BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

NANISIVIK MINE,
A DIVISION OF CANZINCO

NANISIVIK MINE CLOSURE PLAN

MINE OPENINGS CLOSURE PLAN

FINAL

0255-009-10.03
JANUARY 27, 2005

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Project No. 0255-009-10.03
Date: January 27, 2005

Mr. Bob Carreau
Corporate Manager, Environmental Affairs
Breakwater Resources Limited
Suite 950, 95 Wellington Street West
Toronto, ON
M5J 2N7

Re: Mine Openings Closure Plan, Nanisivik Mine, NU

Dear Bob:

Please find attached three copies of our above referenced report dated January 27, 2005. Should you have any questions or comments, please do not hesitate to contact me at the number listed above.

Respectfully submitted,
BGC Engineering Inc.
per:

Geoff Claypool, P.Eng
Geological Engineer

encl. Final Report, Figures, Appendices

GKC/sf

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LIMITATIONS OF REPORT

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1.0 GENERAL

1.1 Introduction

Nanisivik Mine is wholly owned by CanZinco Limited ("CanZinco"), which is a division of Breakwater Resources Limited ("Breakwater"). The Nanisivik Mine is located on the Borden Peninsula on northern Baffin Island in the Canadian Arctic at approximately 73º north latitude (Figure 1). The mine site is located on the south shore of Strathcona Sound, approximately 30 kilometres from Admiralty Inlet.

The Nanisivik Mine began production of zinc and lead concentrates in 1976. The current owner of the mine, CanZinco Ltd. (CanZinco), has been in possession of the mine since 1996. Prior to mid-2002, the Nanisivik Mine was scheduled to operate until the depletion of economic ore reserves in 2004 or 2005. However, depressed international base-metal prices necessitated a re-evaluation of the mine production plan in mid-2002. This assessment resulted in a reduction of economic ore reserves such that these reserves were depleted in September 2002. Mining operations were permanently ceased at that time.

The Final Closure and Reclamation Plan (FCRP) for the Nanisivik Mine was submitted to the Nunavut Water Board (NWB) by CanZinco in March 2004. Approval of the FCRP was conveyed by the NWB in a letter to CanZinco dated July 6, 2004. The Letter of Approval also outlined several terms and conditions which must be adhered to as part of the closure process. Item 13, point iii.) of the Letter of Approval states the following:

> *The Licensee shall submit for NWB review, by November 30, 2004, detailed engineering designs, stamped by an Engineer, for the closure of mine portals, vent raises and all other mine openings to surface.*

As such, this report has been prepared to satisfy this condition of the Letter of Approval.

1.2 Objective of Mine Openings Closure Plan

CanZinco's general approach to closure and reclamation of the Nanisivik Mine site follows the "Mine Site Reclamation Policy for Nunavut" published by the Department of Indian Affairs and Northern Development in July 2002. Accordingly, the guiding principle for closure and reclamation of the Nanisivik site is to "ensure the impact of mining on the environment and human health and safety is minimized".

The general objectives for the Mine Openings Closure Plan include the following:

- To meet the closure and reclamation requirements of the Water License and Land Leases;
- To return the site to a condition of similar environmental productivity and land use that existed prior to development of the mine facilities;

- To minimize the risk to the environment and human health and safety posed by the mine openings; and,
- To eliminate the requirements for long term post-closure care and maintenance.

1.3 Scope of Work

This document outlines the closure design for all mine openings at the Nanisivik site. The scope of the work undertaken includes the following:

- Compile existing information on mine openings including locations and current physical characteristics;
- Complete an engineering design for the closure of all mine openings; and,
- Provide a comprehensive report detailing the closure design and reclamation process for the closure of all mine openings.

As such, the report provided herein addresses the scope of work noted. Although engineering designs are provided for the reclamation of all mine openings, some field modifications to the design presented herein should be anticipated. This is due to the uncertainty in the geometry of some of the openings, potential safety concerns that may be identified in the field and difficulties that may be encountered in practically constructing the proposed reclamation measures.

2.0 BACKGROUND

2.1 Geology

2.1.1 Regional Geology

The bedrock geology of the area has been mapped in detail by Patterson and Powis (2002). The local bedrock geology map of the area is shown in Figure 2 and the regional bedrock stratigraphy is illustrated on Figure 3. The Nanisivik region is underlain by carbonate and terrigenous clastic strata of the Mesoproterozoic Bylot Supergroup. The Bylot Supergroup is comprised of two terrigenous formations (Adam's Sound and Arctic Bay formations) and two carbonate formations (Society Cliffs and Victor Bay formations) and a mixed carbonate and terrigenous clastic formation (Strathcona Sound Formation). Quartz-arenite of the Gallery Formation unconformably overlies the Proterozoic strata.

2.1.2 Orebody Geology

In the mine area, strata usually dips shallowly and the main geologic structure is faulting. Major structures that are recognized in the mine include the South Boundary Fault, which marks the southern margin of sulphide mineralization, and the Keystone Graben Fault, which defines the southern margin of the Main Ore Zone horst (Figure 4).

The various massive sulphide deposits contain more than 50 million tonnes of which barren massive pyrite bodies occupy most of the area and contain the largest sulphide tonnages. Zones containing sphalerite are present within the massive pyrite bodies, but are confined to a restricted vertical interval. All of the known significant sphalerite deposits are in horsts adjacent to the Keystone Graben. Each of the sphalerite-rich ore bodies is confined to a restricted vertical interval that varies in thickness and elevation from zone to zone. Flat sulphide contacts cut at low angles across dolostone bedding and sulphides rarely follow the beds.

The Main Ore Zone is an elongated, sinuous, lenticular body, hosted in carbonate, with a nearly horizontal upper contact. A number of bodies are irregular subvertical veins, while some other bodies underlie gently dipping shale contacts. These variations in structural style occur both in the massive pyrite and in the sphalerite zones.

The Main Zone deposit is about 3 km long. It is oriented east-west, although it is sinuous in plan. The deposit is broadly 'T' shaped, with a flat-topped upper section that is typically about 100 metres wide and 20 metres high. A remarkable feature of this deposit is the constant elevation of the top of the deposit over its entire length. The keel section of the deposit extends to about 80 metres below the upper section. While it is subvertical, no obvious controlling structures have been recognized to date. In places, flat-lying “wings” of sulphides extend out laterally from the keel zone.

The South Boundary Zone is wedge-shaped and consists of massive pyrite. It is controlled by the South Boundary Fault.

The accepted geological model is that the Nanisivik deposits are Mississippi-Valley Type ("MVT"). By definition, these are post-depositional, carbonate hosted deposits. Typically, they are coarse-grained and mineralogically simple. They tend to be sphalerite-rich, may be very large and may contain high base metal grades. However, MVT deposits include quite diverse deposits, different in shape, grade and mineralogy. This diversity appears to result from source fluid chemistry, rocks through which the fluids pass prior to deposition, source fluid temperature and the nature of the depositional environment.

