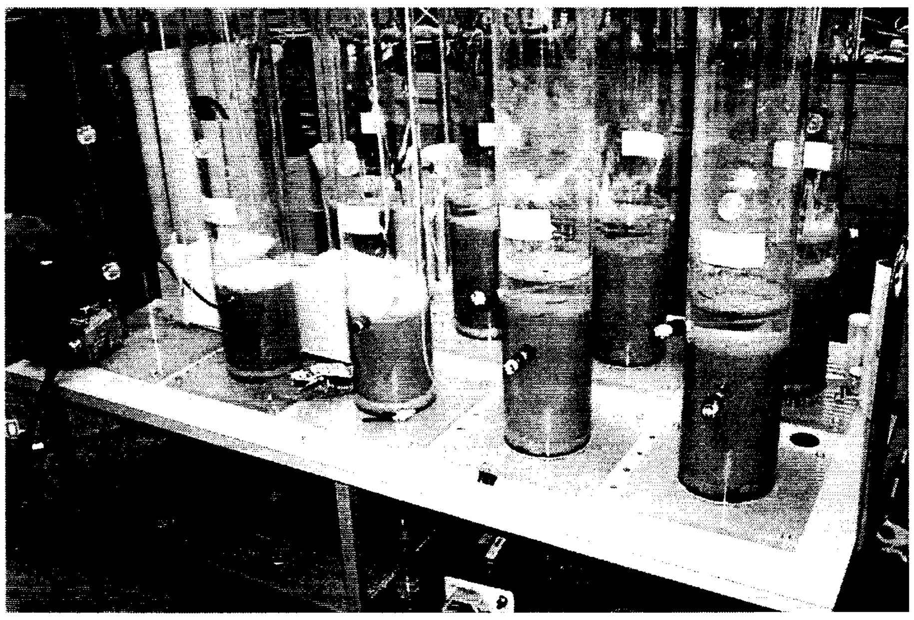


Figure E4: The eight columns set up to study the four disposal options

The results from monitoring and sampling of the columns during the period December 2001 to February 2002 are presented in this appendix. The column monitoring and sampling are ongoing and likely to continue till August/September 2002.

COLUMN STUDY RESULTS

Table E1 shows the Ag, Au, C, S and moisture contents of the composite tailings. The total sulphur contents of the high and low sulfide tailings were 2.81% and 2.14%, respectively. The total carbon content of the high sulphide was observed to be significantly higher than that of the low sulfide tailings. The moisture contents of the high sulfide, low sulfide and mixed tailings were 21.2, 17.8 and 20.5%, respectively.

Table E1: The characteristics of composite tailings samples used in the column study.

Column Type	Ag (ppm)	Au (ppm)	C (%)	S (%)	Moisture Content (%)
High Sulphide	24.4	1.34	0.38	2.81	21.2
Low Sulphide	24.7	2.67	0.18	2.14	17.8
Sulphide/Oxide Mix	25.2	2.2	0.34	2.34	20.5

HIGH SULFIDE COLUMNS

Tables E2 and E3 show the water chemistry of samples collected at the water cover, the porewater and at the base of the high sulfide columns. The Total CN concentrations in the water samples collected in the water cover and in the porewater were below the detection limit of 0.05 mg/L. The maximum Total CN of 0.076 mg/L was observed at the base of the columns. The maximum WAD CN concentration of 0.13 mg/L was observed at the base of one of the columns. The WAD CN concentration was <0.05 mg/L in the majority of samples analyzed. The CNO concentration in samples collected in December was <5 mg/L. The maximum CNO concentration of 25 mg/L was observed in the porewater and at the base for samples collected in January. The presence of CNO after approximately six weeks of column study could be due to natural degradation of CN in the tailings or CNS present in the porewater. The CNS concentration in the water cover was lower than those in the porewater and at the base. The CNS concentration in the porewater decreased with time, whereas its concentration at the base increased with time as a result of CNS degradation to CNO/NH_4-N and also by flushing/displacement of the porewater towards the base of the columns. The NH_4-N concentration in the porewater and the base of the columns increased with time, which was likely due to natural degradation of CN and CNS. The flushing of porewater through the tailings bed due to extraction of water samples from the base may also have contributed to the observed increase in NH_4-N at the base. The NO_3-N and NO_2-N concentrations in the porewater samples were below their respective analytical detection limits. No significant biological oxidation of NH_4-N apparently occurred in the columns. The SO_4 concentration in the water cover and at the base of the columns increased with time. In the porewater, the SO_4 concentration decreased with time.

Table E2: Water chemistry of samples collected at the water cover, the porewater and at the base of the columns containing high sulfide tailings.

Sample Date	pH						Conductivity (µS/cm)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	7.76	7.82	8.06	8.71	7.57	7.46	1100	1060	2130	3220	1440	2130
19-Dec-01	7.90	7.88	8.31	8.36	8.01	8.09	1440	1490	2860	2890	2440	2860
15-Jan-01	7.49	7.84	8.37	8.39	8.13	8.14	1930	1850	3270	2770	3050	3270
11-Feb-02	7.56	7.55	8.19	8.42	8.13	8.12	1890	2070	3780	3050	3490	3780

Sample Date	Total CN (mg/L)						WAD CN (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
19-Dec-01	<0.05	<0.05	<0.05	<0.05	0.053	0.073	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15-Jan-01	<0.05	*	<0.05	<0.05	0.073	<0.05	*	<0.05	*	<0.05	<0.05	<0.05
11-Feb-02	<0.05	<0.05	<0.05	<0.05	0.076	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	0.13

Sample Date	CNO** (mg/L)						CNS** (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<5	<5	<5	<5	<5	<5	12	12	168	167	23	48
19-Dec-01	<2	<2	<2	<2	<2	<2	<5	9	62	82	88	105
15-Jan-01	3	1	25	5	25	5	<2	<2	50	46	119	135
11-Feb-02	3	<1	6	3	6	3	<2	<2	40	38	120	142

Sample Date	NH_4-N (mg/L)						SO_4 (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	4.0	3.8	35.0	27.0	12.0	18.0	471	468	2352	2415	648	1467
19-Dec-01	13.1	10.9	25.3	25.5	20.8	22.6	873	873	2199	2187	1548	2001
15-Jan-01	17.5	15.8	23.3	21.8	26.8	29.0	1131	1110	1830	1818	1797	1971
11-Feb-02	14.3	14.3	20.0	21.6	26.6	27.5	1147	1037	1925	1954	1965	2057

Sample Date	NO_2-N (mg/L)						NO_3-N (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<0.3	<0.3	<0.3	<0.3	<0.3	0.55	5.4	5.4	<0.23	<0.23	4.3	1.6
19-Dec-01	0.36	<0.3	<0.3	<0.3	<0.3	<0.3	1.9	1.3	<0.23	<0.23	<0.23	<0.23
15-Jan-01	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23
11-Feb-02	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23

Note: C1 and C2 denote Column 1 and Column 2 set up for the scenario. *Sample not analyzed. **The detection limit decreased upon request.

Table E3: Dissolved As, Cu, Zn and Sb concentrations observed in the water cover, tailings porewater and at the base of the columns containing high sulfide columns.

Sampling Date	As (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.356	0.206	0.281	1.03	1.05	1.04	0.176	0.469	0.323
19-Dec-01	0.353	0.351	0.352	1.19	1.08	1.14	1.63	0.806	1.22
15-Jan-02	0.661	0.965	0.813	1.40	1.63	1.52	1.32	2.32	1.82
11-Feb-02	1.71	0.927	1.32	1.49	1.35	1.42	1.96	1.43	1.70

Sampling Date	Cu (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.037	0.037	0.037	0.192	0.105	0.171	0.026	0.173	0.100
19-Dec-01	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
15-Jan-02	<0.025	<0.025	<0.025	0.029	0.031	0.030	0.033	0.033	0.033
11-Feb-02	0.034	0.065	0.050	<0.053	<0.053	<0.053	0.032	0.026	0.029

Sampling Date	Zn (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.367	*	0.367	0.085	0.102	0.094	0.243	0.149	0.196
19-Dec-01	0.328	0.905	0.616	0.031	0.042	0.036	0.052	0.043	0.048
15-Jan-02	<0.10	0.084	0.084	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
11-Feb-02	0.157	0.173	0.165	<0.010	<0.010	<0.010	0.008	0.017	0.013

Sampling Date	Sb (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.054	0.049	0.052	0.333	0.349	0.341	0.065	0.175	0.120
19-Dec-01	0.068	0.074	0.071	0.084	0.060	0.072	0.018	0.018	0.018
15-Jan-02	0.098	0.100	0.099	0.011	0.025	0.018	<0.010	<0.010	<0.010
11-Feb-02	0.082	0.068	0.075	0.025	0.029	0.027	<0.010	<0.010	<0.010

Note: C1 and C2 denote Column 1 and Column 2 for the scenario. * Sample analysis result not available. The Brown-McDade pit water metal concentrations: As = 0.024 mg/L, Cu = 0.065 mg/L, Zn = 0.738 mg/L, and Sb = 0.035 mg/L.

Table E3 shows the concentrations of dissolved arsenic, copper, zinc and antimony observed in the water cover, the porewater and at the base of the two high sulfide tailings columns. The average arsenic concentration in the water covers and at the base of the columns increased with time. The average As concentration in the water cover increased from 0.281 mg/L to 1.32 mg/L and at the base of the columns As concentration increased from 0.323 mg/L to 1.70 mg/L. The average As concentration in the porewater increased from 1.04 mg/L to 1.42 mg/L. The average copper concentration in the porewater decreased from 0.171 mg/L at the start and to <0.053 mg/L. At the base of the columns the copper concentration decreased from 0.100 mg/L to 0.029 mg/L. The dissolved zinc concentration in the water covers ranged from 0.084 mg/L to 0.616 mg/L. It should be noted that the Zn concentration in the pit water samples used in the column study was 0.738 mg/L. In the porewater samples, the average Zn concentration decreased from 0.094 mg/L to <0.01 mg/L. The Zn concentration at the base also decreased with time.

The lower Zn concentration observed in the columns could be due to adsorption of zinc on mineral surfaces in the tailings. The average dissolved Sb concentration in the water covers ranged from 0.052 to 0.099 mg/L. In the porewater and at the base the average Sb concentrations decreased with time to 0.025 and <0.010 mg/L, respectively.

LOW SULFIDE COLUMNS

Tables E4 and E5 show the water chemistry of samples collected at the water cover, the porewater and at the base of the low sulfide columns. The Total CN in the water covers and porewater were <0.05 mg/L. The maximum Total CN concentration in the porewater of one of the columns was 0.076 mg/L. The WAD CN concentrations in the water covers and porewater were also <0.05 mg/L. At the base of the columns, the WAD CN concentration was also <0.05 mg/L, with the exception of only one sample having a WAD CN value of 0.14 mg/L. The CNO concentrations in the water covers were <5 mg/L. The maximum CNO concentration of 8 mg/L was observed in the porewater of one of the columns. The CNS concentrations in the water covers and the porewater were below detection limits. At the base of the columns CNS was <5 mg/L in the samples collected in December; however CNS was 10 mg/L in the samples collected in January and February 2002. The NH_4-N concentrations in the water covers ranged from 0.5 to 3.3 mg/L. In the porewater, the average NH_4-N concentration decreased from 23.4 mg/L to 9.0 mg/L. At the base of the columns, the average NH_4-N concentration increased from 7.4 mg/L to 23.5 mg/L. The SO_4 concentration increased in the water cover and at the base of the columns, while a decrease in SO_4 concentration was observed in the porewater.

Table E4: Water chemistry of samples collected at the water cover, the porewater and at the base of the columns containing low sulphide tailings.

Sample Date	pH						Conductivity (μS/cm)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	7.50	7.49	7.87	7.63	7.51	7.56	970	980	2440	2220	1070	1220
19-Dec-01	8.40	8.26	7.98	8.00	7.47	7.61	1220	1250	2380	2380	2310	2370
15-Jan-01	8.14	7.84	7.97	7.85	7.70	7.40	1620	1630	2400	2430	2730	2790
11-Feb-02	7.57	7.82	7.96	8.05	7.93	8.02	1590	1770	2570	3030	3030	3060

Sample Date	Total CN (mg/L)						WAD CN (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	*	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
19-Dec-01	<0.05	<0.05	<0.05	<0.05	<0.05	0.054	*	<0.05	*	<0.05	<0.05	<0.05
15-Jan-01	<0.05	*	<0.05	<0.05	0.076	<0.05	*	<0.05	*	<0.05	<0.05	<0.05
11-Feb-02	<0.05	<0.05	<0.05	<0.05	0.051	0.051	<0.05	<0.05	<0.05	<0.05	0.14	<0.05

Table E4 (Cont.)

Sample Date	CNO** (mg/L)						CNS** (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
19-Dec-01	<2	<2	*	<2	<2	<2	<5	<5	*	<5	<5	<5
15-Jan-01	<2	<1	<1	3	<1	<1	<2	<2	<2	<2	10	10
11-Feb-02	<1	2	8	5	<1	4	<2	<2	<2	<2	11	12

Sample Date	NH_4-N (mg/L)						SO_4 (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	0.8	1.5	22.6	24.1	7.0	7.8	402	399	1914	1914	960	936
19-Dec-01	2.9	3.3	*	16.9	20.6	18.5	666	711	1857	1851	1713	1695
15-Jan-01	0.5	2.1	14.2	15.2	24.3	24.3	915	918	1593	1647	1800	1791
11-Feb-02	0.5	0.7	8.2	9.7	24.7	22.2	958	901	1514	1740	1837	1911

Sample Date	NO_2-N (mg/L)						NO_3-N (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	5.8	5.8	0.22	0.22	3.6	3.6
19-Dec-01	<0.3	<0.3	*	<0.3	<0.3	<0.3	3.8	3.5	<0.22	<0.22	<0.22	<0.22
15-Jan-01	0.95	2.92	0.21	<0.3	<0.3	<0.3	6.1	2.5	<0.22	<0.22	<0.22	<0.22
11-Feb-02	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	6.7	7.0	<0.22	<0.22	<0.22	<0.22

Note: C1 and C2 denote Column 1 and Column 2 set up for the scenario. *Sample not analyzed. **The detection limit decreased upon request.

Table E5: The dissolved As, Cu, Zn and Sb concentrations in the water cover, the porewater and at the base of the columns containing low sulphide tailings.

Sampling Date	As (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.293	0.285	0.289	0.825	0.788	0.806	0.199	0.264	0.232
19-Dec-01	0.297	0.310	0.303	1.09	1.70	1.40	0.728	0.521	0.625
15-Jan-02	0.406	0.356	0.381	1.68	1.74	1.71	1.75	2.09	1.92
11-Feb-02	0.366	0.474	0.420	1.62	1.69	1.66	2.57	2.59	2.58

Sampling Date	Cu (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.026	0.042	0.034	0.036	0.034	0.035	0.026	0.035	0.031
19-Dec-01	0.040	0.026	0.033	<0.025	0.044		<0.025	0.027	
15-Jan-02	0.033	0.037	0.035	0.031	0.029	0.030	0.029	0.031	0.030
11-Feb-02	0.034	0.044	0.039	0.033	0.028	0.031	0.032	0.030	0.031

Table E5 (Cont.)

Sampling Date	Zn (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.644	0.524	0.584	0.159	0.163	0.161	0.211	0.183	0.197
19-Dec-01	0.263	0.682	0.473	0.143	0.337	0.240	0.062	0.276	0.169
15-Jan-02	0.187	0.152	0.170	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
11-Feb-02	0.465	0.228	0.373	0.029	0.027	0.028	<0.010	0.012	

Sampling Date	Sb (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.136	0.100	0.118	0.758	0.734	0.746	0.129	0.241	0.185
19-Dec-01	0.131	0.187	0.159	0.164	0.231	0.198	0.085	0.069	0.077
15-Jan-02	0.447	0.471	0.459	0.279	0.147	0.213	0.010	0.020	0.015
11-Feb-02	0.490	0.412	0.451	0.172	0.122	0.147	0.012	0.014	0.013

Note: C1 and C2 denote Column 1 and Column 2 for the scenario. The Brown-McDade pit water metal concentrations: As = 0.024 mg/L, Cu = 0.065 mg/L, Zn = 0.738 mg/L, and Sb = 0.035 mg/L.

In general, higher concentrations of dissolved As were observed in the porewater and at the base of the columns than in the water cover. In the porewater, the average arsenic concentration increased from 0.806 mg/L to 1.66 mg/L and at the base of the column, the average As concentration increased from 0.232 mg/L to 2.58 mg/L. The maximum dissolved copper concentration in the samples collected was 0.044 mg/L. The average dissolved Zn concentration in the water cover ranged from 0.584 mg/L to 0.170 mg/L. Dissolved Zn concentrations in the porewater and at the base of the columns were higher at the start of the column study and significantly decreased with time, most likely as a result of sorption of Zn ions onto mineral surfaces. The average Sb concentration in the water cover increased from 0.118 to 0.451 mg/L. In the porewater and at the base of the columns, the average Sb concentration decreased with time to 0.147 mg/L and 0.013 mg/L, respectively. The Sb concentrations in the water cover and the porewater of the low sulfide tailings were higher than those in the high sulphide tailings columns.

MIXED TAILINGS SLURRY COLUMNS

Tables E6 and E7 show the water chemistry of samples collected at the water cover, porewater and at the base of the mixed tailings slurry columns. The water cover layer achieved in Column 2 after settling of the tailings from the slurry was lower than the design depth of 7.5 cm and also a small leak had occurred overnight after samples were collected on December 3, 2001. Therefore, on December 6, 2001, 610 mL of additional pit water was added to the column to maintain the desired water cover depth of 7.5 cm. The conductivity of the water cover in the mixed tailings slurry columns was higher than those measured in the high and low sulfide columns. The Total CN concentration in the water covers was <0.05 mg/L. The maximum Total CN concentrations in the porewater and at the base were 0.082 and 0.066 mg/L, respectively. The WAD CN concentrations in the water cover, the porewater and at the base were <0.05 mg/L. The CNO concentration in the water covers was below 5 mg/L. The average CNS concentration in the water covers decreased from 68 mg/L to less than 2 mg/L. The CNS concentration in the porewater also decreased, while the CNS concentration at the base of the columns increased. The average NH_4-N concentration in the porewater decreased from 26 mg/L to 18.3 mg/L and at the base of the columns the average ammonia concentration increased from 14.8 mg/L to 21.7 mg/L. The mixed tailings slurried columns generally had higher NH_4-N in the water covers than the low sulfide columns. The average SO_4 concentration in the water covers decreased from 2091 mg/L to 1188 mg/L. In the porewater the average SO_4 concentration slightly decreased from 1977 to 1817 mg/L. However, the SO_4 concentration at the base of the columns increased from 1427 mg/L to 1941 mg/L. The concentrations of CNS, NH_4-N and SO_4 at the base of the columns increased with time likely due to flushing (from upper regions of the column) created by sampling at the base.

Table E6: Water chemistry of samples at the water cover, the porewater, and at the base of the columns containing mixed tailings deposited in the slurry form.

Sample Date	pH						Conductivity (µS/cm)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	7.59	7.70	7.95	8.06	7.43	7.61	2730	2750	2680	2690	1930	2030
19-Dec-01	7.93	8.03	8.40	8.40	7.90	7.95	2180	1710	2650	2540	2540	2840
15-Jan-01	7.75	7.49	8.35	8.25	8.06	7.96	2280	1610	*	2520	2830	2960
11-Feb-02	7.63	7.22	8.31	8.24	7.93	8.02	2240	1870	3030	3030	3030	3060

Sample Date	Total CN (mg/L)						WAD CN (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
19-Dec-01	<0.05	<0.05	0.058	<0.05	0.054	0.063	*	<0.05	<0.05	*	<0.05	<0.05
15-Jan-01	<0.05	*	0.082	<0.05	0.066	<0.05	*	<0.05	<0.05	*	<0.05	*
11-Feb-02	<0.05	<0.05	0.052	<0.05	0.060	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Sample Date	CNO** (mg/L)						CNS (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<5	<5	<5	<5	<5	<5	67	69	67	67	22	39
19-Dec-01	<2	<2	<2	<2	<2	<2	7	<5	64	45	47	72
15-Jan-01	<1	1	1	<1	<1	<1	<2	<2	50	9	62	58
11-Feb-02	3	1	<1	<1	4	2	<2	<2	28	11	66	50

Sample Date	NH_4-N (mg/L)						SO_4 (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	21.8	21.0	26.4	25.6	12.4	17.1	2091	2091	1968	1986	1269	1584
19-Dec-01	21.0	8.9	26.1	22.8	18.8	23.6	1616	1104	2184	2115	1896	2166
15-Jan-01	19.8	5.5	23.3	18.8	22.5	23.9	1443	897	1887	1719	1824	1917
11-Feb-02	13.3	5.9	20.0	16.6	20.1	23.2	1328	1048	1857	1758	1888	1995

Table E6 (Cont.)

Sample Date	NO_2-N (mg/L)						NO_3-N (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	0.6	0.6	0.6	0.6	0.9	0.6	2.9	3.2	<0.2	<0.2	2.9	2.0
19-Dec-01	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.22	1.8	<0.22	<0.22	<0.22	<0.22
15-Jan-01	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22
11-Feb-02	2.1	<0.3	<0.3	<0.3	<0.3	<0.3	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22

Note: C1 and C2 denote Column 1 and Column 2 for the scenario. *Sample not analyzed. **The detection limit decreased upon request.

Table E7: Dissolved As, Cu, Zn and Sb concentrations in the water cover, the porewater and at the base of the columns containing mixed tailings deposited in the slurry form.

Sampling Date	As (mg/)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.933	0.936	0.929	0.918	1.06	0.989	0.451	0.583	0.517
19-Dec-01	0.709	0.286	0.498	1.45	1.41	1.43	1.52	1.30	1.41
15-Jan-02	0.933	0.593	0.763	1.46	1.43	1.45	1.28	1.40	1.34
11-Feb-02	0.611	1.39	1.00	1.43	1.35	1.39	1.56	1.68	1.62

Sampling Date	Cu (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.072	0.077	0.075	0.069	0.046	0.058	0.010	0.034	0.022
19-Dec-01	0.030	<0.025		0.029	<0.025		<0.025	<0.025	<0.025
15-Jan-02	0.035	0.035	0.035	0.029	0.029	0.029	0.031	0.033	0.032
11-Feb-02	0.038	0.040	0.039	0.049	0.025	0.037	0.032	0.034	0.033

Sampling Date	Zn (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.238	0.441	0.340	0.108	0.042	0.075	0.217	0.065	0.141
19-Dec-01	0.064	0.042	0.053	0.029	0.029	0.029	0.052	0.018	0.035
15-Jan-02	0.046	0.059	0.053	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
11-Feb-02	0.125	0.092	0.109	0.069	<0.010		<0.010	<0.010	<0.010

Sampling Date	Sb (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.360	0.372	0.366	0.421	0.408	0.415	0.181	0.255	0.218
19-Dec-01	0.186	0.109	0.147	0.089	0.068	0.079	0.029	0.018	0.023
15-Jan-02	0.125	0.106	0.155	0.032	0.034	0.033	<0.010	0.010	
11-Feb-02	0.139	0.061	0.100	0.031	0.027	0.029	<0.010	<0.010	<0.010

Note: C1 and C2 denote Column 1 and Column 2 for the scenario. The Brown-McDade pit water metal concentrations: As = 0.024 mg/L, Cu = 0.065 mg/L, Zn = 0.738 mg/L, and Sb = 0.035 mg/L.

Table E8: Water chemistry of samples collected at the base of the mixed flow-through tailings columns.

Sample Date	pH		Conductivity		Total CN (mg/L)		WAD CN (mg/L)		CNO** (mg/L)	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
05-Dec-01	8.23	8.24	1730	2100	<0.05	<0.05	<0.05	<0.05	<5	<5
07-Dec-01	8.18	8.22	2530	2900	<0.5	<0.5	<0.05	<0.05	<5	<5
14-Dec-01	7.57	7.99	2940	3130	0.100	0.09	<0.05	<0.05	<1	<1
21-Dec-01	7.45	7.76	3060	3070	0.076	0.081	<0.05	<0.05	<2	<2
02-Jan-02	6.06	6.73	2930	2910	<0.05	0.054	*	<0.05	<2	<2
07-Jan-02	6.76	7.17	2720	2630	<0.05	<0.05	*	*	<2	<2
14-Jan-02	7.21	7.44	2830	2780	<0.05	<0.05	*	<0.05	<1	<1
21-Jan-02	7.08	7.84	2390	2360	<0.05	<0.05	<0.05	<0.05	<1	<1
28-Jan-02	7.46	7.56	2290	2270	<0.05	<0.05	<0.05	<0.05	<1	<1
06-Feb-02	7.82	7.76	2140	2080	<0.05	<0.05	<0.05	<0.05	<1	14

Sample Date	CNS (mg/L)		NH_4-N (mg/L)		SO_4 (mg/L)	
	C1	C2	C1	C2	C1	C2
05-Dec-01	46	65	12.4	14.8	984	1269
07-Dec-01	92	119	26.8	35.2	1764	2154
14-Dec-01	135	135	30.2	30.6	2481	2475
21-Dec-01	124	117	31.7	32.1	2562	2514
02-Jan-02	32	19	31.0	30.2	2367	2334
07-Jan-02	*	*	28.9	28.6	2031	1950
14-Jan-02	<2	<2	27.8	27.1	1875	1833
21-Jan-02	<2	<2	24.8	25.4	1906	1664
28-Jan-02	<2	<2	23.8	22.4	1787	1759
06-Feb-02	<2	<2	18.5	12.5	1645	1260

Note: C1 and C2 denote Column 1 and Column 2 for the scenario. *Sample not analyzed. **The detection limit decreased upon request.

Table E9: Dissolved As, Cu, Zn and Sb concentrations at the base of the mixed tailings flow through columns.

Sample Date	As (mg/L)			Cu (mg/L)		
	C1	C2	Average	C1	C2	Average
05-Dec-01	0.253	0.259	0.256	0.168	0.212	0.190
07-Dec-01	0.362	0.349	0.355	0.193	0.196	0.194
14-Dec-01	0.613	0.493	0.553	0.08	0.082	<0.081
21-Dec-01	0.894	0.898	0.896	0.114	0.026	0.070
02-Jan-02	1.11	1.07	1.09	<0.016	<0.016	<0.016
07-Jan-02	1.32	1.32	1.32	<0.018	<0.018	<0.018
14-Jan-02	1.54	1.37	1.46	0.034	0.028	0.031
21-Jan-02	1.01	0.978	0.994	0.031	0.031	0.031
28-Jan-02	1.07	0.904	0.987	<0.02	<0.02	<0.02
06-Feb-02	0.999	0.939	0.969	0.031	0.028	0.029

Sample Date	Zn (mg/L)			Sb (mg/L)		
	C1	C2	Average	C1	C2	Average
05-Dec-01	0.110	0.080	0.010	0.310	0.226	0.268
07-Dec-01	0.075	0.058	0.067	0.406	0.420	0.413
14-Dec-01	0.068	0.156	0.112	0.480	0.420	0.450
21-Dec-01	0.031	0.037	0.034	0.115	0.049	0.082
02-Jan-02	<0.010	<0.010	<0.010	0.105	0.041	0.073
07-Jan-02	0.047	0.047	0.047	0.095	0.043	0.069
14-Jan-02	<0.010	<0.010	<0.010	0.098	0.034	0.066
21-Jan-02	<0.010	<0.010	<0.010	0.111	0.043	0.078
28-Jan-02	<0.026	<0.026	<0.026	0.092	0.033	0.062
06-Feb-02	0.013	0.013	0.013	0.086	0.081	0.084

Note: C1 and C2 denote Column 1 and Column 2 set up for the scenario. The Brown-McDade pit water metal concentrations: As = 0.024 mg/L, Cu = 0.065 mg/L, Zn = 0.738 mg/L, and Sb = 0.035 mg/L.

Table E7 shows the dissolved arsenic, copper, and zinc concentrations in the water cover, the porewater and at the base of the columns. The average arsenic concentration in water cover ranged from 0.498 mg/L to 1.00 mg/L. The average porewater As concentration increased from 0.989 mg/L to 1.49 mg/L and at the base of the columns the average As increased from 0.517 mg/L to 1.62 mg/L. The water cover of slurried columns had generally a higher As concentration compared to the water covers in the high and low sulphide columns. The maximum copper concentration in the water cover, the porewater and at base of the columns were 0.077 mg/L, 0.069 mg/L and 0.034 mg/L, respectively. The average zinc concentration in the water cover ranged from 0.340 mg/L at the start to 0.109 mg/L. In porewater and at the base the average zinc concentrations were 0.075 mg/L and 0.141 mg/L at the start and decreased with time. At the start, the average Sb concentrations in the water cover, the porewater and at the base were 0.366 mg/L, 0.415 mg/L and 0.218 mg/L respectively. The Sb concentration in the water cover, the porewater and at the base decreased with time to 0.100, 0.029 and <0.010 mg/L, respectively.

MIXED TAILINGS FLOW THROUGH COLUMN

Tables E8 and E9 show the water chemistry of samples collected at the base of the flow through columns. The conductivity of samples collected at the base of the columns increased from an average of 1915 μS/cm to a maximum of 3065 μS/cm and then decreased to 2635 μS/cm. The maximum Total CN concentration observed was 0.100 mg/L. The majority of samples collected had Total CN concentrations of <0.05 mg/L. The WAD CN concentrations were <0.05 mg/L. CNO was only detected in the sample collected in February at a concentration of 14 mg/L. The average CNS concentration at the start was 55.5 mg/L and increased to a maximum value of 135 mg/L in 10 days and then decreased to 25.6 mg/L in approximately three weeks. In approximately six weeks the measured CNS concentration was less than 1 mg/L. The average NH_4-N concentration at the start was 13.6 mg/L, increased to 31.9 mg/L and then decreased to 15.5 mg/L. The average SO_4 concentration increased from 1127 mg/L to a maximum of 2538 mg/L and then decreased to 1453 mg/L. The average nitrite-N concentration was less than 0.3 mg/L and the average nitrate-N concentration rapidly decreased from 3.6 mg/L at the start to <0.22 mg/L. The average concentration of As increased from 0.256 mg/L at the start to a maximum concentration of 1.46 mg/L and then decreased to 0.969 mg/L. The average dissolved copper concentration decreased from 0.19 mg/L to 0.029 mg/L and the average dissolved Zn concentration decreased from 0.109 to 0.013 mg/L. The Sb concentration initially increased from 0.268 mg/L to 0.450 mg/L and then decreased to 0.082 mg/L.

The results presented above are for the period of December 2001 to February 2002. The column monitoring and sampling is likely to continue till August/September 2002.

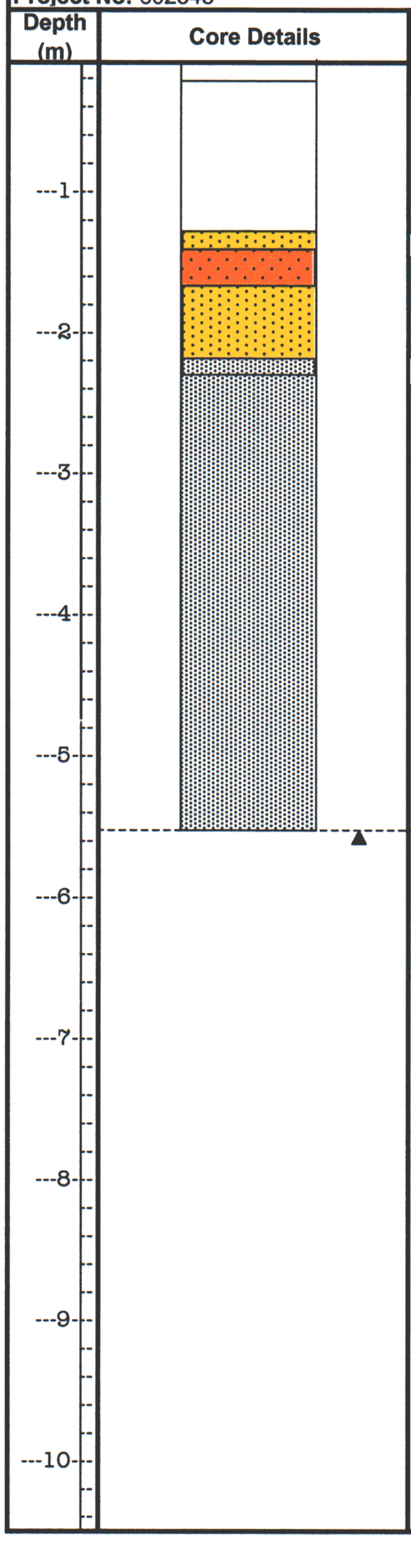
Tailings Core Log

Core No: **MN BH 10**

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.514 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001

Project No: 602345
Drilling Method: Sonic



Description	Sample #	Comments
ice		
water	MN BH10-01	
grey brown silty clay	MN BH10-03	
light brown clay interbed	MN BH10-02	
grey brown silty clay	MN BH10-03	
grey native sand at tailings interface	MN BH10-04	
coarse, grey native sand with roots, organics near bottom	MN BH10-05	

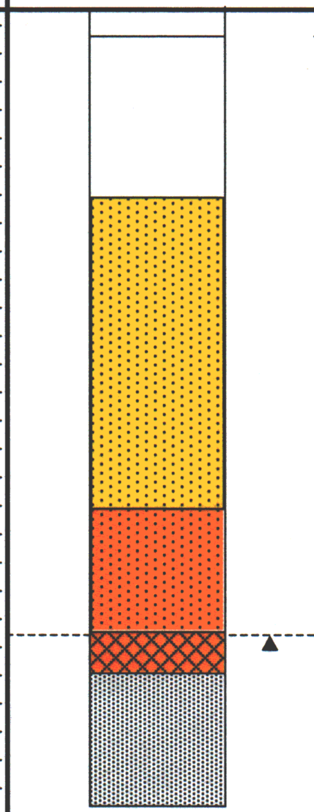
Tailings Core Log

Core No: MN BH 11

Project: Mt. Nansen Tailings Chemical Stability | **Elevation:** 1148.524 m

Location: Mt. Nansen, Yukon Territory | **Sampling Date:** November 16th 2001

Project No: 602345 | **Drilling Method:** Sonic

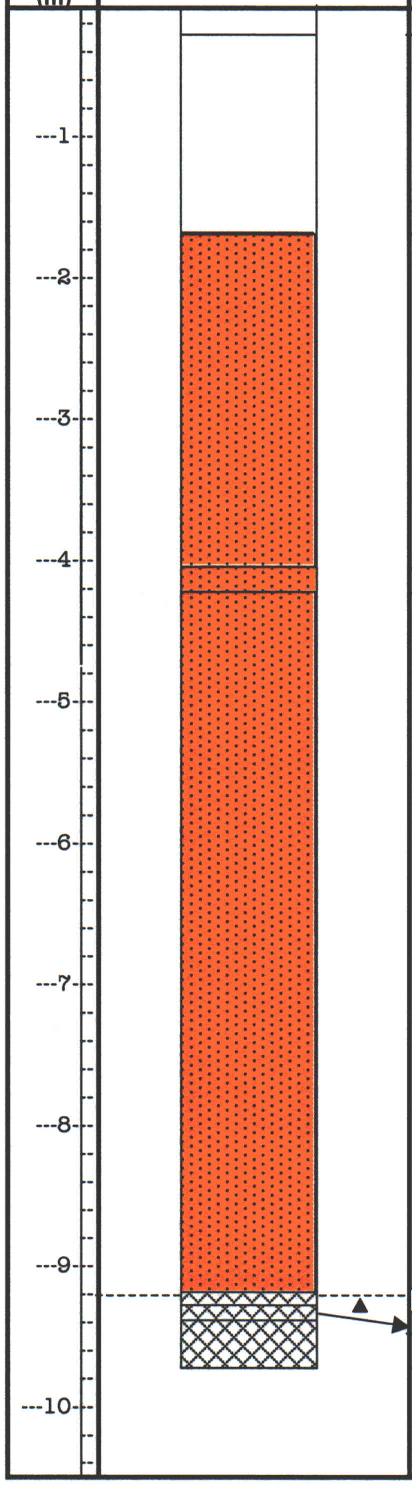


Depth (m)	Core Details	Description	Sample #	Comments
		ice		
1		water	MN BH11-01	
2–3		grey brown silty clay	MN BH11-02	
4		light grey brown silty clay	MN BH11-03	
		clay/peat interface	MN BH11-04	
5		black organic rich soil (black muck with sandy interval)	MN BH11-05	
6				
7				
8				
9				
10				

Tailings Core Log

Core No: MN BH 12

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.514 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 16th 2001
Project No: 602345
Drilling Method: Sonic



Depth (m)	Core Details	Description	Sample #	Comments
		ice		
		water	MN BH12-01	
		light brown clay with <5% grey streaks	MN BH12-02	light grey brown silty clay (laboratory identification)
		light brown clay 50% grey streaks	MN BH 12-03	light grey brown plastic clay
		brown plastic clay with <2% grey streaks	MN BH12-04	brown silty clay (laboratory identification)
		frozen peat grading into grey organic rich soil	MN BH12-05	brown plastic clay in peat
		peat	MN BH12-06	
		black peat and sand	MN BH12-07	

Tailings Core Log

Core No: MN BH 13

Project: Mt. Nansen Tailings Chemical Stability

Elevation: 1148.513 m

Location: Mt. Nansen, Yukon Territory

Sampling Date: November 17th 2001

Project No: 602345

Drilling Method: Sonic

Depth (m)	Core Details	Description	Sample #	Comments
		ice		
		water	MN BH13-01	
---1---		grey plastic clay <40% brown streaks	MN BH13-02	grey brown plastic clay (laboratory classification)
---2---				
---3---		grey brown plastic clay with 50% brown	MN BH13-03	light grey brown plastic clay (laboratory classification)
---4---		brown plastic clay with 30% grey	MN BH13-04	brown plastic clay (laboratory classification)
---5---				
---6---		brown plastic clay with <10% grey	MN BH13-05	brown plastic clay (laboratory classification)
---7---				
---8---				
---9---				
---10---				

Tailings Core Log

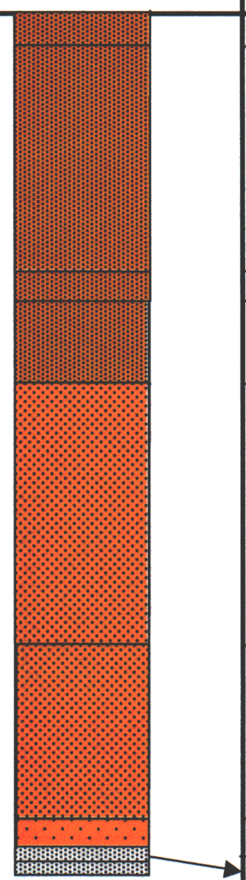
Core No: MN BH 14

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1150.103 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001

Project No: 602345
Drilling Method: Sonic

Depth (m): scale 1–10



Description	Sample #	Comments
light brown frozen silt		NOT SAMPLED
moist light brown silty sand	MN BH 14-01	yellow brown silt (upon re-examination)
light grey brown clayey silt (20% clay)	MN BH14-02	light grey brown silt
light brown sandy silt	MN BH 14-03	grey brown silt (upon re-examination)
saturated light brown clay with 25% slushy sections	MN BH14-04	light grey brown clayey silt (laboratory classification)
brown silt with 20-30% clay	MN BH14-05	grey brown clayey silt (laboratory classification)
brown plastic clay with 20% grey	MN BH14-06	light brown plastic clay
contact zone with native sand, plant remains	MN BH14-07	dark grey organic soil
native sand	MN BH14-08	

Tailings Core Log

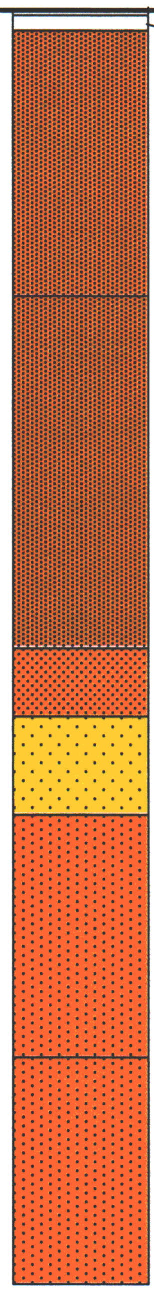
Core No: MN BH 15

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.527 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 17th 2001

Project No: 602345
Drilling Method: Sonic

Core Details:



Depth scale (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Description	Sample #	Comments
ice		
water	MN BH15-01	
saturated brown sand, 1-2% sulfides	MN BH15-02	brown silty sand (laboratory classification)
saturated brown sand 1-2% sulfides	MN BH15-03	light brown silty sand (laboratory classification)
brown clayey silt, 20% grey streaks	MN BH15-04	light grey brown clayey silt
grey brown plastic clay (20-25% grey streaks)	MN BH15-05	light grey brown plastic clay (laboratory classification)
brown silty clay, plastic (10% grey streaks)	MN BH15-06	brown plastic silty clay (laboratory classification)
brown silty clay, plastic (<10% grey streaks)	MN BH 15-07	brown silty clay, plastic (laboratory classification)

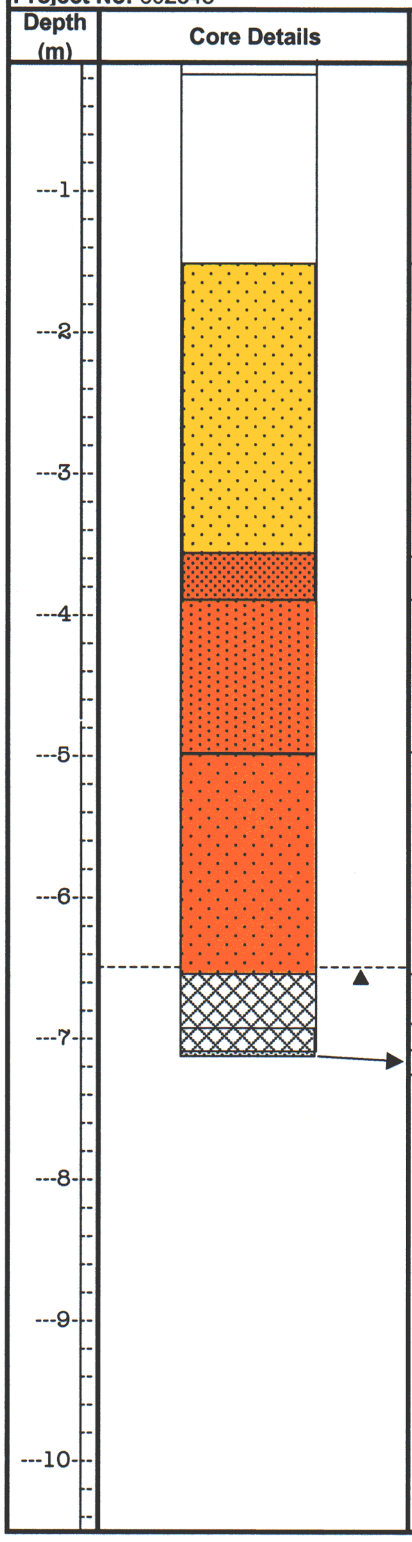
Tailings Core Log

Core No: MN BH 16

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.492 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001

Project No: 602345
Drilling Method: Sonic

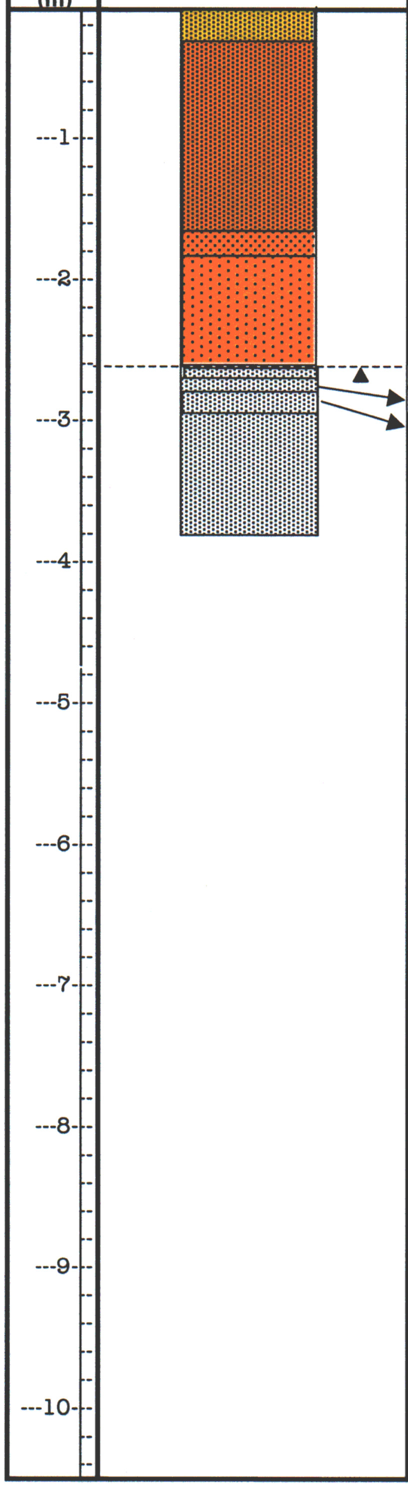


Description	Sample #	Comments
ice		
water	MN BH16-01	
grey brown clay ,<40% brown	MN BH16-02	
light grey brown silt (clayey)	MN BH16-03	
light grey brown plastic clay (<30% grey), silty	MN BH16-04	
light grey yellow brown plastic clay (<20% grey), locally silty	MN BH16-05	
peat moss at contact with clay	MN BH16-06	
black organic rich soil and peat	MN BH16-07	
dark grey frozen sand		NOT SAMPLED

Tailings Core Log

Core No: MN BH 17

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1149.454 m
Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001
Project No: 602345
Drilling Method: Sonic



Depth (m)	Description	Sample #	Comments
	frozen beige sandy silt	MN BH17-01	grey brown sandy silt (thawed)
1	brown, moist silty sand	MN BH17-02	yellow brown silt, slightly sandy (upon re-examination)
	saturated brown silt (20% grey)	MN BH17-03	light grey brown clayey silt
2	clayey silt, 20% brown, <20% clay	MN BH17-04	light grey brown silty clay (laboratory classification)
	native sand in contact with clayey silt	MN BH17-05	
	grey native sand 10-20 cm below contact	MN BH17-06	
3	grey native sand 20-30 cm below contact	MN BH17-07	
	wet native sand	NOT SAMPLED	

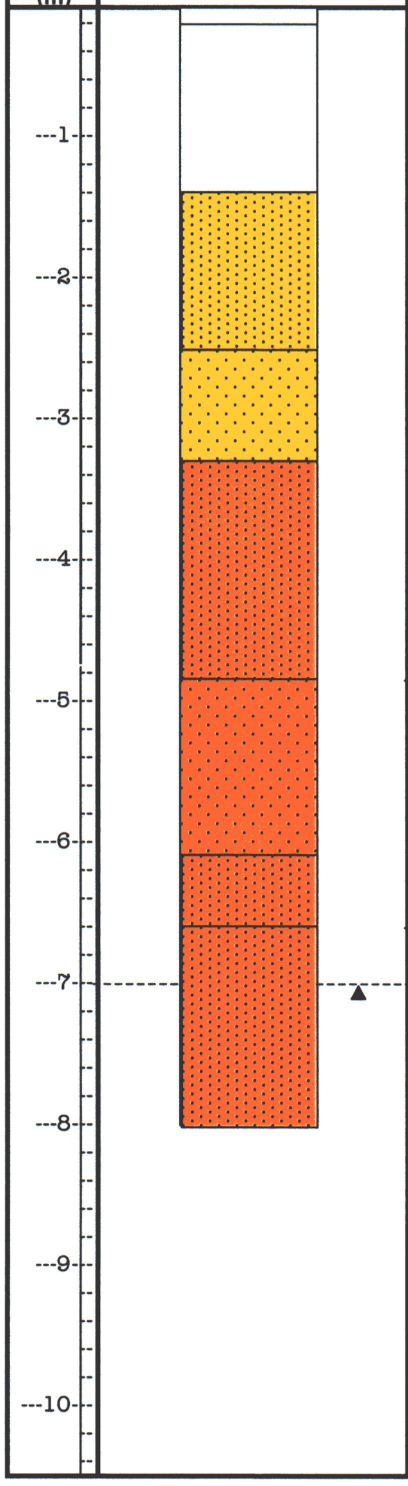
Tailings Core Log

Core No: MN BH 18

Project: Mt. Nansen Tailings Chemical Stability
Elevation: 1148.716 m

Location: Mt. Nansen, Yukon Territory
Sampling Date: November 18th 2001

Project No: 602345
Drilling Method: Sonic

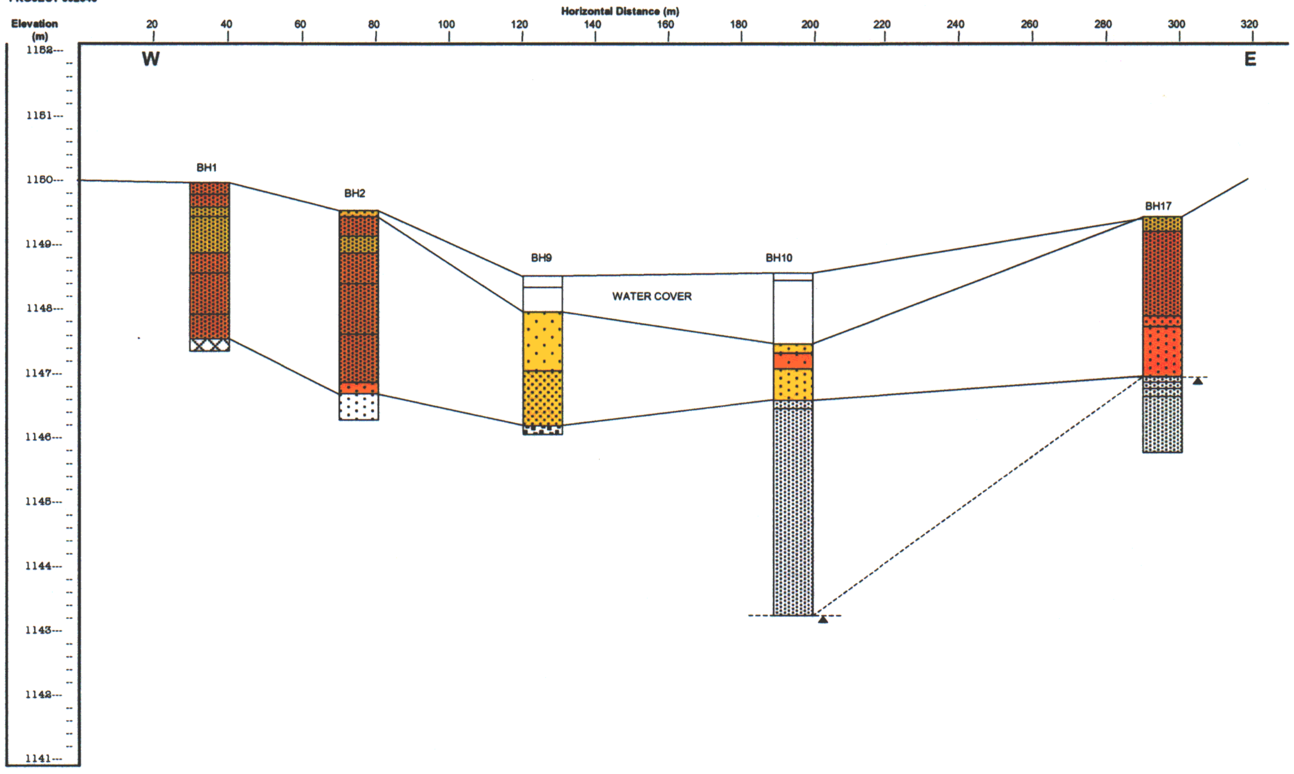


Depth (m)	Core Details	Description	Sample #	Comments
		ice		
		water	MN BH18-00	
		grey brown silty clay	MN BH18-01	
		grey brown plastic clay, 50% clay	MN BH18-02	
		light grey brown clay (25% grey), slightly silty	MN BH18-03	
		brown plastic clay (10% grey)	MN BH18-04	
		light grey brown silty clay with brown sand and ice lenses	MN BH18-05	
		brown silt with 65% ice crystals	MN BH18-06	brown silty clay slurry (thawed)

