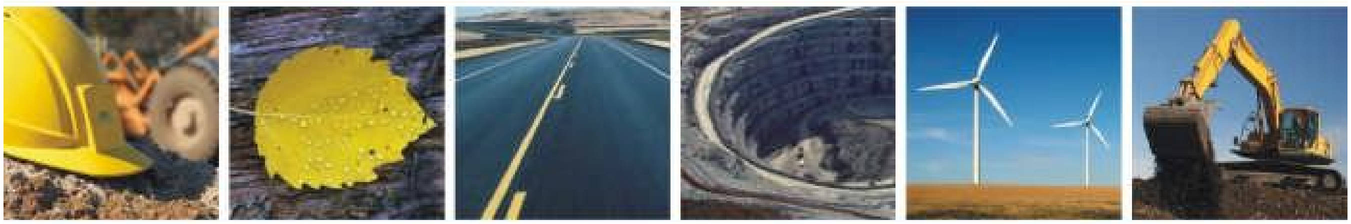
SHEAR DIAMONDS LTD.

FUEL STORAGE CONTAINMENT FACILITY DESIGN PLAN SET 3 TANK FARM JERICHO PROJECT, NUNAVUT



REPORT

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SHEAR DIAMONDS LTD.

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A TETRA TECH COMPANY

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ACRONYMS & ABBREVIATIONS

AA	Atomic Absorption Spectrophotometry
ABA	Acid Base Accounting
ACM	Asbestos-containing Material
AEM	Aquatic Effects Monitoring
AIA	Aquatic Impact Assessment
AIRS	Adaptation and Impacts Research Section
ANCOVA	Analysis of Covariance
ANFO	Ammonium Nitrate Fuel Oil Explosives
ANOVA	Analysis of Variance
APEC	Areas of Potential Environmental Concern
ARD	Acid Rock Drainage
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
BACI	Before-after-control-impact
CALA	Canadian Association for Laboratory Accreditation
CCME	Canadian Council of Ministers of the Environment
CDA	Canadian Dam Association
CPK	Coarse Processed Kimberlite
DIAND	Department of Indian Affairs and Northern Development
DFO	Department of Fisheries and Oceans
DO	Dissolved Oxygen
EBA	EBA, A Tetra Tech Company
EC	Electric Conductivity
EIS	Environmental Impact Statement
EOC	Emergency Operations Centre
EPP	Emergency Preparedness Plan
ERP	Emergency Response Plan
ESA	Environmental Site Assessment
FSCF	Fuel Storage Containment Facility
FPK	Fine Processed Kimberlite
GC/FID	Gas Chromatograph - Flame Ionization Detector
GTC	Ground Temperature Cable
Hazmat	Hazardous Materials
HDPE	High Density Polyethylene
HVAS	High Volume Air Sampling
HWTA	Hazardous Waste Transfer Area
ICP-MS	Inductively Coupled Plasma – Mass Spectrometry
IDLH	Immediately Dangerous to Life and Health
INAC	Indian and Northern Affairs Canada
KIA	Kitikmeot Inuit Association
LBP	Lead-based Paint
LPRM	Long-term Post-reclamation Monitoring
MANOVA	Multivariate Analysis of Variance

MSDS	Material Safety Data Sheets
NIRB	Nunavut Impact Review Board
NP	Neutralization Potential
NWB	Nunavut Water Board
PHC	Petroleum Hydrocarbons
PKCA	Processed Kimberlite Containment Area
PPE	Personal Protection Equipment
QA	Quality Assurance
QC	Quality Control
RBC	Rotating Biological Contactor
RCM	Reclamation Construction Monitoring
ROM	Run of Mine
RPD	Relative Percent Difference
RRPK	Recovery Rejects Processed Kimberlite
SCBA	Self-contained Breathing Aparatus
Shear	Shear Diamonds (Nunavut) Corp.
SOP	Standard Operating Procedure
SPRM	Short-term Post-reclamation Monitoring
TDC	Tahera Diamonds Corporation
TDGR	Transportation of Dangerous Goods Act (RSNWT 1988) and Regulations
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TSS	Total Suspended Solids
WSCC	Workers' Safety and Compensation Commission of the Northwest Territories and Nunavut
WHMIS	Workplace Hazardous Materials Information System
WWTP	Wastewater Treatment Plant

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
LMP	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

1.0 INTRODUCTION

1.1 General

EBA, A Tetra Tech Company (EBA), carried out a geotechnical design of the proposed expansion to the existing Set 1 and 2 tank farms (Figure 1) at Jericho Diamond Mine (Jericho). This expansion is referred to as Set 3. The construction of the Set 1 and Set 2 Fuel Tank Farm areas shown in Drawing TF-1 was completed by October 2005.

The scope of work for this study is to:

- Review available background information;
- Design Set 3 tank farm earthworks;
- Prepare the construction drawings and specifications; and
- Write a report summarizing the design basis and considerations.

This report summarizes the design basis and considerations for the Set 3 Tank Farm. Reduced size construction drawings are presented in Appendix B of this report. Construction specifications are presented in Appendix C.

1.2 Background Information

The Set 3 Tank Farm will be located adjacent to the existing Set 2 Tank Farm, on its northeast side, as shown in Figure 1 and Drawing TF-1.

EBA conducted a desktop geotechnical assessment for the Set 3 Fuel Storage area in April 2006 based on a review of available information. The findings and recommendations from the desktop study were reported in EBA 2006a, which can be found in Appendix D, and will form the basis for the current design. A set of two tanks, each 14.63 m in diameter and 9.75 m in height, was proposed for the Set 3 Tank Farm area when that report was prepared.

Shear Diamonds (Nunavut) Corp. (Shear) is evaluating the feasibility of moving the existing eight tanks from the Set 1 Tank Farm are to the proposed Set 3 Tank Farm area instead of purchasing the two larger tanks mentioned in EBA 2006a. The decision to move the tanks will be based on an evaluation of the tank integrity by a qualified firm. It is understood that each of the eight tanks is 8.15 m in diameter and 9.7 m in height and has a storage capacity of 500,000 L (500 m^3). The empty weight of each tank is approximately 16,000 kg. It is also understood that Shear is planning to use a mobile crane and flatbed trailer to move the tanks to the new location. Some pipe work connecting the existing tanks in the Set 1 Tank Farm area may also be used to connect the tanks in the Set 3 Tank Farm area.

Fill materials were placed over the original ground surface in the area encompassing the proposed Set 3 Tank Farm in late 2005. The surface elevations of the existing fill over the area were surveyed by Sub-Arctic Surveys Ltd. (SAS) and provided to EBA in May 2007.

The construction schedule for the expansion has not been finalized at this time. The tank farm is expected to be in use for less than 10 years after its construction.

1.3 Pre-placed Fill in Set 3 Tank Farm Area

Fill materials were placed in late 2005 over the original ground surface in the area northeast of the existing Set 2 Tank Farm area, as shown in Drawing TF-1. The placement and compaction of the fill materials were monitored during the construction. However, no written document has been found to provide detailed construction information of the fill materials.

The following information about the construction of the pre-placed fill materials was provided to Mr. Gordon Zhang, of EBA, by Mr. Mike Monk, a former EBA employee, in a phone conversation held on June 7, 2007, and summarized in an email (Monk 2007). The information was based on Mr. Monk's memory and must therefore be considered anecdotal.

- The fill materials were placed in frozen conditions such that moisture conditioning of the fill was not applied and no density control testing was done at that time.
- 3.0 m thick run-of-mine (ROM) material was placed in three lifts, each 1.0 m thick, using 777D trucks and a dozer, and compacted by 777D trucks and a 10-tonne drum compactor. The maximum particle size of the ROM was about 900 mm.
- 0.3 m to 0.5 m thick 150 mm minus rockfill was placed in a single lift over the ROM and compacted with a 10-tonne drum compactor for at least a half dozen of passes.
- 0.2 m to 0.3 m thick 50 mm minus rockfill was placed in a single lift over the 150 mm minus and compacted with a 10-tonne drum compactor for at least a half dozen of passes.
- 0.1 m to 0.2 m thick 20 mm minus rockfill was placed in a single lift over the 50 mm minus and compacted with a 10-tonne drum compactor for at least a half dozen of passes.
- Based on the fill thicknesses mentioned above, the total fill thickness would be 3.6 m to 4.0 m, which is about 0.3 m to 0.7 m less than the total fill thickness of the existing fill of approximately 4.3 m from the surveyed existing fill surface to the original ground surface. Mr. Monk agreed that either the actual thickness of the placed ROM may be around 3.3 m to 3.7 m instead of 3.0 m or some fill may have been placed prior to the placement of the ROM material.
- Photos 1 to 4 were taken during the construction of the pre-placed fill materials in late 2005. Photos 5 and 6, taken in June 2007, show the current surface conditions of the pre-placed fill materials within the Set 3 Tank Farm area.

2.0 SITE CONDITIONS

2.1 Surface Conditions

The elevation contours of the original ground surface shown in Figure 1 suggest that the Set 3 Tank Farm area was originally relatively flat with a surface elevation of approximately 517 m or higher, but less than 518.0 m.

The surface elevation contours of the existing pre-placed fill over the Set 3 Tank Farm area are shown in Drawing TF-1. The surface generally slopes down at an average slope of approximately 1.5% from the northeast containment berm of the existing Set 2 Tank Farm towards the northeast direction. The fill surface elevations range from 521.8 m to 521.2 m within the footprint of the proposed Set 3 Tank Farm area.

The existing northeast containment berm for the Set 2 Tank Farm will be incorporated into the containment berms for the Set 3 Tank Farm. Based on the construction record information, the existing berm generally has a crest width of approximately 1.0 m, crest elevations from 523.06 m to 523.26 m, and an average outside slope of approximately 1.5H:1V. The elevation of the liner placed beneath the crest is approximately 522.75 m.

2.2 Subsurface Stratigraphy

No site investigation has been conducted within the Set 3 Tank Farm area for this design. However, probe holes were drilled at the centre of each of the four Set 2 tanks for the Set 2 Tank Farm expansion between March 23 and 27, 2005 (EBA 2006a). The locations of the probe holes are shown in Figure 1. Approximately 2.1 m of ice-rich silty sand was observed at Probe Hole PH-110 under the southeast tank. Two probe holes, PH-128 and PH-129, were drilled about 2 m west and east of Probe Hole PH-110. The two probe holes indicated silty sand overburden to depths of 1.8 m and 3.3 m (includes a 0.6 m boulder), respectively. The silty sand appeared ice rich. Probe Hole PH-111 (southwest tank) has a reduced overburden thickness of 0.75 m. Probe Hole PH-112 (northeast tank) had shallow overburden of 0.3 m; at Probe Hole PH-113 (northwest tank), there was about 2.4 m of ROM fill overlying bedrock. This information suggests that the overburden is thin or non-existent beneath the northeast and northwest tanks towards the Set 3 Tank Farm area.

