APPENDIX 5.

Report on condition of concrete at the Concentrate Storage shed:

Gartner Lee Limited

memorandum

to: Murray Markle, Site Manager
from: Eric Denholm
date: November 12. 2004
c.c.: Bob Carreau, Mike Weirmeir
re: **Nanisivik, Assessment of Concentrate Shed Sub-Floor Soil Samples**

Four samples were collected of the soil underlying the concrete floor of the concentrate storage shed. The samples were analysed for cadmium, iron, lead and zinc content. These samples were collected and analysed to provide information for the assessment of the potential for contaminant migration through the concrete floor, which is a commitment of the Closure Plan.

The samples were collected by Mr. Isaac Rowland of BGC Engineering Inc. in conjunction with on-site contactors and personnel. The sample method largely followed that described in a previous memo titled *Suggested Protocol for Assessment of the Concrete Slab under the Concentrate Storage Shed, June 05, 2004*. The sampling methodology that was employed is described in a memo from BGC Engineering dated October 9, 2004 (attached).

One sample was collected from the surface of the underlying soil (0-5 cm) in each of the three "test pits" and one sample was collected from the 5-30 cm interval in test pit no. 2. The soil was described as hard frozen and generally comprised of sand & gravel. The sample locations were selected in areas where the concrete floor was most damaged adjacent to expansion joints that we understand were cut into the floor after construction as one complete slab. In this way, the samples were intended to represent areas where the potential for contaminant migration through the floor was greatest.

Reasonable measures were taken in the field to minimize the potential for contamination of samples. However, there was some risk of inadvertent sample contamination with metals from the cutting/chipping equipment, the sampling equipment and personnel clothing/gloves. The need to cut through the concrete floor and the frozen nature of the underlying soil required that unique sampling procedures be utilized.

The results of analyses were received from Maxxam Analytics Inc. of Mississauga, ON as listed follows (all μg/g):

Sample	Cadmium	Iron	Lead	Zinc
TP1, 0-5 cm	74.8	23,300	764	23,400
TP2, 0-5 cm	9.8	23,200	102	2,870
TP2, 5-30 cm	15.9	21,200	148	5,150
TP3, 0-5 cm	5.3	19,500	1,280	1,460
SQRO's – dock	2,800	-	4,500	44,000

In summary, the sample results indicate that the soil underlying the slab does not exceed the SQRO's for the dock area for cadmium, lead and zinc. Iron concentrations are similar to those observed site-wide in both contaminated and uncontaminated samples. The samples were not analysed for copper. However, there were no exceedances of the SQRO's for the copper in the dock area in any of the samples collected for the (approved) Phase 2 and 3 ESA investigations, even for samples where other metals exceeded. This indicates that copper is not a contaminant of concern in these samples.

The physical condition of the concrete floor as described by BGC Engineering supports the general expectation that the floor has remained intact and that the risk of contaminant migration through the cracks (the purpose built expansion cracks or other) is very low. Although, the expansion cracks are reported to have propagated to the bottom of the floor, there was no indication from either the physical observations or the analytical results that these cracks had allowed for the migration of contaminants. Further, the dry condition in which the concentrate storage shed was maintained throughout mine operations eliminated water as a potential transport mechanism.

We trust that this information is self-explanatory and look forward to discussing it with you further, if you wish.

Eric Denholm, P.Eng.
Senior Mining Consultant

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AN APPLIED EARTH SCIENCES COMPANY
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PROJECT MEMORANDUM

To:	Gartner Lee	Fax No.:	Via email
Attention:	Eric Denholm	CC:	Murray Markle
From:	Isaac Rowland (867-436-7191)	Date:	October 9, 2004
Subject:	Ore Concentrate Storage Shed Samples		
No. of Pages (including this page): 2		Project No:	0255-009

Introduction:

Sampling of the soils underneath the concrete slab in the concentrate storage facility was undertake at the request of CanZinco Ltd on Oct 9th. Labour was supplied by Wolfden Resources, and BGC representative Isaac Rowland collected the samples.

Sample Locations

Samples were collected from areas considered to have the highest likelihood of contamination. These were areas where the expansion joints in the slab appeared to have sustained substantial damage.