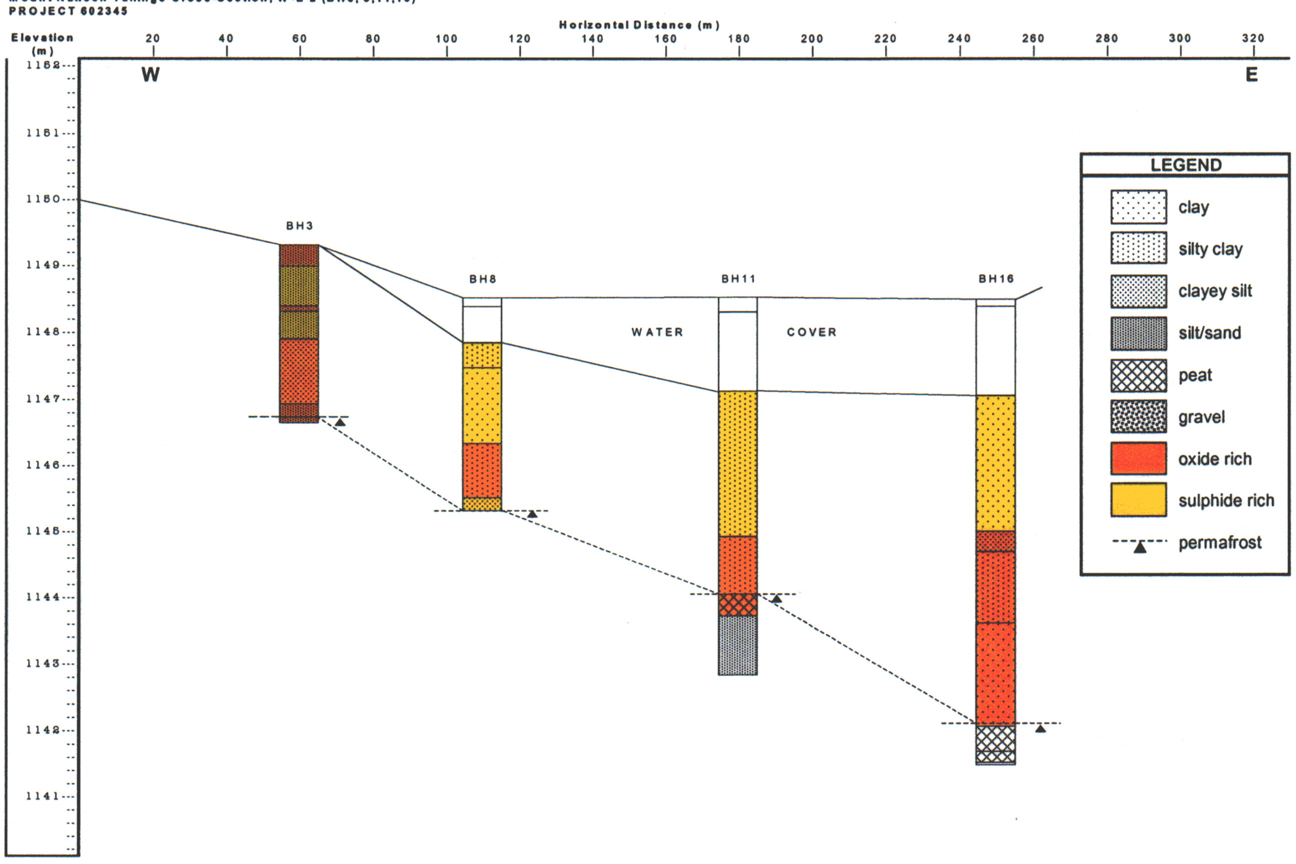
APPENDIX B

Cross Sections of the Tailings Impoundment at Mount Nansen

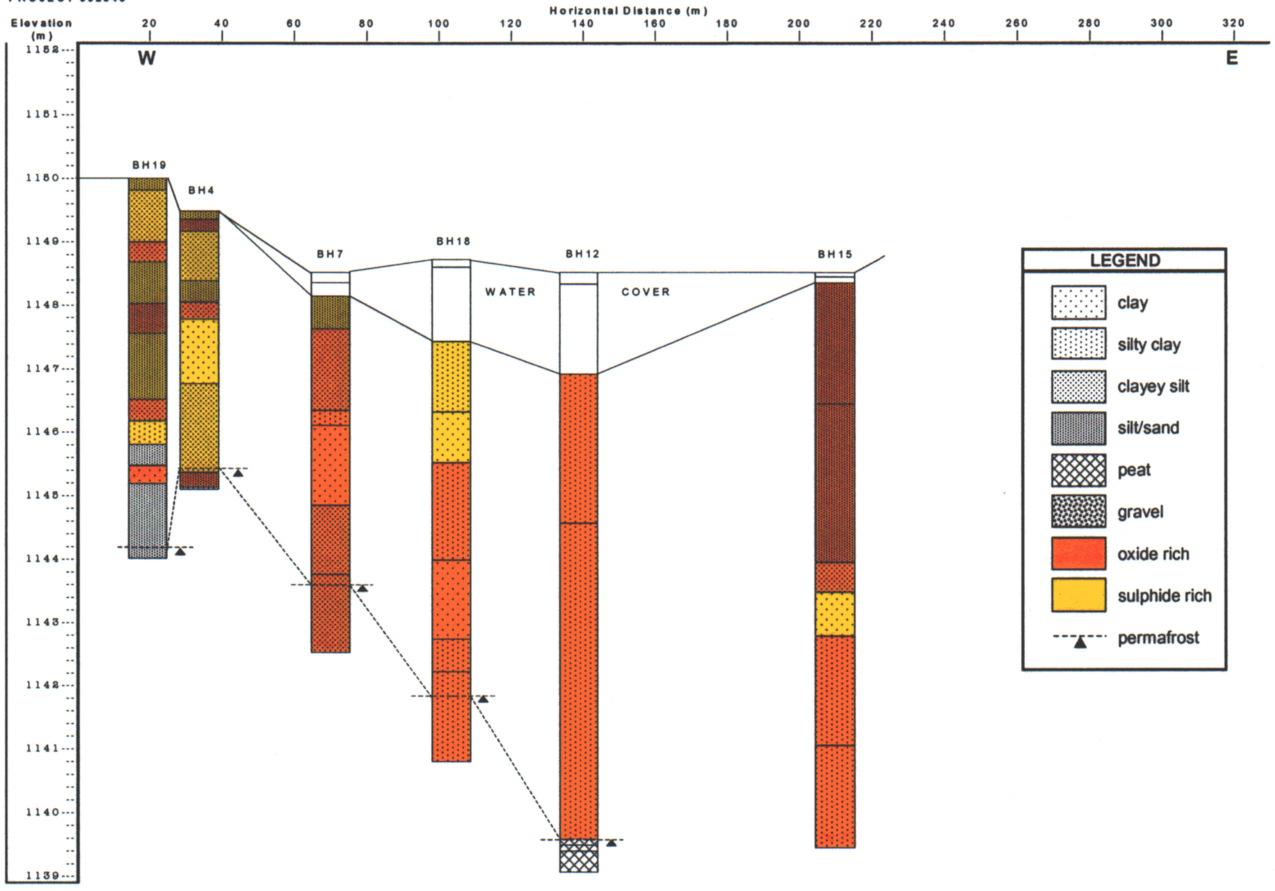
Mount Nansen Tailings Cross-Section, W-E 1 (BH1, 2, 9, 10, 17)
PROJECT 602345



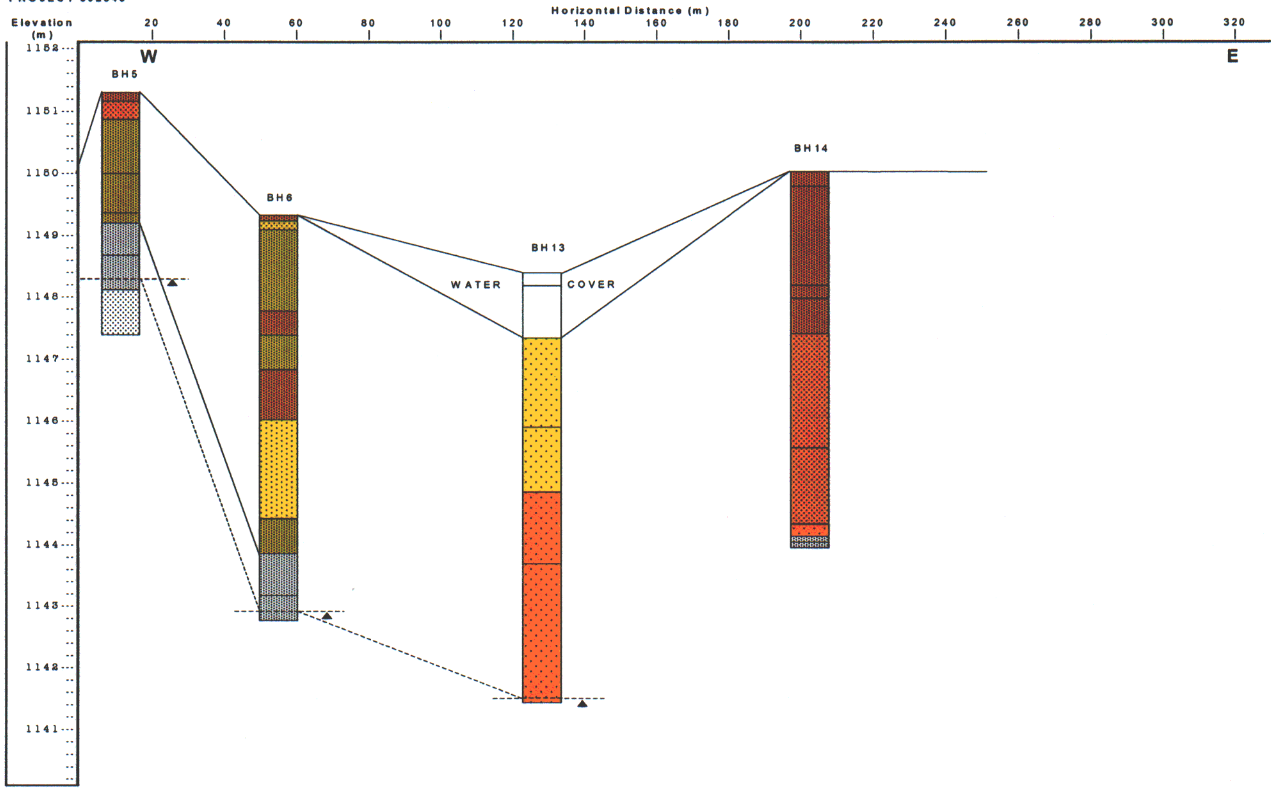
Mount Nansen Tailings Cross-Section, W-E 2 (BH3, 8,11,16)
PROJECT 602345



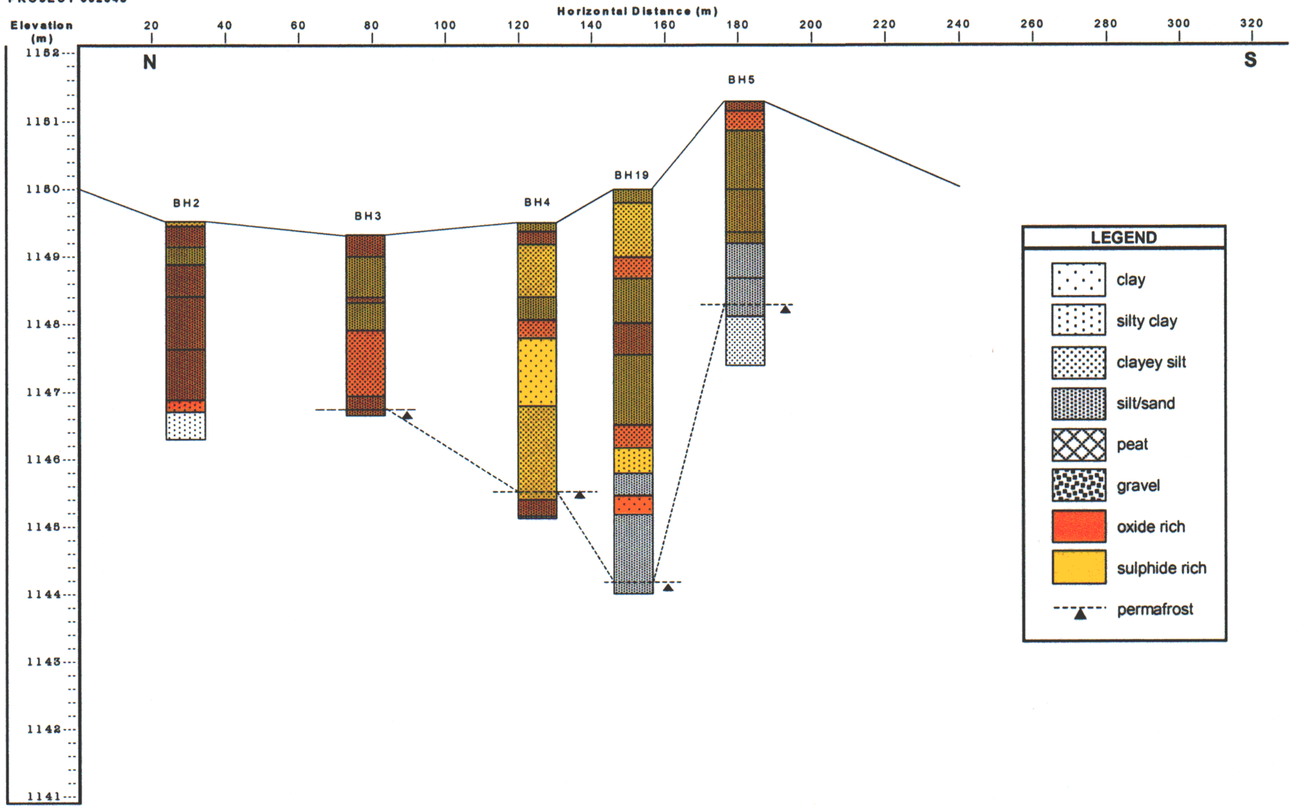
Mount Nansen Tailings Cross-Section, W-E 3 (BH19, 4, 7, 18, 12, 15)
PROJECT 602345



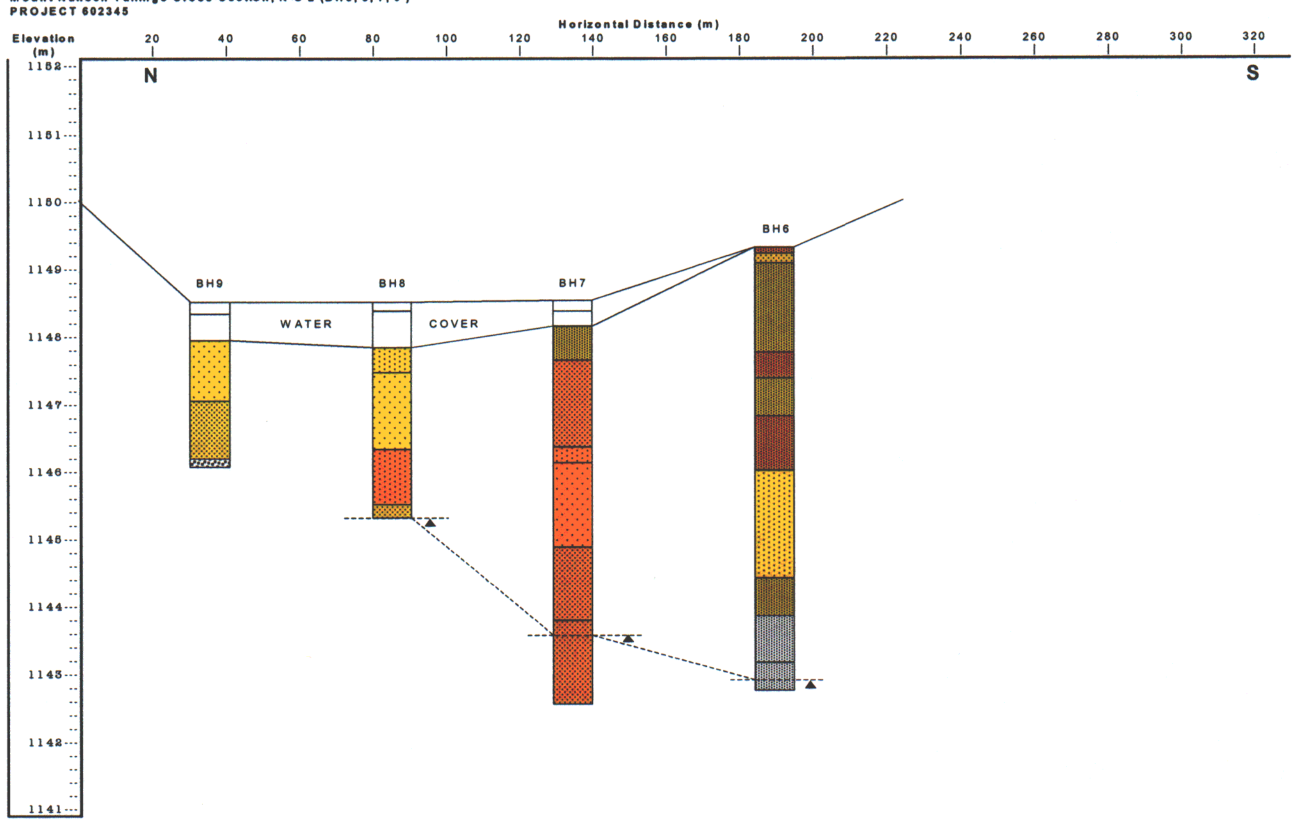
Mount Nansen Tailings Cross-Section, W-E 4 (BH5, 6, 13, 14)
PROJECT 602345



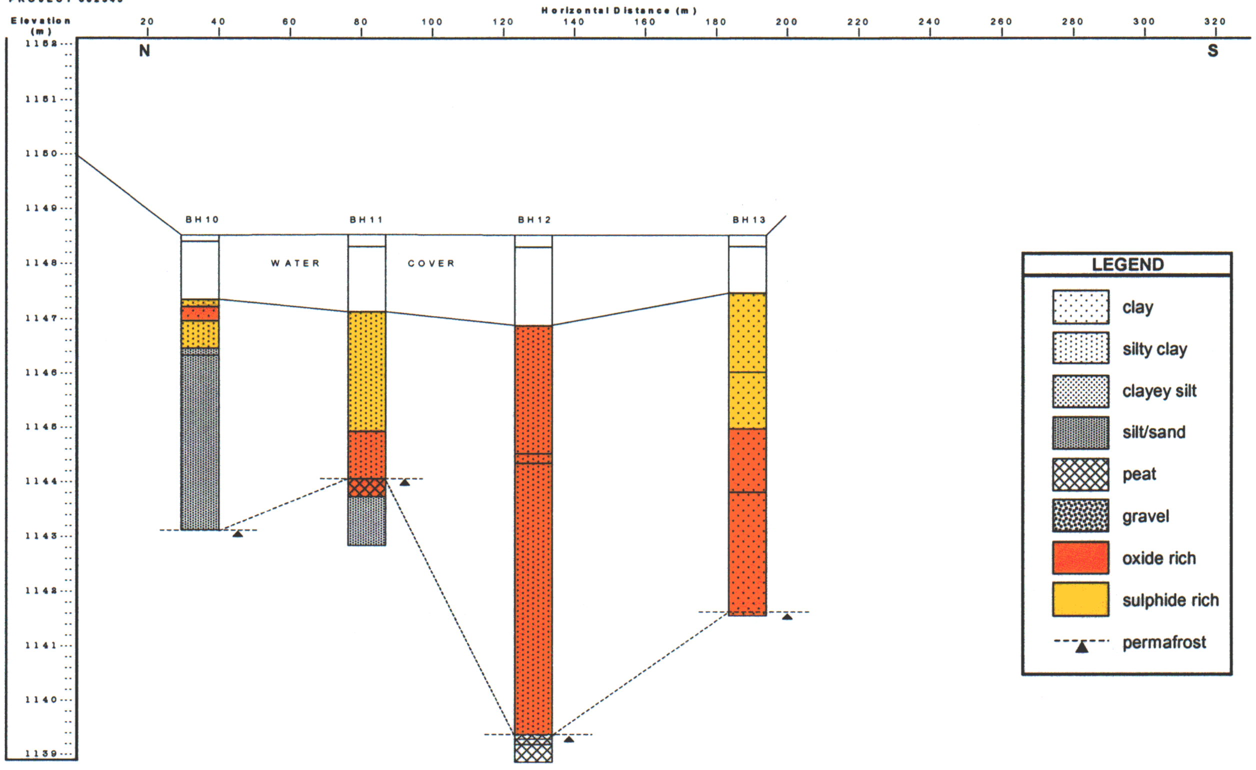
Mount Nansen Tailings Cross-Section, N-S 1 (BH2, 3, 4, 19, 5)
PROJECT 602345



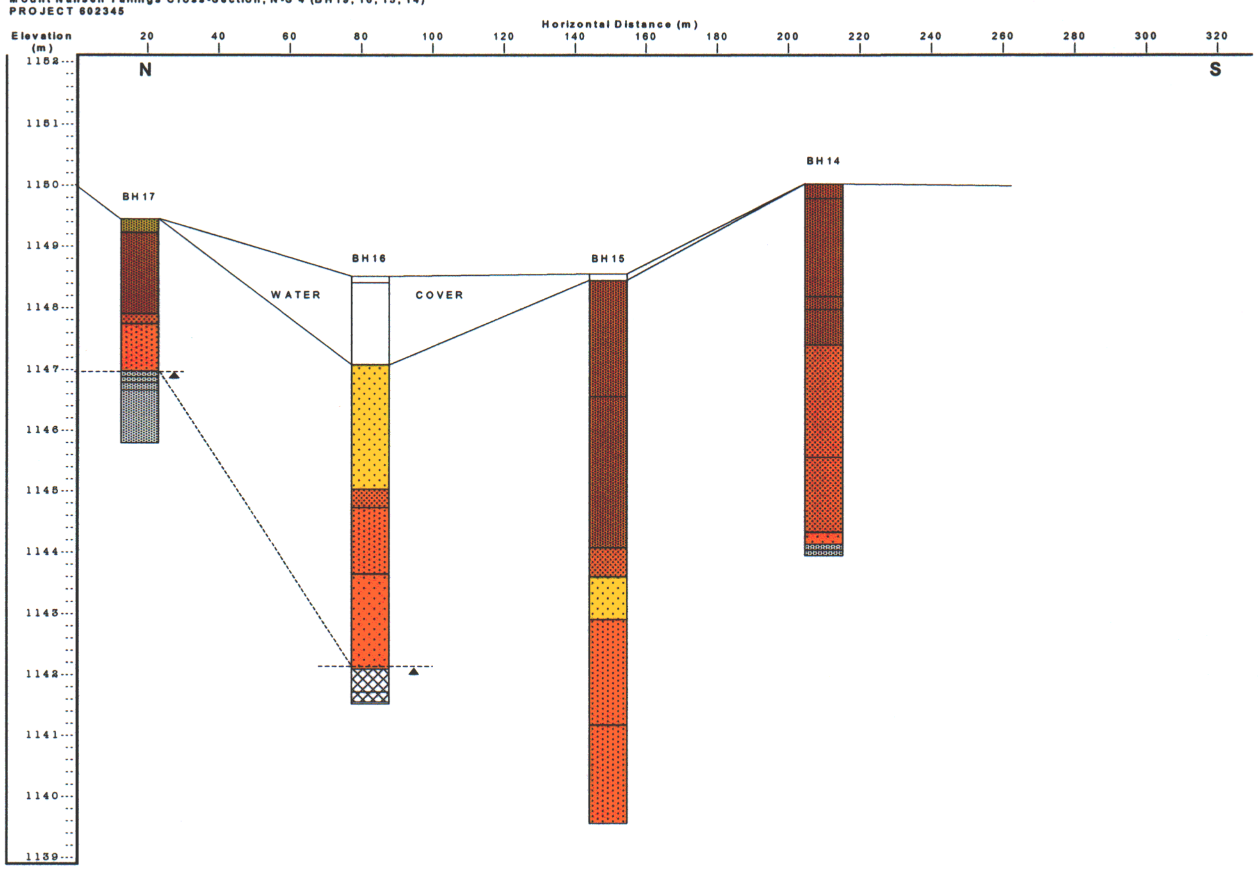
Mount Nansen Tailings Cross-Section, N-S 2 (BH9, 8, 7, 6)
PROJECT 602345



Mount Nansen Tailings Cross-Section, N-S 3 (BH10, 11, 12, 13)
PROJECT 602345



Mount Nansen Tailings Cross-Section, N-S 4 (BH19, 16, 15, 14)
PROJECT 602345



APPENDIX C

Tailings Geochemistry and Particle Size

Appendix C contains the following raw data:

C1. Tailings solids chemistry
  a) Tailings geochemistry as determined by the Analytical Services Group of CANMET-MMSL (**Table C-1a**)
  b) Tailings geochemistry as determined by B.C. Research Inc. (**Table C-1b**)

C2. Acid base accounting analyses of selected tailings solids as determined by B.C. Research Inc. (**Table C-2**)

C3. Porewater chemistry of samples extracted in the field and surface water chemistry at selected locations (Analysis by the Analytical Services Group, CANMET-MMSL) (**Table C-3**).

C4. Detailed particle size analyses of selected samples covering the four varieties of tailings identified (Grain size distribution curves and related data) (**Appendix C-4**)

Table C-1a: Tailings geochemistry as determined by the Analytical Services Group of CANMET-MMSL

	FIELD #	SAMPLE TYPE	Ag µg/g	Al %	As µg/g	B µg/g	Ba µg/g	Bi µg/g	Ca %	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe %	K %
6394 AES-SCAN	MN0101	oxide silt	31	5.56	2700	354	828	<15	2.11	40	7	34	717	5.36	2.03
	MN0103	sulfide silt	24	5.21	2810	557	798	<15	1.96	45	9	26	628	5.88	1.85
	MN0106	oxide silt	20	3.50	2620	165	568	<15	0.623	20	3	17	248	3.65	1.36
	MN0201	sulfide silt	26	5.19	2530	78	832	<15	2.13	39	6	25	880	4.80	1.89
	MN0205	oxide silt	29	4.22	2990	368	699	<15	1.28	34	5	19	529	4.99	1.63
	MN0302	sulfide silt	21	5.15	2020	367	986	<15	1.26	33	7	18	283	4.52	1.90
	DuMN0302	sulfide silt	21	5.23	2020	370	993	<15	1.28	33	7	18	287	4.54	1.91
	MN0304	sulfide silt	27	4.61	2670	373	898	<15	1.19	34	6	23	566	5.10	1.77
	DuMN0304	sulfide silt	n/d	4.64	2670	372	899	<15	1.20	34	7	24	569	5.10	1.78
	MN0402	oxide silt	56	4.07	2650	379	585	<15	2.00	45	5	16	431	4.65	1.43
	MN0405	oxide silt	16	5.53	1440	386	923	<15	1.67	27	8	30	207	4.28	1.76
	DuMN0406	sulfide clay	27	5.05	3080	402	710	<15	2.32	52	10	39	414	5.95	1.76
6395 AES-SCAN	MN0503	sulfide silt	45	4.04	2930	738	628	n/d	1.74	n/d	5	21	455	5.39	1.36
	MN0601	oxide silt	46	5.55	3070	601	818	n/d	2.20	n/d	6	26	745	5.59	1.89
	MN0603	sulfide silt	14	4.58	1950	508	802	15*	1.41	39*	7	26	234	4.95	1.62
	MN0607	sulfide clay	70	7.45	3810	157	1020	26*	1.43	39*	4	36	456	7.31	2.62
	MN0617	sulfide clay	70	7.42	3700	466	1020	6*	1.49	24*	6	36	444	7.31	2.59
	MN0702	sulfide silt	37	4.67	2630	682	698	32*	1.44	33*	4	21	416	5.37	1.71
	DuMN0702	sulfide silt	42	5.26	2760	640	799	32*	1.74	32*	6	29	433	6.04	1.84
	MN0703	oxide silt	41	5.88	2800	425	876	27*	1.60	38*	5	27	577	6.73	2.09
	MN0703F	oxide silt	41	5.89	2970	624	906	26*	1.63	33*	6	29	588	6.77	2.12
	DuMN0703F	oxide silt	41	5.76	2980	625	888	n/d	1.60	n/d	6	29	588	6.64	2.12
	MN0705	oxide clay	40	7.63	4190	239	1020	30*	1.32	27*	6	40	309	6.99	2.65
	MN0705F	oxide clay	42	7.57	4190	468	1020	32*	1.25	27*	5	38	321	7.12	2.72
	DuMN0705F	oxide clay	42	7.24	4200	464	976	n/d	1.20	n/d	5	38	317	6.84	2.66
6396 AES-SCAN	MN0707	oxide silt	23	4.98	3210	580	846	26	0.798	12	6	55	139	4.63	1.73
	DuMN0707	oxide silt	23	5.06	3110	449	854	25	0.792	11	6	70	138	4.55	1.72
	MN0803	sulfide clay	31	6.30	2500	382	860	22	1.62	36	8	20	510	5.82	2.13
	MN0803F	sulfide clay	29	6.08	2440	345	828	23	1.60	35	8	26	469	5.42	2.07
	MN0804	oxide clay	27	6.94	2540	258	969	21	1.57	36	12	30	465	6.21	2.29
	MN0805	sulfide silt	36	4.48	4240	610	712	39	0.567	13	4	32	200	5.54	1.71
	MN0902	sulfide clay	48	5.27	3950	370	834	35	1.39	26	8	18	484	6.65	1.99
	MN0912	sulfide clay	42	5.46	3820	370	836	37	1.40	25	7	22	450	6.70	1.98
	MN0903	sulfide silt	29	4.66	3730	295	815	32	0.657	6	6	41	155	4.84	1.63
	DuMN0903	sulfide silt	29	4.53	3760	298	829	35	0.667	7	7	40	160	4.82	1.67
	MN1002	oxide clay	27	8.46	2460	126	1100	27	1.23	33	9	26	392	6.80	2.84
	MN1003	sulfide clay	60	7.10	4400	264	954	47	1.27	30	8	26	692	7.21	2.61
	DuMN1003	sulfide clay	61	6.97	4400	266	961	51	1.27	29	8	26	720	6.87	2.65
6397 AES-SCAN	MN1003F	sulfide clay	62	7.09	4660	451	1040	77*	1.41	44	8	25	737	7.39	2.68
	DuMN1003F	sulfide clay	62	7.05	4820	393	1030	n/d	1.40	46	8	25	740	7.35	2.68
	MN1004	native sed.	1	6.43	104	296	1210	5*	1.90	2	5	21	202	1.71	1.63
	MN1102	sulfide clay	51	6.62	4070	226	939	41*	1.71	50	9	23	630	7.07	2.42
	MN1103	oxide clay	50	7.58	4120	402	1050	39*	1.27	41	8	21	984	7.85	2.77
	MN1202	oxide clay	28	7.47	2660	378	1080	23*	1.44	46	8	28	372	6.16	2.56
	MN1212	oxide clay	27	7.59	2680	215	1090	22*	1.45	45	10	28	383	6.24	2.59
	MN1204T	oxide clay	56	6.62	5710	456	1040	45*	0.947	41	6	28	238	7.55	2.58
	MN1204B	oxide clay	48	5.59	4830	481	903	41*	0.829	29	5	52	193	6.81	2.20
	DuMN1204B	oxide clay	48	5.57	4860	485	903	n/d	0.829	29	5	52	195	6.78	2.20
	MN1205	native sed.	35	7.21	4060	186	1090	40*	1.01	31	7	66	203	6.03	2.42
	MN1205F	native sed.	35	7.35	3970	382	1100	37*	1.02	31	7	65	212	6.10	2.47
	DuMN1205F	native sed.	35	7.38	3950	381	1100	n/d	1.03	31	n/d	65	210	6.12	2.46
6398 AES-SCAN	MN1206	native sed.	29	6.71	3560	69	1020	28*	1.17	< 1	11	62	421	5.94	2.19
	DuMN1206	native sed.	30	6.75	3280	56	1010	n/d	1.15	n/d	9	61	427	5.95	2.21
	MN1206D	native sed.	28	6.69	3470	192	1020	26*	1.15	101*	9	61	409	5.93	2.19
	MN1207	native sed.	0	6.29	24	91	963	<2*	2.05	< 1*	8	42	27	2.08	1.34
	MN1303	sulfide clay	47	5.84	3240	208	876	27*	1.72	38*	8	32	506	7.00	2.08
	MN1303F	sulfide clay	48	5.83	3380	221	875	28*	1.71	29*	8	31	487	6.99	2.08
	MN1304	oxide clay	58	6.23	4560	254	935	35*	1.47	13*	8	33	367	6.99	2.37
	MN1305	oxide clay	48	6.66	5060	135	1010	36*	1.16	11*	7	35	275	7.30	2.50
	MN1305F	oxide clay	47	6.63	5170	128	1000	37*	1.16	24*	7	36	276	7.28	2.50
	DuMN1305F	oxide clay	47	6.55	5150	127	996	n/d	1.16	n/d	8	36	276	7.29	2.49
	MN1401	oxide silt	35	4.48	3130	258	743	11*	1.45	15*	7	23	339	5.53	1.58
	DuMN1401	oxide silt	35	4.50	3120	258	746	7*	1.45	12*	8	23	337	5.52	1.59
	MN1402	oxide silt	39	4.26	5610	355	749	n/d	1.33	n/d	6	24	238	4.41	1.50
6399 AES-SCAN	MN1406	oxide clay	53	5.38	4920	287	1010	36*	1.06	21*	5	39	260	7.21	2.43
	DuMN1406	oxide clay	54	5.88	4990	159	1050	n/d	1.06	n/d	0	40	256	7.42	2.49
	MN1407	native sed.	3	1.15	275	512	169	<2*	0.585	2*	4	20	13	1.53	0.269
	MN1408	native sed.	1	6.19	30	49	1160	<2*	2.02	< 1*	3	34	11	1.94	1.62
	MN1504	oxide silt	66	4.64	3720	296	719	24*	1.48	30*	6	20	655	5.87	1.92
	MN1506	oxide clay	55	5.56	4480	348	930	27*	1.08	23*	7	22	302	6.22	2.31
	MN1603	oxide silt	38	4.35	2120	259	867	5*	1.13	24*	5	19	188	4.10	1.84
	MN1604	oxide clay	31	5.41	3630	172	921	19*	0.784	12*	2	17	195	5.58	2.32
	MN1605	oxide clay	57	5.55	5380	243	1230	35*	0.865	19*	2	46	367	6.89	2.40
	DuMN1605	oxide clay	58	5.47	5380	243	1230	n/d	0.825	n/d	5	45	364	6.91	2.30

Table C-1a (cont.)

	FIELD #	SAMPLE TYPE	Ag µg/g	Al %	As µg/g	B µg/g	Ba µg/g	Bi µg/kg	Ca %	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe %	K %
6400 AES-SCAN	MN1616	native sed.	73	6.93	4570	180	1080	45.6*	0.699	n/d	2	68	228	8.31	2.56
	DuMN1616	native sed.	74	6.88	4600	168	1060	n/d	0.693	n/d	4	72	224	8.12	2.52
	MN1701	sulfide silt	64	3.65	4480	507	647	18.6*	0.733	n/d	6	19	847	6.18	1.39
	MN1704	oxide silt	40	3.91	3980	550	685	15.6*	0.681	n/d	3	19	354	5.51	1.62
	MN1705F	native sed.	27	6.47	1240	131	1160	4.32*	1.58	n/d	4	28	53	2.86	1.78
	MN1802	sulfide clay	26	6.31	2330	199	955	9.02*	1.35	n/d	7	27	385	5.68	2.16
	MN1802F	sulfide clay	24	6.34	2390	384	969	9.55*	1.36	n/d	6	32	380	5.76	2.17
	MN1804	oxide clay	59	7.28	5460	219	1010	35.7*	1.16	n/d	6	25	485	7.80	2.66
	MN1805	oxide clay	46	5.27	4230	311	832	28.6*	0.652	n/d	2	72	197	6.51	2.07
	DuMN1805	oxide clay	45	5.25	4240	311	826	n/d	0.649	n/d	5	70	197	6.52	2.08
	MN1806	oxide silt	58	6.22	4850	270	924	41.5*	0.903	n/d	6	8	358	0.728	0.228
	MN1806D	oxide silt	59	6.23	4850	200	922	43.9*	0.899	n/d	3	56	497	7.21	2.29
	DuMN1806D	oxide silt	59	6.22	4840	200	919	n/d	0.899	n/d	4	53	494	7.41	2.35
6401 AES-SCAN	MN1901	sulfide silt	54	3.93	3670	534	642	13.5*	1.78	n/d	8	10	709	5.56	1.34
	DuMN1901	sulfide silt	50	3.95	3610	373	650	n/d	1.79	n/d	9	10	695	5.55	1.34
	MN1902	sulfide silt	31	4.96	2580	345	811	9.60*	1.62	n/d	8	11	613	5.06	1.70
	MN1905	oxide silt	20	4.59	1910	296	892	4.77*	1.33	n/d	7	13	323	4.56	1.57
	MN1906	sulfide silt	20	4.61	2210	450	1010	3.46*	1.35	n/d	7	16	455	4.44	1.55
	MN1907	oxide silt	24	4.22	2090	388	839	3.98*	1.15	n/d	5	13	609	3.59	1.46
	MN1908	sulfide silt	25	4.58	2310	452	865	7.55*	1.54	n/d	6	14	472	4.50	1.58
	MN1910	oxide clay	47	5.21	6220	790	850	38.5*	0.944	n/d	5	38	188	6.90	2.06
	NWALL1	pit grab	5	8.43	1240	372	1220	0.00*	0.863	n/d	10	11	477	6.11	3.61
	DuNWALL1	pit grab	5	8.42	1220	368	1220	n/d	0.864	n/d	10	11	477	6.11	3.62
	NWALBX	pit grab	117	1.41	1280	381	128	244*	1.73	n/d	30	5	539	33.8	0.565
	WBH3	pit grab	241	4.43	1670	66	652	11.3*	12.9	n/d	13	38	4130	5.15	1.38
	DuWBH3	pit grab	241	4.45	1660	63	655	n/d	13.0	n/d	13	39	4130	5.17	1.38
6402 AES-SCAN	PITSED	pit grab	10	9.44	1460	12	1360	3.14*	1.90	n/d	17	21	412	6.79	2.07
	DuPITSED	pit grab	10	9.23	1490	13	1380	n/d	1.92	n/d	17	25	376	7.12	2.11
	BATCH01	oxide clay composite	56	6.32	4720	47	961	38.5*	1.02	n/d	5	23	580	6.65	2.46
	BATCH02	oxide clay composite	55	6.35	4720	54	959	36.1*	1.03	n/d	6	16	860	6.69	2.47
	BATCH03	oxide clay composite	56	6.21	4750	71	956	38.4*	1.02	n/d	6	34	249	6.61	2.42
	BATCHS1	sulfide clay composite	42	5.76	3520	73	885	25.3*	1.28	n/d	7	15	344	5.84	2.18
	BATCHS1D	sulfide clay composite	43	5.93	3520	68	881	24.3*	1.32	n/d	7	6	350	6.02	2.23
	BATCHS2	suphide clay composite	43	5.95	3480	61	876	24.9*	1.33	n/d	4	25	345	6.16	2.19
	BATCH1E	composite	55	6.22	4880	63	940	33.5*	1.03	n/d	4	22	491	6.62	2.42
	DuBATCH1E	composite	54	6.15	4790	62	967	n/d	1.01	n/d	5	30	451	6.66	2.27

n/d= not determined

* = MS analysis µg/kg (all other data are AES)

Table C-1a (cont.)

FIELD #	SAMPLE TYPE	Li µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Na µg/g	Ni µg/g	P µg/g	Pb µg/g	S %	Sb µg/g	Sr µg/g	V µg/g	Zn µg/g
MN0101	oxide silt	15	4320	2780	4	1500	13	584	1370	2.69	436	149	49	2100
MN0103	sulfide silt	15	5130	3250	2	1380	14	563	1510	3.52	363	102	55	2650
MN0106	oxide silt	17	1520	924	2	1770	7	425	1660	0.696	368	91	40	649
MN0201	sulfide silt	15	3780	2420	2	1740	16	556	1580	2.30	423	147	52	2030
MN0205	oxide silt	17	2310	1740	2	1360	9	500	1980	2.05	445	104	45	1460
MN0302	sulfide silt	13	2960	2070	3	2810	7	532	1410	1.93	276	131	49	1770
DuMN0302	sulfide silt	13	2970	2080	4	2830	10	542	1410	1.95	265	132	50	1770
MN0304	sulfide silt	13	2730	1880	2	2200	10	528	1970	2.08	377	113	47	1610
DuMN0304	sulfide silt	13	2740	1870	3	2200	10	526	1980	2.07	379	113	47	1610
MN0402	oxide silt	16	3880	2690	6	688	10	442	1450	3.28	560	118	37	2170
MN0405	oxide silt	11	4320	2080	3	6690	14	590	925	1.27	205	190	60	1460
DuMN0406	sulfide clay	10	5530	3370	4	3660	16	521	1890	3.52	433	144	55	2710
MN0503	sulfide silt	23	4170	2770	<5	874	4	n/d	1750	4.15	41500	121	36	2630
MN0601	oxide silt	27	4760	3040	<5	777	5	n/d	2100	3.05	30500	145	49	2940
MN0603	sulfide silt	25	3830	2730	<5	1810	8	70.17*	1150	2.38	23800	111	47	2040
MN0607	sulfide clay	29	3720	2290	<5	1900	6	93.70*	3760	1.99	19900	155	79	2560
MN0617	sulfide clay	31	3780	2290	<5	1910	7	112.4*	3760	1.65	16500	154	79	2670
MN0702	sulfide silt	19	3730	2600	<5	630	5	160.9*	1980	2.74	27400	111	45	2470
DuMN0702	sulfide silt	26	4110	2850	<5	706	6	169.0*	2170	3.10	31000	118	49	2960
MN0703	oxide silt	28	4100	2650	<5	1390	5	147.0*	2700	2.38	23800	124	60	2610
MN0703F	oxide silt	27	4140	2650	<5	1380	6	166.9*	2750	3.69	36900	124	61	2730
DuMN0703F	oxide silt	27	4160	2590	<5	1380	5	n/d	2760	2.39	23900	124	61	2670
MN0705	oxide clay	32	3510	2120	<5	1760	9	157.3*	3750	1.42	14200	146	82	1970
MN0705F	oxide clay	32	3450	2150	<5	1640	7	160.3*	3780	1.38	13800	144	84	1940
DuMN0705F	oxide clay	31	3460	2060	<5	1590	7	n/d	3790	1.59	15900	142	83	1850
MN0707	oxide silt	22	2290	1510	4	2390	4	564	2730	0.619	392	134	55	961
DuMN0707	oxide silt	27	2250	1500	4	2440	5	541	2680	0.607	510	135	55	922
MN0803	sulfide clay	26	4870	2990	2	1180	3	586	1970	2.50	430	116	65	2610
MN0803F	sulfide clay	29	4910	2860	1	1080	1	565	1920	2.40	408	114	64	2480
MN0804	oxide clay	28	4590	3120	1	1350	10	641	2140	2.29	417	124	70	2550
MN0805	sulfide silt	26	1870	1040	3	1230	3	488	3740	1.04	536	102	49	879
MN0902	sulfide clay	27	3230	2070	1	1110	3	610	3140	2.47	436	121	59	1880
MN0912	sulfide clay	21	3210	2060	1	1110	3	585	3060	2.39	594	119	58	1850
MN0903	sulfide silt	18	3220	836	1	4180	13	466	3710	0.784	700	141	64	558
DuMN0903	sulfide silt	19	3200	835	1	4300	14	477	3710	0.794	709	143	64	559
MN1002	oxide clay	28	3660	2900	2	1420	6	732	2350	1.35	358	136	81	2400
MN1003	sulfide clay	30	3840	1860	2	1880	3	651	4480	2.25	746	150	77	1990
DuMN1003	sulfide clay	30	3830	1850	2	1910	4	649	4480	2.25	756	151	77	1990
MN1003F	sulfide clay	27	4040	1940	6	2640	7	719	4520	2.39	831*	147*	76	2110
DuMN1003F	sulfide clay	29	4000	1940	5	2650	7	738	4570	2.37	n/d	n/d	77	2090
MN1004	native sed.	6	4590	361	3	24900	8	323	96	0.0637	330*	438*	44	183
MN1102	sulfide clay	30	4410	2500	3	1810	6	707	3750	2.79	571*	140*	68	2440
MN1103	oxide clay	29	3560	2310	6	1840	7	773	3470	1.86	502*	152*	76	2210
MN1202	oxide clay	28	4370	3210	3	2420	6	728	2060	1.60	312*	120*	73	2580
MN1212	oxide clay	28	4440	3260	4	2410	7	719	2070	1.62	286*	125*	73	2620
MN1204T	oxide clay	31	2850	1680	3	1990	6	786	5700	1.45	912*	128*	71	1510
MN1204B	oxide clay	24	2420	1360	4	2180	7	689	4450	1.30	596*	116*	60	1030
DuMN1003F	oxide clay	25	2410	1360	4	2190	6	691	4450	1.30	n/d	n/d	61	1030
MN1205	native sed.	33	3180	1720	5	3690	8	681	3880	0.932	547*	159	76	1300
MN1205F	native sed.	31	3250	1730	6	3650	8	685	3930	0.945	560*	159	77	1310
DuMN1205F	native sed.	30	3280	1740	5	3660	9	678	3950	0.943	n/d	159	77	1330
MN1206	native sed.	33	3040	1810	<4	2880	12	132*	4130	1.08	681	157	73	1360
DuMN1206	native sed.	32	3000	1810	<4	2900	11	n/d	4110	1.06	706	157	73	1330
MN1206D	native sed.	32	2920	1810	<4	2800	11	148*	3930	1.08	701	157	72	1320
MN1207	native sed.	13	7100	442	<4	19900	15	197*	30	0.147	8	386	72	131
MN1303	sulfide clay	29	3540	2280	4	783	8	104*	3480	3.01	610	125	62	2540
MN1303F	sulfide clay	29	3530	2270	8	774	7	147*	3510	3.04	569	124	62	2530
MN1304	oxide clay	30	3150	2050	<4	1150	6	175*	4550	1.96	812	139	68	2120
MN1305	oxide clay	31	2920	1910	<4	1190	7	171*	4600	1.55	1010	142	74	1670
MN1305F	oxide clay	32	2980	1860	<4	1190	8	256*	4690	1.55	1050	141	74	1660
DuMN1305F	oxide clay	32	2960	1870	<4	1180	8	n/d	4640	1.54	1050	141	74	1650
MN1401	oxide silt	20	3080	2090	<4	1400	6	129*	2260	2.74	398	106	46	2100
DuMN1401	oxide silt	20	3110	2090	<4	1390	7	12.8*	2280	2.74	400	106	47	2100
MN1402	oxide silt	24	2140	1510	<4	2350	6	n/d	2400	1.70	709	130	47	1700
MN1406	oxide clay	36	2890	1550	90	1640	<15	68.5*	5550	1.49	920	128	72	1420
DuMN1406	oxide clay	33	2880	1590	101	1710	<15	n/d	5480	1.53	862	139	73	1410
MN1407	native sed.	6	2920	204	12	1520	7	0.00*	107	0.0717	7	46	42	188
MN1408	native sed.	9	6880	413	112	22300	<15	0.00*	20	0.0356	3	462	59	70
MN1504	oxide silt	30	3070	1980	82	966	<15	23.8*	3270	2.20	735	125	55	2020
MN1506	oxide clay	34	2600	1870	90	897	<15	72.1*	4200	1.23	989	123	68	1610
MN1603	oxide silt	29	2370	2040	69	1470	<15	81.6*	1790	1.07	428	111	54	1620
MN1604	oxide clay	25	2250	1810	89	984	<15	18.3*	1870	0.925	356	107	69	1110
MN1605	oxide clay	32	3000	1120	94	1800	<15	32.9*	5580	1.34	1010	146	70	1030
DuMN1605	oxide clay	31	3040	n/d	94	1720	<15	n/d	5550	1.34	1000	147	71	1040

Table C-1a (cont.)

FIELD #	SAMPLE TYPE	Li µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Na µg/g	Ni µg/g	P µg/kg	Pb µg/g	S %	Sb µg/kg	Sr µg/g	V µg/g	Zn µg/g
MN1616	native sed.	30	2660	1320	123	1650	<7	154*	4780	1.49	546*	154	70	939
DuMN1616	native sed.	29	2600	1340	123	1620	<7	n/d	4770	1.46	n/d	153	71	920
MN1701	sulfide silt	28	2500	1290	66	1170	<7	67.4*	2950	3.78	490*	92	45	1780
MN1704	oxide silt	27	2170	1080	71	1370	<7	460*	2200	2.14	428*	99	51	1230
MN1705F	native sed.	13	4180	532	118	18300	<7	69.6*	1350	0.332	198*	382	49	260
MN1802	sulfide clay	28	3650	3100	114	1550	<7	180*	1850	1.62	256*	123	66	2340
MN1802F	sulfide clay	29	3700	3130	118	1590	<7	144*	1860	1.66	227*	124	65	2360
MN1804	oxide clay	33	3160	1850	136	1200	<7	229*	5460	1.45	791*	140	79	1770
MN1805	oxide clay	32	2210	1430	100	1290	<7	109*	4530	1.15	566*	116	59	1100
DuMN1805	oxide clay	32	2210	1430	98	1280	<7	n/d	4520	1.14	n/d	116	58	1100
MN1806	oxide silt	34	267	1530	113	135	<7	140*	5610	0.140	669*	137	68	132
MN1806D	oxide silt	34	2650	1530	115	1340	<7	80.5*	5530	1.38	500*	137	68	1370
DuMN1806D	oxide silt	34	2710	1530	116	1370	<7	n/d	5550	1.41	n/d	137	68	1410
MN1901	sulfide silt	29	4320	2830	<6	1070	2	56.1*	1760	4.21	575*	116	44	2850
DuMN1901	sulfide silt	30	4360	2840	7	1100	1	n/d	1670	4.19	n/d	117	45	2860
MN1902	sulfide silt	30	4250	2820	<6	1630	1	76.3*	1470	2.76	351*	116	60	2650
MN1905	oxide silt	28	3720	2340	<6	2950	1	85.2*	1090	2.39	224*	121	63	2050
MN1906	sulfide silt	25	3570	1800	<6	4630	4	116*	1140	2.31	232*	152	60	1800
MN1907	oxide silt	26	2960	1690	<6	3800	2	97.2*	1020	1.74	250*	135	52	1670
MN1908	sulfide silt	26	3320	2010	<6	2970	1	21.0*	1300	2.32	263*	129	57	1970
MN1910	oxide clay	30	3070	861	<6	4000	4	131*	6420	1.28	622*	147	69	761
NWALL1	pit grab	12	4100	303	<6	2460	46	168*	721	3.72	121*	116	67	319
DuNWALL1	pit grab	12	4100	304	<6	2470	48	n/d	721	3.73	n/d	116	67	322
NWALBX	pit grab	24	2980	1160	<6	177	1	0.00*	4350	38.0	234*	36	17	2290
WBH3	pit grab	18	7630	3100	10	3520	50	106*	1090	1.29	188*	292	63	2410
DuWBH3	pit grab	18	7650	3120	7	3560	51	n/d	1090	1.28	n/d	290	63	2430
PITSED	pit grab	32	9680	5830	11	4410	10	270*	564	0.815	168*	266	168	3270
DuPITSED	pit grab	29	9360	5900	10	4190	12	n/d	566	0.968	n/d	271	160	3290
BATCH01	oxide clay composite	31	2670	1640	7	1350	8	222*	4470	1.35	860*	132	75	1640
BATCH02	oxide clay composite	30	2670	1670	6	1340	10	103*	4400	1.37	759*	133	76	1790
BATCH03	oxide clay composite	30	2650	1630	7	1340	8	196*	4460	1.37	778*	130	74	1470
BATCHS1	sulfide clay composite	30	3260	2140	5	1380	8	89.3*	2700	1.85	406*	126	69	1850
BATCHS1D	sulfide clay composite	29	3260	2190	6	1320	8	101*	2690	1.88	390*	128	72	1900
BATCHS2	suphide clay composite	29	3210	2200	6	1330	11	77.8*	2700	1.92	468*	127	77	1930
BATCH1E	composite	31	2630	1640	7	1350	7	117*	4530	1.35	816*	130	76	1570
DuBATCH1E	composite	30	2660	1650	7	1200	7	n/d	4420	1.33	n/d	126	76	1590

n/d= not determined
* = MS analysis µg/kg (all other data are AES)

Table C-1b: Tailings Geochmistry of selected samples by B.C. Research Inc.

Metal Contents of tailings solids

Field #	Sample Type	Ag μg/g	Al %	As μg/g	Au μg/g	Ba μg/g	Be μg/g	Bi μg/g	Ca %	Cd μg/g	Co μg/g	Cr μg/g	Cu μg/g	Fe %	K %	La μg/g	Mg %
ENDADIT	pit grab	7.1	7.33	837	5	847	1	12	2.49	12.0	9	11	44.0	5.88	2.96	8	0.83
NWALLCU	pit grab	45.3	4.93	2536	< 4	252	1	75	1.94	29.3	6	6	7438	5.66	2.02	7	0.29
MNOMIX	oxide silt composite	35.6	4.25	2796	< 4	558	1	20	0.770	14.2	3	13	290	4.85	1.79	11	0.24
MNSMIX	sulfide silt composite	42.3	5.56	2274	< 4	788	1	20	1.43	26.9	6	16	365	5.02	2.02	14	0.37
SOMIX	s-o silt composite	31.8	5.00	2468	< 4	383	2	16	1.23	20.8	4	18	285	4.87	1.96	14	0.33
SLURRY	s-o silt composite	35.6	5.06	2473	< 4	598	1	21	1.18	20.3	3	21	312	4.94	1.94	13	0.33
MN0102	oxide silt	25.0	6.59	2370	< 4	559	2	18	1.71	26.5	6	35	437	5.22	2.32	17	0.41
MN0104	sulfide silt	48.7	5.02	2349	< 4	696	1	8	1.29	25.2	4	15	400	5.14	1.92	16	0.34
MN0203	sulfide silt	23.8	5.25	2174	< 4	657	1	18	1.48	24.8	4	14	256	5.04	1.97	14	0.38
MN0304	sulfide silt	32.0	5.36	2604	< 4	539	1	30	1.30	23.9	4	23	599	5.16	2.07	13	0.33
MN0401	sulfide silt	52.1	5.49	1728	< 4	848	1	18	2.23	36.9	8	13	398	5.81	2.00	18	0.55
MN0402	oxide silt	54.3	4.64	1863	< 4	628	1	21	2.10	32.5	4	10	412	4.56	1.76	14	0.47
MN0404	sulfide silt	16.1	5.75	1285	< 4	322	1	16	1.64	18.7	6	19	199	4.06	2.00	15	0.45
MN0501	oxide silt	52.1	5.49	1637	< 4	820	1	26	2.13	33.2	8	17	679	5.46	1.98	17	0.55
MN0502	oxide silt	53.8	4.89	1888	< 4	715	1	23	1.90	34.2	7	12	512	5.51	1.83	17	0.49
MN0503	sulfide silt	76.9	4.86	1924	< 4	537	1	23	1.83	37.4	7	18	524	5.89	1.77	13	0.47
MN0505	sulfide silt	9.7	6.57	349	< 4	282	1	< 5	2.12	8.00	7	39	86.0	3.18	1.89	15	0.66
MN0506T	native sediments	1.0	7.32	17.0	< 4	1069	2	< 5	2.72	0.70	8	47	9.00	2.57	1.82	25	0.90
MN0506B	native sediments	< 0.5	7.52	14.0	< 4	957	2	< 5	3.64	0.60	9	56	49.0	2.81	1.77	26	1.07
MN0605	sulfide silt	25.1	5.12	1427	< 4	555	1	16	1.54	28.0	7	19	315	5.08	1.94	14	0.47
MN0608	sulfide clay	7.5	7.25	523	< 4	1124	2	< 5	2.97	5.00	7	35	66.0	2.62	1.99	16	0.76
MN0609	native sediments	< 0.5	6.90	21.0	< 4	1138	1	< 5	2.92	0.40	7	35	13.0	1.81	1.92	15	0.76
MN0805	sulfide silt	45.9	5.51	5494	< 4	330	1	46	0.750	12.5	2	33	221	5.94	2.18	16	0.25
MN0903	sulfide silt	36.3	5.36	4634	< 4	656	1	35	0.840	6.40	6	49	172	5.02	2.05	20	0.39
MN1204B	oxide clay	55.4	6.12	5617	< 4	379	1	58	0.930	13.1	2	66	201	6.91	2.48	13	0.27
MN1206	native sediments	37.1	6.92	3847	< 4	297	1	39	1.20	17.1	8	65	428	5.87	2.49	13	0.33
MN1305	oxide clay	61.5	7.13	5961	< 4	272	1	51	1.27	24.3	3	32	288	7.43	2.85	15	0.33
MN1405	oxide silt	28.1	5.27	2554	< 4	465	1	13	1.60	19.5	4	21	163	4.23	2.05	16	0.27
MN1406	oxide clay	57.3	6.81	6106	< 4	226	1	61	1.17	22.5	2	47	227	7.82	2.87	16	0.32
MN1407	native sediments	2.8	6.30	267	< 4	1068	1	< 5	2.25	2.10	7	40	11.0	2.23	1.85	21	0.68
MN1502	oxide silt	25.7	3.98	2158	< 4	169	1	24	0.480	14.9	4	16	264	5.08	1.85	12	0.22
MN1607	native sediments	7.4	5.59	131	< 4	1057	1	8	1.98	0.60	5	40	37.0	1.81	1.80	19	0.59
MN1702	oxide silt	46.7	3.85	3808	< 4	294	1	26	0.790	18.1	3	14	404	5.04	1.77	9	0.26
MN1703	oxide silt	33.7	3.72	4394	< 4	228	1	39	0.570	9.30	2	19	210	4.88	1.86	9	0.21
MN1705	native sediments	27.8	5.26	1330	< 4	843	2	16	1.53	3.60	3	36	53.0	2.60	2.05	12	0.42
MN1706	native sediments	28.6	5.43	911	< 4	1072	1	8	1.63	1.80	4	36	40.0	2.33	2.07	14	0.42
MN1904	sulfide silt	28.3	4.94	1854	< 4	731	1	16	1.61	28.2	5	21	402	4.59	1.91	16	0.40
MN1909	native sediments	1.5	6.83	57.0	< 4	989	1	< 5	3.26	1.00	7	47	20.0	2.23	1.80	22	0.85
BATCHO3	oxide clay composite	61.5	6.64	5698	< 4	277	1	56	1.15	22.2	3	37	268	6.72	2.67	14	0.29
BATCHS3	sulfide clay composite	48.1	6.32	3836	< 4	223	1	46	1.50	27.5	4	23	386	6.23	2.50	14	0.34
DuMN0304	sulfide silt	32.3	5.22	2501	< 4	508	1	18	1.26	21.9	4	18	538	5.02	2.04	13	0.33
DuMN0605	sulfide silt	23.2	5.16	1378	< 4	581	1	13	1.56	26.8	7	20	302	5.15	1.97	14	0.48
DuMN1407	native sediments	2.5	6.54	277	< 4	1113	2	< 5	2.28	2.30	7	40	12.0	2.24	1.88	21	0.70
DuBATCHS3	sulfide clay composite	46.9	6.01	3778	< 4	174	1	45	1.46	26.8	4	25	374	6.10	2.46	13	0.34

Table C-1b (cont.)

