

APPENDIX G

DRAFT TECHNICAL SPECIFICATIONS



GOOSEBERRY MINE
BROWNFIELDS PROJECT
STOREY COUNTY, NEVADA



**DRAFT TECHNICAL SPECIFICATIONS
ISSUED FOR AGENCY REVIEW
HEAP LEACH PAD & TAILINGS CLOSURE
GOOSEBERRY MINE, STOREY COUNTY, NEVADA**

Submitted to:

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**HEAP LEACH FACILITY CLOSURE
GOOSEBERRY MINE
STOREY COUNTY, NEVADA**

DRAWING INDEX

DRAWING NO.	REV.	DATE	TITLE
1. CV01	1.0	11/07	COVER SHEET
2. Site	1.0	11/07	SITE PLAN
3. GRD1	1.0	11/07	PRELIMINARY GRADING & UNDER DRAINS
4. GRD2	1.0	11/07	HEAP LEACH PAD & EVAPORATION POND GRADING
5. GRD3	1.0	11/07	ASAMERA TAILING POND GRADING & DRAINAGE DITCH
6. GRD4	1.0	11/07	REWORKED TAILING POND GRADING
7. PRO1	1.0	11/07	DRAINAGE DITCH PROFILE & SECTIONS
8. DT01	1.0	11/07	DETAIL SHEET
9. DT02	1.0	11/07	DETAIL SHEET
10. DT03	1.0	11/07	DETAIL SHEET

**TECHNICAL SPECIFICATIONS
HEAP LEACH PAD CLOSURE
GOOSEBERRY MINE SITE
STOREY COUNTY, NEVADA**

PART I: EARTHWORK

1. GENERAL REQUIREMENTS

1.1 Definitions

The following definitions apply to these Technical Specifications:

- "Owner" is defined as State of Nevada, Division of Environmental Protection (State). The Owner's properly authorized representative will act on behalf of the Owner.
- "Engineer" is defined as a representative appointed and authorized by the Owner. The Engineer shall be a registered Professional Engineer in the State of Nevada. The Owner must identify the Engineer in writing to the Contractor.
- "Inspector" is defined as the party or parties representing the Owner under the supervision of the Engineer. The Inspectors will perform Construction Quality Assurance (CQA) observations and testing for the project. A supervisory Inspector with a minimum of 5 years experience in earthworks and geomembrane liner testing shall review all work performed by Inspectors on the job site. Resumes of all Inspectors shall be submitted to the Owner for approval.
- "Earthwork Contractor" is defined as the party or parties identified as such by the Owner and are responsible for the Scope of Work as identified in Part I of these Technical Specifications.
- "Lining Contractor" is defined as the party or parties identified as such by the Owner and are responsible for the Scope of Work as identified in Part II of these Technical Specifications. The Liner Contractor may be a subcontractor to the Earthwork Contractor.
- "Contract Manager" is defined as a representative appointed and authorized by the Owner to act as a liaison between the Owner, the Earthwork Contractor, the Lining Contractor, and the Engineer.

1.2 Scope of Work

These Technical Specifications and the Construction Drawings constitute the Earthwork package for closure of the Heap Leach Pad (HLP) and conversion of an existing holding pond to an evaporation pond at the Gooseberry Mine site, Storey County, Nevada. The Earthwork package covers the following items of Work:

- Survey for line and grade of the specific project elements.
- Excavation of test pits as needed to locate the existing liner under the HLP.
- Installation of an underdrain around the HLP with geotextile wrap and stone fill
- Finished surface preparation for areas to receive geomembrane lining.
- Excavation of material from the East and West mill tailings ponds and placement on the excavated material on the HLP
- Intermediate grading, final grading and covering the HLP
- Grading and surface preparation the West mill tailing pond to receive geomembrane lining.
- Excavation of material in the "Jello Pile" and placement in the disposal cell.
- Cover and final grading of the disposal cell.
- Lowering the dam and placing cover on the tailings at the Asamera tailing pond.
- Site grading and construction of the drainage ditch at the Asamera Tailing pond.
- Removal of loose tailings and rock, and placement in the pond at the Reworked tailing pond
- Grading and earth cover of the reworked tailing pond.
- Site grading to provide drainage.
- Installation of fencing.
- Finished surface preparation for areas to receive geomembrane lining.

Part II of these Technical Specifications covers the geomembrane lining materials, installation and testing and is not part of the Earthwork Contractor's Scope of Work.

1.3 Dust Control

The Earthwork Contractor, for the duration of the contract, shall maintain all excavations, embankments, haul roads, access roads, plant sites, waste disposal areas, stockpile areas, and all other work areas free from dust as determined by the Owner. Industry accepted methods of dust control suitable for the area involved, such as sprinkling, will be permitted. Alternative methods for dust control shall be approved by the Owner. No separate payment will be made for dust control.

1.4 Control of Natural Waters

The Earthwork Contractor, for the duration of the contract, shall be responsible for temporary diversion of natural waters to protect the work areas from damage. The Contractor shall also be responsible for routing any runoff from the HLP to containment areas during the construction period. No separate payment will be made for control of natural waters.

1.5 Sequence of Work

The sequence of work shall be in accordance with the following requirements.

1.5.1 Task I Construction

- Clearing and grubbing to a nominal depth of 12 inches areas to be covered with fill (as required by site conditions) and undisturbed areas that will be used as borrow pit locations. All materials shall be placed in growth medium stockpile areas designated by the Owner.
- Excavation down to the existing liners in the East and West mill tailing ponds. Place the excavated material on the heap leach pad to the limits shown on the drawings. Remove and dispose of the liners in the ponds
- Preliminary grading of the top of the HLP to smooth out the ridge and fill and compact the existing trenches. This work shall be Coordinated with the placement of the material from the mill tailing ponds.
- Earthwork and grading of the East mill tailing pond as required and shown on the Drawings to create the Disposal Cell. Placement of the material from the "Jello Pile" in the Disposal Cell after approval of the liner installation and tailing layer. Earthwork and grading as shown to close the Disposal after installation of the geomembrane cap.
- Finished surface preparation of all areas to receive geomembrane lining. Placement of the select fill and tailings as protection for the geotextile lining in the Evaporation pond and disposal cell. Placement of the stone fill in the evaporation pond.
- Installation of slotted underdrain piping, drain rock and geotextile fabric at the base of the HLP. Installation of the drain line and fittings from the HLP to the Evaporation pond
- Folding in of the existing liner system in the Pregnant Solution Pond and subsequent backfilling of the pond to reestablish drainage across the area.

- Earthwork grading to the lines and grades shown on the Construction Drawings for the HLP. Note: Contractor shall use caution if operating heavy equipment over the drain line from the HLP to the Evaporation Basin. Additional fill may be placed in a temporary berm over this pipe for protection if needed.
- Earthwork grading to the lines and grades shown on the construction drawings for the Asamera Tailing pond and excavation of the drainage ditch around the pond.
- Excavation the tailings and loose rock on the northeast corner of the reworked tailing Pond down to native ground, or as directed by the engineer. Placement of the material in the pond, and grading and covering the pond to the grades and limits shown.
- Re-grading all borrows pits as needed to provide positive drainage, so that ponding of surface or rain water will not occur.