Additionally, SRK 2003 provided 1:20,000 scale surficial geology mapping prepared by Thurber Engineering Ltd. (TEL) in September 2003 for the mine site. The surficial geology mapping suggests that bedrock beneath the Set 3 Tank Farm area may be near surface, but this conclusion is not definitive (EBA 2006a).

3.0 DESIGN OF SET 3 TANK FARM

3.1 Design Intent and Requirements

The Set 3 Tank Farm will comprise a lined, bermed spill containment area, designed to follow the general guidelines in "Design Rationale for Fuel Storage and Distribution Facilities, 3rd Edition" published by Public Works and Services, Government of the Northwest Territories (GNT 2006). A bermed spill containment area is required for above-ground storage fuel tanks. The capacity of the containment area will be great enough to contain the volume of liquid of the largest tank, plus 10% of the aggregate volume of all the other tanks, or 110% of the volume of liquid of the largest tank, whichever is greater (GNT 2006). The bermed containment area will be made impervious by a minimum 60 mil thick High Density Polyethylene (HDPE) liner membrane.

Natural deposits of ice-rich glacial till materials may exist discontinuously over bedrock beneath the Set 3 Tank Farm footprint, as observed in the original ground beneath the Set 2 Tank Farm. If allowed to thaw under the weight of the proposed fills and tanks, these materials would be susceptible to differential thaw settlement. Assuming that ice-rich soil exists beneath the Set 3 Tank Farm area, the design objective is to place thick fills over the original ground so the fills will preserve the frozen condition of the native soils. This can be accomplished by constructing a sufficiently thick non-frost-susceptible granular fill pad.

The Tank Farm should also be designed to address other geotechnical considerations such as berm slope stability, tank pad settlement and bearing capacity, and protection of the liner system.

The existing fill surface over the Set 3 Tank Farm area generally slopes downwards and to the northeast. This feature will be considered in the design to facilitate the tank farm construction and to drain the water within the containment area towards proposed sumps to be located on the northeast side of the area.

The northeast containment berm for the Set 2 Tank Farm will be incorporated into the containment berm system for the Set 3 Tank Farm to save fill volumes and construction cost. When possible, the spacing between the tanks will be kept the same as those for the existing tanks in the Set 1 Tank Farm area since some pipes connecting the existing tanks may be reused.

3.2 Design Plan Layout and Cross-Sections

The Set 3 Tank Farm consists of a lined fill base pad and perimeter berms encompassing eight tanks with raised tank pads. The planned layout and cross-sections of the Set 3 Tank Farm are described briefly below and shown in Drawings TF-1 and TF-2.

3.2.1 Plan Layout

The design spacing between two adjacent tank walls is 5.5 m for the Set 3 Tank Farm, which is maintained to be the same as that for the existing tanks in the Set 1 Tank Farm to facilitate pipeline connections between the tanks. This spacing is greater than the minimum required distance of 4.1 m between the tank walls based on GNT 2006.

The design minimum horizontal distance between the tank walls and the inside crest of one of the four perimeter berms is 6.0 m on the northeast side and 5.5 m on the other three sides. The required minimum distance is 5.0 m based on GNT 2006.

The Set 3 Tank Farm has been sized to have enough storage capacity to meet the spill containment volume of 850 m^3, according to GNT 2006. The total containment capacity of the Set 3 Tank Farm is 888 m^3, which corresponds to the maximum allowable fluid surface elevation of 522.8 m in the containment area.

Two sumps with a diameter of 0.5 m and a depth of 0.2 m are located 0.3 m away from the inside toe of the northeast berm to collect any water accumulated within the inside area of the Set 3 Tank Farm, as shown in Drawings TF-1 and TF-2. The bottom portions of normal 205 L steel drums that have been cut and perforated can be used to form the lining of the sumps.

3.2.2 Cross-Sections

The perimeter berms have an inside slope of 2.5H:1V and an outside slope of 2H:1V. The southwest berm for the Set 3 Tank Farm incorporates with the existing northeast berm for the Set 2 Tank Farm. Additional fill and a portion of the liner will be placed over the existing berm to avoid disturbing the existing fill and liner. The berm will have a final crest elevation of 523.5 m and a crest width of about 0.6 m to accommodate the existing berm geometry. The rest of the berms for the Set 3 Tank Farm will have a crest elevation of 523.1 m and a crest width of 1.0 m.

The tank farm base fill pad has a surface grade of 1.5% sloping from the southwest down to the northeast to promote surface run-on water flowing towards the two sumps located adjacent to the inside toe of the northeast berm. The base pad has a surface elevation of 522.2 m at the inside toe of the southwest berm and 521.8 m at the inside toe of the northeast berm.

Each tank will rest upon the surface of a raised tank pad that is approximately 0.1 m to 0.5 m higher than the base pad surface to provide suitable drainage and help keep the bottom of the tank dry. Each of the tank pads has a surface elevation of 522.3 m and a shoulder 1.2 m wide all around the tank, as required in GNT 2006. The tank pads will have a sideslope of 2H:1V.

A geomembrane liner system, as shown in Drawing TF-2, will provide required containment of the Set 3 Tank Farm in case of potential fuel spillage. The geomembrane liner system consists of a 60 mil thick HDPE geomembrane liner textured on both sides, which is protected on either side by a layer of nonwoven geotextile. The nonwoven geotextile will protect the geomembrane liner against damage during liner installation, construction, and under long-term service loading. A bedding layer of crushed gravely sand with a maximum particle size of 20 mm should be placed on either side of the liner system, as shown in Drawing TF-2. The minimum design thickness of the bedding material is 0.3 m above the liner and 0.2 m below the liner. The thickness of the nonwoven geotextile is primarily dictated by the gradation of the bedding material and long-term service load. Given the angular particle size of the bedding material and the service loads from the pad and tanks, a minimum weight of 540 g/m^2 is recommended for the nonwoven geotextile.

3.3 Geotechnical Evaluations and Considerations

3.3.1 Thermal Consideration

No geothermal analysis has been carried out in this study to estimate the maximum thaw penetration into the fill over the original ground within the Set 3 Tank Farm area. However, previous geothermal analyses for a proposed landfill with a coarse-grained fill cover at the Jericho mine site indicate that the maximum thaw penetration into the cover is 3.2 m under a mean year, 3.9 m under five consecutive 1-in-100 warm years, and up to 4.6 m after 100 years of climate change following an estimated warming trend.

A minimum fill thickness of 3.5 m over the original ground was recommended for the Set 1 and 2 Tank Farm areas (EBA 2005).

Coarse-grained fill was placed over the original ground in the Set 3 Tank Farm area before the current design. The thickness of the pre-placed fill is approximately 4.3 m. Additional fill will be placed over the existing fill surface to grade the area before the liner placement, cover the liner with 0.3 m thick fill, and construct the tank pad to an elevation of 522.3 m. The minimum thickness of the final fill cover over the original ground will be approximately 4.8 m, which is greater than the expected maximum thaw penetration into the fill. This suggests that the permafrost table will be higher than the original ground surface within the tank farm area and the native overburden soils will be in a frozen condition.

3.3.2 Berm Slope Stability

The perimeter berms will be constructed with well graded, crushed rockfill, which will normally have a friction angle of 45° or higher under low confining stresses. However, the interface friction angle between a geomembrane layer and a geotextile layer would be much lower. Generally, textured geomembrane will have higher interface friction angles than smooth geomembrane. For this reason, a geomembrane liner textured on both sides is adopted for this design. The actual friction angle between a textured geomembrane layer and a geotextile layer varies with specific material properties and manufactures. No tests have been conducted for this design to determine the interface friction angle. Published data from literature (Jones & Dixon 1998; Frost & Lee 2001) suggest that the peak friction angle of the interface between a medium-textured HDPE geomembrane and a nonwoven geotextile ranges from 21° to 30° under low confining pressures (< 50 kPa).

Limit equilibrium analysis has been carried out to determine the factor of safety for berm slope stability through the interface between the geomembrane and the geotextile. The analysis was conducted using the commercial, two-dimensional, slope stability computer program, SLOPE-W. The factor of safety has been computed using the Morgenstern-Price Method. The calculated factor of safety for the inside berm slope is 1.25 for a potential slip surface through the interface of the geomembrane and geotextile when a friction angle of 21° is assumed for the interface and 45° for the liner cover fill.

The calculated factor of safety is lower than the 1.5 normally adopted as the minimum factor of safety for earth structures under long-term static loading. However, the calculated factor of safety is acceptable for this study given the following facts and factors:

- No slope failure has been observed for the existing berms in the Set 1 and 2 Tank Farm area. The existing berms generally have an as-built inside slope of approximately 2H:1V, which is steeper than the design berm inside slope of 2.5H:1V for the Set 3 Tank Farm. The fill cover thickness over the liner for the Set 1 and 2 Tank Farm areas is generally the same as that for the Set 3 Tank Farm.
- The inside berm height is 1.3 m, and the consequence of the slope failure is low. If any slope failure occurs, the slope can be flattened or the liner be anchored deeper into the fill to increase the stability.

The berm slope stability should be inspected and monitored during both the construction stage and the service life of the tank farm. Any signs of berm slope instability should be reported to EBA, who will review the berm design and construction and evaluate the berm conditions, if required, to modify the current design.

3.3.3 Settlement

Coarse-grained rockfill of approximately 4.3 m was placed and compacted over the original ground in the Set 3 Tank Farm area in late 2005. Any potential short-term settlement following the immediate fill placement and most of the long-term settlement due to thawing of the winter-placed rockfill would have been realized after at least two summers before the final construction of the Set 3 Tank Farm.

Additional well-graded coarse-grained rockfill of up to 1.8 m will be placed over the existing fill surface and compacted in unfrozen conditions. The short-term settlement due to the additional fill placement will occur during the construction stage.

