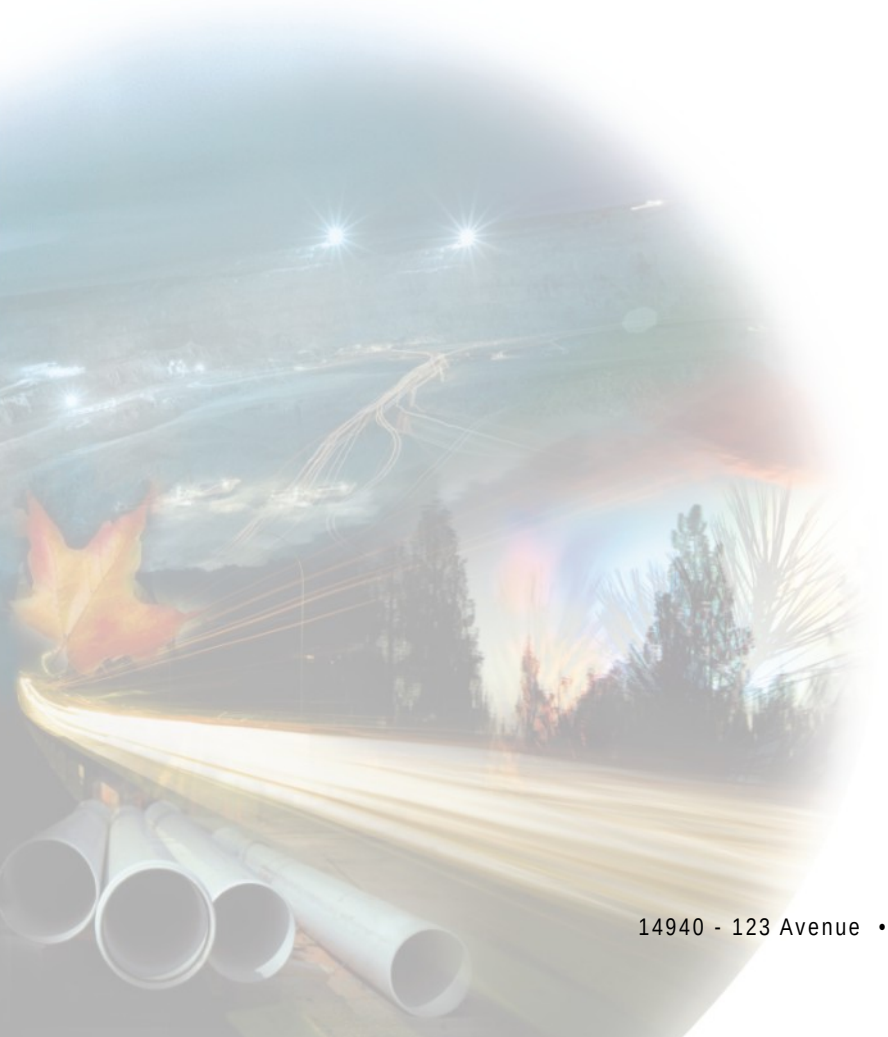
Tahera Diamond Corporation

JERICHO PROJECT
EAST DAM AND SOUTHEAST DAM
CONSTRUCTION SPECIFICATIONS

1100060.004

August 2005



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LIST OF DRAWINGS:

1.0 GENERAL

The East and Southeast Dams are zoned rockfill dams used to retain tailings within the Jericho Processed Kimberlite Tailings Facility.

The structural body of all of the dams is tills and rockfill shell. A geomembrane liner will be constructed in the center of the dam.

2.0 DEFINITIONS OF TERMS USED

Construction Drawings:	the design drawings as issued for construction of the dams.
Construction Specifications:	this document.
Contract :	the legal and binding agreement between the Contractor and Tahera regarding construction of the dam(s).
Contractor:	the general contractor responsible for constructing the dam(s).
Engineer :	EBA Engineering Consultants Ltd. (EBA) representative on site during dam construction or related activities.
Owner:	Tahera Diamonds Corporation
Site:	the area in which dam construction or related activity is occurring
Unsuitable:	not meeting the requirements stated herein or not receiving the Engineer's approval.