The Earthwork Contractor shall work in close coordination with the Lining Contractor so as to provide a prepared surface for liner installation that conforms to the requirements set forth in these Technical Specifications. Lining installation will need to progress in an orderly fashion to allow project completion within the required schedule. The Earthwork Contractor shall excavate and backfill all high-density polyethylene (HDPE) anchor trenches as shown on the Construction Drawings. No separate payment will be made for anchor trench excavation and backfill.

1.5.2 Task II Construction (Not in Earthwork Scope)

- Installation and testing of the 60-mil smooth geomembrane liner for the Evaporation Basin.
- Installation of the pipe boot for the drain line.

2. SURVEYS

The Owner will perform basic construction surveying to establish horizontal and vertical control. Construction surveys to assure completion to the specified lines and grades will be the responsibility of the Earthwork Contractor. Pre-construction and final cross-section surveys to determine earthwork quantities will be the responsibility of the Owner. Mapping accuracy may require adjustments to the plan elevations due to actual field conditions. Any proposed changes shall be submitted in writing and are subject to review and approval by the Engineer.

Except as noted otherwise, grading tolerances shall be plus or minus 0.1 feet for horizontal and sloped surfaces from the elevations shown on the Construction Drawings.

The Earthwork Contractor shall supply electronic (AutoCAD v. 2004 or compatible) as-built drawings of the completed finished grade surfaces. The as-built drawings shall consist of topographic maps of the finished grade surfaces and shall provide sufficient detail to allow for verification of the various project elements including, but not limited to, elevation, grades and location. No areas within the scope of the project shall be covered with geomembrane liner without written approval of the Engineer and the Owner.

Any areas found to be deficient shall be rectified by the Earthwork Contractor at no additional cost to the Owner. Additional electronic as-built drawings shall be provided to the Owner and the Engineer for review and approval prior to final acceptance.

3. FOUNDATION PREPARATION

3.1 Clearing and Grubbing

All vegetation, debris and other deleterious material shall be removed from areas of cut and fill and areas to receive geomembrane lining. Materials to be removed include surface boulders, organic matter including trees, stumps and roots, or other objectionable materials as determined by the Engineer. A nominal twelve (12) inch depth of stripping will be required to meet the aforementioned requirements.

3.2 Stockpiling Growth Media

All growth media removed during the clearing and grubbing operations shall be stockpiled in areas designated by the Owner. The growth media stockpiles shall be graded smooth such that positive surface drainage is maintained. The slopes shall be graded smooth to 2.5:1 (H:V).

3.3 Overexcavation of Existing Surface Soils

After initial clearing and grubbing, overexcavation of any softer soils to the contact of relatively firm soils or rock shall be performed only at the direction of the Engineer. If required, overexcavation shall be performed by the Contractor. Confirmation of adequate subexcavation and exposure of firm soils or rock shall be made by the Inspector subject to approval by the Engineer.

3.4 Surface Preparation and Compaction

The upper eight (8) inches of native soils beneath cut surfaces and areas to receive fill shall be scarified, moisture conditioned and compacted to a minimum of 95 percent of maximum dry density as determined in accordance with ASTM D1557. Moisture content during compaction shall be maintained within the limits of 2 percent below to 3 percent above optimum moisture content as determined by ASTM D1557. Scarification and compaction can be deleted in areas in which intact bedrock is exposed at the surface.

4. EARTHWORK CONSTRUCTION

4.1 General

THE HLP will be capped with a minimum of two feet of random fill or common fill, except that the area above the underdrain trench shall be filled with compacted tailings as shown on the Construction Drawings.

Excavation in soil and rock shall be performed to the lines and grades presented on the Construction Drawings. The Earthwork Contractor can anticipate that materials within the specified depth of excavation will require the use of conventional earthmoving equipment and heavy ripping. Soil materials can be excavated with dozers and scrapers. Light to heavy ripping may be required for excavation in some of the more cemented (caliche) zones. Considerable amounts of cobbles and boulders should be anticipated by the Contractor. Based on the results of field exploration, bedrock is expected to be encountered within the depth of excavation, particularly within the borrow areas.

4.1.1 Common Excavation

Common excavation shall be classified as soil materials that do not meet the specifications for rock excavation as defined in Section 4.2.2.

All earth materials, boulders or detached pieces of solid rock less than one cubic yard in volume shall be classified as common excavation. No additional allowance above the unit prices bid for common excavation shall be permitted for excavation of wet or frozen materials.

All excavated materials may be used as fill provided it meets the requirements for the class of material in which its use is intended as specified herein.

4.1.2 Rock Excavation

Rock excavation shall be classified as material which cannot be effectively loosened or broken down in a single pass by ripping with a late model tractor-mounted hydraulic ripper, equipped with one digging point of standard manufacturer's design that is adequately sized for use with and propelled by a crawler-type tractor, rated at a minimum 520-net flywheel horsepower and operating in low gear. All boulders or detached pieces of solid rock in excess of one cubic yard in volume shall be classified as rock excavation. These materials may be used for fill if they meet the requirements for the class of materials in which its use is intended as specified herein.

4.2 Fills

Fill materials shall be placed to the lines and grades as shown on the Construction Drawings. Material type, quality, placement and compaction procedures and requirements are specified in the following sections.

4.2.1 General

All fill materials shall be free of excessive vegetation, debris, organic matter, frozen materials and other deleterious materials.

4.2.2 Material Quality

4.2.2.1 Rock Fill

Any material having more than 30 percent plus ¾-inch rock shall be classified as rock fill. Rock fill may be obtained from excavation in borrow areas designated by the Owner and approved by the Engineer.

Rock fill can be placed in the base of the deeper fills and shall not be used in the upper two (2) feet.

All excavation from the areas previously defined shall be suitable for rock fill provided they contain no particles larger than 24 inches nominal diameter (least dimension). Leach material or acid generating waste materials are not acceptable for use as rock fill.

4.2.2.2 Random Fill

Random fill may be obtained from excavation of the borrow areas designated by the Owner and approved by the Engineer.

Random fill can be placed in the base of the deeper fills and shall not be used in the upper one (1) foot.

All excavation from the areas previously defined shall be considered suitable for use as random fill provided it contains no particles larger than 8-inches nominal diameter (least dimension) and has a plasticity index of no more than 15 as determined in accordance with ASTM D4318.

4.2.2.3 Common Fill

Common fill may be obtained from borrow areas designated by the Owner and approved by the Engineer. Common fill may extend to finished grade.

Materials shall be considered suitable for use as common fill provided they contain no particles larger than four (4) inches nominal diameter (least dimension). The material shall have no more than 45 percent (by weight) passing the No. 200 sieve and have a plasticity index of no more than 15 as determined in accordance with ASTM D4318.

4.2.2.4 Drain Rock

Drain rock shall be used to backfill the perforated underdrain piping as shown on the Construction Drawings. The Earthwork Contractor shall be responsible for supply and placement of Drain Rock. Drain rock shall meet the following grading requirements as determined by ASTM C117.

Drain Rock

Sieve Size (Square Openings)	Percent Passing (By Dry Weight)
1½-inch	100
¾-inch	50 – 100
½-inch	0 - 20
No. 4	0 - 5
No. 200	0 - 3

Drain rock material shall be nonplastic when tested in accordance with ASTM D4318. The percent of wear when subjected to the Los Angeles abrasion test (ASTM C131, 500 revolutions) shall be no greater than 40. The percent loss when subjected to the sodium sulfate soundness test (ASTM C88) shall be no greater than 12. Alternative materials may be approved subject to review by the Engineer.