Some short-term settlement will occur beneath the tank base when the tanks are filled for the first time. Conventional simple methods using the elastic theory and Young's modulus are seldom used in practice for coarse-grained soils due to the variation of Young's modulus with confining stress (or depth and location) (Craig 1992). In addition, since there are no measured mechanical properties for the rock fill for this study, settlement estimation would not be reliable.

EBA 2006b summarized the observed tank settlements in the Set 1 and 2 Tank Farm area during the 2006 geotechnical inspection. The vertical settlement of the tanks in the Set 1 Tank Farm area at the time was observed to be from 100 mm to 350 mm over a period of fifteen months. The Set 1 Tank Farm was constructed in winter 2004/2005. It is believed that the relatively large tank settlement is due, in part, to the fill being placed under frozen conditions without sufficient compaction. The fill later thawed and compressed to a denser state under tank loading.

On the contrary, the fill for the Set 2 Tank Farm was placed between May and October 2005, and minimal vertical movement (up to 37 mm) of the tanks in the Set 2 Tank Farm was observed in 2006 after up to fourteen months following the tank farm construction.

The tank settlement in the Set 3 Tank Farm area is expected to be in the same magnitude as that observed in the Set 2 Tank Farm area based on the available information and the planned construction schedule.

Ice-rich soils may creep under shear stresses. Probe holes drilled within the Set 2 Tank Farm area indicate that up to 3.3 m of relatively ice-rich overburden soils exist on the southeast side (#10 Tank) towards the Set 1 Tank Farm area. However, the measured settlement of the #10 Tank was only 6 mm after fourteen months of tank loading. This may suggest that creep-induced settlement may not be a major concern. Furthermore, the overburden soils are much shallower (0.3 m) or non-existent on the northeast side towards the Set 3 Tank Farm area.

Each tank should be filled up with water to its full capacity before storing fuel. The hydro test has three purposes: 1) to check the integrity of the tanks after moving from the Set 1 Tank Farm to Set 3 Tank Farm; 2) to observe the potential short-term tank settlement under tank loading; and 3) to check the integrity of the liner system in the spill containment area when the wash water in the tanks is drained into the containment area. If excessive total (or differential) tank settlements are observed during the hydro test, additional granular fill may need to be placed beneath the tanks to offset the settlements before the tanks are filled with fuel.

3.3.4 Other Considerations

The maximum long-term vertical stress (pressure) on the liner beneath the tanks in the Set 3 Tank Farm area is approximately 100 kPa. Based on the method presented in Narejo et al. 1996, the required mass per unit area of the protection geotextile over geomembrane can be estimated based on the long-term service pressure and the bedding material properties. With consideration of a partial factor of safety of 1.3 to 1.4 for creep, a partial factor of safety of 1.5 for chemical/biological degradation, and a global factor of safety of 3.0, the required mass per unit area of the protection geotextile is calculated to be 515 to 554 g/m^2. The 540 g/m^2 (16 oz/yd^2) geotextile has been selected for this design.

The well-graded, coarse-grained rockfill of over 4.8 m was placed beneath the base of the tanks. The estimated allowable bearing capacity of the fill exceeds the required bearing capacity for the loaded tanks.

It is understood that a crane will be used to move the tanks from the Set 1 Tank Farm area to Set 3 Tank Farm area. Depending on the specific loading configuration and total load for the crane, the bearing capacity of the fill may not meet the required capacity for the crane. This concern should be addressed separately by Shear or its contractor, who is in charge of moving of the tanks when the moving plan is finalized. In addition, the liner may be over-stressed or damaged due to the concentrated loads from the crane. The crane should not be allowed to travel over the design pad above the liner without protection measures. Brief discussion on the moving of the tanks using the crane will be presented in Section 4.5 of this report.

4.0 CONSTRUCTION OF SET 3 TANK FARM

4.1 Construction Materials and Quantities

The following provides a brief summary of materials used for pad and berm construction of the Set 3 Tank Farm. Specifications for the material gradation and placement are presented in the Set 3 Tank Farm Construction Specifications (Appendix C).

The recommended geomembrane liner is a 60 mil HDPE liner, textured on both its sides. A 540 g/m^2 nonwoven geotextile is to be placed above and below the geomembrane as a protective cushion.

Bedding material must be placed above and below the liner system. The bedding material will be 20 mm minus crush material, produced from the ROM granite using a cone crusher. The 20 mm minus material can also be used to construct the raised tank pads and grade the existing fill surface within the Set 3 Tank Farm area.

The crushed rockfill material with a maximum particle size of 150 mm can be used to construct the perimeter berms beneath the liner system.

It is understood that the existing fill pre-placed over the original ground within the Set 3 Tank Farm area consists of approximately 0.1 m to 0.15 m of 20 mm minus rockfill, 0.2 to 0.3 m of 50 mm minus rockfill, 0.3 m to 0.5 m of 150 mm minus rockfill, and 3.3 to 3.7 m of ROM rockfill.

EBA understands that the granular fills used for construction of the Set 3 Tank Farm area will consist of ROM granite from Jericho pit. Processing of the ROM will be necessary to obtain the specified 150 mm and 20 mm minus materials.

Table 1 presents the in-place quantities of the materials required for completing the pad and berm construction for the Set 3 Tank Farm if constructed according to design geometry. The quantities of material are “in place” quantities and do not include any contingency for waste liner overlap.

Table 1: Estimated Material Quantities for Pad and Berm Construction of Set 3 Tank Farm

Material	Unit	Estimated Quantity
Textured 60 mil thick HDPE geomembrane	m^2	2,500
Nonwoven geotextile	m^2	5,000
20 mm minus (to be placed)	m^3	1,300
20 mm minus (pre-placed)	m^3	400
50 mm minus (pre-placed)	m^3	900
150 mm minus (to be placed)	m^3	1,000
150 mm minus (pre-placed)	m^3	2,700
Run-of-mine (pre-placed)	m^3	23,100

Note: Quantities are "in-place". Seaming allowance and contingencies must be added to geomembrane and geotextile quantities. It is recommended that 20% extra quantities be available on site. Bulking factors and contingencies must be added to fill quantities; 20% should be added to reported quantities for stockpile volumes.

4.2 Construction Plan

Construction of the Set 3 Tank Farm will be conducted in accordance with the Construction Specifications and Construction Drawings. The Construction Specifications are present in Appendix C, and a set of reduced construction drawings are included in Appendix B. Full-size construction drawings have been issued to Shear as a separate document package. The Construction Specifications and Construction Drawings must be among the governing documents used for the construction planning and supervision of the tank farm.

The Construction Specifications present the details regarding foundation preparation, fill materials, fill placement, the geomembrane liner system, and quality assurance program. It is anticipated that the contractor chosen to conduct the work will develop a construction plan. The construction plan must satisfy the requirements presented in the Construction Specifications to meet their design intent.

While the actual construction schedule for the Set 3 Tank Farm has not been finalized, fill will not be allowed to be placed in frozen conditions.

4.3 Material placement

Under the direction of a geotechnical engineer, the existing fill surface within the proposed Set 3 perimeter berms may be scarified to a minimum depth of 0.1 m below the existing fill surface. Any oversized soil particles greater than 20 mm should be removed from the fill surface. The loosened fill should then be re-compacted to a minimum of 95% of the maximum dry density determined by test method ASTM D698-91 prior to placing additional fill.

The 20 mm minus material beneath the liner and above the base pad for tank pads should be placed in lifts not exceeding 200 mm in thickness in such a manner that will not cause segregation and/or nesting of coarse particles. The 0.3 m thick 20 mm minus bedding material above the liner should be placed in a single lift to limit the potential damage to the liner during construction. All the 20 mm minus material placed below the liner must be moisture conditioned, as required, and compacted to a minimum of 95% of the maximum dry density determined by test method ASTM D698-91 prior to placing a subsequent lift.

The 150 mm minus material for the berm construction must be placed in moisture conditioned lifts not exceeding 400 mm in thickness. This material must be placed in a manner that will not cause segregation and/or nesting of coarse particles. Compaction will be achieved by at least four passes with a smooth drum vibratory compactor weighing five tonnes or more.

Nonwoven geotextile must be placed on both sides of the geomembrane liner to cover the liner surface entirely. The geomembrane liner should be welded together at panel joints. The designated liner installation subcontractor should have installation experience on similar projects in northern weather conditions.

The placement and compaction of all fill materials should be observed and inspected by qualified geotechnical engineering personnel.

4.4 Quality Assurance

The construction quality assurance program must be structured so that construction-sensitive features of the design are achieved. The elements of the program will include:

- Accurate surveying to establish material quantities on a daily basis and allow preparation of as-built drawings;
- Monitoring and field testing of fill materials;
- Specific approval of construction procedures for moisture conditioning and placement of all materials;
- Observation and approval of contractors' proposed material placement sequences and preparation of surfaces below each lift placement;
- Observation of geomembrane welding operation and testing to confirm design requirements are met; and
- Defining procedures for reporting with identified responsibilities for decision-making during construction.

4.5 Moving of Tanks Using Crane

As discussed in Section 3.3.4, the loading from the crane may exceed the allowable bearing capacity of the design pad with liner and the allowable pressure on the liner. This concern should be addressed as a separate task by Shear or its contractor when the tank moving plan and overall pad construction plan are finalized.

Generally, several options are available to overcome the potential problem:

- Construct the Set 3 Tank Farm in stages such that the crane will only travel on the side of the fill surface without the liner placed (recommended);
- Construct a temporary gravel pad road with sufficient thickness for the crane trafficking;
- Place a temporary large lumber or steel pad for the crane trafficking; or

- Redesign the pad for the Set 3 Tank Farm to a thicker permanent pad to accommodate the loading from the crane (not preferred).

5.0 MONITORING AND INSPECTION

Performance monitoring and inspection is an integral part of the operation of the Set 3 Tank Farm. This section describes a recommended monitoring and inspection program for the construction and operation for the Set 3 Tank Farm.

Four survey monitoring points for each of the tanks can be located diagonally along the base of the tank outside wall, as shown in Drawing TF-1. Steel or iron bars can be welded to the lower tank outside wall close to the tank pad to mark as the survey points. In addition, survey prisms on the top of the existing tanks were previously used to measure the tank settlements. This practice should also be applied to the tanks in the Set 3 Tank Farm.

The following schedule of survey monitoring is recommended, as a minimum requirement:

- Empty tank immediately after the tanks being moved to the Set 3 Tank Farm;
- Full tank during initial water-filling test;
- Twice in the first year of operation and annually after; and
- More frequent measurements when required, as directed by the Geotechnical Engineer.

