September 1, 2015

Mr. Bryan Leamons, Engineer Supervisor
Solid Waste Division
Arkansas Department Environmental Quality
5301 Northshore Drive
North Little Rock, AR 72118-5317

Rec'd Digitally

AFIN: 25-00028

PMT#: 0299-S1

RECEIVED
By Barbara J. Mathews at 11:54 am, Sep 01, 2015

DOC ID#: 68057

TO: BL> file

SWMD

SUBJECT: **Notification of Construction – Cell B2**
Cherokee Class 1 Sanitary Landfill
Cell B2 Construction
Permit No. 0299-S1; AFIN: 25-00028

Dear Mr. Leamons:

Terracon Consultants, Inc. (Terracon) is providing this notification of construction on behalf of the IESI Cherokee Village Landfill (Facility), located near Cherokee Village, Arkansas. IESI is constructing Cell B2 at the existing Class 1 Landfill. Terracon and the Facility are notifying the Arkansas Department of Environmental Quality (ADEQ), in accordance with Reg.22.428(f) of Regulation 22 of the proposed construction schedule. The earthwork contractor anticipates beginning excavation to Subgrade on September 1, 2015, pending the weather. Below is the proposed schedule of construction events.

RESPONSIBLE PARTIES	DATES
Earthwork Contractor (Twehouse Construction, Inc.)	9/01/15 – 10/16/15
CQA Services (Terracon Consultants, Inc.)	9/01/15 – 10/16/15
Surveying (Harmon Surveying)	9/01/15 – 10/16/15
Geosynthetics Installer (Commanco)	9/16/15 – 10/7/15

Note: This schedule is tentative and may change due to weather delays.

The test fill is not required from Reg.22.428(c)(11) since the compacted clay liner for Cell B2 is being replaced with a geosynthetic clay liner. Also, Drawing 11 shows the detail of an optional temporary rain-flap. The sole purpose of the temporary rain-flap is to reduce the amount of stormwater getting into the cells collection system. A construction certification report documenting construction activities will be submitted to the ADEQ upon completion of construction.

If you have any questions or comments, please feel free to contact me at dcmccormick@terracon.com or 501-847-9292 at your convenience.

Sincerely,

Terracon

David C. McCormick, P.E.
Senior Project Manager

F. Owen Carpenter, P.E., P.G.
Engineering Department Manager

Cc: Brady Stewart, Progressive Region Engineer
Ronnie Black, Sr., Facility Manager
Attachments: Contractor Experience, Construction Plans and Specifications

N:\Projects\2015\35157094\Working Files\Cell B2 CQA\Notification\ADEQ Notification Narrative Cell B2 9.1.15.doc

SECTION V
TECHNICAL SPECIFICATIONS

Technical Specifications

Cherokee Class 1 Sanitary Landfill
Cell B2 Construction
Fulton County, Arkansas

July 2015
Project No. 35157094

Prepared for:
IESI – AR Landfill Corporation
Cherokee Sanitary Landfill
300 Landfill Road
Cherokee Village, AR 72529
(870) 994-7717

Prepared by:
Terracon Consultants, Inc.
25809 Interstate 30 South
Bryant, Arkansas 72022
(501) 847-9292

TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS

SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

- Description of Payment Items
- Work Covered by Contract Documents.
- Work by Others.
- Work Sequence.
- Existing Site Conditions.
- Contractor's Use of Premises.
- Erosion and Sediment Controls.
- Temporary and Permanent Seeding.
- Interim Stormwater Run-on and Run-off Controls.

1.02 DESCRIPTION OF PAYMENT ITEMS

A. The Earthwork Contractor and Geosynthetic Installer shall be responsible for their respective work as described in this document and as indicated in the construction drawings. Payment for work will be made as indicated in the pay items listed below. Payment will be made based upon in-place quantities and will be verified by a Registered Land Surveyor. A ten (10) percent retainer will be applied to each of the monthly invoices. The retainer will be paid in full upon completion of the project and once a Receipt, Waiver, and Release of Lien Rights is executed. Any work, which the Earthwork Contractor believes not to be covered by one of these pay items shall be addressed in the bid, submitted to the Owner.

The Earthwork Contractor and Geosynthetic Installer shall take all necessary actions needed to meet the proposed schedule, taking into account weather as could be expected for the project area and season. Unless otherwise approved by the Owner, construction activities at the site and material deliveries to the Facility shall be limited to hours approved by the Owner.

1.03 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work consists of, in general, construction of landfill waste area, leachate collection system, and storm water control structures at the Cherokee Landfill facility located near Cherokee Village, Arkansas.

B. The following bid items correspond to the drawing set entitled *Construction Drawings for the Cherokee Class 1 Landfill Facility, Proposed Cell B2.*

B1. **Mobilization/Demobilization –** The Earthwork Contractor shall mobilize all equipment, materials, personnel, etc. to the site and demobilize after completion of construction, leaving allocated work areas, including borrow sources, haul roads and stockpiles, in a satisfactory condition. The Owner is not responsible for assisting the Contractor with unloading or loading of any materials or equipment. In addition to unloading geosynthetic liner materials, the Contractor shall be responsible for storing and protecting the materials from weather. Assume one mobilization for the project.

The Earthwork Contractor shall be responsible for providing all necessary equipment and labor to control and pump storm water within the limits of the construction area for the duration of the project. The Work includes all steps necessary to maintain compliance with the Owners NPDES Storm water Permit ARG160025. The Contractor shall manage (including fuelling) the existing storm water pump provided by the Owner. The Owner will provide necessary maintenance except for instances where the product has not been properly used; if it has been disassembled, modified, abused or tampered with; if the electrical cord has been cut or spliced; if the pump discharge has been reduced in size; or any other instance of neglect.

The Lump Sum Price for Mobilization and Demobilization shall be payment in full for all labor, equipment, material and other incidentals to the site, as well as Contractor provided utilities and ongoing related expenses, considered normal for administration of the work. Fifty (50) percent of the Lump Sum price bid will be paid with the first payment request following satisfactory evidence of mobilization of sufficient labor, equipment and material to adequately progress the work of this contract. The remaining fifty (50) percent of the Lump Sum price bid will be paid with the Final Payment request after satisfactory substantial completion of the *Construction of Cell B2*. The total price paid for this item in the first

installment shall not exceed six (6) percent of the original Contract amount for the Contract. Assume one mobilization for the project.

B2. **Cell B2 Excavation, Stockpiling, and Backfilling** – The Earthwork Contractor shall excavate, haul, place, grade, and compact subgrade in accordance with the Contract Drawings and Technical Specifications within the limits of the Cell B2 liner system. The cut material can be stockpiled at the discretion of the site manager. The Contractor shall be responsible for verifying these quantities, as they are only provided as estimates.

The Contract Price for Subgrade shall be for placed and compacted fill, including all labor, material, equipment, and other incidentals, such as, excavating, moving, placing and segregating, stockpiling, stockpile grading and maintenance, dewatering, and erosion and sedimentation control materials and practices as required to comply with the Drawings and Specifications (unless specifically identified as a pay item).

B3. **Rock Removal –** The Earthwork Contractor shall remove the large rock that is currently in the Cell B2 footprint and relocate it as directed by site personnel.

B4. **Liner Tie-In Preparation** – The Earthwork Contractor shall remove protective cover soils to reveal a minimum of 5 feet of 60-mil HDPE geomembrane for tie-in with existing landfill Cell A5S (north side) and Cell B1 (east side). The Contractor shall provide smooth, continuous transitions between previously-existing and newly-installed liner. The Contractor shall also maintain a clean tie-in that is suitable for geosynthetics installation.

The Contract Price for Cell B2 tie-in shall be full compensation for approved tie-in, including all labor, material, equipment, and other incidentals, such as, excavating, grading, maintenance, and erosion and sedimentation control materials and practices as required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item).

B5. **Compacted Clay Liner** – The Earthwork Contractor shall excavate from onsite borrow source or from mass excavation, haul, place, and compact the 24-inch thick recompacted clay liner above the subgrade of Cell B2 in accordance with the Contract Drawings and Technical Specifications. Hydraulic conductivity values must be less than or equal to 1.0×10^{-7} cm/sec as determined by ASTM D5084.

The Contract Price for the Clay Liner shall be for placed and compacted clay liner material, including all labor, material, equipment, and other incidentals, such as, excavating, moving, placing and segregating, stockpiling, stockpile grading and maintenance, dewatering, and erosion and sedimentation control materials and practices as required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item).

B6. **Temporary Liner Termination Berm** –The Contractor shall provide smooth, continuous transitions between the installed clay liner and the termination berm.

The Contract Price for Cell B2 termination berm shall be full compensation for approved berm, including all labor, material, equipment, and other incidentals, such as, excavating, grading, maintenance, and erosion and sedimentation control materials and practices as required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item).

The 40 mil smooth will be supplied by the Owner. The client currently has approximately 19,205 SF of 40 mil smooth on site. The Contractor will construct the east and south side berms for Cell B2. The installer will be responsible for the installation of the rainflap. The pay quantity will be linear foot based on the centerline of the berm.

B7. **Geosynthetic Anchor Trench** – The Earthwork Contractor shall excavate, backfill, and compact the geosynthetics anchor trench to the lines and grades shown on the Contract Drawings and in accordance with the Technical Specifications. The construction of the anchor trench shall be coordinated with the Geosynthetics Installer.

The Contract Price for anchor trench shall be full compensation for anchor trench, including all excavation, backfill, compaction, labor, material, equipment, and other incidentals. Payment for this task shall be on a lump sum basis for the price provided in the bid form.

B8. **Geomembrane, 60-mil HDPE (Textured)** – The Geosynthetic Installer shall install the geomembrane according to the Contract Drawings and in accordance with the Technical Specifications. The Client will supply the geomembrane. The client currently has 46,460 SF of 60 mil textured geomembrane on site.

The Contract Price for geomembrane installation shall include all installation, testing, equipment, and other incidentals.

B9. **Geocomposite, Double sided** – The Geosynthetic Installer shall install the geocomposite according to the Contract Drawings and in accordance with the Technical Specifications. The Client will supply the geocomposite. The client currently has 32,900 SF of double sided geocomposite on site.

The Contract Price for geocomposite shall include all installation, equipment, and other incidentals.

B10. **Leachate Collection Pipe** – The Earthwork Contractor shall furnish and install gravel leachate collection line in conjunction with the gravel drains and the protective cover that connect into Cell B1. The unit cost for this item includes all materials including pipe, gravel, and geotextile. Final Payment will be based on survey information.

B11. **Gravel Chimney Drains** – The Earthwork Contractor shall install the chimney drains above the geocomposite as shown on the Contract Drawings, and in accordance with the Technical Specifications. The client will supply the geotextile.

The Contract Price for the Chimney Drain shall including all labor, material, equipment, and other incidentals, such as, excavating, moving, placing and grading, stockpiling, stockpile grading and maintenance, dewatering, and practices as required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item).