Field #	Sample Type	Mn µg/g	Mo µg/g	Na %	Nb µg/g	Ni µg/g	P µg/g	Pb µg/g	Sb µg/g	Sc µg/g	Sn µg/g	Sr µg/g	Th µg/g	Ti µg/g	U µg/g	V µg/g
ENDADIT	pit grab	5484	3	0.03	2	7	310	427	68.0	4	5	55.0	< 2	600	10	34
NWALLCU	pit grab	312	2	0.04	2	< 2	810	5700	990	7	6	113	4	900	< 10	59
MNOMIX	oxide silt composite	1332	2	0.10	4	4	440	1470	386	5	3	96.0	3	1200	< 10	44
MNSMIX	sulfide silt composite	2379	2	0.16	5	4	600	1800	433	6	4	125	3	1400	15	53
SOMIX	s-o silt composite	2071	< 2	0.15	4	6	580	1758	375	5	4	114	4	1500	18	52
SLURRY	s-o silt composite	2059	2	0.15	5	5	530	1644	375	5	4	117	3	1600	< 10	51
MN0102	oxide silt	2601	< 2	0.14	5	6	660	1576	370	6	4	147	3	1400	20	58
MN0104	sulfide silt	2360	2	0.13	6	4	510	1830	542	5	4	117	5	1300	< 10	46
MN0203	sulfide silt	2491	< 2	0.20	5	3	570	1544	320	5	< 2	129	3	1400	< 10	48
MN0304	sulfide silt	2120	2	0.21	5	7	610	2059	412	5	4	126	4	1500	< 10	51
MN0401	sulfide silt	3597	< 2	0.07	5	8	580	1553	617	5	4	122	4	1200	19	41
MN0402	oxide silt	2777	< 2	0.06	5	5	480	1576	629	4	5	134	3	1100	< 10	37
MN0404	sulfide silt	2153	< 2	0.56	6	9	620	962	191	7	3	187	3	2000	12	60
MN0501	oxide silt	3482	2	0.09	5	5	520	1402	518	5	4	128	4	1200	11	41
MN0502	oxide silt	3321	< 2	0.07	5	5	470	1749	685	4	4	123	4	1200	22	39
MN0503	sulfide silt	2909	< 2	0.10	5	5	470	2006	804	4	4	136	3	1000	10	39
MN0505	sulfide silt	1216	2	1.71	6	12	590	419	77	7	3	361	3	2100	< 10	64
MN0506T	native sediments	599	< 2	2.41	7	14	580	21.0	5	10	3	487	6	3400	< 10	85
MN0506B	native sediments	672	< 2	2.43	8	16	650	22.0	< 5	11	< 2	503	5	3600	< 10	95
MN0605	sulfide silt	2993	< 2	0.18	6	7	590	1343	299	5	3	113	4	1500	15	50
MN0608	sulfide clay	758	2	2.17	6	11	550	472	81	8	2	458	3	2400	< 10	66
MN0609	native sediments	467	< 2	2.42	6	12	440	21.0	5	7	2	485	8	2300	< 10	59
MN0805	sulfide silt	1268	3	0.15	5	5	640	4352	773	6	5	123	5	1400	14	59
MN0903	sulfide silt	1018	2	0.45	5	17	590	4180	733	7	3	162	5	1500	< 10	72
MN1204B	oxide clay	1541	4	0.15	4	7	730	4971	882	7	7	139	4	1400	< 10	69
MN1206	native sediments	1971	3	0.30	2	13	800	4351	704	8	6	154	3	1200	< 10	77
MN1305	oxide clay	2124	< 2	0.14	2	8	830	5238	1084	8	5	145	4	1500	10	80
MN1405	oxide silt	2260	2	0.19	6	6	650	1248	262	6	4	128	3	1700	< 10	52
MN1406	oxide clay	1753	3	0.19	2	10	820	6431	1112	7	5	142	4	1500	< 10	80
MN1407	native sediments	523	< 2	2.24	6	11	510	118	19.0	7	< 2	446	5	2500	16	69
MN1502	oxide silt	1470	< 2	0.05	3	5	470	1446	235	4	2	68	4	1500	< 10	46
MN1607	native sediments	534	2	1.91	5	12	540	47.0	8	7	4	361	4	2400	< 10	62
MN1702	oxide silt	1205	< 2	0.10	2	3	440	2052	564	5	4	89.0	3	1500	< 10	45
MN1703	oxide silt	750	2	0.10	3	4	500	2738	450	5	2	103	< 2	1500	< 10	48
MN1705	native sediments	581	2	1.70	5	10	440	1245	248	5	6	343	4	1700	< 10	50
MN1706	native sediments	521	< 2	1.90	4	11	410	893	147	5	9	378	4	1700	< 10	54
MN1904	sulfide silt	2633	< 2	0.18	4	7	560	1420	375	5	4	122	4	1500	< 10	47
MN1909	native sediments	585	< 2	2.19	5	14	500	67.0	13	9	2	462	6	2800	11	73
BATCHO3	oxide clay composite	1875	2	0.11	2	8	740	4804	1020	8	6	133	4	1500	10	74
BATCHS3	sulfide clay composite	2483	2	0.12	2	7	740	2888	507	7	5	128	3	1500	< 10	69
MN0304	sulfide silt	2086	2	0.20	5	6	580	2080	390	5	4	124	3	1300	12	49
MN0605	sulfide silt	3045	2	0.18	5	6	560	1283	270	5	3	114	2	1500	< 10	50
MN1407	native sediments	525	2	2.27	10	9	500	128	19.0	7	< 2	462	4	2600	< 10	67
BATCHS3	sulfide clay composite	2423	< 2	0.12	2	8	730	2818	506	7	4	125	4	1600	< 10	72

Table C-1b (cont.)

Field #	Sample Type	W µg/g	Y µg/g	Zn µg/g	Zr µg/g	TOT/S %	CO_2 %
ENDADIT	pit grab	< 4	6	989	10	5.63	3.89
NWALLCU	pit grab	4	5	306	43	6.33	0.04
MNOMIX	oxide silt composite	< 4	5	1023	34	2.30	0.58
MNSMIX	sulfide silt composite	< 4	7	1937	32	2.36	1.31
SOMIX	s-o silt composite	< 4	6	1525	31	2.23	1.04
SLURRY	s-o silt composite	< 4	6	1525	35	2.28	1.12
MN0102	oxide silt	< 4	7	1977	31	2.06	1.42
MN0104	sulfide silt	< 4	6	1834	32	2.70	1.12
MN0203	sulfide silt	< 4	7	1920	30	2.53	1.23
MN0304	sulfide silt	< 4	6	1755	29	2.24	1.15
MN0401	sulfide silt	< 4	8	2766	38	4.06	2.58
MN0402	oxide silt	< 4	7	2376	32	3.43	2.08
MN0404	sulfide silt	< 4	9	1437	26	1.48	1.00
MN0501	oxide silt	< 4	8	2535	44	3.80	2.62
MN0502	oxide silt	< 4	7	2559	33	4.10	2.08
MN0503	sulfide silt	< 4	6	2607	31	4.33	1.96
MN0505	sulfide silt	< 4	8	634	22	0.96	0.77
MN0506T	native sediments	< 4	14	43.0	34	< .02	< .03
MN0506B	native sediments	< 4	16	48.0	25	0.03	0.77
MN0605	sulfide silt	< 4	8	2189	33	2.76	1.85
MN0608	sulfide clay	< 4	12	355	20	0.30	0.81
MN0609	native sediments	< 4	9	40.0	16	< .02	0.85
MN0805	sulfide silt	< 4	5	915	32	1.19	0.46
MN0903	sulfide silt	< 4	7	504	31	0.84	0.23
MN1204B	oxide clay	< 4	5	1002	29	1.36	0.38
MN1206	native sediments	< 4	8	1251	20	1.16	0.77
MN1305	oxide clay	4	6	1633	29	1.54	0.62
MN1405	oxide silt	< 4	7	1473	28	1.28	0.65
MN1406	oxide clay	< 4	6	1393	27	1.62	0.58
MN1407	native sediments	< 4	11	160	21	0.06	0.04
MN1502	oxide silt	< 4	5	1151	32	2.43	0.59
MN1607	native sediments	< 4	10	70.0	21	0.04	0.04
MN1702	oxide silt	< 4	4	1289	24	3.00	0.51
MN1703	oxide silt	< 4	4	745	25	1.63	0.29
MN1705	native sediments	< 4	6	217	21	0.35	0.11
MN1706	native sediments	< 4	7	163	17	0.24	0.11
MN1904	sulfide silt	< 4	7	2090	32	2.72	1.47
MN1909	native sediments	< 4	12	85.0	20	0.06	0.99
BATCHO3	oxide clay composite	< 4	6	1467	29	1.48	0.51
BATCHS3	sulfide clay composite	< 4	7	1983	32	2.19	0.95
MN0304	sulfide silt	< 4	7	1648	33	2.13	1.12
MN0605	sulfide silt	< 4	8	2110	32	2.69	1.89
MN1407	native sediments	< 4	11	159	20	0.06	0.04
BATCHS3	sulfide clay composite	< 4	6	1940	32	2.15	0.95

Table C-2: Acid base accounting characteristics of selected samples

ABA Results
by BC Research

Field #	Sample Type	Paste pH	CO_2 Inorg. (Wt.%)	$CaCO_3$ Equiv. (Kg $CaCO_3$/ Tonne)	Total Sulfur (Wt.%)	Sulfate Sulfur (Wt.%)	sulfide Sulfur* (Wt.%)	Maximum Potential Acidity** (Kg $CaCO_3$/ Tonne)	Neutralization Potential (Kg $CaCO_3$/ Tonne)
ENDADIT	pit grab	7.0	3.89	88.3	5.63	0.47	5.16	161.3	69.2
NWALLCU	pit grab	3.5	0.04	0.91	6.33	1.76	4.57	142.8	-4.4
MNOMIX	oxide silt composite	7.7	0.58	13.2	2.30	0.29	2.01	62.8	11.1
MNSMIX	sulfide silt composite	8.0	1.31	29.7	2.36	0.50	1.86	58.1	24.9
SOMIX	s-o silt composite	8.1	1.04	23.6	2.23	0.36	1.87	58.4	20.4
SLURRY	s-o silt composite	7.9	1.12	25.4	2.28	0.37	1.91	59.7	19.5
MN0102	oxide silt	7.7	1.42	32.2	2.06	0.63	1.43	44.7	26.8
MN0104	sulfide silt	7.7	1.12	25.4	2.70	0.45	2.25	70.3	19.2
MN0203	sulfide silt	7.4	1.23	27.9	2.53	0.52	2.01	62.8	22.4
MN0304	sulfide silt	8.3	1.15	26.1	2.24	0.39	1.85	57.8	20.9
MN0401	sulfide silt	8.0	2.58	58.6	4.06	0.79	3.27	102.2	39.5
MN0402	oxide silt	8.1	2.08	47.2	3.43	0.81	2.62	81.9	36.6
MN0404	sulfide silt	8.0	1.00	22.7	1.48	0.30	1.18	36.9	22.7
MN0501	oxide silt	7.5	2.62	59.5	3.80	0.84	2.96	92.5	42.9
MN0502	oxide silt	6.8	2.08	47.2	4.10	0.75	3.35	104.7	37.2
MN0503	sulfide silt	6.8	1.96	44.5	4.33	0.69	3.64	113.8	31.7
MN0505	sulfide silt	8.0	0.77	17.5	0.96	0.09	0.87	27.2	16.0
MN0506T	native sediments	7.1	<0.03	<0.7	<0.02	<0.01	<0.02	<0.6	3.0
MN0506B	native sediments	7.6	0.77	17.5	0.03	0.02	0.01	0.3	23.6
MN0605	sulfide silt	8.2	1.85	42.0	2.76	0.37	2.39	74.7	34.7
MN0608	sulfide clay	8.0	0.81	18.4	0.30	0.09	0.21	6.6	20.8
MN0609	native sediments	8.2	0.85	19.3	<0.02	<0.01	<0.02	<0.6	21.3
MN0805	sulfice silt	8.5	0.46	10.4	1.19	0.44	0.75	23.4	12.4
MN0903	sulfide silt	8.2	0.23	5.2	0.84	0.25	0.59	18.4	8.2
MN1204B	oxide clay	9.0	0.38	8.6	1.36	0.13	1.23	38.4	14.1
MN1206	native sediments	7.0	0.77	17.5	1.16	0.15	1.01	31.6	14.9
MN1305	oxide clay	9.1	0.62	14.1	1.54	0.32	1.22	38.1	17.3
MN1405	oxide silt	8.4	0.65	14.8	1.28	0.85	0.43	13.4	17.3
MN1406	oxide clay	8.6	0.58	13.2	1.62	0.31	1.31	40.9	17.6
MN1407	native sediments	7.7	0.04	0.9	0.06	0.06	< 0.02	<0.6	3.0
MN1502	oxide silt	7.4	0.59	13.4	2.43	0.11	2.32	72.5	12.4
MN1607	native sediments	6.1	0.04	0.9	0.04	0.04	0.00	0.0	1.7
MN1702	oxide silt	7.0	0.51	11.6	3.00	0.36	2.64	82.5	12.1
MN1703	oxide silt	7.2	0.29	6.6	1.63	0.32	1.31	40.9	7.4
MN1705	native sediments	8.7	0.11	2.5	0.35	0.12	0.23	7.2	4.2
MN1706	native sediments	8.6	0.11	2.5	0.24	0.17	0.07	2.2	4.5
MN1904	sulfide silt	7.8	1.47	33.4	2.72	0.43	2.29	71.6	29.5
MN1909	native sediments	8.2	0.99	22.5	0.06	0.02	0.04	1.3	24.8
BATCHO3	oxide clay composite	8.6	0.51	11.6	1.48	0.65	0.83	25.9	14.1
BATCHS3	sulfide clay composite	8.3	0.95	21.6	2.19	0.89	1.30	40.6	18.8

*Based on difference between total sulfur and sulfate-sulfur

**Based on sulfide-sulfur

Table C-2 (cont.)

Field #	Sample Type	Net Neutralization Potential (Kg $CaCO_3$/ Tonne)	Fizz Rating	Acid Used (mL/N)
ENDADIT	pit grab	-92.1	none	40/0.1
NWALLCU	pit grab	-147.2	none	20/0.1
MNOMIX	oxide silt composite	-51.7	none	20/0.1
MNSMIX	sulfide silt composite	-33.2	none	20/0.1
SOMIX	s-o silt composite	-38.0	none	20/0.1
SLURRY	s-o silt composite	-40.2	none	20/0.1
MN0102	oxide silt	-17.9	none	20/0.1
MN0104	sulfide silt	-51.1	none	20/0.1
MN0203	sulfide silt	-40.4	none	20/0.1
MN0304	sulfide silt	-36.9	none	20/0.1
MN0401	sulfide silt	-62.7	none	30/0.1
MN0402	oxide silt	-45.3	none	30/0.1
MN0404	sulfide silt	-14.2	none	20/0.1
MN0501	oxide silt	-49.6	slight	40/0.1
MN0502	oxide silt	-67.5	slight	40/0.1
MN0503	sulfide silt	-82.1	none	25/0.1
MN0505	sulfide silt	-11.2	none	20/0.1
MN0506T	native sediments	3.0	none	20/0.1
MN0506B	native sediments	23.3	slight	40/0.1
MN0605	sulfide silt	-40.0	slight	40/0.1
MN0608	sulfide clay	14.2	slight	40/0.1
MN0609	native sediments	21.3	slight	40/0.1
MN0805	sulfide silt	-11.0	none	20/0.1
MN0903	sulfide silt	-10.2	none	20/0.1
MN1204B	oxide clay	-24.3	none	20/0.1
MN1206	native sediments	-16.7	none	20/0.1
MN1305	oxide clay	-20.8	none	20/0.1
MN1405	oxide silt	3.9	none	20/0.1
MN1406	oxide clay	-23.3	none	20/0.1
MN1407	native sediments	3.0	none	20/0.1
MN1502	oxide silt	-60.1	none	20/0.1
MN1607	native sediments	1.7	none	20/0.1
MN1702	oxide silt	-70.4	none	20/0.1
MN1703	oxide silt	-33.5	none	20/0.1
MN1705	native sediments	-3.0	none	20/0.1
MN1706	native sediments	2.3	none	20/0.1
MN1904	sulfide silt	-42.1	none	20/0.1
MN1909	native sediments	23.6	slight	40/0.1
BATCHO3	oxide clay composite	-11.8	none	20/0.1
BATCHS3	sulfide clay composite	-21.8	none	20/0.1

*Based on difference between total sulfur and sulfate-sulfur

**Based on sulfide-sulfur

Table C-2 (cont.)

Table C-2a: QA/QC for NP Determination (Mod. ABA)

Sample	Neutralisation Potential (kgCaCO3/Tonne)	Neutralisation Potential (kgCaCO3/Tonne)
Duplicates - NP		
10	20.9	21.8
20	34.7	35.6
30	3.0	3.2
40	18.8	19.3
NBM-1 Reference (NP = 42)	42.9	-

Table C-2b: QA/QC for Sulphur Speciation

Sample	Sulphur (Wt.%)	Sulphur (Wt.%)
Duplicates - total sulphur		
10	2.24	2.13
20	2.76	2.69
30	0.06	0.06
40	2.19	2.15
Std. CSB (5.2% TS)	5.33	5.30
BCRI Std. (0.11% TS)	0.10	0.10
BCRI Std. (0.53% SO4-S)	0.56	-
BCRI Std. (0.05% SO4-S)	0.05	-

Table C-2c: QA/QC for CO2 Determination

Sample	CO2 (Wt.%)	CO2 (Wt.%)
Duplicates		
10	1.15	1.12
20	1.85	1.89
30	0.04	0.04
40	0.95	0.95

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 1 - 03	45 - 90	Leach Water	S-silt	8.79	17.77	43.7			< 0.02			6		10	
MN BH 1 - 04	60 - 120	Porewater	S-silt	7.91		32.6			0.37		188	299	2239	45	
MN BH 1 - 05	120-150	Leach Water	O-silt	8.65		9.10			0.03			2		1	
MN BH 1 - 06	150 - 217	Porewater	O-silt	9.22		7.50	27.6	11.3	11.9	6	63	95	1646	6	7.0
MN BH 1 - 07	217 - 255	Leach Water	O-silt	8.33	2.61				0.12			< 2		7	
MN BH 1 - 08	255 - 270	Leach Water		7.80	> 19.99				< 0.02			9		9	
MN BH 2 - 01	0 - 17.5	Porewater	S-silt	8.10					< 0.02			24		30	0.8
MN BH 2 - 02	18 - 47	Porewater	O-silt	8.31		17.7	0.1	< 0.05	0.19	3	184	229	2785	41	
MN BH 2 - 03	47 - 70	Porewater	S-silt	8.38		58.6	0.2	0.10	0.32	< 2	238	248	2356	43	
MN BH 2 - 04	70 - 120	Porewater	O-silt	8.44		61.9			0.05			230		49	
MN BH 2 - 05	120 - 200	Porewater	O-silt	8.70		35.4	2.6	0.60	2.64	26	166	204	1987	29	
MN BH 2 - 06	200 - 275	Porewater	O-silt	8.95			23.6	4.2	8.47	45	94	87	1913	12	1.8
MN BH 2 - 07	275 - 290	Leach Water	O-clay	8.12	> 19.99				0.03			3		3	
MN BH 2 - 08	290 - 330	Leach Water		6.63					0.02			< 2		4	
MN BH 3 - 01	0 - 40	Porewater	O-silt	7.77					< 0.02			240		59	0.9
MN BH 3 - 02	40 - 100	Leach Water	S-silt	8.75		31.0			0.02			18		7	
MN BH 3 - 03	100 - 110	Porewater	O-silt	8.85					0.02			316		44	
MN BH 3 - 04	110 - 150	Porewater	S-silt	8.77			7.7	0.10	1.17	64	180	192	2242	27	
MN BH 3 - 05	150 - 250	Porewater	O-silt	8.98			65.3	32.8	23.3	75	115	130	1885	12	
MN BH 3 - 06	250 - 275	Leach Water	O-silt	9.15	2.75		7.1	3.8	3.88	8	141	10	141	5	
MN BH 3 - 07	275 - 280	Porewater	O-silt	8.81		28.8	59.3	32.8	32.0	37	54	43	801	8	1.2
MN BH 4 - 01	0 - 25	Porewater	S-silt	8.60					0.07			41		28	7.3
MN BH 4 - 02	25 - 40	Porewater	O-silt	8.64	16.07				0.14			56		27	
MN BH 4 - 03	40 - 120	Porewater	S-silt	8.87	19.92	54.2			1.76		47	62	1968	29	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 4 - 04	120 - 150	Porewater	S-silt	8.66	> 19.99	14.4	1.6	1.5	2.53	20	125	141	2080	41	
MN BH 4 - 06	180 - 280	Porewater	S-clay	8.65		63.0	2.3	1.8	3.47	72	285	285	2388	46	
MN BH 4 - 08	420 - 440	Porewater	S-silt	9.40	10.56		55.6	25.1	25.5	19	33	84	519	5	1.0
MN BH 5 - 01	0 - 25	Leach Water	O-silt	7.80	13.54	24.3			< 0.02			< 2		5	
MN BH 5 - 02	25 - 50	Leach Water	O-silt	6.97	14.32				< 0.02			8		7	
MN BH 5 - 03	50 - 140	Leach Water	S-silt	7.72	12.76	24.3			< 0.02						
MN BH 5 - 04	140 - 205	Leach Water	S-silt	7.93	8.79				<0.02			3		6	
MN BH 5 - 05	205	Leach Water		7.04					0.02			< 2		5	
MN BH 5 - 06	205 - 270	Leach Water	S-silt	7.58	3.54				<0.02			< 2		7	
MN BH 5 - 07	270 - 330	Leach Water		8.04	> 19.99				0.02			11		2	
MN BH 5 - 08	330 - 400	Leach Water		8.04	> 19.99				0.02			5		< 1	
MN BH 6 - 01	0 - 10	Porewater	S-silt	7.96	> 19.99				< 0.02			< 2		74	
MN BH 6 - 03	30 - 166	Porewater	S-silt	8.60	> 19.99	21.0	12.8	13.2	18.7	72	236	253	2492	40	
MN BH 6 - 04	166 - 206	Porewater	O-silt	8.31		21.0	0.1	< 0.05	8.39	124	194	185	2346	< 1	
MN BH 6 - 05	206 - 262	Porewater	S-silt	8.75		27.6	7.8	8.1	25.7	153	239	224	2374	34	
MN BH 6 - 07	342 - 502	Porewater	S-clay	8.68		111	0.2	< 0.05	1.64	9	152	169	2084	14	
MN BH 6 - 08	502 - 626	Porewater	O-silt	8.36		46.4	0.6	< 0.05	8.26	<2	110	106	2229	12	
MN BH 7 - 01	20 - 40	Water		7.90		42.5	0.1	< 0.05	0.13	4	46	57	1365	24	
MN BH 7 - 02	40 - 90	Porewater	S-silt	8.96	15.4				0.03			53		12	
MN BH 7 - 03	90 - 220	Porewater	O-silt	8.87		165	< 0.05	< 0.05	1.55	20	249	255	2267	41	
MN BH 7 - 05	246 - 377	Porewater	O-clay	8.68		93.1	0.8	1.3	17.1	83	139	148	1998	10	
MN BH 7 - 06	377 - 480	Porewater	O-silt	9.32	13.98	98.8	59.9	8.9	12.4	66	64	94	1262	38	
MN BH 7 - 07	480 - 600	Porewater	O-silt	9.67	16.83	51.8	37.1	7.5	7.95	54	38	31	601	29	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 8 - 01	25 - 75	Porewater	S-clay	7.93					0.12			69		22	
MN BH 8 - 02A	75 - 330	Porewater	S-clay	8.48			30.4	4.8	28.4	35	52	77	1256	12	
MN BH 8 - 02	75 - 330A	Porewater	O-clay	8.56					0.15			262			
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt	8.47			0.3	< 0.05	0.38	22	252	257	2672		
MN BH 8 - 05	75 - 330C	Porewater		9.03			43.5	32.9	38.3	103	104	104	2110		
MN BH 8 - 06	75 - 330D										26		1070		
MN BH 9 - 01	20 - 60	Water		7.84			0.3	0.1	0.16	3	46	64	1370	16	1.0
MN BH 9 - 02	60 - 150	Porewater	S-clay	8.47		99.6	0.5	< 0.05	1.72	18	153	174	2151	42	
MN BH 9 - 03	150 - 240	Porewater	S-silt	7.98		11.1	2.2	1.0	0.86	< 2	76	55	1794	7	1.3
MN BH 9 - 04														43	
MN BH 10 - 01	24 - 130	Water		7.63	> 19.99				0.07		47	65	1404	20	
MN BH 10 - 02	140 - 165	Porewater		8.93	16.61				0.04			106		44	
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	8.60			0.3	< 0.05	0.02	11	175	179	2452	51	
MN BH 10 - 04															
MNBH 10 - 06															
MN BH 11 - 01	24 - 140	Water		7.90	13.56				0.09		43	56	1281	24	
MN BH 11 - 02	140 - 362	Porewater	S-clay	8.75		67.7	0.1	< 0.05	1.55	22	196	221	2114	40	
MN BH 11 - 03	362 - 450	Porewater	O-clay	8.64		36.1	0.3	0.1	0.33	5	127	151	1976	12	
MN BH 11 - 05	480 - 570	Porewater	O-clay	7.14	18.61	0.5			0.02		<5	< 2	79	20	
MN BH 12 - 01	25 - 168	Water		7.87					0.09		40	19	1357	26	
MN BH 12 - 02	168 - 407	Porewater	O-clay	9.07		30.0	0.2	< 0.05	0.02	< 2	169	163	2079	27	
MN BH 12 - 04	417 - 920	Porewater	O-clay	9.09		23.6	5.7	< 0.05	3.18	55	157	143	1964	7	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 13 - 01	25 - 110	Water		7.96					0.09		40	39	1393	26	
MN BH 13 - 02	110 -257	Porewater	S-clay	8.40		73.0			0.05			183		46	
MN BH 13 - 03	257 - 356	Porewater	S-clay	8.60		95.1			0.02			175		35	
MN BH 13 - 04	356 - 470	Porewater	O-clay	8.46		34.3			0.08			146		33	
MN BH 13 - 05	470 - 700	Porewater	O-clay	9.05		19.3	2.4	< 0.05	5.86	59	135	135	1881	8	
MN BH 14 - 04	270 - 455	Porewater	O-silt	9.09		7.3	0.9	< 0.05	<0.02	5	128	170	2279	24	
MN BH 14 - 05	455 - 578	Porewater	O-silt	8.85		17.1			< 0.02			179		29	
MN BH 15 - 01	10 - 25 cm	Water	S-clay	7.70					0.16		47	52	1395	24	
MN BH 15 - 02	25 - 210	Porewater	O-silt	7.87		12.8	0.1	< 0.05	0.35	< 2	50	49	1900	17	
MN BH 15 - 03	210 - 460	Porewater	O-silt	8.86		5.41			0.02		143	221	2225	37	
MN BH 15 - 04	460 - 510	Porewater	O-silt	8.34		18.2			0.10		244	245	2399	48	
MN BH 15 - 06	580 - 750	Porewater	O-clay	9.24		24.6	60.6	< 0.05	5.46	53	145	144	1860	5	
MN BH 15 - 07	750 - 910	Porewater	O-clay	8.90		19.3	18.3	0.3	2.33	29	163	171	1691		
MN BH 16 - 01	13 - 150	Water	S-clay	7.79					0.11		42	37	1321	23	
MN BH 16 - 02	150 - 358	Porewater	O-silt	8.58		145	0.3	0.2	0.46	10	212	233	1879	41	
MN BH 16 - 04	386 - 498	Porewater	O-clay	8.70		19.1	1.7	< 0.05	< 0.02	<2	179	171	2295	13	
MN BH 17 - 04	184 - 260	Porewater	O- Silt	8.33					< 0.02		33	18	2183	21	
MN BH 18 -00	20 - 140	Porewater		7.77					0.05			32			
MN BH 18 -01	140 - 250	Porewater	S-clay	8.72		73.3			< 0.02		105	62	1869	31	
MN BH 18 -02	250 - 331	Porewater	S-clay	8.68		7.8			0.45			171		> 55	
MN BH 18 -03	331 - 485	Porewater	O-clay	8.65		27.8			0.07			124			
MN BH 18 -04	485 - 610	Porewater	O-clay	9.10		31.1	2.1	0.5	12.5	81	154	132	1880	31	

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	pH	Conductivity (mS/cm)	Total Cyanide in Tailings (g/g)	Total Cyanide in Porewater Chem Lab (mg/L)	WAD Cyanide (mg/L)		CNO (mg/L)	CNS (mg/L)		SO_4 (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
								MMSL Chem Lab	Onsite		MMSL Chem Lab	Onsite			
MN BH 18 -05	610 - 660	Porewater	O-clay	8.83		24.4	16.5	11.7	22.6	81	125	81	1755		
MN BH 18 -06	660 - 800	Porewater	O-silt	9.12		102	4.4	0.3	1.50	26	16	16	514		
MN BH 19 - 01	0 - 25	Porewater	S-silt	7.57					0.34		<5	25	3008		
MN BH 19 - 02	25 - 103	Porewater	S-silt	8.70		31.1			0.33			17			
MN BH 19 - 03	103 - 140	Porewater	O-silt	8.62		27.8	0.1	0.2	0.72	< 2	31	33	2209	32	
MN BH 19 - 04	140 - 207	Porewater	S-silt	8.85		33.3	0.2	< 0.05	0.02	11	45	36	2175		
MN BH 19 - 05	207 - 251	Porewater		8.26		22.2	0.1	0.1	< 0.02	17		109			
MN BH 19 - 06	251 - 356	Porewater	S-silt	8.38		4.9	0.1	0.08	0.09	16		76		> 55	
MN BH 19 - 07	356 - 389	Porewater		8.35		17.8			< 0.02			15		47	
MN BH 19 - 08	389 - 428	Porewater	S-silt	8.25		37.6			< 0.02		43	42	2215		
MN Seepage Water		Water		7.27			0.3	0.2	0.33	< 2	57	60	1222	17	
MN Pit (Bottom)													2579		
MN Pit (Top)													223		
BLANK 17													<10		
BLANK 18													<10		
BLANK 19													<10		

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_3-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 1 - 03	45 - 90	Leach Water	S-silt	0.1																
MN BH 1 - 04	60 - 120	Porewater	S-silt	3.1	0.056	1.59	0.226	0.052	3.7	540.8	< 0.1	35.9	2.5	1.79	0.049	48.35	2.5	48.17	1.98	1.4
MN BH 1 - 05	120-150	Leach Water	O-silt	0.4																
MN BH 1 - 06	150 - 217	Porewater	O-silt	4.4	0.145	1.22	2.82	0.139	4.7	495.5	< 0.1	22.6	0.2	7.34	4.28	26.24	1.1	1.61	0.036	< 0.1
MN BH 1 - 07	217 - 255	Leach Water	O-silt	0.2																
MN BH 1 - 08	255 - 270	Leach Water		<0.1																
MN BH 2 - 01	0 - 17.5	Porewater	S-silt	4.4																
MN BH 2 - 02	18 - 47	Porewater	O-silt	0.2	0.007	0.609	0.055	0.048	3.7	504.0	5.8	17.9	2.1	0.225	0.104	62.52	1.7	77.89	0.892	< 0.1
MN BH 2 - 03	47 - 70	Porewater	S-silt	0.1	0.031	1.32	0.268	0.050	2.9	531.5	< 0.1	19.8	0.5	0.407	0.143	52.02	1.9	62.07	3.58	< 0.1
MN BH 2 - 04	70 - 120	Porewater	O-silt	< 0.1																
MN BH 2 - 05	120 - 200	Porewater	O-silt	< 0.1						498.0				9.23	1.19	32.70	0.9	31.27	0.373	1.1
MN BH 2 - 06	200 - 275	Porewater	O-silt	< 0.1	0.005	0.426	1.39	0.084	2.1	564.0	< 0.1	35.0	<0.1	0.008	6.69	27.19	0.5	6.19	0.022	2.4
MN BH 2 - 07	275 - 290	Leach Water	O-clay	0.1																
MN BH 2 - 08	290 - 330	Leach Water		< 0.1																
MN BH 3 - 01	0 - 40	Porewater	O-silt	0.4																
MN BH 3 - 02	40 - 100	Leach Water	S-silt	0.2																
MN BH 3 - 03	100 - 110	Porewater	O-silt	0.5																
MN BH 3 - 04	110 - 150	Porewater	S-silt	0.1	0.016	0.713	1.13	0.095	3.7	571.8	< 0.1	38.3	0.5	0.774	1.73	47.41	2.1	20.34	0.092	3.1
MN BH 3 - 05	150 - 250	Porewater	O-silt	0.2	0.062	0.287	1.84	0.050	2.7	564.3	0.3	32.5	<0.1	19.3	12.1	34.04	1.2	3.85	0.011	25.1
MN BH 3 - 06	250 - 275	Leach Water	O-silt	0.2	0.036	0.982	0.667	0.041	4.3	39.25	< 0.1	4.3	0.6	2.68	4.01	6.87	0.5	0.42	0.015	5.9
MN BH 3 - 07	275 - 280	Porewater	O-silt	0.2	0.272	0.888	1.27	0.034	1.6	214.9	< 0.1	24.5	<0.1	16.4	11.5	31.96	0.3	1.55	0.017	7.8
MN BH 4 - 01	0 - 25	Porewater	S-silt	0.2																
MN BH 4 - 02	25 - 40	Porewater	O-silt	0.1																
MN BH 4 - 03	40 - 120	Porewater	S-silt	0.3	0.035	1.27	0.255	0.030	3.2	521.9	1.3	4.5	0.6	2.44	0.167	57.19	0.7	14.49	0.061	8.4

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 4 - 04	120 - 150	Porewater	S-silt	< 0.1	0.005	0.427	0.082	0.043	3.8	503.1	1.7	7.5	<0.1	3.11	0.087	52.46	0.2	33.19	0.115	< 0.1
MN BH 4 - 06	180 - 280	Porewater	S-clay	< 0.1	0.010	0.913	0.067	0.035	2.1	475.8	1.9	3.8	1.3	2.44	0.082	66.46	1.7	50.47	0.355	10.5
MN BH 4 - 08	420 - 440	Porewater	S-silt	0.2	0.062	0.922	0.439	0.047	1.6	128.5	9.1	9.7	2.6	7.84	10.1	13.93	0.2	1.77	0.027	9.7
MN BH 5 - 01	0 - 25	Leach Water	O-silt	0.1																
MN BH 5 - 02	25 - 50	Leach Water	O-silt	0.1																
MN BH 5 - 03	50 - 140	Leach Water	S-silt																	
MN BH 5 - 04	140 - 205	Leach Water	S-silt	0.2																
MN BH 5 - 05	205	Leach Water		< 0.1																
MN BH 5 - 06	205 - 270	Leach Water	S-silt	0.1																
MN BH 5 - 07	270 - 330	Leach Water		0.1																
MN BH 5 - 08	330 - 400	Leach Water																		
MN BH 6 - 01	0 - 10	Porewater	S-silt																	
MN BH 6 - 03	30 - 166	Porewater	S-silt	< 0.1	0.019	0.816	0.086	0.090	2.1	475.6	2.2	10.3	<0.1	18.1	0.129	60.89	0.5	23.95	0.053	12.3
MN BH 6 - 04	166 - 206	Porewater	O-silt	0.1	< 0.001	0.703	0.219	0.225	6.2	505.9	2.7	20.6	1.2	10.8	0.216	53.58	1.8	24.35	0.238	11.2
MN BH 6 - 05	206 - 262	Porewater	S-silt	< 0.1	0.002	0.600	0.093	0.045	1.1	497.1	0.3	16.5	<0.1	27.8	0.091	62.13	0.5	18.67	0.087	21.4
MN BH 6 - 07	342 - 502	Porewater	S-clay	0.1	0.019	1.08	0.497	0.085	3.4	596.1	< 0.1	14.7	0.7	0.733	0.089	36.77	0.7	37.38	0.845	< 0.1
MN BH 6 - 08	502 - 626	Porewater	O-silt	< 0.1	0.030	1.33	0.174	0.053	27.0	539.4	3.6	19.4	<0.1	8.13	0.114	20.37	1.2	60.56	0.643	13.6
MN BH 7 - 01	20 - 40	Water		0.4	0.008	1.62	0.010	0.070	13.9	333.1	0.4	18.5	1.7	0.238	0.183	14.21	0.8	30.91	1.80	4.7
MN BH 7 - 02	40 - 90	Porewater	S-silt	2.2																
MN BH 7 - 03	90 - 220	Porewater	O-silt	< 0.1	0.004	1.55	0.214	0.044	3.7	526.8	4.0	14.8	37.5	1.54	0.205	51.43	1.1	43.47	0.274	7.1
MN BH 7 - 05	246 - 377	Porewater	O-clay	< 0.1	0.003	0.232	0.992	0.056	2.8	489.2	0.3	27.5	<0.1	18.4	1.00	25.75	0.8	18.20	0.414	4.2
MN BH 7 - 06	377 - 480	Porewater	O-silt	0.1	0.020	0.643	1.53	0.040	7.2	379.1	< 0.1	15.6	<0.1	14.0	20.0	29.01	0.9	2.74	0.015	12.7
MN BH 7 - 07	480 - 600	Porewater	O-silt	0.1	0.024	1.33	0.940	0.047	4.4	161.4	< 0.1	16.4	1.5	8.21	11.2	21.46	1.4	1.09	0.020	15.5

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 8 - 01	25 - 75	Porewater	S-clay	0.1																
MN BH 8 - 02A	75 - 330	Porewater	S-clay	< 0.1	0.063	1.54	0.952	0.111	5.4	332.1	9.7	23.6	1.7	18.0	3.80	27.60	0.8	6.9	0.088	5.1
MN BH 8 - 02	75 - 330A	Porewater	O-clay																	
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt		0.004	0.301	0.172	0.063	7.6	550.2	< 0.1	17.9	6.0	1.16	0.589	65.83	1.2	57.27	0.882	10.3
MN BH 8 - 05	75 - 330C	Porewater			0.014	0.350	1.98	0.151	3.4	591.6	< 0.1	6.8	1.7	21.6	1.23	31.32	0.4	8.17	0.044	2.0
MN BH 8 - 06	75 - 330D				0.292	1.08	0.879	0.075	8.4	310.5	< 0.1	15.5	4.0	10.6	0.713	30.52	1.3	5.24	0.052	10.4
MN BH 9 - 01	20 - 60	Water		0.2	0.002	0.617	< 0.005	0.035	7.8	332.2	0.1	10.1	<0.1	0.225	0.117	14.89	0.4	30.71	1.17	9.8
MN BH 9 - 02	60 - 150	Porewater	S-clay	< 0.1	< 0.001	0.788	< 0.005	0.044	4.1	521.0	< 0.1	14.1	1.5	1.62	0.121	42.16	1.5	45.54	0.740	10.7
MN BH 9 - 03	150 - 240	Porewater	S-silt	2.5	< 0.001	0.411	0.928	0.157	49.8	616.9	< 0.1	31.1	0.4	0.020	0.382	37.18	1.6	30.20	1.30	12.5
MN BH 9 - 04																				
MN BH 10 - 01	24 - 130	Water		0.1	< 0.001	0.307	0.043	0.079	11.0	329.6	< 0.1	12.9	<0.1	0.266	0.123	13.62	0.2	30.49	1.19	1.2
MN BH 10 - 02	140 - 165	Porewater		0.3																
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	< 0.1	0.003	0.479	0.300	0.098	6.5	524.1	< 0.1	14.2	1.5	0.182	0.071	44.94	2.5	54.82	0.800	15.7
MN BH 10 - 04										540.8					0.049	48.35		48.17		
MNBH 10 - 06										495.5					4.28	26.24		1.61		
MN BH 11 - 01	24 - 140	Water		0.2	0.006	0.526	0.011	0.070	13.2	308.4	< 0.1	16.2	0.7	0.272	0.092	12.89	0.8	28.36	1.66	< 0.1
MN BH 11 - 02	140 - 362	Porewater	S-clay	0.1	0.025	0.501	0.542	0.073	2.1	527.2	3.0	13.9	<0.1	2.39	0.020	40.25	1.2	37.26	0.442	5.8
MN BH 11 - 03	362 - 450	Porewater	O-clay	0.1	< 0.001	0.310	0.654	0.071	3.9	542.0	2.5	15.1	0.8	0.881	0.081	32.53	1.7	36.46	0.656	3.8
MN BH 11 - 05	480 - 570	Porewater	O-clay	< 0.1	0.006	0.478	0.028	0.044	14.9	14.62	< 0.1	0.76	1.3	0.011	4.23	2.150	0.7	3.56	0.053	1.5
MN BH 12 - 01	25 - 168	Water		0.3	< 0.001	0.403	< 0.005	0.068	9.8	314.7	< 0.1	12.8	1.6	0.211	0.112	13.14	1.2	29.15	1.41	< 0.1
MN BH 12 - 02	168 - 407	Porewater	O-clay	2.5	0.002	0.322	0.989	0.077	2.2	550.9	< 0.1	24.9	<0.1	0.012	0.121	42.95	1.3	32.51	0.356	3.8
MN BH 12 - 04	417 - 920	Porewater	O-clay		0.018	0.222	1.44	0.058	2.1	641.6	< 0.1	17.7	1.5	6.63	1.91	27.08	0.8	10.67	0.081	8.2

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 13 - 01	25 - 110	Water		0.1	0.010	0.389	0.074	0.061	12.9	326.8	< 0.1	15.7	2.4	0.204	0.096	13.52	1.0	30.09	1.63	< 0.1
MN BH 13 - 02	110 -257	Porewater	S-clay	< 0.1																
MN BH 13 - 03	257 - 356	Porewater	S-clay	0.1																
MN BH 13 - 04	356 - 470	Porewater	O-clay	0.1																
MN BH 13 - 05	470 - 700	Porewater	O-clay	< 0.1	0.023	0.390	1.86	0.092	2.5	642.3	< 0.1	18.9	0.5	10.4	1.61	28.16	1.8	11.85	0.108	10.5
MN BH 14 - 04	270 - 455	Porewater	O-silt	0.2	0.011	0.319	1.06	0.054	3.9	501.3	< 0.1	43.5	2.2	0.010	0.281	59.02	0.7	16.03	0.016	8.2
MN BH 14 - 05	455 - 578	Porewater	O-silt	0.2																
MN BH 15 - 01	10 - 25 cm	Water	S-clay	0.1	< 0.001	0.344	0.044	0.069	13.0	330.7	< 0.1	15.5	<0.1	0.347	0.112	13.37	0.6	29.50	1.82	< 0.1
MN BH 15 - 02	25 - 210	Porewater	O-silt	0.2	0.001	0.317	0.090	0.093	5.5	509.2	0.8	14.4	1.9	0.061	0.078	20.36	1.7	32.23	1.76	< 0.1
MN BH 15 - 03	210 - 460	Porewater	O-silt	< 0.1	0.005	0.189	0.925	0.017	1.5	539.8	< 0.1	18.3	<0.1	0.064	0.051	39.34	0.4	19.49	0.12	18.5
MN BH 15 - 04	460 - 510	Porewater	O-silt	< 0.1	0.001	0.425	0.421	0.049	4.2	565.4	1.6	27.2	<0.1	0.039	0.099	52.78	2.3	39.34	0.937	4.1
MN BH 15 - 06	580 - 750	Porewater	O-clay	< 0.1	0.004	0.154	1.42	0.057	2.4	606.8	1.0	15.8	0.7	8.63	2.44	25.17	0.3	7.24	0.064	2.8
MN BH 15 - 07	750 - 910	Porewater	O-clay		0.044	0.303	2.35	0.128	3.4	679.9	< 0.1	30.4	<0.1	3.09	7.30	22.21	0.2	6.66	0.033	5.7
MN BH 16 - 01	13 - 150	Water	S-clay	1.5	0.015	0.285	0.110	0.071	10.0	312.8	< 0.1	12.8	0.3	0.231	0.185	12.84	0.2	28.43	1.40	< 0.1
MN BH 16 - 02	150 - 358	Porewater	O-silt		0.029	0.299	0.267	0.030	1.3	515.5	< 0.1	9.8	< 0.1	2.64	0.042	42.43	0.7	33.7	0.325	5.1
MN BH 16 - 04	386 - 498	Porewater	O-clay		0.160	10.0	11.2	0.141	12.9	359.3	1.8	153	4.9	0.070	0.854	31.17	5.3	5.38	0.220	52.2
MN BH 17 - 04	184 - 260	Porewater	O- Silt		0.039	10.4	0.990	0.168	12.0	634.9	< 0.1	53.6	7.1	0.148	0.147	23.71	10.5	31.96	3.11	41.9
MN BH 18 -00	20 - 140	Porewater																		
MN BH 18 -01	140 - 250	Porewater	S-clay		0.012	10.2	1.43	0.103	8.1	566.2	1.7	25.3	5.4	0.036	0.410	52.56	4.3	22.85	0.490	43.4
MN BH 18 -02	250 - 331	Porewater	S-clay																	
MN BH 18 -03	331 - 485	Porewater	O-clay																	
MN BH 18 -04	485 - 610	Porewater	O-clay		0.024	8.54	5.62	0.237	7.5	449.5	3.2	72.9	6.3	14.3	1.75	28.76	4.3	15.04	0.409	47.0

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	NO_2-N (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (g/L)	Ca (mg/L)	d (g/L)	Co (g/L)	Cr (g/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Li (g/L)	Mg (mg/L)	Mn (mg/L)	Mo (g/L)
MN BH 18 -05	610 - 660	Porewater	O-clay		0.084	8.69	5.36	0.323	5.9	579.8	2.1	87.0	4.1	23.1	4.02	24.83	13.9	9.69	0.178	37.2
MN BH 18 -06	660 - 800	Porewater	O-silt		0.020	0.84	0.382	0.061	3.5	174.5	1.1	6.5	0.9	3.52	2.23	10.16	0.5	2.88	0.066	1.9
MN BH 19 - 01	0 - 25	Porewater	S-silt		0.001	8.09	0.052	0.084	9.9	374.2	58.0	21.6	7.2	0.065	0.202	47.40	18.8	116.9	29.1	5.6
MN BH 19 - 02	25 - 103	Porewater	S-silt																	
MN BH 19 - 03	103 - 140	Porewater	O-silt		0.006	0.618	0.067	0.046	5.2	367.5	< 0.1	7.7	1.3	0.987	0.122	31.08	0.4	9.37	0.084	< 0.1
MN BH 19 - 04	140 - 207	Porewater	S-silt		0.002	7.75	0.434	0.089	12.1	576.9	14.7	38.8	8.7	0.608	0.072	54.69	6.7	27.82	3.51	29.7
MN BH 19 - 05	207 - 251	Porewater																		
MN BH 19 - 06	251 - 356	Porewater	S-silt																	
MN BH 19 - 07	356 - 389	Porewater																		
MN BH 19 - 08	389 - 428	Porewater	S-silt		0.058	6.77	0.397	0.120	23.1	596.4	28.8	50.5	5.6	3.02	0.071	39.64	8.3	36.48	9.68	17.2
MN Seepage Water		Water		0.7	0.002	6.29	0.037	0.084	45.2	289.3	1.6	49.1	6.2		11.2	11.48	1.3	25.55	7.94	6.2
MN Pit (Bottom)					0.001	0.941	< 0.005	0.019	0.53	443.3	6.2	1.3	6.4	0.043	0.02	6.13	4.0	274.0	1.54	1.8
MN Pit (Top)					0.001	0.573	0.019	0.034	4.5	118.7	1.8	0.34	4.8	0.038	0.16	1.97	1.2	26.84	0.070	< 0.1
BLANK 17					0.011	0.904	< 0.005	0.751	< 0.02	0.188	0.1	< 0.01	1.9	0.005	0.06	<0.27	28.0	0.04	0.005	< 0.1
BLANK 18					0.014	0.745	< 0.005	0.131	< 0.02	0.114	< 0.1	2.8	1.2	0.083	0.04	<0.27	0.4	0.01	0.004	< 0.1
BLANK 19					0.010	0.630	< 0.005	0.042	0.87	0.061	< 0.1	< 0.01	4.2	0.005	0.03	<0.27	<0.1	0.01	0.004	< 0.1

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 1 - 03	45 - 90	Leach Water	S-silt									
MN BH 1 - 04	60 - 120	Porewater	S-silt	412	49.1	188	18.6	888.2	79	5.06		27
MN BH 1 - 05	120-150	Leach Water	O-silt									
MN BH 1 - 06	150 - 217	Porewater	O-silt	241	36.3	193	1.1	550.5	19	27.7		< 1
MN BH 1 - 07	217 - 255	Leach Water	O-silt									
MN BH 1 - 08	255 - 270	Leach Water										
MN BH 2 - 01	0 - 17.5	Porewater	S-silt									
MN BH 2 - 02	18 - 47	Porewater	O-silt	608	<0.1	77	1.2	1115	64	3.55	1.68	8
MN BH 2 - 03	47 - 70	Porewater	S-silt	427	23.0	231	1.3	1007	30	5.12	1.16	20
MN BH 2 - 04	70 - 120	Porewater	O-silt									
MN BH 2 - 05	120 - 200	Porewater	O-silt	376	12.5	198	< 0.2	794.4	37	8.73	1.05	< 1
MN BH 2 - 06	200 - 275	Porewater	O-silt	256	4.1	183	< 0.2	668.8	55	19.0	1.27	< 1
MN BH 2 - 07	275 - 290	Leach Water	O-clay									
MN BH 2 - 08	290 - 330	Leach Water										
MN BH 3 - 01	0 - 40	Porewater	O-silt									
MN BH 3 - 02	40 - 100	Leach Water	S-silt									
MN BH 3 - 03	100 - 110	Porewater	O-silt									
MN BH 3 - 04	110 - 150	Porewater	S-silt	433	4.5	224	0.2	874.3	32	11.1	1.49	< 1
MN BH 3 - 05	150 - 250	Porewater	O-silt	340	22.3	172	3.6	680.2	62	20.0	1.50	7
MN BH 3 - 06	250 - 275	Leach Water	O-silt	42.9	8.2	140	52.2	49.5	45	6.69	0.08	18
MN BH 3 - 07	275 - 280	Porewater	O-silt	225	33.1	118	4.8	288.3	74	12.2	0.48	248
MN BH 4 - 01	0 - 25	Porewater	S-silt									
MN BH 4 - 02	25 - 40	Porewater	O-silt									
MN BH 4 - 03	40 - 120	Porewater	S-silt	248	6.7	201	2.5	695.3	51	1.23	1.38	32