The performance of the berms and pads will be inspected weekly during and following the construction stage as part of the Operational Geotechnical Inspections described in the Jericho General Monitoring Plan (GMP, EBA 2011d). An annual inspection of the facility will be performed as part of the Formal Geotechnical Inspection also described in the GMP. The inspections will, where possible, take place in the summer when the ground is snow free. The specific tasks conducted during the inspection include:

- Inspection of the berm or pad slopes for any sign of distress or instability;
- Inspection of the berm or pad crests for any sign of cracking or exposure of the liner; and
- Inspection of the tanks for any sign of vertical or lateral movements together with reviewing the survey monitoring data.

6.0 CLOSURE

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PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature
Date Feb 28, 2011
PERMIT NUMBER: P 018
NWT/NU Association of Professional Engineers and Geoscientists

2011 WATER LICENCE RENEWAL DOCUMENTS

Management Plans

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

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

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

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

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

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

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

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

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

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

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

EBA, A Tetra Tech Company (EBA), 2011n. Fuel Storage Containment Facility Design Plan, Jericho Diamond Mine, Nunavut. Prepared for Shear Diamonds Ltd., February 2011.

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

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

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

REFERENCES

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EBA Engineering Consultants Ltd., 2006a. Fuel Storage Facilities – Set 3 Desktop Geotechnical Assessment, Jericho Diamond Project. Submitted to Tahera Diamond Corporation in April 2006, EBA File: 1100060.002.

EBA Engineering Consultants Ltd., 2006b. Jericho Diamond Mine 2006 Geotechnical Inspection. Submitted to Tahera Diamond Corporation in September 2006, EBA File: 1100060.010.

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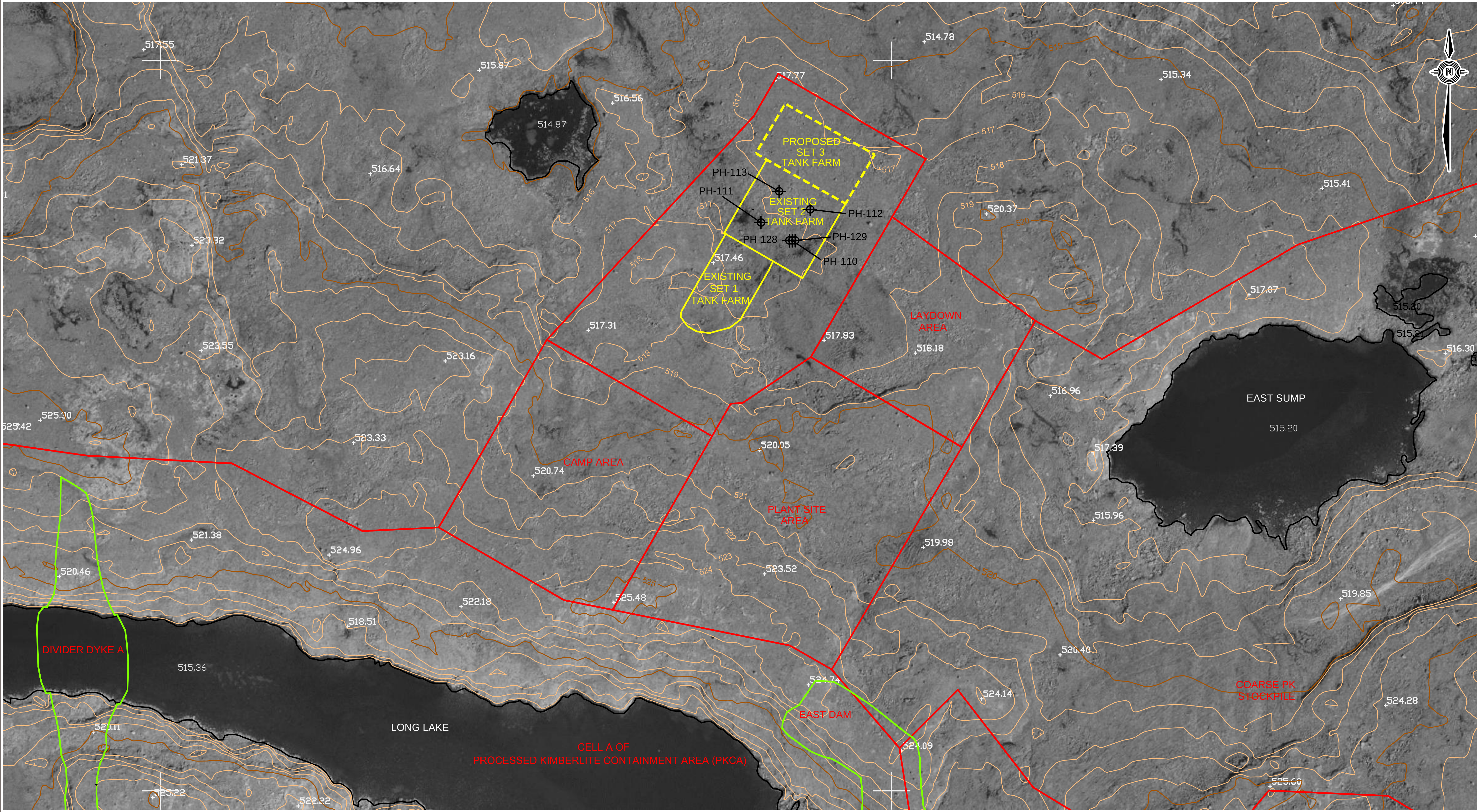
SRK, 2003. Technical Memorandum A, Supplemental Geotechncial Data, Jericho Project, Nanavut, dated October 2003. Prepared by SRK Consulting Engineers and Scientists (SRK).

FIGURES

SHEAR DIAMONDS LTD. eba A TETRA TECH COMPANY

\\eba.local\corp\Edmonton\Drafting\CIVIL3D\E141\E14101118\Civil 3D\Set 3 Fuel Storage Containment Facility Design Plan\acad\E14101118_Figure 1_TF.dwg [FIGURE 1] February 27, 2011 - 2:39:00 pm (BY: MARSH, MAUREEN)



LEGEND

⌖ - PROBEHOLE LOCATION

0 100
metres

NOTES
BASED ON EBA DRAWING 110006.014.dwg dated June 2007

BASE DATA: NTS 1:50,000

STATUS
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FUEL STORAGE CONTAINMENT FACILITY DESIGN PLAN
JERICHO DIAMOND MINE, NUNAVUT

GENERAL LOCATION OF PROPOSED SET 3 TANK FARM & ORIGINAL GROUND SURFACE ELEVATIONS & AIRPHOTO VIEW IN NEARBY AREAS

PROJECT NO.	DWN	CKD	REV
E14101118	DD/MM	JS	0

OFFICE	DATE
EDM	February 25, 2011

Figure 1

PHOTOGRAPHS

Photo 1: Completed lift of 50 mm fill during construction of the Set 3 Tank Farm in late 2005

Photo 2: Dozer spreading 20 mm minus rockfill

Photo 3: Grader placing single lift of 20 mm minus rockfill

Photo 4: Final grade of 20 mm minus rockfill

Photo 5: Surface conditions of the pre-placed fill materials in June 2007

Photo 6: View of surface conditions of the pre-placed fill materials in June 2007

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

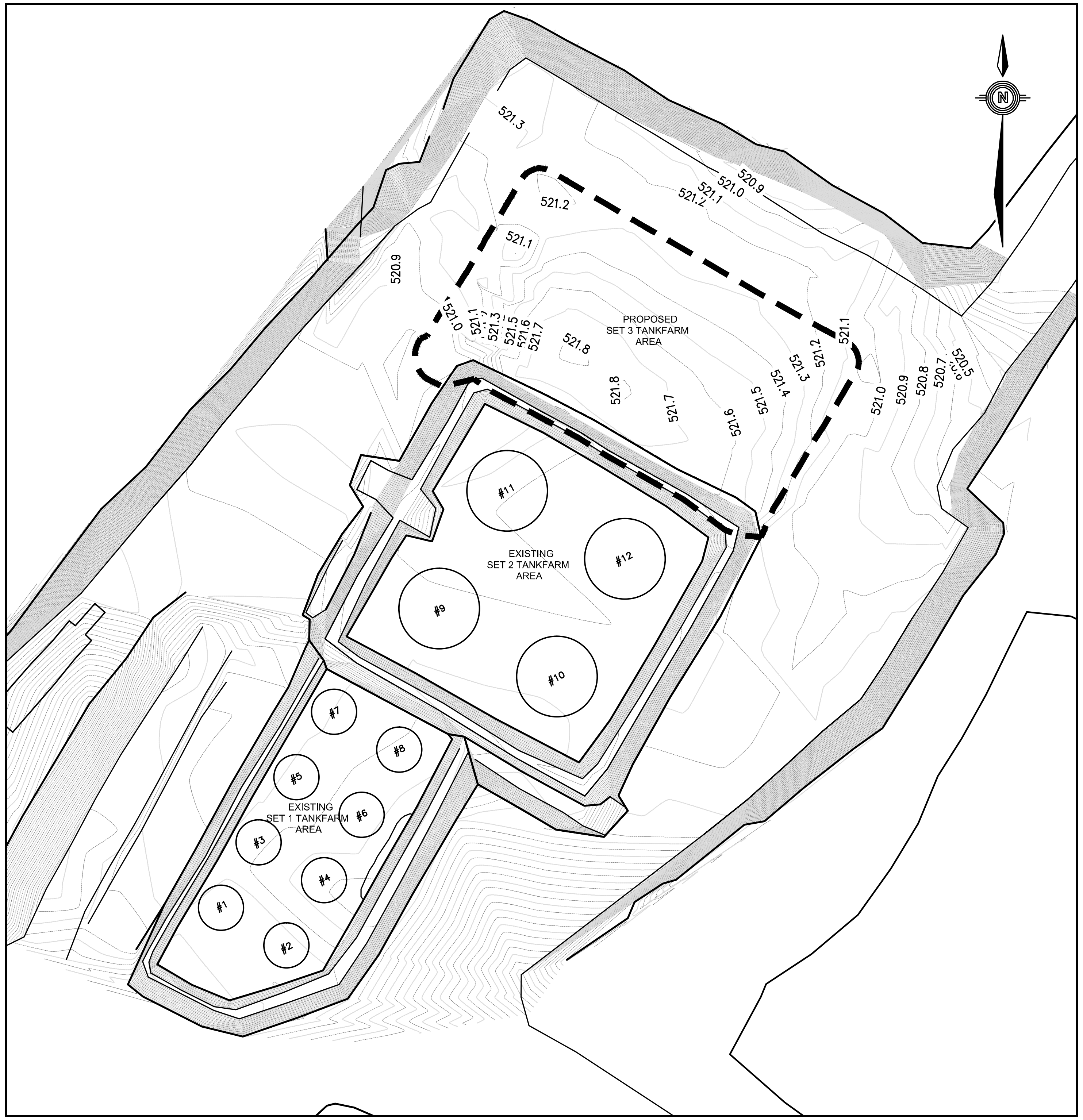
EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