2.2 Regional Permafrost

Nanisivik is located in the region of continuous permafrost. Permafrost has been observed to extend to a depth of at least 430 m, as observed in a borehole drilled from the underground workings. Ground conditions in the area have been characterized by NRC (1995) as having the potential for medium amounts of ground ice (as high as 20%) and mean annual ground temperatures colder than -10°C. This has been verified by ground temperature measurements at various locations around the mine site as cold as -13°C at depth. The depth of the active layer in natural ground has been observed to average between 1 to 2 m below ground surface.

2.3 Mining Methodology

Mining at Nanisivik was completed utilizing both open pit and underground mining methods. The following sections summarize each of the main mining methods used.

2.3.1 Open Pits

There are four small open pits (Figure 5) on the property as follows:

- The West Open Pit is located in the West Adit Area, between the 00/01 Portals and adjacent to Twin Lakes Creek. The pit was actively mined between 1980 and 1995. The dimensions of the West Open Pit are approximately 75 by 200 m and the highest pit wall was approximately 25 m (prior to partial backfilling of the pit during progressive reclamation of the mine site).
- The East Open Pit is located in the East Adit Area adjacent to the 39 Portal that connects to the primary underground workings. The pit was actively mined from 1987 to 2001. The dimensions of the East Open Pit are approximately 100 by 200 m and the highest pit wall was approximately 20 m (prior to partial backfilling of the pit during progressive reclamation of the mine site). Other mine openings within the East Adit Area include the 88 Portal and the Cut 5 Access opening.
- The East Trench is located adjacent to and east of the 88 Portal in the East Adit area. The trench was mined between 2000 and 2001. The dimensions of the trench are approximately 10 x 50 m and up to 15 m deep (prior to partial backfilling of the pit during progressive reclamation of the mine site). Minor drift development was undertaken at the East Trench but it did not connect to the main underground workings.
- The Oceanview Pit is located north and east of the East Adit area. The pit was actively mined from 2000 to 2002 to extract near surface ore. The pit was excavated as a side hill cut with dimensions of approximately 75 x 100 m and up to 10 m deep (prior to partial backfilling of the pit during progressive reclamation of the mine site).

2.3.2 Underground Workings

The mining method utilized in the underground workings consisted of drilling and blasting in ore using standard trackless equipment (jumbo drills, remote scoop trams, and haulage trucks). Ore was hauled to an underground pass that controlled ore flow to the primary and secondary crushers. All crushing took place in the underground mine and the crushed ore was moved to surface via a conveyor system. Since the mine is located in permafrost, there was no requirement for water pumping.

The Main Ore Zone at the Nanisivik Mine was separated into lenses and zones as shown on Figure 6. These include the Main Lens, Lower Lens, Keel Zone and Shale Zone.

The Main Lens mined at the Nanisivik Mine was flat lying and outcropped on surface at both ends of the zone. The geometry of the mineralized body and the presence of permafrost permitted large underground excavations and the use of large scale mining equipment. In the Main Lens, where the dimensions of the mineralized zone are up to 150 m in width and 20 m in height, the primary mining method was room and pillar. For the other zones adjacent to the Main Lens, the mining methods were drift and slash stoping with some cut and fill stoping. The same mining equipment was used in these zones as in the Main Lens. The extent of the underground workings is shown in Figure 6.

Three small underground mines were developed at the K-Baseline, Oceanview and Area 14 sites. The underground workings at K-Baseline and Oceanview are illustrated on Figure 7. No drawings are currently available to illustrate the underground workings at Area 14. There is one portal entrance to each of these workings and the Oceanview workings has two ventilation raises to surface. There was also minor underground drift development at the East Trench. None of these workings connect with each other or with the Main Lens development workings. As discussed in later sections, some of these openings have been previously closed.

2.4 Previous Work on Mine Openings

2.4.1 Lauzier Reports

Mr. Guy Lauzier was the Manager of Technical Services at the mine when the mine closed in September 2002. During his time as Manager of Technical Services, he produced several internal reports and external letters that document the underground mine conditions and proposed closure plans for the various portals and openings. The following significant reports were reviewed as part of the current work scope and some summary comments are provided, as follows.

<u>Nanisivik Mine Accesses Closure Plan – April 2002 (updated in July 2004)</u>

This report provides a comprehensive condition survey of all portals and underground openings and was prepared to comply with Part XVII of the Mine Health and Safety Regulations for the Cessation of Work (17.03). The original report was updated in July 2004 by Mr. Lauzier for submission as part of the Long Term Mine Stability Assessment which was submitted to the Nunavut Water Board by CanZinco in September 2004.

<u>Letter to Chief Inspector of Mines – June 12, 2002</u>

The letter details several issues raised by the Mine Inspector but provides a tabular summary of the proposed plans for closure of mine openings and notes which openings had already been closed at the date of the letter.

Crown Pillar Stability Analysis – July 4, 2002

This brief memo, which is included in this report in Appendix I, addressed the issue of surface subsidence adjacent to mine portals. The main conclusions of the memo are discussed in Section 5.2. It should be noted that this report was produced prior to the Horseshoe Blast at the East Open Pit.

During his time at Nanisivik Mine, Mr. Lauzier was registered as a professional engineer in Nunavut but he is currently registered as a professional engineer in Quebec only. Mr. Lauzier prepared these reports when he was a professional engineer in Nunavut and they document his opinions at that time. As such, they will be used as technical guidance for the final closure designs.

2.4.2 September 2004 BGC Inspection

In 2004, a longitudinal crack was observed in the bench directly above the West Open Pit (WOP) highwall. In response, BGC was requested to assess the cause of this cracking and address the issue of portal safety. Portal safety is a concern because men and equipment will require access to the portals (00 and 01) at the WOP during the underground waste disposal program scheduled for 2005.

As a result, Dr. Wayne Savigny, P.Eng, P.Geol. from BGC visited the site from September 8 to 12, 2004. Dr. Savigny had previously been involved with underground geotechnical issues at Nanisivik Mine. His assessment attributed the crack formation to a toppling mechanism and provided recommendations with respect to safety of the portals for access. The 39 Portal at the East Open Pit was also inspected to assess remedial requirements. Dr. Savigny's recommendations are discussed in Section 6 and his site memo is attached as Appendix II.

2.4.3 Nanisivik Mine Rock Piles and Open Pits Closure Plan

This report was submitted as part of the overall reclamation plan for Nanisivik Mine in February 2004 Gartner Lee (2004a). The report details the reclamation plan for the waste rock piles and open pits including details regarding backfilling, final covering and contouring of the open pits. Several portals, including the 00 Portal, 01 Portal and 39 Portal, are located within the open pits. As such, the closure design for these particular mine openings must be compatible with the reclamation plan for the open pits. This was taken into consideration when developing the closure design for these particular portals.

3.0 INVENTORY OF EXISTING MINE OPENINGS

Mine openings include all portals, adjacent highwalls and raises. The location of all mine openings are illustrated in Figure 5 and mine grid coordinates summarized in Table 1.

All of the portals were temporarily blocked using fencing or rockfill to prevent access into the underground workings after mine operations ceased in September 2002. Due to inactivity in the underground, some portals have completely, or partially, filled with ice. Some raises were permanently closed prior to cessation of mining activities in September 2002 by backfilling the raise with rockfill. The following sections summarize the current physical condition of each opening. As well, the physical characteristics of each opening are illustrated in Figures 8 through 19 and are summarized in Table 1. The information that is presented is based on available information derived from Lauzier (2002b) and visual inspections by BGC.

