In general, the geothermal monitoring data indicates that the subsurface has cooled since September 2002. Permafrost has aggraded into the top 4 to 5 m of the tailings and the tailings below this depth have generally cooled to within +/-0.2° of 0°C.

Area 2

Area 2 is located proximal to the West Twin Dike between the crest of the dike and the historical area of the storage pond. The geothermal monitoring instruments located in Area 2 include:

- thermistors BGC02-06, 03-13, 03-15, 03-33, 03-34; and ,
- thermocouples BGC02-11 and TC35.

In general, the geothermal monitoring data indicates that permafrost has aggraded into the top 8 to 18 m of the tailings. The tailings below this depth have generally cooled to within +/-0.2° of 0°C. The thickness of permafrost appears to increase towards the West Twin Dike. For example, thermistor BGC03-13, located approximately 50 m upstream of the crest of the West Twin Dike, indicates permafrost to approximately 11 m below surface while thermistor BGC03-33, located at the downstream crest of the West Twin Dike, indicates permafrost to a depth of 18 m.

Area 3

Area 3 is located north of Areas 1 and 2 between the West Twin Dike and the retained pond in the Surface Cell. The geothermal monitoring instruments located in Area 3 include:

- thermistors BGC03-09, 03-10, 03-07, 03-37; and,
- thermocouples BGC02-13, TC #38, TC #39, TC #40 and TC #41.

Thermocouples TC #38 through TC #41 are shallow (within 3 m of surface) and were installed by the mine to monitor the performance of a shale test pad located near the north abutment of the dike. Since the data has no implications relating to talik characterization, the data from these instruments is not discussed in this report.

In general, the geothermal monitoring data indicates that permafrost has aggraded into the top 8 to 18 m of the tailings. The tailings below this depth have generally cooled to within +/-0.2° of 0°C. The thickness of permafrost appears to increase towards the West Twin Dike. For example, thermistor BGC03-10, located approximately 75 m upstream of the crest of the West Twin Dike, indicates permafrost to approximately 6 m below surface while thermistor BGC03-09, located approximately 75 m upstream of the crest of the West Twin Dike, indicates permafrost to a depth of 11 m.

Area 4

Area 4 is near the west side of the Surface Cell in between the two remnant retained ponds. The instruments within Area 4 are approximately 250 m upstream of the crest of the West Twin Dike. The geothermal monitoring instruments located in Area 4 include:

- thermistors BGC03-20 and 03-21; and,
- thermocouples BGC03-38, 03-39 and TC #37.

In general, the geothermal monitoring data indicates that permafrost has aggraded into the top 11 to 16 m of the tailings.

4.2.2 West Twin Dike

As discussed in Section 3.0, the West Twin Dike was constructed in stages throughout the 1990's to increase tailings storage capacity in the Surface Cell. The dike has been instrumented with thermocouples and frost gauges at various times and locations since it was constructed. Currently, the operational instruments in the dike include:

- thermocouples – TC #1, TC #2, TC #12, TC #13, TC #14, TC #15, TC #16, TC #18, TC #28, TC #29, TC #30, TC #31, TC #32, TC #33, and TC #34.

The monitoring data collected from the West Twin Dike in 2003 indicate that, for the most part, the dike and the foundation of the dike are frozen to an elevation of at least 359 m (see data from TC #16A). A potentially thawed zone has been indicated by the data from thermocouple TC #33. The data from thermocouple TC #33 indicates that ground temperatures approach 0°C at a depth of 16 m. The tailings deposit extends to 19 m at this location; however, the deepest thermocouple node is located at 16 m depth.

Readings collected at areas where thaw was previously observed in 1999 at TC #13 and TC #18, indicate that the dike and foundation are currently frozen at these locations.

4.2.3 Toe of West Twin Dike

As discussed in Section 3.0, a tailings beach was formed at the toe of the West Twin Dike in the Test Cell and Reservoir during tailings deposition on 2001 and 2002. The instruments located at the toe of West Twin Dike include:

- thermistor – BGC03-19 and
- thermocouples – BGC02-08, 02-10 and 03-18.

