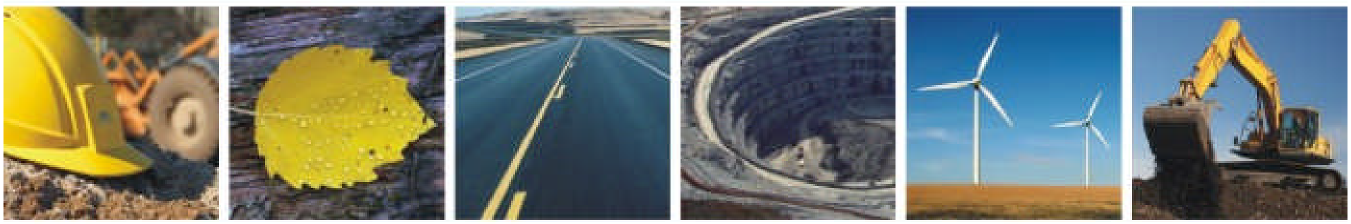
SHEAR DIAMONDS LTD.

PRELIMINARY LANDFILL DESIGN PLAN
JERICHO DIAMOND MINE, NUNAVUT



REPORT

FEBRUARY 2011
ISSUED FOR USE
EBA FILE: E14101118

SHEAR DIAMONDS LTD.

eba
A TETRA TECH COMPANY

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Shear Diamonds Ltd. and their agents. EBA, A Tetra Tech Company, does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Shear Diamonds Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. EBA's General Conditions are included in Appendix A of this report.

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ACRONYMS & ABBREVIATIONS

2011 Water Licence Renewal Documents

AEMP	Aquatic Effects Monitoring Plan
AQMP	Air Quality Management Plan
CAMP	Care and Maintenance Plan
CMP	Contingency Management Plan
EP-RP	Emergency Preparedness and Response Plan for Dam Emergencies
GMP	General Monitoring Plan
ICRP	Interim Closure and Reclamation Plan
LDP	Preliminary Landfill Design Plan
LFP	Landfill Management Plan
LFDP	Preliminary Landfarm Design Plan
LFMP	Landfarm Management Plan
OMS	Operations, Maintenance, and Surveillance Manual
PKMP	PKCA Management Plan
SWMP	Site Water Management Plan
WEMP	Wildlife Effects Management Plan
WMP	Waste Management Plan
WRMP	Waste Rock Management Plan
WTMP	Wastewater Treatment Management Plan

Technical Acronyms & Abbreviations

AA	Atomic Absorption Spectrophotometry
AIA	Aquatic Impact Assessment
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
BACI	Before-after-control-impact
CAEAL	Canadian Association for Environmental Analytical Laboratories
CPK	Coarse Processed Kimberlite
DO	Dissolved Oxygen
EC	Electric Conductivity
EIS	Environmental Impact Statement
FPK	Fine Processed Kimberlite
GC/FID	Gas Chromatograph - Flame Ionization Detector
HWTA	Hazardous Waste Transfer Area
ICP-MS	Inductively Coupled Plasma – Mass Spectrometry
INAC	Indian and Northern Affairs Canada
KIA	Kitikmeot Inuit Association
MANOVA	Multivariate Analysis of Variance
NIRB	Nunavut Impact Review Board
NWB	Nunavut Water Board

PHC	Petroleum Hydrocarbons
PKCA	Processed Kimberlite Containment Area
PPE	Personal Protection Equipment
RBC	Rotating Biological Contactor
RPD	Relative Percent Difference
Shear	Shear Diamonds (Nunavut) Corp.
TDC	Tahera Diamonds Corporation
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TSS	Total Suspended Solids
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

1.1 General

The Jericho Preliminary Landfill Design Plan (LDP) provides preliminary design and operational details for construction of a landfill at the Jericho Diamond Mine (Jericho).

Part D of the Jericho Water Licence NWB1JER0410 (issued December 21, 2004) requires that a Landfill Design Plan be submitted to the water board 60 days prior to construction of the landfill. At this time, the landfill design has been completed and submitted as a preliminary design. Shear Diamonds (Nunavut) Corp. (Shear) only assumed control of the Jericho mine site in August 2010. Since that time, Shear has discovered that detailed information on the present site conditions, including contaminated soil volumes, is limited. Comprehensive historical site monitoring records were not well maintained under the previous ownership and management and the available information is incomplete or lacking detail.

A site investigation is being planned by Shear in 2011, at which time possible landfill locations will be investigated. An updated, detailed landfill design, including stamped and signed drawings, will be submitted to the water board in advance of construction, in accordance with the water licence.

1.2 Objectives of the Design Plan

This document provides a summary of the preliminary landfill design. Operational considerations are discussed briefly in this document; the Jericho Landfill Management Plan (EBA 2011g) provides more details on the management and operation plan for the landfill.

The preliminary design has been based on existing records and the best available information at the time of report preparation. The design has been developed for the current regulatory requirements and to reflect Shear's commitment to best practices in environmental stewardship.

At the time of the water licence renewal application, mining operations have been suspended and the site is under care and maintenance. This document therefore addresses the specific requirements at present, with provision for future waste generated during resumed mining operations.