B12. **Protective Cover Layer** – The Earthwork Contractor shall excavate from onsite stockpile, haul, and place 12-inch thick protective cover material above the geocomposite as shown on the Contract Drawings, and in accordance with the Technical Specifications. The Earthwork Contractor may use off-site material that meets the requirements of Section 02226 of the Specifications such that the gravel chimney drains are not required.

The Contract Price for the Protective Cover shall be full compensation for placed and graded protective cover material, including all labor, material, equipment, and other incidentals, such as, excavating, moving, placing and grading, stockpiling, stockpile grading and maintenance, dewatering, and practices as required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item).

C. BID ALTERNATES

GCL Option

A1. **Cell B2 Excavation, Stockpiling, and Backfilling** – The Earthwork Contractor shall excavate, haul, place, grade, and compact subgrade in accordance with the Contract Drawings and Technical Specifications within the limits of the Cell B2 liner system. The cut material can be stockpiled at the discretion of the site manager. The Contractor shall be responsible for verifying these quantities, as they are only provided as estimates.

The Contract Price for Subgrade shall be for placed and compacted fill, including all labor, material, equipment, and other incidentals, such as, excavating, moving, placing and segregating, stockpiling, stockpile grading and maintenance, dewatering, and erosion and sedimentation control materials and practices as required to comply with the Drawings and Specifications (unless specifically identified as a pay item)

A2. **Subgrade Preparation** – The Earthwork contractor will prepare the subgrade for the GCL. The subgrade must be smooth rolled and maintained in a smooth, uniform, and compacted condition prior to GCL placement. Rough or uneven surfaces, surfaces with protrusions or ruts, puddled water or soil with particle sizes greater than 1-inch must be fixed prior to GCL placement.

A3. **Geosynthetic Clay Liner (GCL)** – The Geosynthetic Installer shall install the GCL according to the Contract Drawings and in accordance with the Technical Specifications. The Client will supply the GCL.

The Contract Price for GCL installation shall include all installation, testing, equipment, and other incidentals.

Optional Construction Items

B1. **Landfill Operation Road** – The Earthwork Contractor shall supply and install an operation road on the east side of the facility in accordance with the Contract Drawings and Technical Specifications. The Contractor shall furnish all incidentals required for the construction of the operation road and gravel paving. It is also the responsibility of the contractor to supply all labor, and equipment, and material necessary to maintain Landfill operation roads during construction of Cell B2. The Contractor shall be responsible for repairing Landfill roads back to preconstruction conditions

upon completion of cell construction. The soil has already been placed on the top of the landfill near the road construction. The gravel has already been delivered to the site.

The Contract Price for gravel paving shall be full compensation for gravel paving, including all labor, material, equipment, and other incidentals, such as haul road construction and maintenance, dewatering, stockpile grading and maintenance, and erosion and sedimentation control materials and practices as required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item).

1.05 WORK SEQUENCE

Sequencing of the Work shall be the responsibility of the Contractor as long as the requirements of these specifications are met, the Contractor's progress is according to the schedule approved by the Engineer and Owner, and compliance with Contract Times stated in the Agreement are met.

1.06 EXISTING SITE CONDITIONS

The IESI Cherokee Class 1 Landfill is an active disposal facility. Construction operations shall not disturb normal landfill operations.

1.07 CONTRACTOR'S USE OF PREMISES

A. All of the Contractor's operations on the Owner's premises, including the storage of materials, shall be confined to areas approved by the Owner or Engineer.

C. The Owner and Engineer will not assume responsibility for damages to facilities on the site due to negligence or carelessness on the part of the Contractor. The Owner and Engineer will not be liable for loss or damage of Contractor's tools equipment or materials due to theft, vandalism or any other causes whatsoever.

1.08 EROSION AND SEDIMENT CONTROLS

Temporary measures to control soil erosion and sediment transport within the construction limits shall be constructed.

1.09 TEMPORARY AND PERMANENT SEEDING

A stand of grass shall be established on all areas disturbed by construction within the construction limits.

1.10 INTERIM STORMWATER RUN-ON AND RUN-OFF CONTROLS

A. Stormwater management system improvements as shown on the Drawings shall be constructed.

B. Related Sections:

1. Section 02200 - Earthwork
2. Section 02223 - Trenching, Backfilling, and Compacting

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

NOTE:
At all times this landfill facility must remain in compliance with laws and regulations governing the operation and construction of such a facility. Accordingly, the CONTRACTOR must at all times sequence their work and implement the necessary temporary facilities or activities to maintain the proper operation and compliance of this facility. Furthermore, all of the CONTRACTOR's activities must be completed while focusing on the proper management of stormwater, landfill leachate and dust control. The Drawings provide the overall scope of work. It is the CONTRACTOR's responsibility to review and understand the necessary tasks required to complete the work. The CONTRACTOR may need to implement steps not necessarily shown on the Drawings in order to maintain landfill operations and landfill compliance. The CONTRACTOR is responsible for all bid items noted on the Bid Sheet and must complete all the work shown on the Drawings while maintaining the landfill operation and environmental compliance.

END OF SECTION

SECTION 01025
MEASUREMENT AND PAYMENT

PART 1 DESCRIPTION OF WORK

A. The project is specified as the Proposed Cell B2 Construction at the Cherokee Class 1 Landfill in Cherokee Village, Arkansas.

B. Payment shall be made on a Unit Rate basis and only be made for Work as specifically described in these Specifications and the Contract Documents. All other work shall be considered incidental to the Work. No payment shall be made for defective work or work beyond the lines and grades of the required Work.

C. Payment shall only be made for approved, in-place materials and Work, unless specifically permitted otherwise by these Specifications.

PART 2 PRODUCTS

A. Products are defined herein specific to the various aspects of construction. Products are considered to include those purchased and delivered to the site as well as those constructed on the site.

PART 3 EXECUTION

3.01 UNIT PRICE SCHEDULE

A. See Section III, Exhibit A – Schedule of Values - Bid Sheet.

3.02 CONTRACT PAY ITEMS

A. See Section IV, Specification 01010 – Summary of Work.

3.03 INCIDENTALS

A. Some items are considered incidental to the Work and shall not be measured or paid. Items not specifically listed as a pay item are considered incidental.

END OF SECTION

SECTION 01039
COORDINATION AND MEETINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Coordination

B. Pre-construction conference

C. Progress Meetings

1.02 COORDINATION

A. Contractor Shall

1. Coordinate scheduling, submittals, and Work of the various sections of Specifications to assure efficient and orderly sequence of installation of interdependent construction elements.
2. Coordinate work of various sections having independent responsibilities for fabrication, installation, connection to, and placing in service, such equipment.
3. Coordinate space requirements and installation of structural work which are indicated diagrammatically on Drawings.
4. Coordinate completion and cleanup of Work of separate sections in preparation for Substantial Completion.
5. After occupancy of premises by Owner, coordinate access to site for correction of defective Work and Work not in accordance with Specifications, to minimize disruption of Owner's activities.

1.03 PRECONSTRUCTION CONFERENCE

A. Engineer will schedule a pre-construction conference.

B. Agenda:

1. Distribution of Specifications.
2. Finalize estimated progress schedule, Shop Drawing Schedule and schedule of values.

3. Designation of personnel representing the parties in Contract, and the

Engineer.

4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
5. Scheduling.

1.04 PROGRESS MEETINGS

A. Contractor shall:

1. Schedule and administer meetings throughout progress of the Work at intervals specified by the Owner.
2. Make arrangements for meeting, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within two days to Engineer, Owner, participants, and those affected by decisions made.

B. Attendance Required: Contractor, Owner, Engineer, and others as appropriate to agenda topics for each meeting.

C. Agenda:

1. Review minutes of previous meetings.
2. Review of Work in progress.
3. Field observations, problems, and decisions.
4. Identification of problems which impede planned schedules.
5. Review of submittals schedule and status of submittals.
6. Review of off-site fabrication and delivery schedules.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected progress.
9. Planned progress during succeeding work period.
10. Coordination of projected progress.
11. Maintenance of quality and work standards.
12. Effect of proposed changes on progress schedule and coordination.
13. Safety issues relating to Work.
14. Other business relating to Work.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SECTION 01040
COORDINATION

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall coordinate material supply, construction, and inspection to assure efficient and orderly completion of the Work:

B. The Contractor shall notify the Owner in writing when coordination of the Owner's or other contractors' activities is required.

1.02 PROJECT PERSONNEL

A. The Engineer is:
David C. McCormick, P.E.
Terracon Consultants, Inc.
25809 Interstate 30 South
Bryant, Arkansas 72022
(501) 847-9292 email: dcmccormick@terracon.com

B. The Regional Engineer is:
Brady Stewart
IESI – AR Landfill Corporation
300 Landfill Road
Cherokee Village, Arkansas 72529
(314) 486-4733 email: brady.stewart@progressivewaste.com

C. The Surveyor-of-Record is:
Dodd Harmon, P.S.
2310 Ginger Kerry Lane
Conway, AR 72034-8213
(501) 329-5264 email: Dodd Harmon (doddharmon@conwaycorp.net)

D. The Technical/Quality Assurance Representative is:
David C. McCormick, P.E.
Terracon Consultants, Inc.
25809 Interstate 30 South
Bryant, Arkansas 72022
(501) 847-9292 email: dcmccormick@terracon.com

END OF SECTION

SECTION 01050
FIELD ENGINEERING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract including General Conditions, Supplementary Conditions and other Division 1 Sections apply to work of this section. This section applies to work of all sections of the Specifications.

1.02 OWNER'S RESPONSIBILITY

A. The Owner will provide reference dimensions for the Contractor's use in determining and controlling horizontal dimensions and vertical elevations of improvements as follows:

Baseline control and benchmark data as shown on Drawings.

1.03 CONTRACTOR'S RESPONSIBILITY

A. Protect all control points, property pins, right-of-way markers, and elevation bench marks. Replace points disturbed or damaged by Contractor at no additional cost to Owner.

B. Provide additional engineering control surveys as deemed necessary for Contractor's benefit. Employ qualified and approved surveyor, engineer, or engineering technician for field surveys.

C. Provide detailed construction layout staking as required for proper construction of site improvements.

D. Where work requires the removal of property pins, or right-of-way monuments or markers; employ an approved Arkansas Professional Land Surveyor to reference points before they are disturbed and to reset points in their original position and condition after the work in that area is complete.

1.04 CONSTRUCTION LAYOUT STAKING

A. The specifications of this subsection shall be applicable in the event that Contractor employs the Engineer to furnish detailed construction layout staking.

B. Notification and request for Services:

1. Properly coordinate requests for staking services with construction activities so as to preclude inefficient scheduling of staking crews.

2. Notify Engineer a minimum of 48 hours in advance of the date that specific services are desired.

3. Stipulate the particular stakes or marks required giving the specific location and/or limiting stations, offsets and other pertinent information.

4. Requests for services shall be for a minimum of 1,500 linear feet of line.

C. Control Staking:

1. Control stakes which are referenced points for all construction, work shall be conspicuously and visibly marked with flagging tape, paint, or other suitable means.