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 4 - 04	120 - 150	Porewater	S-silt	336	12.1	220	11.0	791.9	35	2.46	1.53	< 1
MN BH 4 - 06	180 - 280	Porewater	S-clay	548	20.4	147	8.7	996.2	60	1.54	1.85	51
MN BH 4 - 08	420 - 440	Porewater	S-silt	158	11.2	230	1.3	175.4	28	5.82	0.30	423
MN BH 5 - 01	0 - 25	Leach Water	O-silt									
MN BH 5 - 02	25 - 50	Leach Water	O-silt									
MN BH 5 - 03	50 - 140	Leach Water	S-silt									
MN BH 5 - 04	140 - 205	Leach Water	S-silt									
MN BH 5 - 05	205	Leach Water										
MN BH 5 - 06	205 - 270	Leach Water	S-silt									
MN BH 5 - 07	270 - 330	Leach Water										
MN BH 5 - 08	330 - 400	Leach Water										
MN BH 6 - 01	0 - 10	Porewater	S-silt									
MN BH 6 - 03	30 - 166	Porewater	S-silt	664	28.7	176	1.0	1006	29	2.18	1.45	23
MN BH 6 - 04	166 - 206	Porewater	O-silt	550	38.2	106	2.3	907.2	55	3.38	1.38	< 1
MN BH 6 - 05	206 - 262	Porewater	S-silt	643	41.2	77	1.0	974.6	57	2.64	1.50	10
MN BH 6 - 07	342 - 502	Porewater	S-clay	349	11.4	156	26.4	934.7	46	0.96	1.35	14
MN BH 6 - 08	502 - 626	Porewater	O-silt	459	7.6	158	4.3	852.5	71	5.31	1.51	48
MN BH 7 - 01	20 - 40	Water		229	8.0	89	3.1	475.3	27	3.37	0.96	10
MN BH 7 - 02	40 - 90	Porewater	S-silt									
MN BH 7 - 03	90 - 220	Porewater	O-silt	524	4.6	251	2.4	1055	73	2.11	1.54	< 1
MN BH 7 - 05	246 - 377	Porewater	O-clay	288	37.6	271	6.2	658.8	46	3.98	0.96	8.3
MN BH 7 - 06	377 - 480	Porewater	O-silt	233	16.7	97	3.6	457.0	42	12.9	1.22	< 1
MN BH 7 - 07	480 - 600	Porewater	O-silt	152	28.7	133	191	213.1	34	5.10	0.52	48

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 8 - 01	25 - 75	Porewater	S-clay									
MN BH 8 - 02A	75 - 330	Porewater	S-clay	198	31.8	210	5.5	421.4	36	7.21	0.82	446
MN BH 8 - 02	75 - 330A	Porewater	O-clay									
MN BH 8 - 03	75 - 330 B1	Porewater	S-silt	577	41.3	252	10.1	1143	53	2.63	1.63	73
MN BH 8 - 05	75 - 330C	Porewater		363	31.4	94	12.9	703.1	51	3.99	1.34	4
MN BH 8 - 06	75 - 330D			145	58.4	135	4.5	348.0	32	1.10	0.95	57
MN BH 9 - 01	20 - 60	Water		223	< 0.1	< 10	0.3	476.6	27	3.39	0.95	< 1
MN BH 9 - 02	60 - 150	Porewater	S-clay	331	24.1	110	2.2	822.5	44	5.29	1.23	< 1
MN BH 9 - 03	150 - 240	Porewater	S-silt	213	123	43	9.2	633.1	55	19.3	1.61	6
MN BH 9 - 04												
MN BH 10 - 01	24 - 130	Water		224	7.1	83	11.8	472.8	35	3.31	0.94	6
MN BH 10 - 02	140 - 165	Porewater										
MN BH 10 - 03	130 - 220	Porewater	O-clay & S-clay	430	5.3	41	3.7	919.3	65	2.82	1.38	11
MN BH 10 - 04				412				888.2		5.06	1.24	
MNBH 10 - 06				241				550.5		27.7	1.13	
MN BH 11 - 01	24 - 140	Water		213	9.3	12	16.9	444.3	28	2.88	0.88	16
MN BH 11 - 02	140 - 362	Porewater	S-clay	437	22.8	238	16.0	965.5	71	2.58	1.05	14
MN BH 11 - 03	362 - 450	Porewater	O-clay	317	7.1	178	0.9	823.6	50	3.95	0.99	10
MN BH 11 - 05	480 - 570	Porewater	O-clay	7.3	2.2	98	3.2	18.7	6	2.76	0.08	55
MN BH 12 - 01	25 - 168	Water		212	5.1	121	1.4	452.3	7	2.90	0.89	55
MN BH 12 - 02	168 - 407	Porewater	O-clay	363	3.9	205	2.4	856.4	41	2.72	1.20	90
MN BH 12 - 04	417 - 920	Porewater	O-clay	275	23.0	86	0.6	831.3	27	4.19	1.24	43

Table C-3 - Tailings Porewater Chemistry

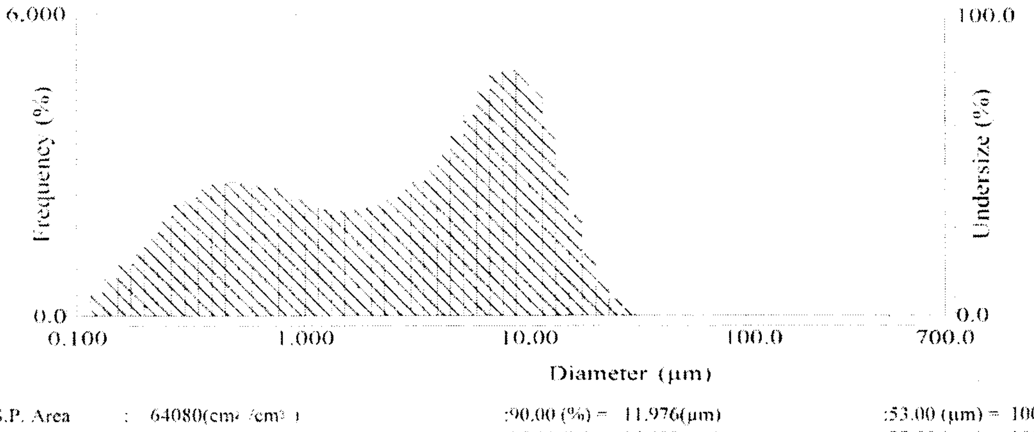
Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 13 - 01	25 - 110	Water		220	7.6	100	0.4	465.8	6	3.04	0.93	3
MN BH 13 - 02	110 -257	Porewater	S-clay									
MN BH 13 - 03	257 - 356	Porewater	S-clay									
MN BH 13 - 04	356 - 470	Porewater	O-clay									
MN BH 13 - 05	470 - 700	Porewater	O-clay	275	31.0	80	19.0	854.0	48	3.48	1.20	46
MN BH 14 - 04	270 - 455	Porewater	O-silt	402	8.0	233	0.9	792.8	32	12.5	1.33	< 1
MN BH 14 - 05	455 - 578	Porewater	O-silt									
MN BH 15 - 01	10 - 25 cm	Water	S-clay	238	6.5	78	0.5	481.8	3	3.59	0.96	3
MN BH 15 - 02	25 - 210	Porewater	O-silt	250	5.8	188	2.3	660.9	34	4.89	1.35	13
MN BH 15 - 03	210 - 460	Porewater	O-silt	403	<0.1	109	3.6	852.0	57	15.4	1.24	19
MN BH 15 - 04	460 - 510	Porewater	O-silt	559	3.2	225	3.1	1047	49	1.65	1.28	18
MN BH 15 - 06	580 - 750	Porewater	O-clay	245	23.8	139	1.6	777.1	22	4.27	1.11	1
MN BH 15 - 07	750 - 910	Porewater	O-clay	229	15.3	120	0.4	820.7	85	8.34	1.34	1
MN BH 16 - 01	13 - 150	Water	S-clay	216	2.8	201	0.4	446.4	15	2.80	0.91	81
MN BH 16 - 02	150 - 358	Porewater	O-silt	490	33.8	132	9.9	966.4	44	3.35	0.95	34
MN BH 16 - 04	386 - 498	Porewater	O-clay	427	34.4	127	44.5	711.5	166	7.77	0.73	161
MN BH 17 - 04	184 - 260	Porewater	O- Silt	256	14.9	101	27.7	780.3	210	5.39	1.27	181
MN BH 18 -00	20 - 140	Porewater										
MN BH 18 -01	140 - 250	Porewater	S-clay	223	17.5	95	28.0	728.4	169	1.92	1.32	146
MN BH 18 -02	250 - 331	Porewater	S-clay									
MN BH 18 -03	331 - 485	Porewater	O-clay									
MN BH 18 -04	485 - 610	Porewater	O-clay	267	157	86	28.0	666.2	142	4.92	0.86	180

Table C-3 - Tailings Porewater Chemistry

Sample Number	Sample Depth (cm)	Sample Type	Tailing Type	Na (mg/L)	Ni (g/L)	P (g/L)	Pb (g/L)	S (mg/L)	Sb (g/L)	Si (mg/L)	Sr (mg/L)	Zn (g/L)
MN BH 18 -05	610 - 660	Porewater	O-clay	246	147	173	8.1	696.5	188	8.53	1.25	331
MN BH 18 -06	660 - 800	Porewater	O-silt	69.7	36.9	207	30.8	185.4	11	1.86	0.46	60
MN BH 19 - 01	0 - 25	Porewater	S-silt	442	33.5	122	14.4	854.4	823	2.24	1.75	5774
MN BH 19 - 02	25 - 103	Porewater	S-silt									
MN BH 19 - 03	103 - 140	Porewater	O-silt	170	2.4	213	2.6	475.9	16	1.48	1.14	34
MN BH 19 - 04	140 - 207	Porewater	S-silt	288	23.0	112	8.8	809.8	167	3.33	1.59	304
MN BH 19 - 05	207 - 251	Porewater										
MN BH 19 - 06	251 - 356	Porewater	S-silt									
MN BH 19 - 07	356 - 389	Porewater										
MN BH 19 - 08	389 - 428	Porewater	S-silt	305	47.5	208	37.3	824.2	226	5.45	1.67	351
MN Seepage Water		Water		233	29.0	72	5.1	429.3	4	3.50	0.85	644
MN Pit (Bottom)				17.4	< 0.1	144	0.3	862.7	1	3.04	1.97	550
MN Pit (Top)				7.7	1.0	123	1.1	74.0	14	6.32	0.52	219
BLANK 17				4.8	< 0.1	< 10	4.0	0.1	6	0.833	< 0.03	4
BLANK 18				<0.25	4.2	130	12.8	<0.1	18	0.266	< 0.03	< 1
BLANK 19				<0.25	< 0.1	115	1.2	0.1	4	0.135	< 0.03	< 1

Appendix C-4: Tailings Particle Size Analysis: (8 selected samples)

MNBH 1102 (wet)
Feb 25, 2002

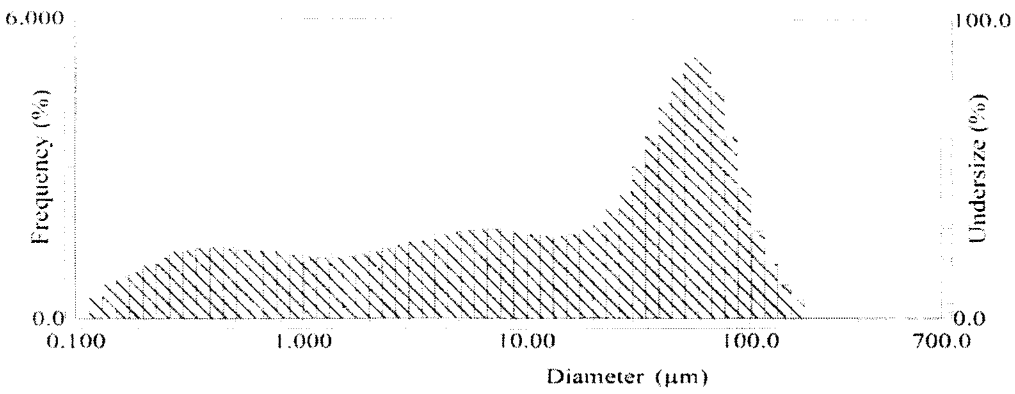


S.P. Area	: 64080(cm²/cm³)		:90.00 (%) = 11.976(μm)			:53.00 (μm) = 100.0
Median	: 3.100(μm)		:95.00 (%) = 14.698(μm)			:38.00 (μm) = 100.0
Diameter on %	:5.000 (%) = 0.227(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 4.841(μm)	
	:10.00 (%) = 0.314(μm)		:600.0 (μm) = 100.000(%)	Variance	: 24.682	
	:20.00 (%) = 0.534(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 4.968(μm)	
	:30.00 (%) = 0.913(μm)		:300.0 (μm) = 100.000(%)	Mode	: 8.235(μm)	
	:40.00 (%) = 1.722(μm)		:212.0 (μm) = 100.000(%)	Span	: 3.762	
	:60.00 (%) = 4.838(μm)		:150.0 (μm) = 100.000(%)			
	:70.00 (%) = 6.725(μm)		:106.0 (μm) = 100.000(%)			
	:80.00 (%) = 8.880(μm)		:75.00 (μm) = 100.000(%)			

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.071	37.980	39	19.904	1.215	98.870	58	262.376	0.000	100.000
2	0.131	0.461	0.461	21	1.729	2.087	40.067	40	22.797	0.663	99.533	59	300.518	0.000	100.000
3	0.150	0.746	1.207	22	1.981	2.138	42.205	41	26.111	0.324	99.857	60	344.206	0.000	100.000
4	0.172	0.996	2.203	23	2.269	2.192	44.398	42	29.907	0.143	100.000	61	394.244	0.000	100.000
5	0.197	1.205	3.409	24	2.599	2.322	46.719	43	34.255	0.000	100.000	62	451.556	0.000	100.000
6	0.226	1.507	4.915	25	2.976	2.487	49.206	44	39.234	0.000	100.000	63	517.200	0.000	100.000
7	0.259	1.856	6.771	26	3.409	2.643	51.849	45	44.938	0.000	100.000	64	592.387	0.000	100.000
8	0.296	2.199	8.970	27	3.905	2.878	54.727	46	51.471	0.000	100.000				
9	0.339	2.352	11.321	28	4.472	3.199	57.926	47	58.953	0.000	100.000				
10	0.389	2.524	13.845	29	5.122	3.580	61.505	48	67.523	0.000	100.000				
11	0.445	2.619	16.464	30	5.867	4.005	65.510	49	77.339	0.000	100.000				
12	0.510	2.646	19.110	31	6.720	4.460	69.970	50	88.583	0.000	100.000				
13	0.584	2.623	21.733	32	7.697	4.859	74.829	51	101.460	0.000	100.000				
14	0.669	2.583	24.316	33	8.816	4.909	79.738	52	116.210	0.000	100.000				
15	0.766	2.528	26.844	34	10.097	4.842	84.581	53	133.103	0.000	100.000				
16	0.877	2.473	29.317	35	11.565	4.452	89.033	54	152.453	0.000	100.000				
17	1.005	2.309	31.626	36	13.246	3.760	92.793	55	174.616	0.000	100.000				
18	1.151	2.183	33.809	37	15.172	2.881	95.674	56	200.000	0.000	100.000				
19	1.318	2.100	35.909	38	17.377	1.981	97.656	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:20020225141376I	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:29	Axis Selection	:LogX-LinY
Laser T%	: 78.2(%)		

MNBH 1401 (wet)
Feb 25, 2002

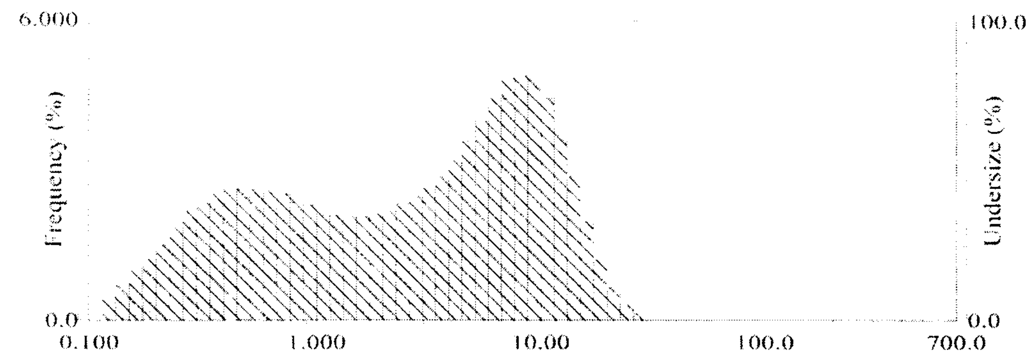


S.P. Area	: 40656(cm²/cm³)	:90.00 (%) = 77.657(µm)		:53.00 (µm) = 76.09
Median	: 16.406(µm)	:95.00 (%) = 95.680(µm)		:38.00 (µm) = 64.88
Diameter on %	:5.000 (%) = 0.255(µm)	% on Diameter :850.0 (µm) = 100.000(%)	Mean	: 30.200(µm)
	:10.00 (%) = 0.420(µm)	:600.0 (µm) = 100.000(%)	Variance	: 1115.943
	:20.00 (%) = 1.177(µm)	:425.0 (µm) = 100.000(%)	S.D.	: 33.406(µm)
	:30.00 (%) = 3.293(µm)	:300.0 (µm) = 100.000(%)	Mode	: 55.248(µm)
	:40.00 (%) = 7.319(µm)	:212.0 (µm) = 100.000(%)	Span	: 4.708
	:60.00 (%) = 31.176(µm)	:150.0 (µm) = 99.550(%)		
	:70.00 (%) = 44.870(µm)	:106.0 (µm) = 96.692(%)		
	:80.00 (%) = 58.644(µm)	:75.00 (µm) = 88.861(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.207	22.209	39	19.904	1.755	52.462	58	262.376	0.000	100.000
2	0.131	0.444	0.444	21	1.729	1.234	23.443	40	22.797	1.914	54.376	59	300.518	0.000	100.000
3	0.150	0.677	1.121	22	1.981	1.273	24.717	41	26.111	2.166	56.542	60	344.206	0.000	100.000
4	0.172	0.822	1.943	23	2.269	1.315	26.032	42	29.907	2.531	59.074	61	394.244	0.000	100.000
5	0.197	0.910	2.853	24	2.599	1.382	27.414	43	34.255	3.025	62.099	62	451.556	0.000	100.000
6	0.226	1.052	3.905	25	2.976	1.453	28.867	44	39.234	3.638	65.737	63	517.200	0.000	100.000
7	0.259	1.202	5.107	26	3.409	1.522	30.388	45	44.938	4.311	70.048	64	592.387	0.000	100.000
8	0.296	1.330	6.437	27	3.905	1.585	31.973	46	51.471	4.910	74.958				
9	0.339	1.358	7.795	28	4.472	1.656	33.629	47	58.953	5.245	80.203				
10	0.389	1.395	9.189	29	5.122	1.716	35.345	48	67.523	5.138	85.341				
11	0.445	1.402	10.591	30	5.867	1.757	37.101	49	77.339	4.549	89.891				
12	0.510	1.387	11.978	31	6.720	1.781	38.882	50	88.583	3.624	93.515				
13	0.584	1.362	13.341	32	7.697	1.777	40.659	51	101.460	2.616	96.130				
14	0.669	1.341	14.682	33	8.816	1.733	42.392	52	116.210	1.740	97.870				
15	0.766	1.324	16.006	34	10.097	1.704	44.096	53	133.103	1.093	98.964				
16	0.877	1.314	17.320	35	11.565	1.668	45.764	54	152.453	0.666	99.630				
17	1.005	1.261	18.581	36	13.246	1.640	47.404	55	174.616	0.370	100.000				
18	1.151	1.221	19.802	37	15.172	1.635	49.039	56	200.000	0.000	100.000				
19	1.318	1.200	21.002	38	17.377	1.668	50.707	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251426762	Calc. Level	:30
Circulation Speed	:14	R.R.Index	:1.16-0.10i
Ultra sonic	:01:41	Axis Selection	:LogX-LinY
Laser T%	: 79.0(%)		

MNBH 1102 (wet)
Feb 25, 2002

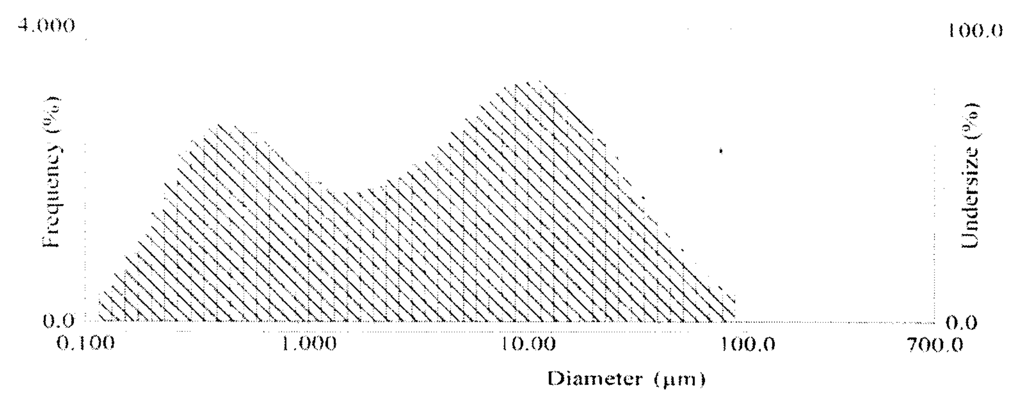


S.P. Area	: 64080(cm² /cm³)		:90.00 (%) = 11.976(µm)			:53.00 (µm) = 100.0
Median	: 3.100(µm)		:95.00 (%) = 14.698(µm)			:38.00 (µm) = 100.0
Diameter on %	:5.000 (%) = 0.227(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 4.841(µm)	
	:10.00 (%) = 0.314(µm)		:600.0 (µm) = 100.000(%)	Variance	: 24.682	
	:20.00 (%) = 0.534(µm)		:425.0 (µm) = 100.000(%)	S.D.	: 4.968(µm)	
	:30.00 (%) = 0.913(µm)		:300.0 (µm) = 100.000(%)	Mode	: 8.235(µm)	
	:40.00 (%) = 1.722(µm)		:212.0 (µm) = 100.000(%)	Span	: 3.762	
	:60.00 (%) = 4.838(µm)		:150.0 (µm) = 100.000(%)			
	:70.00 (%) = 6.725(µm)		:106.0 (µm) = 100.000(%)			
	:80.00 (%) = 8.880(µm)		:75.00 (µm) = 100.000(%)			

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.071	37.980	39	19.904	1.215	98.870	58	262.376	0.000	100.000
2	0.131	0.461	0.461	21	1.729	2.087	40.067	40	22.797	0.663	99.533	59	300.518	0.000	100.000
3	0.150	0.746	1.207	22	1.981	2.138	42.205	41	26.111	0.324	99.857	60	344.206	0.000	100.000
4	0.172	0.996	2.203	23	2.269	2.192	44.398	42	29.907	0.143	100.000	61	394.244	0.000	100.000
5	0.197	1.205	3.409	24	2.599	2.322	46.719	43	34.255	0.000	100.000	62	451.556	0.000	100.000
6	0.226	1.507	4.915	25	2.976	2.487	49.206	44	39.234	0.000	100.000	63	517.200	0.000	100.000
7	0.259	1.856	6.771	26	3.409	2.643	51.849	45	44.938	0.000	100.000	64	592.387	0.000	100.000
8	0.296	2.199	8.970	27	3.905	2.878	54.727	46	51.471	0.000	100.000				
9	0.339	2.352	11.321	28	4.472	3.199	57.926	47	58.953	0.000	100.000				
10	0.389	2.524	13.845	29	5.122	3.580	61.505	48	67.523	0.000	100.000				
11	0.445	2.619	16.464	30	5.867	4.005	65.510	49	77.339	0.000	100.000				
12	0.510	2.646	19.110	31	6.720	4.460	69.970	50	88.583	0.000	100.000				
13	0.584	2.623	21.733	32	7.697	4.859	74.829	51	101.460	0.000	100.000				
14	0.669	2.583	24.316	33	8.816	4.909	79.738	52	116.210	0.000	100.000				
15	0.766	2.528	26.844	34	10.097	4.842	84.581	53	133.103	0.000	100.000				
16	0.877	2.473	29.317	35	11.565	4.452	89.033	54	152.453	0.000	100.000				
17	1.005	2.309	31.626	36	13.246	3.760	92.793	55	174.616	0.000	100.000				
18	1.151	2.183	33.809	37	15.172	2.881	95.674	56	200.000	0.000	100.000				
19	1.318	2.100	35.909	38	17.377	1.981	97.656	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251413761	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:29	Axis Selection	:LogX-LinY
Laser T%	: 78.2(%)		

Batch O (wet)
Feb 25, 2002

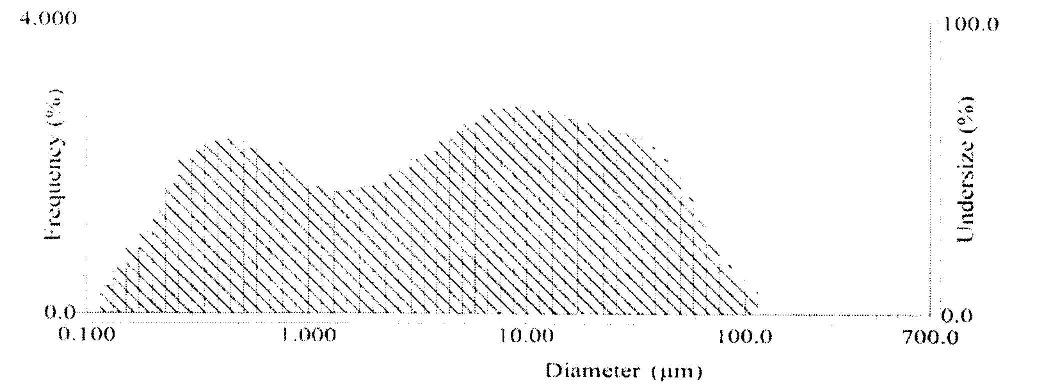


S.P. Area	: 61123(cm²/cm³)		:90.00 (%) = 25.521(μm)			:53.00 (μm) = 97.88
Median	: 3.898(μm)		:95.00 (%) = 37.415(μm)			:38.00 (μm) = 95.16
Diameter on %	:5.000 (%) = 0.232(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 9.296(μm)	
	:10.00 (%) = 0.316(μm)		:600.0 (μm) = 100.000(%)	Variance	: 178.331	
	:20.00 (%) = 0.531(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 13.354(μm)	
	:30.00 (%) = 0.951(μm)		:300.0 (μm) = 100.000(%)	Mode	: 10.796(μm)	
	:40.00 (%) = 2.007(μm)		:212.0 (μm) = 100.000(%)	Span	: 6.467	
	:60.00 (%) = 6.483(μm)		:150.0 (μm) = 100.000(%)			
	:70.00 (%) = 9.952(μm)		:106.0 (μm) = 100.000(%)			
	:80.00 (%) = 15.195(μm)		:75.00 (μm) = 99.516(%)			

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.758	36.270	39	19.904	2.734	85.645	58	262.376	0.000	100.000
2	0.131	0.388	0.388	21	1.729	1.760	38.030	40	22.797	2.494	88.140	59	300.518	0.000	100.000
3	0.150	0.646	1.033	22	1.981	1.793	39.823	41	26.111	2.237	90.376	60	344.206	0.000	100.000
4	0.172	0.917	1.951	23	2.269	1.835	41.658	42	29.907	1.972	92.348	61	394.244	0.000	100.000
5	0.197	1.167	3.118	24	2.599	1.927	43.585	43	34.255	1.708	94.056	62	451.556	0.000	100.000
6	0.226	1.500	4.618	25	2.976	2.035	45.620	44	39.234	1.453	95.508	63	517.200	0.000	100.000
7	0.259	1.901	6.519	26	3.409	2.142	47.762	45	44.938	1.212	96.721	64	592.387	0.000	100.000
8	0.296	2.298	8.817	27	3.905	2.267	50.029	46	51.471	0.993	97.713				
9	0.339	2.453	11.270	28	4.472	2.428	52.457	47	58.953	0.797	98.510				
10	0.389	2.624	13.893	29	5.122	2.599	55.055	48	67.523	0.628	99.139				
11	0.445	2.688	16.581	30	5.867	2.772	57.827	49	77.339	0.488	99.626				
12	0.510	2.659	19.240	31	6.720	2.952	60.779	50	88.583	0.374	100.000				
13	0.584	2.565	21.805	32	7.697	3.105	63.884	51	101.460	0.000	100.000				
14	0.669	2.451	24.257	33	8.816	3.194	67.078	52	116.210	0.000	100.000				
15	0.766	2.329	26.586	34	10.097	3.270	70.348	53	133.103	0.000	100.000				
16	0.877	2.218	28.803	35	11.565	3.281	73.630	54	152.453	0.000	100.000				
17	1.005	2.026	30.829	36	13.246	3.226	76.856	55	174.616	0.000	100.000				
18	1.151	1.886	32.715	37	15.172	3.111	79.967	56	200.000	0.000	100.000				
19	1.318	1.796	34.511	38	17.377	2.944	82.911	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251442763	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:29	Axis Selection	:LogX-LinY
Laser T%	: 75.2(%)		

Batch S (wet)
Feb 25, 2002

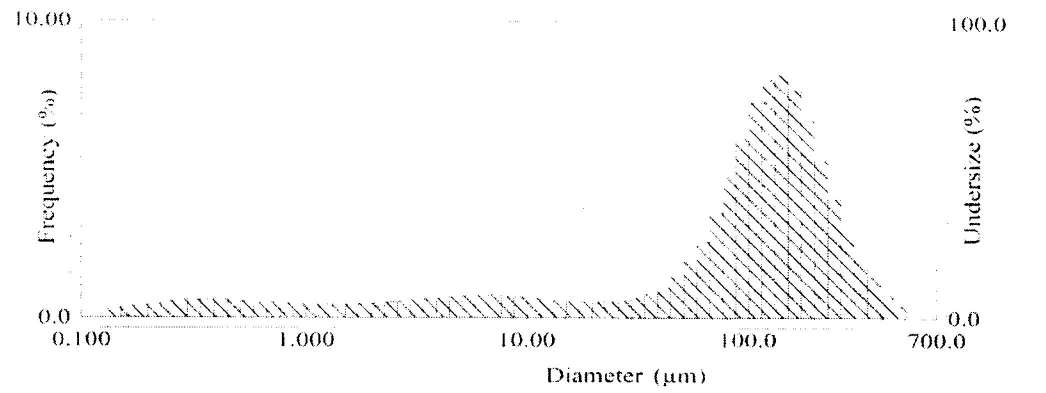


S.P. Area	: 56066(cm²/cm³)		:90.00 (%) = 37.766(µm)		:53.00 (µm) = 95.01
Median	: 4.834(µm)		:95.00 (%) = 52.930(µm)		:38.00 (µm) = 90.10
Diameter on %	:5.000 (%) = 0.238(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 12.732(µm)
	:10.00 (%) = 0.331(µm)		:600.0 (µm) = 100.000(%)	Variance	: 335.877
	:20.00 (%) = 0.593(µm)		:425.0 (µm) = 100.000(%)	S.D.	: 18.327(µm)
	:30.00 (%) = 1.199(µm)		:300.0 (µm) = 100.000(%)	Mode	: 9.436(µm)
	:40.00 (%) = 2.617(µm)		:212.0 (µm) = 100.000(%)	Span	: 7.744
	:60.00 (%) = 8.011(µm)		:150.0 (µm) = 100.000(%)		
	:70.00 (%) = 12.989(µm)		:106.0 (µm) = 99.791(%)		
	:80.00 (%) = 21.665(µm)		:75.00 (µm) = 98.314(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.657	32.824	39	19.904	2.611	78.399	58	262.376	0.000	100.000
2	0.131	0.363	0.363	21	1.729	1.678	34.502	40	22.797	2.563	80.962	59	300.518	0.000	100.000
3	0.150	0.608	0.971	22	1.981	1.727	36.230	41	26.111	2.519	83.481	60	344.206	0.000	100.000
4	0.172	0.869	1.840	23	2.269	1.785	38.014	42	29.907	2.470	85.951	61	394.244	0.000	100.000
5	0.197	1.101	2.941	24	2.599	1.884	39.899	43	34.255	2.401	88.352	62	451.556	0.000	100.000
6	0.226	1.398	4.339	25	2.976	1.995	41.894	44	39.234	2.292	90.644	63	517.200	0.000	100.000
7	0.259	1.757	6.096	26	3.409	2.107	44.001	45	44.938	2.127	92.772	64	592.387	0.000	100.000
8	0.296	2.102	8.198	27	3.905	2.219	46.220	46	51.471	1.897	94.669				
9	0.339	2.218	10.416	28	4.472	2.355	48.575	47	58.953	1.608	96.277				
10	0.389	2.349	12.765	29	5.122	2.486	51.061	48	67.523	1.287	97.564				
11	0.445	2.384	15.149	30	5.867	2.605	53.666	49	77.339	0.969	98.533				
12	0.510	2.344	17.493	31	6.720	2.715	56.381	50	88.583	0.689	99.223				
13	0.584	2.254	19.748	32	7.697	2.790	59.171	51	101.460	0.469	99.691				
14	0.669	2.157	21.905	33	8.816	2.810	61.980	52	116.210	0.309	100.000				
15	0.766	2.059	23.964	34	10.097	2.830	64.811	53	133.103	0.000	100.000				
16	0.877	1.978	25.942	35	11.565	2.816	67.626	54	152.453	0.000	100.000				
17	1.005	1.829	27.771	36	13.246	2.775	70.401	55	174.616	0.000	100.000				
18	1.151	1.727	29.498	37	15.172	2.722	73.123	56	200.000	0.000	100.000				
19	1.318	1.669	31.167	38	17.377	2.665	75.788	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202251402760	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:01:40	Axis Selection	:LogX-LinY
Laser T%	: 73.4(%)		

OMIX (wet)
Feb 25, 2002

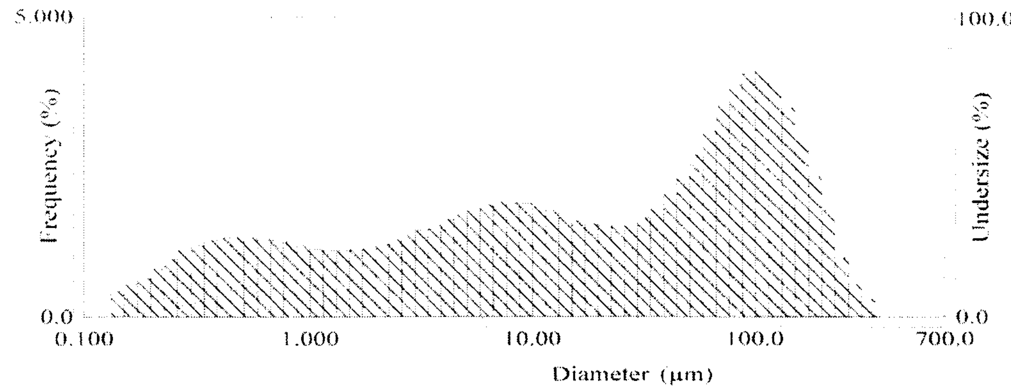


S.P. Area	: 16846(cm²/cm³)		:90.00 (%) = 241.022(μm)			:53.00 (μm) = 26.80
Median	: 110.915(μm)		:95.00 (%) = 295.057(μm)			:38.00 (μm) = 23.78
Diameter on %	:5.000 (%) = 0.490(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 118.796(μm)	
	:10.00 (%) = 1.992(μm)		:600.0 (μm) = 100.000(%)	Variance	: 8819.891	
	:20.00 (%) = 16.199(μm)		:425.0 (μm) = 99.225(%)	S.D.	: 93.914(μm)	
	:30.00 (%) = 64.549(μm)		:300.0 (μm) = 95.353(%)	Mode	: 142.039(μm)	
	:40.00 (%) = 90.262(μm)		:212.0 (μm) = 85.461(%)	Span	: 2.155	
	:60.00 (%) = 131.840(μm)		:150.0 (μm) = 67.819(%)			
	:70.00 (%) = 155.696(μm)		:106.0 (μm) = 47.572(%)			
	:80.00 (%) = 187.454(μm)		:75.00 (μm) = 33.607(%)			

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	0.438	9.061	39	19.904	0.531	20.817	58	262.376	4.007	92.506
2	0.131	0.000	0.000	21	1.729	0.450	9.510	40	22.797	0.527	21.345	59	300.518	2.884	95.390
3	0.150	0.322	0.322	22	1.981	0.469	9.979	41	26.111	0.545	21.890	60	344.206	2.017	97.406
4	0.172	0.379	0.701	23	2.269	0.490	10.469	42	29.907	0.592	22.481	61	394.244	1.391	98.798
5	0.197	0.422	1.123	24	2.599	0.522	10.991	43	34.255	0.678	23.159	62	451.556	0.773	99.571
6	0.226	0.483	1.606	25	2.976	0.557	11.549	44	39.234	0.819	23.978	63	517.200	0.429	100.000
7	0.259	0.544	2.150	26	3.409	0.593	12.142	45	44.938	1.040	25.018	64	592.387	0.000	100.000
8	0.296	0.597	2.747	27	3.905	0.631	12.773	46	51.471	1.377	26.395				
9	0.339	0.605	3.352	28	4.472	0.672	13.445	47	58.953	1.876	28.271				
10	0.389	0.615	3.967	29	5.122	0.710	14.155	48	67.523	2.588	30.859				
11	0.445	0.610	4.577	30	5.867	0.740	14.895	49	77.339	3.552	34.411				
12	0.510	0.592	5.170	31	6.720	0.759	15.654	50	88.583	4.749	39.160				
13	0.584	0.566	5.736	32	7.697	0.762	16.416	51	101.460	6.067	45.227				
14	0.669	0.539	6.275	33	8.816	0.732	17.148	52	116.210	7.271	52.498				
15	0.766	0.513	6.788	34	10.097	0.705	17.853	53	133.103	8.069	60.567				
16	0.877	0.491	7.280	35	11.565	0.668	18.521	54	152.453	8.236	68.803				
17	1.005	0.463	7.743	36	13.246	0.626	19.148	55	174.616	7.719	76.522				
18	1.151	0.444	8.187	37	15.172	0.586	19.733	56	200.000	6.654	83.176				
19	1.318	0.435	8.623	38	17.377	0.552	20.286	57	229.075	5.323	88.499				

Filename	:	Form of Distribution	:Standard
ID#	:200202251516768	Calc. Level	:30
Circulation Speed	:14	R.R.Index	:1.16-0.10i
Ultra sonic	:02:34	Axis Selection	:LogX-LinY
Laser T%	: 76.1(%)		

SMIX (wet)
Feb 25, 2002



S.P. Area : 32318(cm²/cm³)
Median : 20.560(µm)

Diameter on % :5.000 (%) = 0.315(µm)
:10.00 (%) = 0.532(µm)
:20.00 (%) = 1.656(µm)
:30.00 (%) = 4.478(µm)
:40.00 (%) = 9.303(µm)
:60.00 (%) = 45.503(µm)
:70.00 (%) = 72.992(µm)
:80.00 (%) = 103.110(µm)
:90.00 (%) = 146.294(µm)
:95.00 (%) = 184.842(µm)

% on Diameter :850.0 (µm) = 100.000(%)
:600.0 (µm) = 100.000(%)
:425.0 (µm) = 100.000(%)
:300.0 (µm) = 99.687(%)
:212.0 (µm) = 97.131(%)
:150.0 (µm) = 90.646(%)
:106.0 (µm) = 80.841(%)
:75.00 (µm) = 70.707(%)
:53.00 (µm) = 62.71
:38.00 (µm) = 57.30

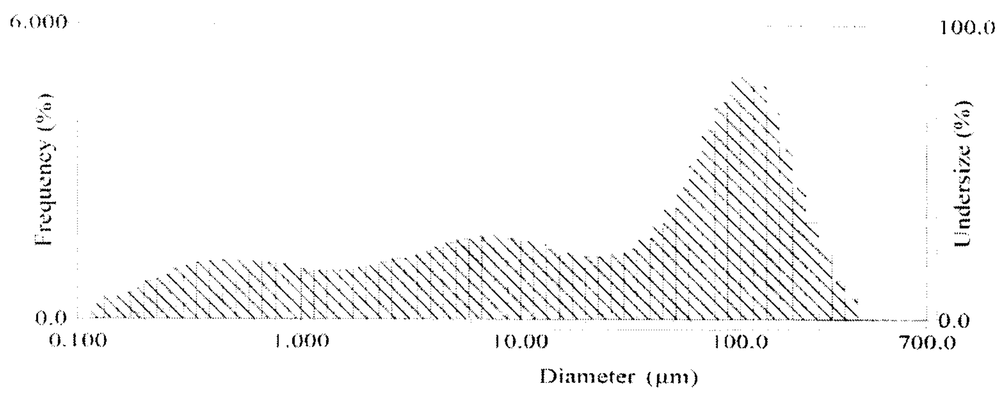
Mean : 52.218(µm)
Variance : 4062.040
S.D. : 63.734(µm)
Mode : 108.247(µm)
Span : 7.090

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.101	19.234	39	19.904	1.556	49.636	58	262.376	0.992	99.143
2	0.131	0.000	0.000	21	1.729	1.127	20.361	40	22.797	1.521	51.157	59	300.518	0.551	99.694
3	0.150	0.427	0.427	22	1.981	1.168	21.529	41	26.111	1.522	52.679	60	344.206	0.306	100.000
4	0.172	0.540	0.967	23	2.269	1.213	22.742	42	29.907	1.567	54.247	61	394.244	0.000	100.000
5	0.197	0.638	1.605	24	2.599	1.286	24.028	43	34.255	1.664	55.911	62	451.556	0.000	100.000
6	0.226	0.789	2.394	25	2.976	1.364	25.392	44	39.234	1.823	57.734	63	517.200	0.000	100.000
7	0.259	0.954	3.348	26	3.409	1.442	26.833	45	44.938	2.050	59.784	64	592.387	0.000	100.000
8	0.296	1.116	4.465	27	3.905	1.525	28.358	46	51.471	2.349	62.132				
9	0.339	1.190	5.655	28	4.472	1.625	29.983	47	58.953	2.714	64.846				
10	0.389	1.273	6.928	29	5.122	1.723	31.706	48	67.523	3.124	67.970				
11	0.445	1.321	8.248	30	5.867	1.810	33.517	49	77.339	3.537	71.508				
12	0.510	1.334	9.582	31	6.720	1.886	35.402	50	88.583	3.891	75.399				
13	0.584	1.321	10.903	32	7.697	1.931	37.334	51	101.460	4.110	79.509				
14	0.669	1.301	12.204	33	8.816	1.914	39.247	52	116.210	4.130	83.639				
15	0.766	1.274	13.478	34	10.097	1.897	41.145	53	133.103	3.921	87.560				
16	0.877	1.249	14.726	35	11.565	1.848	42.993	54	152.453	3.505	91.065				
17	1.005	1.179	15.905	36	13.246	1.776	44.768	55	174.616	2.950	94.015				
18	1.151	1.128	17.033	37	15.172	1.695	46.463	56	200.000	2.349	96.364				
19	1.318	1.100	18.133	38	17.377	1.617	48.081	57	229.075	1.786	98.150				

Filename :
ID# :200202251332759
Circulation Speed :12
Ultra sonic :00:45
Laser T% : 82.4(%)

Form of Distribution :Standard
Calc. Level :30
R.R.Index :1.16-0.10i
Axis Selection :LogX-LinY

SOMIX (wet)
Feb 25, 2002



S.P. Area	: 31579(cm²/cm³)		:90.00 (%) = 157.446(μm)		:53.00 (μm) = 56.49
Median	: 33.831(μm)		:95.00 (%) = 196.128(μm)		:38.00 (μm) = 51.37
Diameter on %	:5.000 (%) = 0.311(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 60.210(μm)
	:10.00 (%) = 0.556(μm)		:600.0 (μm) = 100.000(%)	Variance	: 4596.574
	:20.00 (%) = 1.980(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 67.798(μm)
	:30.00 (%) = 5.475(μm)		:300.0 (μm) = 99.556(%)	Mode	: 108.457(μm)
	:40.00 (%) = 12.446(μm)		:212.0 (μm) = 96.245(%)	Span	: 4.637
	:60.00 (%) = 62.405(μm)		:150.0 (μm) = 88.659(%)		
	:70.00 (%) = 87.888(μm)		:106.0 (μm) = 76.743(%)		
	:80.00 (%) = 115.794(μm)		:75.00 (μm) = 64.917(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	0.992	17.936	39	19.904	1.303	44.793	58	262.376	1.405	98.786
2	0.131	0.302	0.302	21	1.729	1.015	18.950	40	22.797	1.274	46.067	59	300.518	0.781	99.566
3	0.150	0.446	0.748	22	1.981	1.052	20.002	41	26.111	1.282	47.350	60	344.206	0.434	100.000
4	0.172	0.543	1.291	23	2.269	1.092	21.095	42	29.907	1.336	48.686	61	394.244	0.000	100.000
5	0.197	0.624	1.915	24	2.599	1.159	22.254	43	34.255	1.447	50.133	62	451.556	0.000	100.000
6	0.226	0.756	2.671	25	2.976	1.231	23.485	44	39.234	1.626	51.759	63	517.200	0.000	100.000
7	0.259	0.896	3.567	26	3.409	1.303	24.788	45	44.938	1.890	53.649	64	592.387	0.000	100.000
8	0.296	1.030	4.597	27	3.905	1.380	26.168	46	51.471	2.253	55.903				
9	0.339	1.089	5.687	28	4.472	1.471	27.639	47	58.953	2.721	58.624				
10	0.389	1.156	6.842	29	5.122	1.559	29.198	48	67.523	3.282	61.906				
11	0.445	1.193	8.036	30	5.867	1.633	30.831	49	77.339	3.891	65.797				
12	0.510	1.202	9.238	31	6.720	1.692	32.523	50	88.583	4.461	70.259				
13	0.584	1.190	10.428	32	7.697	1.721	34.244	51	101.460	4.872	75.130				
14	0.669	1.172	11.600	33	8.816	1.686	35.930	52	116.210	5.001	80.132				
15	0.766	1.147	12.747	34	10.097	1.655	37.584	53	133.103	4.785	84.917				
16	0.877	1.125	13.872	35	11.565	1.595	39.179	54	152.453	4.250	89.167				
17	1.005	1.063	14.935	36	13.246	1.517	40.696	55	174.616	3.510	92.677				
18	1.151	1.017	15.953	37	15.172	1.434	42.130	56	200.000	2.714	95.391				
19	1.318	0.991	16.944	38	17.377	1.360	43.490	57	229.075	1.989	97.380				

Filename	:	Form of Distribution	:Standard
ID#	:200202251509765	Calc. Level	:30
Circulation Speed	:13	R.R.Index	:1.16-0.10i
Ultra sonic	:01:08	Axis Selection	:LogX-LinY
Laser T%	: 82.9(%)		

APPENDIX D

Results of Mineralogical Analysis

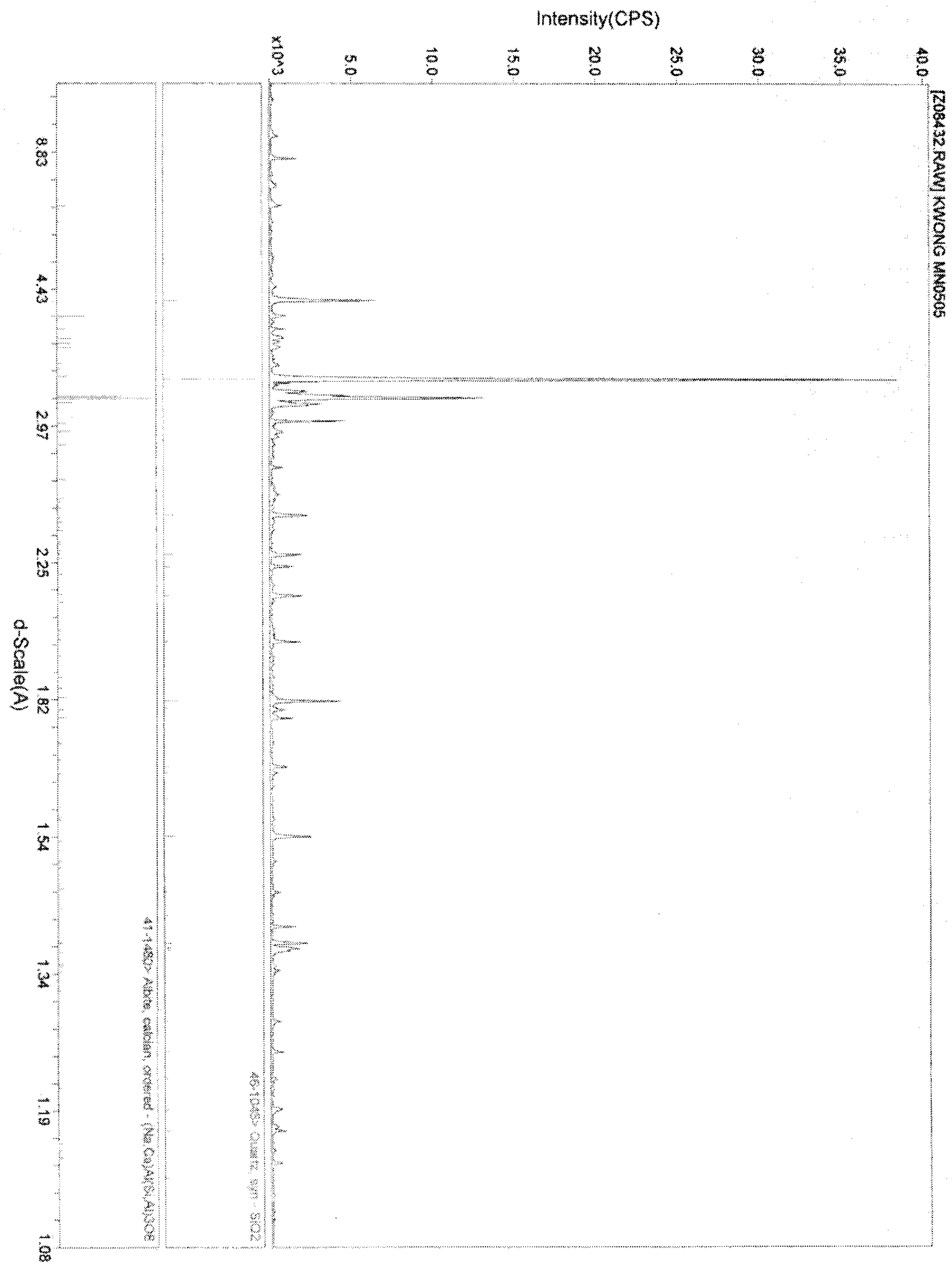
Appendix D-1: X-Ray Diffraction Analysis

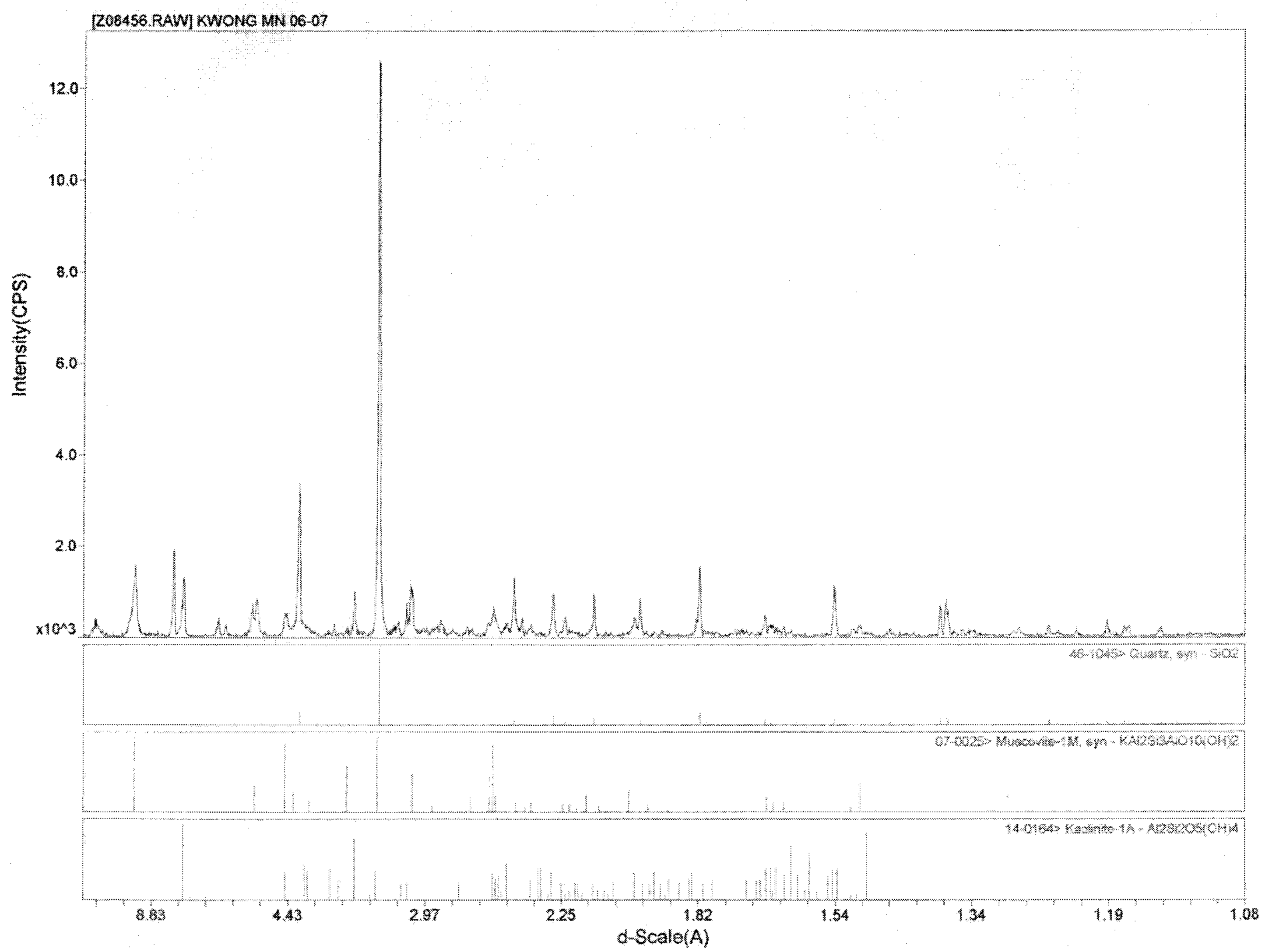
This appendix contains selected X-ray diffractograms illustrating the mineralogy of the four types of tailings and native sediments identified in the tailings impoundment as well as grab samples from the Brown-McDade open pit at Mount Nansen. Only reference diffraction patterns for the major components are given below each individual diffractogram. Other minerals identified in the selected samples are tabulated below:

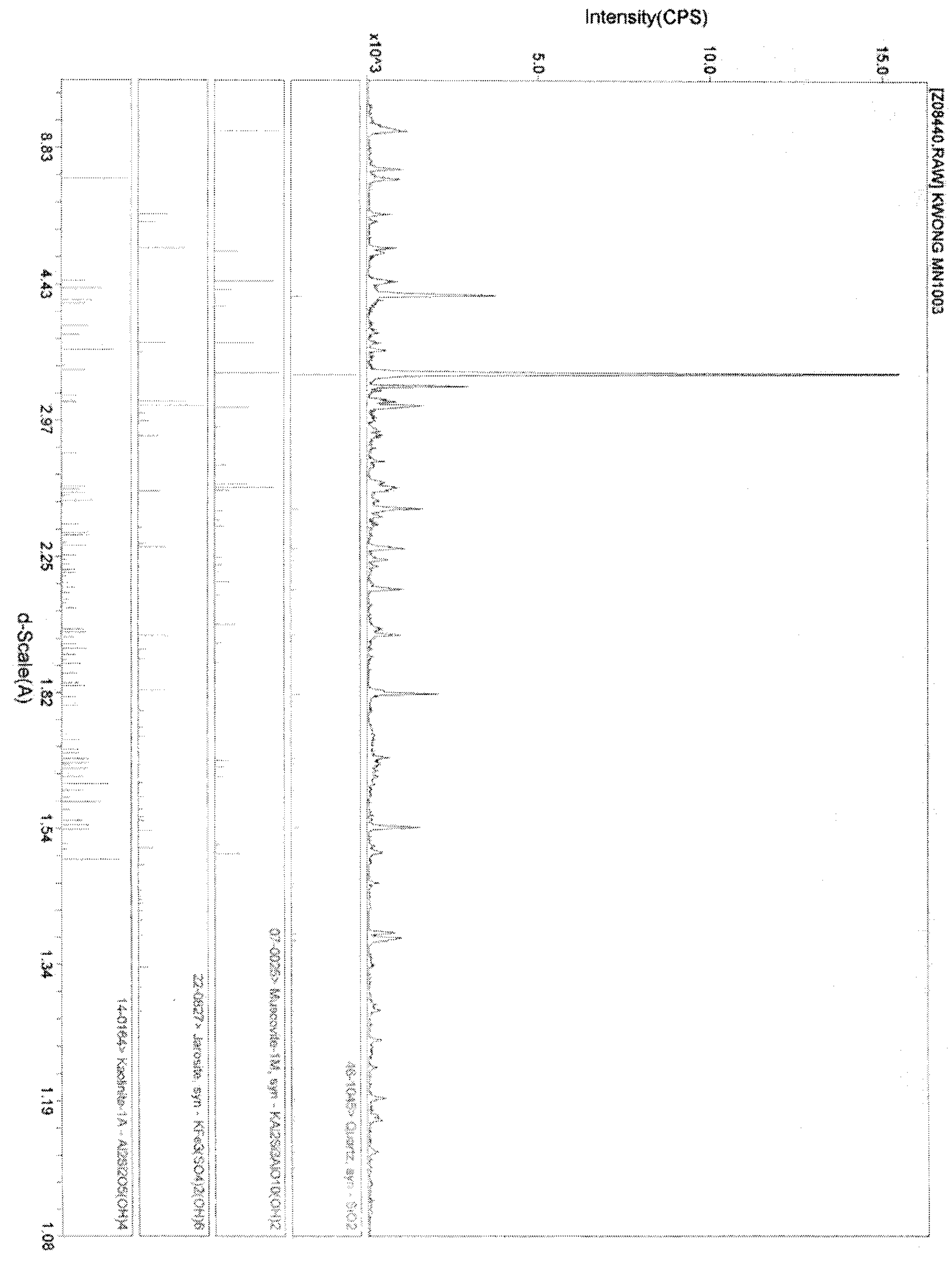
Table D-1. Minerals identified by X-ray diffraction in selected samples from Mount Nansen

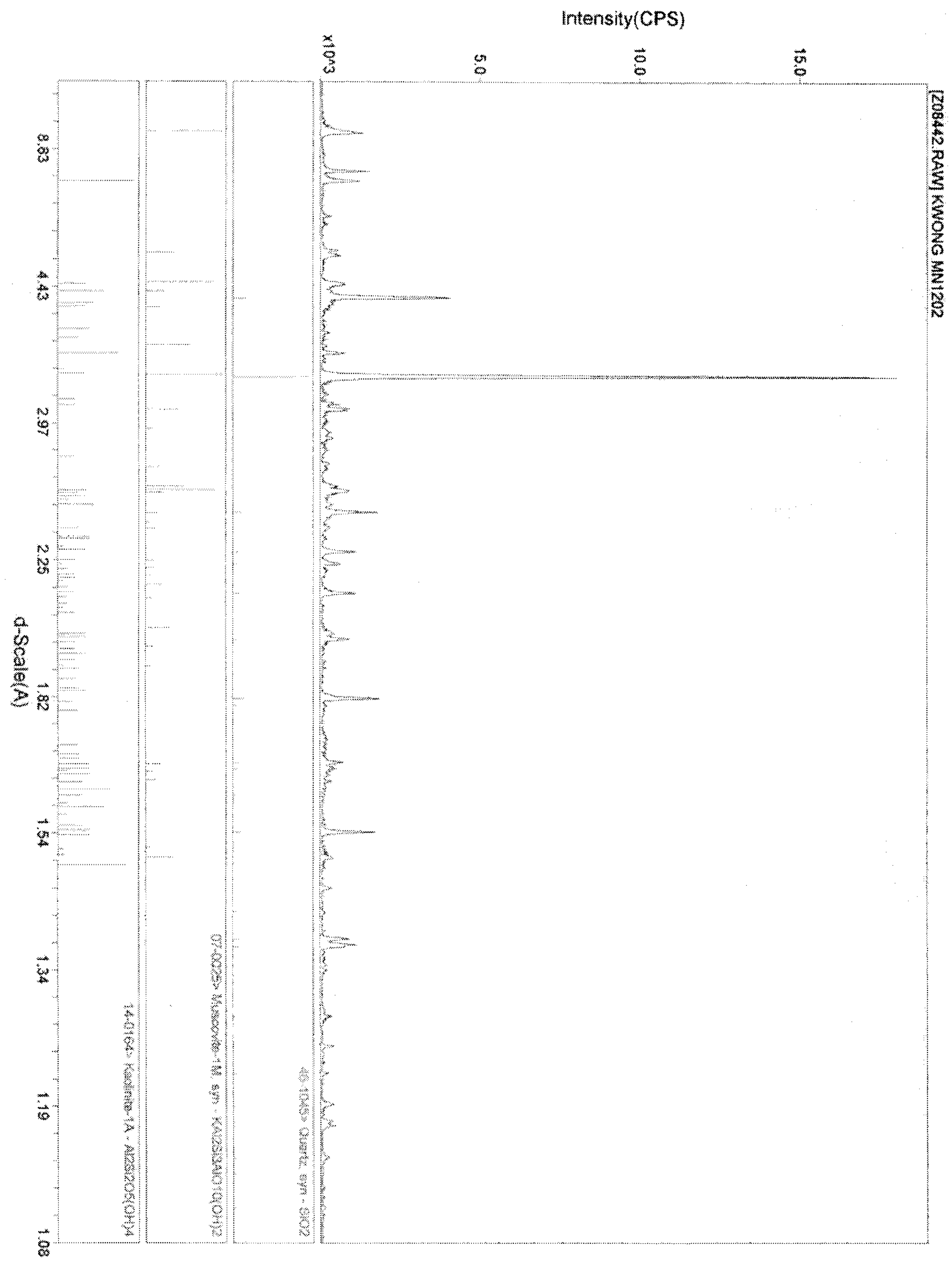
Sample #	*Sample Type*	*Minerals Identified**
MN0505	Native sediment	Q > plag >> minor amp, Ksp > trace ms, kao
MN0607	Clayey sulfide tails	Q >> minor ms, kao, gyp, ja > trace py, fels
MN1003	Clayey sulfide tails	Q >> minor ms, gyp, kao, ja, py, Ksp
MN1202	Clayey oxide tails	Q >> minor ms, kao, gyp, ja >trace py
MN1804	Clayey oxide tails	Q >> minor ms, mont, kao, ja
MNSMIX	Silty sulfide tails	Q >> minor kao > trace ms, gyp, ja, fel, py
SOMIX	Mixed oxide-sulfide silty tails	Q >> minor gyp, ms, kao, ja > trace fels, py
WBH3	Alteration on surface tailings	Q ~ cc >> minor gyp, kao,ms, ja
PITSED	Pit sediment	Q > mont > kao > minor ms, ja, Ksp, plag
NWALBX	Pit grab, breccia	Py >> Q ~ gyp > minor ja, ms, kao

*amp=amphibole; cc=calcite; fels=feldspar, undifferentiated; gyp=gypsum; ja=jarosite; kao=kaolinite; Ksp=potassic feldspar; mont=montmorillonite; ms=muscovite/illite; plag=plagioclase; py=pyrite; Q=quartz

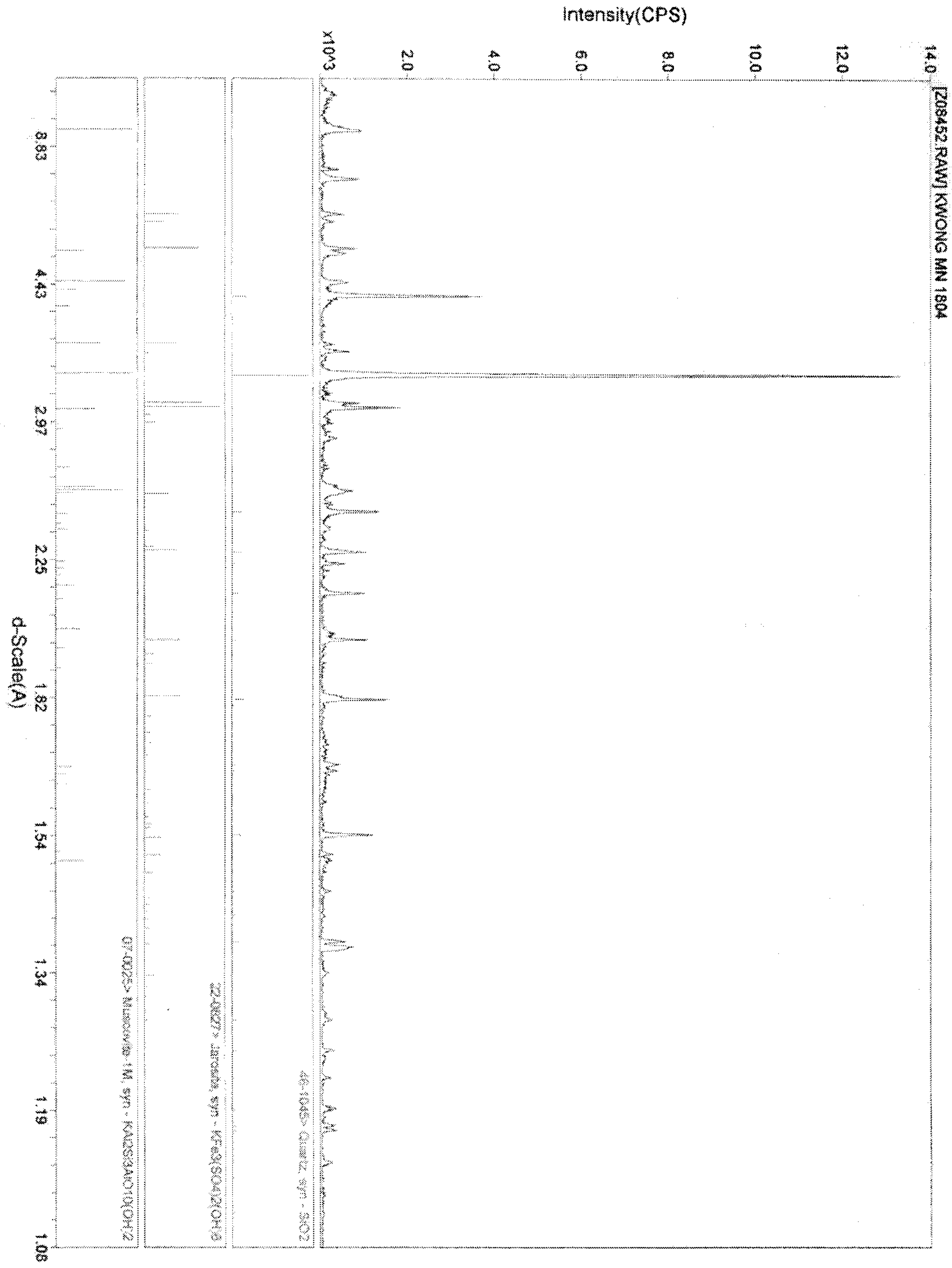

Intensity(CPS)
x10^3
[Z08432.RAW] KWONG MN0505
d-Scale(A)
46-1045> Quartz, syn - SiO2
41-1480> Albite, calcian, ordered - (Na,Ca)Al(Si,Al)3O8

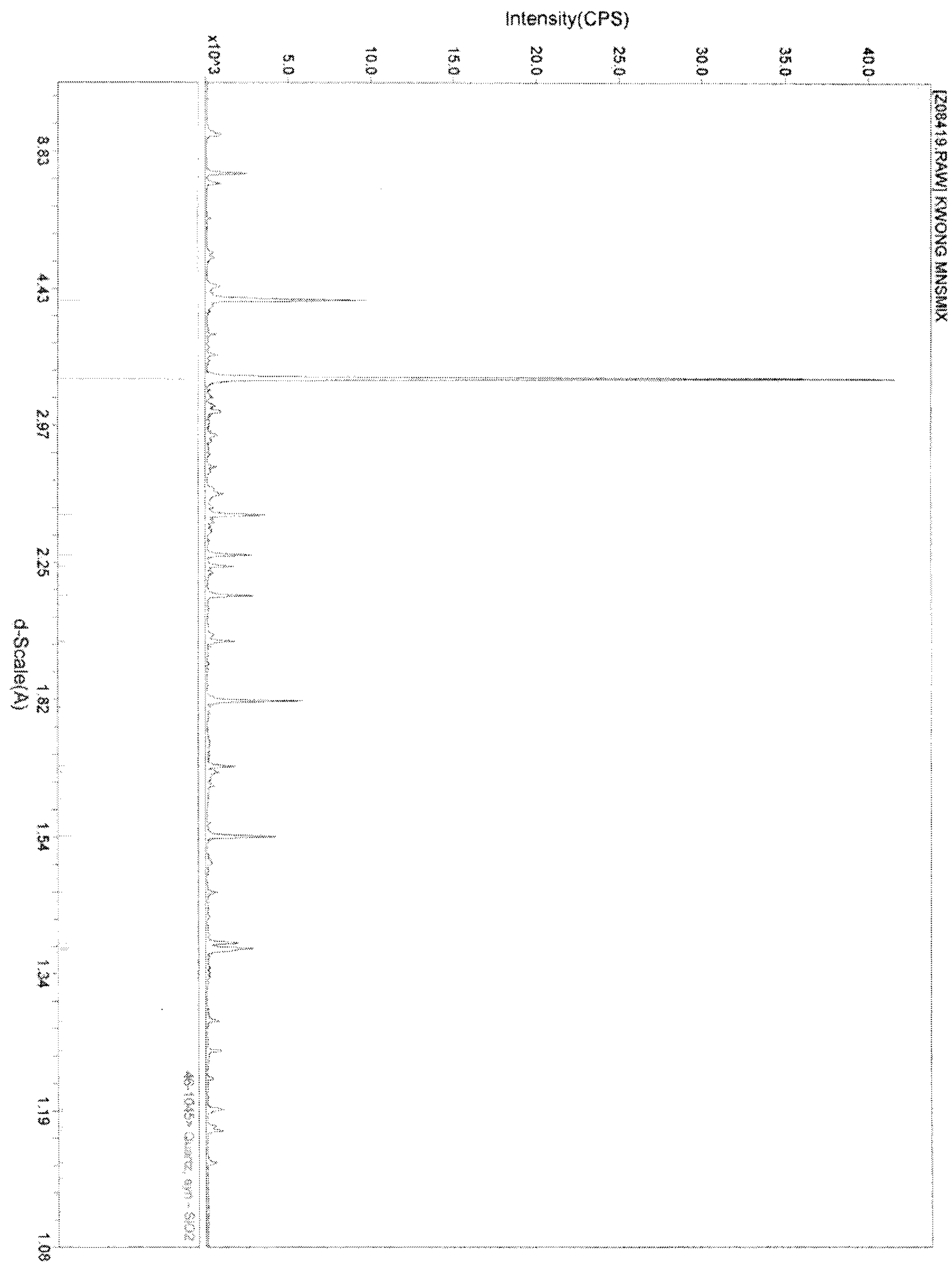

[Z08456.RAW] KWONG MN 06-07
Intensity(CPS)
x10^3
2.0
4.0
6.0
8.0
10.0
12.0
46-1045> Quartz, syn - SiO2
07-0025> Muscovite-1M, syn - KAl2Si3AlO10(OH)2
14-0164> Kaolinite-1A - Al2Si2O5(OH)4
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)

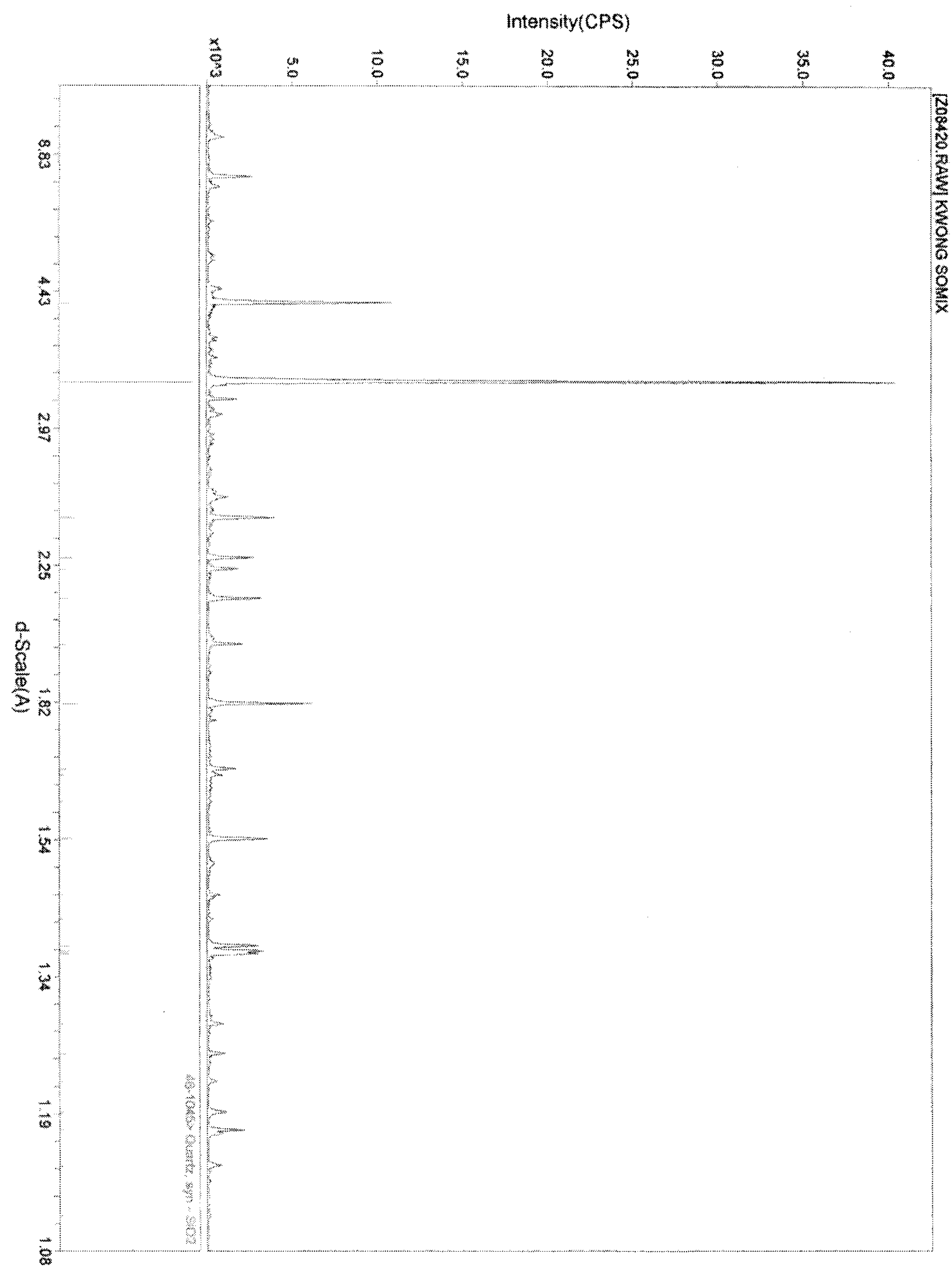

[Z08440.RAW] KWONG MN1003
Intensity(CPS)
x10^3
5.0
10.0
15.0
d-Scale(A)
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
48-1045> Quartz, syn - SiO2
07-0025> Muscovite-1M, syn - KAl2Si3AlO10(OH)2
22-0827> Jarosite, syn - KFe3(SO4)2(OH)6
14-0164> Kaolinite-1A - Al2Si2O5(OH)4

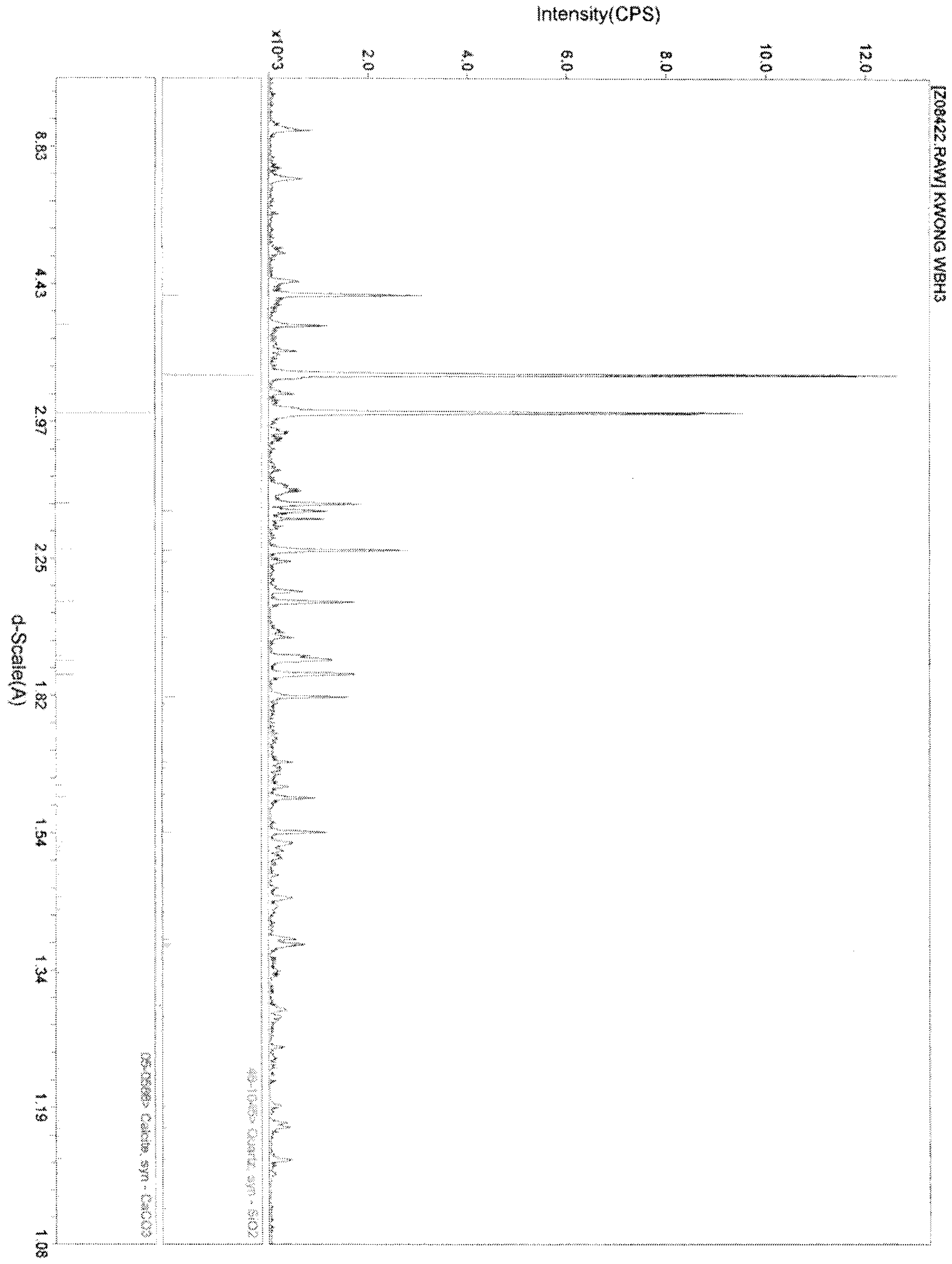


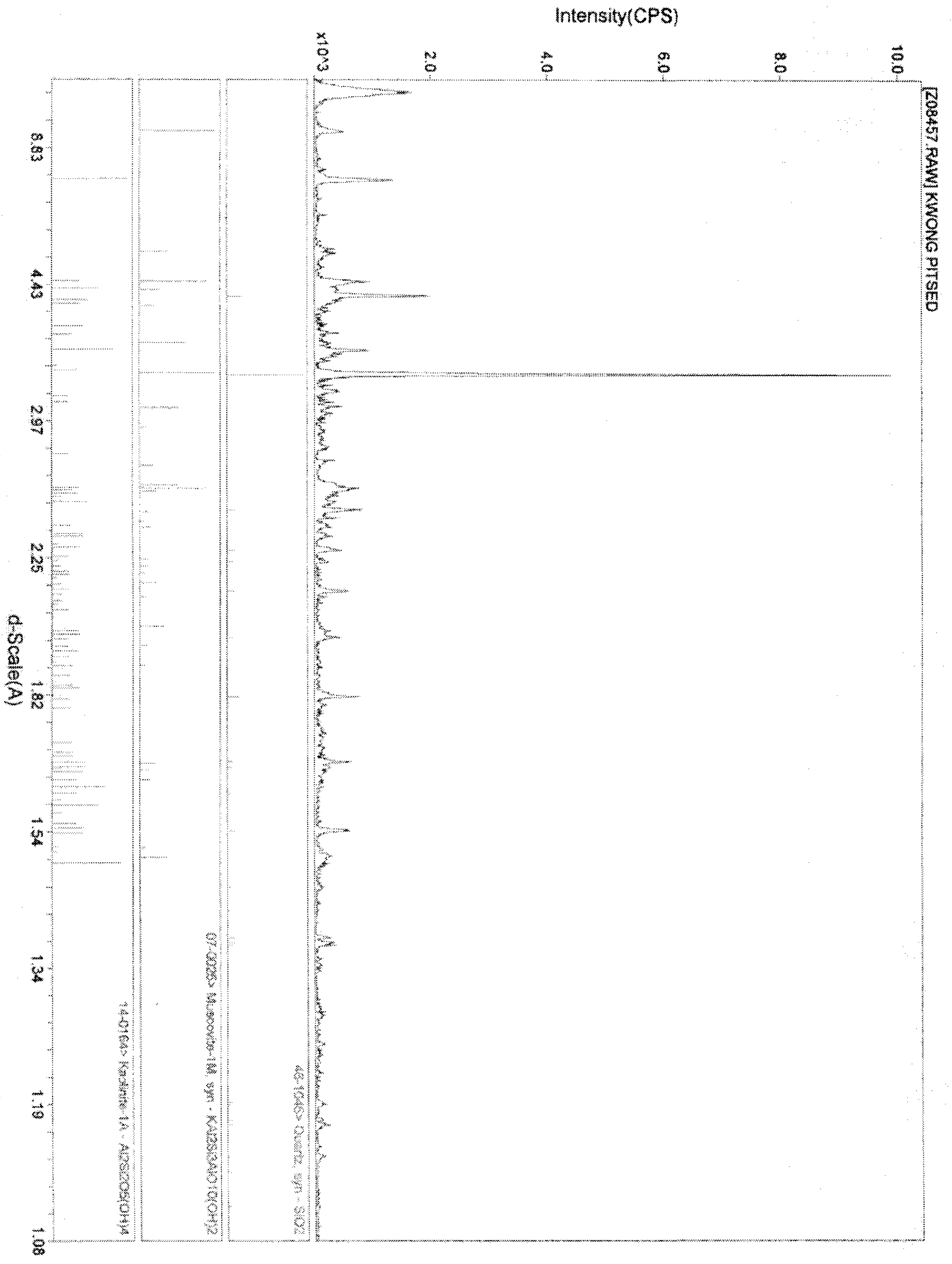
[Z08442.RAW] KWONG MN1202
Intensity(CPS)
x10^3
5.0
10.0
15.0
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
46-1045> Quartz, syn - SiO2
07-0025> Muscovite-1M, syn - KAl2Si3AlO10(OH)2
14-0164> Kaolinite-1A - Al2Si2O5(OH)4


Intensity(CPS)
x10^3
2.0
4.0
6.0
8.0
10.0
12.0
14.0
[Z08452.RAW] KWONG MN 1804
d-Scale(A)
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
46-1045> Quartz, syn - SiO2

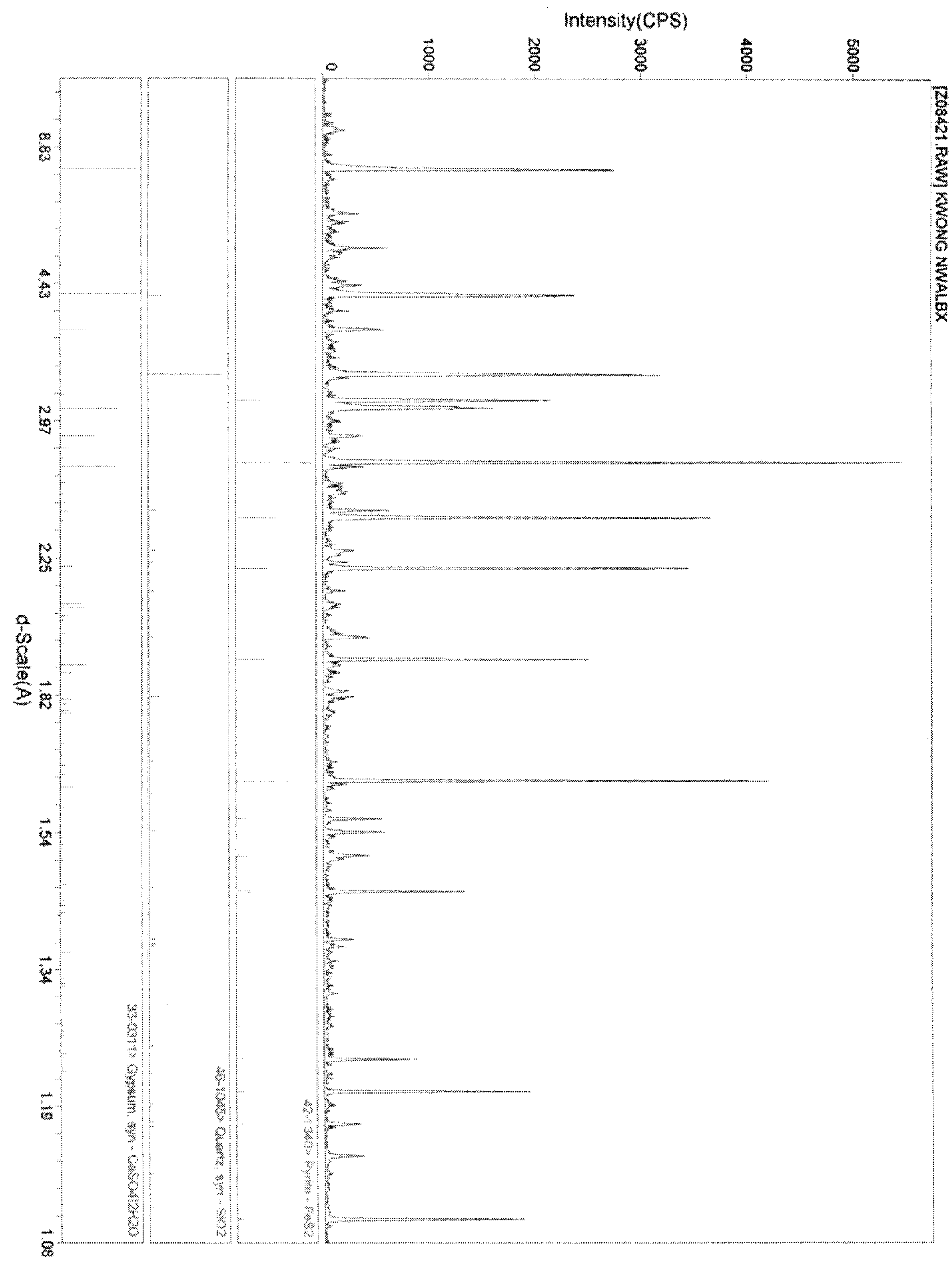

Intensity(CPS)
x10^3
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
[Z08419.RAW] KWONG MNSMIX
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
46-1045> Quartz, syn - SiO2


[Z08420.RAW] KWONG SOMIX
Intensity(CPS)
x10^3
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
d-Scale(A)
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
46-1045> Quartz, syn - SiO2


[Z08422.RAW] KWONG WBH3
Intensity(CPS)
x10^3
2.0
4.0
6.0
8.0
10.0
12.0
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)
46-1045> Quartz, syn - SiO2
05-0586> Calcite, syn - CaCO3



[Z08457.RAW] KWONG PITSED
Intensity(CPS)
x10^3
2.0
4.0
6.0
8.0
10.0
46-1045> Quartz, syn - SiO2
07-0025> Muscovite-1M, syn - KAl2Si3AlO10(OH)2
14-0164> Kaolinite-1A - Al2Si2O5(OH)4
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
d-Scale(A)



Intensity(CPS)
0
1000
2000
3000
4000
5000
[Z08421.RAW] KWONG NWALBX
d-Scale(A)
8.83
4.43
2.97
2.25
1.82
1.54
1.34
1.19
1.08
33-0311> Gypsum, syn - CaSO4!2H2O
46-1045> Quartz, syn - SiO2
42-1340> Pyrite - FeS2

Appendix D-2: SEM-EDX Analysis

In this appendix, data on mineral abundance in selected tailings samples as determined by point counting under a scanning electron microscope are tabulated (Table D-2). Electron micrographs as well as energy-dispersive X-ray spectra of selected grains of interest are also furnished.

Table D-2. Mineral abundance in selected Mount Nansen tailings by point counting under a scanning electron microscope. (Note that hits on voids in the polished sections are excluded in the tally; minerals in composite grains are proportionally counted in fractions/decimals.)

OMIX (oxide silt composite)

Mineral	*Count*	*%*
Quartz	189	69.7
Muscovite	28.5	10.5
Kaolinite	7	2.6
Biotite	5.5	2
FeO.OH	14	5.2
Pyrite	14	5.2
Jarosite	4.5	1.7
Ca-albite	2	0.7
K-feldspar	1	0.4
Amphibole	1	0.4
Calcite	2	0.7
Ankerite	1	0.4
Gypsum	1	0.4
Scorodite	0.5	0.2
Total	271	100.1

SMIX (sulfide silt composite)

Mineral	*Count*	*%*
Quartz	187	59.6
Muscovite	51.5	16.4
Kaolinite	13.5	4.3
Aspy	1	0.3
FeO.OH	13	4.1
Pyrite	3.5	1.1
Jarosite	8	2.6
Plag.	0.5	0.2
K-feldspar	24.5	7.8
Mn-carb	0.5	0.2
Calcite	5	1.6
Gypsum	3	1
Scorodite	3	1
Total	314	100.2

SOMIX (mixed silt composite)

Mineral	*Count*	*%*
Quartz	208.9	58.2
Muscovite	41.6	11.6
Kaolinite	17.7	4.9
Rutile	1.3	0.4
FeO.OH	18.4	5.1
Pyrite	2.8	0.8
Jarosite	10.2	2.8
Gibbsite	0.5	0.1
K-feldspar	45.3	12.6
Calcite	7.8	2.2
Ankerite	0.5	0.1
Gypsum	0.5	0.1
Scorodite	1	0.3
MnZnO	2.5	0.7
Total	359	99.9

MN0406 (clayey sulfide tails)

Mineral	*Count*	*%*
Quartz	139.2	45.3
Muscovite	61.6	20.1
Kaolinite	8.3	2.7
Sphalerite	0.5	0.2
FeO.OH	8	2.6
Pyrite	7.7	2.5
Jarosite	5.3	1.7
Ca-albite	4.5	1.5
K-feldspar	50.7	16.5
Aspy	3.8	1.2
Calcite	7.8	2.5
Ankerite	1.5	0.5
Gypsum	5	1.6
Scorodite	1.3	0.4
MnZnO	2	0.7
Total	307	100

MN0603 (silty sulfide tails)

Mineral	*Count*	*%*
Quartz	140	58.8
Muscovite	35.9	15.1
Kaolinite	7.5	3.2
Rutile	0.5	0.2
FeO.OH	8.2	3.5
Pyrite	2.5	1.1
Jarosite	2.5	1.1
Ca-albite	0	
K-feldspar	32.9	13.8
Aspy	0	
Calcite	5.3	2.2
Ankerite	0	
Gypsum	1.8	0.7
Scorodite	0	
MnZnO	1	0.4
Total	238	100.1

MN0703 (clayey sulfide tails)

Mineral	*Count*	*%*
Quartz	147.1	42.6
Muscovite	88.8	25.7
Kaolinite	5.3	1.5
Sphalerite	0	0
FeO.OH	18.7	5.4
Pyrite	9.6	2.8
Jarosite	12.7	3.7
Ca-albite	1	0.3
K-feldspar	50.5	14.6
Aspy	0	0
Calcite	6.1	1.8
Ankerite	1	0.3
Gypsum	4.6	1.3
Total	345.3	100

Note: 1 grain of scorodite with remnant Aspy observed but not hit by grid.

Table D-2 (cont.)

MN0803 (clay-silt sulfide tails)

Mineral	Count	%
Quartz	148.8	41.2
Muscovite	86.6	24
Kaolinite	24.3	6.7
Rutile	0.3	0.1
FeO.OH	17.8	4.9
Pyrite	11.8	3.3
Jarosite	6.9	1.9
Ca-albite	0.7	0.2
K-feldspar	50.8	14
FeSbAsS	1	0.3
Calcite	8.8	2.4
Ankerite	0.5	0.1
Gypsum	2.3	0.6
Scorodite	0	0
MnZnO	1	0.3
Total	361.5	100.0

MN0903 (oxide silt tailings)

Mineral	Count	%
Quartz	214.1	57.7
Muscovite	40.3	10.9
Kaolinite	13.1	3.5
Rutile	0.5	0.1
FeO.OH	18.4	5
Pyrite	0.7	0.2
Jarosite	20.8	5.6
Ca-albite	0	0
K-feldspar	55.1	14.8
Calcite	4.3	1.1
Ankerite	1	0.3
Gypsum	1	0.3
Scorodite	1.5	0.4
Apatite	0.5	0.1
Total	371.3	100.0

*Other minerals observed: zircon

MN1202 (clayey oxide tails)

Mineral	Count	%
Quartz	164.2	47.4
Muscovite	85.2	24.6
Kaolinite	22.4	6.5
Ilmenite	0.5	0.1
FeO.OH	17.8	5.2
Pyrite	2.3	0.7
Jarosite	7.4	2.1
MnO	0.5	0.1
K-feldspar	32.8	9.5
Native Fe	1	0.3
Calcite	3.2	0.9
Ankerite	1.7	0.5
Gypsum	4.5	1.3
Kutnohorit	1	0.3
FeMnZnO	2.1	0.6
Total	346.5	100.1

MN1502 (silty oxide tails)

Mineral	Count	%
Quartz	202.7	67.3
Muscovite	32.7	10.9
Kaolinite	9.8	3.3
Rutile	0	0
FeO.OH	18.8	6.3
Pyrite	3	1
Jarosite	7.2	2.4
Ca-albite	0	0
K-feldspar	21.8	7.2
FeSbAsS	0	0
Calcite	2.8	0.9
Ankerite	0.5	0.2
Gypsum	0.8	0.3
Scorodite	1	0.3
Total	301.0	100.1

*Other minerals observed: zircon, covellite, galena and arsenopyrite.

MN1701 (sulfidic silt tails)

Mineral	Count	%
Quartz	191.1	64
Muscovite	30.2	10.1
Kaolinite	7.5	2.5
Rutile	2	0.7
FeO.OH	11.2	3.7
Pyrite	5.5	1.8
Jarosite	10.5	3.5
Ilmenite	1	0.3
K-feldspar	28.9	9.7
Aspy	0.5	0.2
Calcite	1.3	0.4
Ankerite	1	0.3
Gypsum	2.3	0.8
Scorodite	1.7	0.6
Kutnohorit	1.5	0.5
Sphalerite	0.5	0.2
Plag	2	0.7
Total	298.5	100.0

MN1804 (clayey oxide tails)

Mineral	Count	%
Quartz	186.2	51.4
Muscovite	49.8	13.8
Kaolinite	27.3	7.5
Ilmenite	0.5	0.1
FeO.OH	20.3	5.6
Pyrite	1.5	0.4
Jarosite	27.2	7.5
Ca-albite	0	0
K-feldspar	43.4	12
Native Fe	1	0.3
Calcite	4.3	1.2
Ankerite	0	0
Gypsum	0.5	0.1
Scorodite	0	0
Total	361.9	99.9

*Other minerals observed: scorodite

OMIX (supplementary analysis)

Mineral	Count	%
Quartz	54.2	66.9
Muscovite	11.6	14.3
Kaolinite	4.7	5.8
Biotite	0	0
FeO.OH	3.9	4.8
Pyrite	1	1.2
Jarosite	1.2	1.4
Ca-albite	1	1.2
K-feldspar	2.2	2.7
Amphibole	0	0
Calcite	0	0
Ankerite	0	0
Gypsum	1.3	1.7
Scorodite	0	0
Total	81.0	100

SMIX (supplementary analysis)

Mineral	Count	%
Quartz	50.4	62.2
Muscovite	14.3	17.6
Kaolinite	3	3.7
Aspy	0	0
FeO.OH	3.5	4.3
Pyrite	0	0
Jarosite	1.8	2.3
Plag.	0	0
K-feldspar	3.8	4.6
Mn-carb	1	1.2
Calcite	1	1.2
Ankerite	1	1.2
Gypsum	0.8	0.9
Rutile	0.5	0.6
Total	81.0	99.8

SOMIX (supplementary analysis)

Mineral	Count	%
Quartz	53.3	60.6
Muscovite	14.2	16.1
Kaolinite	6.8	7.7
Sphene	1	1.1
FeO.OH	2.4	2.8
Pyrite	0.8	0.9
Jarosite	2.8	3.2
Gibbsite	0	0
K-feldspar	4.7	5.3
FeSbAsS	0	0
Calcite	0	0
Ankerite	1	1.1
Gypsum	1	1.1
Scorodite	0	0
Total	88.0	99.9

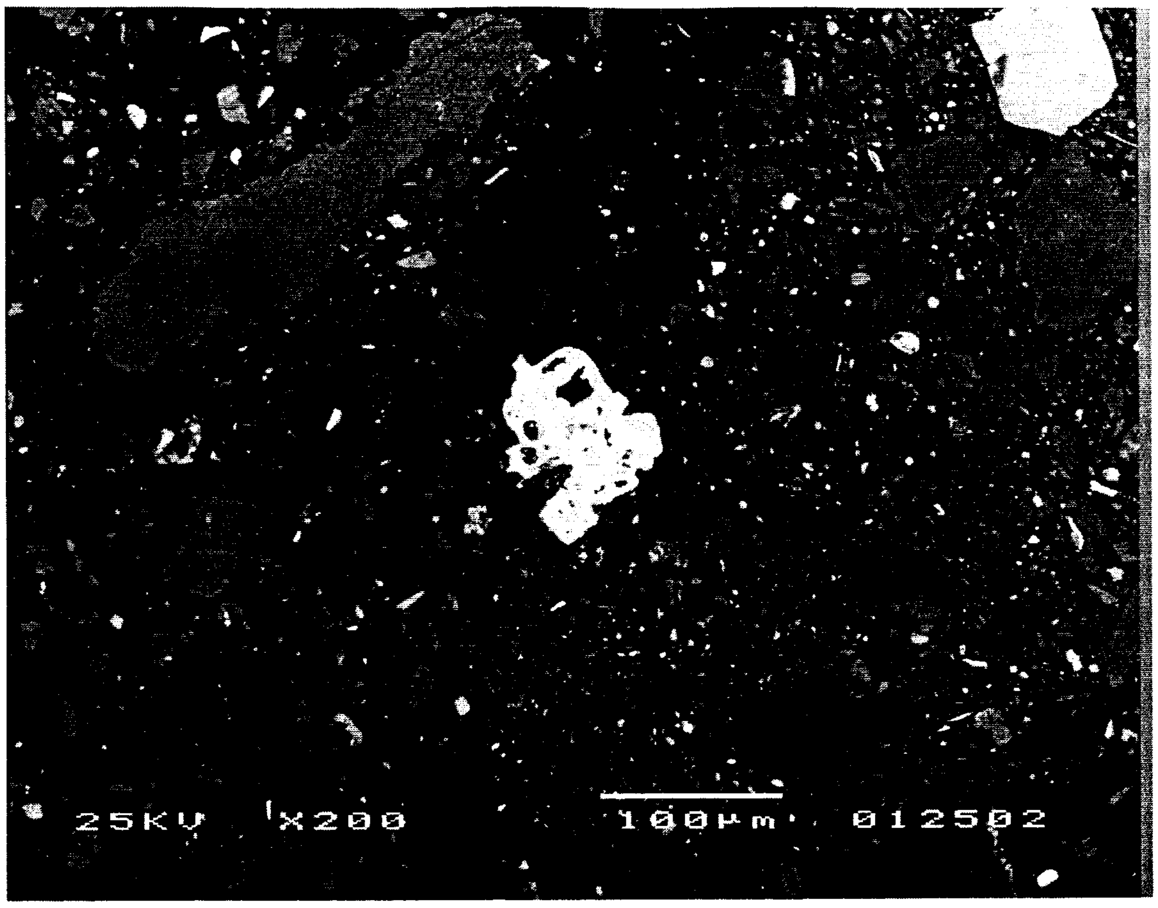


Figure D2-1a. Backscattered electron micrograph of Sample MN0703 showing a scorodite ($FeAsO_4.2H_2O$) grain at the center (greyish white) and an apatite [$Ca_5(PO_4)_3(OH,F,Cl)$] at the top right hand corner (light grey). Energy-dispersive X-ray spectra of the two grains are shown in Figure D2-1b.

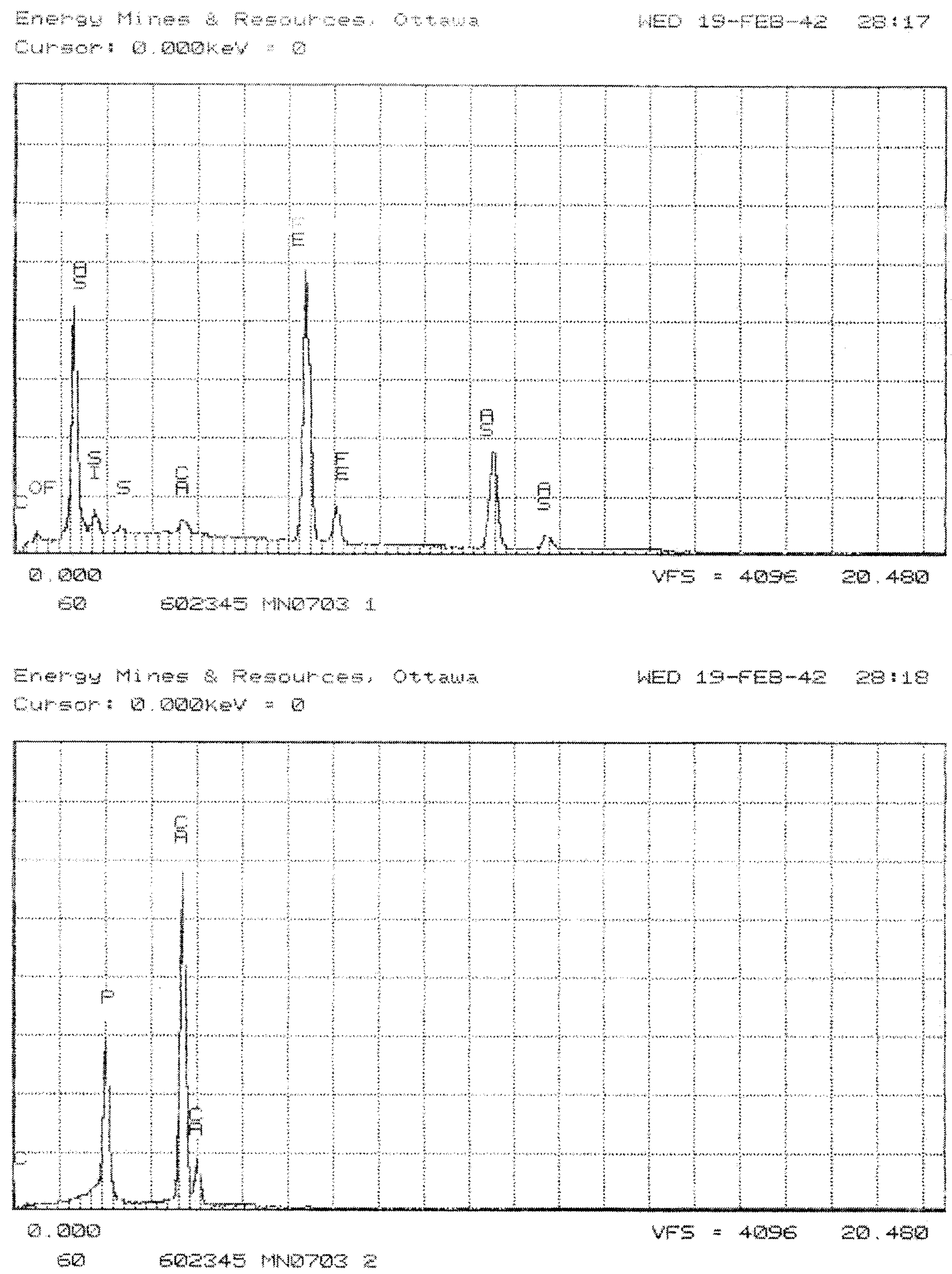


Figure D2-1b. Energy-dispersive X-ray spectra of scorodite (top) and apatite (bottom).

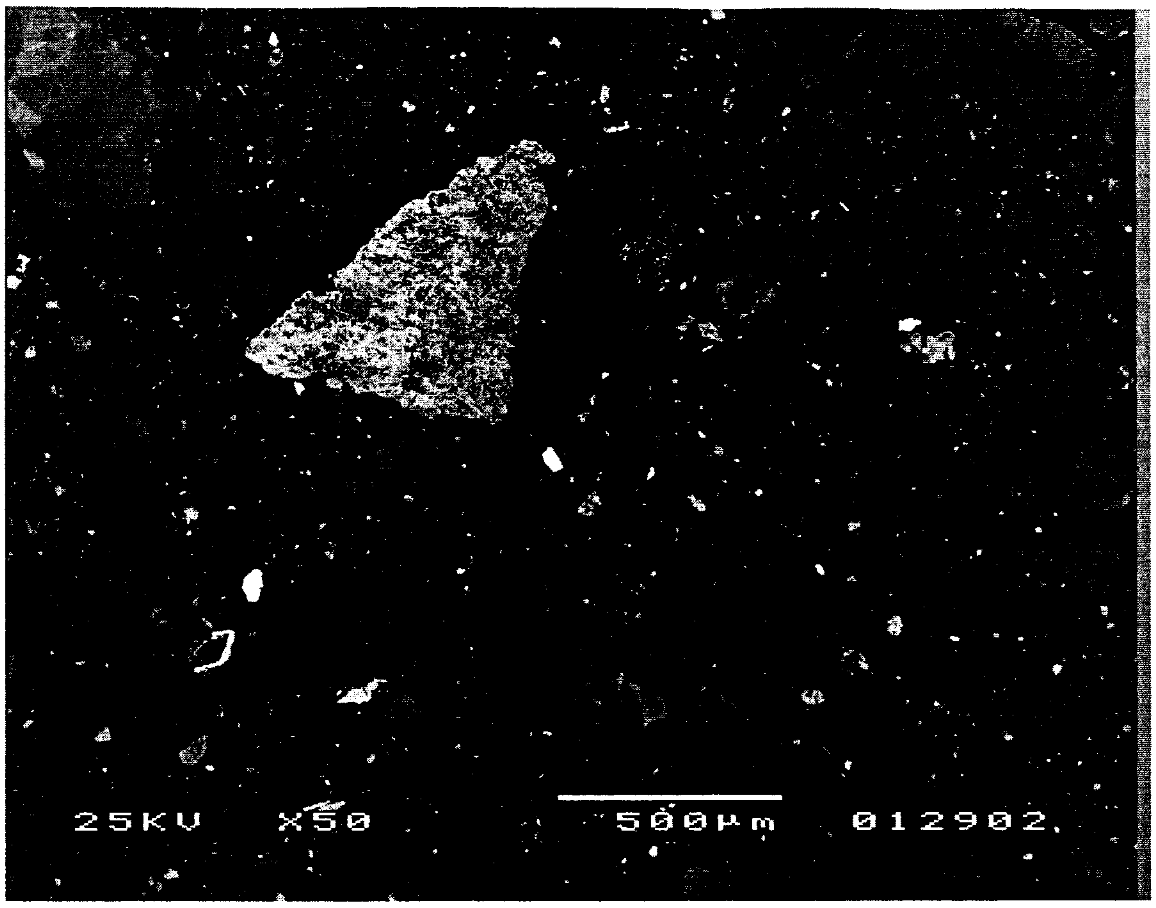
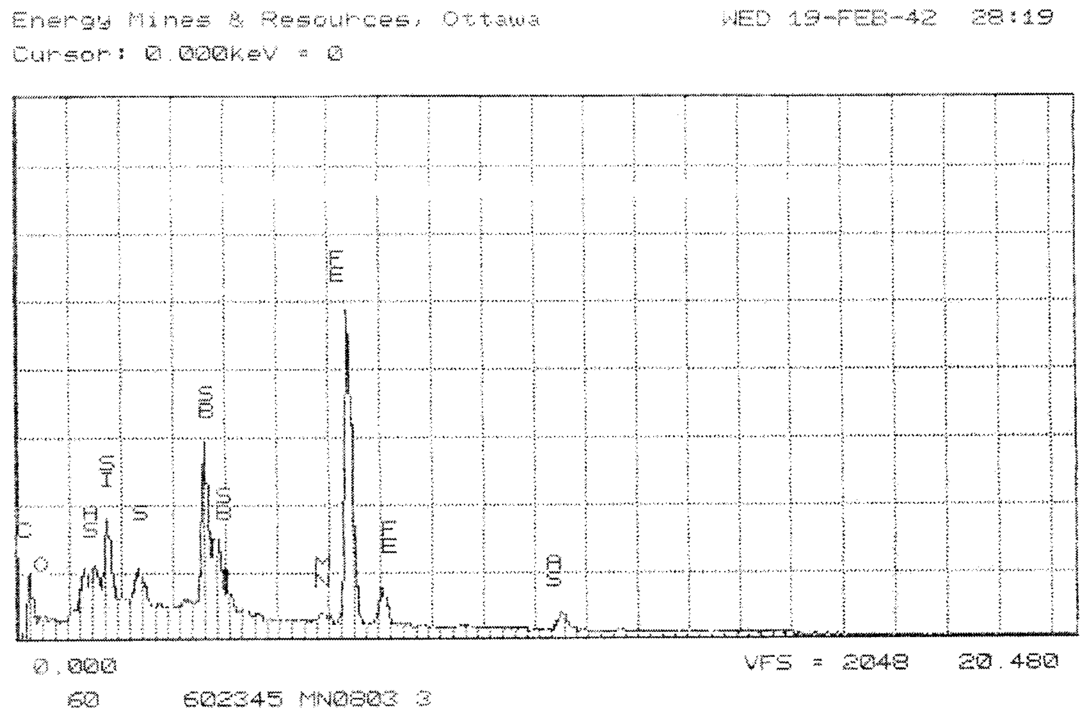


Figure D2-2a. Backscattered electron micrograph of Sample MN0903 showing a triangular, composite grain of goethite (grey, near center). The small, white rectangular grain at the center and the curved white grain at the lower left corner are unidentified sulfosalts, the energy-dispersive X-ray spectra of which are shown in Figure D2-2b. Other scattered, small greyish white grains are mostly pyrite.