3.0 MATERIALS

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

TABLE 1001.1: DAM MATERIAL QUANTITIES

Structure	Geomembrane (m^2)	Geotextile (m^2)	Fill Material Type				Coarse Tailings (m^3)
			Bedding (m^3)	Transition (m^3)	Rock Fill Shell (m^3)	Till (m^3)	
East Dam	4,900	9,800	6,800	2,100	17,000	8,400	12,000
Southeast Dam	4,200	8,400	5,800	2,600	14,000	8,600	12,000

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.

.1 Volumes have been calculated based on 1.0 m bathymetry and topographic data provided by Tahera. The survey was carried out by Sub-Arctic Surveys.

.2 The depth and volume of key trench excavation is dependent on the conditions encountered. The required depth will be determined during construction by the Geotechnical Engineer.

4.0 SITE CLEANUP

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

1.0 GENERAL

.1 Water control for construction of East Dam and Southeast Dam is described in this section.

.2 The key trench and dam footprint areas shall be dewatered as required to allow for fill placement in a dry environment.

.3 The key trenches for all of the dams must be protected from erosion by freshet run off.

.4 Water control and dewatering is the responsibility of the Contractor.

2.0 DEWATERING SUMP(S)

.1 Any inflow of ground water or surface run off water into the key trench or dam footprint must be controlled using suitably placed and sized sumps and pumps.

.2 Water collected in the sumps must be discharged into the PKCA area of the dam construction area. Discharge of water must not cause erosion or decrease of water quality in the receiving water body.

.3 Construction, operation and maintenance of the sump(s) and pump(s) are the responsibility of the Contractor.

3.0 EROSION CONTROL

.1 The key trench backfill must be protected from erosion during freshet.

1.0 GENERAL

.1 Foundation preparation for dams is presented in this section.

2.0 NON-KEY TRENCH FOUNDATIONS

.1 Open graded boulders must be removed as determined by the Engineer.

.2 Ice rich or other soils beneath the liner system and deemed to be unsuitable by the Engineer must be removed.

3.0 KEY TRENCH

.1 The key trench must be excavated into ice saturated, permanently frozen soil or rock as determined by the Engineer. The base of the excavation must have no natural or excavation related open voids or joints.

.2 The depth of excavation will be determined in the field by the Engineer. The depth of the key trench may be increased in some areas at the discretion of the Engineer to confirm the suitability of the foundation soils beneath the key trench.

.3 Excavation of rock shall be conducted in a manner that avoids excessive fracturing of underlying rock.

.4 The key trench can be excavated using mechanical or drill and blast means. Drill and blast excavation may be limited by the Engineer if excessive cracking of rock or soil beneath the key trench occurs.

.5 Final cleaning of the key trench must be conducted with hand excavation, brooms and compressed air or other appropriate equipment such as rippers, jack hammers etc. to remove all loose, broken or altered material from the base of the key trench. Snow and ice must be removed from the key trench prior to fill placement.

.6 Ice rich soil exposed on the upstream face of the key trench excavation shall be removed from areas underlying the liner system. Additional excavation beyond the limits of the key trench excavation may be required at the Engineer's discretion.

.7 Any inflow of water into the key trench excavation shall be controlled by sumps and pumps in a manner that minimizes thaw and erosion of the key trench base.

4.0 DRILLING AND BLASTING

.1 The Contractor is responsible for ensuring that blasting procedures used are within guidelines set by all regulatory bodies and authorities having jurisdiction on Site.

.2 The Contractor must use excavation methods that minimize fracturing beyond excavation limits.