1.3 Background Information

The Jericho Diamond Mine is located approximately 260 km southeast of Kugluktuk, NU, and 30 km north of Lupin Mine. The Jericho Mine was constructed and operated by Tahera Diamond Corporation (TDC) between 2004 and 2008. In January 2008, mining operations were suspended by TDC, and the site was placed under care and maintenance. Shortly thereafter, Indian and Northern Affairs Canada (INAC) assumed control of the care and maintenance activities for the site. In August 2010, Shear purchased the Jericho Mine and its assets and assumed the responsibility for the site.

A landfill was constructed under the previous ownership in Waste Rock Dump 2, as shown in Figure 1. This landfill will be decommissioned and a new landfill constructed in Waste Dump 1, as discussed in Section 3.0.

Presently, the mine remains under care and maintenance as Shear evaluates the mineral resource. Once the evaluation is complete, a mine plan and operations schedule for the project will be established.

1.4 Linkage to Other Management Plans

The LDP is part of the site wide management system. Other management plans that are related to or refer to the LDP include:

- Landfill Management Plan (LMP)
- Site Water Monitoring Plan (SWMP)
- Waste Management Plan (WMP).

2.0 REGULATORY SETTING

Waste management is regulated under the Nunavut *Public Health Act*, the Nunavut *Environmental Protection Act* and the federal *Environmental Protection Act*.

In addition to mandatory requirements, a number of waste management guidelines are commonly used in the Northwest Territories, as referenced in the water licence. The most recent of these was developed for municipal solid waste, and is titled "Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the NWT" (Kent et al. 2003). While the recommendations provided in this guideline may not all necessarily be appropriate for managing industrial waste such as that generated at Jericho, applicable principles have been adopted for the design and operation of the landfill.

3.0 LANDFILL SETTING

The landfill will be located within Waste Dump 1, in accordance with the environmental impact statement (EIS) (TDC 2003); however, the precise location has not yet been determined. The regional geology of Jericho site is detailed in SRK 2005.

The region consists of extensive Achean granite rocks, which vary locally and over short distances from granodiorite to syenogranite, with associated pegmatite phases. Pleistocene glacial sediments occur sporadically throughout the region, and provide 10 to 20 m cover over the kimberlite pipe. Drilling results and the surficial geological mapping indicate that the foundation conditions at waste dump sites consist of bedrock with isolated soil deposits. The soil deposits typically range in thickness from 0.2 m to 3.2 m and consist of granular colluvial soils with a thin mantle of organic soil in some locations. Both waste dump sites are underlain by permafrost.

Regional permafrost maps, complemented by site-specific thermal data and data from the Lupin Mine, indicate that Jericho lies in a region of continuous permafrost (SRK Consulting 2005). Permafrost is everywhere except beneath large lakes. Available data suggests that the permafrost depth is about 450 m, which is consistent with published data from the Jericho area. In surficial soils, the active layer typically ranges from less than 1 m in organic soil to slightly more than 3 m where well-drained granular soils are present. The active layer thickness in exposed rock locally exceeds 3 m (SRK Consulting 2005).

4.0 PRELIMINARY LANDFILL DESIGN

The landfill is operated as an industrial dry waste landfill and not a municipal solid waste landfill. The mine generates a variety of wastes, both hazardous and non-hazardous. A landfill is used to dispose of non-hazardous wastes that cannot be recycled. Food wastes are incinerated and hazardous materials are separated, stored and sent off site for disposal or for the recycling of hazardous recyclables via the winter road. Sludge from the wastewater clarifier is disposed of in a pit area segregated from the main landfill facility.

The landfill design is based on the approach used at EKATI Diamond Mine, NT, where permafrost is used to minimize water leaching into the subsoil. The design also allows for the landfill to be fully encased in the permafrost as the site develops and the landfill is closed. A plan and cross-section of the landfill development is presented in Figure 2 of this report.

4.1 Hazardous Waste Storage Facilities

Hazardous materials are not deposited in the dry waste landfill. These are separated, packaged, and stored at the hazardous materials compound away from the landfill area. Hazardous waste storage facilities are addressed in the Jericho Waste Management Plan (EBA 2011k).

4.2 Landfill Sizing and Location

The landfill will be located within Waste Dump 1, in accordance with the EIS; however, the precise location has not yet been determined. The landfill location will be finalized as part of the investigation work being undertaken by Shear in 2011. The existing landfill located in Waste Dump 2 will be decommissioned once the new landfill construction is complete.

The size of the existing landfill was based on the size of landfills at other mine sites relative to the camp capacity, and has base dimensions of 150 m in length by 50 m wide. It is expected that the new landfill will be of similar size; however, debris containment volumes will be reviewed during the detailed design of the landfill.

4.3 Permafrost Encapsulation During Operation and Closure

As noted in Section 3.0, the site is located in a region of continuous permafrost. As such, permafrost is expected to develop through the waste. Unfrozen waste will be present during operation in the summer months.