The requirements for geotextile encapsulating the drain rock are presented in Section 5.1.2.

4.2.2.5 Evaporation Pond Stone Fill

The Evaporation Pond shall be filled to the elevation shown on the Construction Drawings with a stone backfill. The material shall consist of stones with a minimum dimension of 2-inches up to a maximum dimension of 5-inches.

Stone fill material shall be nonplastic when tested in accordance with ASTM D4318. The percent of wear when subjected to the Los Angeles abrasion test (ASTM C131, 500 revolutions) shall be no greater than 40. The percent loss when subjected to the sodium sulfate soundness test (ASTM C88) shall be no greater than 12. Alternative materials may be approved subject to review by the Engineer.

4.2.3 Placement and Compaction

Fill materials shall be placed to the lines and grades shown on the Construction Drawings.

4.2.3.1 Rock Fill Placement

Rock fill for mass grading operations shall be placed in lifts not to exceed twelve (12) inches in compacted thickness unless authorized by the Engineer. The type of compaction equipment,

and number of passes, shall be approved by the Engineer in writing based on an acceptable field fill compaction performance test.

Construction and monitoring of the field test shall be performed per U.S. Army Corps of Engineers' guidelines for test fill construction. The test fill may be located so that it is incorporated within the limits of the compacted fill areas. Borrow moisture content on minus ¾-inch material shall be within two percent of optimum moisture prior to placement.

The data to be collected during construction of the test fill and submitted to the Engineer for approval shall include:

- Amount of settlement after every two passes of a 10-ton minimum (static drum weight) vibratory, smooth-drum roller compactor, to a maximum of 10 passes.
- Gradation and moisture content of in-place material.
- In-place fill density at completion of the test by bulk density or nuclear gauge methods.

A curve showing settlement versus number of passes shall be produced from the data. This curve will be used to evaluate the required minimum number of passes for acceptable compaction. Final evaluation by the Engineer will be based on a review of the test data.

4.2.3.2 Random and Common Fill Placement

Random and common fill shall be placed in lifts not to exceed 12-inches in loose thickness, unless otherwise authorized by the Engineer. Where the Earthwork Contractor demonstrates that the equipment being used effectively compacts lifts thicker than 12-inches, thicker lifts may be authorized by the Engineer.

Compaction of random and common fill shall be between 85 percent and 90 percent of ASTM D1557 maximum dry density. The moisture content during compaction shall be maintained within the limits of 2 percent below to 3 percent above optimum moisture content as determined in accordance with ASTM D1557. Fill materials that are compacted in excess of 90 percent relative compaction shall be scarified to yield materials within the specified range.

4.2.3.3 Stone Fill Placement

The stone fill for the Evaporation Pond shall be placed on a protective layer of geotextile to protect the geomembrane pond liner from damage.

Placement methods and haulage equipment proposed by the Contractor shall be selected to prevent damage to the pond lining system. Depending on the construction equipment proposed by the Contractor for placement operations, consideration shall be given to hand placement of the initial layer of materials. Proposed equipment and placement methods to prevent damage to the liner system shall be outlined in the Contractor's proposal to the Owner.

At no time shall equipment be operated directly on the surface of the liner. The working surface during the placement of the drainage materials shall be maintained at a level that will not induce stresses sufficient to puncture or damage the underlying liner system. If haulage and/or placement vehicle traffic is proposed to travel onto the working surface, a minimum thickness of material shall be established based upon a successful test pad with liner, geotextile and the equipment proposed for use. Proposed methods and equipment used for haulage as well as material placement shall be reviewed and approved by the Engineer prior to commencing operations.

As the ambient air temperature increases, wrinkles in the liner will develop due to the thermal expansion and contraction properties of the HDPE liner. Stone fill materials shall be placed during the cooler times of the day when the liner lays relatively flat. To minimize the effect of wrinkles, stone fill materials shall be placed in an uphill direction and/or parallel to the contours.

5. UNDERDRAIN PIPING SYSTEM

5.1 Materials

5.1.1 PVC Piping

PVC piping shall be 6 inch, ASTM D3034, SDR 35, with integral bell gasket joints: Rubber gaskets shall be factory installed and conform to ASTM F477.

PVC Fittings. ASTM D3034, SDR 35 with integral bell gasketed joints. Gaskets shall conform to ASTM F477.

5.1.2 HDPE Underdrain Pipe

HDPE slotted underdrain piping shall be ASTM F-405 Heavy Duty. Pipe may be supplied in coils or sections. Provide manufactures standard fittings to transition to PVC pipe

5.1.3 Geotextile

Geotextile shall consist of a nonwoven, needle punched, polypropylene fabric having a minimum weight of 10-ounces per square yard in conformance with ASTM D5261. Geotextile

shall consist of GSE Lining Technology NW10, Contech C-120NW, Amoco ProPex 4510, or an equivalent product approved by the Engineer.

5.2 Submittals

5.2.1 Certificates

The Contractor shall submit one (1) original and two (2) copies of certificates provided by the manufacturer and indicating that all materials, pipe and fittings comply with the applicable portions of this specification.

Before incorporating any piping and geotextile materials into the project, a certification of materials shall be submitted by the manufacturer or supplier. The certificate shall include:

- Name of manufacturer.
- Name of fabricator.
- Chemical composition and coating, if any.
- Product description and life expectancy, if applicable.
- Statement of specification compliance including the name of this project.
- Signature of authorized official attesting to the information presented.
- Manufacturer's recommendations for field installation and repairs.

All materials shall be subject to the approval of the Engineer prior to incorporating any of the materials into the work.

5.2.2 Samples

Submit for approval samples of the material proposed for use, where appropriate.

5.3 Delivery, Handling and Storage of Materials

5.3.1 General

All pipe and materials furnished by the Earthwork Contractor shall be delivered, distributed and stored at the project site by the Earthwork Contractor. The Earthwork Contractor shall be responsible for all materials at all times. The Earthwork Contractor shall replace or repair, in a manner approved by the Engineer and at the Earthwork Contractor's own expense, all such material found to be defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered damaged or defective prior to the final acceptance of the work, or during the guarantee period.

5.4 Pipe Placement

The slotted underdrain pipe shall be installed along the edge of the existing liner as shown on the Drawings. The solid pipe and cleanouts shall be installed as shown on the Construction Drawings.

Pipe fittings shall be installed at the required locations. Prior to installation, each section of pipe and each fitting shall be inspected for defects and/or damage.

The Earthwork Contractor shall use equipment and methods approved by the Engineer for safe, convenient and satisfactory execution of the work. All pipe; fittings and other appurtenances shall be carefully lowered into the trench piece by piece. Under no circumstances shall such materials be dropped into trenches or lined channels. Extreme care shall be taken to prevent foreign material from entering the pipe while it is being installed. During periods when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or other means approved by the Engineer.

The cutting of pipe for inserting fittings or closure pieces shall be done in a neat and workmanship-like manner without damage to the pipe or coating and so as to leave a smooth end at right angles to the axis of the pipe.

Whenever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted, the amount of deflection allowed shall not exceed that required for satisfactory joining and shall be approved by the Engineer.