.3 Care must be taken in locating the drill holes, orienting the drills and during drilling so that accurate positioning and alignment of the drill holes is achieved.

.4 The method of excavation must produce a key trench base that is free of abrupt changes in elevation.

.5 The Contractor will drill test holes for use in percolation tests prior to drilling and blasting in the key trench area as instructed by the Engineer.

.6 Controlled blasting techniques must be used to satisfy the excavation requirements stated herein. The initial explosive type and quantity, blasting sequence and delay pattern must be flexible in order to meet these requirements.

.7 The Contractor shall submit complete details of any proposed blast to the Engineer twenty four (24) hours prior to commencement of drilling for each blast. Submitted data shall include the following:

- the location, depth and area of the blast,
- the type, strength, quantity, column load and distribution of explosives to be used per hole, per day and per blast,
- the sequence and pattern of the delay, and
- the description and purpose of any special methods to be adopted.

.8 If, in a specific area, a plan that was previously adopted does not produce conditions in accordance with the requirements stated herein, the Contractor must submit a revised blasting plan to the Engineer before continuing with drilling and blasting in adjacent areas.

5.0 FOUNDATION APPROVAL

.1 The foundation must be inspected and approved by the Engineer before any fill material is placed. The Contractor shall give not less than twenty-four (24) hours notice to the Engineer regarding required approval of a length of completed key trench excavation. The notice must include chainages of the areas requiring approval.

1.0 GENERAL

.1 The material specifications for fill materials used in construction of the dams are presented in this section.

.2 Material quantities are presented in Section 1001

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 Contractor must process all materials to meet the gradations specified herein.

.4 Bedding 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.

.5 Transition -200 mm material shall 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.

.6 Run-of-mine material, 700 mm maximum shall be obtained from Jericho pit or other sources approved by the Owner, provided the final product meets the requirements stated herein. Specific quarrying and/or processing procedures may be required to achieve the specified maximum top size.

.7 Till shall be obtained form the Jericho pit or other sources approved by the Owner,

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

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

3.0 MATERIAL SPECIFICATIONS

.1 Bedding Material (-20 mm minus)

a. The Bedding 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.

b. The Bedding material to be used in the key trench shall be 20 mm minus crush granite. The liner bedding in the superstructure can be crush granite or esker material.

TABLE 1005.1 : BEDDING 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 Transition -200 mm Material

a. The Transition -200 mm 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 : TRANSITION -200 MM MATERIAL GRAIN SIZE DISTRIBUTION LIMITS	
Grain Size (mm)	% Passing
200	100
100	60 – 100
50	40 - 70
20	20 – 50
10	0 - 30
5	0 - 10

.3 Run-of Mine Material

a. The Run-of-mine material can have a wide variation in gradation with a maximum particle size of 700 mm. Rockfill particles must be hard, durable and angular.

b. The depth and spacing of drill holes as well as the weight and delay of charges shall be selected to produce run-of-mine material meeting the specification.

c. Any significant concentration of unsuitable materials must be removed and directed to a waste disposal area, other location approved by the Owner or, with the Engineer's approval, mixed with other materials to produce a material meeting specifications.

.4 Till Material

a. The Till material can have a wide variation in gradation with a maximum particle size of 300 mm. Particles must be hard, durable and angular.

1.0 GENERAL

.1 The placement methods to be used in the construction of the dams 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. Embankment 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 No embankment fill material shall be placed on any part of the foundation until it has been prepared as specified herein and approved by the Engineer. 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 Embankment construction must not proceed when the work can not be performed in accordance with the requirements of the Construction Specifications. Any part of the embankment 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 BEDDING MATERIAL (KEY TRENCH FILL)

.1 The key trench foundation must be cleared of all deleterious material as described in Section 1004. The foundation area must be inspected and approved by the Engineer before fill placement proceeds.

.2 Snow and ice must be removed from the base of the key trench excavation before fill can be placed in that area.