To facilitate waste encapsulation in permafrost at closure, the final layer of cover material will be a minimum of 4.6 m thickness of waste rock. Thermal analysis to support the design is presented in Appendix B. Climate change has been considered in the design and is also addressed in Appendix B. This method of encapsulation is consistent with the design, operation, and closure of other landfill sites under licence in the Northwest Territories and Nunavut. Ongoing daily operation through the life of the landfill will maintain a cover for frozen waste in the spring to reduce the movement of seasonal thaw in the material.

4.4 Development Method

The landfill will be developed using the area fill method as detailed in Kent et al. (2003). Figure 2 provides a plan and cross-section of the landfill development based on the area fill method. The area fill method is the selected design method since permafrost and geological rock conditions inhibit development of trenches.

Waste will be deposited on a prepared rock fill base and containment side berms. The rock fill base will be prepared by removing surface debris, large rocks, and brush. The side berms used to develop the area fill will be approximately 3.0 m in height and have stabilized sideslopes of 2H:1V typical on the outside and inside of the berm. The berms may be constructed using waste rock material.

Since the development of the landfill is located within the Waste Rock Dump, the landfill in cross-section will resemble cross-section Figure 3-4 Mounding Concept, as illustrated in the Guidelines for Planning, Design, Operations and Maintenance (Kent et al. 2003). The landfill will increase in depth as rock waste material is deposited on site. Encapsulated waste cells will develop as waste materials are deposited and covered. Intermediate cover will be spread over the compacted waste materials with a dozer. Some materials that could be used as intermediate cover are remediated landfarm soil, till, or granular crush having a maximum 100 mm top size. The intermediate cover will then be track packed with a dozer. The lift thickness of the intermediate cover should be 0.3 m to 0.5 m. Successive layers will facilitate permafrost development within the landfill. Final cover material will provide protection from animal incursion and maintain the permanent permafrost conditions.

The landfill will be capped and closed progressively as final elevations are achieved. Final elevations will be field fit so that stability of the dump is maintained. Rounded tops will be established on all completed portions of the landfill so that water does not accumulate on tops and percolate through the waste piles. With increase in the perimeter berm height, additional lifts of waste may be stored.

Final closure of the landfill will be undertaken once it can no longer be used, which is dictated by site conditions (not anticipated) or when the mine closes as part of mine closure activities. Final closure will consist of pushing waste rock over the landfill to a depth to allow permanent freezing and encapsulation in permafrost.

4.5 Fencing

Fencing is not required for the site because the only materials entering the landfill are residue solid waste that will have no organic or food-related items. Waste placed in the site will be covered regularly, particularly when wind conditions are elevated.

4.6 Burning

The Jericho Landfill Management Plan (EBA 2011g) allows for burning of certain wastes. Scrap, clean wood, and paper are proposed for burning to reduce the quantity of material to be buried. Burning will be controlled as an authorized activity on site. The location of the burn pit will be chosen following the site inspection.

4.7 Sludge Pit

A sludge pit to contain solid waste from the wastewater clarifier will be constructed in a segregated area of the landfill construction. The pit will consists of depression excavated in the waste rock and lined with a minimum 0.5 m of till. The till is intended to reduce seepage of the sludge through porous waste rock material. The location of the sludge pit will be determined as part of the detailed design process.

5.0 GROUND WATER MONITORING

Groundwater monitoring will be implemented to evaluate any changes in water quality resulting from landfill release. The monitoring method depends on the foundation conditions of the landfill and local topography. If the landfill is constructed on a large waste rock pad or on the waste rock pile, monitoring wells may not effectively evaluate groundwater quality, so surface testing from several sampling stations may prove more effective. General sampling locations to monitor waste rock dump seepage have been indentified as part of the Jericho General Monitoring Plan (EBA 2011d). Shear will evaluate the specific monitoring method and requirements once the landfill location has been determined.

6.0 CLOSURE

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Signature
Date Feb 28, 2011
PERMIT NUMBER: P 018
NWT/NU Association of Professional Engineers and Geoscientists

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Environment Manager
Shear Diamonds Ltd.

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Shear Diamonds Ltd.

2011 WATER LICENCE RENEWAL DOCUMENTS

Management Plans

EBA, A Tetra Tech Company (EBA), 2011a. Aquatic Effects Monitoring Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011b. Care and Maintenance Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011c. Contingency Management Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011d. General Monitoring Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011e. Interim Closure and Reclamation Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011f. Landfarm Management Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011g. Landfill Management Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011h. Processed Kimberlite Management Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011i. Site Water Management Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011j. Waste Management Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011k. Waste Rock Management Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011l. Wastewater Treatment Management Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

Design Reports

EBA, A Tetra Tech Company (EBA), 2011m. C1 Diversion Construction Summary, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011n. Geotechnical Design Report – Set 3 Tank Farm of Fuel Storage Facilities, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011o. Preliminary Landfarm Design Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011p. Preliminary Landfill Design Plan, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

Additional Plans

EBA, A Tetra Tech Company (EBA), 2011q. Operations, Surveillance, and Maintenance Manual, PCKA Dams, Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

EBA, A Tetra Tech Company (EBA), 2011r. Emergency Preparedness and Response Plans for Dam Emergencies at the Jericho Project, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

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AMEC Earth & Environmental, April 2005, Spill Prevention and Emergency Response-Contingency Plan, Jericho Diamond Project.