In general, the geothermal monitoring data indicates that permafrost has aggraded into the entire thickness of tailings which ranges between 4 and 9 m. Ground temperatures at depth in permafrost have been measured to fluctuate around -7°C.

4.2.4 Test Cell Dike

As discussed in Section 3.0, a shale dike was constructed into the Reservoir in 2001 and 2002. The dike was constructed using two tailings causeways that had previously formed in the Reservoir. The instruments located in the Test Cell Dike include:

- thermistors – BGC02-09, 3-22, and;
- thermocouples – TC 36.

The monitoring data verifies the observations made during the 2002 and 2003 field investigations that permafrost has aggraded into the tailings beneath the Test Cell Dike to a depth of between 14 and 18 m. The monitoring data indicates that the tailings beneath this depth exhibit temperatures near 0°C. It should be noted that the tailings below 14 to 18 m depth were interpreted to be thawed during drilling.

4.3 Surface Cell and Test Cell Talik Characterization

The results of the geotechnical investigation programs completed in 2002 and 2003 and the geothermal monitoring, during the same time, indicate that taliks exist within the tailings in the Surface Cell and the Test Cell. This information, along with the historical tailings deposition practices within the WTDA previously discussed in Section 3.2, was reviewed and interpreted in order to characterize the extent and magnitude of the Surface Cell and Test Cell taliks.

4.3.1 Geotechnical/ Geothermal Information

The geotechnical and geothermal information collected during the 2002/2003 investigations was discussed in Section 4.1 and 4.2. The following list summarizes the information that is pertinent to characterization of the Surface Cell and Test Cell taliks:

- The thickness of tailings contained within the Surface Cell ranges to a maximum of approximately 34 m;
- The thickness of tailings contained within the Test Cell ranges to a maximum of approximately 20 m;
- The tailings consist of sand and silt size particles that exhibit a relatively high specific gravity of between 3.9 and 4.5 (typical value for sand = 2.65);
- The tailings are generally saturated and some frozen samples were observed to contain ice lenses;
- Ground ice was encountered in several boreholes above and below the thawed tailings;
- The Surface Cell talik exhibits artesian pore pressures near the West Twin Dike and near hydrostatic pore pressures near the retained pond;
- Geothermal data collected from thermistors in the Surface Cell indicates sub-zero temperatures in the range of -0.1 to -1.0°C within the depth ranges where high pore pressures were encountered during drilling.

4.3.2 Talik Magnitude and Extent

Figure 13 illustrates six cross sections constructed through the Surface Cell. The significant geotechnical observations from the boreholes located along each alignment are indicated on the sections. Where possible, the estimated original lake bottom elevations have been plotted on the simplified logs provided on the sections.

Figure 14 illustrates the extent of the Surface Cell talik. These figures were developed based on information collected during the various site investigations and subsequent monitoring. The figures indicate the Surface Cell talik thins towards the upstream face of the dike and thins outwards from the middle of the Surface Cell. Figure 14 shows the approximate thickness and extent of the talik, its relation to the location of the original West Twin Lake and the former location of the deep water storage pond. Based on the information presented on Figure 14, it is estimated that the Surface Cell contains approximately 2,000,000 m^3 of thawed tailings.

Figure 15 illustrates two cross sections constructed through the Reservoir and Test Cell. The significant geotechnical observations from each borehole located along each alignment is indicated on the cross sections. Geotechnical information regarding the tailings in the Test Cell has been derived from boreholes drilled into the Test Cell Dike and Test Cell Test Covers. The deposition of tailings into the Test Cell has also been reconstructed from bathymetry maps as discussed in Section 3.2. The thickness of tailings within the Test Cell ranges between 2 and 14 m. The boreholes drilled into the Test Cell Dike indicate that frozen tailings extend down to a depth of between 14 to 18 m. Tailings beneath this depth were presumed to be thawed based on observations made during the geotechnical drilling conducted in the 2003 investigation.