14.0 INFORMATION PROVIDED TO EBA BY OTHERS

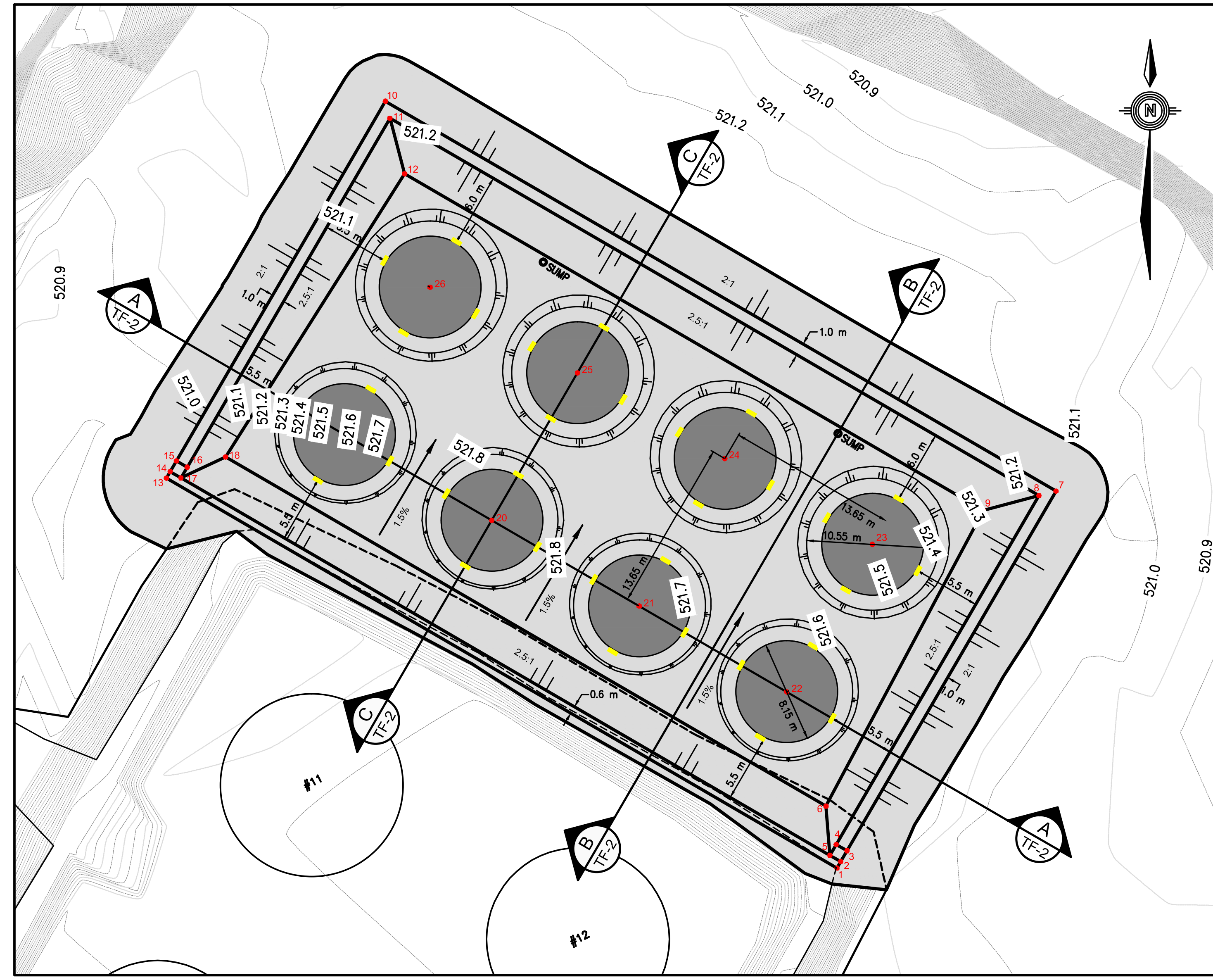
During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability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

APPENDIX B

APPENDIX B REDUCED SIZE CONSTRUCTION DRAWINGS FOR SET 3 TANK FARM



PLAN
EXISTING SET 1 AND SET 2 TANKFARMS
AND PRE-PLACED FILL PAD IN SET 3 TANK FARM AREA



PLAN
PROPOSED SET 3 TANK FARM

LEGEND:

– TANK WALL SETTLEMENT SURVEY POINTS (NOT IN SCALE)

CO-ORDINATES

POINT NO.	EASTING	NORTHING	ELEVATION
1	477464.98	7318903.58	523.50
2	477465.28	7318904.10	523.50
3	477465.79	7318904.97	523.10
4	477464.92	7318905.47	523.10
5	477464.42	7318904.60	523.50
6	477464.11	7318908.54	522.20
7	477482.52	7318933.76	523.10
8	477481.15	7318933.39	523.10
9	477476.71	7318932.22	521.80
10	477428.83	7318964.97	523.10
11	477429.19	7318963.60	523.10
12	477430.36	7318959.16	521.80
13	477411.29	7318934.79	523.50
14	477411.59	7318935.31	523.50
15	477412.09	7318936.18	523.10
16	477412.96	7318935.68	523.10
17	477412.45	7318934.81	523.50
18	477416.03	7318936.49	522.20
19	477425.54	7318938.28	522.30
20	477437.34	7318931.42	522.30
21	477449.15	7318924.56	522.30
22	477460.95	7318917.69	522.30
23	477467.81	7318929.50	522.30
24	477456.00	7318936.36	522.30
25	477444.20	7318943.22	522.30
26	477432.40	7318950.08	522.30

STATUS
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FUEL STORAGE CONTAINMENT FACILITY
DESIGN PLAN
JERICHO DIAMOND MINE, NUNAVUT

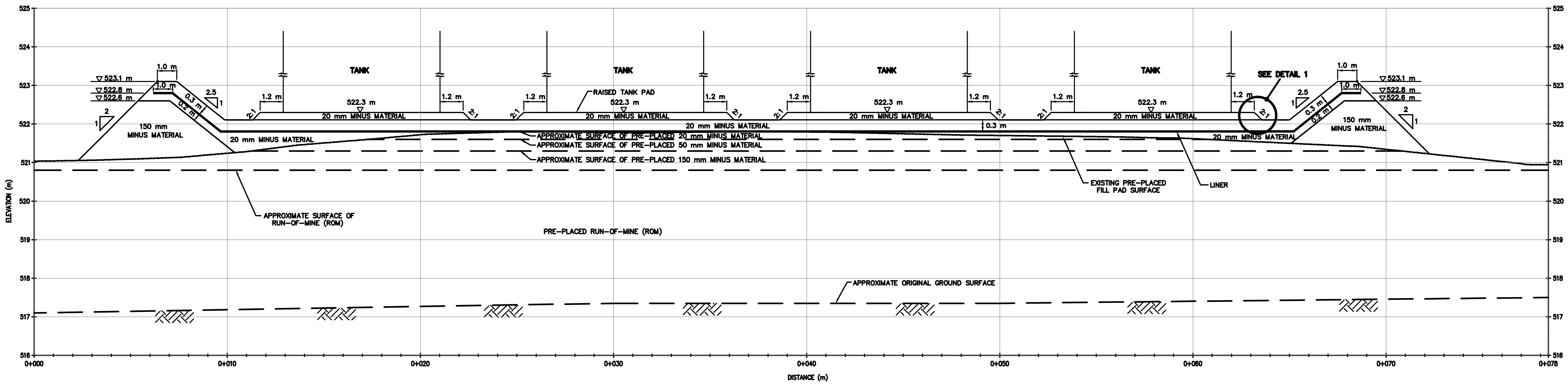
GENERAL LOCATION OF PROPOSED SET 3 TANK FARM & ORIGINAL GROUND SURFACE ELEVATIONS & AIRPHOTO VIEW IN NEARBY AREAS