Duong, Diep and Kent, Ron. 1996. Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the NWT. Municipal and Community Affairs.

Kent, R., P. Marshall and L. Hawke. 2003. Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the NWT. Report prepared for Department Of Municipal and Community Affairs, GNWT by Ferguson Simek Clark.

Tahera Diamond Corporation, 2004, Hazardous Materials Management Plan, Jericho Diamond Mine.

Tahera Diamond Corporation, 2003. Jericho Diamond Project Final Impact Statement.

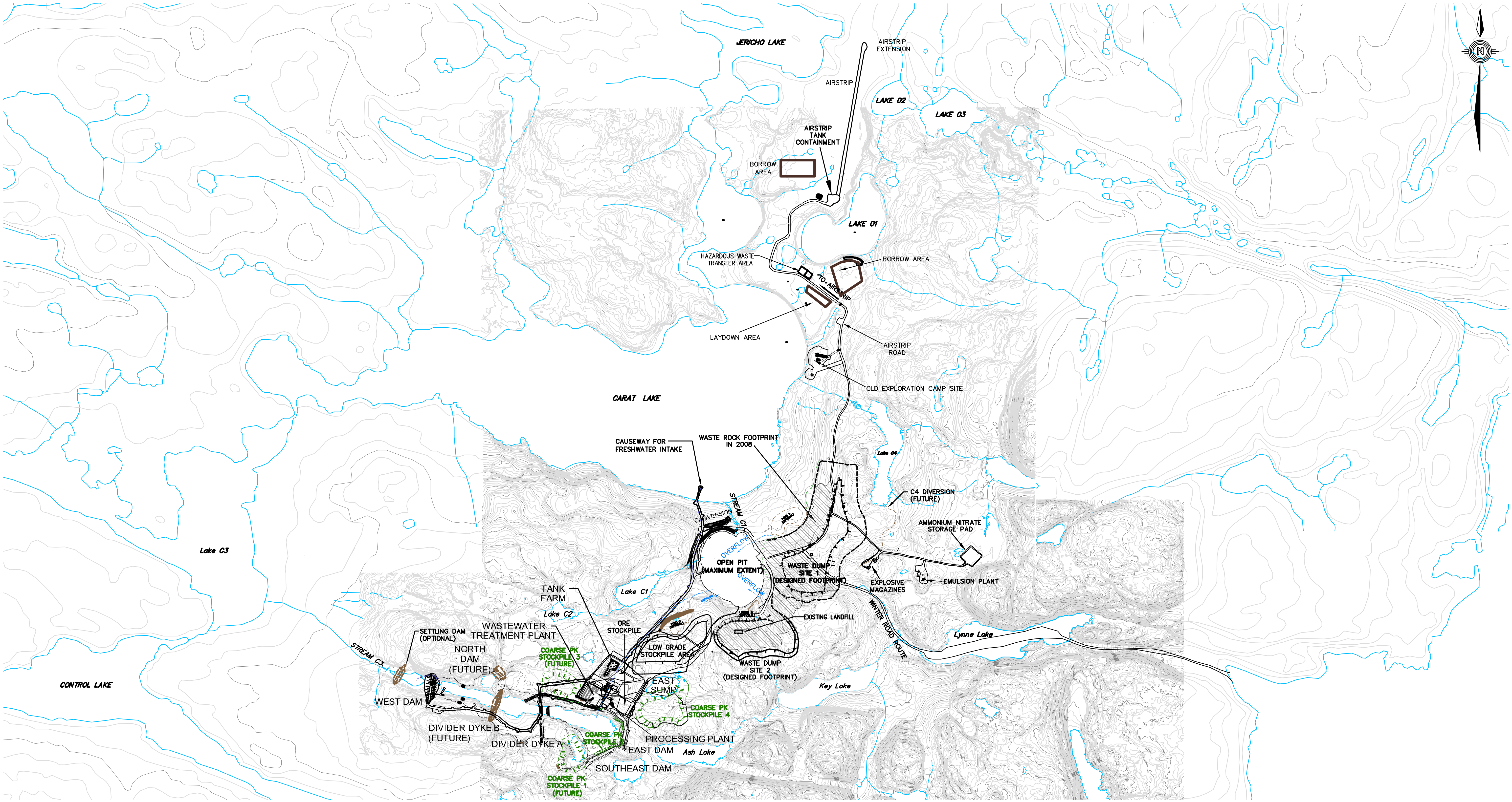
SRK Consulting, 2005, Waste Rock Management Plan, Part 1, Waste Rock and Overburden, Jericho Diamond Mine, Tahera Diamond Corporation.

EBA Engineering Consultants Ltd., December 2005, Landfarm and Contaminated Snow Containment Facility, Design Summary Report, Tahera Diamond Corporation.

EBA Engineering Consultants Ltd., February 2006, Jericho Project, Processed Kimberlite Management Plan, Tahera Diamond Corporation.