Figure 16 illustrates the interpreted extent and magnitude of thawed tailings in the Test Cell. This drawing was derived using the limited geotechnical information that exists concerning the Test Cell and the historical bathymetry of the area. Based on the information presented on Figure 16, it is estimated that the Test Cell contains approximately 1,000,000 m^3 of thawed tailings.

No detailed geotechnical investigation of the Reservoir was undertaken. The deposition of tailings into the Reservoir was studied and discussed in Section 3.2. The thickness of tailings in the Reservoir likely ranges to a maximum of 18 m and the tailings that are currently under water have been under water cover since deposited. The tailings in the Reservoir will remain thawed. Since the present closure plan for the tailings in the Reservoir includes isolation by water cover and does not include permafrost aggradation, no further study of the tailings in the Reservoir is required.

4.4 Hydraulic Connectivity between Taliks and Reservoir

Previous drilling investigations (Golder 1999) and more recent work in 2002 and 2003 confirm the frozen nature of the tailings and bedrock directly beneath the West Twin Dike to an elevation of approximately 359 m. Hence, it is unlikely that any hydraulic connection exists across the foundation zone that was confirmed to be frozen. It is possible that hydraulic connection may exist at a greater depth.

Considering the geotechnical investigation results indicate that thawed tailings exist beneath the Test Cell Dike, hydraulic connectivity will exist between the Test Cell Area and the Reservoir.

4.5 Geochemical Characterization

4.5.1 Acid Generation Potential

4.5.1.1 1999 and 2001 Studies

The acid generation potential for tailings has been characterized by several studies completed by Lorax Environmental. Lorax (1999) describes metals analysis, acid base accounting, mineralogical examination, grain size analysis and humidity cell testing of a sample collected from the WTDA Surface Cell. Lorax (2001) presents acid base accounting of three additional samples of tailings from the WTDA Surface Cell. The results of these reports are summarized below.

The determination of total metal concentrations in tailings were: 25.2% iron; 2,610 ppm zinc; 406 ppm lead; 4.5 ppm cadmium; and 6 ppm silver.

The acid base accounting analyses confirmed that the tailings are potentially acid generating. The tailings samples contained high concentrations of total sulphur (39.5 to 48.0%) of which most was in the form of sulphides (39.3 to 45.5%). The samples contained some neutralizing potential ("NP") from 79 to 237 $kgCaCO_3/t$ that was primarily in the form of carbonates (72 to 232 $kgCaCO_3/t$). However, the resulting net neutralization potential for tailings was negative (–997 to –1419 $kgCaCO_3/t$) and the resulting ratio of NP to acid potential was much less than one for all samples (0.05 to 0.19), which demonstrates their classification as potentially acid generating.

The mineralogical analysis indicated that sulphides in the tailings sample consisted primarily of pyrite (80%) with trace amounts of marcasite and sphalerite. Calcite (crystallized carbonate) comprised the majority of the remainder of the sample with minor quartz grains.

The sample analysed for grain size was generally within the size ranges for silt and sand with approximately 81% finer than 0.2 mm (i.e., fine sand and silt) and 100% finer than 2 mm (i.e., coarse sand and finer).

A humidity cell test was conducted for 35 weeks. The test was run at 20°C for 26 weeks and then at 2°C for the remainder of the test to determine the effect of colder temperatures. The primary observations of the tests are as follows:

1. Leachate remained neutral (pH>7.5) throughout the test;
2. Sulphate production rates were generally steady throughout the test but became reduced by approximately 50% at the time of switching to the colder temperature; the calculated rate of carbonate depletion did not vary with temperature;
3. Calcium and magnesium were released at rates of at least two orders of magnitude greater than other metals; and
4. Zinc was released at a rate of approximately two orders of magnitude greater than other heavy metals.