Wherever significant site variations not shown on the Construction Drawings are encountered during construction, and where such obstructions interfere with the work to an extent that an alteration in the lines or grades of the pipe is required, the Engineer shall have the authority to order such deviation or to arrange for removal, relocation or reconstruction of the obstructions. If the deviation results in a change in the amount of work done by the Earthwork Contractor, an increase in the work shall be compensated for on the basis of payment as detailed in the

proposal, or on a change-order basis. A reduction of work shall result in a similar credit to the Owner.

5.5 Installation of Geotextile

Geotextile shall be dry and clean immediately prior to installation. The geotextile shall be installed such that foot traffic is minimized and no vehicle traffic crosses the liner. All joints shall be overlapped a minimum of twelve (12) inches. All holes or tears that occur during installation shall be immediately marked and repaired, at the Contractor's expense. Repair methods shall be approved by the Engineer.

Geotextiles are sensitive to ultraviolet radiation and must have very limited exposure to direct sunlight. Any geotextile stored at the site shall be covered with ultraviolet stabilized tarps for protection. The geotextile shall not be exposed to direct sunlight for more than five days.

6. FENCING

6.1 Materials

Unless otherwise noted all fence materials shall conform the requirements of the Nevada Department of Transportation "Standard Specifications for Road and Bridge Construction", Current Edition. Fencing shall be NDOT "Standard Fencing" as specified in Section 616.03.02 of the NDOT Standard Specifications with three strands barbed wire, and one strand smooth wire.

6.1.1 Barbed Wire

Barbed wire shall be 2-strand 12-1/2 gauge zinc-coated wire with 4-point barbs and shall conform to the requirements of ASTM A 121

6.1.2 Posts

Steel posts shall be C-Section, or T-Section conforming to AASHTO M281. Wood Posts shall conform to the requirements of Section 724.03.01 of the NDOT Standard Specifications.

6.2 Drive Gates

Gate frames shall conform to the requirements of Section 734.03.07 of the NDOT Standard Specifications.

6.3 Submittals

6.3.1 Certificates

The Contractor shall submit one (1) original and two (2) copies of certificates provided by the manufacturer and indicating that all materials, comply with the applicable portions of this specification.

Before incorporating any fencing into the project, a certification of materials shall be submitted by the manufacturer or supplier. The certificate shall include:

- Name of manufacturer.
- Name of fabricator.
- Chemical composition and coating, if any.
- Product description and life expectancy, if applicable.
- Statement of specification compliance including the name of this project.
- Signature of authorized official attesting to the information presented.
- Manufacturer's recommendations for field installation and repairs.

All materials shall be subject to the approval of the Engineer prior to incorporating any of the materials into the work.

6.4 Delivery, Handling and Storage of Materials

6.4.1 General

All fencing material furnished by the Earthwork Contractor shall be delivered, distributed and stored at the project site by the Earthwork Contractor. The Earthwork Contractor shall be responsible for all materials at all times. The Earthwork Contractor shall replace or repair, in a manner approved by the Engineer and at the Earthwork Contractor's own expense, all such material found to be defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the

replacement of installed material discovered damaged or defective prior to the final acceptance of the work, or during the guarantee period.

6.5 Fence Installation

Steel posts shall be driven at the required dimension and depth and at the spacing shown on the Drawings.

Wood posts shall be set in concrete. The concrete shall be thoroughly compacted around the posts by tamping or vibrating and shall have a smooth finish slightly higher than the ground and sloped to drain away from the posts. All posts shall be set plumb and to the required grade and alignment. No materials shall be installed on the posts, nor shall the posts be disturbed in any manner within seven days after the individual post footing is completed.

Should rock be encountered at a depth less than the planned footing depth, a hole 2-inches (50 mm) larger than the greatest dimension of the posts shall be drilled to a depth of 12-inches (300 mm). After the posts are set, the remainder of the drilled hole shall be filled with grout, composed of one part Portland cement and two parts mortar sand. Any remaining space above the rock shall be filled with concrete in the manner described above.

In lieu of drilling, the rock may be excavated to the required footing depth. No extra compensation shall be made for rock excavation.

Stress panels shall be installed as shown on the Drawings. Corner panels shall be installed at all changes in direction greater than 45 degrees.

At locations of small natural swales or drainage ditches and where it is not practical to have the fence conform to the general contour of the ground surface, longer posts may be used and multiple strands of barbed wire stretched thereon to span the opening below the fence. The vertical clearance between strands of barbed wire shall be 6-inches (150 mm) or less.

7. FINISHED SURFACE PREPARATION OF AREAS TO RECEIVE LINING

All surfaces to receive geomembrane lining shall meet the following specifications.

All finished grade areas to receive geomembrane lining shall be free of angular gravel, objectionable gravel over ¼-inch in diameter and hard objects. In areas with excessive coarse particles exposed on the existing lining surface, removal by appropriate methods will be required. Areas to receive geomembrane liner shall be cleaned to the satisfaction of the Inspector prior to geomembrane deployment. Any objectionable particles beneath the existing liner system shall be cut out and removed prior to deployment of the new liner system.

Prior to installation of the liner, the Lining Contractor shall, in the presence of the Earthwork Contractor, the Inspector and the Owner, inspect and verify the conditions of the specified area as adequate for placement of the liner. Following the verification of the surface, the Lining Contractor shall sign an acceptance form and assumes full responsibility for the verified area should conditions be altered by occurrences outside the control of the Earthwork Contractor.

8. WEATHER LIMITATIONS

Unless approved in the field by the Engineer, controlled fill shall not be constructed when the atmospheric temperature is at 35 degrees F and falling. When the temperature falls below 35 degrees F, it shall be the responsibility of the Earthwork Contractor to protect all areas of completed surfaces against any detrimental effects by methods approved by the Engineer. Any areas that are damaged by freezing shall be removed or reconditioned, reshaped and recompacted by the Earthwork Contractor in conformance with the requirements of this specification.

9. QUALITY ASSURANCE

9.1 General

The Inspector, under the supervision of the Engineer, shall represent the Owner and shall be responsible during construction for the following:

- Construction observations for quality assurance
- Materials testing for compliance with the specifications
- Soils testing
- Reports

The Earthwork Contractor shall be responsible for all surveying and verification of lines and grades during construction. The Owner shall provide final cross-section surveys and will determine earthwork quantities. The Owner shall verify quantities and grades for final acceptance of site grading.

9.2 Construction Observations

The Engineer shall be the interpreter of the site construction specifications, and shall direct observations and tests as considered necessary to assess and accept the quality of work. An Inspector under the direction of the Engineer shall make continuous observations and tests of construction operations.

9.3 Material Selection and Use

The Engineer shall advise the Earthwork Contractor as to the suitability of proposed borrow material for its specified use in the project construction. It shall be the responsibility of the representative of the Engineer to confirm that all materials meet the specified requirements. Processing may be required to meet the gradation requirements specified herein. Final acceptance of construction materials shall be after placement and compaction. In the event testing indicates the specifications are not being achieved, the Contractor shall at his expense, either remove and replace or rework the material within the area represented by the failing test until passing tests are achieved.

9.4 Earthwork Material Testing

9.4.1 General

The Inspector, under the supervision of the Engineer, shall perform testing to classify each specified construction material type. Tests performed shall consist of grain-size distribution analyses and Atterberg limits testing to classify each material type for its specified use in construction. Additionally, moisture content, moisture-density relationships and in-place density and moisture tests shall be performed to verify that the construction conforms to the Construction Drawings and Technical Specifications. Table I-1 depicts a CQA Sampling and Testing Guide. Observations and tests performed by the Inspector shall not relieve the Earthwork Contractor of responsibility for providing adequate quality control measures nor of responsibility for damage to or loss of material before acceptance. The Earthwork Contractor shall, at his expense, furnish any labor and equipment necessary to assist the Inspector in obtaining samples for testing. The Earthwork Contractor shall allow sufficient time for the Inspector to carry out the required testing and observations at no additional cost to the Owner.