FIGURES

Q:\Edmonton\Drafting\CIVIL3D\E141\E14101118\Civil 3D\Landfill Design Plan\ACAD\E14101118_FIG 1_Landfill Design Plan.dwg [FIGURE 1] February 25, 2011 - 11:05:44 am (BY: KIROS, TIGISTI)



NOTES:

1. LAYOUTS ARE APPROXIMATE, AND MAY NOT REFLECT ACTUAL SIZE AND LOCATIONS
2. FOOTPRINTS OF WASTE ROCK PILES, COARSE PK STOCKPILES, AND ORE STOCKPILES ARE SHOWN IN MAXIMUM LIMITS, ACTUAL FOOTPRINTS MAY VARY

0 1 000

Scale: 1: 25 000 (metres)

STATUS
ISSUED FOR USE

CLIENT
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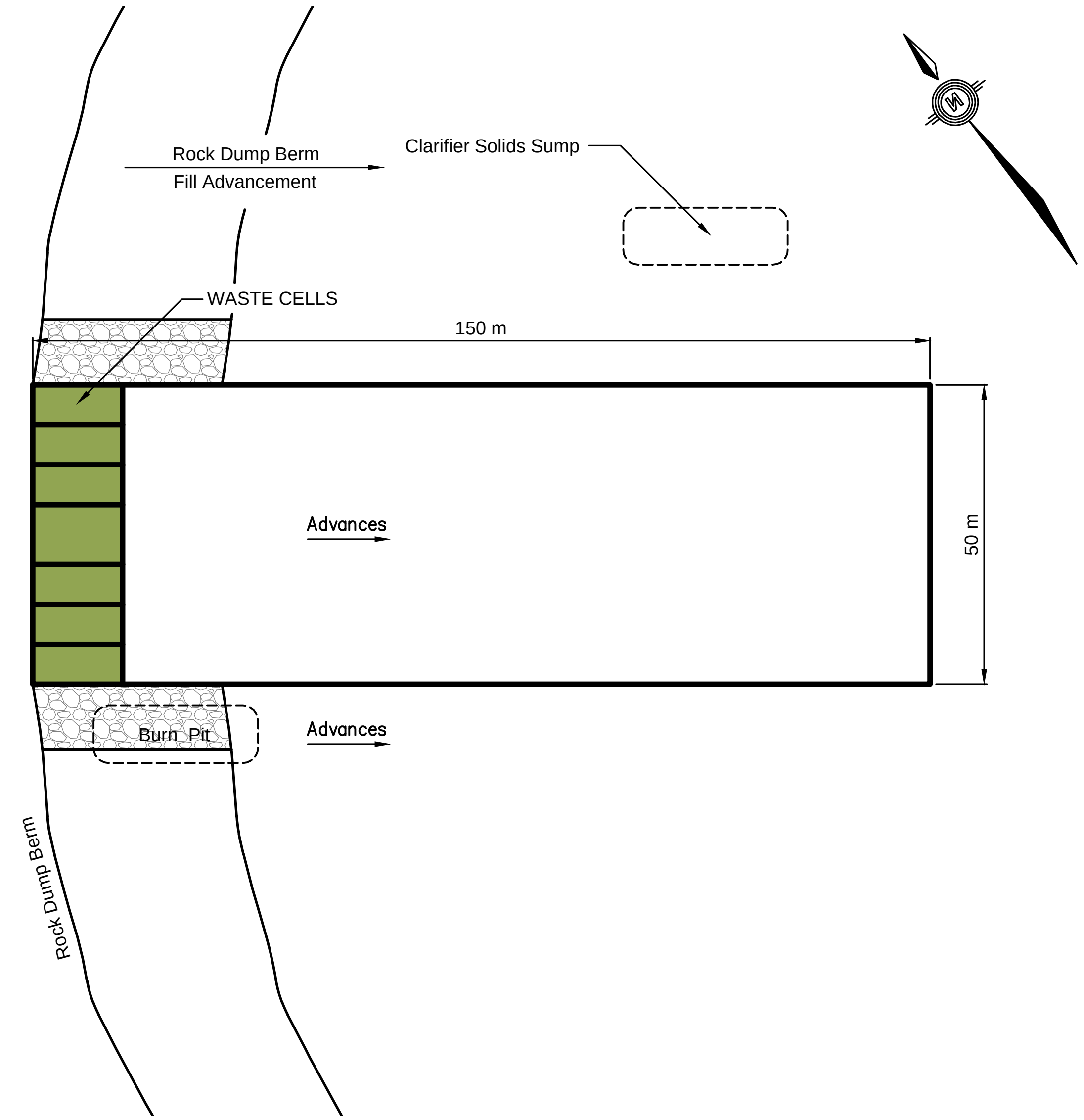
LANDFILL DESIGN PLAN
JERICHO DIAMOND MINE, NUNAVUT