2. Contractor shall protect all control points and shall replace points disturbed or damaged by Contractor at his expense.

3. Control stakes which are located in the work area and which require removal in order to properly execute work will be referenced and removed at no cost to Contractor.

D. Flagging for Clearing:

1. For utilities, road right-of-way or other proposed improvements presently located in wooded areas, Engineer will flag proposed centerline or one side of right-of-way to be cleared.

2. After clearing and grubbing is completed, the remainder of construction will be staked.

E. Road Alignment and Grade Staking:

1. Contractor is responsible for constructing the proper road cross-section as shown on the Drawings.

2. One set of initial alignment and cut and fill stakes shall be set along one right-of-way for rough grading purposes. Stakes at 100 foot intervals and at other critical points shall indicate cut and/or fill to finished centerline elevation.

3. One set of final hubs shall be set on 100 foot stations along one side of the road and shall indicate finish gravel course alignment and cut and/or fill to top of gravel.

F. Restaking and Checking:

1. Contractor responsible for verifying location and elevation of all reference stakes and all markings noted thereon.

2. At Contractor's request, Engineer shall check validity of any questionable stake. Any stakes found to be in error will be reset at no charge to the Contractor.

3. Engineer not responsible for any standby or "down" time as a result of such checking and/or resetting.

4. All stakes or reference marks described in this section shall be set one time only. Upon written request by Contractor, Engineer will perform restaking at Contractor's expense.

END OF SECTION

SECTION 01051
CONTROL OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. This section includes the control of Work, including:

1. Plans and working drawings;
2. Conformity with plans and specifications;
3. Construction stakes, lines, and grades;
4. Load restrictions;
5. Maintenance of traffic; and
6. Maintenance during construction.

1.02 PLANS AND WORKING DRAWINGS

A. Plans will show such details of all structures, lines, grades, location, and design of all structures and pipelines as are necessary to give the comprehensive idea of the proposed construction. The Contractor shall keep one set of the most current plans available on the project at all times.

B. The plans will be supplemented by such working drawings as are necessary to adequately control the Work.

1.03 CONFORMITY WITH PLANS AND SPECIFICATIONS

A. All Work performed and all materials furnished shall be in conformity with the lines, grades, details, dimensions, and material requirements including tolerances as indicated on the drawings or in the specifications.

B. In the event the Engineer finds the materials, the finished product in which the materials are used, or the Work performed are not in conformity with the drawings and specifications or within tolerances specified on the drawings or in the specifications, and the Engineer finds that this has resulted in an inferior or unsatisfactory product, the Work or materials shall be removed and replaced or otherwise corrected by, and at the expense of the Contractor.

C. In the event the Engineer finds the materials, the finished product in which the materials are used, or the Work performed are not in conformity with the drawings and specifications or within tolerances specified on the drawings or in the

specifications, but that reasonably acceptable Work has been produced, the Engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials.

1.04 CONSTRUCTION STAKES, LINES AND GRADES

A. The Contractor shall be responsible to provide his own construction control stakes to establish lines, slopes, and grades as necessary for layout and completion of the Work. All survey work performed for layout of the site and final grade checks shall be performed by a licensed surveyor of the State of Arkansas. The Surveyor shall have construction experience with projects of similar type and nature to this project.

1.05 LOAD RESTRICTIONS

A. The Contractor shall comply with all legal load restrictions in the hauling of materials on public highways beyond the limits of the project. The Contractor shall be responsible for all damage done by his hauling equipment and his construction activities.

1.06 MAINTENANCE OF TRAFFIC

A. All public and private roads used for haul roads shall be maintained to provide an adequate and safe driving condition for all public and private traffic.

1.07 MAINTENANCE DURING CONSTRUCTION

A. The Contractor shall maintain the Work during construction and until the project is accepted. The maintenance shall constitute continuous and effective work performed day to day with adequate equipment and forces such that all structures are kept in satisfactory condition at all times.

B. The Contractor shall provide all necessary drainage control and diversion structures, and sufficient pumping equipment and manpower to keep the construction area well drained and free of standing water that may adversely impact construction procedures and schedules.

1.08 FUEL STORAGE, WASTE PRODUCTS, TRASH AND DEBRIS

A. The Contractor shall observe all federal, state, and local requirements and regulations regarding the transportation, storage, and containment of fuels.

B. The Contractor shall be responsible for proper containment and labeling of containers, handling and disposal of all waste products and trash from all machinery, vehicles, and any other items used during the Work.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SECTION 01300
SUBMITTALS

PART 1 GENERAL

1.01 SUMMARY

Section includes submittal procedures and types of submittals required prior to the beginning of certain phases of the Work, prior to the incorporation of products in the Work, and during the progress of the Work.

1.02 INITIAL SUBMITTALS

A. Submit the following to the Engineer for review not more than fourteen calendar days after the Effective Date of the Agreement:

1. Preliminary Schedule of Values.
2. Initial Construction Progress Schedule (specified in this Section).
3. Preliminary Schedule of Shop Drawing and Sample Submittals (specified in this Section).
4. Proposed Products List (specified in this Section).

1.03 PROGRESS SUBMITTALS

A. Submit the following to the Engineer for review during the progress of the Work:

1. Applications for Payment.
2. Individual processing submittals and change orders.
3. Independent quality control inspection and testing information.
4. Project Record Documents.
5. Equipment manufacturer's instructions and certificates.
6. All other miscellaneous submittals not mentioned herein and as specified in other individual specification Sections.

1.04 SUBMITTAL PROCEDURES

A. Timing of Submittals

1. Make submittals in advance of scheduled dates for installation, as specified in individual specification sections, to allow for reviews, for securing necessary approvals, for possible revisions and resubmittals, and for placing orders and securing deliveries. Preferred timing for the submittals will be discussed during the Preconstruction Meeting.

2. Contractor shall be responsible for delays occasioned by incomplete submittals.

B. Submittals shall be complete, and shall be combined into one package for each Section of the specifications, unless otherwise specified.

C. Sequentially number the transmittal forms.

D. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet and detail number(s), and specification section number, as appropriate.

E. Apply Contractor's stamp, signed or initialed certifying that review, verification of products required, field dimensions, adjacent construction work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.

F. Schedule submittals to expedite the project, and deliver to Engineer. Coordinate submission of related items.

G. Identify variations from Contract Documents and product or system limitations, which may be detrimental to successful performance of the completed Work.

H. Provide a four-inch square blank space for Engineer's review stamp.

I. Revise and resubmit submittals in the same quantity as required for the original submittal. Identify all changes made since previous submittal.

J. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

K. Maintain one copy of each submittal in Project Record Documents.

1.05 CONSTRUCTION PROGRESS SCHEDULE

A. Submit initial Construction Progress Schedule (first revision of schedule submitted with the Bid) in duplicate within the time specified in subsection 1.02 of this Section.

B. Submit revised Schedule with each Application for Payment, identifying changes since previous version.

C. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration. Schedule shall be in accordance with the required work sequence and completion dates specified in Section 01010 and elsewhere in the Contract Documents.

D. Indicate estimated percentage of completion for each item of Work at each submission.

E. Indicate submittal dates required for shop drawings, product data, samples, product delivery, and quality control test reports.

F. The Schedule shall be revised as required throughout the project to indicate anticipated and actual duration and sequence of activities. Copies of revised Schedules shall be provided promptly to the Engineer for review and comment.

1.06 PROPOSED PRODUCTS LIST

A. Within the time specified in subsection 1.02 of this Section, submit complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

C. Indicate on the list the product delivery dates, including those furnished by the Owner.

1.07 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

A. Within the time specified in subsection 1.02 of this Section, submit a preliminary Schedule of Shop Drawings and Samples in accordance. Include the following:

1. The dates for Contractor's submittals.
2. The dates submittals will be required for Owner-furnished products, if applicable.
3. The dates approved submittals will be required from the Engineer.
4. A list of all long lead items (equipment, materials, etc.).

B. Shop Drawings and Product Data Submittals

1. Submit the number of copies, which Contractor requires, plus three copies, which will be retained by Engineer.
2. Mark each copy of product data submittals to identify applicable products, models, options, and other data. Supplement manufacturer's standard data to provide information unique to this Project.

C. Sample Submittals

1. Submit samples to illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
2. Include identification on each sample, with full project information.
3. Submit the number of samples specified in the individual specification Sections. The Engineer will retain one sample.

D. After review, distribute in accordance with subsection 1.03 above.

1.08 MANUFACTURERS' INSTRUCTIONS

A. When specified in individual specification Sections, submit manufacturers' printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for Shop Drawings and Product Data in subsection 1.07.A above.

B. Identify conflicts between manufacturers' instructions and Contract Documents.

1.09 MANUFACTURERS' CERTIFICATES

A. When specified in individual specification Sections, submit manufacturers' certificates to Engineer for review, in quantities specified for Shop Drawings and Product Data in subsection 1.07.A above.

B. Indicate material or product conforms to or exceeds specified requirements Submit supporting reference data, affidavits, and certificates as appropriate.

C. Certificates shall be based on test results acceptable to the Engineer.

1.10 INSPECTION AND TEST CERTIFICATES

A. Submit to Engineer for review, inspection and test certificates required for demonstrating proof or compliance of materials with specification requirements.

B. Each certificate shall be signed by an official authorized to certify on behalf of the manufacturing company and shall indicate the name and address of the Contractor, the project name and location, and the quantity and date or dates of shipment or delivery to which the certificates apply.

C. Copies of laboratory test reports submitted with certificates shall contain the name and address of the testing laboratory and the date or dates of the test to which the report applies.

D. Certification will not be construed as relieving the Contractor from furnishing satisfactory material, if, after tests are performed on selected samples, the material is found not to meet the specified requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01400
QUALITY CONTROL AND ASSURANCE SERVICES

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. Owner will employ and pay for the services of the Technical Representative to perform construction monitoring and testing services to assure the Owner that the Work is completed according to the Specifications and Drawings.

B. Contractor shall cooperate with the Technical Representative to facilitate the execution of its required services.

C. Employment of the Technical Representative shall in no way relieve Contractor's obligations to perform the Work and supply materials in accordance with the Contract Documents.

D. The Contractor shall provide any additional testing and services required to control construction quality at no additional cost to the Owner. Quality control testing and services do not include activities performed by the Technical Representative.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONTRACTOR'S RESPONSIBILITIES

The Contractor shall:

A. Cooperate with the Technical Representative and its personnel and provide access to Work and to Supplier's operations.

B. Secure and deliver to the Technical Representative adequate quantities of representative samples of materials proposed to be used which require testing.

C. Furnish copies of Supplier's test reports as required.

D. Furnish incidental labor and facilities:

1. To provide access to Work to be tested;
2. To obtain and handle samples at the Project site or at the source of the product to be tested;
3. To facilitate inspections and tests; and
4. For storage and curing of test samples.