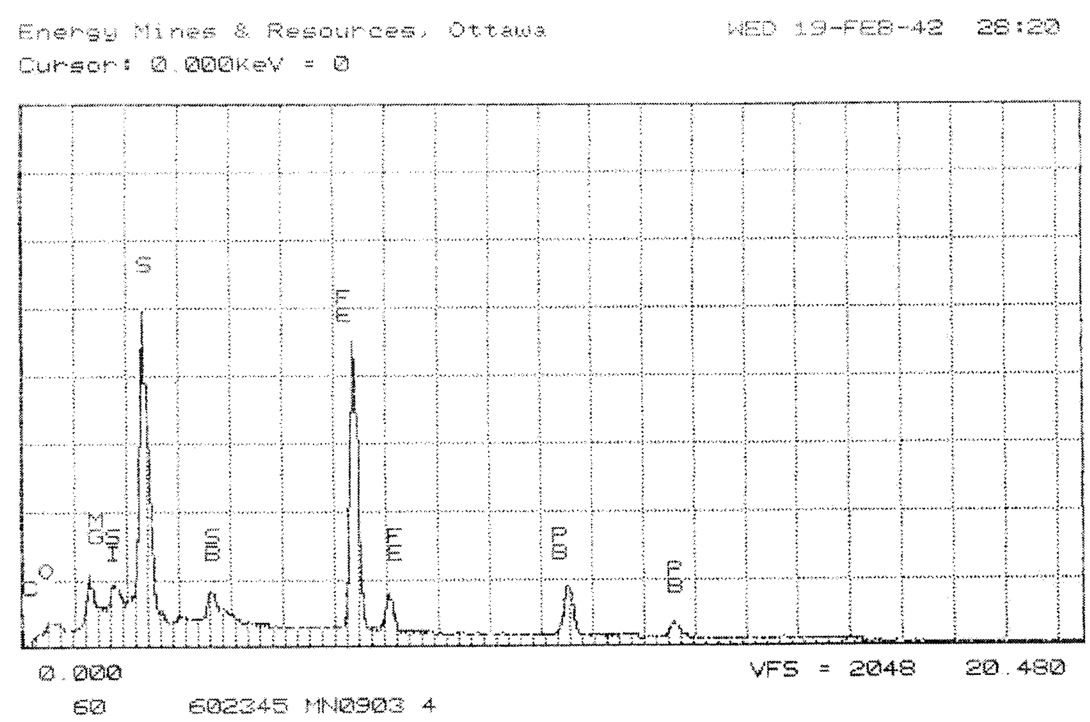
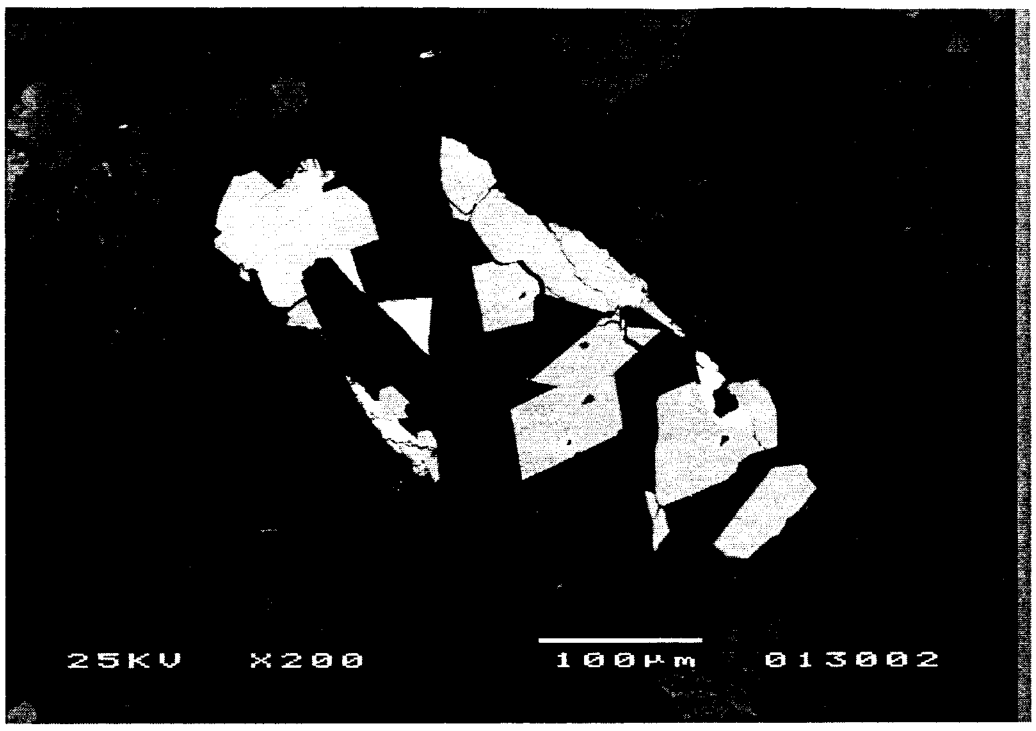


Figure D2-2b. Energy-dispersive X-ray spectra of unidentified sulfosalts observed in Sample MN0903.



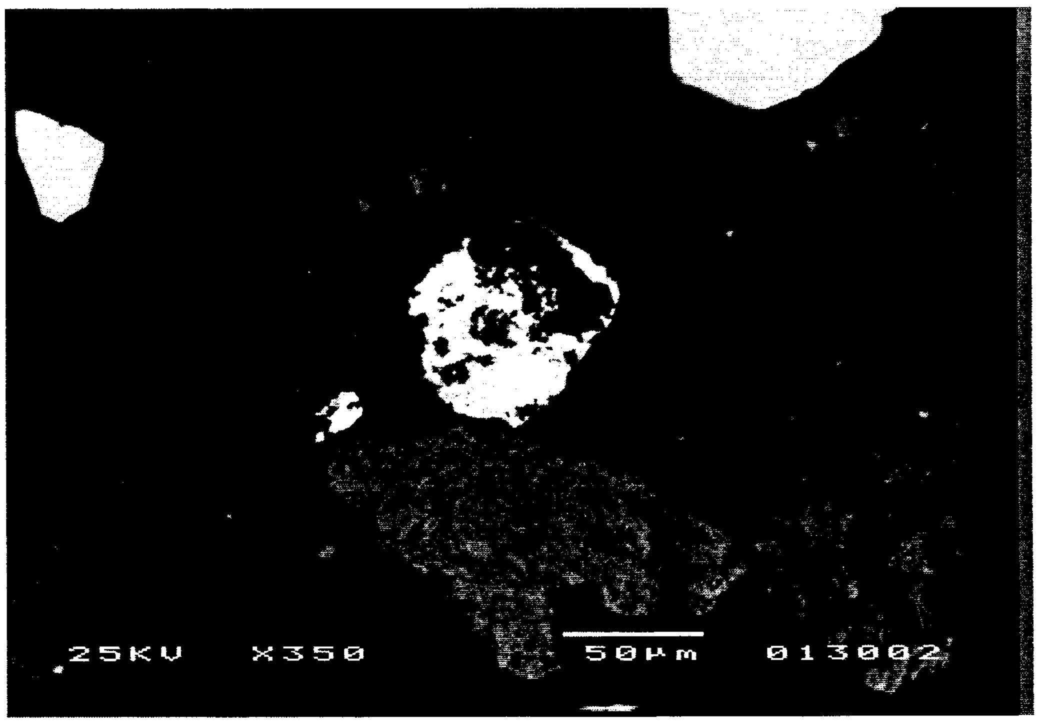


Figure D2-3. Backscattered electron micrographs of Sample MN1502. Top: A quartz grain (dark grey) with included arsenopyrite (grey) and unidentified sulfosalts (white, triangular). Bottom: A composite grain of unidentified sulfosalts (whitish grey, center) surrounded by goethite (dark grey, bottom) and subhedral pyrite (grey, top left and right hand corners).

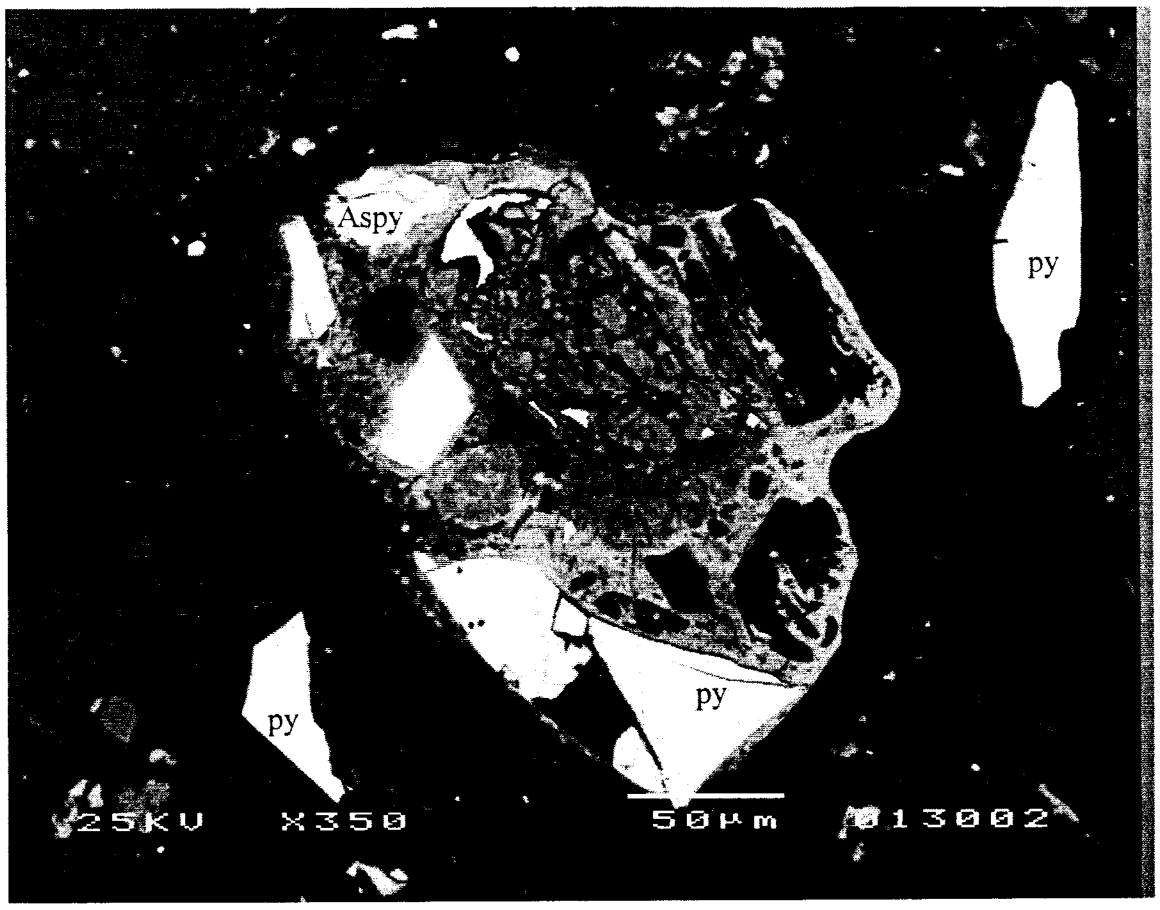


Figure D2-4. A backscattered electron micrograph of Sample MN1701 showing an goethite aggregate with included pyrite (py), arsenopyrite (Aspy) and native iron (white, irregular grain to the right of arsenopyrite).

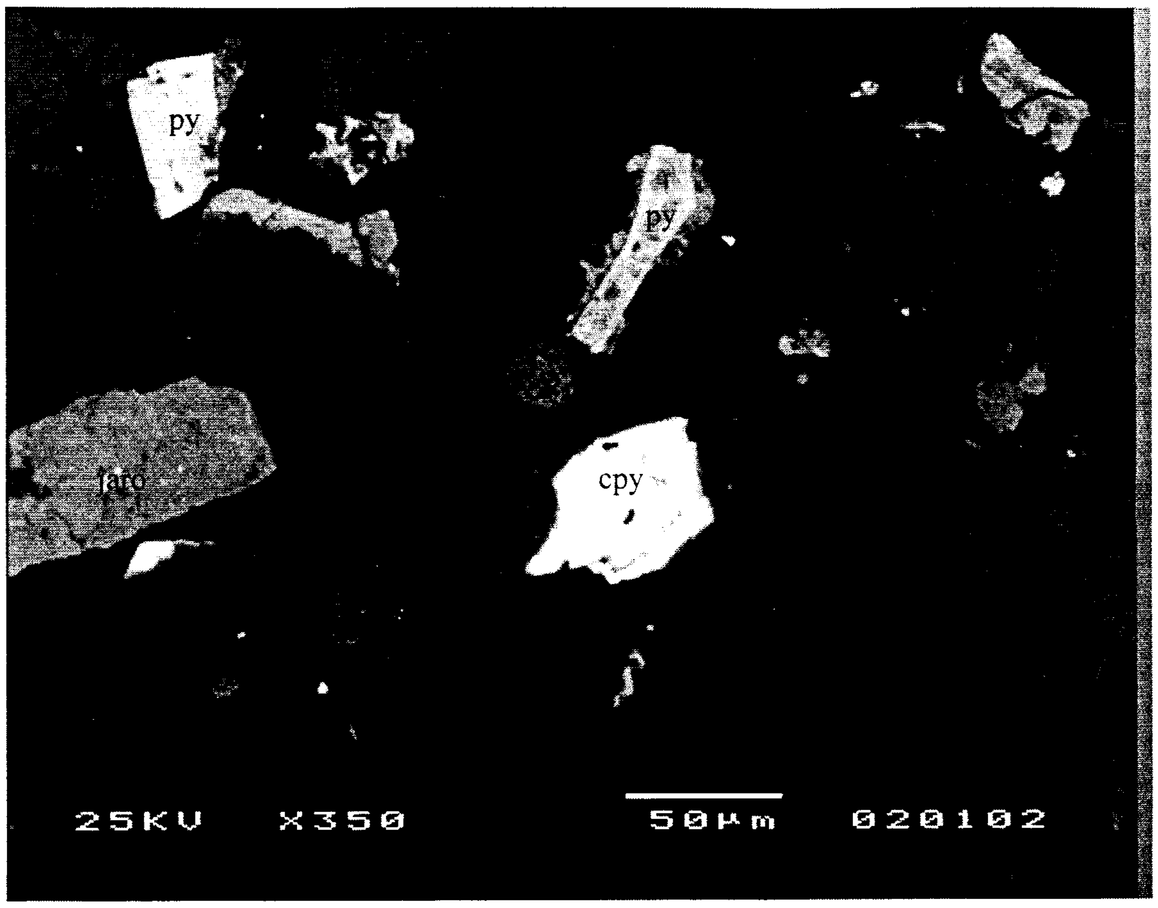


Figure D2-5. A backscattered electron micrograph of Sample MNOMIX showing the occurrence of chalcopyrite (cpy), jarosite (jaro), pyrite (py). Note that the elongated pyrite grain above the chalcopyrite grain is surrounded by goethite.

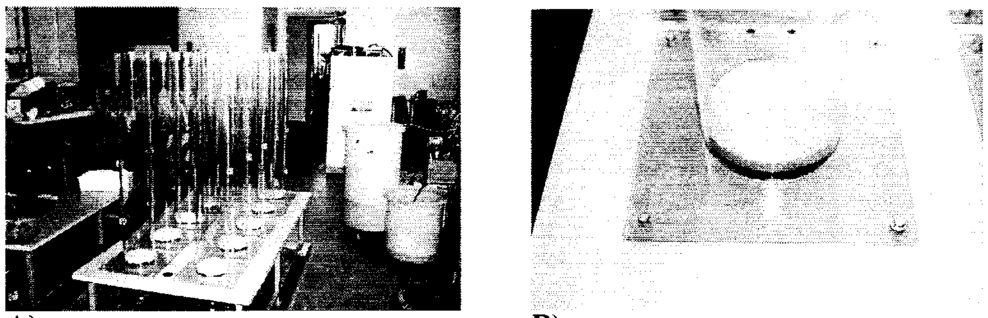
APPENDIX E

Column Set Up, Test Procedure and Results

COLUMNS SET–UP

Eight plexi-glass columns (15.2 cm inside diameter) were set up to investigate the following disposal scenarios in duplicate:

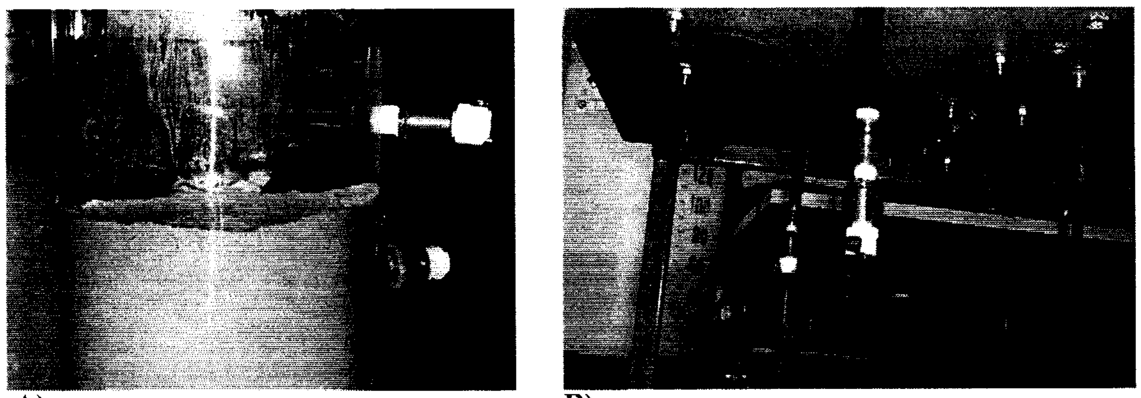
1. High sulfide tailings under a water cover;
2. Low sulfide tailing under a water cover;
3. Mixed (mixture of high and low sulfide) tailings slurried and placed under a water cover; and
4. Mixed tailings under flow through conditions.



A) B)

Figure E1: A) The layout of the columns, and B) The drainage layer at the bottom of the column.

Prior to placing the tailings in the columns, a layer of glass wool was placed at the base of all the columns. On top of the glass wool layer, a one-inch layer of acid washed (10% HCl) quartz with an effective size of 1 mm was placed. The columns were secured on a 45 cm high table. Figure E1 shows the layout of the columns placed on the table with the quartz layer overlying the glass wool. The height of the tailings bed in the columns was approximately 23 cm. The columns with tailings under a water cover were sampled at the water cover, porewater and at the base of the column. The water cover samples were collected at 5 cm above the water/tailing interface and the porewater samples were collected at 5 cm below the water/tailing interface. Figure E2 shows the location of the sampling ports.



A) B)

Figure E2: A) The sampling port in the water cover and in the tailings for porewater, and B) The sampling ports at the base of the columns.

Only coarse tailings were used in the columns to study their interaction with the Brown-McDade pit water. The interaction of fine tailings with the Brown-McDade pit water was studied by sequential batch leaching. The coarser tailings were visually inspected and classified as high and low sulfide for use in this study. The coarse tailings suitable for the column study were in limited quantity. The high sulfide tailings from core samples BH 1 – 03, – 04; BH 2 – 02, 03, 04, 05; BH 3 – 02; BH 4 – 04; BH 5 – 03; BH 6 – 04, – 06; BH 7 – 07; BH 12 – 02; BH 14 – 03; and BH 17 – 01 were placed in a large bucket and thoroughly mixed by hand to prepare a composite of high sulfide tailings. Similarly, low sulfide tailings from core samples BH 1 – 06, BH 3 – 03, BH 15 – 02, 03, and BH 17 – 02 were used to prepare a composite of low sulphide tailings. Before the tailings were placed in the column a layer of approximately 2.5 cm of pit water was transferred to the columns. The tailings were then placed in a 5 to 7.5 cm layer at a time and compacted using a plexi-glass rod to displace air pockets from the tailings bed. When the tailings bed reached the location of porewater sampling ports, the sampling ports were inserted into the columns (Figure E3) and additional tailings were placed on top of the sampling ports to achieve a tailings bed of approximately 23 cm in height. A similar procedure was used for the set up of the columns containing low sulfide tailings. The two high sulfide tailings columns contained 8.02 and 8.1 kg of tailings. The two low sulfide tailings columns contained 7.24 and 7.14 kg of tailings. After the tailings were placed in the columns, Brown-McDade pit water was pumped in the columns to obtain a water cover of 7.5 cm in depth. The individual high sulfide columns required approximately 1400 mL of pit water for 7.5 cm of water cover. The individual low sulfide columns required approximately 1650 mL of pit water for 7.5 cm of water cover. The moisture contents of the high and low sulfide tailings composite samples were 21.2% and 18% respectively.

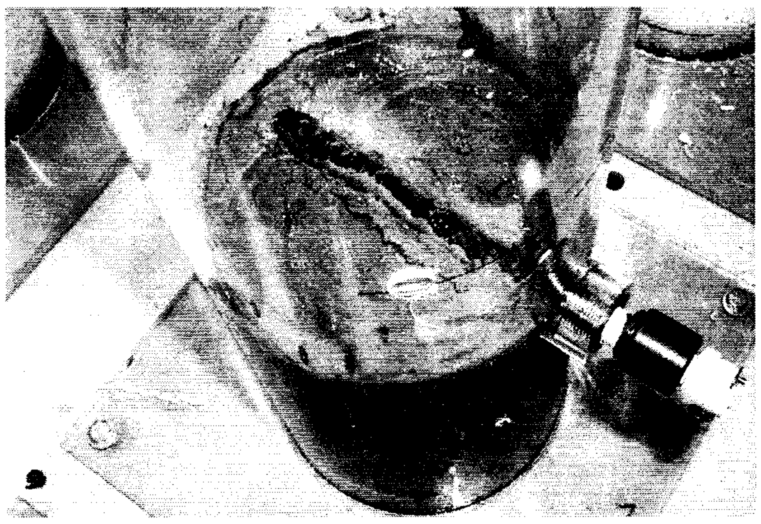


Figure E3: The sampling port for tailing porewater samples.

The remaining high and low sulfide tailings were mixed for use in the set up of additional columns. The mixed tailings were slurried by placing 18.4 kg of tailings in 3.6 L of Brown-McDade pit water. The slurry was then poured into the two columns. The tailings in the columns were allowed to settle and the water cover height was adjusted to 7.5 cm. The height of tailings bed in the mixed slurried columns was approximately 25 cm. The high sulfide, low sulfide and mixed columns under water cover were sampled approximately every three weeks at the water cover, porewater and the base of the respective column.

The remaining mixed tailings were used in the columns to simulate flow-through conditions. The two flow-through columns contained 6.2 kg of mixed tailings each. The tailings bed in each of the columns was approximately 18 cm. To ensure even distribution of pit water subsequently applied to the columns, a layer of glass wool covered by a filter paper was placed on the tailings. The Brown-McDade pit water was applied to columns at the rate of five times the average annual precipitation of 25 cm per year at Mount Nansen. The pit water was applied twice a week (190 mL each time @ 6 mL/min) and the samples were collected at the base of the columns. The water samples collected during the week were mixed together and the composite samples analyzed for the various parameters. Figure E4 shows all eight columns set up to study the four disposal scenarios. The water samples collected were analyzed for pH, conductivity, Total and WAD CN, CNS, CNO, NH_4-N, NO_3-N, NO_2-N, SO_4, and dissolved metals by ICP AES/MS metal scans. 100 mL of sample was collected from each sampling port for the analysis of parameters listed above.

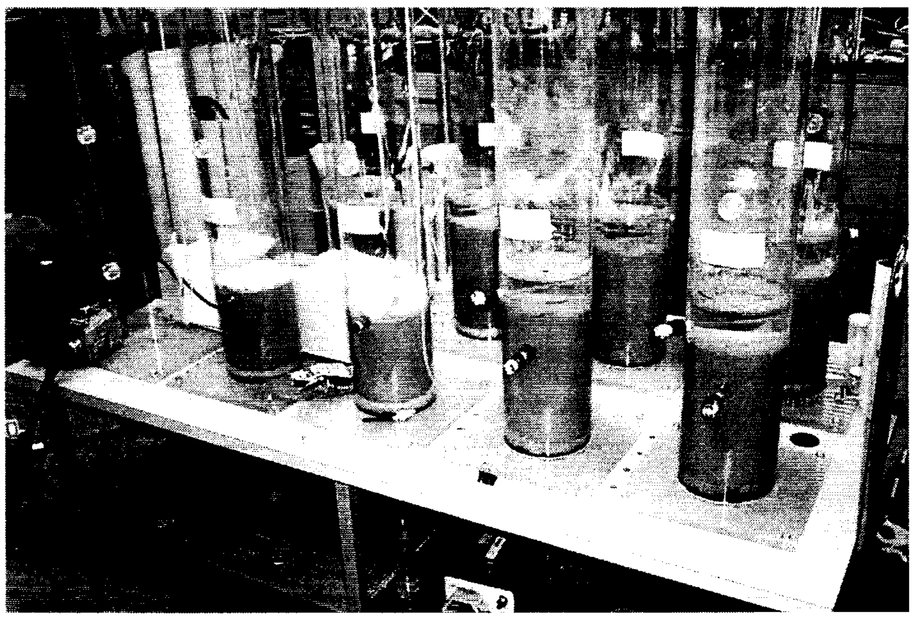


Figure E4: The eight columns set up to study the four disposal options

The results from monitoring and sampling of the columns during the period December 2001 to February 2002 are presented in this appendix. The column monitoring and sampling are ongoing and likely to continue till August/September 2002.

COLUMN STUDY RESULTS

Table E1 shows the Ag, Au, C, S and moisture contents of the composite tailings. The total sulphur contents of the high and low sulfide tailings were 2.81% and 2.14%, respectively. The total carbon content of the high sulphide was observed to be significantly higher than that of the low sulfide tailings. The moisture contents of the high sulfide, low sulfide and mixed tailings were 21.2, 17.8 and 20.5%, respectively.

Table E1: The characteristics of composite tailings samples used in the column study.

Column Type	Ag (ppm)	Au (ppm)	C (%)	S (%)	Moisture Content (%)
High Sulphide	24.4	1.34	0.38	2.81	21.2
Low Sulphide	24.7	2.67	0.18	2.14	17.8
Sulphide/Oxide Mix	25.2	2.2	0.34	2.34	20.5

HIGH SULFIDE COLUMNS

Tables E2 and E3 show the water chemistry of samples collected at the water cover, the porewater and at the base of the high sulfide columns. The Total CN concentrations in the water samples collected in the water cover and in the porewater were below the detection limit of 0.05 mg/L. The maximum Total CN of 0.076 mg/L was observed at the base of the columns. The maximum WAD CN concentration of 0.13 mg/L was observed at the base of one of the columns. The WAD CN concentration was <0.05 mg/L in the majority of samples analyzed. The CNO concentration in samples collected in December was <5 mg/L. The maximum CNO concentration of 25 mg/L was observed in the porewater and at the base for samples collected in January. The presence of CNO after approximately six weeks of column study could be due to natural degradation of CN in the tailings or CNS present in the porewater. The CNS concentration in the water cover was lower than those in the porewater and at the base. The CNS concentration in the porewater decreased with time, whereas its concentration at the base increased with time as a result of CNS degradation to CNO/NH_4-N and also by flushing/displacement of the porewater towards the base of the columns. The NH_4-N concentration in the porewater and the base of the columns increased with time, which was likely due to natural degradation of CN and CNS. The flushing of porewater through the tailings bed due to extraction of water samples from the base may also have contributed to the observed increase in NH_4-N at the base. The NO_3-N and NO_2-N concentrations in the porewater samples were below their respective analytical detection limits. No significant biological oxidation of NH_4-N apparently occurred in the columns. The SO_4 concentration in the water cover and at the base of the columns increased with time. In the porewater, the SO_4 concentration decreased with time.

Table E2: Water chemistry of samples collected at the water cover, the porewater and at the base of the columns containing high sulfide tailings.

Sample Date	pH						Conductivity (μS/cm)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	7.76	7.82	8.06	8.71	7.57	7.46	1100	1060	2130	3220	1440	2130
19-Dec-01	7.90	7.88	8.31	8.36	8.01	8.09	1440	1490	2860	2890	2440	2860
15-Jan-01	7.49	7.84	8.37	8.39	8.13	8.14	1930	1850	3270	2770	3050	3270
11-Feb-02	7.56	7.55	8.19	8.42	8.13	8.12	1890	2070	3780	3050	3490	3780

Sample Date	Total CN (mg/L)						WAD CN (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
19-Dec-01	<0.05	<0.05	<0.05	<0.05	0.053	0.073	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15-Jan-01	<0.05	*	<0.05	<0.05	0.073	<0.05	*	<0.05	*	<0.05	<0.05	<0.05
11-Feb-02	<0.05	<0.05	<0.05	<0.05	0.076	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	0.13

Sample Date	CNO** (mg/L)						CNS** (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<5	<5	<5	<5	<5	<5	12	12	168	167	23	48
19-Dec-01	<2	<2	<2	<2	<2	<2	<5	9	62	82	88	105
15-Jan-01	3	1	25	5	25	5	<2	<2	50	46	119	135
11-Feb-02	3	<1	6	3	6	3	<2	<2	40	38	120	142

Sample Date	NH_4-N (mg/L)						SO_4 (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	4.0	3.8	35.0	27.0	12.0	18.0	471	468	2352	2415	648	1467
19-Dec-01	13.1	10.9	25.3	25.5	20.8	22.6	873	873	2199	2187	1548	2001
15-Jan-01	17.5	15.8	23.3	21.8	26.8	29.0	1131	1110	1830	1818	1797	1971
11-Feb-02	14.3	14.3	20.0	21.6	26.6	27.5	1147	1037	1925	1954	1965	2057

Sample Date	NO_2-N (mg/L)						NO_3-N (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<0.3	<0.3	<0.3	<0.3	<0.3	0.55	5.4	5.4	<0.23	<0.23	4.3	1.6
19-Dec-01	0.36	<0.3	<0.3	<0.3	<0.3	<0.3	1.9	1.3	<0.23	<0.23	<0.23	<0.23
15-Jan-01	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23
11-Feb-02	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.23	<0.23	<0.23	<0.23	<0.23	<0.23

Note: C1 and C2 denote Column 1 and Column 2 set up for the scenario. *Sample not analyzed. **The detection limit decreased upon request.

Table E3: Dissolved As, Cu, Zn and Sb concentrations observed in the water cover, tailings porewater and at the base of the columns containing high sulfide columns.

Sampling Date	As (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.356	0.206	0.281	1.03	1.05	1.04	0.176	0.469	0.323
19-Dec-01	0.353	0.351	0.352	1.19	1.08	1.14	1.63	0.806	1.22
15-Jan-02	0.661	0.965	0.813	1.40	1.63	1.52	1.32	2.32	1.82
11-Feb-02	1.71	0.927	1.32	1.49	1.35	1.42	1.96	1.43	1.70

Sampling Date	Cu (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.037	0.037	0.037	0.192	0.105	0.171	0.026	0.173	0.100
19-Dec-01	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
15-Jan-02	<0.025	<0.025	<0.025	0.029	0.031	0.030	0.033	0.033	0.033
11-Feb-02	0.034	0.065	0.050	<0.053	<0.053	<0.053	0.032	0.026	0.029

Sampling Date	Zn (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.367	*	0.367	0.085	0.102	0.094	0.243	0.149	0.196
19-Dec-01	0.328	0.905	0.616	0.031	0.042	0.036	0.052	0.043	0.048
15-Jan-02	<0.10	0.084	0.084	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
11-Feb-02	0.157	0.173	0.165	<0.010	<0.010	<0.010	0.008	0.017	0.013

Sampling Date	Sb (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.054	0.049	0.052	0.333	0.349	0.341	0.065	0.175	0.120
19-Dec-01	0.068	0.074	0.071	0.084	0.060	0.072	0.018	0.018	0.018
15-Jan-02	0.098	0.100	0.099	0.011	0.025	0.018	<0.010	<0.010	<0.010
11-Feb-02	0.082	0.068	0.075	0.025	0.029	0.027	<0.010	<0.010	<0.010

Note: C1 and C2 denote Column 1 and Column 2 for the scenario. * Sample analysis result not available. The Brown-McDade pit water metal concentrations: As = 0.024 mg/L, Cu = 0.065 mg/L, Zn = 0.738 mg/L, and Sb = 0.035 mg/L.

Table E3 shows the concentrations of dissolved arsenic, copper, zinc and antimony observed in the water cover, the porewater and at the base of the two high sulfide tailings columns. The average arsenic concentration in the water covers and at the base of the columns increased with time. The average As concentration in the water cover increased from 0.281 mg/L to 1.32 mg/L and at the base of the columns As concentration increased from 0.323 mg/L to 1.70 mg/L. The average As concentration in the porewater increased from 1.04 mg/L to 1.42 mg/L. The average copper concentration in the porewater decreased from 0.171 mg/L at the start and to <0.053 mg/L. At the base of the columns the copper concentration decreased from 0.100 mg/L to 0.029 mg/L. The dissolved zinc concentration in the water covers ranged from 0.084 mg/L to 0.616 mg/L. It should be noted that the Zn concentration in the pit water samples used in the column study was 0.738 mg/L. In the porewater samples, the average Zn concentration decreased from 0.094 mg/L to <0.01 mg/L. The Zn concentration at the base also decreased with time.

The lower Zn concentration observed in the columns could be due to adsorption of zinc on mineral surfaces in the tailings. The average dissolved Sb concentration in the water covers ranged from 0.052 to 0.099 mg/L. In the porewater and at the base the average Sb concentrations decreased with time to 0.025 and <0.010 mg/L, respectively.

LOW SULFIDE COLUMNS

Tables E4 and E5 show the water chemistry of samples collected at the water cover, the porewater and at the base of the low sulfide columns. The Total CN in the water covers and porewater were <0.05 mg/L. The maximum Total CN concentration in the porewater of one of the columns was 0.076 mg/L. The WAD CN concentrations in the water covers and porewater were also <0.05 mg/L. At the base of the columns, the WAD CN concentration was also <0.05 mg/L, with the exception of only one sample having a WAD CN value of 0.14 mg/L. The CNO concentrations in the water covers were <5 mg/L. The maximum CNO concentration of 8 mg/L was observed in the porewater of one of the columns. The CNS concentrations in the water covers and the porewater were below detection limits. At the base of the columns CNS was <5 mg/L in the samples collected in December; however CNS was 10 mg/L in the samples collected in January and February 2002. The NH_4-N concentrations in the water covers ranged from 0.5 to 3.3 mg/L. In the porewater, the average NH_4-N concentration decreased from 23.4 mg/L to 9.0 mg/L. At the base of the columns, the average NH_4-N concentration increased from 7.4 mg/L to 23.5 mg/L. The SO_4 concentration increased in the water cover and at the base of the columns, while a decrease in SO_4 concentration was observed in the porewater.

Table E4: Water chemistry of samples collected at the water cover, the porewater and at the base of the columns containing low sulphide tailings.

Sample Date	pH						Conductivity (μS/cm)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	7.50	7.49	7.87	7.63	7.51	7.56	970	980	2440	2220	1070	1220
19-Dec-01	8.40	8.26	7.98	8.00	7.47	7.61	1220	1250	2380	2380	2310	2370
15-Jan-01	8.14	7.84	7.97	7.85	7.70	7.40	1620	1630	2400	2430	2730	2790
11-Feb-02	7.57	7.82	7.96	8.05	7.93	8.02	1590	1770	2570	3030	3030	3060

Sample Date	Total CN (mg/L)						WAD CN (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	*	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
19-Dec-01	<0.05	<0.05	<0.05	<0.05	<0.05	0.054	*	<0.05	*	<0.05	<0.05	<0.05
15-Jan-01	<0.05	*	<0.05	<0.05	0.076	<0.05	*	<0.05	*	<0.05	<0.05	<0.05
11-Feb-02	<0.05	<0.05	<0.05	<0.05	0.051	0.051	<0.05	<0.05	<0.05	<0.05	0.14	<0.05

Table E4 (Cont.)

Sample Date	CNO** (mg/L)						CNS** (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
19-Dec-01	<2	<2	*	<2	<2	<2	<5	<5	*	<5	<5	<5
15-Jan-01	<2	<1	<1	3	<1	<1	<2	<2	<2	<2	10	10
11-Feb-02	<1	2	8	5	<1	4	<2	<2	<2	<2	11	12

Sample Date	NH_4-N (mg/L)						SO_4 (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	0.8	1.5	22.6	24.1	7.0	7.8	402	399	1914	1914	960	936
19-Dec-01	2.9	3.3	*	16.9	20.6	18.5	666	711	1857	1851	1713	1695
15-Jan-01	0.5	2.1	14.2	15.2	24.3	24.3	915	918	1593	1647	1800	1791
11-Feb-02	0.5	0.7	8.2	9.7	24.7	22.2	958	901	1514	1740	1837	1911

Sample Date	NO_2-N (mg/L)						NO_3-N (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	5.8	5.8	0.22	0.22	3.6	3.6
19-Dec-01	<0.3	<0.3	*	<0.3	<0.3	<0.3	3.8	3.5	<0.22	<0.22	<0.22	<0.22
15-Jan-01	0.95	2.92	0.21	<0.3	<0.3	<0.3	6.1	2.5	<0.22	<0.22	<0.22	<0.22
11-Feb-02	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	6.7	7.0	<0.22	<0.22	<0.22	<0.22

Note: C1 and C2 denote Column 1 and Column 2 set up for the scenario. *Sample not analyzed. **The detection limit decreased upon request.

Table E5: The dissolved As, Cu, Zn and Sb concentrations in the water cover, the porewater and at the base of the columns containing low sulphide tailings.

Sampling Date	As (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.293	0.285	0.289	0.825	0.788	0.806	0.199	0.264	0.232
19-Dec-01	0.297	0.310	0.303	1.09	1.70	1.40	0.728	0.521	0.625
15-Jan-02	0.406	0.356	0.381	1.68	1.74	1.71	1.75	2.09	1.92
11-Feb-02	0.366	0.474	0.420	1.62	1.69	1.66	2.57	2.59	2.58

Sampling Date	Cu (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.026	0.042	0.034	0.036	0.034	0.035	0.026	0.035	0.031
19-Dec-01	0.040	0.026	0.033	<0.025	0.044		<0.025	0.027	
15-Jan-02	0.033	0.037	0.035	0.031	0.029	0.030	0.029	0.031	0.030
11-Feb-02	0.034	0.044	0.039	0.033	0.028	0.031	0.032	0.030	0.031

Table E5 (Cont.)

Sampling Date	Zn (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.644	0.524	0.584	0.159	0.163	0.161	0.211	0.183	0.197
19-Dec-01	0.263	0.682	0.473	0.143	0.337	0.240	0.062	0.276	0.169
15-Jan-02	0.187	0.152	0.170	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
11-Feb-02	0.465	0.228	0.373	0.029	0.027	0.028	<0.010	0.012	

Sampling Date	Sb (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.136	0.100	0.118	0.758	0.734	0.746	0.129	0.241	0.185
19-Dec-01	0.131	0.187	0.159	0.164	0.231	0.198	0.085	0.069	0.077
15-Jan-02	0.447	0.471	0.459	0.279	0.147	0.213	0.010	0.020	0.015
11-Feb-02	0.490	0.412	0.451	0.172	0.122	0.147	0.012	0.014	0.013

Note: C1 and C2 denote Column 1 and Column 2 for the scenario. The Brown-McDade pit water metal concentrations: As = 0.024 mg/L, Cu = 0.065 mg/L, Zn = 0.738 mg/L, and Sb = 0.035 mg/L.

In general, higher concentrations of dissolved As were observed in the porewater and at the base of the columns than in the water cover. In the porewater, the average arsenic concentration increased from 0.806 mg/L to 1.66 mg/L and at the base of the column, the average As concentration increased from 0.232 mg/L to 2.58 mg/L. The maximum dissolved copper concentration in the samples collected was 0.044 mg/L. The average dissolved Zn concentration in the water cover ranged from 0.584 mg/L to 0.170 mg/L. Dissolved Zn concentrations in the porewater and at the base of the columns were higher at the start of the column study and significantly decreased with time, most likely as a result of sorption of Zn ions onto mineral surfaces. The average Sb concentration in the water cover increased from 0.118 to 0.451 mg/L. In the porewater and at the base of the columns, the average Sb concentration decreased with time to 0.147 mg/L and 0.013 mg/L, respectively. The Sb concentrations in the water cover and the porewater of the low sulfide tailings were higher than those in the high sulphide tailings columns.

MIXED TAILINGS SLURRY COLUMNS

Tables E6 and E7 show the water chemistry of samples collected at the water cover, porewater and at the base of the mixed tailings slurry columns. The water cover layer achieved in Column 2 after settling of the tailings from the slurry was lower than the design depth of 7.5 cm and also a small leak had occurred overnight after samples were collected on December 3, 2001. Therefore, on December 6, 2001, 610 mL of additional pit water was added to the column to maintain the desired water cover depth of 7.5 cm. The conductivity of the water cover in the mixed tailings slurry columns was higher than those measured in the high and low sulfide columns. The Total CN concentration in the water covers was <0.05 mg/L. The maximum Total CN concentrations in the porewater and at the base were 0.082 and 0.066 mg/L, respectively. The WAD CN concentrations in the water cover, the porewater and at the base were <0.05 mg/L. The CNO concentration in the water covers was below 5 mg/L. The average CNS concentration in the water covers decreased from 68 mg/L to less than 2 mg/L. The CNS concentration in the porewater also decreased, while the CNS concentration at the base of the columns increased. The average NH_4-N concentration in the porewater decreased from 26 mg/L to 18.3 mg/L and at the base of the columns the average ammonia concentration increased from 14.8 mg/L to 21.7 mg/L. The mixed tailings slurried columns generally had higher NH_4-N in the water covers than the low sulfide columns. The average SO_4 concentration in the water covers decreased from 2091 mg/L to 1188 mg/L. In the porewater the average SO_4 concentration slightly decreased from 1977 to 1817 mg/L. However, the SO_4 concentration at the base of the columns increased from 1427 mg/L to 1941 mg/L. The concentrations of CNS, NH_4-N and SO_4 at the base of the columns increased with time likely due to flushing (from upper regions of the column) created by sampling at the base.

Table E6: Water chemistry of samples at the water cover, the porewater, and at the base of the columns containing mixed tailings deposited in the slurry form.

Sample Date	pH						Conductivity (µS/cm)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	7.59	7.70	7.95	8.06	7.43	7.61	2730	2750	2680	2690	1930	2030
19-Dec-01	7.93	8.03	8.40	8.40	7.90	7.95	2180	1710	2650	2540	2540	2840
15-Jan-01	7.75	7.49	8.35	8.25	8.06	7.96	2280	1610	*	2520	2830	2960
11-Feb-02	7.63	7.22	8.31	8.24	7.93	8.02	2240	1870	3030	3030	3030	3060

Sample Date	Total CN (mg/L)						WAD CN (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
19-Dec-01	<0.05	<0.05	0.058	<0.05	0.054	0.063	*	<0.05	<0.05	*	<0.05	<0.05
15-Jan-01	<0.05	*	0.082	<0.05	0.066	<0.05	*	<0.05	<0.05	*	<0.05	*
11-Feb-02	<0.05	<0.05	0.052	<0.05	0.060	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Sample Date	CNO** (mg/L)						CNS (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	<5	<5	<5	<5	<5	<5	67	69	67	67	22	39
19-Dec-01	<2	<2	<2	<2	<2	<2	7	<5	64	45	47	72
15-Jan-01	<1	1	1	<1	<1	<1	<2	<2	50	9	62	58
11-Feb-02	3	1	<1	<1	4	2	<2	<2	28	11	66	50

Sample Date	NH_4-N (mg/L)						SO_4 (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	21.8	21.0	26.4	25.6	12.4	17.1	2091	2091	1968	1986	1269	1584
19-Dec-01	21.0	8.9	26.1	22.8	18.8	23.6	1616	1104	2184	2115	1896	2166
15-Jan-01	19.8	5.5	23.3	18.8	22.5	23.9	1443	897	1887	1719	1824	1917
11-Feb-02	13.3	5.9	20.0	16.6	20.1	23.2	1328	1048	1857	1758	1888	1995

Table E6 (Cont.)

Sample Date	NO_2-N (mg/L)						NO_3-N (mg/L)					
	Water Cover		Porewater		Base of the Column		Water Cover		Porewater		Base of the Column	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
03-Dec-01	0.6	0.6	0.6	0.6	0.9	0.6	2.9	3.2	<0.2	<0.2	2.9	2.0
19-Dec-01	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.22	1.8	<0.22	<0.22	<0.22	<0.22
15-Jan-01	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22
11-Feb-02	2.1	<0.3	<0.3	<0.3	<0.3	<0.3	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22

Note: C1 and C2 denote Column 1 and Column 2 for the scenario. *Sample not analyzed. **The detection limit decreased upon request.

Table E7: Dissolved As, Cu, Zn and Sb concentrations in the water cover, the porewater and at the base of the columns containing mixed tailings deposited in the slurry form.

Sampling Date	As (mg/)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.933	0.936	0.929	0.918	1.06	0.989	0.451	0.583	0.517
19-Dec-01	0.709	0.286	0.498	1.45	1.41	1.43	1.52	1.30	1.41
15-Jan-02	0.933	0.593	0.763	1.46	1.43	1.45	1.28	1.40	1.34
11-Feb-02	0.611	1.39	1.00	1.43	1.35	1.39	1.56	1.68	1.62

Sampling Date	Cu (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.072	0.077	0.075	0.069	0.046	0.058	0.010	0.034	0.022
19-Dec-01	0.030	<0.025		0.029	<0.025		<0.025	<0.025	<0.025
15-Jan-02	0.035	0.035	0.035	0.029	0.029	0.029	0.031	0.033	0.032
11-Feb-02	0.038	0.040	0.039	0.049	0.025	0.037	0.032	0.034	0.033

Sampling Date	Zn (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.238	0.441	0.340	0.108	0.042	0.075	0.217	0.065	0.141
19-Dec-01	0.064	0.042	0.053	0.029	0.029	0.029	0.052	0.018	0.035
15-Jan-02	0.046	0.059	0.053	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
11-Feb-02	0.125	0.092	0.109	0.069	<0.010		<0.010	<0.010	<0.010

Sampling Date	Sb (mg/L)								
	Water Cover			Porewater			Base of the Column		
	C1	C2	Average	C1	C2	Average	C1	C2	Average
03-Dec-01	0.360	0.372	0.366	0.421	0.408	0.415	0.181	0.255	0.218
19-Dec-01	0.186	0.109	0.147	0.089	0.068	0.079	0.029	0.018	0.023
15-Jan-02	0.125	0.106	0.155	0.032	0.034	0.033	<0.010	0.010	
11-Feb-02	0.139	0.061	0.100	0.031	0.027	0.029	<0.010	<0.010	<0.010

Note: C1 and C2 denote Column 1 and Column 2 for the scenario. The Brown-McDade pit water metal concentrations: As = 0.024 mg/L, Cu = 0.065 mg/L, Zn = 0.738 mg/L, and Sb = 0.035 mg/L.

Table E8: Water chemistry of samples collected at the base of the mixed flow-through tailings columns.

Sample Date	pH		Conductivity		Total CN (mg/L)		WAD CN (mg/L)		CNO** (mg/L)	
	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
05-Dec-01	8.23	8.24	1730	2100	<0.05	<0.05	<0.05	<0.05	<5	<5
07-Dec-01	8.18	8.22	2530	2900	<0.5	<0.5	<0.05	<0.05	<5	<5
14-Dec-01	7.57	7.99	2940	3130	0.100	0.09	<0.05	<0.05	<1	<1
21-Dec-01	7.45	7.76	3060	3070	0.076	0.081	<0.05	<0.05	<2	<2
02-Jan-02	6.06	6.73	2930	2910	<0.05	0.054	*	<0.05	<2	<2
07-Jan-02	6.76	7.17	2720	2630	<0.05	<0.05	*	*	<2	<2
14-Jan-02	7.21	7.44	2830	2780	<0.05	<0.05	*	<0.05	<1	<1
21-Jan-02	7.08	7.84	2390	2360	<0.05	<0.05	<0.05	<0.05	<1	<1
28-Jan-02	7.46	7.56	2290	2270	<0.05	<0.05	<0.05	<0.05	<1	<1
06-Feb-02	7.82	7.76	2140	2080	<0.05	<0.05	<0.05	<0.05	<1	14

Sample Date	CNS (mg/L)		NH_4-N (mg/L)		SO_4 (mg/L)	
	C1	C2	C1	C2	C1	C2
05-Dec-01	46	65	12.4	14.8	984	1269
07-Dec-01	92	119	26.8	35.2	1764	2154
14-Dec-01	135	135	30.2	30.6	2481	2475
21-Dec-01	124	117	31.7	32.1	2562	2514
02-Jan-02	32	19	31.0	30.2	2367	2334
07-Jan-02	*	*	28.9	28.6	2031	1950
14-Jan-02	<2	<2	27.8	27.1	1875	1833
21-Jan-02	<2	<2	24.8	25.4	1906	1664
28-Jan-02	<2	<2	23.8	22.4	1787	1759
06-Feb-02	<2	<2	18.5	12.5	1645	1260

Note: C1 and C2 denote Column 1 and Column 2 for the scenario. *Sample not analyzed. **The detection limit decreased upon request.

Table E9: Dissolved As, Cu, Zn and Sb concentrations at the base of the mixed tailings flow through columns.

Sample Date	As (mg/L)			Cu (mg/L)		
	C1	C2	Average	C1	C2	Average
05-Dec-01	0.253	0.259	0.256	0.168	0.212	0.190
07-Dec-01	0.362	0.349	0.355	0.193	0.196	0.194
14-Dec-01	0.613	0.493	0.553	0.08	0.082	<0.081
21-Dec-01	0.894	0.898	0.896	0.114	0.026	0.070
02-Jan-02	1.11	1.07	1.09	<0.016	<0.016	<0.016
07-Jan-02	1.32	1.32	1.32	<0.018	<0.018	<0.018
14-Jan-02	1.54	1.37	1.46	0.034	0.028	0.031
21-Jan-02	1.01	0.978	0.994	0.031	0.031	0.031
28-Jan-02	1.07	0.904	0.987	<0.02	<0.02	<0.02
06-Feb-02	0.999	0.939	0.969	0.031	0.028	0.029

Sample Date	Zn (mg/L)			Sb (mg/L)		
	C1	C2	Average	C1	C2	Average
05-Dec-01	0.110	0.080	0.010	0.310	0.226	0.268
07-Dec-01	0.075	0.058	0.067	0.406	0.420	0.413
14-Dec-01	0.068	0.156	0.112	0.480	0.420	0.450
21-Dec-01	0.031	0.037	0.034	0.115	0.049	0.082
02-Jan-02	<0.010	<0.010	<0.010	0.105	0.041	0.073
07-Jan-02	0.047	0.047	0.047	0.095	0.043	0.069
14-Jan-02	<0.010	<0.010	<0.010	0.098	0.034	0.066
21-Jan-02	<0.010	<0.010	<0.010	0.111	0.043	0.078
28-Jan-02	<0.026	<0.026	<0.026	0.092	0.033	0.062
06-Feb-02	0.013	0.013	0.013	0.086	0.081	0.084

Note: C1 and C2 denote Column 1 and Column 2 set up for the scenario. The Brown-McDade pit water metal concentrations: As = 0.024 mg/L, Cu = 0.065 mg/L, Zn = 0.738 mg/L, and Sb = 0.035 mg/L.

Table E7 shows the dissolved arsenic, copper, and zinc concentrations in the water cover, the porewater and at the base of the columns. The average arsenic concentration in water cover ranged from 0.498 mg/L to 1.00 mg/L. The average porewater As concentration increased from 0.989 mg/L to 1.49 mg/L and at the base of the columns the average As increased from 0.517 mg/L to 1.62 mg/L. The water cover of slurried columns had generally a higher As concentration compared to the water covers in the high and low sulphide columns. The maximum copper concentration in the water cover, the porewater and at base of the columns were 0.077 mg/L, 0.069 mg/L and 0.034 mg/L, respectively. The average zinc concentration in the water cover ranged from 0.340 mg/L at the start to 0.109 mg/L. In porewater and at the base the average zinc concentrations were 0.075 mg/L and 0.141 mg/L at the start and decreased with time. At the start, the average Sb concentrations in the water cover, the porewater and at the base were 0.366 mg/L, 0.415 mg/L and 0.218 mg/L respectively. The Sb concentration in the water cover, the porewater and at the base decreased with time to 0.100, 0.029 and <0.010 mg/L, respectively.