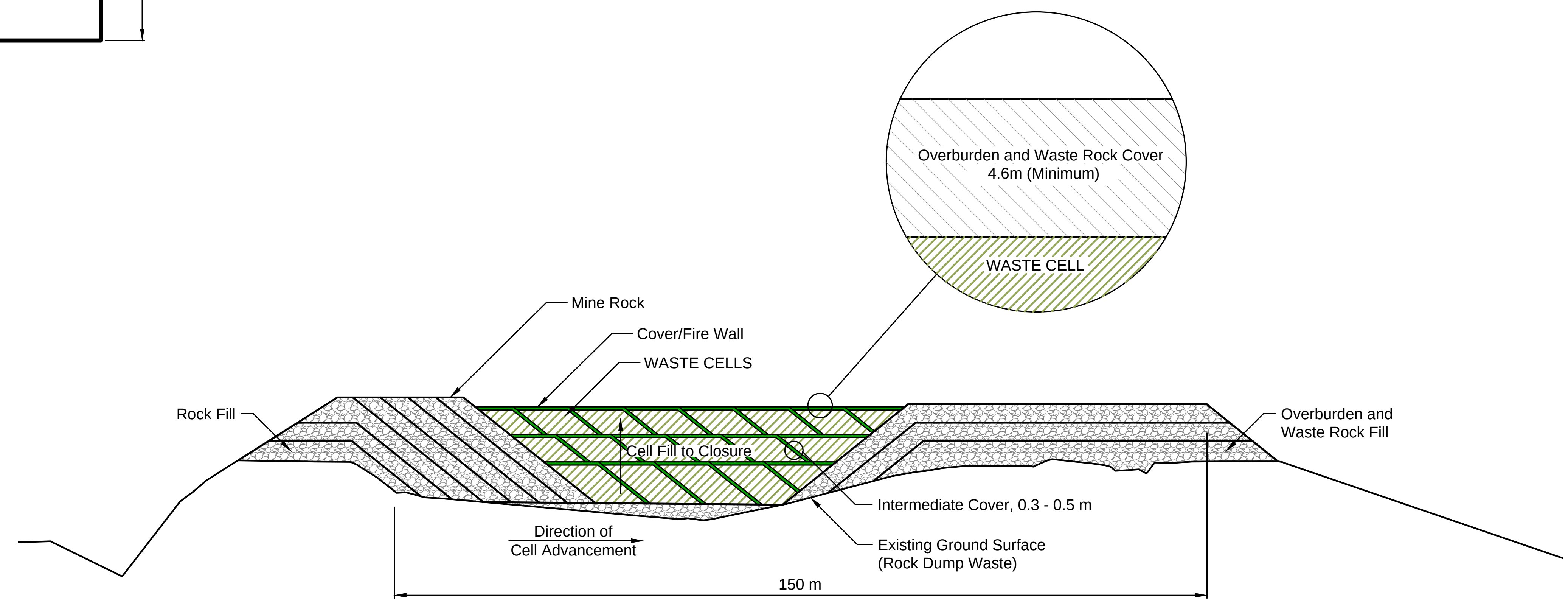
GENERAL SITE PLAN

PROJECT NO.	DWN	CKD	REV
E14101118	TK	JS	0

OFFICE	DATE
EBA-EDM	February 24, 2011

Figure 1





NOTES:

1. Landfill base approximately 150 m X 50 m
2. Layer depth 3 m approximately.
3. Location of burn pit, sump and incinerator to be determined during detailed landfill design

DRAWING NOT TO SCALE

STATUS
ISSUED FOR USE

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LANDFILL DESIGN PLAN
JERICHO DIAMOND MINE, NUNAVUT

SCHEMATIC OF LANDFILL DEVELOPMENT AND STABILITY PLAN PLAN VIEW AND TYPICAL PROFILE

PROJECT NO.	DWN	CKD	REV	
E14101118	TK	JS	0	Figure 2
OFFICE	DATE			
EBA-EDM	February 28, 2011			

APPENDIX A

APPENDIX A EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEOTECHNICAL REPORT

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA's Client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. EBA's instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

8.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

9.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

10.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

11.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

12.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

13.0 SAMPLES

EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

14.0 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX B

APPENDIX B LANDFILL THERMAL ANALYSIS

LANDFILL THERMAL ANALYSIS

1.0 INTRODUCTION

Thermal analyses were carried out to estimate the required waste rock cover thickness to maintain the long-term frozen condition of the Jericho Landfill. The following summarizes the input data and results of the thermal analyses.

The thermal analyses were conducted for the existing landfill on Waste Rock Dump No. 2 and will be used for the future landfill on Waste Rock Dump No. 1 due to similar ground conditions.

The landfill at the Jericho Diamond Mine site is operated as a dry waste landfill with food wastes removed from the waste stream. The landfill location has not yet been determined and will be finalized as part of the investigation work being undertaken by Shear in 2011. Final closure of the landfill will be undertaken when the mine closes as part of mine closure activities. The landfill will be capped and closed during the mine closure stage. The landfill closure plan is to cover the landfill waste with a thick layer of mine waste rock to promote the permafrost development within the landfill waste.

2.0 LANDFILL SITE CONDITIONS

The landfill will be located within the Waste Rock Dump No. 1. The surficial geological mapping presented in SRK 2003a indicates that the original ground at the Waste Rock Dump No. 1 primarily consists of bedrock. The bedrock at the mine site is mostly granite. Regional permafrost maps and site-specific measured ground temperature data indicate that the mine site lies in a region of continuous permafrost (SRK 2003b). Permafrost is everywhere except areas beneath or near large lakes. Permafrost is expected to exist beneath the landfill area.