3.1 Portals

There are two main types of portals present at the Nanisivik Mine site. Bare rock portals were developed directly into the rock, with no additional surface structure (other than occasional use of bolts and strapping). Culverted (corrugated metal pipe) portals were developed by constructing a culverted entry into the portal. The culverts were constructed to improve safety conditions around the portal entrance or provide more reliable access in areas subject to snow drifting. The culverts vary from full circumference to upper half circumference with a lower concrete pony wall base.

3.1.1 Lower Adit

The Lower Adit, illustrated in Figure 8, provided the main access into the underground crusher and fine ore bin, as well as secondary access to the Main Ore Zone. The adit housed the feed belt from the fine ore bin to the DMS plant and Mill in a covered galley way.

The Lower Adit was originally cut at approximately 3 by 5.5 m. The collar of the adit was encased in concrete, resulting in an approximate 5 by 3 m opening and 0.25 m thick concrete walls inside the solid rock and up to 0.5 m thick outside the solid rock. The concrete roof outside of the solid rock is supported with steel beams fixed to the walls. The area above the concrete was subsequently filled with rockfill. Supported by a 0.5 m thick concrete facing.

The entrance to the Lower Adit is currently gated to restrict access into the underground mine workings. However, the Lower Adit has recently been accessed during the decommissioning of the feed belt. As such, it is known that no ice plug has developed within the portal area.

3.1.2 00 Portal

The 00 Portal, illustrated in Figure 9, was the principal access at the western extremity of the mine. The portal measures approximately 5 x 5 m in cross section. The brow immediately above the portal is approximately 4 to 5 m high. The brow is bolted and there is a fenced catch bench directly above the brow. A portion of the rib pillar (00-11/1) connecting the 00 and 01 portals was removed during the final stages of mining. The current status of the rib pillar is discussed further in Section 3.3.1.

The entrance to the 00 Portal was fenced after cessation of mining activities in September 2002 of the mine to prevent access into the underground mine workings. In 2004, the portal was opened to prepare for the underground waste disposal program to be undertaken during 2004/2005. When the portal was accessed, it was observed that the walls are covered in frost but no ice plug is present.

A crack has developed on the catch bench approximately 2 to 4 m from the edge of the highwall. The cause of the cracking is discussed further in Section 3.3.1 and mitigative requirements are discussed in Section 6.

3.1.3 01 Portal

The 01 Portal, illustrated in Figure 10, houses the main ventilation fans. During mining operations, four 75 hp fans were mounted in the bulkhead. Currently, only two of the vent fans remain. The two vent fans are mounted in a plate steel bulkhead on a rockfill pad approximately 18 m wide by 12 m high and extending 10 m into the underground side of the opening. The rockfill pad is constructed of mine waste and shale in a permanently frozen state. The size of the steel bulkhead is approximately 0.2 m wide, 22 m long and 4 m high. There is a fenced catch berm 4 m above the opening as a safety measure.

This portal does not provide access to the underground works due to the presence of the bulkhead in the portal entrance.

The 01 Portal was inspected by Dr. Savigny of BGC in September 2004. A crack was also observed on the bench above this portal. This crack is thought to be an extension of the crack observed above the 00 Portal. The cause of the cracking is discussed further in Section 3.3.1 and mitigative requirements are discussed in Section 6.

3.1.4 09 South Portal

The 09 South Portal, illustrated in Figure 11, is a culverted entry giving access to the Main Ore Zone on the south side of 09 Block. The 09 south drift is approximately 5 x 5 m in cross section. The culvert is round with a diameter of 5 m and a length of 28 m. The bottom of the culvert is filled with rockfill to provide a smooth floor. The culvert extends 13 m inside the shale bedrock of 09 south drift, leaving 15 m exposed on surface, a portion of which is covered with talus from the slope above.

The entrance of the 09 South Portal was plugged with rockfill material after mining operations ceased in September 2002. The portal has since been re-opened to provide access to the underground as part of the underground waste disposal program currently underway. According to site staff, an ice plug had formed in the portal and it had to be melted in order to gain access into the underground workings at this location.

3.1.5 17 North Portal

The entrance to the 17 North Portal (Figure 12) is a culverted entry giving access to the Main Ore Zone and the former compressor room on the north side of 16 block in the Main Mine. The 17 North Decline is approximately 5 x 5 m in cross section and the culvert is half round with a diameter of 5 m and a length of 28 m. The culvert is supported by a 0.25 m thick by 2 m high concrete wall on either side and extends 5 m inside the dolostone bedrock of the drift. This leaves 23 m exposed on surface.

The entrance to the 17 N portal was plugged with rockfill material after mining operations ceased in September 2002. Currently, the portal remains blocked and will remain so until permanent closure measures are implemented. Ice conditions within the portal are currently unknown.

3.1.6 39 Portal

The 39 Portal, illustrated in Figure 13, was the main access into the east end of the Main Ore Zone for much of the mine life. Mining activities late in the mine life removed all the pillars within the extreme east end of the mine itself. Additionally, the remaining material in the rib between the mine and the East Open Pit was removed resulting in an opening of over 50 m wide by 12 to 15 m high (called the 38-11 stope). Additional detail regarding the Horseshoe blast is provided in Section 3.3.2.

3.1.7 Cut 5 Access Portal

The Cut 5 Access Portal is located in the East Open Pit, approximately 50 m east of the 39 Portal. Minimal information is currently available for this opening other than the fact the it is a bare rock portal approximately 4 m high by 6 m wide. The brow above the opening is approximately 10 m high. Visual inspection of the opening in July 2004 by BGC indicated that an ice plug was present in the opening directly proximal to the entrance. Note that since limited information is known about the opening, no schematic drawing is provided.

3.1.8 88 Portal

The 88 Portal, illustrated in Figure 14, is an entrance at the east end of the lower lenses of the mine. This portal was used as the main access at the east end of the mine during the later portion of the mine life. The 88 Portal has a cross section of approximately 5 x 5 m and a brow height of approximately 3 m. Steel belts were installed at the base of the crown pillar directly above the portal likely as a remediation measure against rockfalls.

A fence was placed at the portal entrance to prevent access into the underground workings at this location. Frost and ice formation has been observed at the entrance to the mine portal during inspections in 2004. The ice conditions beyond the immediate portal entrance were observed by mine personnel during underground waste disposal operations. It was noted that the ramp leading from the 88 Portal entrance was covered in ice but the stope was not completely blocked with ice.

3.1.9 K Baseline Portal

The K Baseline portal, illustrated in Figure 15, is a culverted entry formerly used to access the K Baseline orebody. The K Baseline decline is approximately 5 x 5 m in cross section and the culvert is half round with a diameter of 5 m and a length of 28 m. The culvert is supported by two concrete pony walls, 1 m wide by 2.4 m high, on both sides and these extend 3 m inside the dolostone bedrock of the drift. Of the remaining 25 m, all but approximately 5 m has been covered with waste rock material.