The general conclusions of the humidity cell tests were:

1. The tailings sample was confirmed to be potentially acid generating (neutralization depletion rate faster than acidity depletion rate);
2. A reduction in temperature reduced the rate of sulphate production;
3. The total sulphide concentration was 39% to 46% with pyrite being the dominant sulphide mineral present; pyrrhotite was not identified as being present;
4. Zinc is the most mobile metal in the tailings; and
5. Neutralization potential is present primarily in the form of carbonates.

4.5.1.2 2003 Study

Geochemical analyses were conducted on a sample of tailings collected from the surface of the Surface Cell as part of a study conducted for the Department of Indian Affairs and Northern Development, Nunavut, in 2003. The geochemical data generated for these studies has been made available for use in the Nanisivik 2004 RCP. The tailings sample was separated into a "sand" sized fraction and a "silt" sized fraction in the field such that two sets of duplicate analyses were conducted.

The study included ICP metals concentrations, acid base accounting and leach extraction tests and a mineralogical analysis.

The determinations of total metals concentrations agreed with the previous results with: >15% each iron; 2,926/2,262 ppm zinc; 856/1,912 ppm lead; 6/5 ppm cadmium; and 3.8/4 ppm silver for the sand/silt samples, respectively. The metals concentrations do not indicate a consistent bias of higher concentrations in one of the size fractions. For example, lead and copper are greater in the silt sized fraction while zinc and chromium are greater in the sand sized fraction.

The acid base accounting analyses further confirmed that the tailings are potentially acid generating and the data agreed with the previous analyses. Tailings pH was 8.5 and 8.6. The concentrations of total sulphur (32.8 and 34.1%) were slightly lower than the previous analyses but most was, again, in the form of sulphides (32.3 and 33.8%). The neutralizing potential ("NP") (321.3 kg$CaCO_3$/t each) was slightly higher than previous analyses but most was, again, in the form of carbonates (324.2 and 319.2 kg$CaCO_3$/t). The resulting net neutralization potential was again negative (–703.8 and –744.4 kg$CaCO_3$/t) but higher than previous analyses. The resulting ratio of NP to acid potential was again much less than one (0.3 each) but higher than previous analyses.

The mineralogical analysis reinforced the previous observation that pyrite is the dominant sulphide present in concentrations of approximately 56% and 62%. Pyrrhotite was not observed. Dolomite was the dominant carbonate mineral present at concentrations of approximately 33% and 29%. Comments on textures were also provided by the petrographic analyst that indicated "no rims or encapsulation" in either the silt or sand samples.

Leach tests with distilled water were run at a 3:1 mix ratio. The tests produced leachate containing 1,796/1,392 mg/L sulphate, <0.03 mg/L iron each and 0.62/1.98 mg/L zinc for the sand/silt samples, respectively, at neutral pH of 7.5. The leachate concentrations do not indicate a consistent bias of higher concentrations in one of the size fractions. For example, zinc and cadmium are greater in the silt sized fraction while sulphate and cobalt are greater in the sand sized fraction.

4.5.1.3 Conclusions

The geochemical tests clearly demonstrate that the tailings are potentially acid generating and will contain a high sulphide content, as expected. Nonetheless, the tailings do contain abundant neutralization potential and leachate pH remained neutral during both humidity cell and leach extraction tests.

The absence of pyrrhotite from the tailings is noteworthy. Pyrite is less geochemically reactive than pyrrhotite and, therefore, reduces the risk of acid rock drainage slightly as compared to cases where pyrrhotite is abundant. Similarly, the petrographic observation that no rims or encapsulation are present is noteworthy as it suggests that the acid generation process has not been initiated in the tailings since the oxidation process typically results in mineralogical changes in the surfaces of some minerals.

Tailings paste pH was neutral to slightly alkaline, including the grab sample collected from the pond surface in 2003. This is further indication that the tailings have not oxidized (to 2003), even at surface under maximum exposure to oxygen.