.3 Key trench backfill placement must be conducted during winter months when air temperatures will freeze a lift of key trench material within 24 hours of placement. Experience has shown that a 250 mm thick lift freezes back within 24 hours when

air temperatures are below –15ºC. The time to freezeback will depend on the moisture content, wind speed, air temperature and solar radiation.

.4 The Bedding material from the stockpile must be mixed with heated water using a method approved by the Engineer to create a homogeneous mix that is fully thawed and not contain interstitial ice. The mix must not freeze until after it is placed and compacted in the key trench excavation. The temperature of the mix water required to meet the requirements stated herein may vary depending on the air temperature, wind speed and solar radiation.

.5 The placed Bedding material must have a moisture content no less than 2% above the optimum water content determined from the Density Test (ASTM D698-91).

.6 The Bedding material placed in the key trench must be spread and levelled immediately upon placement. The material must not be reworked, disturbed or rutted after compaction. Extra care should be taken by the Contractor to ensure the surface of the first lift before liner placement is as smooth and even as possible. Additional work, described in Section 1007, may be required if the lift surface is rough or uneven.

.7 The Bedding material placed in the key trench shall be compacted with a smooth drum vibratory compactor weighing not less than 10 tons. The Bedding material shall be compacted with at least six passes (back and forth being two passes) to achieve the maximum density possible at the placed moisture content. The number of passes may be adjusted at the Engineer's discretion to suit varying conditions.

.8 The lift thickness must be varied to achieve 100% freezeback prior to placement of the next lift. Freezeback is defined as a maximum temperature of –2ºC. The lift thickness may be adjusted depending on the placed moisture content and climatic conditions and results of fill temperature monitoring. Individual lifts must have uniform thickness.

.9 The key trench fill must be cleared of snow, ice and loose material before a new lift is placed. The surface of each lift must be approved by the Engineer before it is covered by a subsequent lift.

.10 Small batches of Bedding material may be required to provide localised levelling and smoothing of the first lift surface to ensure the liner system has a level, even subgrade beneath it. Localised frozen high points on the surface of the first lift that the Engineer believes may cause puncture or stressing of the liner system must be removed without disturbing the surrounding lift surface. Equipment suitable for this task may include, but not limited to, an excavator with a toothless bucket or jackhammer. Smoothing and patching with Bedding material must be done if the lift surface is rough or pocketed after the high points is removed.

.11 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, avoid turning tracked vehicles on the first two lifts after liner system installation, providing light plants in the work area to improve operator visibility, or use pylons to mark the lift/liner system interface or any other sensitive areas.

.12 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 or thermosyphons has been compromised. Excavation of fill surrounding the damaged liner system or thermosyphon may have to be excavated, without further damaging the integrity of the liner, to permit repairs to be made. Excavation methods suitable for this task may vary depending on the degree of freezing that may have already taken place.

3.0 BEDDING MATERIAL (SUPERSTRUCTURE)

.1 The Bedding material placed in the superstructure must not be placed in lifts no thicker than 0.3m. The placement method used must ensure that segregation and nesting of coarse particles is avoided.

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

.3 The placed Bedding material must be compacted to 95% 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, without further damaging the integrity of the liner, to permit repairs to be made. Hand excavation must be used to expose damaged portions of the liner for repair.

4.0 TRANSITION -200 MM ROCKFILL MATERIAL

.1 The Transition -200 mm rockfill material must be placed in lifts not exceeding 0.5 m thickness. The placement method used must ensure that segregation and nesting of coarse particles is avoided.

.2 The Transition -200 mm rockfill material must be compacted with a smooth drum vibratory compactor weighing not less than 10 tons. Moisture conditioning may be required prior to compaction. The Transition -200 mm rockfill material must be compacted with at least four passes of the compactor (back and forth being two passes). Rolling patterns must be used throughout construction to optimize the number of passes, amount of water added and vibration frequency for compacting the –200 mm rockfill material.