The portal has been inactive for a period of nearly 10 years and ice has completely filled the access to a point 20 m inside the culvert. The portal entrance was plugged with rockfill after mining operations ceased in September 2002. In October 2004, the top of the culvert was removed and the inside was partially filled with rockfill. The presence of ice in the culvert was confirmed during these operations.

3.1.10 Oceanview Portal

The Oceanview Portal, illustrated in Figure 16, was a bare rock entrance into the north side of the Oceanview underground workings and had a cross section of approximately 5 x 5 m. The brow was approximately 5 m in height.

As of October 2002, the portal had been filled with waste rock and covered over with overburden from the Oceanview pit. Lauzier (2002b) indicates that the portal was filled with ice prior to construction of the closure plug.

3.1.11 Area 14 Portal

The Area 14 Portal was a bare rock portal that provided access to the Area 14 underground workings. Mining ceased in this area around 1987 and the portal was backfilled with waste. The waste was covered and contoured with shale in 1987 and 1988. It should be noted that no geometric information or pre- or post-closure photos are currently available for this portal.

3.2 Raises

3.2.1 Shale Hill Raise

This raise to surface from the underground workings of the Shale Hill zone provided ventilation for the area as illustrated in Figure 17. The top of the 3 m diameter by 47 m high raise was sealed with a 3 m diameter steel tank with the bottom cut out and with two adaptors in the top for 36 inch ventilation fans. The tank was fixed to a cemented collar at the top of the raise.

Information provided by the mine site indicates that the fans have been removed. The raise was partially filled with waste rock in 2002. It is possible that the backfilling was completed to surface after the Lauzier (2002b) report was produced and this will be confirmed during a field inspection in spring 2005.

3.2.2 Oceanview East Raise

The Oceanview East Raise, illustrated in Figure 18, is situated at the extreme east end of the Oceanview underground workings. The 4 by 4 m raise is approximately 10 m deep and provided ventilation for the underground workings. The raise was covered with a wooden wind deflector with a locked door.

In 2002, the wooden deflector was removed and the raise was backfilled with waste rock as part of the progressive reclamation of the mine site. During backfilling, it was noted that an ice plug was present in the raise at a depth of approximately 1.5 m below ground surface. As such, waste rock was placed only to this depth. A 3 m mound was placed on top of the raise to accommodate for possible future settlement of the ice plug.

3.2.3 Oceanview West Raise

The Oceanview West Raise, illustrated in Figure 19, is located near the west end of the Oceanview underground workings. The 3 m diameter raise is approximately 26 m deep and provided ventilation for the underground workings. The raise was covered by a steel enclosure with a locked wooden cover.

In 2002, the steel enclosure was removed and the raise was backfilled with waste rock as part of the progressive reclamation of the mine site. During backfilling, it was noted that an ice plug was present in the raise at a depth of approximately 1.5 m below ground surface. As such, waste rock was placed only to this depth. A 3 m mound was placed on top of the raise to accommodate for possible future settlement of the ice plug.

3.2.4 Area 14 Raise

The Area 14 Raise, as illustrated on Figure 20, has a cross section of 5 by 5 m and an approximate depth of 8 m. Mining ceased in this area around 1987 and the raise was completely backfilled to the floor of the underground workings. Backfilling was completed with waste rock and the surface was then covered and contoured with shale in the summer of 1987 and 1988. Note that no pre- or post-closure photographs are currently available for this raise.

3.3 Highwalls

3.3.1 West Pit Highwall

The West Pit highwall, illustrated on Figure 21, is the surface expression of the limits of open pit mining carried out at this location over the years. It has a total lateral extent of approximately 188 m and varies in overall height between 8 and 12 m depending on location. Sulphide exposures exist on the highwall as illustrated on Figure 21.

Prior to cessation of mining activities in September 2002, steel pipes were laid against the highwall for most of the distance between 00 and 01 Portals (the 00-11/1 rib pillar) and a large volume of rockfill was piled against them. Several 5 m long rings were blasted from the rib pillar 00-11/1 and mucked from the 00-11 stope underground.

In 2004, cracking was observed in the bench immediately above the highwall. One, and at times two, generally continuous cracks run the length of the bench, usually set back 2 to 4 m from the crest of the highwall. As noted earlier, the cracking on the bench above the highwall was inspected in September 2004 by BGC. The observations and resultant recommendations are summarized in the memorandum included in Appendix II. Based on visual observations and joint mapping, BGC attributed the cracking to a toppling failure mechanism. This toppling failure was caused by unfavourable foliation orientation (relative to the highwall orientation) exacerbated by strain relief occurring on the open highwall face.

3.3.2 East Pit Highwall

The East Pit Highwall (Figure 22) is the surface expression of the limits of open pit mining carried out at this location over the years. It has a total lateral extent of approximately 163 m and varies in overall height, depending on location, between approximately 15 and 20 m. The top of the highwall is partially fenced. The top 5 m of the highwall was sloped back to 60° at some locations. Sulphide exposures exist on the highwall as illustrated on Figure 22.

As discussed previously in Section 3.1.6, the 39 Portal and adjacent 38-11 stope provide an opening into the mine over 50 m wide by 12 to 15 m high. In 2002, during the last few months of mining operations, an attempt was made to seal the 39 Portal and the adjacent 38-11 stope by blasting a portion of the portal crown pillar (the Horseshoe Blast). The blasted portion of the portal crown pillar dropped into the portal and stope, leaving an opening exposed above the muck of an approximate length of 60 m. Additional trim blasting and contouring was completed along the highwall in October 2004 to temporarily block the opening into the stope to improve mine ventilation. This blockage will be removed in 2005, and the stope will be closed appropriately.

3.3.3 East Trench Highwall

The East Trench Highwall (Figure 23) is 24 m wide by 75 m long and 20 m deep at the west end. In 2002, much of the East Trench was backfilled with waste rock and the height of the highwall was reduced to a maximum of approximately 10 m. The opening to the underground drift development at the base of the East Trench Highwall was inspected in 2004 and was observed to be filled with ice. Information supplied by the mine site indicates that the drift development at the back of the East Trench was limited to within 5 m of the highwall.

3.3.4 Oceanview Pit Highwall

The Oceanview Pit highwall (Figure 24) is the surface expression of the limits of open pit mining carried out to the east of the Oceanview underground workings. The highwall has a total lateral extent of 300 m and averages 4 m in height, with a maximum height of approximately 8 m.

The Oceanview Pit was partially backfilled with waste rock and covered with overburden in 2002 as part of progressive reclamation of the mine site. As a result, the highwall of the pit was reduced to a maximum of approximately 2 to 3 m.

4.0 DESIGN GUIDELINES

In order to prepare engineering designs for the closure of the various openings, it is necessary to review relevant regulatory guidelines and Acts that are appropriate for the closure of mines. As a result, the following regulatory guidelines and acts were reviewed:

<u>Indian and Northern Affairs Canada – Mine Site Reclamation Policy for Nunavut (2002)</u>
The policy states that a Mine Closure and Reclamation Plan should fully address the following points:

- The progressive reclamation of the site during the life of the operation, to the extent feasible, given the mining and processing methods employed.
- The removal or stabilization of any structures and workings remaining at the site after closure to ensure that, over time, they remain physically sound and are no threat to public safety.