The leaching of metals and sulphate in the humidity cell test and the leachate extraction test provides an indication of the production rate of these contaminants. The humidity cell test also provides further indications of the beneficial effects of reduced temperature through reduced contaminant production rates.

Tailings groundwater quality shows no indications of the occurrence of acid rock drainage in the tailings (i.e., dissolved metal concentrations are generally low), which is attributed to the alkaline pH and rapid freezing and/or saturation of the tailings upon deposition.

4.5.2 Rate of Oxidation

Given that the tailings are confirmed to be potentially acid generating, the rate of oxidation is an important consideration. The rate of oxidation in Nanisivik tailings will be controlled by two key factors: temperature and oxygen availability.

A common reference regarding sulphide oxidation in the north is Dawson and Morin, 1996, which demonstrates that the rate of sulphide oxidation decreases at low temperatures but may not be eliminated completely at freezing temperatures. This text also confirms that the cold arctic climate substantially limits the rate of oxidation by maintaining frozen conditions through most of the year. This is especially applicable to the Nanisivik site because of the extremely cold daily temperatures (average –15°C).

The site specific effects of temperature on the rate of sulphide oxidation in Nanisivik tailings were measured by Dr. Bo Elberling of the University of Copenhagen in 1998 as part of a multi-year research program. The tests were conducted on columns loaded with undisturbed tailings. One of the test columns consisted of older, well-drained tailings from the Surface Cell. The measurements from that column confirmed that the rate of oxidation decreased with decreasing temperature. At 2°C, the rate of oxidation was reduced by a factor of 30% relative to the rate at 20°C. Oxidation was observed to continue at a decreasing rate to as cold as 0°C. The temperature at which oxidation would cease completely was not determined and could not be accurately extrapolated.

Dr. Elberling's testwork also demonstrated that the sulphide oxidation rate was controlled by oxygen diffusivity and not by reaction kinetics. The testwork went on to verify that, as is generally acknowledged, application of a saturated diffusive barrier layer would reduce oxygen diffusivity and, therefore, the oxidation rate by several orders of magnitude.

The reference to an oxygen diffusive barrier is analogous to both the proposed shale cover on the Surface Cell/Test Cell areas and the proposed water cover on the Reservoir. The shale cover on the Surface Cell is anticipated to form a frozen, saturated zone at the base of the cover. The frozen, saturated zone will provide the same beneficial effect of a water saturated diffusive barrier layer due to the reduced oxygen diffusivity in water and ice relative to air. The water cover on the Reservoir will provide this same benefit.

Therefore, the rate of oxidation of tailings after reclamation in the Surface Cell, the Test Cell area and the Reservoir is anticipated to be reduced to a negligible level due to the effects of cold temperatures/freezing and the presence of oxygen diffusivity barriers.

4.5.3 Transport Mechanism

The MEND study referenced above (Dawson and Morin, 1996) confirms that the cold arctic climate substantially restricts the primary contaminant transport mechanism by maintaining frozen conditions through most of the year when surface water is immobile.

This is directly applicable to the Nanisivik site because of the extremely cold temperatures (average mean annual temperature of -15°C). The ground (including the covers on the Surface Cell and Test Cell areas) at Nanisivik will be frozen to the surface during the winter season and any transport of contaminants will be prevented. The cover is designed to maintain frozen conditions within the tailings and the base of the cover even during the short summer season. It is anticipated that a frozen saturated zone will form at the base of the active layer (within the cover) as a result of the recurring infiltration of snow melt, runoff and precipitation water. This zone will prevent the contact of surface run off water with tailings and, therefore, will prevent the transport of contaminants to surface water.

4.5.4 Summary

There are two primary conclusions regarding the geochemistry of the tailings that stem from the information described above:

1. The tailings are potentially acid generating.
2. Acid generation has not yet become established in the tailings.
3. The rate of oxidation of tailings after reclamation in the Surface Cell, the Test Cell area the Reservoir is anticipated to be reduced to a negligible level due to the effects of cold temperatures/freezing and the presence of oxygen diffusivity barriers.
4. The frozen saturated zone in the base of the cover on the Surface Cell and Test Cell areas will prevent the contact of surface run off water with tailings and, therefore, will prevent the transport of contaminants to surface water.