As described in the Landfill Management Plan, the landfill waste will consist of scrap metal, rubble, wood products, rubber products, construction debris, glass, fabrics, and lines, etc. The landfill waste will be dumped in the landfill area, crushed with a dozer, track packed, and then buried regularly with waste rock as the dump elevations increase.

3.0 CLIMATIC DATA FOR THERMAL EVALUATIONS

3.1 Mean Climatic Conditions

Climatic data required for the thermal analyses includes monthly air temperature, wind speed, solar radiation, and snow cover. There has been no meteorological station at the Jericho Diamond Mine site. The closest meteorological station is at Lupin/Contwoyto Lake, which is approximately 30 km south of the mine site. The climatic data for air temperature, snow cover, and wind speed were obtained from Environment Canada's meteorological station at Lupin/Contwoyto Lake, which has been operating since 1959. Mean monthly air temperatures for the thermal analyses were based on the 1971-2000 climatic normals at Lupin/Contwoyto Lake (data from Environment Canada's webpage). Monthly wind speed data were based on the 1951-1981 climatic normals at Contwoyto Lake (Environment Canada 1982a). Month end snow cover data were based on the 1961-1991 climatic normals at Contwoyto Lake (Environment Canada 1993).

The solar radiation data were obtained from the meteorological station at Norman Wells, which is at a similar latitude as that for the Jericho mine site. The solar radiation data were based on the 1951 to 1980 climatic normals at Norman Wells (Environment Canada 1982b). Table B1 summarizes the climatic conditions used for the thermal analyses.

Table B1: Summary of Climatic Data Used in Thermal Analysis

Month	Monthly Air Temperature (°C)		Monthly Wind Speed (km/h)	Month-End Snow Cover (m)	Daily Solar Radiation (W/m^2)
	Mean (1971 to 2000)	1 in 100 Warm			
January	-30.4	-25.2	20.2	0.44	5.4
February	-28.5	-23.6	13.3	0.52	31.6
March	-24.9	-20.6	13.8	0.60	97.3
April	-15.9	-13.2	14.3	0.65	179.2
May	-5.7	-4.7	16.5	0.30	233.1
June	6.5	9.2	14.6	0	267.2
July	11.5	16.3	16.8	0	234.5
August	8.8	12.5	18.8	0	166.8
September	1.8	2.5	23.0	0.02	93.9
October	-8.6	-7.1	19.8	0.15	32.5
November	-20.7	-17.1	16.9	0.28	9.6
December	-26.8	-22.2	16.3	0.37	2.0

3.2 1 in 100 Warm Year Air Temperatures

A probabilistic analysis was carried out to determine the mean monthly temperatures representative of a 1 in 100 warm year. The freezing index and thawing index for each year at Lupin/Contwoyto Lake from 1959 to 2004 were calculated. The freezing index for each winter was ranked in ascending order and plotted on probability paper. A "best-fit" line was drawn through the set of points to estimate the 1 in 100 warm year freezing index. A similar procedure was repeated for the summer temperatures to obtain the 1 in 100 warm year thawing index. Mean winter air temperatures were multiplied by the ratio of the 1 in 100 year freezing index to the mean freezing index to estimate the monthly winter air temperatures of a 1 in 100 warm year. Similarly, mean summer air temperatures were multiplied by the ratio of the 1 in 100 year thawing index to the mean thawing index to estimate the monthly summer air temperatures of a 1 in 100 warm year.

Monthly air temperatures for a 1 in 100 warm year are also listed in Table C1. As shown in Table C1, the 1 in 100 warm year annual air temperature is approximately 3.3°C warmer than the mean annual air temperature for the period of 1971 to 2000.

3.3 Air Temperatures Considering Global Warming Trends

According to Environment Canada's "Climate Trends and Variations Bulletin" (http://www.msc-smc.ec.gc.ca/ccrm/bulletin/national_e.cfm), seven of the ten warmest years on record in northern Canada have occurred since 1994. There is an international scientific consensus that most of the warming observed over the last 50 years is attributable to human activities, namely in the emissions of greenhouse gases through the burning of fossil fuels (ACIA 2004).

Global Circulation Models, or GCMs, are mathematical representation of the atmosphere, land surfaces, and oceans that have been developed to predict future climate behaviour in response to changes in the composition of the atmosphere. Several scenarios have been developed to estimate the likely range of future emissions that may affect climate (IPCC, 2000). Different GCMs have been developed, resulting in different degrees of projected global warming. In this study, using results from the Canadian Climate Impact Scenario project (http://www.cics.uvic.ca/scenarios/index.cgi), seasonal temperature changes for the Jericho Mine site area were estimated for the "B21 scenario" from four GCMs: a) CGCM2 (Canadian Centre for Climate Modelling and Analysis, Canada); b) GFDL-R30 (Geophysical Fluid Dynamics Laboratory, United States); c) ECHAM4 (Max-Planck Institute of Meteorology, Germany), and d) HadCM3 (Hadley Centre for Climate Prediction and Research, United Kingdom).