- The design of tailings and waste rock disposal areas within accepted engineering standards for slope stability and erosion control.
- The reclamation of the surface to meet acceptable standards.

<u>Mine Safety Division– Consolidation of Mine Health and Safety Act – Amended February 2003</u>

- Section 17.03 notes the following clauses related to mine closure;

  (1)…the owner or manager shall cause the entrances to the mine or exploration site and all other pits and openings that are dangerous by reason of their depth or otherwise, to be suitably protected against inadvertent access…

  (2)…the owner or manager shall ensure that all shafts, raises, stope openings, adits or drift openings to surface are either capped with a stopping of reinforced concrete or filled with material so that subsidence of the material will not pose a future hazard.

Based on this review, the closure design must satisfy the Mines Act by preventing access into the underground mine workings. The closure design will also incorporate backfilling of raises and other openings as opposed to reinforced concrete.

5.0 CLOSURE DESIGN CONSIDERATIONS

5.1 Design Objectives

In addition to the general closure objectives stated in Section 1.1, the specific objective of the closure design of mine openings includes the following:

- to prevent access to the underground workings,
- to reduce the potential for subsidence of the ground surface proximal to the openings, and
- to mitigate acid generation potential of sulphide exposures on highwalls proximal to the portals.

It should be noted that the portal closure design is not required to retain water. This is due to the fact that the normal ground temperatures (-13°C) ensures that any water entering the mine will freeze in-situ. Additionally, it should be reiterated that the design will not completely eliminate the potential for surface subsidence but will limit the potential and magnitude for ground subsidence to occur.

The following section identifies potential stability issues that must be addressed by the closure design to satisfy this requirement.

5.2 Crown Pillar Stability

The issue of crown pillar stability for the Nanisivik Mine has been studied and documented on several occasions including most recently in the submission to the NWB by CanZinco dated September 30, 2004. Studies by Lauzier (2002a) and Betournay (2003) state that, in general, *"there is a low risk associated with instability and subsidence of the underground mine".* The areas considered most vulnerable to instability are the areas proximal to the mine openings.

According to Lauzier (2002a), openings exhibiting the following characteristics could potentially cause subsidence of the surface:

- a span greater than 75 m,
- ground cover less than 35 m, and
- height of the excavation greater than 14 m.

Using this criteria, only the mine openings at the West Open Pit and East Open Pit areas present potential for subsidence. In these areas, the openings connect directly to the underground mine.

If the subsidence criteria are met, surface subsidence may be limited if the strength of the rock above the opening is adequate to support the ground above. Using typical rock strength characteristics, Lauzier (2002a) reports that portals with a brow height of 5 m will satisfy the stability conditions to long term stability. Since the mine openings at the West Open Pit and East Open Pit areas have brow heights in excess of 5 m, the conditions for long term stability are considered to be satisfied without any additional support.

It should be noted that the design work completed by Lauzier is a conventional analysis and does not account for any additional support provided by permafrost which is present within the Nanisivik Mine. It should also be noted that the Lauzier analysis has been used as a guide for the development of the closure designs and no additional analysis has been completed for this report.

6.0 CLOSURE DESIGN

The reclamation requirements for each specific mine opening are summarized in Table 2. The estimated material volume requirements for the reclamation of each portal are summarized in Table 3. It should be noted that the specified reclamation requirements and associated material volumes are subject to change to reflect actual field conditions. The following sections outline general closure design requirements for each type of opening.

6.1 Portals

The general closure design concept for mine portal involves constructing a portal plug comprised of rockfill into each of the portals. The portal plug will satisfy the design criteria by providing the following:

- prevent access to the underground workings,
- provide some support for the portal crown pillars, and
- cover sulphide exposures on highwalls adjacent to the portals to mitigate the potential for acid generation.

It should be noted that support for the portal crown pillars is not required according to the analysis completed by Lauzier discussed previously in Section 5.3. However, limited support for the crown pillar is provided in the closure design by including the placement of some backfill within the portal. Practical construction considerations will prevent the placement of rockfill tight to the roof line, but some support will be provided if any deformations of the crown occur. Hence, some cracking at the portal highwalls should be expected.

Figures 25 and 26, show typical closure designs for both portals directly encased in rock and culverted portals.

If safe to do so, portals directly encased in rock will be inspected by the Field Representative prior to fill placement. Structural geology in the near portal area will be documented and field modifications to the plug design will be made if required.

Portals directly encased in rock will be filled with waste rock or shale as far back into the portal as practically and safely as possible, to a maximum portal depth of 5 m. The extent to which the plug can be extended into the portal is dependent on construction equipment. It is not expected that the plug will be tight to the back (roof) of the portal, or extend a full 5 m from the portal entrance at the back, due to practical construction considerations. Since it is not a design requirement, placement of backfill into the portal should be completed on an “as much as practical” basis and will only be completed, if deemed safe to do so.

The construction details of the portal plug will depend on the type of rockfill used.

If the rockfill is comprised of shale, the following construction sequence will be followed:

- the plug will extend out of the portal opening,
- the outside face will be contoured to an appropriate grade (3H:1V), and
- a minimum thickness of 0.25 m of armour material will be applied to the shale surface.

If the rockfill is comprised of waste rock the following construction sequence will be followed:

- a 1.95 m (minimum thickness) cap of shale will be applied to the outside face of the waste rock,
- the outside face will be contoured to an appropriate grade (3H:1V), and
- a 0.25 m (minimum thickness) layer of armouring material will be applied to the shale surface.

Some compaction control of the portal plug lifts will be required. In addition, the final 3H:1V subgrade surface (beneath the shale cover) will require some compaction. Both of these requirements will assist with the integrity of the final shale and armour cover.

For culverted portals, a similar construction sequence will occur:

- the top portion of the culvert will be removed,
- shale or waste rock will be placed into the portal as far as possible and will extend back to the front of the culvert,
- the surface of the backfill (top and front face) will be covered with a minimum thickness of 1.95 m of shale and sloped to a maximum grade of 3:1, and
- a minimum thickness of 0.25 m of armouring material will be applied to the surface of the shale to prevent erosion.

The following additional apply to both plug designs:

- If an ice plug is encountered within 5 m of the portal entrance, the placement of rockfill will extend only to the ice plug.
- For culverted portals, the backfill must cover the remaining portion of the culvert that is to be left in place.
- Armour material must be non-acid generating and resistant to weathering, similar to the Twin Lakes sand and gravel.
- The plug and shale cap will be constructed such that all sulphide exposures on highwalls adjacent to the portals are covered by a minimum thickness of 2.2 m of shale and armour material.

6.2 Raises

The general closure design concept for raises involves backfilling each of the raises with rockfill. Figure 27 shows typical closure design concept for a raise.

The following construction sequence will be followed during the closure of each of the raises:

- the surface structure will be removed,
- the raises will be backfilled with rockfill (shale or waste rock) to 1.5 m below surface,
- the remaining portion of the raise will be backfilled with shale to surface, and
- a cap of a minimum of 1.95 m of shale and 0.25 m of armouring material will be applied at surface. This cap is to accommodate minor amounts of surface subsidence and to ensure the rockfill within the plug remains in a frozen condition year round.

It should be reiterated that many of the raises have already been backfilled with rockfill and the only raise that remains to be completely backfilled is the Shale Hill Raise.