The first conclusion is as expected given that the Nanisivik mine processed sulphidic ore. The confirmation that the tailings are acid generating creates the requirement for reclamation of the tailings with the objective of preventing, controlling or mitigating acid generation and transport of oxidation products.

The second conclusion is reasonable for the Nanisivik site given the relatively high inherent neutralization potential and high pH of the tailings and given that tailings were frozen and/or saturated in place shortly after deposition. This conclusion suggests that reclamation measures at this site should be focussed on the prevention of acid generation rather than on control or mitigation strategies.

The remaining conclusions are also as expected given that they mirror the widely accepted conclusions of previous research on the effects of the Arctic climate on acid rock drainage.

5.0 CLOSURE OBJECTIVES

5.1 Specific Reclamation Objectives

CanZinco's 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. The primary objectives of the Reclamation and Closure Plan are in accordance with the Mines Reclamation Policy to "ensure the impact of mining on the environment and human health and safety is minimized".

The specific reclamation objectives for the WTDA follow from this policy. Further, the specific reclamation objectives follow from the "Guidelines for Abandonment and Restoration Planning for Mines in the Northwest Territories" (1990), which states that the objective of a mine reclamation plan should be to "prevent progressive degradation and to enhance natural recovery in areas affected by mining."

Given that the primary risks posed by the WTDA facilities are related to the potential for acid rock drainage, the potential for the physical movement of tailings to the environment and the potential loss of surface land use values, the specific reclamation objectives for the WTDA reclamation plan are as follows:

1. Isolate potentially acid generating tailings from the atmosphere to minimize the risk of acid rock drainage;
2. Minimize the risk of physical movement of tailings to the environment; and
3. Provide a safe and useable surface environment that corresponds to the natural surroundings.

The reclamation measures described in this report are proposed as an efficient and practical means of achieving these objectives. The reclamation measures are described in detail Section 6 and are summarized in an overview format, for ease of reference, in Section 5.2.

5.2 Specific Measures

5.2.1 Minimization of Oxygen Exchange in Surface Cell and Test Cell Tailings

The closure plan for Surface Cell and Test Cell tailings is based on minimizing oxygen exchange by placing a cover of shale and sand and gravel over the exposed tailings. The cover will provide thermal insulation, to maintain frozen conditions and allow for permafrost aggradation, with a durable surface cap of local natural material. The cover will be thick enough to maintain continuous frozen conditions within the underlying tailings during mean annual and warmer conditions, even in light of a worst case climate change predictions over the next 100 years.

5.2.2 Minimization of Oxygen Exchange in Reservoir Tailings

The tailings contained within the Reservoir will remain under a minimum of 1 m of water cover. Erosion protection will be applied to the tailings within a zone just above and just below the pond water level to minimize the risk of re-suspension due to wave and ice action. The final water level in the Reservoir pond and Polishing Pond will be the same and will be returned to the original, pre-mining elevation of West Twin Lake (370.2 m). The re-establishment of previously existing water levels hence negates the need for a water retention dam.

5.2.3 Transfer of Water Flow from Surface Cell to Reservoir

A spillway and outlet channel will be constructed to safely pass seasonal run-off and severe storm events around the West Twin Dike, to minimize the risks to the tailings solids retention dike. The spillway will be constructed near the south abutment of the dike and will convey water from the Surface Cell to the Reservoir without the aid of pumps and/or siphons.

5.2.4 West Twin Dike

The West Twin Dike will remain in place during closure for permanent retention of Surface Cell tailings. The dike will be graded smooth to a slope shallower than previously its approved closure design and will be covered with Twin Lakes sand and gravel to prevent erosion.