E. Coordinate activities to accommodate services with a minimum delay. Notify

Technical Representative 48 hours in advance of operations to allow for laboratory assignment of personnel and scheduling of tests. When tests or inspections cannot be performed after such notice, reimbursing Owner for laboratory personnel and travel expenses incurred due to Contractor's negligence;

F. Employ and pay for the services of a separate, qualified independent testing laboratory to perform additional inspections, sampling and testing required:

1. For the Contractor's convenience;
2. As required by the Specifications or approved Quality Control Plans; or
3. When initial tests indicate Work does not comply with Contract Documents.

G. Promptly notify the Technical Representative of observed irregularities or deficiencies of Work or products;

H. Promptly submit a copy of a written report of each test to Technical Representative. Each report shall include:

1. Date issued;
2. Project title and number;
3. Testing laboratory name, address and telephone number;
4. Name and signature of laboratory inspector;
5. Date and time of sampling or inspection;
6. Record temperature and weather conditions;
7. Date of test;
8. Identification of product and specification section;
9. Location of sample or test in the Project;
10. Type of inspect or test;
11. Results of tests and compliance with Contract Documents; and
12. Interpretation of test results, when requested by Technical Representative.

I. Be responsible for retesting where results of inspections and tests prove unsatisfactory and indicates noncompliance with requirements.

3.02 REPAIR AND PROTECTION

Unless specified otherwise, the Contractor shall protect construction exposed for testing and shall repair construction damaged by sampling, testing or inspection.

END OF SECTION

SECTION 01500
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Mobilization.
2. Temporary Utilities.
3. Barriers and enclosures.
4. Protection of existing utilities and installed Work.
5. Site security.
6. Access roads and parking.
7. Temporary Controls: construction cleaning; noise; water; soil erosion and sediment; pollution; and, dust.
8. Traffic control and haul routes.
9. Project identification and signs.
10. Field offices and sheds.
11. Removal of temporary utilities, facilities and controls.

1.02 MOBLIZATION

A. Mobilize to the site and be prepared to initiate the construction activities within 15 days after receiving Notice to Proceed from the Owner.

B. Mobilization shall not be attempted unless the Contractor has:

1. Obtained all permits, licenses and OSHA training certificates necessary to perform the Work, where required.

2. Received approval from the Owner for the location of temporary structures and storage areas.

3. Submitted initial documents to the Engineer as listed in subsection 1.02 A of Section 01300.

C. Mobilization includes, but is not necessarily limited to: transportation of personnel, equipment and operating supplies to the site; establishment of offices, buildings, all necessary temporary utilities; installation and relocation of necessary facilities at the site; and, other preparatory work at the site.

1.03 TEMPORARY UTILITIES

A. Connect to existing power service to provide required temporary electrical utilities to the project area. Contractor shall pay all costs for connection of service and costs for power service. A licensed electrical contractor shall install temporary electrical utilities.

B. Provide and maintain adequate lighting for construction operations and field offices.

C. Provide and pay for adequate drinking water for construction operations.

D. Provide adequate fire protection at the site as required by local fire codes and standards.

E. Provide adequate temporary sanitary facilities in compliance with laws and regulations. Arrange for proper maintenance of such facilities. Pay all costs for installation and maintenance of the facilities.

F. Provide, maintain and pay for telephone service to Contractor's offices.

G. Provide, maintain and pay for any other temporary utility that is necessary to accomplish the Work.

1.04 BARRIERS AND ENCLOSURES

A. Provide barriers to prevent unauthorized entry to construction areas to protect existing facilities and adjacent properties from damage from construction operations.

B. Provide barricades, covered walkways and other temporary construction required by governing authorities for public rights-of-ways.

C. All temporary construction shall be in accordance with applicable federal, state and local laws and building codes.

D. Provide protection for plant life designated to remain. Trim tree branches if necessary for access and only if permitted by the Owner. Replace damaged plant life, or repair as follows:

1. Damaged branches shall be properly pruned and all wounds covered with approved tree paint.

2. Repair work shall be done on a daily basis without exception.

E. Protect non-covered vehicular traffic, stored materials, site and structures from damage.

1.05 PROTECTION OF EXISTING UTILITIES

A. Contact and cooperate with the Owner and utility companies to locate all utilities (including pipelines, cables, power poles and other structures) on the construction site prior to beginning the Work.

B. All utilities shall be protected from damage during construction, unless otherwise indicated to be removed or abandoned.

C. Comply with requirements of the utility owners for clearances and access for all construction within and adjacent to the utility right-of-way.

D. If damaged, the utilities shall be repaired as required by the Owner at the Contractor's expense.

E. If a utility is encountered which is not shown on the Drawings or otherwise made known to the Contractor prior to beginning the Work, promptly take necessary steps to assure that the utility is not damaged, and give written notice to the Owner or Engineer and to the utility owner. The Owner and Engineer will then review the conditions and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence of the utility.

1.06 PROTECTION OF INSTALLED WORK

A. Protect installed Work and provide special protection where required in individual specification sections.

B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage.

1.07 SECURITY

Provide security and facilities to protect Work from unauthorized entry, vandalism or theft.

1.08 ACCESS ROADS AND PARKING

A. Construct and maintain temporary roads accessing existing roads to serve construction area.

B. Extend and relocate, as Work progress requires. Provide detours necessary for unimpeded traffic flow.

C. Designated existing on-site roads may be used for construction traffic, unless otherwise directed by the Owner or Engineer.

D. Construct temporary gravel surface parking areas in areas approved by the Owner to accommodate construction personnel.

E. When site space is not adequate, provide additional off-site parking.

F. Repair existing roads damaged by operation of construction equipment, as determined by the Engineer.

1.09 CONSTRUCTION CLEANING

A. Maintain areas free of trash and rubbish. Maintain site in a clean and orderly condition.

B. No trash or rubbish containers will be supplied by Owner. Supply all containers required for storage and removal of trash, rubbish and debris resulting from the Work included in this project.

C. Remove trash and rubbish from the construction area periodically and dispose in active waste area.

1.10 NOISE CONTROL

Contractor's vehicles and equipment shall be such as to minimize noise to the greatest degree practicable. Noise levels shall conform to the latest OSHA standards and state, county and local ordinance requirements, and in no case will noise levels be permitted which interfere with the work of the Owner or others.

1.11 WATER CONTROL

Provide and maintain water control as specified in Section 01563.

1.12 SOIL EROSION AND SEDIMENT CONTROL

Provide and maintain soil erosion and sediment control as specified in Section 01565.

1.13 POLLUTION CONTROL

A. Provide methods, means and facilities required to prevent contamination of soil, water or atmosphere by the discharge of noxious substances from construction operations.

B. Provide equipment and personnel, perform emergency measures required to contain significant spillage on-site, as determined necessary by the Engineer and Owner. Collect all oil and other fluids discharged during vehicle maintenance operation in drums and dispose of properly.

C. Take special measures to prevent harmful substances from entering public waters. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to streams, or in sanitary or storm sewers. Conform to Owner's existing NPDES permit for the facility.

D. Provide systems for control of atmospheric pollutants. Prevent toxic concentrations of chemicals, and prevent harmful dispersal of pollutants in the atmosphere.

E. All Contractors' equipment used during construction shall conform to all current federal, state and local laws and regulations.

1.14 DUST CONTROL

A. Maintain all excavations, embankments, stockpiles, roads, and all other work areas within or outside the project boundaries free from visible airborne dust that would cause a hazard or nuisance to others.

B. Approved temporary methods of stabilization, consisting of sprinkling with clean water, or similar methods, will be required to control dust. Sprinkling must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times.

1.15 TRAFFIC CONTROL

A. Coordinate movement of construction equipment and hauling vehicles with Owner to prevent interference with public traffic and parking, access by emergency vehicles, and Owner's operations.

B. Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.

1.16 HAUL ROUTES

A. Consult with authority having jurisdiction in establishing public thoroughfares to be used for haul routes and site access.

B. Confine construction traffic to designated haul routes.

1.17 FIELD OFFICES AND SHEDS

A. Office: Weather-tight, with lighting, electrical outlets, heating, cooling and ventilating equipment, and equipped with sturdy furniture.

1.18 REMOVAL OF TEMPORARY UTILITIES, FACILITIES AND CONTROLS

A. Remove temporary above-grade and buried utilities, equipment, facilities and materials prior to final inspection.

B. Clean and repair damage caused by installation or use of temporary work.

C. Restore existing facilities used during construction to original condition.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01563
CONTROL OF WATER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Controlling surface water runoff.

B. Dewatering trenches, excavations, and other elements.

C. Controlling water of every origin.

1.02 SUBMITTALS

Submit in accordance with Section 01300 -Submittals

PART 2 PRODUCTS

Provide structures, machinery, appliances, and equipment designed and manufactured to control water.

PART 3 EXECUTION

3.01 GENERAL

A. Dewatering Procedures: The Contractor shall construct, maintain, and operate channels, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work.

B. Dewater and dispose of water in a manner that will not cause injury to public and private property.

C. Do not cause a nuisance to the Owner's operations.

D. Keep sufficient pumping equipment and machinery on hand at all times for emergencies, including electric power failures.

E. Keep experienced personnel available at all times to operate pumping equipment, machinery and appliances.

F. Do not shut down dewatering systems between shifts, on holidays and weekends, nor during Work stoppages, unless authorized by Owner or Engineer.

END OF SECTION

SECTION 01565
TEMPORARY SOIL EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY

Section includes construction of temporary measures to control soil erosion and sediment transport within the construction limits.

1.02 REFERENCES

A. "Erosion and Sediment Control Handbook", published by McGraw-Hill Book Company.

B. American Society for Testing and Materials (ASTM):

1. ASTM D 488, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.

1.03 SUBMITTALS

Submit product data and specifications for approval as required by the Engineer prior to use.

1.04 QUALITY ASSURANCE

Comply with the requirements of governmental authorities having jurisdiction.

1.05 PROJECT REQUIREMENTS

A. Obtain all required permits prior to commencement of Work in areas requiring erosion control measures.

B. The use of temporary control measures shall be coordinated with the permanent erosion control features specified elsewhere to the extent practical, to assure effective and continuous erosion control.

PART 2 PRODUCTS

2.01 MATERIALS

A. Mulch: Hay, straw, wood chips, or other suitable material reasonably clean of noxious weeds and deleterious material.

B. Grasses: Rye grass, cereal grasses, or other quick-growing species suitable to the area and as a temporary cover, which will not compete with the grasses specified for permanent cover.

C. Silt Fencing: "Envirofence" by Mirafi, "Propex Silt Stop" by Amoco, or equivalent. Posts shall be as shown on the Drawings.

D. Check Dams shall be constructed of locally available sound crushed stone; size conforming to ASTM D 448, size number 1.

PART 3 EXECUTIONS

3.01 GENERAL

A. All Work under this contract shall be performed in such a manner that objectionable erosion shall not be created in watercourses through or adjacent to the project area.