5.0 RUN-OF-MINE ROCKFILL

.1 The run-of-mine rockfill must be placed in lifts not exceeding 700 mm thickness. The placement method must ensure that segregation and nesting of coarse particles is avoided.

.2 The run-of-mine rockfill shall be compacted by ensuring that loaded haul truck traffic is routed over the entire surface of each lift. Particles greater than 700 mm diameter must be moved to the upstream or downstream face of the fill.

6.0 TILL MATERIAL

.1 The Till material must be placed in lifts not exceeding 0.3 m thickness. The placement method used must ensure that segregation and nesting of coarse particles is avoided.

.2 The Till material must be compacted with a smooth drum vibratory compactor weighing not less than 10 tons. Moisture conditioning may be required prior to compaction. The Till rockfill material must be compacted with at least four passes of the compactor (back and forth being two passes). Rolling patterns must be used throughout construction to optimize the number of passes, amount of water added and vibration frequency for compacting the Till material.

1.0 GENERAL

.1 The installation specifications for the non-woven geotextile, polypropylene geomembrane liner system to be used in the dams is presented in this section.

2.0 PRODUCT

.1 Materials

a. The non-woven geotextile must have a weight of 542 g/m2 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 1007.1.

b. The polypropylene geomembrane must be a 40 mil thick unsupported polypropylene geomembrane or equivalent. 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 PROPERTIES

Property	Test Method	Units	Value
Grab Tensile	ASTM D4632	N	1690
Elongation	ASTM D4632	%	50
Trapezoidal Tearing Strength	ASTM D4533	N	645
Puncture Strength	ASTM D4833	N	1070
Mass per unit area	ASTM D5261	g/m2	542

TABLE 1007.2: POLYPROPYLENE GEOMEMBRANE PROPERTIES			
Property	Test Method	Units	Value
Thickness (Nominal)	ASTM D1593	mm	1.0
Tensile Strength at Break	ASTM D882	N	334
Elongation	ASTM D882	%	700
Tear Resistance	ASTM D1004	N	53
Puncture Resistance	ASTM D4833	N	169
Low Temperature Impact	ASTM D1790	DegC	-40
Polypropylene Minimum Shop Seam Strengths			
Heat Bonded Seam Strength	ASTM D3083	N/mm	9.1
Heat Bonded Peel Adhesion Strength	ASTM D413	N/mm	3.5
Polypropylene Minimum Field Seam Strengths			
Heat Bonded Seam Strength	ASTM D3083	N/mm	9.1
Heat Bonded Peel Adhesion Strength	ASTM D413	N/m	3.5

3.0 SHIPPING AND STORAGE

.1 Geotextile

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

b. Storage of geotextile rolls on site must be in a secure location that will minimize exposure to the elements and physical damage.

.2 Polypropylene Geomembrane

a. Polypropylene panels must be shipped in palletized boxes, which are inspected before leaving the factory. Shipping must conform to the manufacturer's requirements and must be conducted in a manner that avoids damage. Any visible damage to the shipment must be noted on the freight receipt and project records.

b. The Polypropylene must remain packaged in dry storage until ready for use. The palletized boxes must not be stacked.

4.0 INSTALLATION

.1 Geotextile

a. Where applicable, any cracks or voids in the subgrade beneath the geotextile should be filled with 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 polypropylene geomembrane. When placed over the polypropylene geomembrane, placement of the geotextile must be conducted in a manner that will prevent damage to the polypropylene geomembrane. When placed over Bedding material, the installation of the geotextile shall not begin until the sub-base has been approved by the Engineer.

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

c. 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.

d. The geotextile must be overlapped a minimum of 1.5 m where overlap joints are required.

e. 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.

.2 Polypropylene Geomembrane

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

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

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

d. The Polypropylene 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.

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

f. 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.

g. A heated, portable shelter will be required to permit the polypropylene panels to be welded during the key trench liner system placement. The minimum air temperature within the shelter must not drop below –7 degC.