Table I-1
Earthwork CQA Sampling and Testing Guide

Material	Tests	Frequency
Subgrade & Finished Grade - Cut - Random and Common fill	1. Laboratory Compaction Curve 2. Density (in-place)	1. One Per Soil Type 2. Minimum of One Density Test per 1,000 Square Yards
Granular Fill & Drain Rock	1. Gradation, Los Angeles Abrasion, Soundness, Atterberg Limits	1. Once Per Source or Visually Approved

9.4.2 Test Procedures

All tests performed shall be in accordance with the current edition of the ASTM Testing Standards as indicated below.

- ASTM C88-99a Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C117-03 Standard Test Method for Materials Finer than 75µm (No. 200) Sieve in Mineral Aggregates by Washing
- ASTM C131-03 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

- ASTM C136-01 Standard Test for Sieve Analysis of Fine and Coarse Aggregates
- ASTM D422-63 (2002) Standard Test Method for Particle-Size of Soils
- ASTM D1557-02e1 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
- ASTM D2216-98 Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D2922-01 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- ASTM D4318-00 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

9.4.2.1 Quality Assurance Reports

The Engineer shall submit reports of observations and tests to the Owner. The reports shall be submitted to the Owner in a timely fashion. As soon as possible, after identification, items of non-conformance will be brought to the attention of the Owner.

A copy of all test results will be maintained at the construction site, and shall include the following:

- Date issued.
- Project title and number.
- Date of testing and/or sampling.
- Designation or use of material tested.
- Type of test and specification.
- Location of test.
- Observations regarding compliance or noncompliance with the Construction Drawings and Technical Specifications.

Upon completion of construction, the Engineer shall submit a final Construction Quality Assurance Report stating that the project was completed in substantial conformance with the approved Construction Drawings and Technical Specifications and presenting test summaries, record drawings and other supporting data necessary to document the completed construction.

**TECHNICAL SPECIFICATIONS
HEAP LEACH PAD CLOSURE
GOOSEBERRY MINE SITE
STOREY COUNTY, NEVADA**

**PART II: GEOMEMBRANE LINING MATERIALS,
INSTALLATION AND TESTING**

1. GENERAL REQUIREMENTS

1.1 Definitions

The following definitions apply to these Technical Specifications:

- "Owner" is defined as The State of Nevada, Division of Environmental Protection (State). The Owner's properly authorized representative will act on behalf of the Owner.
- "Engineer" is defined as a representative appointed and authorized by the Owner. The Engineer shall be a registered Professional Engineer in the State of Nevada. The Owner must identify the Engineer in writing to the Contractor.
- "Inspector" is defined as the party or parties representing the Owner under the supervision of the Engineer. The Inspectors shall perform Construction Quality Assurance (CQA) observations and testing for the project. A supervisory inspector with a minimum of 5 years experience in earthworks and geomembrane liner testing shall review all work performed by inspectors on the job site. Resumes of all inspectors shall be submitted to the Owner for approval.
- "Earthwork Contractor" is defined as the party or parties identified as such by the Owner and is responsible for Tasks I & III as defined in these Technical Specifications.
- "Lining Contractor" is defined as the party or parties identified as such by the Owner and is responsible for Task II as defined in these Technical Specifications. The Lining Contractor may be a subcontractor to the Earthwork Contractor.
- "Contract Manager" is defined as a representative appointed and authorized by the Owner to act as a liaison between the Owner, the Earthwork Contractor, the Lining Contractor, and the Engineer.

1.2 Site Cleanup

The Lining Contractor shall, at all times, keep the work area in a neat, clean and safe condition. All scrap material, debris, trash, sandbags and the like shall be removed from the pond area as well as the surrounding project area. Sand bags shall be UV resistant. These materials shall be cleaned up on a regular basis and shall be disposed of in an area provided by the Owner at the Lining Contractor's expense. The Lining Contractor shall leave the work area in a neat,

clean, and safe condition. In the event of the Lining Contractor's failure to comply with the foregoing, the same may be accomplished by the Owner at the Lining Contractor's expense.

1.3 Liner Deliveries

Liner deliveries shall be coordinated with the Contractor's field crew. The Owner is not responsible for liner delivery, unloading or storage. The Owner will not accept liner deliveries that arrive at the project site when the liner crew is not present.

1.4 Scope of Work

These Technical Specifications cover the requirements for manufacture, installation and testing of the geomembrane lining system construction for the Heap Leach Pad Closure, Gooseberry Mine, Storey Pine County, Nevada as indicated by the Construction Drawings and summarized as follows.

- Installation and testing of the 60-mil smooth geomembrane liner for the evaporation pond.
- Installation of the pipe boot for the drain inlet.
- As-built drawings documenting the layout and numbering of panels, roll numbers and destructive test sample locations for each element of the project shall be required. As-built drawings shall be submitted to the Engineer within two weeks of the completion of liner deployment. As-built drawings shall be prepared and submitted in AutoCAD v. 2004 or compatible format.

The work requirements outlined above and as shown on the Construction Drawings include furnishing materials, labor, quality control testing, construction machinery and services for construction of the facility as outlined in the Construction Drawings and these Technical Specifications.

The Lining Contractor's construction layout drawings shall be submitted for approval and shall specify all components and details required to meet these Technical Specifications. The responsibility of the Owner and the Lining Contractor shall be clearly indicated.

1.5 Standards and Test Methods

All tests performed shall be in accordance with the current edition of the ASTM Testing Standards or other Standards as indicated below.

- ASTM D638 Standard Test Method for Tensile Properties of Plastics
- ASTM D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- ASTM D882 Standard Test Method for Tensile Properties of Thin Plastic Sheet
- ASTM D1004 Standard Test Method for Initial Tear Resistance of Plastic Film and Sheet
- ASTM D1204 Standard Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheet or Film at Elevated Temperatures
- ASTM D1238 Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
- ASTM D1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique
- ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics
- ASTM D3895 Standard Test Method for Oxidative Induction Time of Polyolefins by Differential Scanning Calorimetry
- ASTM D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
- ASTM D4354 Standard Practice for Sampling of Geosynthetics for Testing
- ASTM D4437 Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
- ASTM D4439 Standard Terminology for Geosynthetics
- ASTM D4759 Standard Practice for Determining the Specification Conformance of Geosynthetics
- ASTM D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- ASTM D5084 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
- ASTM D5199 Standard Test Method for Measuring the Nominal Thickness of Geomembranes

- ASTM D5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
- ASTM D5323 Standard Practice for Determination of 2% Secant Modulus for Polyethylene Geomembranes
- ASTM D5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
- ASTM D5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geomembranes
- ASTM D5617 Standard Test Method for Multi-Axial Tension Test for Geosynthetics
- ASTM D5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
- ASTM D5885 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
- ASTM D6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
- ASTM D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
- GRI GM11 Standard Specification for Accelerated Weathering of Geomembranes using a Fluorescent UVA-Condensation Exposure Device
- GRI-GM13 Standard Specification for Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
- GRI-GM14 Standard Specification for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes

1.6 Submittals

The Lining Contractor shall submit the following to the Engineer and Owner prior to mobilization onto the project site.