B. The Contractor shall be responsible for the selection of appropriate temporary erosion control measures to suit the intended construction methods. The Contractor shall submit a scheme of control measures for each potentially impacted area prior to construction for approval by the Engineer.

C. Notify the Engineer and Owner in the event of conflict between these specification requirements and pollution control laws, rules or regulations of other federal, state, or local agencies.

3.02 EROSION AND SEDIMENT CONTROL

A. The Engineer shall have the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow, and fill operations and to direct the Contractor to provide immediate, permanent or temporary sediment control measures to minimize damage to adjacent property and to minimize effects on adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment.

B. Incorporate all permanent erosion control features (including seeding) into the project at the earliest practical time. Temporary control measures shall be those that are needed prior to installation of permanent control features; or that is needed temporarily to control erosion that develops during normal construction activities, but are not associated with permanent control features on the project.

C. Where erosion is likely to be a problem, clearing and grubbing operation should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter, if the project conditions permit; otherwise temporary erosion control measures may be required between successive construction stages.

3.03 INSTALLATION AND MAINTENANCE OF SILT FENCING

A. Install in accordance with details shown on the Drawings and as specified in paragraphs B through E below. In slope areas greater than 30 percent slope, install two parallel silt fences.

B. Install posts at a maximum spacing of six feet, and to depth of approximately 18 inches, or as otherwise approved by the Engineer and Owner.

C. Excavate six-inch wide by six-inch deep trench along line of posts and upslope from barrier.

D. Fasten fabric to upstream side of posts using heavy-duty wire staples (at least one-inch long), tie wires or hog rings. Eight inches of the fabric shall extend into the trench.

E. Backfill trench and compact soil over the fabric.

F. Remove sediment deposits when deposits reach approximately one-half the height of the barrier. Sediment shall be placed in areas approved by the Engineer and spread uniformly over the ground surface.

G. Replace fabric when it has deteriorated, is torn, loose or no longer effectively performs.

H. Replace any silt fence, which has been overtopped with two new parallel fences.

3.04 APPLICATION OF TEMPORARY GRASS AND MULCH

A. Comply with Section 02930.

B. Temporary seeding shall be applied to areas lacking vegetation if no construction activities will be performed in the area for more than 30 days. Temporary seed mixtures shall be applied to such areas within 21 days of temporarily suspending work in the area.

3.05 CONSTRUCTION AND MAINTENANCE OF CHECK DAMS

A. Construct across creeks within the project limits as shown on the Drawings.

B. Inspect after each rainfall event. Make required repairs if the check dams have deteriorated to the extent that their effectiveness is reduced.

C. Remove sediment deposits when deposits reach approximately one-half the height of the dams. Sediments shall be placed in areas approved by the Engineer and spread uniformly over the ground surface.

D. Check dams shall be removed after completion of construction activities. Coarse aggregate shall be deposited on-site where approved by the Engineer.

3.06 INSTALLATION AND MAINTENANCE OF OTHER EROSION CONTROL MEASURES

A. Install according to manufacturer's recommendations and standard local practice.

B. Maintenance of the installations shall be performed as required for proper erosion and sediment control until the Work is accepted by the Owner.

3.07 REMOVAL OF SILT FENCING

A. Silt fencing shall be removed when approved by the Engineer and Owner, after a sufficient stand of grass has been established on all disturbed areas.

B. Any sediment deposits remaining after the silt fence is removed shall be dressed to conform to the existing grade, prepared, and seeded.

END OF SECTION

SECTION 01600
MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Addresses:

1. Products;
2. Transportation and handling;
3. Storage and protection;
4. Product options; and
5. Substitutions.

1.02 PRODUCTS

A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.

1.03 TRANSPORTATION AND HANDLING

A. Contractor shall transport and handle products in accordance with manufacturer's instructions.

B. Contractor shall promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

C. Contractor shall provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, and damage.

1.04 STORAGE AND PROTECTION

A. Contractor shall store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Contractor shall store sensitive products in weather-tight, climate controlled enclosures.

B. For exterior storage of fabricated products, materials shall be placed on sloped supports, above ground.

C. Contractor shall provide off-site storage and protection when site does not permit on-site storage or protection.

D. Contractor shall cover products subject to deterioration with impervious sheet covering. Contractor shall provide ventilation to avoid condensation.

E. Contractor shall store loose granular materials on solid flat surfaces in a well-drained area. Contractor shall make every effort to prevent mixing with foreign matter.

F. Contractor shall provide equipment and personnel to store products by methods to prevent damage.

G. Contractor shall arrange storage of products to permit access for inspection. Contractor shall periodically inspect storage areas to assure products are undamaged and are maintained under specified conditions.

1.05 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications; no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

1.06 SUBSTITUTIONS

A. Engineer will consider requests for Substitutions only within 15 days after Effective Date of Agreement.

B. Subsequent Substitutions will be considered only when a product becomes unavailable through no fault of the Contractor. Improper planning will not be considered as a reason to increase Contract Price as a result of product substitution.

C. A request constitutes a representation that the Contractor:

1. Will provide the same warranty for the Substitution as for the specified product.
2. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to the Owner.
3. Waives claims for additional costs or time extension which may subsequently become apparent.
4. Will reimburse Owner for review or redesign services associated with re-approval by Engineer and Engineer's consultants and regulatory agencies.

D. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

E. Substitution Submittal Procedure:

1. Contractor will submit copies of each request for Substitution for consideration. Contractor shall limit each request to one proposed Substitution.
2. Contractor shall submit the number of copies required for all submittals, as specified in Section 01300.
3. Contractor shall submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.

1.07 MANUFACTURER'S INSTRUCTIONS

A. Installation of equipment and materials shall comply with manufacturer's instructions. Contractor shall obtain and distribute printed copies of such instructions to parties involved in installation, including two copies to Owner.

1. Contractor shall maintain one set of complete instructions at job site during installation and until completion of work.

B. Contractor shall handle, store, install, connect, clean, condition, and adjust materials and equipment in accordance with manufacturer's written instructions and in conformance with specifications.

1. If job conditions or specified requirements conflict with manufacturer's instructions, Contractor shall consult with Owner or Engineer for further instructions.
2. Contractor shall not proceed with work without written instructions.

1.08 INSTALLATION, INSTRUCTIONAL, AND POST START-UP SERVICES

A. Installation Services:

1. Where installation services are called for in Specifications, Contractor shall provide competent and experienced technical representatives of manufacturers of equipment and systems to resolve assembly or installation procedures attributable to, or associated with, equipment furnished.
2. After equipment is installed, representatives shall perform initial equipment and system adjustment and calibration to conform to Specifications and manufacturer's requirements and instructions.
3. Contractor shall provide "Certificate of Installation Services" stating proper adjustments have been made to equipment or system and equipment or system ready for start-up and operation.

B. Instructional Services:

1. Where training is called for in Specifications, Contractor shall provide competent and experienced technical representative of supplier to provide detailed instructions to Owner's personnel for operation of equipment. Training services shall include maintenance of instrumentation, maintenance of process equipment and operation of process equipment in classroom and on-site equipment instruction, as stated in Specifications.
2. Contractor shall coordinate pre-startup training periods with Owner and supplier's representatives.
   a. Contractor shall notify Owner at least 48 hours before training sessions are to begin so Owner can make arrangements with operating personnel.
   b. Contractor shall reschedule canceled training sessions 48 hours in advance.
   c. Failure of supplier's or manufacturer's representative to appear for scheduled training, failure to notify Owner 24 hours in advance of need to cancel scheduled training or failure to arrive within 30 minutes of start of scheduled training shall result in reimbursement to Owner for time lost by Owner's operating personnel in waiting for arrival of manufacturer's representative. Except in case of failure to arrive on time, time will not exceed one hour for each employee scheduled to receive training. Failure to arrive on time will be reimbursed by actual time late up to one hour, after one hour training will be rescheduled.

3. Similar types of equipment differing in model, size or manufacturer shall require equal service time as stated in specific Specification section.
4. Contractor shall complete pre-startup training 14 days prior to system operations demonstrations.
5. O&M data shall constitute basis of instruction.
   a. Contractor shall review data contents with personnel in full detail to explain aspects of operations and maintenance.
6. Contractor shall provide "Certificate of Instructional Services," co-signed by Owner and supplier's representative, verifying training accomplished to satisfaction of all parties.

1.09 SPECIAL TOOLS AND LUBRICATING EQUIPMENT

A. Contractor shall furnish, in accordance with manufacturer's recommendations, special tools required for checking, testing, parts replacement, and maintenance. Special tools are those specially designed or adapted for use on parts of equipment, and not customarily and routinely carried by maintenance mechanics.

B. Special tools and lubricating equipment (when applicable) will be delivered to Owner when unit placed into operation and after operating personnel have been properly instructed in operation, repair, and maintenance of equipment.

C. Tools and lubricating equipment shall be of quality compatible to equipment manufacturer has furnished.

1.10 LUBRICATION

A. Where lubrication is required for proper operation of equipment, Contractor shall incorporate necessary and proper provisions in equipment in accordance with manufacturer's requirements. Where possible, lubrication shall be automated and positive.

B. Where oil is used, reservoir shall be of sufficient capacity to supply unit for 24-hour period.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01720
PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 DESCRIPTION

A. Owner will have the right to the access of all records, such as correspondence and claims that are maintained on site or any other locations by Contractor.

B. Contractor shall maintain at site for Owner one record copy of:

1. Drawings;
2. Specifications;
3. Addenda;
4. Change orders and other modifications to Contract;
5. Field orders, written instructions, or clarifications;
6. Approved submittals;
7. Field test records;
8. All associated permits; and
9. Certificates of inspection and approvals.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Contractor shall maintain documents in clean, dry, legible condition and in good order. Contractor shall not use record documents for construction purposes.

B. Contractor shall provide secure storage space for storage of samples and maintain same in good order.

C. Contractor shall make documents and samples available at all times for inspection by Owner.

D. Failure to properly maintain record documents may be reason to delay a portion of progress payments until records comply with Contract Documents.

1.03 RECORD DOCUMENTS

A. Contractor shall maintain a record set of drawings and specifications legibly changed to transfer approved modifications in completed work that differ from Contract Documents.

B. Contractor shall label each document "PROJECT RECORD" in neat, large printed letters.

C. Contractor shall record information concurrently with construction progress.

1. Contractor shall not cancel any work until required information is recorded.
2. Contractor shall record changes made by Written Amendment, Field Order, Change Order, or Work Directive Change.

D. Drawings (By Owner)

Based on Contractor mark-ups and survey data provided by Contractor and Owner's survey, a set of record as-built drawings will be prepared by Owner (or Owner's representative) for inclusion in the project Certification Report.

E. At completion of work:

1. Using data accumulated on drawings, Contractor shall submit a set of marked up drawings showing all approved changes and revisions to the Work as authorized by the Owner and Engineer. This information will provide the basis for preparation of the as-built record drawings (by others).
2. Submit separate document indicating changes made to specifications during work.