Post construction monitoring will be conducted to evaluate if the ice plug is subsiding resulting in surface deformation. It should be noted that the design provides excess material at surface so that if only minor amounts of subsidence occur, any resultant surface disturbance will be minimized.

6.3 Highwalls

The closure design for highwalls was conceptually covered in the Waste Rock and Open Pits Closure Plan approved by the NWB in July 2004. This plan outlines the closure plan for each open pit. Essentially, the open pits are to be backfilled with waste rock, covered with shale and a layer of armouring material and contoured to fit natural topography as much as practically feasible. Sulphide exposures on the highwalls are to be covered by a minimum of 2.2 m of shale and armour material.

The highwalls at most of the small open pits (Oceanview and East Trench) are small and no specific remedial work is prescribed. The physical characteristics of the East and West Open Pit highwalls require that additional remediation work prior to placement of waste rock. This remedial work is required to provide the following:

- safe working conditions during the backfilling of the pits, and
- provide safe and adequate access to the portals and stopes such that backfilling of the portals can occur as required.

The following sections provide remediation plans for the East and West Open Pit highwalls.

6.3.1 West Open Pit Highwall

Figure 28 provides some detail on the current configuration and the closure design for the West Open Pit highwall. Within the designated portion of the highwall between the 00 and 01 Portals (excavated portion of 00-11/1 rib pillar), conduct the following remedial work:

- Trim the southwest edge of the crown pillar over an approximate 12 m length.
- Check scale the exposed edge of the crown pillar after the trim blast.
- Use a dozer to push a ramp across the waste rock and steel pipes to open access into the stope.
- Push fill into the stope as far as possible without the operator passing under the crown pillar.
- Ramp fill across the remaining highwall and completion of the preceding task.

This conceptual plan may need to be modified as practical safety and construction considerations will determine the finally constructed plan.

6.3.2 East Open Pit Highwall

Figure 29 provides some detail on the current configuration and the closure design for the Easy Open Pit highwall. The brow above the 39 Portal and adjacent 38-11 stope was inspected by BGC who identified an area of the brow which was unsafe for people to work under, as will be required to adequately close the portal. As a result, the following remedial work was proposed:

- Trim blast the designated area to reduce the slope gradient (see Figure 29).
- Scale the portion of the crown pillar where the trim blast was completed.
- Scale the remaining steep face of the crown pillar between the designated areas.
- Open access to the top of the Horseshoe Blast muckpile.
- Import shale fill and push it as far into the stope as possible without the equipment operator passing under the crown pillar.
- Continue placing fill until the entire Horseshoe Blast area and recently trimmed area are completely backfilled and slopes so as to conform approximately to the pre-existing natural slope.

Again, this plan may require field modifications as required.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Construction Supervision

A qualified technical representative, the Field Representative, will be on-site daily during construction of the mine portal plugs and will be working under the direction of a professional geotechnical engineer. Field fit modifications to the reclamation design are anticipated and this continuous attendance of the Field Representative will be required to identify and approve these adjustments, in consultation with the site manager. The Field Representative will also be required to collected information that is required to produce the as-built report required after the construction is complete. The Field Representative will ensure that the constructed works conform to the design drawings and design intent of the reclamation plan described in this document. The Field Representative will have the authority to reject any substandard work and order the contractor to redo the work such that it meets the requirements and the intent of the contract and drawings. The Field Representative will provide daily inspection reports summarizing work undertaken, methodology used, manpower and equipment utilized and written confirmation regarding field decisions made and design alterations permitted.

7.2 Shift Documentation

The Site Supervisor, representing the contractor, will be required to maintain accurate records of all fill placement operations and shall provide the Field Representative with a copy of the daily record at the end of each shift. The following information will be recorded on the fill placement summary sheets:

- Estimated quantity of material placed during the shift.

- Location of rockfill sources placed in each shift (waste rock or shale).
- Confirmation if any rockfill was previously placed before any new rockfill was placed.
    - Includes type of rockfill and to what depth.
- Confirmation if and where an ice plug was encountered.
- Number of workers and equipment engaged during the shift.
- Unusual occurrences during fill placement such as portal stability concerns, extreme precipitation events or variations in fill quality.
- Any safety concerns or incidents noted during the shift.

These reports will supplement the daily reports to be filled out by the Field Representative.

7.3 Safety

As in all reclamation construction at the mine site, safe working conditions must be maintained throughout construction. Construction of closure plugs for mine openings will require working in and around the underground mine workings. Consideration must be given to potential for rock fall activity in and around the portals during construction of the portal plug. As such, additional temporary remedial works may be required during construction. These remedial works may include, but not be limited to, scaling of loose rock, constructing rockfall deflection berms or installing temporary fencing.

Since part of the work may be completed underground (within 10 m of portal entrance) a shift boss may be required to comply with mine safety regulations. This aspect should be verified by mine personnel prior to initiation of the work and appropriate measures should be taken to comply with all mine safety regulations.

The Field Representative and a designated safety person representing the contractor will be present at each portal during all construction operations to ensure a safe work place is maintained. Either the Field Representative or the designated safety person may request additional temporary remedial works, if they feel they are required.

7.4 Fill Placement

Rockfill used in closure of mine openings may include shale or waste rock. Fill placement into the portal openings may occur by the following sequence:

- stockpiling shale near the portal entrance, and
- transporting shale into the portal by means of loader or dozer.

If a portal is deemed unsafe to enter or work under by the Site Supervisor (possibly a shift boss) or Field Representative, the rockfill may only be placed into the portal as far as the dozer or loader operator can push it without the cab of the equipment proceeding beneath the brow of the portal.

The outside face of the portal plug will be graded to a slope no steeper than 3H:1V and will be blended into the natural topography as much as possible. Placement of the portal plug lifts will be subject to the compaction specifications noted on Figure 28 and 29. Compaction and placement of shale lifts and armour surface for the cover should be completed in accordance with the requirements outlined in the QA/QC plan (BGC 2004).

7.5 Surveying

Surveyors will be required to undertake the following tasks with respect to the construction of the portal plugs and reclamation covers:

- Elevation documentation on portals, raises and culverts to be covered.
- Validation of cover thicknesses;
- Topographic surveys and the calculation of quantities placed for the various materials;
- Coordinates and elevations of all instrumentation installed; and,
- Production of final as-built drawings in both plan and section views.

7.6 Instrumentation

Settlement monitoring points will be installed into the crown pillars immediately above the portals. The settlement monitoring points will provide a means of monitoring the magnitude and rate of subsidence in these areas in the future.

The Field Representative, in combination with the Site Supervisor, will be required to coordinate the installation of these instruments, where and when practical.

7.7 As-Built Report

As required in the Water License, an as-built report will be produced for the closure plugs constructed for each mine opening. These reports will contain the following information:

- Summary of construction schedule;
- Summary of quantities and test results on materials placed;
- Summary of technical decisions made as they may deviate from original design specifications and/or intent;
- Survey information and plans; and,
- A selection of construction photos.

The objective of the as-built report is to confirm that the plugs have been constructed in accordance with the design intent. Any deviations, and the associated rationale, will also be included. This report will be stamped by a professional geotechnical engineer, registered to practice in Nunavut.