5.2.5 Test Cell Dike

The Test Cell Dike will partially remain to retain tailings solids. The crest of the Test Cell Dike will be graded as a portion of the grading plan for the entire cell.

5.2.6 Polishing Pond and West Twin Lake Outlet

The water control outlet structure that was used to release water in a controlled manner during mine operations will be removed and replaced with an open outlet channel and overflow weir that is approximately 7 m wide at the base. The invert level will be set at the original elevation of the outlet of West Twin Lake (i.e. 370.2 m). Water passing through the outlet channel will join with water flowing from East Twin Lake and flow into Twin Lakes Creek.

5.2.7 Reclamation and Post-Closure Period Monitoring Programs

A comprehensive program for determining the long-term performance of the proposed reclamation measures is to be implemented. The monitoring information will also provide information that identifies areas where maintenance, repairs or contingencies may be required in the short term.

The monitoring information to be collected includes:

- ground temperatures within the cover, the tailings and the natural ground;
- subsurface water pressures related to freezing of the taliks;
- quality of water entering the environment;
- climate data;
- regular inspections of surface conditions by trained technical staff; and
- professional inspections of surface conditions by a professional geotechnical engineer.

This information will be reviewed by CanZinco, in concert with other technical experts as required, and CanZinco will undertake appropriate actions where required. Additionally, this information will be forwarded to the Nunavut Water Board for their review and public posting.

If some of the reclamation measures are found to be substantively underperforming, then a contingency action would be performed. The specific actions to be implemented would depend on the circumstances but would include consideration of the following:

- Increased frequency of monitoring;
- Blading of the cover, erosion protection and spillways to fill/close cracks or settlement depressions;
- Placement of additional material or different material (i.e. larger rip rap);
- Clearing of debris for water flow paths;
- Application to the Nunavut Water Board for modification of works; and

- Water treatment with lime.

In 2010, a comprehensive, all-encompassing assessment of the monitoring information is to be conducted that will determine whether the reclamation objectives have been achieved and whether the WTDA is considered to be successfully reclaimed.

6.0 CLOSURE PLAN

6.1 Surface Cell and Test Cell Reclamation Covers

The design of the Surface Cell and Test Cell closure covers are discussed in detail in the component closure plan report "Engineering Design of Surface Reclamation Covers" (Water License Part G, Item 4). The following sections review the design aspects of the covers as requested in water license clause Part G, Item 15, requirement iv.

6.1.1 Design Criteria

The closure concept for the Surface Cell and Test Cell is a cover of natural materials that will be constructed to mitigate the potential long term environmental impacts from exposed tailings. This cover will prevent wind and water erosion of the tailings. In addition, the cover will limit oxygen exchange between the air and tailings and will maintain frozen conditions within the tailings throughout the year.

Mine waste covers constructed of natural materials in cold regions generally incorporate an insulating layer of material overlain by a layer of coarse-grained armouring material. The insulating material is generally saturated and frozen to provide a low permeability barrier to infiltration by water and oxygen. The insulating layer generally exhibits a low thermal conductivity that does not allow the full penetration of active layer thaw. The purpose of the armouring layer is to prevent erosion of the underlying insulating material. A light coloured armouring material may provide additional geothermal benefits by reflecting sunlight, thereby reducing heat absorption.

6.1.2 Materials

The reclamation cover for the Surface Cell, Test Cell and tailings at the toe of the West Twin Dike will be constructed of an insulating layer of shale overlain by an armouring layer of Twin Lakes sand and gravel. For a detailed description of the cover materials, their availability and geotechnical and geochemical characteristics, refer to the Reclamation Covers Report (Water License Part G, Item 4).