1.04 SUBMITTALS

A. At substantial completion Contractor shall:

1. Deliver one set of marked up record drawings to Owner; and
2. Deliver documents described in Paragraph 1.01.B to Owner.

B. Submittals shall include a transmittal letter in duplicate, containing:

1. Date;
2. Project title and number;
3. Contractor's name and address;
4. Title of record document; and
5. Signature of Contractor or authorized representative.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SECTION 02110
CLEARING AND GRUBBING

PART1 GENERAL

1.01 SUMMARY

A. Section includes clearing and grubbing of vegetation, stripping of topsoil, and disposal of vegetation.

1.02 QUALITY ASSURANCE

A. Site clearing shall be performed in a manner that does not disturb existing structures, utilities, monitoring wells, or other facilities not indicated to be removed or abandoned.

B. Conform to applicable local codes for disposal of cleared and grubbed vegetation.

C. Coordinate clearing work with utility companies.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CLEARING

A. Remove exposed trees, brush, logs, grass, and other vegetative material resting on or protruding through the ground surface in those areas identified for clearing on the Drawings.

B. Remove roots of all vegetation (including tree stumps) to a minimum depth of one foot below existing grade, or the proposed subgrade elevation, whichever is lower.

3.03 TOPSOIL STRIPPING

A. Excavate topsoil from areas to receive fill.

B. Stockpile topsoil in an area on-site where approved by the Owner or Engineer for later placement on surface to be seeded. Implement temporary erosion and sediment control measures specified in Section 01565.

3.04 DISPOSAL OF WOOD AND BRUSH

A. All wood and brush shall be disposed of within 15 days after cutting or felling unless otherwise approved. Coordinate disposal with owner.

END OF SECTION

SECTION 02200
EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes general earthwork for grading of the site, excavation, subgrade fill, general fill, fill placement for access roads, berms, underground pipelines, and stormwater facilities.

B. Related Sections:

1. Section 02220 - Excavation and Backfilling

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM).

1. ASTM D 422, Standard Method for Particle-Size Analysis of Soils.

2. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

3. ASTM D 1140, Standard Test Method for Amounts of Material in Soils Finer than the Number 200 Sieve.

4. ASTM D 1557, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using Ten-Pound (4.54 kg) Hammer and 18-Inch (457 mm) Drop.

5. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

6. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.

7. ASTM D 6938, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

8. ASTM D 3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

9. ASTM D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 DEFINITIONS

A. Excavation: Consists of the removal of material encountered to subgrade elevations and the reuse disposal of materials removed.

B. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below base course.

C. Borrow: Soil material obtained from borrow areas when sufficient approved soil material is not available from excavations.

D. Unauthorized Excavation: Consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Engineer. Unauthorized excavation shall be at the Contractor's expense.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

Owner will retain the services of an inspection and testing firm to determine conformance of the materials and constructed work with the specifications.

1.05 PROJECT CONDITIONS

A. Provide temporary controls as specified in Sections 01563 and 01565.

B. The Contractor is solely responsible for excavation slope stability. Excavation work shall be in compliance with applicable OSHA regulations and State regulations.

PART 2 PRODUCTS

2.01 GENERAL

Provide all labor, materials, and equipment necessary to accomplish the Work specified in this section.

2.02 SOIL MATERIALS

A. General Fill: On-site soil or borrow material free of large rock, debris, waste, frozen material, vegetation, and other deleterious matter with a maximum particle size of six inches.

B. Prepared Subgrade: In areas to be filled, unless otherwise noted, upper eight inches of in-situ soil, scarified and recompacted to density of subsequent layer of fill/backfill material.

2.03 OTHER MATERIALS

Provide other materials, not specifically described herein but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

2.04 WATER FOR COMPACTION

Furnish as required. Contractor will have to obtain a source from Owner.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties.

3.02 DEWATERING

A. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site surrounding areas.

B. Protect subgrade soils from softening and damage by rain or water accumulation.

3.03 EXCAVATION

A. Perform excavation of every type of material encountered within the limits of the Work to the lines, grades, and elevations indicated on the Drawings and specified herein.

B. Satisfactory Excavated Materials shall be transported to, and placed in, fill or embankment areas within the limits of Work.

C. Unsatisfactory Excavated Materials

1. Unsatisfactory material excavation shall include excavation and disposal of soft or compressible soils, old spoil material, or any other materials judged by the Engineer to be unsuitable for foundations or the placement of compacted soils.

2. Excavate to a distance below grade as directed by the Engineer, and replace with satisfactory materials.

3. The Contractor shall include excavation of unsatisfactory materials, and replacement by satisfactory materials, as parts of the Work of this Section.

4. Dewatering shall be provided in areas of undercutting to a depth of at least two feet below the bottom of the excavation and shall be maintained until compacted earth fill is placed to at least three feet above the original water level or original ground level, whichever is higher.

D. Surplus Materials or unsatisfactory excavated materials, and surplus satisfactory excavated material, shall be disposed of on-site in designated areas.

3.04 DITCHES AND GUTTERS

A. Cut accurately to the cross sections, grades and elevations shown on the Drawings.

B. Maintain excavation from detrimental quantities of debris until completion of work.

C. Dispose of excavated materials as shown on the Drawings or as directed by the Engineer; except do not, in any case, deposit materials less than three feet from the edge of a ditch.

3.05 UNAUTHORIZED EXCAVATION

Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific instruction from the Engineer.

3.06 STABILITY OF EXCAVATIONS

Comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.

3.07 APPROVAL OF SUBGRADE

A. Notify Engineer when excavations have reached required subgrade.

B. When Engineer determines that unforeseen unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Unforeseen additional excavation and replacement material will be paid according to the Contract provisions for changes in Work.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Engineer.

3.08 STORAGE OF SOIL MATERIALS

A. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust.

B. Stockpile soil material away from edge of excavations. Do not store within drip line of remaining trees or coordinate with owner.

3.09 GENERAL BACKFILLING

A. Backfill excavations promptly, but not before completing the following:

1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Testing, inspecting, and approval of underground utilities.

4. Removal of trash and debris from excavation.
5. Removal of temporary shoring, bracing, and sheeting.
6. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.10 FILL

A. Preparation: Remove vegetation, topsoil, debris, wet, and unsatisfactorily soil materials, obstructions, and deleterious materials from ground surface prior to placing fills.

B. Place fill material in not more than eight to nine-inch loose layers to required elevations for each location listed below.

3.11 MOISTURE CONTROL

A. Unless otherwise noted, uniformly moisten or aerate subgrade and each subsequent fill or backfill layer to obtain compaction of 95% of the standard proctor.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air-dry satisfactory soil material that is too wet to compact to specified density.

3. Stockpile or spread and dry removed wet satisfactory soil material.

3.12 COMPACTION

A. Place backfill and fill materials in layers not more than eight to nine inches in loose depth for material compacted by heavy compaction equipment and not more than four inches loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations.

C. Unless otherwise noted, scarify and recompact upper six inches of subgrade to density not less than required for the subsequent layer of fill/backfill material.

D. Percentage of Maximum Dry Density Requirements: Unless otherwise noted, compact soil to not less than the following percentages of maximum dry density according to ASTM D 698:

1. All areas: compact each layer of backfill or fill material at 95 percent maximum dry density.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and evaluations indicated.

1. Provide a smooth transition between existing adjacent grades and new grades.

2. Cut off soft spots, fill low spots, and trim high spots to conform to required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within plus or minus 0.10-foot tolerances:

3.14 TOPSOIL

After rough grading is completed and reviewed by Engineer, spread topsoil over specified areas as shown on the Drawings to a minimum compacted thickness of twelve inches.

3.15 FIELD QUALITY CONTROL

A. Testing Agency Services: Allow testing agency to inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.

1. Perform field in-place density tests by the nuclear method according to ASTM D 6938.

B. When testing agency reports that subgrades, fills, or backfill are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained.

3.16 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.

   1. Scarify or remove and replace material to depth directed by the Engineer; reshape and recompact to optimum moisture content or the required density.

C. Settling: Where settling occurs during the Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.

D. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

END OF SECTION

SECTION 02210
FILL COMPACTION FOR
EARTHWORK STRUCTURES OTHER THAN CLAY LINER

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the construction of earthwork structures as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. The work of this Section shall include, but not necessarily be limited to: separating, hauling, stockpiling, backfilling, compacting, and grading of soils. The work of this Section may pertain in whole or in part to construction of the following: perimeter berm, roads, sedimentation basin, and access bench. The work of this Section also includes dewatering and protection. The Contractor shall be prepared to construct the structural fill in conjunction with other construction activities and subcontractors at the site.

C. Notwithstanding the prequalification of any material sources for the structural fill, the Contractor shall be entirely responsible for meeting the requirements of this Section.

1.02 REFERENCES

A. *Construction Quality Assurance Plan,* IESI – Cherokee Landfill, dated December 1999 and updated February 2006, Brian Edwards, P.A.

B. Latest version of American Society for Testing and Materials (ASTM) standards:

1. ASTM D 422, Standard Test Method for Particle-Size Analysis of Soils.

2. ASTM D 698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).

3. ASTM D 1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

4. ASTM D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

5. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

6. ASTM D 2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

7. ASTM D 6938, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

8. ASTM D 2937, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.

9. ASTM D 4220, Standard Practices for Preserving and Transporting Soil Samples.

10. ASTM D 4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 SUBMITTALS

A. The Contractor shall discuss with the Owner and the CQA Consultant the proposed methods of construction, including stripping, dewatering, excavation, filling, compaction, and backfilling for the various portions of the work. The review shall be for method only. The Contractor shall remain responsible for the adequacy and safety of the methods.

B. For each soil type specified in Part 2 of this Section, the Contractor shall submit to the Owner and the CQA Consultant the following information and samples a minimum of 14 days prior to starting construction:

1. the proposed material source;

2. the results of grain-size analyses conducted on the proposed material in accordance with ASTM D 422;

3. for fine-grained materials, the results of liquid and plastic limit tests conducted on the proposed material in accordance with ASTM D 4318;

4. the results of a moisture-density relation test (ASTM D 698); and

5. a 50-lb sample of each of the proposed soils or authorization to access the proposed source(s) for sampling.

C. The Contractor shall notify the Owner and the CQA Consultant in writing at least seven days in advance of intention to perform the work of this Section.

D. If work is interrupted for reasons other than inclement weather, the Contractor shall notify the Owner and the CQA Consultant immediately and provide a plan and schedule for resumption of the work.

E. The Contractor shall abide by all qualification requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. The construction of the structural fill shall be performed in accordance with the requirements of this section and the CQA Plan.

B. The construction of the structural fill shall be monitored by the CQA Consultant as outlined in the CQA Plan.

C. The Contractor shall be aware of the activities outlined in the CQA Plan and account for these CQA activities in the construction schedule.

1.05 PROTECTION

A. The Contractor shall contact utility companies and locate, mark and protect all existing utilities before commencement of construction.

B. The Contractor shall protect trees, shrubs, lawns, rock outcroppings and other features remaining as part of final landscaping.