7.8 Construction Schedule

Construction of closure plugs for the various mine openings is scheduled to occur in 2005. The actual construction date will vary depending on trying to optimizing equipment usage and mine ventilation requirements. It is currently anticipated that most of the construction will occur in July and August, 2005.

8.0 PERFORMANCE MONITORING

In accordance with the “Guidelines for Abandonment and Restoration of Mines in the NWT” (1990), a performance monitoring program has been developed to provide a means of measuring the effectiveness of the reclamation works for the closure of mine openings.

In general, the monitoring program provides for performance monitoring during the Reclamation Period and for a subsequent five year Closure Period. The monitoring program will consist of visual observations and survey measurements. Visual observations will assess the physical stability of the portal and raise plugs and any large scale deformation of the crown pillar above the mine opening. Survey measurements will be utilized to assess the magnitude and rate of small scale deformation of the crown pillar above the portals.

During the reclamation construction, locations above the crown pillar proximal to the mine opening will be selected for installation of survey pins by the on site geotechnical engineer. The survey pins will be installed such that they provide a reliable and repeatable method of assessing surface deformation. A baseline survey of the survey pins will be collected during the reclamation construction period.

Each year, for the first five years following the reclamation period, the physical integrity of the reclamation works will be inspected by a professional engineer, licensed to practice in Nunavut. The site inspection will evaluate and document evidence of instability, settlement, and deterioration of the crown pillar in the immediate vicinity of the portal plugs. In 2010, the success of reclamations works will be reviewed based on information collected during the Closure Period monitoring. Possible additions or adjustments to existing reclamation works will be determined during this review.

9.0 CONTINGENCY PLANS

It should be restated that the design will not eliminate the potential for surface subsidence of crown pillars but will limit the magnitude and potential for ground subsidence to occur. Therefore, it is possible that surface subsidence and related deformation and cracking may occur. As such, a contingency plan has been developed in order to address performance issues that may be identified during the performance monitoring program. The potential issues include, but not limited to, the following:

- surface deformation (subsidence) of the crown pillars in proximity to the mine openings,
- settlement of the portal plug rockfill and the shale cover layer, and
- erosion or deformation of the closure plug.

The consequences of each issue and suggested mitigation approach are identified in Table 4. The mitigation measures generally vary from placement of additional fill in required areas to blasting down a portion of the crown pillar. Common to all suggested mitigation measures is identification of the root cause of poor performance and appropriate reaction to reduce the safety risk to people and animals and limit the environmental consequences of each concern.

10.0 CLOSURE

This report provides development and reclamation plans for various mine openings required for closure work. These plans are based on information provided by various professionals and the information is assumed to be accurate and representative of site conditions.

We trust the above meets your present requirements. Thank you for allowing BGC to be of service, once again, to Nanisivik Mine. If you have any questions or require additional details, please contact the undersigned.

Respectfully submitted,
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Per:

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TABLES

Table 1: Mine Openings Location and Current Closure Status

Opening	Mine Grid Coordinates		Current Status
	Easting	Northing	
Lower Adit	16,470E	15,811N	• Gated to restrict access.
00 Portal	16,755E	15,591N	• Open for underground waste disposal program.
01 Portal	16,825E	15,538N	• Ventilation fans and bulkhead present in entrance preventing access.
09 South Portal	17,367E	15,420N	• Opening temporarily blocked with waste rock preventing access (removed in 2004 for underground waste disposal program).
17 North Portal	17,887E	15,927N	• Opening temporally block with waste rock to prevent access.
39 Portal	19,370E	15,788N	• Opening blocked with rockfill debris from horseshoe blast.
Cut 5 Access Portal	N/A	N/A	• Opening blocked with ice plug.
88 Portal	19,562E	15,774N	• Fenced to prevent access.
K Baseline Portal	20,431E	15580N	• Opening temporarily blocked with waste rock preventing access • Top of culvert removed in October 2004. • Ice plug present in portal.
Oceanview Portal	21,214E	16,223N	• Backfilled with waste rock and covered with overburden sourced from the Oceanview Pit.
Area 14 Portal	20,373E	14,086N	• Backfilled and contoured.
Shale Hill Raise	18,775E	16,200N	• Partially filled with waste rockfill.
Oceanview West Raise	21,090E	16,116N	• Ice filled to 1.5 m below surface. • Filled with waste rock on top of ice. • Contoured mound remains at surface.
Oceanview East Raise	21,375E	16,130N	• Ice filled to 1.5 m below surface. • Filled with waste rock on top of ice. • Contoured mound remains at surface.
Area 14 Raise	20,350E	14,318N	• Backfilled and contoured

Opening	Mine Grid Coordinates		Current Status
	Easting	Northing	
West Open Pit Highwall	16,825E	15,538N	• Portion of 00-11/1 rib pillar removed. • Cracking observed on bench above highwall.
East Open Pit Highwall	19,358E	15,760N	• Open, some filling has begun. • Portions of crest of highwall sloped back to 60 degrees.
East Trench Highwall	19,600E	15,600N	• Partially filled with waste rock. • Opening filled with ice.
Oceanview Pit Highwall	21,688E	16,175N	• Waste rock placed in 1st and 2nd bench, or along the southern edge of the pit where highwall was highest in order to maximize burial depth of waste rock. • Eastern part of pit was terraced and can be considered complete. • Western part is currently incomplete.

Table 2: Reclamation Requirements for Nanisivik Mine Openings

Opening	Reclamation Requirements
Lower Adit	1. Remove gate and ice built up at front of portal. (Complete) 2. Removal of all exterior fine ore transporting infrastructure and galley way. (Underway) 3. Construct the portal plug by backfilling the inside of the portal to a maximum of 5 m, and up as close as possible to back (roof) with waste rock or shale. 4. Construct the outside face of the plug to 2.2 m above the opening with shale as illustrated conceptually on Figure 25. 5. General clean up of debris in area adjacent to the Lower Adit.
00 Portal	1. Construct the portal plug by backfilling the inside of the portal to a maximum of 5 m, and up as close as possible to back with waste rock or shale. 2. Construct the outside face of the plug to 2.2 m above the opening with shale as illustrated conceptually on Figure 25. 3. Removal of the fence above the portal and general clean up of the portal area.
01 Portal	Prior to Construction: 1. Protect cables and pipes on bench from potential damage due to rockfall. 2. Build rockfall protection berm on east side of portal 3. Move transformer hut 10 m to the southwest to protect from damage due to rockfall. 4. Remove ventilation fans. 5. Check scale upper highwall and lower 15 m of natural slope. 6. Inspect the back of the portal after trim blast of pillar 00-11/1 rib pillar for potential unstable rock conditions and remediate, if required. During Construction: 7. Construct the portal plug by backfilling the inside of the adit to the bulkhead, and up as close as possible to back with waste rock or shale. 8. Construct the outside face of the plug to 2.2 m above the opening with shale as illustrated conceptually on Figure 25. 9. Removal of the fence above the portal and general clean up of the portal area.
09 Portal	1. Remove the top half of culvert up to culvert/ talus interface. 2. Construct the portal plug by backfilling the inside of the portal to a maximum of 5 m, and up as close as possible to back with waste rock or shale. 3. Backfill the remaining portion of the culvert to 0.5 m above the surface of the culvert. 4. Filling and contouring the top and front of the plug with shale and armour material as illustrated conceptually in Figure 26. 5. General clean up of the portal area.