The average seasonal changes in temperatures over 110 years estimated from the four GCMs for the mine site area are 5.9°C, 4.1°C, 3.6°C, and 4.2°C during winter, spring, summer, and fall, respectively.

Table B2 compares the estimated/predicted mean annual air temperatures and freezing/thawing indexes for mean, 1 in 100 warm year, and long-term global warming (GCMs) climatic conditions.

Table B2: Summary of Air Temperature Conditions

Climate Scenario	Mean Annual Air Temperature(°C)	Freezing Index (°C-days)	Thawing Index (°C-days)
Mean (1971 to 2000)	-11.1	4,884	878
1 in 100 Warm Year (based on air temperature data from 1959 to 2004)	-7.8	4,044	1,243
Predicted 2013 (average of GCMs warming trend)	-10.0	4,593	993
Predicted 2113 (average of GCMs warming trend)	-5.9	3,535	1,408

4.0 THERMAL EVALUATION OF LANDFILL

4.1 Thermal Analysis Methodology

Analyses were carried out using EBA's proprietary two-dimensional finite element computer model, GEOTHERM. The model simulates transient, two-dimensional heat conduction with change of phase for a variety of boundary conditions. The heat exchange at the ground surface is modelled with an energy balance equation considering air temperature, wind velocity, snow depth, and solar radiation. The model facilitates the inclusion of temperature phase change relationships for saline soils, such that any freezing depression and unfrozen water content variations can be explicitly modelled. The model has been verified by comparing its results with closed-form analytical solutions and many different field observations. The model has formed the basis for thermal evaluations and designs of a substantial number of projects in the arctic and sub-arctic regions, including dams, ground freezing systems, foundations, pipelines, utilidor systems, and landfills.

One-dimensional thermal analyses were first carried out to predict the temperatures of the original ground prior to the till placement and the temperatures of the placed till material and landfill waste with time based on mean climatic conditions. One-dimensional thermal analyses were then conducted to estimate the landfill cover thickness required to maintain the long-term frozen conditions of the landfill waste for mean, 1 in 100 warm year, and long-term global warming climatic conditions.

The thermal model was calibrated to the measured ground temperatures at both BH-03-08 and BH-03-10 during previous thermal evaluations for the designs of West and East Dams at the Jericho mine site. Good agreements were obtained between the measured and predicted ground temperatures. Calibration thermal analysis was not conducted for this study since no measured temperature data are available at the landfill site.

4.2 Soil Index and Thermal Properties

The soil index properties for the materials in the thermal analysis were estimated based on the past experience for similar materials. Thermal properties of the materials were determined indirectly from well-established correlations with soil index properties or based on past experience. Table B3 summarizes the material properties used in the thermal analyses.

Table B3: Material Properties Used in Thermal Analyses

Material	Water Content (%)	Bulk Density (Mg/m^3)	Thermal Conductivity (W/m-K)		Specific Heat (kJ/kg°C)		Latent Heat (MJ/m^3)
			Frozen	Unfrozen	Frozen	Unfrozen	
Waste Rock Cover Fill	2	2.14	1.45	1.67	0.76	0.80	14
Landfill Waste	3	1.96	1.50	1.50	0.77	0.83	19
Till Fill	13	2.26	2.77	1.94	0.89	1.13	87
Bedrock	1	2.53	3.00	3.00	0.75	0.77	8

4.3 Results, Discussions, and Recommendations

Thermal analysis results indicate that the ground temperature at depth for the original ground (bedrock) prior to the till placement is estimated to be -5.2°C under mean climatic conditions. It is predicted that the till material placed in summer 2005 will be frozen back about two years after its placement. The temperatures in the original ground are estimated to be 1 to 3°C warmer after the placement of the till fill and landfill waste.

Parametric thermal analyses were carried out to determine the minimum required fill cover thickness under mean, 1 in 100 warm year, and long-term global warming climatic conditions. The predicted active layer thicknesses (or maximum thaw penetration) in the landfill cover for the analyzed climatic conditions are summarized in Table B4.

Table B4: Summary of Predicted Maximum Depth of Thaw Penetration into Landfill Cover

Air Temperature Conditions	Predicted Active Layer Thickness (m)
After five consecutive mean years	3.2
After one 1 in 100 warm year following five mean years	3.6
After five consecutive 1 in 100 warm years following five mean years	3.9
After 100 years of global warming, average of four GCMs	4.6

Table B4 suggests that the predicted maximum depth of thaw penetration ranges from 3.2 m to 4.6 m for various climatic conditions. The required landfill cover thickness is a function of the climatic conditions selected as the design criteria for the landfill. Additional factors of safety can also be applied to account for uncertainties in the geothermal model, soil input parameters, and climate input parameters.

Given these uncertainties, it is recommended that the landfill at the Jericho Mine site be designed for 100 years of long-term climate warming (average of four GCMs) to maintain the landfill waste in long-term permafrost condition. Therefore, the recommended minimum landfill cover thickness is 4.6 m.

The required cover thickness is expected be less when till material is used instead of mine waste rock. However, further thermal evaluations are required to verify and estimate the required cover thickness if till material are used.

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