Sample Number	Location and Depth
Slab TP 1-1	Intersection of T6 transverse joint and central joint. 0-5 cm depth
Slab TP 2-1	Intersection of T4 transverse joint and central joint. 0-5 cm depth
Slab TP 2-2	Intersection of T4 transverse joint and central joint. 5-20 cm composite.
Slab TP 3-1	Damaged portion of T1 joint in lead concentrate storage area. 0-5 cm.

Sample Collection

The area around the selected sample location was cleaned using brooms and compressed air. Samples were collected by cutting a hole through the slab using a diamond cutting saw and breaking out the concrete using a large hammer and scaling bar. The broken slab material was cleaned away as much as possible and a sample was collected from the underlying gravels at a depth of approximately 0-5 cm. The sample was collected using a metal spoon and placed in a glass jar for shipping. The subgrade material was frozen and very difficult to remove; metal tools had to be used to chip out enough gravel for a sample. A composite sample from the 5-20 cm range was collected from Test Pit #2 by cutting the soil with a diamond saw and chipping out the frozen material. No other deep samples were collected. A total of three test pits were completed and a total of four samples were taken. Photographs of the undisturbed slab as well as the completed test pit were taken for each sample. The samples collected were shipped to Maxxam Labs Inc to be tested for Zn, Pb, Cd, and Fe.

Slab Condition

The concrete slab appears to ranges in thickness from 7-8 in. The expansion joints consisted of simple cuts in the concrete. It appears that these originally did not completely penetrate the slab, however the in the areas tested, through cracks have now developed. Multiple lengths of rebar were encountered in every test pit oriented in the transverse, longitudinal and vertical directions In general the concrete appeared be in good condition except in the immediate area of the expansion joints. It should be noted that the sample locations were chosen based the maximum amount of visible damage and these areas are not representative.

No visible concentrate was noted in the subgrade material due to the frozen nature of the ground. Photographs were taken documenting the actual condition of the expansion cracks and the thickness of the slab. Photo quality however is generally poor due to lack of lighting and the light color of the slab.

Closing:

This memo provides a summary of the sampling program of the concentrate storage shed on October 9th, 2004. If you have any questions regarding the information provided please do not hesitate to contact me.

BGC Engineering Inc.
Per:

Isaac Rowland EIT
Mining Engineer

APPENDIX 5.5

QA/QC measures for reclamation covers

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

NANISIVIK MINE
A DIVISION OF CANZINCO LTD.

NANISIVIK MINE
RECLAMATION CONSTRUCTION

QUALITY ASSURANCE/ QUALITY CONTROL PLAN FOR SURFACE RECLAMATION COVER CONSTRUCTION

FINAL

PROJECT NO.: 0255-009-10
DATE: NOVEMBER 18, 2004

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Project No. 0255-009-10
Date: November 18, 2004

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

Re: Quality Assurance/ Quality Control Plan – Surface Reclamation Covers

Dear Bob,

Please find attached three copies of our above referenced report dated November 18, 2004. Please note that a preliminary QA/QC plan outlining specific requirements for the Surface Cell and Test Cell reclamation covers was supplied to the Contractor prior to initiation of this work in August 2004. This current document is a more comprehensive version of the QA/QC requirements and includes reclamation covers for tailings, waste rock, open pits and the landfill.

Should you have any questions or comments regrading the information provided herein, please contact the undersigned at your convenience.

Regards,
BGC Engineering Inc.
Per:

Geoff Claypool, P.Eng. (AB)
Geological Engineer

Encl. Final Report, Tables. Figures

GKC/sf

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIMITATIONS OF REPORT

This report was prepared by BGC Engineering Inc. (BGC) for the account of Nanisivik Mine, a Division of CanZinco Ltd. The material in it reflects the judgement of BGC staff in light of the information available to BGC at the time of report preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be based on it are the responsibility of such Third Parties. BGC Engineering Inc. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

As a mutual protection to our client, the public, and ourselves, all reports and drawings are submitted for the confidential information of our client for a specific project and authorization for use and / or publication of data, statements, conclusions or abstracts from or regarding our reports and drawings is reserved pending our written approval.

1.0 GENERAL

1.1 Introduction

Construction of the reclamation covers (consisting of shale fill and Twin Lakes "sand and gravel" surficial erosion protection) for tailings deposits at the Nanisivik Mine began near the end of August 2004. As such, a Quality Assurance/Quality Control (QA/QC) Plan has been developed to ensure that the reclamation covers are constructed to the design specifications and design intent. A preliminary QA/QC plan outlining specific requirements for the Surface Cell and Test Cell reclamation covers was supplied to the Contractor prior to initiation of this work in August 2004. This current document is a more comprehensive version of the QA/QC requirements and includes reclamation covers for tailings, waste rock, open pits and the landfill.