PROJECT NO.	DWN	CKD	REV
E14101118	DD/MM	JS	0

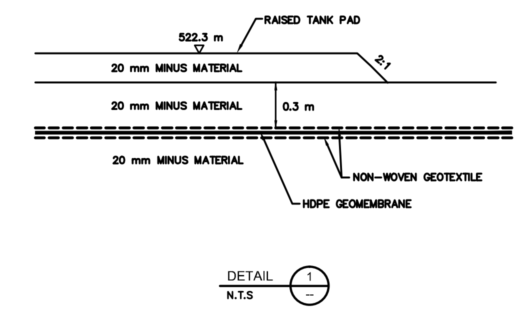
OFFICE	DATE
EDM	February 28, 2011

Figure TF-1

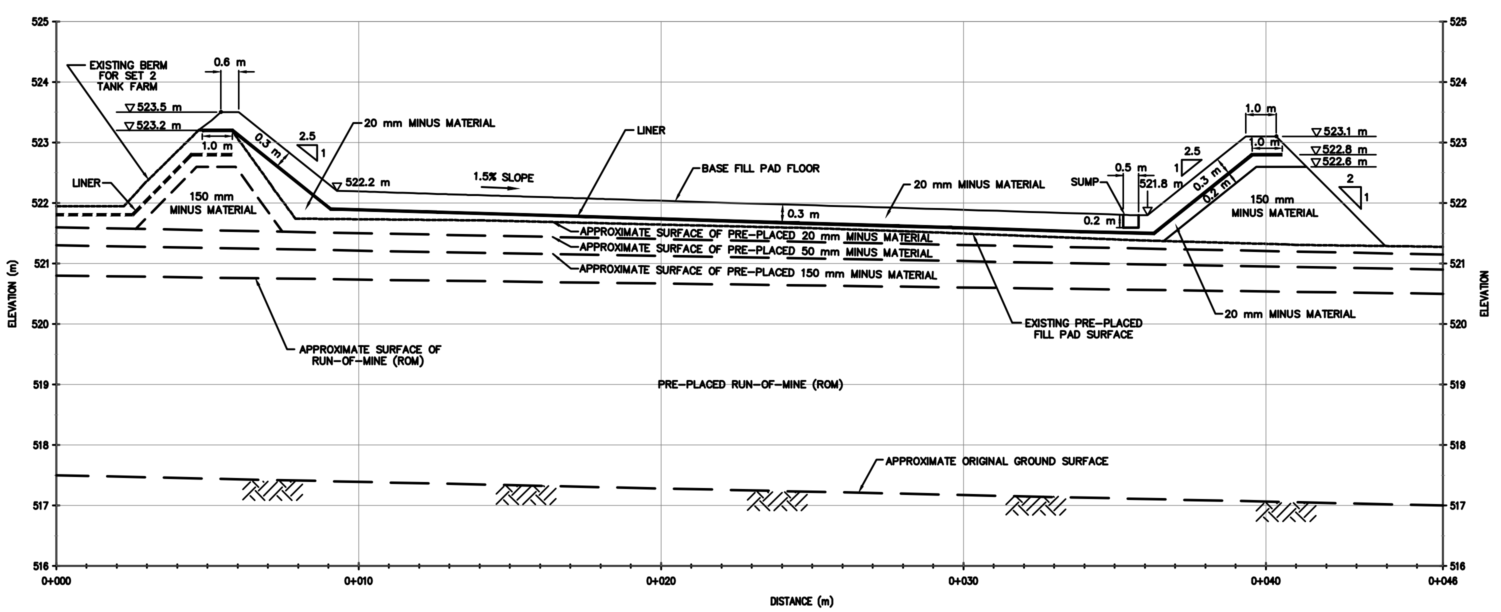
\\eba.local\corp\Edmonton\Drafting\CIVIL3D\E141\E14101118\Civil 3D\Set 3 Fuel Storage Containment Facility Design Plan\acad\E14101118_Figure TF-1+2.dwg [FIGURE TF-2] February 27, 2011 - 2:42:38 pm (BY: MARSH, MAUREEN)



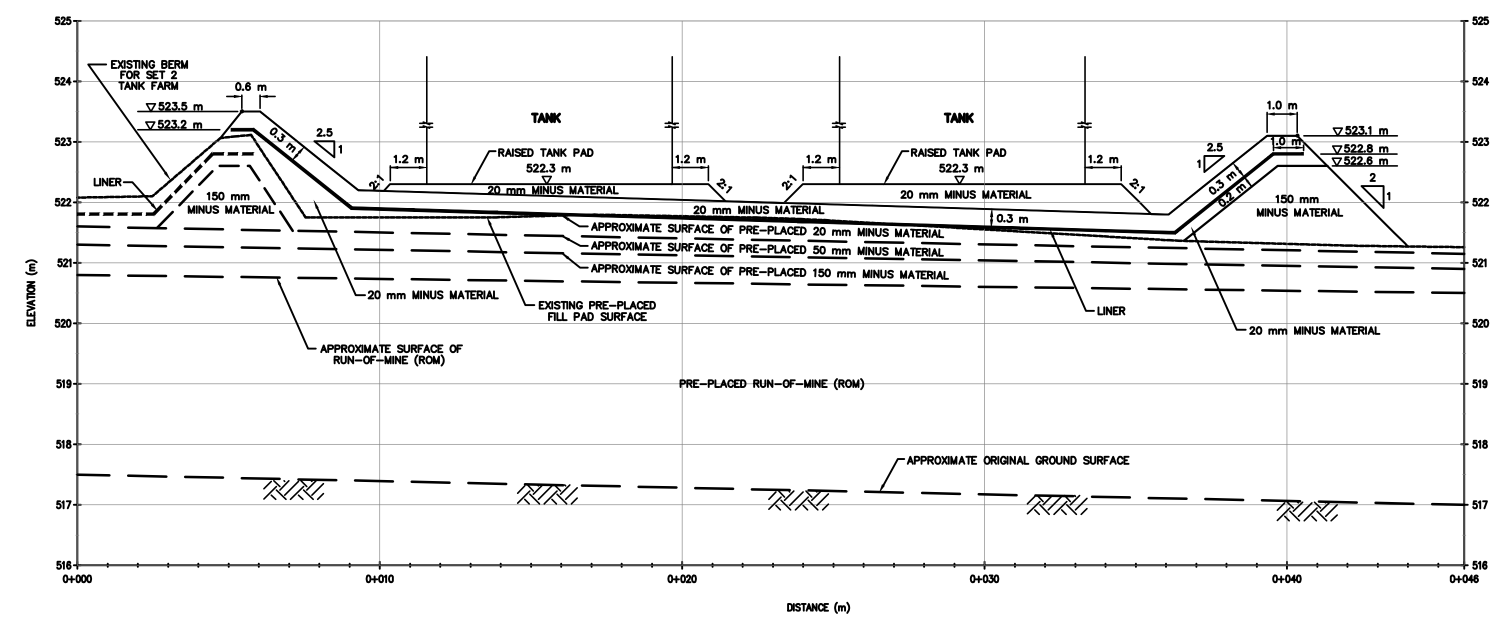
SECTION A TF-1



DETAIL 1 N.T.S



SECTION B TF-1



SECTION C TF-1

STATUS
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FUEL STORAGE CONTAINMENT FACILITY DESIGN PLAN
JERICHO DIAMOND MINE, NUNAVUT

SECTIONS AND DETAILS FOR PROPOSED SET 3 TANK FARM

PROJECT NO.	DWN	CKD	REV
E14101118	DD/MM	JS	0

OFFICE	DATE
EDM	February 28, 2011

Figure TF-2

APPENDIX C

APPENDIX C CONSTRUCTION SPECIFICATIONS FOR SET 3 TANK FARM

1.0 GENERAL

.1 The Set 3 Tank Farm will be comprised of lined perimeter berms and fill pads to form a spill containment area for eight steel fuel tanks within the Jericho Fuel Storage Facilities.

.2 Some fill materials were placed in late 2005 over the original ground within the Set 3 Tank Farm footprint. Additional fill materials, including 20 mm minus and 150 mm minus materials, will be placed over the existing fill surface to construct the perimeter berms and tank pads to their design elevations. A liner system consisting of a textured high density polyethylene (HDPE) geomembrane, protected on both sides by non-woven geotextiles, will be buried in the interior side slopes of the berms and the base fill pad of the tank farm. This facility will form a secondary containment area to hold any potential fuel spillage from the tanks.

2.0 DEFINITIONS OF TERMS USED

Construction Drawings:	the design drawings as issued for construction of the Set 3 Tank Farm.
Construction Specifications:	this document.
Contract:	the legal and binding agreement between the Contractor and Shear Minerals Ltd. regarding construction of the Set 3 Tank Farm.
Contractor:	the general contractor responsible for constructing the Set 3 Tank Farm.
Engineer:	EBA, A Tetra Tech Company (EBA), representative on site during Set 3 Tank Farm construction or related activities.
Owner:	Shear Diamonds Ltd. (Shear)
Site:	the area in which Set 3 Tank Farm construction or related activity is occurring.
Unsuitable:	not meeting the requirements stated herein or not receiving the Engineer's approval.

3.0 MATERIALS

.1 The material zones referenced in these specifications are designated on the Construction Drawings. Total material quantities have been estimated as follows:

Table 1001.1 Estimated Material Quantities for Pad and Berm Construction of Set 3 Tank Farm

Material	Unit	Estimated Quantity
Textured 60 mil thick HDPE geomembrane	m^2	2500
Non-woven geotextile	m^2	5000
20 mm minus (to be placed)	m^3	1300
20 mm minus (pre-placed)	m^3	400
50 mm minus (pre-placed)	m^3	900
150 mm minus (to be placed)	m^3	1000
150 mm minus (pre-placed)	m^3	2700
Run-of-mine (ROM) (pre-placed)	m^3	25100

Note: Quantities are "in-place". Seaming allowance and contingencies must be added to geomembrane and geotextile quantities. It is recommended that 20% extra quantities be available on site. Bulking factors and contingencies must be added to fill quantities; 20% should be added to reported quantities for stockpile volumes

.2 Volumes have been calculated based on 1.0 m contour topographic data. The survey was carried out by Sub-Arctic Surveys.

4.0 SITE CLEANUP

.1 The Contractor shall remove all temporary materials and equipments and shall clean up the construction areas, borrow areas, and stockpile areas

END OF SECTION

1.0 GENERAL

.1 Some fill materials were previously placed over the original ground within the Set 3 Tank Farm footprint. Additional fill materials, including 20 mm minus and 150 mm minus materials, will be placed over the existing fill surface to construct the perimeter berms and tank pads to their design elevations.

.2 This section presents the preparation of the existing fill surface within the Set 3 Tank Farm footprint prior to placement of the additional fill materials.

2.0 PREPARATION OF EXISTING FILL SURFACE

.1 Under direction of the Engineer, the existing fill surface within the Set 3 Tank Farm footprint may be scarified to a minimum depth of 0.1 m below the existing fill surface. Any oversized soil particles greated than 20 mm would be removed from the loosened fill.

.2 The loosened fill should be compacted using approved equipment to 95% (or greater) of the Maximum Dry Density (ASTM D698 91) determined for the 20 mm minus material described in Fill Materials - Section 1005 of this specifications. Moisture conditioning will be required to achieve the specified level of compaction.

.3 The fill shall not be compacted in frozen condition.

3.0 FOUNDATION APPROVAL

.1 The foundation must be inspected and approved by the Engineer before any fill material is placed.

END OF SECTION

1.0 GENERAL

.1 The specifications for fill materials used in the construction of the Set 3 Tank Farm are presented in this section.

.2 Material quantities are presented in Section 1001 – General.

2.0 MATERIAL SOURCES

.1 No material shall be borrowed or excavated without the Owner's prior approval.

.2 Pits and quarries must be maintained and managed in accordance with the requirements set out in the Owner's Land Use and Quarry Permits.

.3 The 20 mm minus material may be processed from material obtained from the Jericho pit or sources approved by the Owner provided the final product meets the requirements specified herein. Processing will be required to achieve the specified gradation.

.4 The 150 mm minus material may be obtained from Jericho pit or other sources approved by the Owner providing the final product meets the gradations specified herein. Processing will be required to achieve the specified gradation.

.5 The Contractor may use some of the fill materials from existing stockpiles at the mine site under the Owner's prior approval when the fill materials meet the gradations specified below in this section.