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

i. 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 (100,000) m2 of polypropylene liner involving the thickness and grade of liner and welding processes required for this project.

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

.4 Backfilling

a. The Contractor must take the necessary steps to ensure that the integrity of the liner system is not compromised during key trench backfilling. Frozen key trench fill material adhering to the liner system must not be removed unless repairs are required.

b. The liner system must be temporarily anchored so that movement downslope does not occur during backfilling at any stage of construction.

c. The Contractor must take the necessary steps to ensure that backfilling does not induce tensile stress in the liner system during backfilling. Care must be taken to avoid any damage to the liner system by making sharp turns, sudden stops or sudden starts adjacent to the liner system. Non-essential heavy equipment traffic in the immediate vicinity of the liner system must be minimized.

d. 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.

e. 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.

.5 Damage

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. Damaged sections of geotextile must be repaired or replaced at the Engineer's discretion.

c. The polypropylene geomembrane is the primary water retention barrier in the dams. Polypropylene geomembrane integrity and quality is absolutely essential for the dams to fulfil their design intent.

- Defects in the polypropylene panels will include roughness or striations, bubbles, blisters, any local variation in sheet thickness that exceeds +/- 20% or exceeds 6 inches in any direction, undispersed raw material or foreign matter present in either the surface or cross section of the sheet and pinholes, tears, gouges or any other through-thickness defect.

- Any of the defects listed above in the polypropylene geomembrane must be patched with a piece of the same membrane material. Patches must be cut with rounded corners and should overlap the damaged area a minimum of 3 inches. Polypropylene patches will be applied with a hand held heat gun and roller. The patch and damaged membrane area must be clean and dry. The heat gun will be inserted between the patch and the membrane liner, heating the surfaces of each to a molten state. Steel roller pressure over a hard surface must be applied during the heating process in such a way as to smooth out any wrinkles while mating both polypropylene membrane surfaces.

1.0 GENERAL

.1 The required geotechnical instrumentation for monitoring the performance of the dams is presented in this section.

.2 Ground temperature cables, casings, and data logger housings will be supplied and installed by the Engineer with the Contractor's assistance when needed. The following specifications for these instruments are provided for information only.

.3 The Contractor shall be responsible for providing protection for all instruments installed before construction of the dams is complete. The method of protection must be approved by the Engineer. The Contractor may be held responsible (at the Engineer's discretion) for replacement or repair of instruments damaged during construction.

2.0 INSTRUMENTATION REQUIREMENTS

.1 Ground temperature cables must be installed as shown on the Construction Drawings to measure ground temperature during construction and operation of the dams. Ground temperature cables will be provided by the Engineer.

.2 Data logger housings for the ground temperature cables will be provided by the Engineer. The housings will be rigidly attached to steel pipe as shown on the Construction Drawings.

.3 Single bead ground temperature cables will be used to monitor the freeze back of individual lifts of key trench backfill. These instruments will be provided by the Engineer.

.4 Settlement monuments must be installed as shown on the Construction Drawings to allow any settlements of the dams to be measured. The settlement monuments will be supplied and installed by the Contractor.

3.0 GROUND TEMPERATURE CABLE INSTALLATION

.1 Horizontal ground temperature cables must be installed during construction. Vertical ground temperature cables must be installed during construction. The locations and orientation of the ground temperature cables are shown in the Construction Drawings.

.2 Drillholes for ground temperature cable installation must be 100 mm ID or greater. Drillholes must be drilled in the presence of the Engineer to the depths shown on the Construction Drawings. Schedule 40 PVC 50 mm ID pipe, or approved equivalent, with a water tight end cap, must be placed in the hole prior to casing removal.

.3 The portion of the cable extending beyond the dam fill must be protected with a steel pipe extending 1 m above the final elevation of the dam. The steel pipe must be painted with fluorescent paint.