1.2 Scope and Objective of Plan

In general, the QA/QC Plan provides monitoring requirements to ensure the reclamation covers are constructed to their design intent. The plan outlines the following details:

- The basis for the design and construction of the reclamation cover;
- QA/QC requirements for the reclamation covers including construction specifications, field inspection and testing requirements;
- Responsible parties for overseeing various aspects of the QA/QC plan;
- Required documentation such that a comprehensive As-Built Report may be developed after construction is complete.

1.3 Responsible Parties

The Owner, CanZinco Ltd. (CanZinco), will be represented on site by the Site Manager and the Contract Administrator. The construction of the reclamation covers will be undertaken by the Contractor, ATCON Construction Inc. (ATCON). A Field Representative will be supplied by BGC Engineering Inc. (BGC) as the Owner's technical representative on site. The Field Representative will be onsite during the construction of the reclamation covers.

The Contractor is responsible to construct and provide Quality Control (QC) during the construction of the reclamation covers. The Owner and the Field Representative will be responsible to monitor construction and for the Quality Assurance (QA) of the cover. BGC understands that the Owner and Contractor have agreed that the Field Representative will be supplied by BGC and will be responsible for both the QA and portions of the QC program during the construction of the reclamation covers.

2.0 REFERENCE DOCUMENTS AND DRAWINGS

The design of the various reclamation covers has been documented previously in the following reports:

1. BGC Engineering Inc. 2004a. Engineering Design of Reclamation Covers – Nanisivik Mine Closure Studies. Submitted to CanZinco Ltd., February 6, 2004.
2. BGC Engineering Inc. 2004b. Quarry Development and Reclamation Plan. Submitted to CanZinco Ltd., February 6, 2004.
3. BGC Engineering Inc., Gartner Lee Ltd. Inc. and Golder Associates Ltd. 2004. West Twin Disposal Area Closure Plan. Submitted to CanZinco Ltd., March 4, 2004.
4. Gartner Lee Limited 2004a. Nanisivik Mine Rock Piles and Open Pits Closure Plan. Submitted to CanZinco Ltd., February 6, 2004
5. Gartner Lee Limited 2004b. Nanisivik Mine Landfill Closure Plan. Submitted to CanZinco Ltd., February 6, 2004

Final topography and surface grades for the Surface Cell were supplied to the Contractor during preliminary construction of the cover. Construction drawings containing final topography, grades for construction and construction specifications for the other areas are currently being produced by BGC and will be forwarded to the Owner and Contractor as they become available.

3.0 COVER DESIGN AND REVIEW

3.1 Design Intent

3.1.1 Surface Cell and Test Cell Covers

The reclamation concept (as documented in BGC 2004a) for the tailings in the Surface Cell and Test Cell is to provide a cover that will mitigate the potential long-term environmental impacts from exposed tailings. The design objectives for the cover are the following:

1. Physically isolate the tailings and prevent water and wind erosion.
2. Place the cover so that permafrost aggradation occurs and the tailings remain subzero through the entire year.
3. Allow for water infiltration to occur into the cover so that water (and the associated ice-saturation) within void space significantly reduces oxygen exchange into the underlying tailings.
4. During periods of high surface water run-off into the Surface Cell, direct the surface water to the spillway inlet located near the south edge of the Surface Cell.
5. During periods of high surface water run-off into the Test Cell, direct the surface water to the Reservoir via the main drainage swale.
6. The cover will prevent ponding of water and associated negative geothermal impacts by being sufficiently graded such that water will either infiltrate into the cover and freeze in situ or drain along the surface to designated discharge points.

The design concept has been proven in the test covers constructed at site, as discussed in Sections 3.3.

3.1.2 Waste Rock and Open Pit Covers

The reclamation concept (as documented in GLL 2004a) for the waste rock and open pit areas is to minimize the risk of acid rock drainage or metal leaching and provide a safe surface environment that matches natural conditions. The overall approach to achieving the reclamation objectives is to apply the most appropriate combination of one or more of the following reclamation measures:

1. Relocate waste rock to eliminate or reduce the requirements for surface reclamation at the pile location;
2. Fill open pits to achieve a smooth surface contour that prevents surface ponding and provides a safe surface environment;
3. Provide a thermal cover such that the covered materials freeze into permafrost.