6.1.3 Design

The reclamation cover of the tailings in the Surface Cell, Test Cell and at the toe of the West Twin Dike will be constructed of a layer of 0.25 m (minimum thickness) of Twin Lakes sand and gravel (for erosion protection) overlying a 1.0 m (minimum thickness) layer of quarried shale (for insulation and containment of infiltration water). The gradation specifications for each of these materials is included in the Reclamation Covers Report (Water License Part G, Item 4). The Twin Lakes sand and gravel will be quarried from the deltaic deposit located between East Twin Lake and West Twin Lake. The shale will be quarried from several sites around the mine site. The majority of the shale is expected to be derived from the Mt. Fuji, East Twin and West Twin quarries.

Topographic high points on the tailings surface will be graded prior to construction of the cover to limit the thickness of cover required in the topographic low spots. In addition, where fill thicknesses are greatly in excess of 1.25 m, select native materials such as till or shale quarry strippings may be used. The proposed tailings grading plan for the Surface Cell is illustrated on Figure 17. The cover will be constructed according to the cover grading plan illustrated on Figure 18. The longitudinal grade of the main drainage swales within Surface Cell cover will be constructed to a minimum of 0.5%. The drainage swales will direct surface water to the spillway inlet location near the south edge of the Surface Cell.

The proposed tailings grading plan for the Test Cell and tailings located at the toe of the West Twin Dike is illustrated on Figure 19. The cover will be constructed according to the cover grading plan illustrated on Figure 20. The main drainage swales within the cover will be constructed to a minimum grade of 0.5%. The drainage swales will direct surface water into the Reservoir.

6.1.4 Construction Considerations

The remoteness of the site, the available options to transport equipment and supplies to site and the length of the construction season present limitations on the construction schedule for reclamation activities.

Transportation to site by sea generally occurs between July and September, although vessels have come in as early as May and as late as October. Any required heavy equipment or bulk supplies would have to be delivered during these months.

The construction season available for quarrying shale extends between April and October. Different extraction methods may be required at different times of the year. Blasting may be conducted during the early spring when ground conditions are frozen. Ripping of the thawed portion of the active layer may be completed in late spring and summer. Testing completed earlier by mine site staff on a sample collected from a test blast indicates that similar grain size characteristics can be achieved to that of normal ripping operations.

If saturated, tailings may be displaced into the shale material during cover placement due to the weight of the construction traffic. Therefore, some areas may need to be covered while the ground is frozen. The ponded water in the Surface Cell and Test Cell will be removed prior to initiation of cover placement in those areas. Currently, only the subaqueous tailings and a small "island" of tailings on the west side of the Surface Cell would be exposed at surface once the ponded water is removed. The remaining tailings in the Surface Cell are currently already covered by a layer of shale that is estimated to average 300 mm thickness. The tailings currently covered by the thin layer of shale may be covered while the tailings are thawed during the summer due to the increased trafficability provided by the shale cover. Most of the tailings in the Test Cell and toe of the West Twin Dike are currently exposed at the ground surface.

The regrading of tailings must be accomplished when the active layer thaw is minimal. It is suggested that regrading of the tailings surface occur in May/June to avoid the poor trafficability later in summer. It is anticipated that the reclamation works will proceed over the summer portions of a two year period.

The required volumes of shale and Twin Lakes sand and gravel for each portion of the WTDA are summarized in Table 7. These quantities are neat and in-place with no allowance for bulking.

6.2 Reservoir Shoreline Tailings and Reservoir Water Cover

6.2.1 Design Criteria

The Reservoir/Polishing Pond area will be reclaimed by restoring the water level to the natural elevation of 370.2 m asl (the "normal" water level - NWL). All tailings within the Reservoir will be relocated to greater than 1 m below the NWL, to as great a degree as practical. This approach continues to provide the long term benefits of water cover for prevention of acid rock drainage without the need for water retention dams or manually operated outlet structures. Additionally, the design water depth will prevent the physical remobilization of tailings due to wave action, as described in later sections.

The perimeter of the Reservoir pond has been divided into three sections, for reclamation planning: the toe of the Test Cell Dike, the toe of the West Twin Dike; and the remainder of the perimeter. The extent of these three areas are shown on Figure 21.