1.6.1 Qualifications

Prior to the start of work, the FML Manufacturer and the Installation Contractor each shall submit, for approval by the Engineer and the Owner, documented evidence of their ability and capacity to perform this work. The evidence must address manufacturing capabilities and available personnel. Lining materials shall be obtained from an approved North American manufacturer.

The Contractor shall submit the name and qualifications of the project superintendent that will be on the project whenever lining materials are being handled and installed plus the names and qualifications of senior installation personnel on the project.

The Lining Manufacturer and the Contractor each shall submit a complete description of their quality control program, as applicable, for manufacturing, handling, installing, testing, repairing and providing a completed lining in accordance with requirements of these Technical Specifications. The description shall include, but not be limited to, polymer resin supplier, product identification, acceptance testing, fabrication and production testing, installation testing, documentation of changes, alterations and repairs, retests and acceptance.

The Lining Manufacturer and the Contractor each shall have successfully manufactured and/or installed a minimum of ten (10) million square feet of similar lining material in liquid/solid waste containment structures.

The lining placement superintendent shall have successfully supervised the installation of a minimum of five (5) million square feet of HDPE lining material in liquid/solid waste containment structures.

The Lining Manufacturer shall provide on-site technical supervision and assistance at all times during installation of the lining system. The Lining Manufacturer and the Contractor, as applicable to each, shall submit for approval by the Engineer and the Owner written certification that the lining system was installed in accordance with the Lining Manufacturer's recommendations, the approved Construction Drawings and Technical Specifications, and approved submittals.

The Contractor shall make arrangements with the Lining Manufacturer to allow the Engineer and Owner to visit the manufacturing plant during manufacture of the lining materials for this project, in order to observe manufacturing methods and quality control of manufactured materials. The Contractor is not responsible for expenses incurred by the Engineer and Owner for their visits to the manufacturing plant.

The Engineer and the Owner will conduct a pre-construction meeting with the Lining Contractor and the Earthwork Contractor prior to installation of the lining system. Topics for review and discussion shall include, as a minimum, Construction Drawings and Technical Specifications, approved submittals, training and qualifications procedures for Contractor personnel, and daily production.

1.6.2 Samples

Submit for approval samples of the liner material proposed for use.

1.6.3 Shop Drawings

Submit for approval, as soon as practicable after award of the contract, three (3) sets of full and complete shop and installation drawings showing a minimum of:

- Layout of liner system.
- Details of jointing, liner system and liner anchorages.

1.6.4 Certificates

Certificates of compliance with the requirements of standards and testing methods specified herein shall be submitted for each roll of material prior to delivery. The certificates of compliance shall clearly indicate the roll or rolls of material that they represent. The liner material manufacturer must satisfy by affidavit to the Lining Contractor, the Engineer and the Owner that the material he offers to furnish will meet, in every respect, the requirements set forth in these Technical Specifications. The Lining Contractor shall transmit to the Engineer and the Owner the affidavit given him by the manufacturer or supplier prior to approval for the furnishing and installing of any such material.

1.6.5 Schedules

The Lining Contractor shall submit a schedule detailing the liner fabrication and installation. The Lining Contractor shall work in coordination with the Earthwork Contractor so that the placement of lining will follow, in orderly sequence, the progression of the project.

1.7 Delivery, Storage & Handling of Materials

1.7.1 Delivery

Materials shall be delivered to the site after the Engineer has approved the required submittals.

1.7.2 Storage and Handling

Storage and handling of the materials shall conform to the Manufacturer's recommendations and shall be done in such a manner so as to prevent damage to any part of the work. The Lining Contractor shall be responsible for unloading, storage and handling of materials. Any unloading and handling performed by the Owner will be back-charged to the Lining Contractor.

1.8 Verification of Areas to Receive Geomembrane Liners

Prior to installation of the liner, the Lining Contractor shall, in the presence of the Earthwork Contractor, the Inspector and the Owner, inspect and verify the conditions of the specified area as adequate for placement of the liner. Finished surface preparation specifications are outlined in Part I, Sections 3 and 7. Following the verification of the surface, the Lining Contractor shall sign an acceptance form and assumes full responsibility for the verified area should conditions be altered by occurrences outside the control of the Earthwork Contractor.

1.9 Liner Testing

Trained quality control personnel of the Lining Contractor shall perform destructive and nondestructive testing. Quality Control procedures are specified in Section 3.

1.10 Warranty

The Lining Contractor shall submit a proposed warranty with the bid proposal. Terms and conditions of the warranty are to be agreed upon between the Owner and the Lining Contractor.

2. INSTALLATION SPECIFICATIONS

2.1 Inspection of Sheet Liner at Job Site

The Lining Contractor shall be responsible for inspection of the sheet rolls at the job site. Should rolls show damage from transit, they will be so identified by the Lining Contractor and set aside.

During unrolling of the lining material, the Lining Contractor will carry out visual inspection of the sheet surface. Any faulty areas shall be marked and repaired by the Lining Contractor in a manner that is acceptable to the Engineer.

2.2 Finished Grade

The finished grade surfaces in contact with the geomembrane liner shall be smooth and free of angular gravel, objectionable gravel over $\frac{3}{4}$ -inch in size, or hard objects within 4-inches of the surface. The surface shall have no sudden, sharp or abrupt changes or breaks in grade.

2.3 Liner Placement

The geomembrane shall be laid out and installed by trained technicians in accordance with the Construction Drawings; the layout and details as presented in the approved shop drawings; and in accordance with the Manufacturer's requirements. The lining layout shall be designed to minimize the number and length of field joints, consistent with proper methods of liner installation. The liner shall be oriented to minimize stress on the field seams. Liner panels shall be laid out such that the seam is oriented longitudinally with the grade and not along the contours (the field seam shall be oriented up and down the slope or grade).

The liner shall be installed such that foot traffic is minimized and no vehicle traffic crosses the liner. Heavy generators and All Terrain Vehicles (ATVs) will not be allowed to travel on the liner surface. The liner shall have no cuts, nicks, abrasions, holes, tears or insufficient HDPE joints which could leak or develop into leaks after installation is complete. Any holes, tears or suspect material or joints that occur during installation shall be immediately marked and repaired. The Inspector shall approve repair methods. The Lining Contractor shall have sufficient quality control to detect holes, tears or insufficient joints during installation. Field seams shall have sufficient overlap for proper seaming. Typical overlap shall be a minimum of 4 inches. All field seams shall be 100 percent inspected by the Lining Contractor.

Under no circumstances shall the lining be subjected to materials, sandbags, equipment or other items being dragged across its surface, nor shall workers and others slide down slopes atop the lining. All scuffed surfaces resulting from abuse of any kind caused by the Contractor in performance of the work shall be repaired at no additional cost to the Owner.

Deployed liner shall be secured from damage due to high winds by using sandbags. A sufficient quantity of sandbags shall be placed along unseamed roll and liner edges at intervals no greater than 5 to 6 feet. Sandbags should remain in place on all sheets and edges until the liner is covered. No open seams or holes shall be allowed in the deployed liner at the end of the day.

Liner shall be placed with sufficient slack to prevent excessive lifting of the liner from the subgrade upon contraction. Compensating seams may be required to prevent excessive lifting (trampolines).