.6 The parent rock from which all fill materials are derived from must be hard, durable rock. The rock in a potential quarry source must be approved by the Engineer prior to quarrying. The Engineer may require trial crushing and durability testing.

.7 The parent rock sources for the fill materials must be inspected by the Engineer throughout material processing and construction activities to ensure the requirements stated herein are being met.

3.0 MATERIAL SPECIFICATIONS

.1 20 mm Minus Material

.a The 20 mm minus material must consist of hard, durable particles, be free of roots, topsoil or deleterious material and have a grain size distribution falling within the limits set forth in Table 1005.1.

Table 1005.1 : 20 mm Minus Material Grain Size Distribution Limits

Grain Size (mm)	% Passing
20	100
12.5	65 – 100
5	45 – 70
.63	15 - 35
.08	4 - 10

.2 150 mm Minus Material

.a The 150 mm minus material must be free of roots, topsoil and other deleterious material and have a grain size distribution falling within the limits presented in Table 1005.2.

Table 1005.2 : 150 mm Minus Material Grain Size Distribution Limits

Grain Size (mm)	% Passing
150	100
100	50 – 100
50	25 – 60
20	20 – 35
10	5 – 30
5	0 – 15

END OF SECTION

1.0 GENERAL

.1 The placement methods to be used in the construction of the Set 3 Tank Farm are described in this section.

.2 .Construction must be performed in accordance with the best modern practice and with equipment best adapted to the work being performed. Frozen materials must be placed so that each zone is homogeneous, free of stratifications, ice chunks, lenses or pockets, and layers of material with different texture grading not conforming to the requirements stated herein.

.3 .Placement of fill material must conform to the lines, grades and elevations shown on the Construction Drawings, as specified herein or as per the direction of the Engineer. Fill placement must be conducted in such a manner that mixing of fill materials with fill materials in adjacent zones is avoided.

.4 .The fill placement must not proceed when the work can not be performed in accordance with the requirements of the Construction Specifications. Any part of the placed fill that has been damaged by the action of rain, snow or any other cause must be removed and replaced with the appropriate material conforming to the requirements stated herein before succeeding layers are placed.

.5 .Stockpiling, loading, transporting, dumping and spreading of all materials must be carried out in such a manner to avoid segregation or any other condition that does not meet the requirements stated herein. Segregated materials must be removed and replaced with the materials meeting the requirements stated herein and receiving the Engineer's approval.

.6 .The Contractor must remove all debris, vegetation or any other material not conforming to the requirements stated herein. The Contractor must dispose of these materials in an area approved by the Owner.

2.0 20 MM MINUS MATERIAL

.1 The 20 mm minus material beneath the liner and above the base pad for tank pads should be placed in lifts not exceeding 200 mm in thickness in such a manner that will not cause segregation and/or nesting of coarse particles. The 0.3 m thick 20 mm minus bedding material above the liner should be placed in a single lift to limit the potential damage to the liner during construction.

.2 .The 20 mm minus material must be free of oversize particles, top soil, roots or other deleterious materials that may compromise the integrity of the liner system.

.3 .All the 20 mm minus material placed should be compacted to 95% or greater of the Maximum Dry Density (ASTM D698 91). Moisture conditioning may be required to achieve the specified level of compaction.

.4 .The Contractor must ensure that the integrity of the liner system is not compromised during construction. Precautions the Contractor may take to avoid damaging the liner system may include, but will not be limited to, providing light plants in the work area to improve operator visibility or using pylons to mark the lift/liner system interface.

.5 .Any damage to the liner system must be immediately reported to the Engineer. Repair work must commence as soon as possible. Fill placement must cease immediately in an area where the integrity of the liner system has been compromised. Excavation of fill surrounding the damaged liner system may have to be excavated with hand tools to permit repairs to be made without further damaging the integrity of the liner. Hand excavation must be used to expose damaged portions of the liner for repair.

3.0 150 MM MINUS ROCKFILL MATERIAL

.1 The 150 mm minus rockfill material must be placed in lifts not exceeding 400 mm thickness. The placement method used must ensure that segregation and nesting of coarse particles is avoided.

.2 The 150 mm minus material must be compacted with a smooth drum vibratory compactor weighing not less than 5 tonnes. Moisture conditioning may be required prior to compaction. The 150 mm rockfill material must be compacted with at least four passes of the compactor (back and forth being two passes).

END OF SECTION

1.0 GENERAL

.1 This section specifies the requirements for the supply and installation of the non-woven geotextile, textured (both sides) high density polyethylene (HDPE) geomembrane liner system to be used in the Set 3 Tank Farm area.

2.0 PRODUCT

.1 Materials

.a The non-woven geotextile must have a minimum weight of 540 g/m2. The manufacturer must provide to the Engineer, prior to shipment of materials, a signed manufacturing certification that materials to be shipped to site have test values that meet or exceed the requirements listed in Table 1007.1.

.b The polypropylene geomembrane must be a 60 mil thick high density polyethylene (HDPE) geomembrane. The geomembrane shall incorporate a co-extruded textured surface on both its sides to increase the friction between the geomembrane and geotextile. The manufacturer must provide to the Engineer, prior to shipment of materials, a signed manufacturing certification that materials to be shipped to site have test values that meet or exceed the requirements listed in Table 1007.2.

Table 1007.1: Non-Woven Geotextile Material Test Requirements

Property	Test Method	Units	Value
Grab Tensile	ASTM D4632	N	1650
Elongation	ASTM D4632	%	50
Trapezoidal Tearing Strength	ASTM D4533	N	640
Puncture Strength	ASTM D4833	N	1060
Mass per unit area	ASTM D5261	g/m2	540

Table 1007.2: Textured HDPE Geomembrane Material Test Requirements

Property	Test Method	Units	Value
Thickness (Minimum)	ASTM D5199	mm	1.42
Tensile Strength , Stress at Break	ASTM D638 Modified Type IV Die	kN/m	15.8
Tensile Strength, Stress at Yield	ASTM D638 Modified Type IV Die	kN/m	22.0
Tensile Strength, Strain at Break	ASTM D638 Modified Type IV Die	%	100
Tensile Strength, Strain at Yield	ASTM D638 Modified Type IV Die	%	12
Tear Resistance	ASTM D1004	N	187
Puncture Resistance	ASTM 4833	N	375
Carbon Black Content	ASTM D1603	%	2
Notched Constant Load (ESCR)	ASTM D5897	Hour	200
Low Temperature	ASTM D746	°C	-60
Asperity Height (Average)	GRIGM12	mm	0.175
Coefficient of Friction between Geomembrane and Nonwoven Geotextile (Peak and Residual)	ASTM 5321	°	21 (Peak) 18 (Residual)

3.0 SHIPPING AND STORAGE

.1 Geotextile

.a Provide the geotextile in rolls wrapped with protective covering to protect the fabric from mud, dirt, dust, and debris. The fabric shall be free of defects or flaws which significantly affects its physical properties. Label each roll of fabric in the shipment with a number or symbol to identify that production run.

.b Any visible damage to the shipment of geotextile must be noted on the freight receipt and project records.

.c During delivery and storage, protect geotextile from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris, rodents and water.

.2 HDPE Geomembrane

.a Ship the geomembrane in conformance with the requirements of the geomembrane manufacturer, but in any event carry out in a manner which protects the material from damage in transit. Place a protective cover on each package to protect the material against damage during shipping, handling and storage.

.b Any visible damage to the shipment of geomembrane must be noted on the freight receipt and project records.

.c Store geomembranes on site in a secure location that will minimize the potential for damage due to the proximity of working equipment, vandalisms, etc. In some cases, geomembrane can be marshalled at various locations to minimize transit distances and delays during deployment.

4.0 INSTALLATION

.1 Geotextile

.a When placed over the bedding material, the installation of the geotextile shall not begin until the sub-base has been approved by the Engineer.

.b Where applicable, any cracks or voids in the subgrade beneath the geotextile should be filled with 20 mm minus bedding material. The area to be covered by the geotextile must be smooth and free of sharp objects that could pierce or tear the geotextile and damage the geomembrane. When placed over the geomembrane, placement of the geotextile must be conducted in a manner that will prevent damage to the geomembrane. The surface of the geomembrane should be cleared of any loose geomembrane debris and foreign materials prior to placement of the geotextile.

.c Geotextile placement must not be conducted during periods of high wind.

.d Place geotextile material on sloping surfaces in one continuous length from toe of slope to upper extent of geotextile.

.e The geotextile must be sewn to minimize the number of required overlaps. The sew strength efficiency must be a minimum of 60% as tested using the wide width strength test ASTM D4595-86.

.f The geotextile must be overlapped to a minimum of 1.0 m in width where overlap joints are required, unless the seams are fused in which case a 150 mm overlap is acceptable.

.g Sufficient temporary anchorage must be used to hold the geotextile in place during placement of the other elements of the liner system or during backfilling.

.h Repair rips or tears with a patch to cover a minimum of 1.0 m on each side of the rip or tear.

.2 .HDPE Geomembrane Deployment

.a The area to be lined should be smooth and free of sharp objects that could puncture the geomembrane. Placement of the geomembrane must be conducted in a manner that will prevent damage to the underlying geotextile. The installation of the geomembrane must not begin until the sub-base has been approved by the Engineer.

.b The method used to place the geomembrane panels should not cause scratches or crimps in the geomembrane and not damage the supporting soil or underlying geotextile.

.c Care must be taken when the geomembrane panels are deployed. Sharp objects, vehicles and equipment must not contact the material.

.d No personnel working on the geomembrane should wear damaging shoes or engage in other activities that could damage the geomembrane.

.e The method used to place the geomembrane panels should minimize wrinkles (especially differential wrinkles between adjacent panels).

.f Where possible, orient seams on the slopes perpendicular to the toe of the slope, i.e. oriented down, not across the slope. Seams which parallel the toe of the slope shall have the top sheet overlap the bottom sheet.

.g Slack for thermal contraction should be well distributed, and in accordance with the manufacturer's recommendations.

.h The liner must be placed in a relaxed condition, free of stress or tension. The panels should be positioned so that there is a nominal six (6)-inch seam overlap. Any methods used to temporarily bond adjacent rolls together must not damage the geomembranes.

.i The panels should not be unfolded during periods of high wind. The panels must not be unfolded when air temperature is below –20 °C without first being warmed in a heated enclosure.