C. The Contractor shall protect benchmarks, survey markers, fences, roads, sidewalks, paving, curbs and other existing structures from damage due to the Contractor's activities.

D. The Contractor shall repair damage caused by the construction operations.

E. Erosion control must be maintained. Erosion control measures shall be as noted on the grading plan or as directed by the Company.

PART 2 PRODUCTS

2.01 MATERIALS

A. All laboratory testing to evaluate the suitability or conformance of soil materials for the structural fill shall be carried out in accordance with the test methods indicated in Part 1.04 of this Section.

B. Structural fill shall consist of relatively homogeneous, natural soils that are free of debris, foreign objects, large rock fragments, roots, and organics. No materials larger than three in. shall be allowed. If structural fill is to be placed above geosynthetics, no materials larger than one in. shall be allowed within one ft of the geosynthetics. The structural fill shall be classified according to the Unified Soil Classification System (USCS) as SP, SW, SM, SC, ML, CL, CH, or MH material.

PART 3 EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any work described in this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this Section and the CQA Plan.

B. Inspection:

1. Prior to implementing any of the work in this Section, the Contractor shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the installation of the work specified in this Section may properly commence without adverse impact.

2. If the Contractor has any concerns regarding the installed work of other Sections, the Owner should be immediately notified in writing within 48 hours of the site inspection. Failure to notify the Owner or continuance with structural fill placement shall be construed as Contractor's acceptance of the related work of all other Sections.

3.02 SITE PREPARATION

A. The Contractor shall develop access to the construction area in accordance with the requirements of the Drawings and any supplemental Specifications.

B. The Contractor shall install silt fences immediately down-slope of each area to be disturbed prior to the beginning of work in that area. The Contractor shall maintain the silt fences for the duration of construction. Accumulated sediment behind the silt fences shall be disposed of on-site by the Contractor in a manner approved by the

Owner.

C. All brush, vegetation, rubbish, and other objectionable material shall be removed from the construction area and disposed of in an area designated by the Owner.

D. All topsoil shall be removed from the construction area and stockpiled.

E. Diversion ditches, either permanent or temporary, shall be constructed in accordance with the Drawings. The Contractor shall be responsible for constructing diversion ditches as required to divert potential run-on around the construction area. The construction of temporary ditches not shown on the Drawings shall not be undertaken until the Contractor's plan for constructing the ditches is approved by the Owner.

3.03 EXCAVATION AND STOCKPILING

A. Excavated materials to be used as structural fill shall be stockpiled in designated areas segregated from soils not suitable for use as fill, clearing debris, or other objectionable materials. Stockpile areas shall be designated by the Owner.

B. Stockpiles of structural fill shall have side slopes no steeper than 3H:1V (3 horizontal:1 vertical) unless approved otherwise by the Owner. The stockpiles of structural fill shall be graded to drain, sealed by tracking parallel to the slope with a dozer or other means approved by the Owner, and dressed daily during periods when structural fill is taken from the stockpile. The Contractor may cover structural fill stockpiles with plastic sheeting or other material approved by the Owner in order to preserve the moisture content of the structural fill.

C. Stockpiles that shall remain out of active use for a period greater than seven months shall either be covered as described in Part 3.03.C of this Section or stabilized by seeding and fertilizing in accordance with the requirements given in Section 02930.

D. Surplus excavated soils shall not be removed from the site or disposed of by the Contractor unless such removal or disposal is approved by the Owner.

3.04 STRUCTURAL FILL

A. The structural fill used during this construction shall be constructed to the lines and grades shown on the Drawings using the appropriate material.

B. The structural fill shall meet the requirements of Part 2.01 of this Section.

C. The structural fill shall be placed in a loose lift that results in a compacted lift thickness of no greater than 12 inches.

D. The Contractor shall be responsible for installation of suitable material that meets the projects specifications for classification, moisture content and density. The Contractor shall not proceed to the next lift until the current lift has been tested and approved by the CQA representative. The Contractor will be held responsible for proceeding to the next lift without prior approval from the CQA Firm.

E. Each lift shall be compacted to at least 95 percent of the maximum dry unit weight as measured according to ASTM D 698. The dry unit weight and moisture content shall be measured in place in accordance with ASTM D 6938.

F. If the moisture content of the structural fill is not suitable for proper compaction, the structural fill shall be moisture conditioned and reworked, as appropriate. Wetting shall be accomplished using a water truck and spray nozzle, unless the CQA Consultant approves an alternative method. During wetting or drying, the structural fill shall be regularly disced or otherwise mixed so that uniform moisture conditions in the appropriate range are obtained. In the event the moisture content is at optimum $\pm$ 1 percent and the compaction requirement of 95 percent can not be achieved, the lift thickness shall be reduced.

G. The Contractor shall not place frozen structural fill, nor shall structural fill be placed on frozen ground.

H. If the structural fill freezes during construction, the Contractor shall remove the frozen structural fill, scarify the remaining unfrozen fill, and then place and compact new structural fill in accordance with these Specifications and any supplemental Specifications. The frozen structural fill shall not be reused until it has thawed, been disced, and then reworked to an acceptable uniform moisture content.

3.05 SURVEY CONTROL

A. The Contractor shall survey the location and elevation of the structural fill, access road, drainage ditches, and drainage swales.

B. The Owner may supply surveying for quality assurance purposes and Record Drawings.

3.06 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and all partially-completed and completed work specified in this Section and prior work of other Sections.

B. At the end of each day, the Contractor shall verify that the entire work area was left in a state that promotes surface drainage off and away from the area and from finished work. If threatening weather conditions are forecast, compacted surfaces shall be seal-rolled to protect finished work.

C. In the event of damage to prior work or work completed as specified in this Section, the Contractor shall submit a repair plan to the Owner and CQA Consultant(s). The repair plan shall describe the areas requiring repair, and the Contractor shall make all repairs and replacements necessary to the approval of the Owner and CQA Consultant(s) and at no additional cost to the Owner.

3.07 PUMPING AND DRAINAGE

A. At all times during construction, the Contractor shall provide and maintain proper equipment and facilities to remove all water entering excavations and keep such excavations dry so as to obtain a satisfactory condition for progress of work.

B. Drainage shall be disposed of only in an area approved by the Owner. Drainage shall be disposed of in a manner which prevents flow or seepage back into the excavated area.

END OF SECTION

SECTION 02220
EXCAVATION AND BACKFILLING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes excavation, backfilling and compaction for installation of landfill liner system components and culverts.

B. Related Sections:

1. Section 02200 - Earthwork
2. Section 02226 - Protective Cover Layer
3. Section 02227 - Washed Gravel

C. Definitions:

1. Excavation: Consists of the removal of material encountered to subgrade elevations.
2. Unauthorized Excavation: Consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Engineer. Unauthorized excavation shall be at the Contractor's expense.
3. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below proposed structure or facility.
4. Borrow: Soil materials obtained from borrow areas when sufficient approved soil material is not available from excavations.
5. Unsuitable Material: Topsoil, peat, organic soils, lignite, debris, rubble, and soft, loose or saturated soils, as determined by the Owner.
6. Lift: Constructed portion of backfill layer comprised of suitable material placed in specified compacted thickness.

1.02 REFERENCES

A. *Construction Quality Assurance Plan,* IESI – Cherokee Landfill, dated December 1999 and updated February 2006, Brian Edwards, P.A.

B. American Society for Testing and Materials (ASTM):

1. ASTM D 422, Standard Method for Particle-Size Analysis of Soils.
2. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
3. ASTM D 1140, Standard Test Method for Amounts of Material in Soils Finer than the Number 200 Sieve.
4. ASTM D 1557, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using Ten-Pound (4.54 kg) Hammer and 18-Inch (457 mm) Drop.
5. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
6. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.
7. ASTM D 6938, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
8. ASTM D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Test Results: The testing laboratory shall submit written reports of all specified tests, showing conformance of the materials and constructed work with the specifications. Submit test results within three days after samples are obtained.

C. Submit as-built survey maps of each specified fill layer.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

A. Testing shall be done in accordance with the most current version of the *Construction Quality Assurance Plan,* IESI – Cherokee Landfill, dated December 1999 and updated February 2006, Brian Edwards, P.A.

B. Testing work be performed with the specifications, in accordance with Section 01400.

C. Use special testing frequency at discretion of Owner or Engineer when visual observations of construction performance indicate potential problem. Additional testing for suspected areas should be considered when:

1. Rollers slip during rolling operation.

2. Lift thickness is greater than specified.

3. Fill materials are at improper or variable moisture content.

4. The number of roller passes is less than specified number.

5. Compaction equipment has dirt-clogged rollers.

6. Compaction equipment may not be using optimum ballast.

7. Fill materials differ substantially from those specified.

8. Degree of compaction is doubtful.

9. Directed by Owner or Engineer.

D. During construction, testing frequency may also be increased in following situations:

1. Adverse weather conditions.

2. Breakdown of equipment.

3. At start or finish of grading.

4. Material fails to meet specifications.

5. Work area is reduced.

1.05 PROJECT CONDITIONS

A. Work shall be performed in a manner that does not disturb existing environmental monitoring wells or other site facilities not indicated to be removed within the construction limits.

B. Provide temporary controls as specified in Section 01563 and 01565.

C. The Contractor is solely responsible for excavation slope stability. Excavation work shall be in compliance with applicable OSHA regulations.

PART 2 PRODUCTS

2.01 GENERAL

A. Proposed materials shall be approved for use on this project by the Engineer as specified, prior to use of the material in the construction.

B. Fill material to be reasonably well-graded soils derived from on-site and borrow sources.

C. Soil materials on-site, in-place, and/or in stockpiles are available for use the construction operations. These materials are to be used subject to acceptance by the Engineer.

2.02 GENERAL FILL

A. Material shall meet the standards as defined in Section 02210, subsection 2.001.B.

B. Place in areas as shown on Drawings, including geomembrane anchor trenches and waste cell separator berms.

2.03 PROTECTIVE COVER LAYER

A. Material to conform to the requirements of Section 02226.

B. Protective Cover material shall be placed on landfill base and side-slopes as shown on the Drawings.

2.04 WASHED GRAVEL

A. Material to conform to the requirements of Section 02227.

B. Shall be installed within the leachate collection pipe trench surrounding the leachate collection pipe, as shown on the Drawings.

2.05 PIPE BEDDING MATERIAL

A. Material to conform to the requirements of Section 02223, subsection 2.02.

B. Shall be installed within the leachate collection pipe trench on the landfill bottom, surrounding the leachate collection pipe, as shown on the Drawings.

PART 3 EXECUTION

3.01 GENERAL

A. Prior to beginning excavation work, Contractor shall review and satisfy himself as the adequacy and accuracy of the control surveys and data established by the Owner for the purpose of computing payment quantities. Contractor may make such measurements and surveys as it deems necessary to confirm the Owner's control surveys. The Engineer will resolve any variances or discrepancies. When control surveys and data have been established to both parties' satisfaction, the Contractor shall indicate his acceptance by signing a copy of the Owner's field survey notes, which shall be maintained at the job site by the Engineer throughout the Work.