2.4 Field Welding

Resin used for extrusion welding to make field seams between HDPE sheets and for repairs shall be HDPE produced from HDPE resin that is fully compatible with the HDPE sheet resin. Physical properties of the resin shall be the same as HDPE lining sheets.

The weld area shall be free of all dirt, dust, moisture or other foreign material. The contact surface of the sheets shall be wiped with clean rags to remove any contamination.

Production field welding shall be performed by a double-wedge fusion welding process or an equivalent method approved by the Engineer. Small areas, such as butt joints and repairs, shall be completed by an extrusion fusion welding process. A sample weld shall be made prior to the start-up of each shift, every time personnel are changed, at work stoppages of 30 minutes or more, or at the request of the Inspector. Sample welds shall be made under ambient conditions, from each welding machine, prior to commencement of production welding. Test welds shall be a minimum of 5 feet in length for extruded seams and 10 feet long for hot wedge seams. Test weld samples shall be tested in shear and peel. Sample approval by the Inspector and the Lining Contractor must be made before production welding may begin. For extrusion welded seams, the edge of the FML shall be beveled and cleaned of oxidation on surfaces to receive extrudate by disk grinding or equivalent not more than one hour before seaming.

All 'T' joints shall be capped. Cap-patches shall extend a minimum of 6 inches beyond the intersection of the joint and shall be extrusion welded and vacuum tested. No open seams or holes or Leister patches shall be allowed in the deployed liner at the end of the day.

All field test welds and production welds shall have bonded seam (shear) strength equal to a minimum of 95 percent of the tensile strength of the HDPE parent material when tested in accordance with ASTM D6392 and shall have a film tearing bond failure. Peel tests shall have a minimum strength of 62 and 72 percent (extrusion welds and fusion welds, respectively) of the tensile strength of the HDPE parent material when tested in accordance with ASTM D6392 and shall exhibit a film tearing bond failure. The values for seam testing criteria for HDPE are presented in Section 3.4.1. A film tearing bond (FTB) failure is defined as a failure of one of the sheets by tearing, instead of separating from the other sheet at the weld interface area. A separation greater than 10 percent of the width of the weld cross-section shall constitute a non-FTB failure.

Both weld interfaces on double-wedge welds shall be tested. Four (4) out of the five (5) test coupons tested in shear and peel must meet or exceed the values presented in Section 3.4.1 and the fifth sample shall meet or exceed 80% of the given values to constitute a passing test. Both weld interfaces on double-wedge welds shall be tested.

The minimum tensile strength of the parent material is defined to be equal to the value specified in Section 3.2.

3. QUALITY CONTROL

3.1 Raw Material

Raw material shall be first quality, virgin polyethylene resin and shall be tested in the laboratory prior to acceptance during production, and shall meet or exceed the minimum requirements as stated herein. Raw materials shall also meet or exceed the manufacturer's published typical or average lot specifications, if they exceed the requirements stated herein.

The manufacturer shall perform conformance testing to demonstrate that the raw material meets the minimum requirements. Prior to delivery of material to the project site, the manufacturer shall submit the following information for each batch of raw resin utilized in the manufacture of roll goods.

- Resin suppliers name.
- Resin identification.
- Production date.
- Quality control certificates issued by the resin supplier.
- Manufacturer's compliance test results.

3.2 Roll Goods

3.2.1 General

Roll goods shall meet or exceed the minimum requirements for HDPE as stated herein. Finished roll goods shall also meet or exceed the manufacturer's published specifications and these specifications.

Prior to delivery, the manufacturer shall submit a Quality Control Certificate for each roll of material. These certificates shall clearly indicate the roll or rolls that the results represent. Roll goods shipped to the project site that do not meet or exceed the manufacturer's published specifications and the specifications stated herein shall be rejected. The Quality Control Certificate shall include the following information:

- Roll number and identification.
- Results of quality control tests.

3.2.2 60-Mil Smooth HDPE Geomembrane

Tests to be performed and minimum specifications shall include, but not be limited to, the following:

Smooth HDPE Specification		
Property	Test Method	60-mil
Thickness (min. ave.)	ASTM D5199	Nominal
Lowest individual of 10 values	& GRI-GM 13	Minus 10%
Density (min.)	ASTM D1505/D792	0.94 g/cc
Tensile Properties ⁽¹⁾ (min. ave.)	ASTM D6693	
Yield strength	Type IV	126 lb/in.
Break strength	(both directions)	228 lb/in.
Yield elongation	1.3" gauge	12%
Break elongation	2.0" gauge	700%
Tear Resistance (min. ave.)	D1004	42 lb
Puncture Resistance (min. ave.)	D4833	108 lb
Stress Crack Resistance ⁽²⁾	D5397 (App.)	300 hr.
Carbon Black Content (range)	D1603 ⁽³⁾	2.0 – 3.0%
Carbon Black Dispersion	D5596 & GRI-GM13	Note (4)
Oxidative Induction Time (OIT) (min. ave.) ⁽⁵⁾		
(a) Standard OIT or	D3895	100 min.
(b) High Pressure OIT	D5885	400 min.
Oven Aging at 85° C (min. ave.) % retained after 90 days ^{(5) (6)}	D5721	
(a) Standard OIT or	D3895	55%
(b) High Pressure OIT	D5885	80%
UV Resistance (min. ave.) ⁽⁷⁾	GRI-GM11	
(a) Standard OIT or	D3895	N.R. ⁽⁸⁾
(b) High Pressure OIT-% retained after 1600 hrs. ⁽⁹⁾	D5885	50%
<p>(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gage length of 1.3 inches Break elongation is calculated using a gage length of 2.0 inches</p> <p>(2) The yield stress used to calculate the applied load for the SP-NCLT test should be the manufacturer's mean value via MQC testing.</p> <p>(3) Other methods such as D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.</p> <p>(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.</p> <p>(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.</p> <p>(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.</p> <p>(7) The condition of the test should be 20 hr. UV cycle at 75° C followed by 4 hr. condensation at 60° C.</p> <p>(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.</p> <p>(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.</p>		

3.3 Conformance Testing

Conformance testing shall be conducted by a third party laboratory to statistically measure conformance of the HDPE roll goods shipped to the project.

3.3.1 Testing Requirements

The following are the minimum tests that shall be performed as part of the conformance testing program.

Property	Test Method
Density	ASTM D1505
Melt Flow Index	ASTM D1238
Thickness	ASTM D5199 & GRI-GM13
Carbon Black Content	ASTM D1603
Tensile Properties Stress at yield Stress at break Elongation at yield Elongation at break	ASTM D6693 Type IV (both directions)

3.3.2 Sampling Procedures

Samples shall be taken at a rate of one per lot or one per 100,000 square feet of roll goods shipped to the project, whichever results in the greater number of tests. Rolls shall be selected at random for testing.

Samples shall be removed from the roll at a random location, but shall not include any area within the first 3 lineal feet of the end and/or edge of the roll. The sample shall be a minimum of 1.5 feet by 3 feet in size and shall be marked with an arrow to indicate the machine direction and the Lining Manufacturers roll and lot identification number.

3.3.3 Test Results

The Engineer shall review the test results for project compliance and shall provide a written report to the Owner.