3.1.3 Nanisivik Mine Landfill Cover

The reclamation concept (as documented in GLL 2004b) for the landfill is to mitigate the flow of water through the landfill waste and to construct a surface that resembles natural surroundings. The design objectives for the cover are the following:

1. Physically isolate the waste and prevent water and wind erosion.
2. Place the cover so that permafrost aggradation occurs and the landfilled material remains subzero through the entire year.
3. Allow for water infiltration to occur into the cover so that water (and the associated ice-saturation) within void space significantly reduces infiltration of surface water into the underlying waste debris.
4. The cover will prevent ponding of water and associated negative geothermal impacts by being sufficiently graded such that water will either infiltrate into the cover and freeze in situ or drain along the surface .

This design approach has been successfully used for landfill closures at other northern mine sites in the Canadian Arctic.

3.2 Design Details

3.2.1 Surface and Test Cell Covers

The Surface Cell and Test Cell tailings reclamation covers will be constructed of a layer of 0.25 m (minimum thickness) of armouring material (Twin Lakes sand and gravel) for erosion protection overlying a 1.0 m (minimum thickness) layer of quarried shale fill. It should be noted that the "sand and gravel" material actually includes particles larger than gravel size as well. Where a cover thickness greater than 1.25 m is required to maintain an acceptable grade, select native materials such as till or shale quarry strippings may be used to fill in topographic lows below the top 1.25 m of cover material. Detailed information regarding the grain size specifications for the shale and armour material is provided in Section 6.

The Surface Cell reclamation cover will direct surface water to the inlet of a spillway channel to be located near the south edge of the Surface Cell via a series of drainage swales. These drainage swales will be constructed to a minimum grade of 0.5%.

The Test Cell reclamation cover will direct surface water directly to the Reservoir via a singular main drainage swale located near the centre of the Test Cell. This drainage swale will also be constructed to a minimum grade of 0.5%.

Rip rap will be placed along the portion of the Reservoir shoreline along the toe of the Test Cell Dike and the tailings beach at the toe of the West Twin dike. The rip rap will provide erosion protection against waves. The riprap will consist of clean, well graded hard bedrock fragments or coarse-grained particles. The rip rap will be placed on a layer of bedding material (sand and gravel) which will prevent waves from plucking fine materials form the thermal cover beneath the rip rap. Detailed information regarding the grain size specifications for the rip rap and bedding material is provided in Section 6.

It is anticipated that approximately 650,000 m^3 of shale, 140,000 m^3 of armouring material, 4,000 m^3 of rip rap and 750 m^3 of bedding material will be required for reclamation covers at the West Twin Disposal Area. It should be noted that an additional 660 m^3 of rip rap and 440 m^3 of bedding material will be required for additional reclamation projects around the WTDA.

3.2.2 Waste Rock, Open Pit and Landfill Covers

The reclamation covers for the waste rock, open pits and landfill will be constructed of 0.25 m (minimum thickness) armouring material, overlaying 1.95 m (minimum thickness) quarried shale for a total cover thickness of 2.2 m.

The landfill, waste rock and open pits reclamation covers will be constructed to restore natural drainage as much as possible. As such, surficial drainage will be directed into downslope, natural drainage courses.

It is currently anticipated that a total of 191,000 m^3 of shale and 38,000 m^3 of armouring material will be required to complete the covering of these areas.

3.3 Test Covers

3.3.1 Basis for Design

Test Covers for Tailings

Since 1988, several studies on potential cover design alternatives have been undertaken by the mine. Of these studies, the most significant related to development of the tailings cover design was the Test Cell Test Cover (TCTC) Study. The assessment of several cover design alternatives was undertaken by constructing test covers in the Test Cell. The test covers were instrumented with thermocouples and frost gauges and monitored to determine the effect of different design options on the depth of active layer thaw.