.4 The inside and outside of the PVC pipe must be backfilled with sand such that there are no air voids around the pipe or ground temperature cable.

.5 The installed instrument must be surveyed to 100 mm horizontal and 20 mm vertical accuracy.

.6 Horizontal ground temperature cables passing through the –200 mm rockfill material and the run-of-mine material must be placed in a steel pipe of sufficient strength to resist crushing upon placement of fill material.

4.0 SETTLEMENT MONUMENTS

.1 Settlement monuments must be supplied and installed by the Contractor as directed by the Engineer.

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 Bedding Material

a. Quality control testing must be performed during the crushing operation when the Bedding material is being processed. The tests and testing frequency required during processing of the Bedding 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
Grain Size Analysis	One per 500 m3 produced
Standard Proctor Density	One per 1000 m3 produced

b. Additional sieve analysis testing may be conducted by Engineer on samples collected from the dam fill to verify that the placed gradation meets the gradation requirements stated herein.

c. The compacted density of the Bedding material used as key trench backfill must be evaluated by coring samples for lab testing and in-situ compaction testing. Samples of the placed key trench backfill will be obtained using a concrete coring rig. The sample will be used to determine if the lift of key trench backfill is completely frozen and to determine the soil properties. The testing frequency may be adjusted as determined by the Engineer. The required tests and testing frequency for the key trench backfill is presented in Table 1010.2. Additional testing may be required at the discretion of the Engineer.

TABLE 1010.2: REQUIRED KEY TRENCH BACKFILL TESTING AND FREQUENCY		
Test	Test Frequency of Mixed Material	Test Frequency for Placed Material
Mixture Density	One per 500 m3	-
Moisture Content	One per 250 m3	4 per lift or 2 per day
Placed Bulk Density	-	4 per lift or 2 per day
Degree of Saturation	-	4 per lift or 2 per day
Grain Size Analysis	One per two days	
Specific Gravity	One per two days	

d. The compacted density of the Bedding material used as liner bedding material in the superstructure of the dams must be evaluated by using in-situ measurements of density. In-situ density measurements of the compacted Bedding material will be conducted with a nuclear densometer. Samples of the bedding 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 Bedding material placed in the superstructure of the dams is presented in Table 1010.3.

TABLE 1010.3: REQUIRED BEDDING SUPERSTRUCTURE FILL TESTING AND FREQUENCY	
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 every two days
Specific Gravity	One every two days

.2 Transition -200 mm Rockfill Material

a. Samples of the Transition -200 mm 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 Fill Testing Methods

a. Mixture density of key trench backfill shall be determined by using a concrete yield bucket as specified in CSA Can 3-A23.2-M90 or approved equivalent.

b. Samples of placed key trench backfill must be taken once freezeback is completed by means of a concrete coring machine. The core must extend through the lower contact of the lift. All cored samples must be evenly distributed over the lift surface. All holes must be thoroughly washed with clean water to remove any remaining drilling fluid and backfilled with saturated Bedding material immediately after extraction of the core.

c. Each cored sample of key trench backfill shall be split in half longitudinally and transversely to be examined and photographed by the Engineer. The bonding between layers, ice-saturation and ice bonding will be evaluated.

d. Moisture content is defined as the ratio of the weight of water to the weight of dry soil. Moisture content testing must be conducted according to ASTM D2216.

e. The method of determining bulk density of the cored key trench material will depend on the quality of the sample. The sample volume can be determined from its dimensions if the core has uniform dimensions. The Engineer will rely on in-situ measurements of key trench backfill density with a nuclear densometer if core recovery is poor or if the recovered cores are non-uniform.

f. The degree of saturation for cored key trench backfill samples will be determined, when possible, from the measured moisture content, bulk density and measured specific gravity.

g. Specific gravity shall be determined using the flask method according to ASTM D854.

3.0 POLYPROPYLENE 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.