MIXED TAILINGS FLOW THROUGH COLUMN

Tables E8 and E9 show the water chemistry of samples collected at the base of the flow through columns. The conductivity of samples collected at the base of the columns increased from an average of 1915 μS/cm to a maximum of 3065 μS/cm and then decreased to 2635 μS/cm. The maximum Total CN concentration observed was 0.100 mg/L. The majority of samples collected had Total CN concentrations of <0.05 mg/L. The WAD CN concentrations were <0.05 mg/L. CNO was only detected in the sample collected in February at a concentration of 14 mg/L. The average CNS concentration at the start was 55.5 mg/L and increased to a maximum value of 135 mg/L in 10 days and then decreased to 25.6 mg/L in approximately three weeks. In approximately six weeks the measured CNS concentration was less than 1 mg/L. The average NH_4-N concentration at the start was 13.6 mg/L, increased to 31.9 mg/L and then decreased to 15.5 mg/L. The average SO_4 concentration increased from 1127 mg/L to a maximum of 2538 mg/L and then decreased to 1453 mg/L. The average nitrite-N concentration was less than 0.3 mg/L and the average nitrate-N concentration rapidly decreased from 3.6 mg/L at the start to <0.22 mg/L. The average concentration of As increased from 0.256 mg/L at the start to a maximum concentration of 1.46 mg/L and then decreased to 0.969 mg/L. The average dissolved copper concentration decreased from 0.19 mg/L to 0.029 mg/L and the average dissolved Zn concentration decreased from 0.109 to 0.013 mg/L. The Sb concentration initially increased from 0.268 mg/L to 0.450 mg/L and then decreased to 0.082 mg/L.

The results presented above are for the period of December 2001 to February 2002. The column monitoring and sampling is likely to continue till August/September 2002.

APPENDIX F

Sequential Batch Leach and Other Leach Test Results

Table F-1a: Sequential batch leach test results – leachate and residue chemistry

Leach Tests Chemical Analysis (Jan/02- Mar/02)
Mount Nansen Tailings Stability Project
602345

FIELD#	DESCRIPTION	Ag mg/L	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Bi mg/L	Ca mg/L	Cd mg/L	Co mg/L
Sequential Batch Leach Test- leaching time: 17-18hours											
batop1	BATCHO	0.049	0.18	7.08	0.606	<0.032	nd	nd	657	nd	0.113
batoa1	BATCHO	0.055	0.21	4.20	0.547	<0.032	nd	nd	643	nd	<0.097
batoa2	BATCHO	0.142	0.23	4.65	0.648	<0.032	nd	nd	690	nd	<0.097
batoa3	BATCHO	0.099	0.24	4.91	0.742	<0.032	nd	nd	730	nd	0.102
batob1	BATCHO	<0.034	0.49	3.78	0.513	<0.032	nd	nd	609	nd	<0.097
batob2	BATCHO	<0.034	0.20	3.84	0.666	<0.032	nd	nd	633	nd	<0.097
batob3	BATCHO	0.057	0.22	4.05	0.725	<0.032	nd	nd	657	nd	<0.097
batoc1	BATCHO	<0.034	0.17	1.34	0.165	<0.032	nd	nd	619	nd	<0.097
batoc2	BATCHO	<0.034	<0.16	1.70	0.316	<0.032	nd	nd	630	nd	<0.097
batoc3	BATCHO	<0.034	0.20	3.72	0.618	<0.032	nd	nd	628	nd	<0.097
batsp1	BATCHS	<0.034	0.19	2.57	0.516	<0.032	nd	nd	595	nd	<0.097
batsa1	BATCHS	0.158	0.18	1.88	0.414	<0.032	nd	nd	634	nd	<0.097
batsa2	BATCHS	0.148	0.19	2.03	0.496	<0.032	nd	nd	654	nd	<0.097
batsa3	BATCHS	0.205	0.20	2.23	0.579	<0.032	nd	nd	671	nd	<0.097
batsb1	BATCHS	<0.034	0.18	1.72	0.284	<0.032	nd	nd	640	nd	<0.097
batsb2	BATCHS	0.079	0.19	1.83	0.440	<0.032	nd	nd	655	nd	<0.097
batsb3	BATCHS	0.141	0.19	1.89	0.527	<0.032	nd	nd	647	nd	<0.097
batsc1	BATCHS	<0.034	<0.16	5.15	0.357	<0.032	nd	nd	244	nd	<0.097
batsc2	BATCHS	<0.034	0.22	3.99	0.587	<0.032	nd	nd	608	nd	<0.097
batsc3	BATCHS	<0.034	<0.16	1.15	0.400	<0.032	nd	nd	602	nd	<0.097
Dubatsb1	BATCHS	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Dubatoc3	BATCHO	<0.034	0.18	3.68	0.61	<0.032	nd	nd	633	nd	<0.097
Dubatop1	BATCHO	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TM-28.2	REFERENCE	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Dubatsc3	BATCHS	<0.034	<0.16	1.20	0.387	<0.032	nd	nd	600	nd	<0.097
Dubatsp1	BATCHS	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Dubatsa1	BATCHS	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Dubatsc2	BATCHS	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
SOLID RESIDUE		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
BATO-C1-R	BATCHO	55	64200	5030	25	986	1	45	7980	27	<2
BATO-C2-R	BATCHO	53	54500	5060	36	928	1	32	8300	27	<2
BATO-C3-R	BATCHO	54	71700	5240	123	1040	1	47	10500	28	<2
BATS-C1-R	BATCHS	47	59300	3530	37	873	1	25	9640	31	<2
BATS-C2-R	BATCHS	41	64900	3690	50	908	1	31	13700	33	<2
BATS-C3-R	BATCHS	41	68300	3700	30	931	1	37	13600	33	<2

nd=not determined

Table F-1a (cont.)

FIELD#	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
Sequential Batch Leach Test- leaching time: 17-18hours													
batop1	<0.094	0.081	0.511	38.9	<0.036	11.3	0.170	<0.23	325	<0.18	0.54	<0.85	1430
batoa1	<0.094	<0.023	0.513	23.6	<0.036	14.7	0.132	<0.23	98.9	<0.18	<0.46	<0.85	658
batoa2	<0.094	0.041	0.730	34.9	<0.036	11.1	0.093	<0.23	171	<0.18	0.53	<0.85	796
batoa3	<0.094	0.029	0.722	41.4	<0.036	10.7	0.126	<0.23	226	<0.18	0.68	<0.85	916
batob1	<0.094	0.090	0.631	24.0	<0.036	19.1	0.173	<0.23	31.1	<0.18	0.64	<0.85	563
batob2	<0.094	<0.023	0.543	27.7	<0.036	13.6	0.093	<0.23	65.0	<0.18	0.77	<0.85	616
batob3	<0.094	<0.023	0.618	31.6	<0.036	10.9	0.075	<0.23	103	<0.18	<0.46	<0.85	685
batoc1	<0.094	<0.023	2.91	8.36	<0.036	29.9	1.84	<0.23	13.3	<0.18	0.54	<0.85	536
batoc2	<0.094	<0.023	0.081	17.1	<0.036	34.3	1.51	<0.23	24.5	<0.18	0.54	<0.85	575
batoc3	<0.094	<0.023	0.463	20.9	<0.036	13.0	0.071	<0.23	37.5	<0.18	<0.46	<0.85	587
batsp1	<0.094	0.089	0.104	84.7	<0.036	38.4	1.21	<0.23	491	<0.18	0.73	<0.85	1290
batsa1	<0.094	0.127	<0.078	38.0	<0.036	34.3	1.14	<0.23	141	<0.18	<0.46	<0.85	746
batsa2	<0.094	0.224	0.101	57.0	<0.036	37.0	0.905	<0.23	238	<0.18	0.54	<0.85	911
batsa3	<0.094	0.114	0.102	65.6	<0.036	39.3	0.986	<0.23	319	<0.18	0.61	<0.85	1240
batsb1	<0.094	<0.023	0.082	18.6	<0.036	31.9	1.48	<0.23	37.8	<0.18	0.61	<0.85	610
batsb2	<0.094	0.043	0.080	35.2	<0.036	35.9	1.14	<0.23	81.4	<0.18	<0.46	<0.85	707
batsb3	<0.094	0.068	0.091	44.9	<0.036	38.3	1.01	<0.23	131	<0.18	0.57	<0.85	773
batsc1	<0.094	<0.023	0.200	6.89	<0.036	14.6	0.111	<0.23	13.1	<0.18	<0.46	<0.85	194
batsc2	<0.094	<0.023	0.379	15.4	<0.036	14.3	0.106	<0.23	23.6	<0.18	<0.46	<0.85	554
batsc3	<0.094	<0.023	0.095	27.4	<0.036	38.2	1.67	<0.23	46.1	<0.18	<0.46	<0.85	589
Dubatsb1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Dubatoc3	<0.094	<0.023	0.466	21.5	<0.036	12.9	0.072	<0.23	38.7	<0.18	<0.46	<0.85	589
Dubatop1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TM-28.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Dubatsc3	<0.094	<0.023	0.094	27.2	<0.036	38.2	1.68	<0.23	45.1	<0.18	0.49	<0.85	587
Dubatsp1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Dubatsa1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Dubatsc2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
RESIDUE	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
BATO-C1-R	31	273	67500	24200	4	2840	1670	6	1220	<4	745	4640	11500
BATO-C2-R	32	278	64500	21300	5	2550	1650	2	1350	9	714	4300	12000
BATO-C3-R	31	282	68500	26700	5	3030	1690	4	1340	6	773	4940	13700
BATS-C1-R	24	394	61100	21600	3	3250	2180	5	1270	4	685	2680	16100
BATS-C2-R	23	394	63300	23400	3	3440	2290	5	1240	11	720	3000	18300
BATS-C3-R	24	392	65100	24800	4	3570	2300	5	1190	5	751	3220	17700

nd= not determined

FIELD#	Sb mg/L	Se mg/L	Si mg/L	Sr mg/L	Te mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	Zr mg/L	As mg/L	Alkalinity mg/L	SO4 mg/L
Sequential Batch Leach Test- leaching time: 17-18hours													
batop1	<0.29	nd	7.47	1.44	nd	0.441	nd	<0.044	<0.044	nd	7470	nd	nd
batoa1	0.41	nd	5.39	1.21	nd	0.637	nd	<0.044	<0.044	nd	4220	nd	nd
batoa2	0.47	nd	5.47	1.42	nd	0.499	nd	<0.044	<0.044	nd	4840	nd	nd
batoa3	0.38	nd	5.87	1.55	nd	0.493	nd	<0.044	<0.044	nd	5260	nd	nd
batob1	0.54	nd	5.42	1.04	nd	0.467	nd	<0.044	0.082	nd	3980	nd	nd
batob2	0.50	nd	4.76	1.20	nd	0.260	nd	<0.044	<0.044	nd	4050	nd	nd
batob3	0.49	nd	4.70	1.31	nd	0.564	nd	<0.044	<0.044	nd	4110	nd	nd
batoc1	0.41	nd	8.31	1.04	nd	0.472	nd	<0.044	<0.044	nd	1410	nd	nd
batoc2	0.57	nd	6.97	1.24	nd	0.419	nd	<0.044	<0.044	nd	1640	nd	nd
batoc3	0.43	nd	3.55	1.10	nd	0.414	nd	<0.044	<0.044	nd	3810	nd	nd
batsp1	0.37	nd	5.27	1.48	nd	0.424	nd	<0.044	<0.044	nd	2690	119	2294
batsa1	0.56	nd	5.25	1.37	nd	0.464	nd	<0.044	<0.044	nd	2020	98	1898
batsa2	0.57	nd	4.85	1.56	nd	0.344	nd	<0.044	<0.044	nd	2180	87	2097
batsa3	0.58	nd	4.95	1.69	nd	0.659	nd	<0.044	<0.044	nd	2360	nd	nd
batsb1	0.44	nd	6.96	1.22	nd	0.402	nd	<0.044	<0.044	nd	1940	125	1747
batsb2	0.65	nd	5.57	1.46	nd	0.539	nd	<0.044	<0.044	nd	1930	92	1897
batsb3	0.56	nd	4.99	1.55	nd	0.433	nd	<0.044	<0.044	nd	1960	85	1990
batsc1	0.77	nd	6.73	0.485	nd	0.080	nd	<0.044	<0.044	nd	5390	161	1570
batsc2	0.62	nd	4.71	0.960	nd	0.319	nd	<0.044	<0.044	nd	4420	125	1685
batsc3	0.51	nd	5.12	1.35	nd	0.373	nd	<0.044	<0.044	nd	1370	102	1703
Dubatsb1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	125	nd
Dubatoc3	0.48	nd	3.48	1.10	nd	nd	nd	<0.044	<0.044	nd	nd	nd	nd
Dubatop1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	7340	nd	nd
TM-28.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	7.71	nd	nd
Dubatsc3	0.51	nd	5.13	1.34	nd	nd	nd	<0.044	<0.044	nd	nd	nd	1667
Dubatsp1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	2680	nd	nd
Dubatsa1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	1875
Dubatsc2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
RESIDUES	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
BATO-C1-R	1090	<72	251	132	9	1270	<22	<4	1720	31	nd	nd	nd
BATO-C2-R	1090	<72	249	128	20	1570	<22	<4	1470	32	nd	nd	nd
BATO-C3-R	1130	<72	590	135	13	1250	<22	<4	1580	33	nd	nd	nd
BATS-C1-R	596	<72	329	124	10	1510	<22	<4	1930	32	nd	nd	nd
BATS-C2-R	625	<72	190	133	15	1300	<22	<4	2000	34	nd	nd	nd
BATS-C3-R	649	<72	284	138	9	1200	<22	<4	2080	29	nd	nd	nd

nd=not determined

Table F-1a (cont.)

FIELD#	Total CN mg/L	CNS mg/L	CNO mg/L	WAD CN mg/L	NH3 mg/L	pH	Conductivity mS/cm
Sequential Batch Leach Test- leaching time: 17-18hours							
batop1	0.07	nd	nd	<0.05	nd	8.03	3.91
batoa1	1.1	nd	nd	<0.05	nd	8.60	2.88
batoa2	1.5	nd	nd	<0.05	nd	8.99	3.28
batoa3	1.5	nd	nd	<0.05	nd	8.81	3.46
batob1	nd	nd	nd	nd	nd	8.58	2.45
batob2	1.3	nd	nd	<0.05	nd	8.59	2.58
batob3	1.5	nd	nd	<0.05	nd	8.80	2.92
batoc1	0.4	nd	nd	<0.05	nd	8.40	1.21
batoc2	0.8	nd	nd	<0.05	nd	8.55	2.45
batoc3	1.1	nd	nd	<0.05	nd	8.49	2.73
batsp1	<.05	nd	nd	<0.05	nd	8.76	4.48
batsa1	<.05	nd	nd	nd	nd	8.35	3.22
batsa2	<.05	nd	nd	<0.05	nd	8.69	3.70
batsa3	<.05	nd	nd	<0.05	nd	8.62	3.91
batsb1	<.05	nd	nd	<0.05	nd	8.15	2.71
batsb2	<.05	nd	nd	<0.05	nd	8.32	2.94
batsb3	<.05	nd	nd	<0.05	nd	8.41	3.24
batsc1	<.05	nd	nd	<0.05	nd	7.95	2.55
batsc2	0.05	nd	nd	nd	nd	8.14	2.69
batsc3	1.0	nd	nd	<0.05	nd	8.03	2.82
Dubatsb1	nd	nd	nd	nd	nd	nd	nd
Dubatoc3	1.0	nd	nd	nd	nd	nd	nd
Dubatop1	nd	nd	nd	nd	nd	nd	nd
TM-28.2	nd	nd	nd	nd	nd	nd	nd
Dubatsc3	nd	nd	nd	nd	nd	nd	nd
Dubatsp1	nd	nd	nd	nd	nd	nd	nd
Dubatsa1	nd	nd	nd	nd	nd	nd	nd
Dubatsc2	<.05	nd	nd	nd	nd	nd	nd
RESIDUE	mg/kg						
BATO-C1-R	32.0	nd	nd	nd	nd	nd	nd
BATO-C2-R	31.2	nd	nd	nd	nd	nd	nd
BATO-C3-R	41.0	nd	nd	nd	nd	nd	nd
BATS-C1-R	61.1	nd	nd	nd	nd	nd	nd
BATS-C2-R	48.5	nd	nd	nd	nd	nd	nd
BATS-C3-R	48.4	nd	nd	nd	nd	nd	nd

nd=not determined

Table F-2: Miscellaneous leach test results

FIELD#	DESCRIPTION	Ag mg/L	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Bi mg/L	Ca mg/L	Cd mg/L	Co mg/L
Shake Flask Leach Test with NaOAc solution- AEC											
batoa1	BATCHO	<0.013	0.248	14.5	0.331	0.157	<0.0007	<0.12	194	0.252	<0.028
batoa2	BATCHO	<0.013	0.319	4.29	0.202	0.151	<0.0007	<0.12	13.7	0.065	<0.028
batsa1	BATCHS	<0.013	0.340	9.27	0.389	0.108	<0.0007	<0.12	273	0.324	<0.028
batsa2	BATCHS	<0.013	0.387	3.21	0.340	0.151	<0.0007	<0.12	17.5	0.080	<0.028
mn112a1	MN1102	<0.013	0.345	8.03	0.375	0.104	<0.0007	<0.12	288	0.381	<0.028
mn112a2	MN1102	<0.013	0.406	3.53	0.331	0.159	<0.0007	<0.12	19.6	0.112	<0.028
somixa1	SOMIX	<0.013	0.408	3.28	0.356	0.096	<0.0007	<0.12	192	0.208	<0.028
somixa2	SOMIX	<0.013	0.498	1.28	0.331	0.101	<0.0007	<0.12	14.8	0.072	<0.028
sla1	SLURRY	<0.013	0.431	3.47	0.360	0.102	<0.0007	<0.12	175	0.198	<0.028
sla2	SLURRY	<0.013	0.416	0.95	0.317	0.079	<0.0007	<0.12	9.80	0.059	<0.028
mn141a1	MN1401	<0.013	0.348	3.66	0.333	0.070	<0.0007	<0.12	281	0.213	<0.028
mn141a2	MN1401	<0.013	0.452	1.49	0.331	0.087	<0.0007	<0.12	14.6	0.086	<0.028
mnaac	NAOAC blank	<0.013	0.057	<0.55	0.330	0.002	<0.0007	<0.12	0.192	<0.043	<0.028
Dupl.-sla2	SLURRY	<0.013	0.425	0.82	0.328	0.080	<0.0007	<0.12	9.91	0.054	<0.028
Shake Flask Leach Test with NH2OH.HCl in HCl solution: oxide-bound											
batoo1	BATCHO	0.243	29.8	8.48	<0.14	2.80	0.0032	<0.50	35.0	0.178	<0.028
batoo2	BATCHO	0.033	4.88	2.17	<0.14	0.467	<0.0009	<0.50	2.08	<0.043	<0.028
batso1	BATCHO	0.221	29.3	9.27	<0.14	2.16	0.0042	<0.50	77.5	0.241	0.037
batso2	BATCHO	0.050	5.37	2.45	<0.14	0.393	<0.0009	<0.50	3.34	<0.043	<0.028
mn112o1	MN1102	0.206	28.0	10.8	<0.14	2.58	0.0051	<0.50	108	0.274	<0.028
mn112o2	MN1102	0.072	7.56	3.22	<0.14	0.376	<0.0009	<0.50	5.07	<0.043	<0.028
somixo1	SOMIX	0.092	9.75	2.27	<0.14	1.24	0.0024	<0.50	90.4	0.155	<0.028
somixo2	SOMIX	0.016	1.23	0.63	<0.14	0.282	<0.0009	<0.50	2.48	<0.043	<0.028
slo1	SLURRY	0.080	10.3	2.30	<0.14	1.22	0.0023	<0.50	98.2	0.158	<0.028
slo2	SLURRY	0.014	1.28	0.60	<0.14	0.259	<0.0009	<0.50	2.85	<0.043	<0.028
mn141o1	MN1401	0.157	12.1	3.56	<0.14	1.52	0.0025	<0.50	79.2	0.220	<0.028
mn141o2	MN1401	0.020	1.56	0.94	<0.14	0.343	<0.0009	<0.50	2.62	<0.043	<0.028
mnnh2oh	NH2OH blank	<0.013	0.058	<0.55	<0.14	0.002	<0.0009	<0.50	0.088	<0.043	<0.028
Dupl.-slo2	SLURRY	<0.013	1.29	0.71	<0.14	0.261	<0.0009	<0.50	2.80	<0.043	<0.028
Dupl.-batoo2	BATCHO	0.034	4.88	2.09	<0.14	0.468	<0.0009	<0.50	2.09	<0.043	<0.028
Leach Test with Ca(OH)2 solution											
batoca	BATCHO	<0.013	0.258	<0.55	<0.14	0.0397	<0.0009	<0.50	620	<0.043	<0.028
batsca	BATCHS	<0.013	0.359	<0.55	<0.14	0.0615	<0.0009	<0.50	900	<0.043	<0.028
somixca	SOMIX	<0.013	0.396	<0.55	<0.14	0.0851	<0.0009	<0.50	934	<0.043	<0.028
soslca	SLURRY	<0.013	0.371	<0.55	<0.14	0.0795	<0.0009	<0.50	883	<0.043	<0.028
1102ca	MN1102	<0.013	0.428	<0.55	<0.14	0.0666	<0.0009	<0.50	981	<0.043	<0.028
1401ca	MN1401	<0.013	0.406	<0.55	<0.14	0.0605	<0.0009	<0.50	943	<0.043	<0.028
mncabk	CA(OH)2 blank	<0.013	0.540	<0.55	<0.14	0.0188	<0.0009	<0.50	825	<0.043	<0.028
Dupl.-mncabk	CA(OH)2 blank	<0.013	0.541	<0.55	<0.14	0.0187	<0.0009	<0.50	820	<0.043	<0.028
Leach Test with Distilled Water											
batodw	BATCHO	<0.0065	0.32	3.22	0.337	0.0093	<0.0007	<0.12	413	<0.035	<0.051
batsdw	BATCHS	0.0309	0.31	1.18	0.230	0.0086	<0.0007	<0.12	643	<0.035	<0.051
mn1102dw	MN1102	0.0236	0.31	<0.49	0.156	0.0077	<0.0007	<0.12	689	<0.035	<0.051
mn1401dw	MN1401	<0.0065	0.26	<0.49	<0.096	0.0100	<0.0007	<0.12	610	<0.035	<0.051
somixdw	SOMIX	<0.0065	0.28	<0.49	0.136	0.0117	<0.0007	<0.12	611	<0.035	<0.051
sldw	SLURRY	<0.0065	0.28	<0.49	0.135	0.0099	<0.0007	<0.12	610	<0.035	<0.051

nd= not determined

Table F2 (cont.)

FIELD#	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
Shake Flask Leach Test with NaOAc solution- AEC													
batoa1	<0.019	0.363	<0.037	48.1	<0.055	5.00	8.34	<0.078	14400	<0.12	25.1	4.57	72.7
batoa2	<0.019	0.176	0.152	46.6	<0.055	1.72	3.60	<0.078	14600	<0.12	35.3	2.24	0.78
batsa1	<0.019	1.11	0.057	48.6	<0.055	8.32	13.5	<0.078	14820	<0.12	24.6	2.32	152
batsa2	<0.019	0.475	<0.032	46.8	<0.055	2.58	5.26	<0.078	15410	<0.12	35.1	0.96	1.40
mn112a1	<0.019	1.01	0.038	52.3	<0.055	10.4	15.4	<0.078	15170	<0.12	26.2	4.65	191
mn112a2	<0.019	0.441	<0.032	47.3	<0.055	3.87	6.49	<0.078	14650	<0.12	34.6	1.57	1.80
somixa1	<0.019	0.740	<0.032	49.6	<0.055	4.66	8.60	<0.078	15160	<0.12	32.5	2.20	119
somixa2	<0.019	0.312	<0.032	47.0	<0.055	3.16	5.06	<0.078	14500	<0.12	35.4	0.73	0.93
sla1	<0.019	0.652	<0.032	48.9	<0.055	5.09	9.73	<0.078	13470	<0.12	31.2	1.73	115
sla2	<0.019	0.181	0.066	46.0	<0.055	1.74	3.18	<0.078	15410	<0.12	36.8	0.62	0.72
mn141a1	<0.019	0.790	0.067	49.4	<0.055	6.79	6.90	<0.078	15380	<0.12	30.6	2.92	195
mn141a2	<0.019	0.361	0.061	46.9	<0.055	2.43	4.24	<0.078	14260	<0.12	35.6	1.10	1.12
mnaac	<0.019	<0.018	<0.037	67.8	<0.055	0.122	<0.006	<0.078	20690	<0.12	57.6	<0.52	<0.52
Dupl.-sla2	<0.019	0.191	0.100	46.7	<0.055	1.76	3.22	<0.078	14310	<0.12	37.1	0.70	0.70
Shake Flask Leach Test with NH2OH.HCl in HCl solution- oxide-bound													
batoo1	0.310	1.17	177	6.47	<0.18	12.2	24.4	<0.097	191	<0.17	15.1	25.4	5.04
batoo2	0.069	0.181	20.1	1.75	<0.18	0.62	0.857	<0.097	4.47	<0.17	2.27	5.41	1.55
batso1	0.247	1.44	195	5.75	<0.18	28.7	36.5	<0.097	167	<0.17	14.4	13.7	3.93
batso2	0.079	0.288	22.5	1.67	<0.18	1.29	1.23	<0.097	3.32	<0.17	2.83	4.20	1.24
mn112o1	0.138	1.55	205	5.54	<0.18	42.0	40.1	<0.097	153	<0.17	15.9	15.8	2.92
mn112o2	0.062	0.540	30.1	1.68	<0.18	2.31	1.62	<0.097	3.30	<0.17	3.45	6.03	1.04
somixo1	0.216	0.914	92.0	2.37	<0.18	31.8	32.1	<0.097	68.0	<0.17	8.06	6.59	2.41
somixo2	0.101	0.142	8.17	0.79	<0.18	0.784	0.610	<0.097	1.36	<0.17	<1.62	1.14	0.61
slo1	0.210	1.05	94.9	3.02	<0.18	32.8	33.6	<0.097	55.6	<0.17	7.08	6.71	2.55
slo2	0.083	0.178	9.12	0.77	<0.18	0.971	0.780	<0.097	1.39	<0.17	<1.62	1.17	0.83
mn141o1	0.309	1.55	117	3.25	<0.18	26.0	35.2	<0.097	64.1	<0.17	6.99	13.1	3.21
mn141o2	0.089	0.147	12.0	0.98	<0.18	0.808	0.861	<0.097	1.52	<0.17	<1.62	1.79	0.85
mnnh2oh	<0.019	0.025	0.075	<0.40	<0.18	0.008	<0.006	<0.097	0.794	<0.17	<1.62	<0.52	<0.52
Dupl.-slo2	0.085	0.177	9.16	0.77	<0.18	0.979	0.783	<0.097	1.40	<0.17	<1.62	1.08	0.70
Dupl.-batoo2	0.069	0.174	20.0	1.86	<0.18	0.617	0.856	<0.097	4.47	<0.17	2.45	5.36	1.52
Leach Test with Ca(OH)2 solution													
batoca	0.030	<0.018	1.08	10.0	<0.18	0.008	<0.006	<0.097	22.2	<0.17	<1.62	<0.52	216
batsca	0.031	<0.018	1.99	14.0	<0.18	0.011	<0.006	<0.097	28.0	<0.17	<1.62	<0.52	552
somixca	0.032	<0.018	0.752	10.9	<0.18	0.011	<0.006	<0.097	20.7	<0.17	<1.62	0.69	438
soslca	0.031	<0.018	0.595	9.61	<0.18	0.013	<0.006	<0.097	12.8	<0.17	<1.62	0.57	426
1102ca	0.032	0.021	2.05	18.7	<0.18	0.012	<0.006	<0.097	42.2	<0.17	<1.62	1.00	814
1401ca	<0.019	<0.018	0.868	13.3	<0.18	0.010	<0.006	<0.097	41.8	<0.17	<1.62	1.04	439
mncabk	0.032	<0.018	<0.037	0.634	<0.18	0.007	<0.006	<0.097	0.383	<0.17	<1.62	<0.52	5.67
Dupl.-mncabk	0.039	<0.018	<0.037	0.474	<0.18	0.006	<0.006	<0.097	0.384	<0.17	<1.62	<0.52	5.63
Leach Test with Distilled Water													
batodw	<0.036	<0.027	0.253	11.1	<0.055	3.27	0.039	<0.078	23.7	<0.12	<0.12	<0.45	364
batsdw	<0.036	<0.027	0.047	14.2	<0.055	12.5	1.10	<0.078	31.9	<0.12	<0.12	<0.45	592
mn1102dw	<0.036	<0.027	0.036	17.8	<0.055	16.0	1.14	<0.078	45.8	<0.12	<0.12	<0.45	682
mn1401dw	<0.036	<0.027	0.136	14.2	<0.055	21.8	1.18	<0.078	49.5	<0.12	<0.12	<0.45	577
somixdw	<0.036	<0.027	<0.032	11.2	<0.055	11.0	2.41	<0.078	24.8	<0.12	<0.12	<0.45	547
sldw	<0.036	<0.027	<0.032	8.85	<0.055	9.10	1.75	<0.078	15.6	<0.12	<0.12	<0.45	535

nd= not determined

Table F-2 (cont.)

FIELD#	Sb mg/L	Se mg/L	Si mg/L	Sr mg/L	Te mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	Zr mg/L	As mg/L	Alkalinity mg/L	SO4 mg/L
Shake Flask Leach Test with NaOAc solution- AEC													
batoa1	0.57	<0.93	11.4	0.342	nd	<0.013	nd	<0.011	3.62	<0.011	nd	nd	nd
batoa2	<0.32	<0.93	3.49	0.044	nd	<0.013	nd	<0.011	2.08	<0.011	nd	nd	nd
batsa1	0.33	<0.66	7.54	0.396	<0.32	<0.013	<0.29	<0.011	5.34	nd	nd	nd	nd
batsa2	<0.32	<0.66	2.30	0.050	<0.32	<0.013	<0.29	<0.011	2.70	nd	nd	nd	nd
mn112a1	<0.32	<0.66	4.90	0.440	<0.32	<0.013	<0.29	<0.011	6.26	nd	nd	nd	nd
mn112a2	<0.32	<0.66	2.05	0.059	<0.32	<0.013	<0.29	<0.011	3.48	nd	nd	nd	nd
somixa1	<0.32	<0.66	3.81	0.267	<0.32	<0.013	<0.29	<0.011	4.19	nd	nd	nd	nd
somixa2	<0.32	<0.66	1.99	0.044	<0.32	<0.013	<0.29	<0.011	2.57	nd	nd	nd	nd
sla1	<0.32	<0.66	4.62	0.273	<0.32	<0.013	<0.29	<0.011	4.42	nd	nd	nd	nd
sla2	<0.32	<0.66	1.24	0.030	<0.32	<0.013	<0.29	<0.011	1.74	nd	nd	nd	nd
mn141a1	0.34	<0.66	4.84	0.387	<0.32	<0.013	<0.29	<0.011	5.27	nd	nd	nd	nd
mn141a2	<0.32	<0.66	2.33	0.047	<0.32	<0.013	<0.29	<0.011	2.79	nd	nd	nd	nd
mnaac	<0.32	<0.93	<0.31	0.005	nd	<0.013	nd	<0.011	0.045	<0.011	nd	nd	nd
Dupl.-sla2	<0.32	<0.66	1.26	0.030	<0.32	<0.013	<0.29	<0.011	1.75	nd	nd	nd	nd
Shake Flask Leach Test with NH2OH.HCl in HCl solution- oxide-bound													
batoo1	<0.32	<0.93	25.8	0.224	nd	<0.038	nd	0.078	14.0	<0.011	nd	nd	nd
batoo2	<0.32	<0.93	2.16	0.037	nd	<0.038	nd	<0.032	1.18	<0.011	nd	nd	nd
batso1	<0.32	<0.93	21.5	0.312	nd	<0.038	nd	0.093	20.4	<0.011	nd	nd	nd
batso2	<0.32	<0.93	2.04	0.050	nd	<0.038	nd	<0.032	1.64	<0.011	nd	nd	nd
mn112o1	<0.32	<0.93	20.4	0.339	nd	<0.038	nd	0.121	23.5	<0.011	nd	nd	nd
mn112o2	<0.32	<0.93	2.79	0.065	nd	<0.038	nd	<0.032	2.28	<0.011	nd	nd	nd
somixo1	<0.32	<0.93	8.58	0.271	nd	<0.038	nd	0.062	12.41	<0.011	nd	nd	nd
somixo2	<0.32	<0.93	0.88	0.021	nd	<0.038	nd	<0.032	0.543	<0.011	nd	nd	nd
slo1	<0.32	<0.93	9.26	0.291	nd	<0.038	nd	0.084	13.4	<0.011	nd	nd	nd
slo2	<0.32	<0.93	1.02	0.025	nd	<0.038	nd	<0.032	0.666	<0.011	nd	nd	nd
mn141o1	<0.32	<0.93	12.7	0.278	nd	<0.038	nd	0.079	17.3	<0.011	nd	nd	nd
mn141o2	<0.32	<0.93	1.29	0.024	nd	<0.038	nd	<0.032	0.871	<0.011	nd	nd	nd
mnnh2oh	<0.32	<0.93	<0.31	0.001	nd	<0.038	nd	<0.032	0.057	<0.011	nd	nd	nd
Dupl.-slo2	<0.32	<0.93	1.03	0.025	nd	<0.038	nd	<0.032	0.671	<0.011	nd	nd	nd
Dupl.-batoo2	<0.32	<0.93	2.17	0.038	nd	<0.038	nd	<0.032	1.18	<0.011	nd	nd	nd
Leach Test with Ca(OH)2 solution													
batoca	<0.32	<0.93	0.40	1.20	nd	<0.038	nd	<0.032	0.027	<0.011	nd	nd	nd
batsca	<0.32	<0.93	<0.31	1.60	nd	<0.038	nd	<0.032	0.137	<0.011	nd	nd	nd
somixca	<0.32	<0.93	<0.31	1.35	nd	<0.038	nd	<0.032	0.062	<0.011	nd	nd	nd
soslca	<0.32	<0.93	<0.31	1.31	nd	<0.038	nd	<0.032	0.204	<0.011	nd	nd	nd
1102ca	<0.32	<0.93	0.37	1.76	nd	<0.038	nd	<0.032	0.132	<0.011	nd	nd	nd
1401ca	<0.32	<0.93	<0.31	1.38	nd	<0.038	nd	<0.032	0.067	<0.011	nd	nd	nd
mncabk	<0.32	<0.93	<0.31	0.952	nd	<0.038	nd	<0.032	<0.010	<0.011	nd	nd	nd
Dupl.-mncabk	<0.32	<0.93	<0.31	0.949	nd	<0.038	nd	<0.032	<0.010	<0.011	nd	nd	nd
Leach Test with Distilled Water													
batodw	0.36	<0.66	3.47	0.554	<0.32	<0.013	<0.29	<0.011	<0.075	nd	nd	nd	975
batsdw	0.45	<0.66	4.02	0.855	<0.32	<0.013	<0.29	<0.011	<0.075	nd	nd	nd	1610
mn1102dw	0.57	<0.66	2.41	0.978	<0.32	<0.013	<0.29	<0.011	<0.075	nd	nd	nd	1709
mn1401dw	0.69	<0.66	7.52	0.920	<0.32	<0.013	<0.29	<0.011	<0.075	nd	nd	nd	1624
somixdw	0.57	<0.66	5.06	0.784	<0.32	<0.013	<0.29	<0.011	<0.075	nd	nd	nd	1512
sldw	0.62	<0.66	5.15	0.716	<0.32	<0.013	<0.29	<0.011	<0.075	nd	nd	nd	1496

nd= not determined

Table F-2 (cont.)

FIELD#	Total CN mg/L	CNS mg/L	CNO mg/L	WAD CN mg/L	NH3 mg/L	pH	Conductivity mS/cm
Shake Flask Leach Test with NaOAc solution- AEC							
batoa1	<.05	nd	nd	<0.05	nd	nd	nd
batoa2	nd	nd	nd	nd	nd	nd	nd
batsa1	<.05	nd	nd	<0.05	nd	nd	nd
batsa2	nd	nd	nd	nd	nd	nd	nd
mn112a1	<.05	nd	nd	<0.05	nd	nd	nd
mn112a2	nd	nd	nd	nd	nd	nd	nd
somixa1	<.05	nd	nd	<0.05	nd	nd	nd
somixa2	nd	nd	nd	nd	nd	nd	nd
sla1	<.05	nd	nd	<0.05	nd	nd	nd
sla2	nd	nd	nd	nd	nd	nd	nd
mn141a1	<.05	nd	nd	<0.05	nd	nd	nd
mn141a2	nd	nd	nd	nd	nd	nd	nd
mnaac	nd	nd	nd	nd	nd	nd	nd
Dupl.-sla2	nd	nd	nd	nd	nd	nd	nd
Shake Flask Leach Test with NH2OH.HCl in HCl solution- oxide-bound							
batoo1	<.05	nd	nd	<0.05	nd	nd	nd
batoo2	nd	nd	nd	nd	nd	nd	nd
batso1	<.05	nd	nd	<0.05	nd	nd	nd
batso2	nd	nd	nd	nd	nd	nd	nd
mn112o1	<.05	nd	nd	<0.05	nd	nd	nd
mn112o2	nd	nd	nd	nd	nd	nd	nd
somixo1	<.05	nd	nd	<0.05	nd	nd	nd
somixo2	nd	nd	nd	nd	nd	nd	nd
slo1	<.05	nd	nd	<0.05	nd	nd	nd
slo2	nd	nd	nd	nd	nd	nd	nd
mn141o1	<.05	nd	nd	<0.05	nd	nd	nd
mn141o2	nd	nd	nd	nd	nd	nd	nd
mnnh2oh	nd	nd	nd	nd	nd	nd	nd
Dupl.-slo2	nd	nd	nd	nd	nd	nd	nd
Dupl.-batoo2	nd	nd	nd	nd	nd	nd	nd
Leach Test with Ca(OH)2 solution							
batoca	2.3	7	<1	<0.05	nd	12.27	6.61
batsca	4.7	6	<1	<0.05	nd	12.22	7.55
somixca	2.1	<1	<1	0.06	nd	12.24	8.26
soslca	1.5	<1	<1	<0.05	nd	12.17	8.00
1102ca	4.2	12	<1	<0.05	nd	12.14	7.67
1401ca	2.5	<1	1	0.06	nd	12.18	8.13
mncabk	nd	nd	nd	nd	nd	nd	nd
Dupl.-mncabk	nd	nd	nd	nd	nd	nd	nd
Leach Test with Distilled Water							
batodw	0.60	5	1	<0.05	2	8.58	1.72
batsdw	0.09	<1	<1	<0.05	7	8.02	2.47
mn1102dw	0.05	11	1	<0.05	10	7.99	2.70
mn1401dw	<.05	<1	<1	<0.05	5	7.62	2.44
somixdw	<.05	<1	<1	<0.05	5	7.79	2.34
sldw	<.05	<1	<1	<0.05	4	7.70	2.33

nd= not determined

APPENDIX G

Freeze-Thaw Testing Report

INTRODUCTION

Freeze-thaw and soil freezing mechanisms have been extensively studied for sludge and soil liquid-solid segregation (Vesilind and Martel, 1990; Martel, 1989; Carry, 1987 and Chamberlain, 1989). To understand the freeze-thaw mechanism, water in soil could be classified in various types: 1) free water, 2) interstitial water, 3) surface water, and 4) bound water. Free water is the water in tailings surrounding the particles. Interstitial water is trapped in the tailings and can be removed by mechanical action converting it into free water. The thin film of water adjacent to the particle is called surface water and bound water is the water chemically bound to the particle.

The freeze-thaw process could have an impact on grain size distribution. When a sample freezes, water incorporated in the sample will freeze and consequently, the volume increase generated by the ice expansion may break some particles. If the particle becomes smaller after several freeze-thaw cycles, the specific surface area of the particle may increase. As a major impact, metal leachability as well as cyanide leaching may increase. In the literature, the opposite effect has also been reported by Logson and Edgerly (1971). Experiments conducted by Ahukrichs and White (1962) and Anderson and Hoekstra (1965) using X-Ray diffraction measurements have shown that freezing removed interlayer water from between saturated clay crystal, causing collapse of the crystal lattice. Thus removal of water from a fine-grained soil such as clay, can cause the clay to consolidate. Thus, freeze-thaw could increase or decrease the specific surface area and particle size, which in turn affects the metal and cyanide mobility.

The objective of the freeze-thaw task was to study the effect of the freeze-thaw process on the grain size distribution, metal leaching and the impact on cyanide speciation. In order to accomplish this work, five samples from the Mount Nansen site were studied:

- Clayey oxide tailings (BatchO)
- Clayey sulfide tailings (BatchS)
- Silty oxide tails (MN1401)
- Silty sulfide tails (MN1102)
- Sulfide-oxide composite (Somix)

EXPERIMENTAL

The test samples were initially analyzed for particle size distribution, leaching characteristics and chemical composition. Freeze-thaw study was then conducted in duplicate. Three freeze-thaw cycles were applied to the samples. Afterward, the particle size distribution, leaching characteristics and chemical composition were determined.

Sample Preparation

- The samples were centrifuged at 10,000 rpm for half an hour.
- The supernatant water was frozen and kept for further analysis (if required).
- The samples were homogenized.

Leaching Procedure

A solid/liquid ratio of 5:1 was used for the leaching study. An amount of 40 g of moist centrifuged tails were mixed with 200 mL of distilled water in a 500 mL Erlenmeyer flask. The samples were agitated for 24 hours at 150 rpm.

Chemical Analysis

The leachates were analyzed for Al, As, Ba, Cd, Cr, Cu, Fe, Ni, Pb, Se, Si, Zn, SO_4^{2-}, cyanide (WAD and Total), CNS^- and ammonia. Before the freeze thaw study, the 5 samples were subjected to the leaching test in duplicate for a total of 10 samples. After the freeze-thaw study, all the samples were again subjected to the leaching tests.

Freeze-thaw Study

For the freeze-thaw study, a fully temperature programmable freezer was used. The temperature range was from 20° to -20°C. An amount of 50 g of centrifuged samples was placed in a 1-L Nalgen bottle (open mouth). Experiments were conducted on 5 different tailings in duplicate for a total of 10 samples. Table G1 displays the settings of the freezer for the freeze-thaw experiments. Three freeze-thaw cycles were applied.

Table G1. Freezer parameters for the freeze-thaw conditions

Steps	Initial temperature °C	Final Temperature °C	Rate °C/hour
First	20	-20	2
Second	-20	20	2

Particle Size Determination

Particle size determination was completed on all the samples using a laser scattering particle size analyser (Horiba LA-300). The particle size range for the analyser was 0.10 to 600 μm. The samples were homogenized and split using a spinning riffler. The measurements were carried out in a diluted state using water as the dispersing fluid. The samples were run in duplicate using a run time of two minutes.

RESULTS

Metal Leachability

The samples collected from the Mount Nansen site were subjected to the leaching test. As mentioned in the experimental section, deionized water was used with a liquid/solids ratio of 5:1. Table G2 presents metal, cyanide, ammonia, thiocyanate concentrations as well as the final pH and Eh in the leachate before the freeze-thaw study. Particle size distribution plots before the freeze-thaw study are appended (Appendix G-A).

SOMIX

The sample Somix consisted of a mixture of silty oxide and sulfide tailings. After the leaching tests, the final pH was around 8.1 and the redox potential was 370 mV. Arsenic was leached from both samples with a concentration typically between 0.24 mg/L and 0.44 mg/L. Major cations such as calcium, magnesium and sodium were leached with values of 450 mg/L, 7.2 mg/L and 16 mg/L respectively. Initially, the Somix sample contained 24.5 μg/g of cyanide. However, no Total or WAD cyanide were detected in the leachate. A relatively small amount of ammonia (4 mg/L) was measured in the leachate; cyanate and thiocyanate results were lower than the limit of quantification (1.0 mg/L) of the analytical method used.

The particle size distribution of the Somix sample before the freeze-thaw study displayed a trimodal distribution. A major peak was centered at 100 μm and two other minor peaks were observed at 0.30 μm and 8.8 μm.

Table G-2. Leachate chemistry before freeze-thaw

Samples	Al mg/L	As mg/L	Ba mg/L	Ca mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Mg mg/L	Mn mg/L	Na mg/L	Ni mg/L
Somix	< 0.33	0.442	< 0.047	449	< 0.11	< 0.043	< 0.025	0.007	7.24	1.05	16.23	< 0.44
Somix-Dup	< 0.33	0.243	< 0.047	455	< 0.11	< 0.043	< 0.025	0.007	7.25	1.25	14.96	< 0.44
MN1102	< 0.33	0.702	< 0.047	641	< 0.11	< 0.043	< 0.025	0.0519	15.7	0.778	45.65	< 0.44
MN1102-Dup	< 0.33	0.766	< 0.047	618	< 0.11	< 0.043	< 0.025	0.0641	15.41	0.923	42.26	< 0.44
BatchO	0.16	3.32	< 0.03	358.3	< 0.096	< 0.097	< 0.018	0.424	2.84	0.0314	26.29	< 0.24
BatchO-Dup	0.14	3.08	< 0.03	358	< 0.096	< 0.097	< 0.018	0.463	2.71	0.021	26.49	< 0.24
BatchS	0.14	1.53	< 0.03	581.5	< 0.096	< 0.097	< 0.018	0.017	11.05	0.852	34.4	< 0.24
BatchS-Dup	0.14	1.38	< 0.03	584.9	< 0.096	< 0.097	< 0.018	0.014	11.18	0.793	34.8	< 0.24
MN1401	0.15	0.522	< 0.03	522.3	< 0.096	< 0.097	< 0.018	0.002	24.22	1.11	53.25	< 0.24
MN1401-Dup	0.16	0.349	< 0.03	521.2	< 0.096	< 0.097	< 0.018	0.008	23.53	1.24	52.31	< 0.24

Samples	Pb mg/L	Se mg/L	Si mg/L	Zn mg/L	SO_4 mg/L	NH3 mg/L	Total CN mg/L	WAD mg/L	CNO mg/L	CNS mg/L	Final pH	Final Eh mV
Somix	< 0.5	< 0.68	4.18	< 0.062	1185	4	< 0.05	< 0.05	< 1.0	< 1	8.19	370
Somix-Dup	< 0.5	< 0.68	4.29	< 0.062	1117	4	< 0.05	< 0.05	1.0	< 1	8.05	369
MN1102	< 0.5	< 0.68	2.37	< 0.062	1698	11	< 0.05	< 0.05	18.0	12	8.64	377
MN1102-Dup	< 0.5	< 0.68	2.39	< 0.062	1595	10	< 0.05	< 0.05	< 1.0	11	8.54	384
BatchO	< 1.21	< 0.78	3.27	< 0.046	902	3	1.00	< 0.05	< 1.0	8	9.12	412
BatchO-Dup	< 1.21	< 0.78	3.3	< 0.046	904	3	1.00	< 0.05	< 1.0	8	9.29	317
BatchS	< 1.21	< 0.78	3.69	< 0.046	1600	7	< 0.05	< 0.05	< 1.0	7	8.14	319
BatchS-Dup	< 1.21	< 0.78	3.6	< 0.046	1624	7	< 0.05	< 0.05	< 1.0	8	8.25	315
MN1401	< 1.21	< 0.78	6.86	0.147	1583	5	< 0.05	< 0.05	< 1.0	< 1	7.65	462
MN1401-Dup	< 1.21	< 0.78	5.71	0.083	1562	5	< 0.05	< 0.05	< 1.0	< 1	7.54	441

MN1102

After the leaching test, the silty sulfide tails (MN1102) had a final pH around of 8.6 and the Eh was around 380 mV. Similar to the Somix sample, arsenic, calcium magnesium and sodium were leached. Values of 0.70 mg/L and 0.77 mg/L As were analysed in the leachate. Thiocyanate measured in the leachate had a value of 12 mg/L, cyanate and cyanide were also below the limit of quantification.

The particle size distribution of the MN1102 sample revealed a fine-grained material with a bimodal distribution. A strong peak was centered at 10.1 μm and a smaller peak was centered at 0.44 μm. The particle size was small with a D_{60} value of 5.0 μm, this value refers to the percentage of particle finer than 5.0 μm in diameter. The largest particle size was 34.3 μm and the mean diameter value was 5.32 μm.

BatchO

The clayey oxide sample (BatchO) released higher amounts of arsenic and iron compared to other samples subjected to the leaching test. Over 3.0 mg/L of As were leached from the sample. Total cyanide analysis revealed 1.0 mg/L of total cyanide was leached for both samples and the weak acid dissociable cyanide was below the limit of quantification. Thiocyanate and ammonia were typically 8 mg/L and 3 mg/L, respectively. Compared to all the samples used in this study, the clayed oxide samples were the only samples to have a final pH higher than 9.0.

The particle size distribution of the clayey oxide tails showed a bimodal distribution with two peaks centered at 0.51 μm and 11.5 μm. The BatchO sample consisted of a fine material with D_{60} value of 5.58 μm and a mean of 6.83 μm.

BatchS

Arsenic was leached from the clayey sulfide tails (BatchS) with a value of 1.5 mg/L. The end pH and final Eh were respectively 8.1 and 319 mV. Total cyanide, WAD and cyanate concentrations were below the limit of quantification. Thiocyanate was measured at a level similar to the clayey oxide tailings with a value of 7 mg/L.

Similar to the clayey oxide tails, the clayey sulfide tails showed a bimodal distribution with two strong peaks centered at 0.51 μm and 7.69 μm. The mean particle diameter was 6.21 mm and the highest particle size diameter was 67.5 μm. Compared to the BatchO sample, the BatchS sample had a smaller overall particle size.

MN1401

The silty oxide tails (MN1401) had the lowest final pH and the highest redox potential during the freeze-thaw study. However, metal mobility was similar to the other samples with the exception that more zinc was leached from this sample with a value of 0.15 mg/L. Arsenic was typically measured at a level of 0.50 mg/L and major metals in the order of mg/L. Ammonia values were half the value reported for the silty sulfide tails (MN1102) with a value of 5 mg/L. Total-CN, WAD-CN, cyanate and thiocynate were below the limits of quantification.

The MN1401 sample displayed a trimodal distribution with peaks centered at 0.44 μm, 10.1 μm and 67.5 μm. The D_{60}, mean diameter and highest particle size were respectively 21.7 μm, 29.1 μm and 200 μm.

Freeze Thaw Study

The centrifuged samples were placed in individual Nalgen bottles for the freeze-thaw study. The samples were subjected to temperatures dropping from 20°C to -20°C at a rate of 2°C/hour. Then, the samples were warmed up at the same rate to 20°C. The complete cycle took approximately two days and the samples were subjected to a total of three cycles. Afterwards, leaching tests were conducted on the samples with a liquid/solids ratio of 5:1. Table G3 presents metal, cyanide, ammonia, thiocyanate concentrations as well as the final pH and Eh in the leachate after the freeze-thaw study. Particle size distribution plots after the freeze-thaw study are presented in Appendix G-B.

Table G-3. Leachate chemistry after freeze-thaw

Samples	Al mg/L	As mg/L	Ba mg/L	Ca mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Mg mg/L	Mn mg/L	Na mg/L	Ni mg/L
Somix	0.0704	0.184	0.0101	500	< 0.10	<0.015	<0.022	0.106	9.51	1.54	16.5	<0.17
Somix-Dup	< 0.07	0.186	0.0102	476.2	< 0.10	<0.015	<0.022	<0.065	8.8	1.42	16.47	<0.17
MN1102	< 0.07	0.425	0.0135	568.1	< 0.10	<0.015	0.0231	<0.065	20.31	2.76	46.64	<0.17
MN1102-Dup	< 0.07	0.575	0.0124	574.6	< 0.10	<0.015	0.0355	<0.065	19.51	2.43	46.87	<0.17
BatchO	< 0.07	3.33	0.0105	382.5	< 0.10	<0.015	<0.022	0.275	3.7	0.0515	27.54	<0.17
BatchO-Dup	< 0.07	3.29	0.0095	387.5	<0.10	<0.015	<0.022	0.276	4.03	0.0528	27.96	<0.17
BatchS	< 0.07	1.19	0.0091	540.4	<0.10	<0.015	<0.022	<0.065	12.68	0.872	35	<0.17
BatchS-Dup	0.10	1.21	0.0102	538.9	<0.10	<0.015	<0.022	0.146	12.64	0.974	35.61	<0.17
MN1401	< 0.07	0.369	0.011	513.5	<0.10	<0.015	<0.022	<0.065	26.38	1.06	55.41	<0.17
MN1401-Dup	< 0.07	0.313	0.0112	514.4	<0.10	<0.015	<0.022	<0.065	26.37	0.981	55.48	<0.17

Samples	Pb mg/L	Se mg/L	Si mg/L	Zn mg/L	SO_4 mg/L	NH3 mg/L	Total CN mg/L	WAD mg/L	CNO mg/L	CNS mg/L	Final pH	Final Eh mV
Somix	<1.47	<6.50	4.83	<0.026	1455	5	< 0.05	< 0.05	< 1.0	< 1.0	7.79	337
Somix-Dup	<1.47	<6.50	4.69	0.0414	1220	4	< 0.05	< 0.05	2.0	< 1.0	7.76	353
MN1102	<1.47	<6.50	3.24	<0.026	1640	10	< 0.05	< 0.05	2.0	13	7.7	378
MN1102-Dup	<1.47	<6.50	3.11	<0.026	1715	10	< 0.05	< 0.05	3	13	7.89	384
BatchO	<1.47	<6.50	3.61	<0.026	1030	3	0.37	< 0.05	1	9	8.67	341
BatchO-Dup	<1.47	<6.50	3.08	<0.026	1032	3	0.44	< 0.05	2	9	8.63	293
BatchS	<1.47	<6.50	4.44	<0.026	1588	6	0.12	< 0.05	< 1.0	7	8.03	346
BatchS-Dup	<1.47	<6.50	4.48	0.0386	1582	7	< 0.05	< 0.05	1	7	7.94	369
MN1401	<1.47	<6.50	6.97	0.0313	1483	5	< 0.05	< 0.05	1	< 1.0	7.71	345
MN1401-Dup	<1.47	<6.50	7.08	0.0339	1595	5	< 0.05	< 0.05	2	< 1.0	7.63	355

Somix

No major difference was observed in terms of metal release. Arsenic concentrations decreased to below 0.20 mg/L and a slight increase was observed for calcium, magnesium and sodium. The final pH was lower with a value of 7.8 and the redox potential was slightly lower compared to the results before freeze-thaw. No significant changes were measured for ammonia, cyanate and thiocyanate.