The Surface Cell and Test Cell reclamation cover design is based largely on the performance observed from TCTC #1, which is summarized as follows:

1. TCTC #1 was constructed of a nominal thickness of shale fill, from the Mt. Fuji Quarry, without controlled saturation or compaction efforts.
2. Thaw depth in the four frost gauges in this cover (F3- F6) showed that the maximum depths of thaw improved continuously between 1991 and 1997 and were continuing to improve, albeit slowly, at the termination of the monitoring period. This is attributed to the gradual build-up of the ice layer at the bottom of the active zone.
3. Results in 1997 (end of program) showed thaw depths at each of the instruments measuring 0.73, 0.95, 1.05 and 0.97 m respectively (or an average value of 0.92 m).
4. Direct comparison of the two pairs of frost gauges in TCTC #1 (F3 vs. F4; and F5 vs. F6) indicates that areas with light surface coloured material (F3 and F6) experienced an average of 0.26 m less thaw depth than their darker coloured counter parts (F4 and F5).

An additional test cover, TCTC #2, was constructed utilizing moisture conditioning and controlled compaction. Monitoring of the thermal performance of this cover was also undertaken over the same time period as for TCTC #1. The results indicated that, during the first two years of the study, the depth of active layer thaw in TCTC #2 was less than that observed at TCTC #1. The geothermal performance of both TCTC's #1 and #2 in subsequent years (i.e. years 3 through 7) was observed to be essentially the same. Therefore, minimal advantage was realized from the moisture conditioning and controlled compaction.

Waste Rock, Open Pit and Landfill Covers

The basis for the design of the reclamation covers over unsaturated material such as waste rock and landfill debris was also determined through field trials.

In the summer of 1988, a sulphide waste dump at Area 14 was flattened and covered with a layer of shale material. Boreholes were drilled through the shale cover into the underlying material in September 1990 and thermocouple strings (TC#7 and TC#8) were installed to provide geothermal monitoring capabilities. These thermocouples have been monitored since that time and hence, they provide a data set for the long-term assessment of the thermal performance of the waste rock.

Geothermal monitoring of the shale cover over waste rock at Area 14 indicated an average maximum depth of thaw of approximately 1.7 m. This data, along with geothermal modelling to assess possible effects of global warming were used to determine the required reclamation cover thickness. Hence, the following rationale is provided for the shale cover thickness placed over unsaturated materials such as waste rock and landfill wastes.

1.	Thaw depth measured in field trials (over parts of 9 years)	1.70 m.
2.	Increase for global warming estimates for high-moisture content shale	0.35 m.
3.	Additional conservative thickness for lower- moisture content shale	0.15 m.
	Estimated total thickness	2.20 m.

Thus, a minimum total thickness of 2.2 m combined shale fill (1.95 m) and sand and gravel cap (0.25 m) is required as a cover over unsaturated material.

3.3.2 Test Pit Investigations

To further develop construction specifications for the reclamation covers, a test pitting investigation was undertaken at the Area 14 Waste Rock Cover and at TCTC #1. The test pitting investigations are documented photographically on Figures 1 and 2. The test pit investigations were undertaken to observe the physical properties of the material within the cover. The following physical properties of the cover material were observed and documented:

- Mineralogy/ lithology,
- Grain size distribution,
- In-situ density of the shale, and
- Moisture content of shale within the ice saturated zone within the base of the cover.

Mineralogy

The mineralogy of the material within TCTC #1 was observed to be mainly composed of black, friable shale with some dark grey, friable dolomitic mudstone. The percentage of dolomitic mudstone within TCTC #1 was visually estimated to be approximately 10 to 20%.

The mineralogy of the material in the Area 14 Waste Rock Cover was observed to be mainly composed of light to dark grey, friable dolomitic mudstone with some black, friable shale. The percentage of black shale was visually estimated to be 20 to 30%.

Grain Size Distribution

The grain size distributions of in-situ samples collected from TCTC #1 confirm that the shale cover is granular in nature, consisting mainly of gravel sized particles with minor amounts of sand. The principal conclusions derived from the results of the grain size distribution analyses include the following:

- The composition of gravel and larger sized particles ranged between 62% and 94%;
- The composition of fines (percentage of sample smaller than 0.075 mm) ranged between 2% and 10%;

The grain size distributions of in-situ samples collected from Area 14 Waste Rock Cover confirm that the cover is granular in nature, consisting mainly of gravel sized particles with minor amounts of sand. The principal conclusions derived from the results of the grain size distribution analyses include the following:

- The composition of gravel and larger sized particles ranged between 80% and 95%;
- The composition of fines (percentage of sample smaller than 0.075 mm) ranged between 0% and 2%;

This information was used to develop the grain size specification for the reclamation cover. The grain size specifications for reclamation cover materials is discussed in detail in Section 6.