Opening	Reclamation Requirements
17 North Portal	1. Remove waste rock blocking portal entrance. 2. Remove the top half of culvert up to culvert/ rock interface. 3. Backfill the remaining portion of the culvert to 0.5 m above the surface of the culvert. 4. Filling and contouring the front of the plug with shale and armour material as illustrated conceptually in Figure 26. 5. General clean up of the portal area.
39 Portal/ 38-11 Stope	1. Trim blast to reduce slope of brow, improve safety of work area and provide access to portal (completed October 2004). 2. Scale area trimmed blasted and remaining portion of brow. 3. Using a dozer, open access to top of “horseshoe blast” muck pile. 4. Import shale fill and push it as far into stope as possible without operator passing underneath crown pillar. 5. Continue placing fill until entire “horseshoe blast” and recently trimmed areas are completely backfilled and sloped to conform to the pre-existing natural angle. 6. Ramp an additional 1.5 m of backfill on eastern face of crown pillar and extending 10 m east and 20 m west. 7. When complete there should be at minimum 2.2 m of shale fill covering all waste backfill and the shale backfill will be 2.2 m above the opening as illustrated in Figure 29. 8. General clean up of the portal area.
Cut 5 Access Portal	1. Construct the portal plug by backfilling the inside of the portal to the ice plug up as close to the back as possible. 2. Construct the outside face of the plug to 2.2 m above the sulphide outcrop in the brow directly above the portal as illustrated conceptually on Figure 25.
88 Portal	1. Remove gate and ice built up at front of portal. 2. Construct the portal plug by backfilling the inside of the portal to a maximum of 5 m, and up as close as possible to back with waste rock or shale. 3. Construct the outside face of the plug to 2.2 m above the opening with shale as illustrated conceptually on Figure 25. 4. Removal of the fence above the portal and general clean up of the portal area.
K Baseline Portal	1. Remove waste rock blocking portal (Complete). 2. Remove the top half of culvert up to culvert/ rock interface (Complete). 3. Backfill the remaining portion of the culvert to 0.5 m above the surface of the culvert (Partially Complete). 4. Filling and contouring the front of the plug with shale and armour material as illustrated conceptually in Figure 26. 5. General clean up of the portal area.

Opening	Reclamation Requirements
Oceanview Portal	1. Visual inspection of reclaimed portal area to see if further work is required.
Area 14 Portal	1. Visual inspection of reclaimed portal area to see if further work is required.
Shale Hill Raise	1. Visual inspection of raise area. 2. Complete backfilling with shale or waste rock to the original surface elevation if required. 3. Cover the raise with a mound comprised of a minimum of 1.95 m shale and 0.25 m of armouring material as illustrated conceptually in Figure 27. 4. General clean up of debris adjacent to the raise.
Oceanview West	1. Visual inspection of reclaimed raise area to see if further work is required.
Oceanview East Raise	1. Visual inspection of reclaimed raise area to see if further work is required.
Area 14 Raise	1. Visual inspection of reclaimed raise area to see if further work is required.
West Pit Highwall	Stabilize area before filling: ❑ Scale loose rock on sidewalls of 00N Portal. 1. Trim exposed edge of crown pillar over approximately 12 m with good fragmentation. The trim should be in a concave outward (i.e. southwest) configuration, extending far enough back into the crown pillar to be assured the fragmented rock falls easily into the stope. Fragmentation is important to assure rock falls freely into the stope and does not cause additional damage to 00-11/1 stope pillar. 2. Check scale exposed edge after blast. 3. Push a ramp across waste rock and steel pipes to open access to stope. 4. Push fill as far as possible into stope without operator passing underneath crown pillar. 5. Ramp fill across remaining highwall. 6. Continue or start filling along rest of highwall of pit. The remaining backfilling operations will be completed with waste, approved solid refuse and reject material from the DMS plant. 7. Final filling and contouring with a 2.2 m cap of shale. Upon completion, the limit of any vertical face along the backfilled highwall will be no more than 5 m as illustrated in Figure 28.

Opening	Reclamation Requirements
East Pit Highwall	1. The East Lower Lens sill area in the center of the pit will be filled with waste material to the ultimate pit elevation. 2. Filling and final contouring against the highwall and the mine openings will be done at the natural angle of repose (35°) and to a height that will limit any vertical face to a maximum of 5 m, using a cap of 2.2 m as illustrated in Figure 29.
East Trench Highwall	1. Backfilling of the opening will be carried out using waste rock currently located adjacent to the highwall. 2. Final contouring and filling with a 2.2 m cap of shale and armouring material. 3. Screening and fencing removed
Ocean View Pit Highwall	1. Backfilled with mine waste and final contouring will be done with overburden material removed from the pit.

Table 3: Rock Volumes Required for Each Mine Opening Closure

Opening	Rockfill for Main Plug (Shale or Waste Rock) (m^3)	Protective Cover	
		Shale (m^3)	Armour (m^3)
Adit	125	100	15
00 Portal*	150	0	0
01 Portal*	500	0	0
39 Portal*	4000	0	0
88 Portal	350	160	20
Oceanview Portal**	0	N/A	N/A
09 Portal	300	160	20
17N Portal	300	160	20
K Baseline Portal	300	160	20
Shale Hill Raise**	N/A	55	10
Oceanview West Raise**	0	0	N/A
Oceanview East Raise**	0	0	N/A
Area 14 Portal**	0	0	N/A
Total Volumes* (Minimum)**	**6025**	**795**	**105**

* No Volume allotted for protective cover because this volume is already accounted for in the closure plan for the relevant open pit.
** Final volume dependent on field inspection of reclamation activities completed to date.
*** Note all volumes are neat and in-place.

Table 4: Contingency Plans

Component	Issues	Consequences	Mitigation Approach
Crown Pillar	Subsidence	Safety concern to people and animals. Infiltration of air and surface water into mine workings.	1. Temporary signage and fencing if required. 2. Assessment of root cause of subsidence. 3. Filling of subsidence hole. 4. Blast down of unstable portion of crown pillar if required.
Portal Plug	Erosion of armour layer and shale cap. Settlement of portal plug fill and/ or surface.	Potential exposure of underlying waste rock to air and surface water. Localized settlement. Interruption of slope drainage or erosion	1. Filling and adding armour to cap. 2. Increased monitoring if required. 1. Fix and repair. 1. Fix, grade and repair.
Raise Plug	Subsidence	Safety concern to people and animals. Infiltration of air and surface water into mine workings.	1. Temporary signage and fencing if required. 2. Assessment of root cause of subsidence. 3. Consider and implement alternative plug design or backfilling of subsidence holes.

FIGURES

APPENDIX I
NANISIVIK MINE
CROWN PILLAR STABILITY ANALYSIS
(LAUZIER 2002a)

APPENDIX II
SUMMARY RECOMMENDATIONS FROM BGC SITE VISIT
SEPTEMBER 8 TO 12, 2004