.3 HDPE Geomembrane Field Seaming

.a Do not proceed with seaming when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. The installer shall demonstrate that acceptable seaming can be performed by completing trial welds acceptable to the Engineer. Do not carry out geomembrane seaming during any precipitation, in the presence of excessive moisture (e.g. fog, rain, dew) or the presence of excessive winds as determined by the Engineer.

.b The contact surfaces of the two sheets should be wiped clean to remove all dirt, dust, moisture or other foreign materials.

.c Field seams must be made by hot wedge fusion welding. Trial seams must be made and tested to verify the welding temperature, speed of welding and the effects of ambient air temperature. The machine settings should be adjusted accordingly. Throughout the seaming operation occasional adjustments of welding temperature or speed as the result of changing ambient conditions may be necessary to maintain a consistent seam. A 1.5 inch nominal seam width is required for single-track welds. Dual track weld should have two 0.5-inch nominal seams separated by an air test channel.

.d All welders will be required to successfully complete a qualification weld, witnessed by the Engineer prior to starting any welding.

.e All welding must be performed under the supervision of a field supervisor who will remain on site and be responsible for all geomembrane installation. The supervisor must have installed or supervised a minimum of one hundred thousand square meters (100,000 m^2) of HDPE liner involving the thickness and grade of liner and welding processes required for this project.

.f Sufficient temporary anchorage must be used to hold the geomembrane in place during placement of the other elements of the liner system and during backfilling.

.g Cross and toe seams shall be staggered a minimum of one metre. An overlap line, a minimum of 0.15 m from the edge of the underlying sheet should be clearly identified on every fusion seam. The overlap shall be sufficient to leave a loose flap of the geomembrane at least 25 mm wide adjacent to both sides of the seam.

.4 Defects and Repairs

.a All areas of the liner system components requiring repair due to manufacturing flaws or damage during shipping, handling, or placement shall be recorded and surveyed. The Engineer shall prescribe the method of repair to be used for all liner system materials.

.b Inspect all seams and non-seam areas of the installed geomembrane for defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Brush, blow, or wash the geomembrane surface, if required for inspection. The inspection shall be done immediately after the placement of the liner.

.c Test non-destructively of each suspect locations in seam and non-seam areas, as appropriate, in the presence of the Engineer. Mark each location that fails the non-destructive testing, and repair accordingly.

.d Adhere to the following procedures in completion of geomembrane repairs:

- Repair holes, tears, blisters, undispersed raw materials, and contamination by foreign matter by patching. Where the tear is on a slope or an area of stress and has a sharp end it must be rounded prior to patching.
- Patches shall be round or oval in shape, made of the same geomembrane, and extend a minimum of 150 mm beyond the edge of defects. All patches shall be of the same compound and thickness as the geomembrane specified. Patches shall be applied using the approved methods only. The patch and damaged membrane area must be clean and dry during patching.
- Non-destructively test each repair, except when the Engineer requires a destructive seam sample obtained from a repaired seam. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved.

.5 Cover Soil Placement

.a The Contractor must take the necessary steps to ensure that the integrity of the liner system is not compromised during placement of the cover soil.

.b The liner system must be temporarily anchored so that movement downslope does not occur during placement of the cover soil.

.c A minimum of 300 mm of cover soil between low ground pressure equipment and the liner is required at all times.

.d The Contractor must take the necessary steps to ensure that soil placement does not induce undue tensile stress in the liner system. Push cover material up side slopes, not down. Avoid making sharp turns, skid steer turns, sudden stops or sudden starts adjacent to the liner system with equipment that could pinch and tear the liner. Place material ahead of the leading edge of the fill in such a fashion as to prevent stressing the geomembrane. Do not slide cover material over the liner.

.e Stresses in the liner imposed by placing backfill on the sloping liner must be released at the top of the slope during cover soil placement.

.f Report any damage to the liner to the Engineer immediately and perform repairs without needless delay.

.g The Contractor must discuss with the Engineer the schedule for liner system and backfill placement. The Engineer must approve all plans and schedules for backfilling the liner system.

END OF SECTION

1.0 GENERAL

.1 The quality assurance testing required by the Engineer is described in this section.

.2 The quality testing will be conducted by the Engineer.

2.0 FILL TESTING REQUIREMENTS

.1 20 mm Minus Material

.a Quality control testing must be performed during the crushing operation when the 20 mm minus material is being processed. The tests and testing frequency required during processing of the20 mm minus material are presented in Table 1010.1. Additional testing may be required at the discretion of the Engineer

Table 1010.1: Required Testing and Frequency During Processing of Bedding Material

Test	Test Frequency
Particle Size Analysis	One per 500 m^3 produced
Standard Proctor Density	One per 1000 m^3 produced

.b Additional sieve analysis testing may be conducted by the Engineer on samples collected from the Set 3 Tank Farm site during the fill placement to verify that the placed gradation meets the gradation requirements stated herein.

.c The compacted density of the 20 mm minus material must be evaluated by using in-situ measurements of density. In-situ density measurements of the compacted 20 mm minus material will be conducted with a nuclear densometer. Samples of the material may be taken from the lift surface for additional testing at the discretion of the Engineer. The required tests and testing frequency for the material is presented in Table 1010.2.

Table 1010.2: Required Testing and Frequency for 20 MM Minus Material

Test	Test Frequency for Placed Material
Moisture Content	2 per lift or 2 per day
Placed Dry Density	2 per lift or 2 per day
Grain Size Analysis	One per lift or one per day

.2 150 mm Minus Material

.a Samples of the 150 mm minus material will be evaluated from time to time during processing and placement to ensure that the produced and placed gradation meets the specification stated herein. Additional testing may be conducted at the discretion of the Engineer

3.0 HDPE GEOMEMBRANE TESTING REQUIREMENTS

.1 General

.a The Contractor is responsible for obtaining mill certificates from the manufacturer and forwarding them to the Engineer.

.b The Contractor shall record all seam parameters (i.e. time, date, operator, welding speed and temperature) on the liner.

.c The Engineer will conduct a limited program of testing on seam welds.

.d The Contractor shall be responsible for completing the vacuum box testing and fusion seam pressure testing. The Contractor shall mark the test number and parameters on the liner.

.e The Contractor shall supply a field tensometer for testing liner seams for shear and peel strength. The tester shall be available for the Engineer's use.

.f Qualifying seams will be tested by the Engineer.

.g The Engineer is responsible for maintaining testing records.

.h All coupons and test specimens remain the property of the Owner

.2 .Preliminary Qualification

.a Upon delivery of the material to the site, the Contractor shall remove a sample and submit it to the Engineer for audit testing if required. Samples shall consist of a strip 0.75 m wide cut across the full width of one roll, which was not sampled at the factory. If all rolls were sampled, then one roll shall be picked at random by the Engineer.

.b Immediately after delivery of material to the site, the Contractor shall submit to the Engineer a 1 m long sample of each type of seam to be used in the installation. The test seams will be fabricated from a sheet used in the installation by a welder working on the installation. Test seams will be used to evaluate the welding procedures used by the Contractor. Evaluation of welding procedures will involve destructive testing, as described in this specification, for each type of weld. Test values obtained during this procedure will not be considered as "bench mark" values for any subsequent evaluations.

.3 Qualifying Welds

.a Qualifying seams shall be conducted on fragment pieces of sheet at the following times:

- At the start of each shift of production seaming, and at 4 hour intervals during production seaming;
- When a new operator or new machine starts welding;
- When a machine is restarted after repairs;
- When welding is stopped for sixty (60) minutes or more;
- When there is a change in the ambient conditions; and
- At the discretion of the Engineer.

.b Qualifying seams shall be 1 m long, and shall be subject to shear and peel testing. The test seam shall meet the minimum requirements stated herein for seam strength, when tested on a field tensiometer. If a qualifying seam fails, the seaming procedure must be reviewed and the test must be repeated.

.4 Non Destructive Testing

.a Test all welded seams over their full length using a vacuum unit or air pressure test (for split-wedge fusion process).

- Seam intersections will also be subject to vacuum box testing, regardless of seaming method employed.
- The Contractor shall supply all apparatus and personnel for this type of test.
- The tests shall be witnessed and documented by the Engineer.

.b Clean all seams to permit proper inspection.

.c Repair any seams which fail non-destructive testing in accordance with this Specification. Repairs shall be fully documented by the Contractor.

.5 Destructive Testing for Production Seams

.a Cut-out coupons shall be taken at a minimum frequency of one (1) per 150 m of seam, or once per seam. Coupons shall be cut by the contractor at the location directed by the Engineer. Coupons should generally be taken form a location that does not affect the performance of the liner. All cut-outs must have rounded corners. Care shall be taken to ensure that no slits penetrate the parent liner.

.b All holes left by cut outs must be patched immediately.

.6 Testing of Repairs

.a All repairs shall be tested using the Air Lance or Vacuum Box methods as laid out in ASTM 4437-84 or CGSB 148.1 Method 111, respectively.

.7 Seam Acceptance Criteria

.a Seam and adhesion tests will be performed according to ASTM D3083 NSF54 and ATSM D413 NSF54.

.b Seam and adhesion strength acceptance will be based on five (5) samples in each coupon, which must meet or exceed the minimum value specified. No individual sample may have a seam shear strength less than the minimum value specified in Table 1007.2.

.c If a coupon does not meet the acceptance criteria, two (2) additional coupons shall be cut from the seam within three (3) meters to each side of the failed coupon, and tested. This shall continue until the extent of the unsatisfactory seam has been defined.

.8 Seam Strength Acceptance

.a All seams shall meet or exceed the seam strength and adhesion criteria presented in Table 1007.2

.9 Vacuum Box Testing and Fusion Seam Pressure Testing

.a No leaks shall be permitted. Leak testing shall be conducted using vacuum box testing and fusion seam pressure testing.

.b If a vacuum box test cannot be carried out on a particular area a pick test and air lance test must be performed on the area.

.10 Air Pressure Testing

.a Air pressure tests must be conducted for seams made with split wedge welding. The split wedge welder prepares welds with two bonded areas separated by an unbonded channel. This channel can then be sealed at each end and air pressure applied to determine the integrity of the seams. Air pressure testing shall be carried out according to GRI Test Method GM6, Pressurized Air Channel Test for Dual Seamed Geomembranes.

.11 Test Pit

.a When required, under the direction of a field engineer, test pits shall be excavated with hand tools in the liner cover fill to expose the liner and to inspect the liner integrity for some suspected areas.

END OF SECTION