If the grain size characteristics are appropriate, till material to be excavated during spillway construction or quarry development may be used as bedding layer material. Bedding layer material is required below the rip rap layer to be placed along designated sections of the Reservoir shoreline (BGC et al. 2004). As such, grain size analysis was completed on several till samples collected from the drilling investigation of the proposed spillway alignment conducted in 2003. The results indicate that the grain size distribution of the till is highly variable but is generally a granular material composed of sand and gravel sized particles. The fines content of the till samples ranged between 7 and 29%, which indicates that the till generally contains more fine grained particles than the shale in the test cover. Since the till is much finer than the shale within the test cover, every practical effort should be made to minimize the amount of till or quarry stripping within the top 1.25 m of the reclamation cover. This includes stripping as much as possible of the overburden material at all quarry locations.

In-situ Density

The compaction specification for the reclamation covers was designed to be performance based. As such, it was important to determine the in situ density of the shale material in TCTC #1. Secondly, it is necessary to determine the compactive effort required to achieve this value during construction of the reclamation cover. To determine this value, a test pit was excavated by hand into TCTC #1 (Figure 3). The material was collected in pails and weighed upon completion of the test pit excavation. The test pit was lined with plastic and filled with a measured volume of water. Using the volume of the test pit and the weight of the material excavated from the test pit, an in situ bulk density was calculated. The results of the density test pit excavation in TCTC #1 indicated an in situ bulk density of 2059 kg/m^3. Assuming a moisture content of 5%, a dry density of 1960 kg/m^3 was calculated. This value is within the range of dry density (1870 to 2010 kg/m^3) determined previously through Standard Proctor Density tests as documented in the Engineering Design of Surface Reclamation Covers report (BGC 2004a).

Moisture Content

The performance of the reclamation cover is expected to increase as the bottom of the shale layer become ice saturated. As such, it was an objective of the test pit investigation to determine if the bottom of the shale layer in the cover was ice saturated, and if so, at what moisture content.

Frozen samples of ice saturated shale were collected from test pits excavated in the Surface Cell Test Cover, TCTC #1 and the Area 14 Waste Rock Cover. The samples were tested for moisture content and the results indicated a gravimetric moisture content ranging between 15.4 and 21.0% and a volumetric moisture content ranging between 29.0 and 35.7% for 5 samples. The moisture content testing validates the volumetric moisture content for the shale used in the thermal modelling for the talik which was 34.6% and the gravimetric moisture content for the shale used for the geothermal modelling for the cover which was 10 and 20% as documented in the Engineering Design of Surface Reclamation Covers report (BGC 2004a).

3.3.3 July 2004 Test Cover Construction

During July 2004, a test cover was constructed in the Surface Cell. The objectives of this activity included the following:

- Determine the compactive effort required to achieve compaction similar to that observed in TCTC #1.
- Observe the effects of compaction by dozer and loaded rock truck.
- Observe the constructability of 0.5 and 1.0 m thick lifts over wet tailings.

The test cover was constructed at the north end of the Surface Cell using dark grey to black, fissile shale and dolomitic mudstone quarried from the West Twin Quarry (Figure 4). This material was coarser in nature and contained a higher percentage of dolomitic mudstone (visually estimated to be approximately 40%) than the material observed in TCTC #1. No particle sizes greater than those specified for inclusion within the reclamation covers was placed within the test cover. The shale was compacted using both a D8 dozer and fully loaded 30 tonne rock truck. The cover was constructed over a tailings subgrade which exhibited a range of moisture and strength conditions. The test cover was constructed in three configurations:

- one 0.5 m lift,
- two 0.5 m lifts for an overall cover thickness of 1.0 m and
- one 1.0 m lift.

The lifts were compacted using both the dozer and loaded 30 tonne rock truck. Visual observations from these two methods indicate that cracking of a 0.5 m lift occurs when compaction by a D8 dozer exceeds 12 passes. When compaction was completed using a loaded 30 tonne rock truck, rutting on the scale of 10 to 20 cm was observed as the compaction was taking place. During construction of the test cover, the following observations were made:

- Pore water was expelled from the underlying tailings when the shale was placed and compacted.
- The pore water was forced up into the shale cover and on to the tailings surface adjacent to the cover.
- The shale was not observed to mix into the underlying tailings during compaction.
- The shale was observed to slide laterally on the surface of the tailings during compaction.