After freeze-thaw, the particle size analysis showed again a trimodal distribution with peaks centered at 0.44 μm, 7.70 μm and 174 μm. The D_{60} value was 94.74 μm and the mean diameter value was 93.66 μm. Overall, the particle distribution size decreased, but did not have a major effect on the metal and cyanide mobility.

MN1102

Similar to the Somix sample, freeze-thaw did not influence significantly metal mobility for the silty sulfide tails. Slight decrease of arsenic and calcium concentration was measured. Concentrations of ammonia, cyanide, cyanate and thiocyanate stayed at the same level as before the freeze-thaw step. After the freeze-thaw study, the pH decreased from 8.6 to 7.7.

The particle size distribution displayed a bimodal distribution with a mean value of 6.64 μm and D_{60} value of 5.26 μm. The particle size distribution of the silty sulfide material was similar to the particle size distribution before the freeze-thaw.

BatchO

The freeze-thaw cycles led to slight increase in the leachate calcium, magnesium and sulphate concentrations. The final pH was about 0.5 pH unit lower than the initial measurement before the freeze-thaw of pH8.7. The total cyanide concentration decreased from 1.0 mg/L to around 0.40 mg/L and the cyanate and thiocyanate concentrations slightly increased.

The freeze-thaw cycles did not change the particle size distribution which displayed a bimodal distribution with a similar D_{60} and mean diameter value of 5.74 μm and 8.12 μm, respectively.

BatchS

The final pH of the clayey sulfide tails was around 7.9 and the redox potential was around 350 mV. Arsenic concentration decreased slightly and the releases of the other metals remained essentially the same compared with the results obtained before the freeze-thaw. A small increase of total cyanide concentration was measured for the BatchS sample at a value of 0.12 mg/L. WAD cyanide stayed below the limit of quantification. No significant changes were observed for the ammonia, cyanate and thiocyanate.

The particle size distribution of the BatchS sample after the freeze-thaw study showed a trimodal distribution instead of a bimodal distribution. After the freeze-thaw, some particles seemed to agglomerate together and consequently increased the overall particle size. The peaks were observed at 0.51 μm, 7.70 μm and 44 μm. The mean diameter increased from 6.21 to 17.32 μm and the D_{60} value increased from 4.55 to 8.48 μm.

MN1401

The silty oxide tails had no major changes in terms of metal mobility. The arsenic concentration was slightly lower compared to the initial leaching tests and the copper, zinc, nickel, lead and iron concentrations were near or below the limit of quantification. The final pH stayed the same before and after the leaching tests. No significant changes were reported for the cyanide, ammonia, cyanate and thiocyanate concentrations.

The particle size distribution displayed a trimodal distribution, the particle size increased after the freeze-thaw study with a mean diameter value of 64.10 μm and D_{60} value of 60.85 μm.

DISCUSSION

The objective of the freeze-thaw task was to study the metal mobility of various types of tailings samples after several freeze-thaw cycles. More specifically, the task examined the interaction between freeze-thaw and clayey oxide tailings, clayey sulfide tailings, silty oxide tails, silty sulfide tails and a silty sulfide-oxide mix. Depending on the nature of the material, the freezing action will vary with the characteristics of the material. Freeze-thaw action is more problematic for some types of soil; the stability of fine-grained soils is more sensitive to changes in moisture content than is the stability of granular material (Dimillio, 1998). Consequently, slight increases in moisture content for silts and clays may have a significant negative impact on their stability while similar changes in water content will not affect granular materials.

In this study, no trends or major differences were noted between all the samples in terms of metal mobility. The liquid/solid ratio for the leaching test was 5:1 and the samples were agitated at 150 rpm for 24h to allow time for the samples to reach equilibrium between the solid and the liquid phase. After the freeze-thaw cycles, metal release slightly decreased for arsenic for all the samples and variations regarding calcium, magnesium and sodium were reported. Overall, the metal leachability remained more or less the same before and after the freeze-thaw study.

Cyanide concentrations measured were usually below the limit of quantification except for the BatchO sample. As the final pH was below 9.0 after the leaching test, cyanide may have been leached from the solid and then, converted into the gas form. This assumption was supported by the results using a lime solution as the leachant. Using lime solution as the leachant, cyanide concentrations were measured in the leachate with concentration between 1.0 and 5.0 mg/L.

The initial concentration of cyanide in the BatchO was 47 μg/g and only a small fraction of the cyanide was leached from the solid sample. Before the freeze-thaw study, the final pH of the BatchO sample was above 9.0, consequently all the cyanide leached from the sample remained in solution. The total cyanide concentration of the clayey oxide tails decreased by more than 50% in the leachate after the freeze-thaw step. However, after the freeze-thaw study, the final pH was below 9.0 and part of the cyanide might have been converted to HCN. The reduction is probably not related to the effect of the freeze-thaw but most probably pH dependant. For the other samples, no cyanide was measured in the leachate probably because they all showed a leachate pH below 9.0.

The particle size distribution was different after the freeze-thaw for the clayey sulfide tails and the silty oxide tails. The mean diameter increased from 6.21 μm to 17.32 μm for the BatchS sample and from 29.14 μm to 64.10 μm for the MN1401 sample. Several researchers (Ahukrichs and White, 1962; Anderson and Hoekstra,1965; Dilon 1972) found that clay aggregates were produced by freezing. Further mineralogical analysis should provide more information about the consolidation of the BatchS and MN1401 samples.

Overall, the freeze-thaw cycles did not change significantly the metal leachability; the main factor affecting metal leachability appeared to be the pH of the leachate. Samples collected from the Mount Nansen site might have already been subjected to many freeze-thaw cycles. Consequently, the impact of incremental freezing action is expected to be very small.

Results may have been different if using fresh tailings that have never been subjected to cold climates were tested. The freeze-thaw process seems to have modified the final pH. After freeze-thaw, the pH was systematically lower. The pH decrease may be due to Fe(II) oxidation and subsequent hydrolysis, which gives rise to net generation of acidity.

CONCLUSIONS

- The freeze-thaw cycles did not significantly modify the particle size distribution, metal and cyanide mobility.
- Metal mobility was pH dependant.
- Small amounts of cyanide were probably leached but not detected in the leachate because of a final pH below 9.0.
- No trends were identified regarding the effect of freeze-thaw cycles on the particle size distribution of older tailings.

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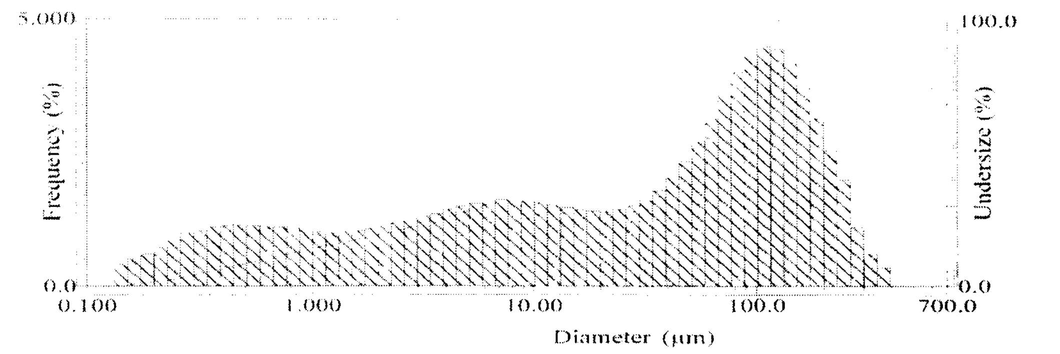
Appendix G-A. Particle size distribution before the freeze-thaw task

Somix - T
Feb 22, 2002



S.P. Area : 28851(cm²/cm³)
Median : 35.750(μm)
Diameter on % :5.000 (%) = 0.334(μm)
:10.00 (%) = 0.611(μm)
:20.00 (%) = 2.212(μm)
:30.00 (%) = 6.000(μm)
:40.00 (%) = 14.252(μm)
:60.00 (%) = 63.454(μm)
:70.00 (%) = 91.251(μm)
:80.00 (%) = 123.913(μm)
:90.00 (%) = 173.097(μm)
:95.00 (%) = 217.910(μm)

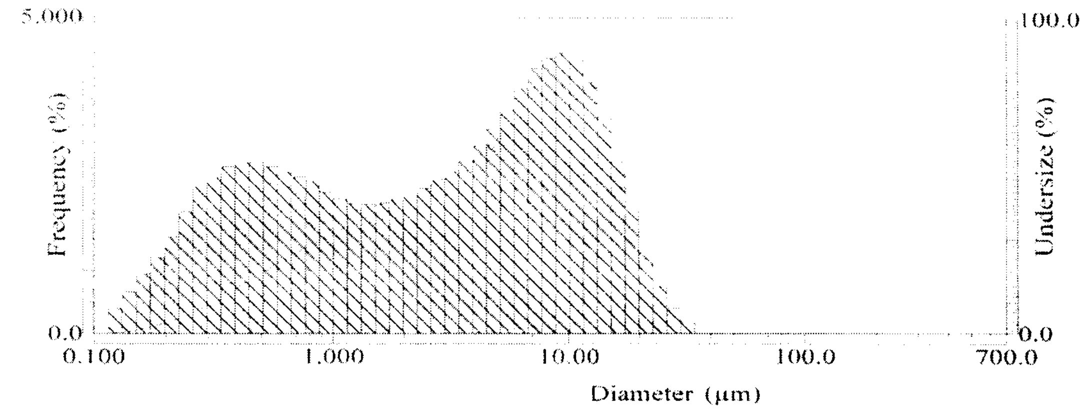
% on Diameter :850.0 (μm) = 100.000(%)
:600.0 (μm) = 100.000(%)
:425.0 (μm) = 100.000(%)
:300.0 (μm) = 99.028(%)
:212.0 (μm) = 94.483(%)
:150.0 (μm) = 86.023(%)
:106.0 (μm) = 74.845(%)
:75.00 (μm) = 64.220(%)
:53.00 (μm) = 56.16
:38.00 (μm) = 50.80

Mean : 64.837(μm)
Variance : 5533.423
S.D. : 74.387(μm)
Mode : 108.762(μm)
Span : 4.825

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.006	16.987	39	19.904	1.401	43.504	58	262.376	1.995	97.934
2	0.131	0.000	0.000	21	1.729	1.034	18.021	40	22.797	1.398	44.903	59	300.518	1.108	99.042
3	0.150	0.402	0.402	22	1.981	1.073	19.094	41	26.111	1.427	46.330	60	344.206	0.616	99.658
4	0.172	0.507	0.910	23	2.269	1.116	20.210	42	29.907	1.496	47.825	61	394.244	0.342	100.000
5	0.197	0.595	1.504	24	2.599	1.176	21.386	43	34.255	1.612	49.438	62	451.556	0.000	100.000
6	0.226	0.719	2.224	25	2.976	1.238	22.623	44	39.234	1.786	51.224	63	517.200	0.000	100.000
7	0.259	0.857	3.080	26	3.409	1.299	23.923	45	44.938	2.025	53.249	64	592.387	0.000	100.000
8	0.296	0.988	4.068	27	3.905	1.357	25.279	46	51.471	2.335	55.584				
9	0.339	1.042	5.110	28	4.472	1.425	26.704	47	58.953	2.712	58.296				
10	0.389	1.103	6.213	29	5.122	1.489	28.193	48	67.523	3.143	61.439				
11	0.445	1.136	7.349	30	5.867	1.544	29.737	49	77.339	3.595	65.034				
12	0.510	1.143	8.492	31	6.720	1.590	31.327	50	88.583	4.017	69.050				
13	0.584	1.132	9.624	32	7.697	1.615	32.943	51	101.460	4.342	73.393				
14	0.669	1.118	10.741	33	8.816	1.602	34.544	52	116.210	4.503	77.896				
15	0.766	1.101	11.843	34	10.097	1.590	36.134	53	133.103	4.450	82.346				
16	0.877	1.089	12.932	35	11.565	1.559	37.693	54	152.453	4.176	86.522				
17	1.005	1.042	13.974	36	13.246	1.515	39.208	55	174.616	3.717	90.239				
18	1.151	1.010	14.984	37	15.172	1.468	40.676	56	200.000	3.148	93.388				
19	1.318	0.997	15.981	38	17.377	1.427	42.103	57	229.075	2.552	95.939				

Filename :
ID# :200202221543753
Circulation Speed :12
Ultra sonic :02:00
Laser T% : 78.1(%)
Form of Distribution :Standard
Calc. Level :30
R.R.Index :1.16-0.10i
Axis Selection :LogX-LinY

MN 1102-T
Feb 25, 2002



S.P. Area : 63854(cm²/cm³)
Median : 3.125(µm)
Diameter on % :5.000 (%) = 0.230(µm)
:10.00 (%) = 0.313(µm)
:20.00 (%) = 0.523(µm)
:30.00 (%) = 0.902(µm)
:40.00 (%) = 1.721(µm)
:60.00 (%) = 5.003(µm)
:70.00 (%) = 7.175(µm)
:80.00 (%) = 9.802(µm)

:90.00 (%) = 13.630(µm)
:95.00 (%) = 17.024(µm)
% on Diameter :850.0 (µm) = 100.000(%)
:600.0 (µm) = 100.000(%)
:425.0 (µm) = 100.000(%)
:300.0 (µm) = 100.000(%)
:212.0 (µm) = 100.000(%)
:150.0 (µm) = 100.000(%)
:106.0 (µm) = 100.000(%)
:75.00 (µm) = 100.000(%)

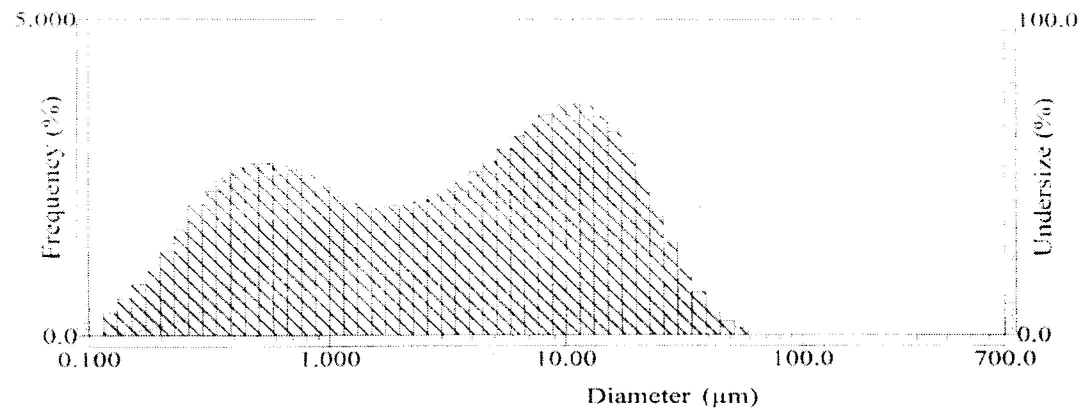
:53.00 (µm) = 100.0
:38.00 (µm) = 100.0
Mean : 5.325(µm)
Variance : 33.257
S.D. : 5.767(µm)
Mode : 9.431(µm)
Span : 4.262

No.	Diameter	Freq %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.043	38.008	39	19.904	1.962	97.372	58	262.376	0.000	100.000
2	0.131	0.404	0.404	21	1.729	2.064	40.071	40	22.797	1.285	98.657	59	300.518	0.000	100.000
3	0.150	0.665	1.069	22	1.981	2.117	42.188	41	26.111	0.756	99.413	60	344.206	0.000	100.000
4	0.172	0.950	2.020	23	2.269	2.177	44.365	42	29.907	0.398	99.812	61	394.244	0.000	100.000
5	0.197	1.206	3.226	24	2.599	2.290	46.656	43	34.255	0.188	100.000	62	451.556	0.000	100.000
6	0.226	1.530	4.756	25	2.976	2.428	49.083	44	39.234	0.000	100.000	63	517.200	0.000	100.000
7	0.259	1.925	6.681	26	3.409	2.558	51.641	45	44.938	0.000	100.000	64	592.387	0.000	100.000
8	0.296	2.313	8.994	27	3.905	2.729	54.370	46	51.471	0.000	100.000				
9	0.339	2.464	11.458	28	4.472	2.961	57.331	47	58.953	0.000	100.000				
10	0.389	2.635	14.094	29	5.122	3.232	60.563	48	67.523	0.000	100.000				
11	0.445	2.707	16.801	30	5.867	3.537	64.099	49	77.339	0.000	100.000				
12	0.510	2.698	19.498	31	6.720	3.876	67.975	50	88.583	0.000	100.000				
13	0.584	2.632	22.130	32	7.697	4.194	72.169	51	101.460	0.000	100.000				
14	0.669	2.553	24.683	33	8.816	4.357	76.526	52	116.210	0.000	100.000				
15	0.766	2.469	27.152	34	10.097	4.445	80.970	53	133.103	0.000	100.000				
16	0.877	2.397	29.550	35	11.565	4.329	85.299	54	152.453	0.000	100.000				
17	1.005	2.234	31.784	36	13.246	3.981	89.280	55	174.616	0.000	100.000				
18	1.151	2.122	33.906	37	15.172	3.419	92.700	56	200.000	0.000	100.000				
19	1.318	2.059	35.965	38	17.377	2.711	95.410	57	229.075	0.000	100.000				

Filename :
ID# :200202260904772
Circulation Speed :12
Ultra sonic :02:29
Laser T% : 73.2(%)

Form of Distribution :Standard
Calc. Level :30
R.R.Index :1.16-0.10i
Axis Selection :LogX-LinY

BatchO - T
Feb 22, 2002

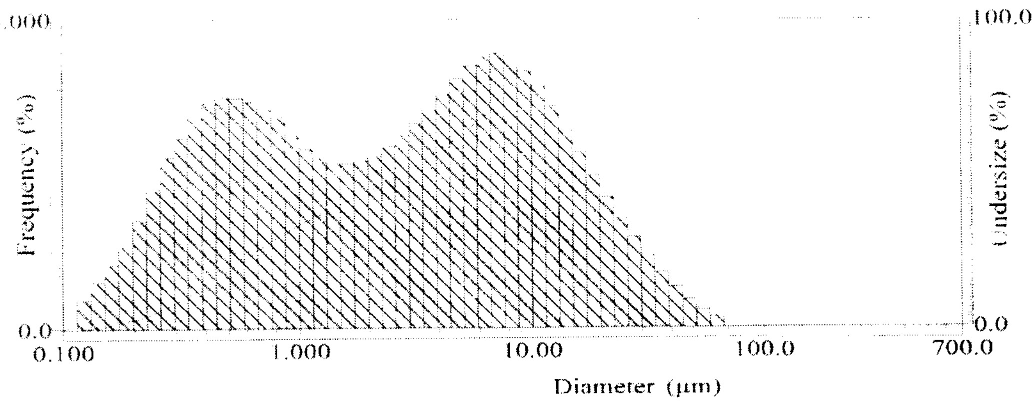


S.P. Area	: 60174(cm²/cm³)		:90.00 (%) = 18.433(µm)		:53.00 (µm) = 99.91
Median	: 3.341(µm)		:95.00 (%) = 24.302(µm)		:38.00 (µm) = 99.09
Diameter on %	:5.000 (%) = 0.242(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 6.837(µm)
	:10.00 (%) = 0.336(µm)		:600.0 (µm) = 100.000(%)	Variance	: 70.514
	:20.00 (%) = 0.560(µm)		:425.0 (µm) = 100.000(%)	S.D.	: 8.397(µm)
	:30.00 (%) = 0.944(µm)		:300.0 (µm) = 100.000(%)	Mode	: 10.807(µm)
	:40.00 (%) = 1.789(µm)		:212.0 (µm) = 100.000(%)	Span	: 5.416
	:60.00 (%) = 5.575(µm)		:150.0 (µm) = 100.000(%)		
	:70.00 (%) = 8.443(µm)		:106.0 (µm) = 100.000(%)		
	:80.00 (%) = 12.274(µm)		:75.00 (µm) = 100.000(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.049	37.449	39	19.904	2.878	91.628	58	262.376	0.000	100.000
2	0.131	0.365	0.365	21	1.729	2.036	39.484	40	22.797	2.445	94.073	59	300.518	0.000	100.000
3	0.150	0.589	0.954	22	1.981	2.054	41.538	41	26.111	1.968	96.041	60	344.206	0.000	100.000
4	0.172	0.813	1.767	23	2.269	2.077	43.615	42	29.907	1.487	97.527	61	394.244	0.000	100.000
5	0.197	1.026	2.793	24	2.599	2.153	45.768	43	34.255	1.046	98.573	62	451.556	0.000	100.000
6	0.226	1.329	4.122	25	2.976	2.245	48.012	44	39.234	0.680	99.254	63	517.200	0.000	100.000
7	0.259	1.694	5.815	26	3.409	2.333	50.345	45	44.938	0.407	99.661	64	592.387	0.000	100.000
8	0.296	2.076	7.892	27	3.905	2.444	52.789	46	51.471	0.225	99.885				
9	0.339	2.286	10.178	28	4.472	2.598	55.387	47	58.953	0.115	100.000				
10	0.389	2.518	12.696	29	5.122	2.769	58.156	48	67.523	0.000	100.000				
11	0.445	2.669	15.365	30	5.867	2.953	61.110	49	77.339	0.000	100.000				
12	0.510	2.737	18.102	31	6.720	3.157	64.267	50	88.583	0.000	100.000				
13	0.584	2.734	20.836	32	7.697	3.349	67.616	51	101.460	0.000	100.000				
14	0.669	2.698	23.534	33	8.816	3.498	71.114	52	116.210	0.000	100.000				
15	0.766	2.633	26.167	34	10.097	3.623	74.737	53	133.103	0.000	100.000				
16	0.877	2.558	28.726	35	11.565	3.672	78.409	54	152.453	0.000	100.000				
17	1.005	2.363	31.088	36	13.246	3.628	82.037	55	174.616	0.000	100.000				
18	1.151	2.209	33.297	37	15.172	3.483	85.520	56	200.000	0.000	100.000				
19	1.318	2.103	35.400	38	17.377	3.230	88.750	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202221508752	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:02:00	Axis Selection	:LogX-LinY
Laser T%	: 76.7(%)		

Batch S-T
Feb 25, 2002

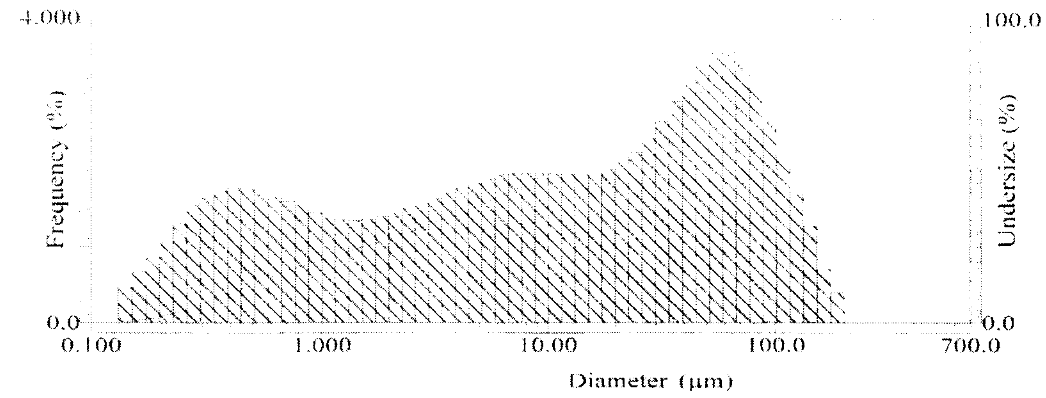


S.P. Area : 63532(cm²/cm³)	:90.00 (%) = 16.491(μm)		:53.00 (μm) = 99.67
Median : 2.799(μm)	:95.00 (%) = 23.890(μm)		:38.00 (μm) = 98.56
Diameter on % :5.000 (%) = 0.240(μm)	% on Diameter :850.0 (μm) = 100.000(%)	Mean	: 6.209(μm)
:10.00 (%) = 0.327(μm)	:600.0 (μm) = 100.000(%)	Variance	: 74.377
:20.00 (%) = 0.528(μm)	:425.0 (μm) = 100.000(%)	S.D.	: 8.624(μm)
:30.00 (%) = 0.848(μm)	:300.0 (μm) = 100.000(%)	Mode	: 7.182(μm)
:40.00 (%) = 1.530(μm)	:212.0 (μm) = 100.000(%)	Span	: 5.776
:60.00 (%) = 4.549(μm)	:150.0 (μm) = 100.000(%)		
:70.00 (%) = 6.792(μm)	:106.0 (μm) = 100.000(%)		
:80.00 (%) = 10.074(μm)	:75.00 (μm) = 100.000(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.128	39.795	39	19.904	1.963	92.835	58	262.376	0.000	100.000
2	0.131	0.370	0.370	21	1.729	2.126	41.921	40	22.797	1.678	94.513	59	300.518	0.000	100.000
3	0.150	0.596	0.966	22	1.981	2.168	44.089	41	26.111	1.411	95.924	60	344.206	0.000	100.000
4	0.172	0.823	1.789	23	2.269	2.215	46.304	42	29.907	1.161	97.085	61	394.244	0.000	100.000
5	0.197	1.050	2.839	24	2.599	2.339	48.643	43	34.255	0.930	98.015	62	451.556	0.000	100.000
6	0.226	1.381	4.220	25	2.976	2.485	51.128	44	39.234	0.717	98.731	63	517.200	0.000	100.000
7	0.259	1.779	6.000	26	3.409	2.636	53.763	45	44.938	0.526	99.257	64	592.387	0.000	100.000
8	0.296	2.205	8.204	27	3.905	2.811	56.574	46	51.471	0.364	99.621				
9	0.339	2.449	10.653	28	4.472	3.021	59.595	47	58.953	0.236	99.857				
10	0.389	2.718	13.371	29	5.122	3.220	62.816	48	67.523	0.143	100.000				
11	0.445	2.898	16.269	30	5.867	3.387	66.203	49	77.339	0.000	100.000				
12	0.510	2.979	19.248	31	6.720	3.516	69.719	50	88.583	0.000	100.000				
13	0.584	2.972	22.220	32	7.697	3.564	73.283	51	101.460	0.000	100.000				
14	0.669	2.920	25.139	33	8.816	3.445	76.728	52	116.210	0.000	100.000				
15	0.766	2.827	27.966	34	10.097	3.327	80.055	53	133.103	0.000	100.000				
16	0.877	2.721	30.687	35	11.565	3.125	83.180	54	152.453	0.000	100.000				
17	1.005	2.488	33.175	36	13.246	2.862	86.043	55	174.616	0.000	100.000				
18	1.151	2.307	35.482	37	15.172	2.567	88.610	56	200.000	0.000	100.000				
19	1.318	2.185	37.667	38	17.377	2.262	90.872	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202270930779	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:02:43	Axis Selection	:LogX-LinY
Laser T%	: 76.4(%)		

MN1401 - T
Feb 22, 2002



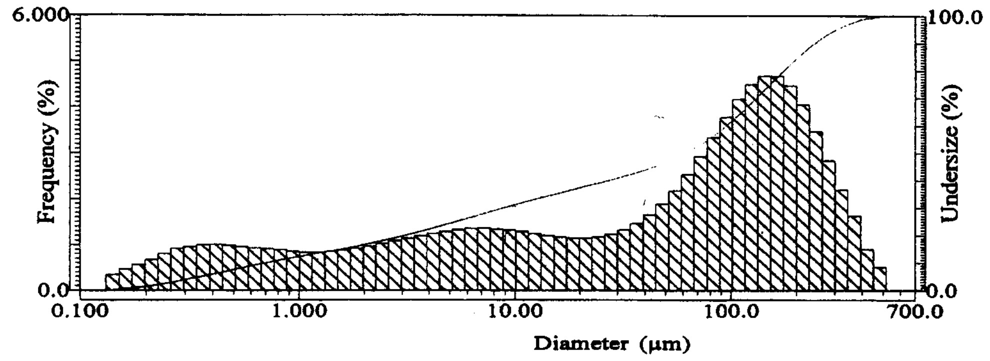
S.P. Area	: 41404(cm²/cm³)		:90.00 (%) = 84.278(μm)		:53.00 (μm) = 78.30
Median	: 10.968(μm)		:95.00 (%) = 109.546(μm)		:38.00 (μm) = 70.27
Diameter on %	:5.000 (%) = 0.274(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 29.139(μm)
	:10.00 (%) = 0.411(μm)		:600.0 (μm) = 100.000(%)	Variance	: 1397.370
	:20.00 (%) = 0.934(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 37.381(μm)
	:30.00 (%) = 2.471(μm)		:300.0 (μm) = 100.000(%)	Mode	: 62.910(μm)
	:40.00 (%) = 5.471(μm)		:212.0 (μm) = 100.000(%)	Span	: 7.646
	:60.00 (%) = 21.714(μm)		:150.0 (μm) = 98.749(%)		
	:70.00 (%) = 37.519(μm)		:106.0 (μm) = 94.476(%)		
	:80.00 (%) = 56.550(μm)		:75.00 (μm) = 87.280(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.345	24.859	39	19.904	2.018	58.650	58	262.376	0.000	100.000
2	0.131	0.000	0.000	21	1.729	1.362	26.221	40	22.797	2.105	60.755	59	300.518	0.000	100.000
3	0.150	0.475	0.475	22	1.981	1.397	27.618	41	26.111	2.237	62.991	60	344.206	0.000	100.000
4	0.172	0.668	1.143	23	2.269	1.438	29.056	42	29.907	2.417	65.409	61	394.244	0.000	100.000
5	0.197	0.839	1.983	24	2.599	1.503	30.559	43	34.255	2.644	68.052	62	451.556	0.000	100.000
6	0.226	1.049	3.032	25	2.976	1.572	32.130	44	39.234	2.905	70.957	63	517.200	0.000	100.000
7	0.259	1.304	4.336	26	3.409	1.640	33.771	45	44.938	3.173	74.130	64	592.387	0.000	100.000
8	0.296	1.549	5.885	27	3.905	1.701	35.471	46	51.471	3.407	77.537				
9	0.339	1.639	7.524	28	4.472	1.772	37.244	47	58.953	3.553	81.089				
10	0.389	1.740	9.265	29	5.122	1.837	39.081	48	67.523	3.560	84.649				
11	0.445	1.777	11.042	30	5.867	1.892	40.973	49	77.339	3.400	88.049				
12	0.510	1.763	12.806	31	6.720	1.939	42.911	50	88.583	3.082	91.131				
13	0.584	1.714	14.519	32	7.697	1.964	44.876	51	101.460	2.648	93.778				
14	0.669	1.657	16.176	33	8.816	1.963	46.838	52	116.210	2.162	95.941				
15	0.766	1.599	17.776	34	10.097	1.967	48.805	53	133.103	1.689	97.630				
16	0.877	1.552	19.327	35	11.565	1.959	50.764	54	152.453	1.272	98.901				
17	1.005	1.452	20.779	36	13.246	1.949	52.714	55	174.616	0.706	99.608				
18	1.151	1.385	22.164	37	15.172	1.949	54.663	56	200.000	0.392	100.000				
19	1.318	1.350	23.514	38	17.377	1.969	56.632	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202221434749	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:02:01	Axis Selection	:LogX-LinY
Laser T%	: 71.6(%)		

Appendix G-B: Particle size distribution after the freeze-thaw task

SOMIX
Feb 25, 2002



S.P. Area : 25645(cm² /cm³)
Median : 61.111(μm)
Diameter on % :5.000 (%) = 0.353(μm)
:10.00 (%) = 0.706(μm)
:20.00 (%) = 3.090(μm)
:30.00 (%) = 8.888(μm)
:40.00 (%) = 27.271(μm)
:60.00 (%) = 94.736(μm)
:70.00 (%) = 130.794(μm)
:80.00 (%) = 174.942(μm)

:90.00 (%) = 243.259(μm)
:95.00 (%) = 304.744(μm)
% on Diameter :850.0 (μm) = 100.000(%)
:600.0 (μm) = 100.000(%)
:425.0 (μm) = 99.095(%)
:300.0 (μm) = 94.738(%)
:212.0 (μm) = 86.147(%)
:150.0 (μm) = 74.699(%)
:106.0 (μm) = 63.256(%)
:75.00 (μm) = 54.121(%)

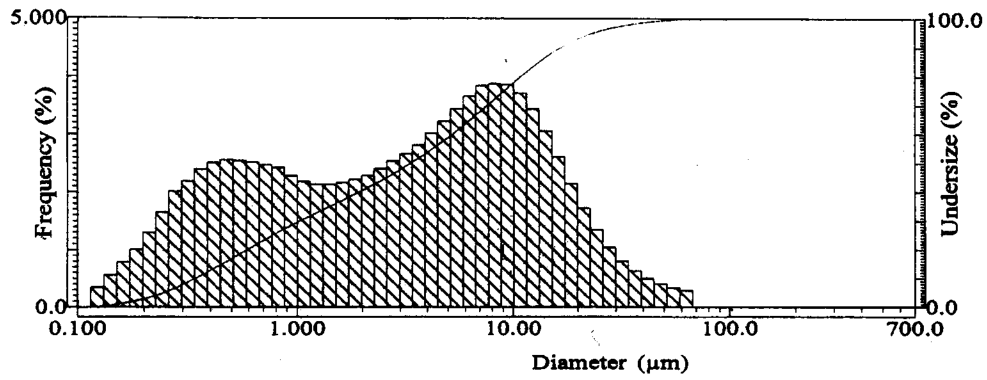
:53.00 (μm) = 47.62
:38.00 (μm) = 43.27
Mean : 93.664(μm)
Variance :10644.464
S.D. : 103.172(μm)
Mode : 162.661(μm)
Span : 3.969

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	0.850	14.801	39	19.904	1.148	37.284	58	262.376	3.481	91.940
2	0.131	0.000	0.000	21	1.729	0.881	15.682	40	22.797	1.148	38.432	59	300.518	2.834	94.774
3	0.150	0.345	0.345	22	1.981	0.923	16.604	41	26.111	1.174	39.606	60	344.206	2.194	96.969
4	0.172	0.458	0.803	23	2.269	0.969	17.574	42	29.907	1.230	40.836	61	394.244	1.626	98.595
5	0.197	0.555	1.358	24	2.599	1.026	18.600	43	34.255	1.324	42.160	62	451.556	0.903	99.498
6	0.226	0.669	2.027	25	2.976	1.084	19.684	44	39.234	1.460	43.620	63	517.200	0.502	100.000
7	0.259	0.803	2.830	26	3.409	1.142	20.826	45	44.938	1.645	45.265	64	592.387	0.000	100.000
8	0.296	0.925	3.755	27	3.905	1.190	22.016	46	51.471	1.885	47.150				
9	0.339	0.960	4.715	28	4.472	1.242	23.258	47	58.953	2.180	49.330				
10	0.389	1.003	5.718	29	5.122	1.288	24.546	48	67.523	2.529	51.859				
11	0.445	1.013	6.731	30	5.867	1.324	25.871	49	77.339	2.923	54.783				
12	0.510	0.998	7.729	31	6.720	1.352	27.222	50	88.583	3.348	58.131				
13	0.584	0.967	8.696	32	7.697	1.361	28.583	51	101.460	3.778	61.909				
14	0.669	0.937	9.633	33	8.816	1.338	29.921	52	116.210	4.176	66.085				
15	0.766	0.909	10.542	34	10.097	1.318	31.239	53	133.103	4.495	70.579				
16	0.877	0.891	11.433	35	11.565	1.284	32.523	54	152.453	4.679	75.258				
17	1.005	0.852	12.286	36	13.246	1.243	33.766	55	174.616	4.680	79.939				
18	1.151	0.833	13.119	37	15.172	1.202	34.968	56	200.000	4.468	84.407				
19	1.318	0.832	13.951	38	17.377	1.168	36.136	57	229.075	4.052	88.459				

Filename :
ID# :200202251137758
Circulation Speed :12
Ultra sonic :01:43
Laser T% : 72.1(%)

Form of Distribution :Standard
Calc. Level :30
R.R.Index :1.16-0.10i
Axis Selection :LogX-LinY

MN 1102-D
Feb 25, 2002



S.P. Area : 58567(cm^2/cm^3)
Median : 3.361(µm)
Diameter on % :5.000 (%) = 0.245(µm)
:10.00 (%) = 0.342(µm)
:20.00 (%) = 0.588(µm)
:30.00 (%) = 1.033(µm)
:40.00 (%) = 1.934(µm)
:60.00 (%) = 5.262(µm)
:70.00 (%) = 7.627(µm)
:80.00 (%) = 10.867(µm)

:90.00 (%) = 16.670(µm)
:95.00 (%) = 23.574(µm)
% on Diameter :850.0 (µm) = 100.000(%)
:600.0 (µm) = 100.000(%)
:425.0 (µm) = 100.000(%)
:300.0 (µm) = 100.000(%)
:212.0 (µm) = 100.000(%)
:150.0 (µm) = 100.000(%)
:106.0 (µm) = 100.000(%)
:75.00 (µm) = 100.000(%)

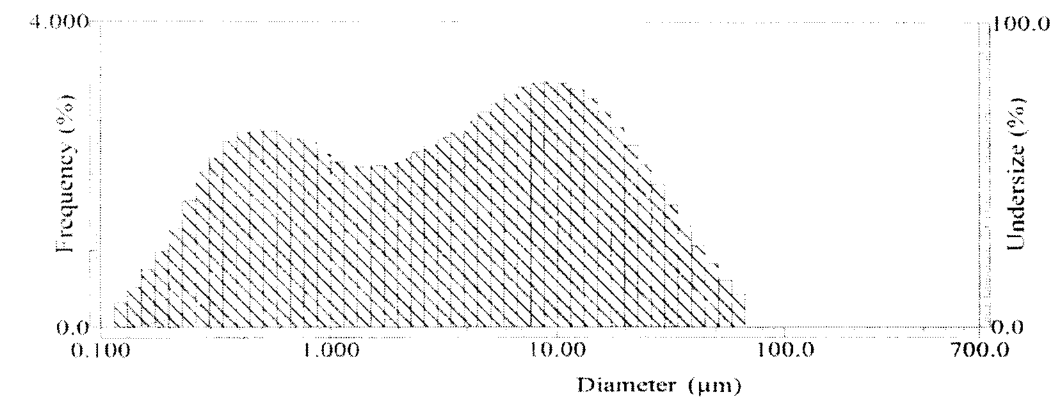
:53.00 (µm) = 99.44
:38.00 (µm) = 98.33
Mean : 6.643(µm)
Variance : 79.393
S.D. : 8.910(µm)
Mode : 8.240(µm)
Span : 4.858

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.128	36.010	39	19.904	2.150	92.949	58	262.376	0.000	100.000
2	0.131	0.346	0.346	21	1.729	2.159	38.168	40	22.797	1.719	94.668	59	300.518	0.000	100.000
3	0.150	0.555	0.901	22	1.981	2.220	40.388	41	26.111	1.345	96.013	60	344.206	0.000	100.000
4	0.172	0.786	1.687	23	2.269	2.288	42.676	42	29.907	1.039	97.052	61	394.244	0.000	100.000
5	0.197	1.007	2.693	24	2.599	2.403	45.079	43	34.255	0.802	97.854	62	451.556	0.000	100.000
6	0.226	1.295	3.988	25	2.976	2.536	47.615	44	39.234	0.624	98.478	63	517.200	0.000	100.000
7	0.259	1.648	5.636	26	3.409	2.663	50.278	45	44.938	0.494	98.972	64	592.387	0.000	100.000
8	0.296	2.012	7.648	27	3.905	2.812	53.090	46	51.471	0.401	99.373				
9	0.339	2.192	9.840	28	4.472	3.008	56.097	47	58.953	0.336	99.709				
10	0.389	2.394	12.235	29	5.122	3.219	59.317	48	67.523	0.291	100.000				
11	0.445	2.515	14.749	30	5.867	3.438	62.755	49	77.339	0.000	100.000				
12	0.510	2.561	17.311	31	6.720	3.662	66.417	50	88.583	0.000	100.000				
13	0.584	2.550	19.860	32	7.697	3.841	70.258	51	101.460	0.000	100.000				
14	0.669	2.518	22.378	33	8.816	3.871	74.129	52	116.210	0.000	100.000				
15	0.766	2.471	24.850	34	10.097	3.860	77.989	53	133.103	0.000	100.000				
16	0.877	2.429	27.278	35	11.565	3.713	81.702	54	152.453	0.000	100.000				
17	1.005	2.284	29.563	36	13.246	3.435	85.137	55	174.616	0.000	100.000				
18	1.151	2.186	31.748	37	15.172	3.053	88.190	56	200.000	0.000	100.000				
19	1.318	2.133	33.882	38	17.377	2.609	90.799	57	229.075	0.000	100.000				

Filename :
ID# :200202260829771
Circulation Speed :12
Ultra sonic :03:47
Laser T% : 74.0(%)

Form of Distribution :Standard
Calc. Level :30
R.R.Index :1.16-0.10i
Axis Selection :LogX-LinY

Batch O - D
Feb 25, 2002

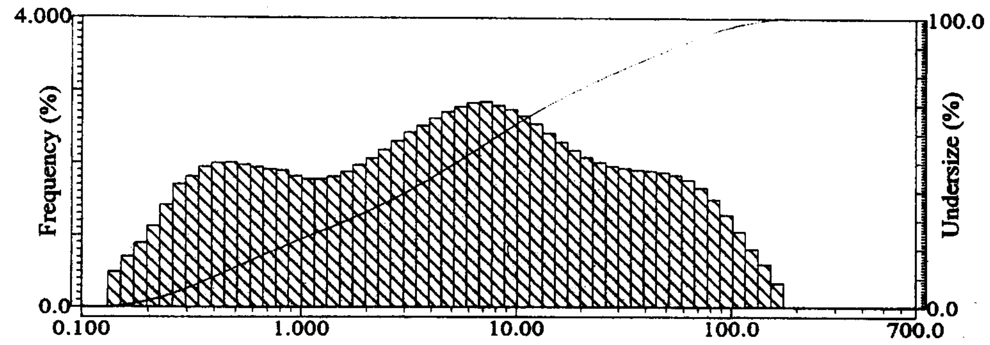


S.P. Area	: 57840(cm² /cm³)		:90.00 (%) = 22.611(µm)			:53.00 (µm) =	99.08
Median	: 3.501(µm)		:95.00 (%) = 32.200(µm)			:38.00 (µm) =	96.74
Diameter on %	:5.000 (%) = 0.247(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 8.124(µm)		
	:10.00 (%) = 0.343(µm)		:600.0 (µm) = 100.000(%)	Variance	: 122.272		
	:20.00 (%) = 0.587(µm)		:425.0 (µm) = 100.000(%)	S.D.	: 11.058(µm)		
	:30.00 (%) = 1.032(µm)		:300.0 (µm) = 100.000(%)	Mode	: 9.436(µm)		
	:40.00 (%) = 1.961(µm)		:212.0 (µm) = 100.000(%)	Span	: 6.360		
	:60.00 (%) = 5.741(µm)		:150.0 (µm) = 100.000(%)				
	:70.00 (%) = 8.875(µm)		:106.0 (µm) = 100.000(%)				
	:80.00 (%) = 13.637(µm)		:75.00 (µm) = 100.000(%)				

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	2.083	35.917	39	19.904	2.608	87.767	58	262.376	0.000	100.000
2	0.131	0.323	0.323	21	1.729	2.100	38.018	40	22.797	2.376	90.143	59	300.518	0.000	100.000
3	0.150	0.525	0.849	22	1.981	2.145	40.162	41	26.111	2.126	92.269	60	344.206	0.000	100.000
4	0.172	0.762	1.611	23	2.269	2.197	42.359	42	29.907	1.863	94.132	61	394.244	0.000	100.000
5	0.197	0.992	2.603	24	2.599	2.284	44.643	43	34.255	1.594	95.726	62	451.556	0.000	100.000
6	0.226	1.285	3.889	25	2.976	2.380	47.023	44	39.234	1.326	97.053	63	517.200	0.000	100.000
7	0.259	1.652	5.541	26	3.409	2.473	49.496	45	44.938	1.068	98.120	64	592.387	0.000	100.000
8	0.296	2.032	7.573	27	3.905	2.563	52.059	46	51.471	0.827	98.948				
9	0.339	2.218	9.791	28	4.472	2.682	54.741	47	58.953	0.615	99.562				
10	0.389	2.426	12.217	29	5.122	2.803	57.544	48	67.523	0.438	100.000				
11	0.445	2.546	14.763	30	5.867	2.923	60.467	49	77.339	0.000	100.000				
12	0.510	2.587	17.350	31	6.720	3.046	63.512	50	88.583	0.000	100.000				
13	0.584	2.566	19.916	32	7.697	3.143	66.655	51	101.460	0.000	100.000				
14	0.669	2.523	22.439	33	8.816	3.186	69.841	52	116.210	0.000	100.000				
15	0.766	2.466	24.905	34	10.097	3.217	73.058	53	133.103	0.000	100.000				
16	0.877	2.414	27.319	35	11.565	3.191	76.249	54	152.453	0.000	100.000				
17	1.005	2.261	29.580	36	13.246	3.112	79.361	55	174.616	0.000	100.000				
18	1.151	2.156	31.736	37	15.172	2.984	82.345	56	200.000	0.000	100.000				
19	1.318	2.098	33.834	38	17.377	2.814	85.159	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:20020226093275	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:02:55	Axis Selection	:LogX-LinY
Laser T%	: 72.3(%)		

Batch S - D
Feb 25, 2002

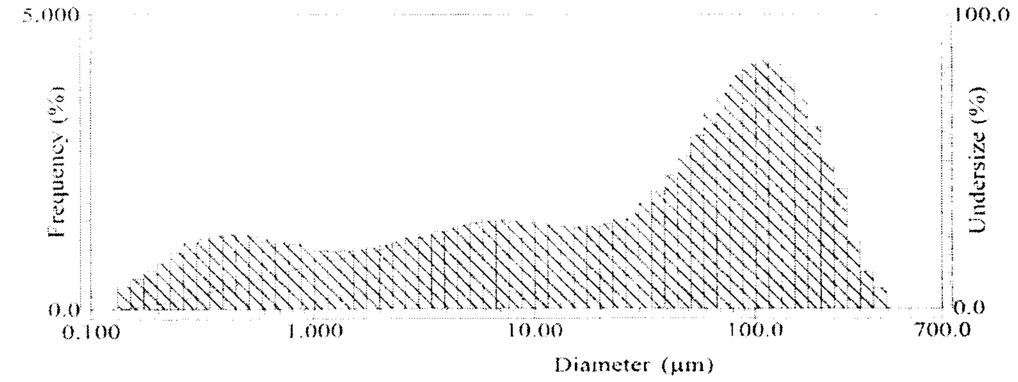


S.P. Area	: 47401(cm² /cm³)		:90.00 (%) = 54.613(μm)		:53.00 (μm) = 89.59
Median	: 5.233(μm)		:95.00 (%) = 81.269(μm)		:38.00 (μm) = 84.99
Diameter on %	:5.000 (%) = 0.267(μm)	% on Diameter	:850.0 (μm) = 100.000(%)	Mean	: 17.323(μm)
	:10.00 (%) = 0.387(μm)		:600.0 (μm) = 100.000(%)	Variance	: 779.261
	:20.00 (%) = 0.773(μm)		:425.0 (μm) = 100.000(%)	S.D.	: 27.915(μm)
	:30.00 (%) = 1.630(μm)		:300.0 (μm) = 100.000(%)	Mode	: 7.185(μm)
	:40.00 (%) = 3.092(μm)		:212.0 (μm) = 100.000(%)	Span	: 10.363
	:60.00 (%) = 8.484(μm)		:150.0 (μm) = 99.599(%)		
	:70.00 (%) = 14.245(μm)		:106.0 (μm) = 97.567(%)		
	:80.00 (%) = 26.720(μm)		:75.00 (μm) = 94.080(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	1.812	28.937	39	19.904	2.175	75.583	58	262.376	0.000	100.000
2	0.131	0.000	0.000	21	1.729	1.878	30.815	40	22.797	2.080	77.663	59	300.518	0.000	100.000
3	0.150	0.489	0.489	22	1.981	1.965	32.780	41	26.111	2.006	79.669	60	344.206	0.000	100.000
4	0.172	0.699	1.188	23	2.269	2.061	34.841	42	29.907	1.953	81.622	61	394.244	0.000	100.000
5	0.197	0.889	2.077	24	2.599	2.181	37.022	43	34.255	1.920	83.542	62	451.556	0.000	100.000
6	0.226	1.125	3.202	25	2.976	2.300	39.322	44	39.234	1.901	85.443	63	517.200	0.000	100.000
7	0.259	1.414	4.616	26	3.409	2.418	41.740	45	44.938	1.888	87.331	64	592.387	0.000	100.000
8	0.296	1.698	6.314	27	3.905	2.509	44.249	46	51.471	1.869	89.200				
9	0.339	1.809	8.122	28	4.472	2.613	46.862	47	58.953	1.833	91.033				
10	0.389	1.937	10.059	29	5.122	2.702	49.564	48	67.523	1.766	92.799				
11	0.445	1.995	12.055	30	5.867	2.772	52.336	49	77.339	1.656	94.455				
12	0.510	2.000	14.055	31	6.720	2.825	55.161	50	88.583	1.493	95.948				
13	0.584	1.969	16.024	32	7.697	2.839	58.000	51	101.460	1.282	97.231				
14	0.669	1.937	17.961	33	8.816	2.787	60.787	52	116.210	1.042	98.272				
15	0.766	1.907	19.868	34	10.097	2.737	63.524	53	133.103	0.803	99.075				
16	0.877	1.894	21.762	35	11.565	2.649	66.172	54	152.453	0.594	99.670				
17	1.005	1.814	23.576	36	13.246	2.535	68.708	55	174.616	0.330	100.000				
18	1.151	1.774	25.350	37	15.172	2.411	71.119	56	200.000	0.000	100.000				
19	1.318	1.774	27.125	38	17.377	2.288	73.408	57	229.075	0.000	100.000				

Filename	:	Form of Distribution	:Standard
ID#	:200202260915773	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:02:20	Axis Selection	:LogX-LinY
Laser T%	: 72.6(%)		

MN1401
Feb 25, 2002



S.P. Area	: 30306(cm² /cm³)		:90.00 (%) = 173.233(µm)		:53.00 (µm) = 56.91
Median	: 35.625(µm)		:95.00 (%) = 218.904(µm)		:38.00 (µm) = 50.95
Diameter on %	:5.000 (%) = 0.319(µm)	% on Diameter	:850.0 (µm) = 100.000(%)	Mean	: 64.098(µm)
	:10.00 (%) = 0.552(µm)		:600.0 (µm) = 100.000(%)	Variance	: 5519.687
	:20.00 (%) = 2.006(µm)		:425.0 (µm) = 100.000(%)	S.D.	: 74.295(µm)
	:30.00 (%) = 5.802(µm)		:300.0 (µm) = 99.008(%)	Mode	: 108.584(µm)
	:40.00 (%) = 14.734(µm)		:212.0 (µm) = 94.396(%)	Span	: 4.847
	:60.00 (%) = 60.847(µm)		:150.0 (µm) = 86.178(%)		
	:70.00 (%) = 88.052(µm)		:106.0 (µm) = 75.696(%)		
	:80.00 (%) = 121.795(µm)		:75.00 (µm) = 65.385(%)		

No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %	No.	Diameter	Freq. %	Under %
1	0.115	0.000	0.000	20	1.510	0.979	17.857	39	19.904	1.396	43.081	58	262.376	2.035	97.892
2	0.131	0.000	0.000	21	1.729	1.003	18.859	40	22.797	1.434	44.515	59	300.518	1.131	99.023
3	0.150	0.374	0.374	22	1.981	1.039	19.899	41	26.111	1.506	46.021	60	344.206	0.628	99.651
4	0.172	0.509	0.883	23	2.269	1.081	20.980	42	29.907	1.620	47.641	61	394.244	0.349	100.000
5	0.197	0.629	1.512	24	2.599	1.139	22.119	43	34.255	1.782	49.423	62	451.556	0.000	100.000
6	0.226	0.776	2.288	25	2.976	1.198	23.316	44	39.234	1.997	51.420	63	517.200	0.000	100.000
7	0.259	0.950	3.238	26	3.409	1.258	24.574	45	44.938	2.268	53.689	64	592.387	0.000	100.000
8	0.296	1.115	4.353	27	3.905	1.309	25.883	46	51.471	2.590	56.278				
9	0.339	1.174	5.527	28	4.472	1.366	27.248	47	58.953	2.948	59.227				
10	0.389	1.240	6.767	29	5.122	1.416	28.664	48	67.523	3.320	62.546				
11	0.445	1.263	8.030	30	5.867	1.455	30.119	49	77.339	3.669	66.215				
12	0.510	1.250	9.281	31	6.720	1.485	31.604	50	88.583	3.960	70.175				
13	0.584	1.213	10.494	32	7.697	1.496	33.100	51	101.460	4.157	74.332				
14	0.669	1.170	11.664	33	8.816	1.479	34.579	52	116.210	4.230	78.562				
15	0.766	1.127	12.791	34	10.097	1.467	36.047	53	133.103	4.157	82.719				
16	0.877	1.093	13.884	35	11.565	1.444	37.490	54	152.453	3.929	86.648				
17	1.005	1.029	14.914	36	13.246	1.416	38.907	55	174.616	3.561	90.209				
18	1.151	0.990	15.904	37	15.172	1.394	40.301	56	200.000	3.088	93.296				
19	1.318	0.974	16.877	38	17.377	1.385	41.686	57	229.075	2.560	95.857				

Filename	:	Form of Distribution	:Standard
ID#	:20020225092754	Calc. Level	:30
Circulation Speed	:12	R.R.Index	:1.16-0.10i
Ultra sonic	:02:00	Axis Selection	:LogX-LinY
Laser T%	: 72.7(%)		