3.3.4 Procedures for Conformance Test Failure

Should any test results indicate non-conformance with the Technical Specifications, the nonconforming roll number shall be identified and additional conformance testing shall be performed on rolls with adjacent numbers. All non-conforming rolls shall be identified and set aside. The cost for additional conformance testing due to test results that indicate non-conformance shall be borne by the Lining Contractor.

3.4 Field Seam Testing

3.4.1 General

The Lining Contractor and the Inspector shall carefully inspect each seam after the welding operations have been completed. Suspected discrepant areas shall be identified with a contrasting marker. A CQA sampling and testing guide is presented in Table II-1.

Destructive shear and peel tests shall be performed on samples of field seams every 500 lineal feet of seam for each welder used during that day. The actual location of seam tests will be randomly determined in the field by the Inspector.

Table II-1
Liner CQA Sampling and Testing Guide

Material	Tests	Frequency
60-mil HDPE geomembrane liner	1. Destructive shear and peel tests (minimum).	1. Every 500 lineal feet of seam for each welding machine (randomly located).
	2. Air pressurization testing, vacuum testing, or equivalent method. (Performed by Lining Contractor and observed by the Inspector.)	2. Entire length of field welded seams.

All field test welds and production welds shall have bonded seam (shear) strength equal to a minimum of 95 percent of the tensile strength of the HDPE parent material when tested in accordance with ASTM D6392 and shall have a film tearing bond failure. Peel tests shall have a minimum strength of 62 and 72 percent (extrusion welds and fusion welds, respectively) of the tensile strength of the HDPE parent material when tested in accordance with ASTM D6392 and shall exhibit a film tearing bond failure. The values for seam testing criteria for HDPE are presented in Section 3.4.1. A film tearing bond (FTB) failure is defined as a failure of one of the sheets by tearing, instead of separating from the other sheet at the weld interface area. A separation greater than ten (10) percent of the width of the weld cross-section shall constitute a non-FTB failure. Both weld interfaces on double-wedge welds shall be tested. Four (4) out of

the five (5) test coupons tested in shear and peel must meet or exceed the values presented in the table and the fifth sample shall meet or exceed 80% of the given values to constitute a passing test. Both weld interfaces on double-wedge welds shall be tested.

Geomembrane Seam Strength Criteria

Destructive Seam Samples ⁽²⁾	ASTM D4437/D6392	60-mil (ppi width)
HDPE – Smooth and Textured		
Fusion Weld – Shear	95 percent of the parent strength at yield & FTB ⁽¹⁾	120
Fusion Weld – Peel	72 percent of the parent strength at yield & FTB ⁽¹⁾	91
Extrusion Weld Shear	95 percent of the parent strength at yield & FTB ⁽¹⁾	120
Extrusion Weld – Peel	62 percent of the parent strength at yield & FTB ⁽¹⁾	78
Notes: 1) FTB: A film tearing bond is defined as a failure through the parent material while achieving a separation of less than 10 percent. 2) Four out of the five test coupons tested in shear and peel must meet or exceed the values presented in the table and the fifth sample shall meet or exceed 80% of the given values to constitute a passing test. Both weld interfaces on double-wedge welds shall be tested.		

The minimum tensile strength of the parent material is defined to be equal to the value specified in Section 3.2. Copies of the results of these tests shall be submitted to the Lining Contractor, the Engineer and the Owner. Approval of test results must be obtained prior to final acceptance.

The Lining Contractor's Quality Control inspector shall mark, log and identify each type and location of repair to be made at all discrepant areas. No open seams or holes or Leister patches shall be allowed at the end of the day.

The Engineer and the Owner shall have the right to reject any field made seam for cause at no cost to the Owner. Cause shall be defined to include poor workmanship, defective welds and insufficient overlap of panels. Any field made seam rejected for cause shall be repaired or replaced to the satisfaction of the Engineer at no additional cost to the Owner.

The entire length of each field-welded seam shall, under the observation of the Inspector, be tested by air pressurization of the unwelded test channel to a minimum pressure of 30 psi for a minimum duration of 5 minutes. A pressure drop greater than 2 psi is indicative of a failing test. Patches and extrusion welds shall be tested by vacuum methods with a minimum vacuum pressure equal to 8 inches of mercury (4 psi), or by an equivalent method approved by the Engineer.

3.4.2 Procedure in the Case of Destructive Test Failure

In the case that a destructive seam test fails in either shear or peel, the entire length of seam represented by this test is in question. As a minimum, the procedure for destructive test failures shall be as follows:

- A. The Lining Contractor shall provide the Engineer with two additional destructive test samples spaced a minimum of 150 feet on either side of the failed test.
- B. The Engineer and the Owner reserve the right to take additional samples as warranted to adequately assess the quality of the work.
- C. From each destructive test sample, ten test coupons will be cut. Five of these samples will be tested for seam shear strength and five will be tested for peel strength. Both weld interfaces on double wedge welds shall be tested. A passing test for destructive samples is defined in Section 3.4.1..
- D. If passing tests are achieved from the tracking samples obtained in Item A, the 300 feet of seam represented by the passing tests is in question. Additional samples at closer intervals can be taken or the 300 feet of seam shall be capped.
- E. If a failing test occurs at the new destructive test location, an additional test will be taken at a minimum of 50 feet from the failed test. This procedure is repeated until the failed section is fully defined or the edge of the seam that was originally represented by the original test is reached.
- F. If passing tests are achieved at the minimum 150-foot distance from the failed destructive test, additional destructive tests may be taken at a closer spacing from the failed test at the discretion of the Lining Contractor. If the tests at the closer interval fail, additional destructive tests at a wider interval shall be taken until the length of failed seam is fully defined.
- G. Once the length of defective seam is identified, the Lining Contractor shall either cut out the defective seam and wedge weld a new piece of liner in the seam area; or install a cap-patch strip over the affected seam area. Cap-patches shall be a minimum of 3 feet in width and shall be centered over the defective seam. Extrusion welding the exposed flap of liner on wedge welded seams or additional extrusion welding of extrusion-welded seams shall not be allowed.
- H. An additional destructive test sample shall be taken within the repaired area and tested in accordance with Item C. Nondestructive testing by appropriate methods shall also be performed within the repaired area.

- I. In the case that the retest of the repaired area fails, the procedure described above shall be repeated until passing tests are achieved.

4. CONSTRUCTION QUALITY ASSURANCE

4.1 Construction Observations

The Engineer shall be the interpreter of the site construction specifications, and shall make observations and tests as considered necessary to assess and accept the quality of the work. Inspectors shall make continuous observations and tests of construction operations under the direction of the Engineer.

The Owner shall be responsible for verification of lines and grades prior to acceptance of the completed work. The Lining Contractor shall be responsible for any surveying required during liner placement. The Lining Contractor shall also be responsible for the preparation of as-built drawings.

4.2 Quality Assurance Reports

The Engineer shall submit reports of observations and tests made by the Inspectors to the Owner. The reports shall be submitted to the Owner in a timely fashion.

A copy of all test results will be maintained at the construction site, and shall include the following:

- Date issued.
- Project title and number.
- Date of testing and/or sampling.
- Designation of material tested.
- Type of test and specification.
- Location of test.
- Observations regarding compliance or noncompliance with the Construction Drawings and Technical Specifications.

Upon completion of construction, the Engineer shall submit a Final Quality Assurance Report stating that the project was completed in substantial conformance with the approved Construction Drawings and Technical Specifications and presenting test summaries, record drawings and other supporting data necessary to document the completed construction.