Test pits were hand dug into each cover configuration to observe the in-situ density. The excavated material was placed into pails and later weighed to determine the mass of material removed form the test pit. When completely excavated, the test pit was lined with plastic and filled with a measured volume of water. The mass of material and volume of water were then used to determine the in situ density of the shale material. The results of the density testing are summarized in Table 1.

Table 1 Summary of Density Test Pit Testing

Sample	Compactive Effort	Bulk Density (kg/m^3)	Dry Density (kg/m^3)*
Bottom 0.5 m lift	4 passes with dozer	1852	1759
Top 0.5 m lift	10 passes with dozer	2573	2444
1.0 m lift (middle of lift)	4 passes with dozer and two passes with rock truck	1920	1824
TCTC #1	No controlled compaction	2059	1956

*Dry density calculation assumes moisture content of 5%.

The results indicate that the compactive effort applied by 5 to 6 passes of a D8 dozer are required to attain similar compaction levels to that observed in TCTC #1. The results also indicate that increased compactive effort applied to a 1.0 m lift thickness also results in the desired compaction level being attained.

The compactive effort provided by the contractor's equipment was verified using the during preliminary construction of the reclamation cover of the Surface Cell. Three density test pits were excavated by hand and the density was calculated using the method previously described. The results indicate that dry densities in excess of 2000 kg/m^3 are achieved by the process of levelling with a D8 dozer, plus compaction with three passes of a vibrating drum roller compactor. Additional compactive effort is applied by loaded rock trucks which drive over much of the surface of the cover during placement activities.

4.0 PRECONSTRUCTION ACTIVITIES

4.1 Activities Covered

Prior to construction of the reclamation covers, the following activities are to be undertaken:

- Removal of surface water from topographic lows in the Surface Cell and Test Cell,
- Regrading of tailings in the Surface Cell and Test Cell to minimize areas where a cover thickness in excess of 1.25 m is required,
- Regrading of the current landfill slopes to 3:1,
- Relocation of waste rock and inert demolition debris into open pits;
- Regrading of remnant waste rock piles to minimize areas where a cover thickness in excess of 2.20 m is required,
- Layout of survey benchmarks for use in construction of the reclamation covers,
- Survey of the pre-cover construction surfaces, and
- Preparation of quarry sites including overburden stripping and stockpiling of rippable shale.

The following sections outline the activities undertaken to-date and provide guidance on additional work to be completed.

4.2 Surface Water Management

Some areas of the Surface Cell and Test Cell may pool surface water in Spring 2005 because the construction is not yet complete. This water is to be removed as much as practically feasible prior to cover placement. This is desired in order to create as stable a surface (as practically possible) for trafficability during construction and also to limit the mixing of tailings and shale during cover construction. In areas where ice has formed a continuous ice lens, this should be removed to the satisfaction of the Field Representative.

4.3 Grading

Prior to construction of the reclamation covers, it will be necessary to re-grade the existing surfaces to a more uniform surface for safe and efficient cover construction. At the Surface Cell and Test Cell, the re-grading involved moving material from areas of topographic highs to areas of topographic lows. At the landfill, the side slopes are to be re-graded to a maximum slope of 3H:1V. The upper, flatter surface of the landfill will be re-graded to ensure positive drainage towards the crest of the landfill (minimum 2%). The final graded surface of each area will be surveyed prior to construction of the reclamation cover.

4.4 Relocation of Waste Rock

Waste rock relocation will be undertaken as specified in GLL (2004a). This document should be referenced for any detailed information regarding relocation of waste rock. Some of the general guiding principles from this document include the following:

- Large boulders should be preferentially placed into the bottom of one of the open pits or segregated for placement into the underground mine,
- Placement and compaction of waste rock into the open pits will follow the same quality control measures as described for the placement of shale.
- Placement of inert demolition debris into an open pit, either into the deep portion of the pit or against the toe of the wall, will require finer grained fill material to be incorporated into the voids of the debris for physical stabilization during construction and covering.
- Demolition debris and waste rock should be placed jointly in lifts no greater than 1 m thick.
- The surface of the backfill should be waste rock that is groomed as smooth and free of voids as possible.

The final graded surface of each open pit will be surveyed prior to construction of the reclamation cover.