B. Flag and protect all known utilities and environmental monitoring stations.

3.02 EXCAVATION

A. Excavation consists of open-cut excavation and removal of all types of material encountered when establishing required subgrade and finished grade.

B. Unauthorized excavation consists of removal of materials beyond indicated subgrade or finished elevations without specific direction of Engineer or Owner. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be at the Contractor's expense. Backfill and compact unauthorized excavations with material of subsequent layer and meet specified density of that layer.

C. Excavate areas as indicated on the Drawings in a safe manner and in conformance with all local, state, and federal regulations.

D. Separate excavated materials into stockpiles as shown on the Drawings and as directed by the Engineer. Maintain stockpiles in free-draining condition.

E. Grade final surfaces to the lines and elevations shown on the Drawings with a tolerance of 0.1 foot.

F. Final surfaces shall be free of loose material, clods, and other debris including grading stakes and hubs.

G. Grade top perimeter of excavation to prevent surface water from draining into excavation area.

H. Upon completion of excavation, notify Engineer before proceeding with backfilling operations.

I. Provide minimum trench depth indicated below to maintain a minimum cover over the top of the installed item below the finish grade:

1. Areas subject to vehicular traffic: 36 inches

2. Areas not subject to vehicular traffic: 18 inches

3. All areas: Electrical cables: 42 inches

   Electrical ducts: 36 inches

4. Where utilities are under a concrete structure slab or pavement, the minimum depth need only be sufficient to completely encase the conduit or pipe sleeve, provided it will not interfere with the structural integrity of the slab or pavement.

5. Where the minimum cover is not provided, encase the pipes in concrete as indicated on Drawings. Provide concrete with a minimum 28-day compressive strength of 2,500 pounds per square inch.

3.03 REMOVAL OF WATER

Provide and operate equipment adequate to keep all excavations free of water as specified in Section 01563.

3.04 PREPARATION

A. Prior to placement of fill materials, examine all surfaces and subgrades to receive fill to identify the existence of soft areas caused by ponding water or unsuitable soils. The Contractor will Proof-roll the area with a large rubber-tired vehicle of sufficient weight to reveal unstable areas. Remove all unsuitable soils and backfill with subsequent materials and compact to density as specified for that material layer.

B. Scarify top six to eight inches of subgrade, moisture condition, and unless otherwise noted, compact to moisture content and minimum density not less than the subsequent layer of fill/backfill material.

C. Survey Engineer-approved prepared subgrade area for record drawings in conformance with Section 01400. Acceptable tolerances on survey coordinates shall be plus or minus 0.1 foot on elevations and coordinates, unless otherwise specified.

D. Maintain benchmarks and other elevation control points; re-establish, if disturbed or destroyed, at no additional cost to the Owner.

3.05 BACKFILLING

A. Notify Engineer at least 48 hours prior to placing any fill material.

B. Place fill material in accordance with procedures required to achieve specified performance standards outlined in each referenced section.

C. Hauling and spreading equipment will not be considered as compaction equipment unless Contractor has demonstrated suitability on test pad.

D. Contractor is responsible for maintaining proper lift thickness to achieve compaction as stated below. Place and compact fill materials in maximum uncompacted lift thickness and to minimum density indicated.

E. Material not meeting specified density shall be additionally compacted to meet specifications, or removed. Material not within specified moisture content range shall be scarified; moisture conditioned, and recompacted to meet the specifications, or removed.

TABLE 02220-1
GENERAL COMPACTION REQUIREMENTS

Material	Maximum Lift Thickness (inches)	Minimum Compaction (%)	Moisture Requirements
General Fill	9 inches	95 Standard Proctor	±5% of OMC

3.06 FIELD QUALITY CONTROL

A. Tests specified below shall be performed by the CQA Soil testing firm during placement of fill.

B. Testing of General Fill:

Compaction/Density tests, (using ASTM D 6938: Minimum of one test per 10,000 square feet area for each compacted lift or minimum of six tests per lift, and at every material change.

C. Testing of Protective Cover as per Section 02226.

D. Compacted fill, which does not meet density specifications shall be scarified, the moisture content adjusted, and the area recompacted and re-tested at Contractor's expense.

E. Surveying shall be performed to monitor as-built soil layer elevations. Measure on a 50-foot maximum grid pattern at the following locations:

1. Prepared Subgrade, and

2. Top of Protective Cover.

F. Provide topographic survey maps of the as-built surfaces to Engineer for review and approval before proceeding with subsequent construction. Survey maps shall be prepared by a registered Land Surveyor.

3.07 STOCKPILING

A. Locate stockpiles as shown on Drawings, or as directed by the Engineer. Do not exceed 50 feet height of piles unless permitted by the Engineer or Owner. Place, grade, and shape stockpiles for proper drainage. Stockpiles shall have a minimum vertical side slopes of 3 horizontal to 1 vertical.

B. Provide erosion control fences and barriers to prevent loss of material or movement outside the stockpile limits, as necessary.

END OF SECTION

SECTION 02223
TRENCHING, BACKFILLING, AND COMPACTING

PART 1 GENERAL

1.01 SUMMARY

A. This Section addresses excavation, backfill and compaction for installation of underground pipelines, anchor trenches for geosynthetics installations, and riser pipes.

B. Related Sections:

1. Section 02200 – Earthwork

2. Section 02715 - Leachate Collection System Piping (HDPE)

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM).

1. ASTM D 422, Standard Method for Particle-Size Analysis of Soils.
2. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
3. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
4. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.
5. ASTM D 6938, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.03 SUBMITTALS

A. Submittals shall be submitted under the provisions in Section 01300.

B. Test Results:

1. The testing laboratory shall submit written reports of all specified tests, showing conformance of the materials and constructed work with the specifications; and

2. The test results shall be submitted within three days after samples are obtained.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

A. Owner will retain the services of an independent inspection and testing firm(s) to determine conformance of the materials and constructed work with the specifications, in accordance with the General Conditions.

1.05 PROJECT CONDITIONS

A. Work shall be performed in a manner that does not disturb existing environmental monitoring wells or other site facilities not indicated to be removed within the construction limits.

B. Contractor shall provide temporary controls to prevent erosion as specified in the General Conditions.

C. The Contractor is solely responsible for excavation slope stability. Excavation work shall be in compliance with applicable OSHA regulations.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Proposed materials shall be approved for use on this project by the Engineer as specified, prior to use of the material in the construction.

2.02 PIPE BEDDING MATERIAL, HAUNCHING MATERIAL, AND INITIAL TRENCH BACKFILL

A. Pipe bedding material shall be sand or fine gravel, having characteristics consistent with SW, SP, GW or GP soils as defined by the Unified Soil Classification System (ASTM D 2487).

B. Shall be substantially free of sharp edges or corners, and debris. Maximum particle size shall be 3/8-inch or less.

C. Testing of Soil:

1. Soil Type (ASTM D 2487): Minimum of one test for each visible change in material.

2.03 FINAL TRENCH BACKFILL

A. Soil used for final backfill in all pipe trenches may be soil excavated from trench except if it is an organic or silt (MH, ML) soil. The soil shall be substantially free of organic matter or other perishable matter, rocks larger than two inches in maximum dimension, pavement material, litter, and topsoil.

B. For pipe trenches beneath areas which will carry vehicular traffic, trench backfill shall consist of same material as pavement surface coarse material.

2.04 GEOCOMPOSITE ANCHOR TRENCH BACKFILL

A. General fill material to be placed in Geocomposite anchor trenches.

B. Material shall conform to the requirements as specified in Section 02220.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Testing of Geosynthetic Anchor Trench Backfill:

1. Compaction/Density tests, using ASTM D 6938: Minimum of one test for each six inch completed lift of backfill placed and for every 100 feet of trench, or fraction thereof.

B. Materials not meeting density specification requirement shall be scarified, recompacted and retested at Contractor's expense.

C. The Engineer may require additional tests to establish gradation, maximum density, and in-place density as required by working conditions, at the Contractor's expense.

3.02 PREPARATION

A. Contractor shall establish required lines and levels, and check contours and datum.

B. Contractor shall remove and replace or compact in-situ soils or compacted fill material softened by surface water as required by the Engineer.

C. Unsuitable materials shall be removed from within the trench.

D. Contractor shall provide and operate equipment adequate to keep all excavations free of water as specified in the General Conditions.

E. Contractor shall maintain benchmarks and other elevation control points; re-establish, if disturbed or destroyed, at no additional cost to the Owner.

3.03 TRENCH EXCAVATION

A. Trenches shall be excavated to the dimensions shown on the Drawings, and as indicated in the following paragraphs.

B. For pipe installation across existing pavement, cut edge of pavement in a uniform straight alignment on each side of excavation at a distance of approximately twelve inches beyond top of excavation. Maintain pavement cuts in good order until pipe installation and pavement patching operations are completed.

C. If existing material below the trench bottom grade is unsuitable for properly laying pipe, as determined by the Engineer, excavate and remove the unsuitable material to

a depth of approximately four inches and replace the same with Pipe Bedding Material (meeting the qualifications of subsection 2.02 of this Section) properly compacted to produce a firm and even bearing surface.

D. Removal of materials beyond the indicated subgrade elevations, without authorization by the Engineer, shall be classified as unauthorized excavation and shall be backfilled and compacted at no additional cost to the Owner.

E. Contractor shall remove water from the excavations as required for installation of piping, and placement of backfill and geotextile (if applicable), in accordance with these specifications and the details shown on the Drawings.

F. Contractor shall notify Engineer before proceeding with installation of fill material or piping.

G. Cover:

1. Contractor shall provide minimum trench depth indicated below to maintain a minimum cover over the top of the installed item below the finish grade:

a.	Areas subject to vehicular traffic:	24 inches
b.	Areas not subject to vehicular traffic:	12 inches
c.	All areas:	
	i. Electrical cables:	42 inches
	ii. Electrical ducts:	36 inches

2. Where utilities are under a concrete structure slab or pavement, the minimum depth need only be sufficient to completely encase the conduit or pipe sleeve, provided it will not interfere with the structural integrity of the slab or pavement.

3.04 PIPE INSTALLATION

A. Engineer must approve pipe bedding prior to placement of piping.

B. Installation of all pipe and appurtenances shall be subject to the review of the Engineer.

C. Contractor shall install piping as shown on the Drawings and as specified in Section 02715.

3.05 BACKFILLING AND COMPACTING FOR PIPING

A. This subsection includes backfilling only for piping outside the limits of the landfill.

B. Contractor shall not completely backfill trenches until the piping system as installed conforms to the specifications.

C. Contractor shall place haunching material around the pipe up to at least the pipe

spring line. Haunching material shall be placed on both sides of the pipe at the same time and to approximately the same elevation. Contractor shall compact using manually-guided compaction equipment, being careful not to damage the pipe.

D. Contractor shall place initial trench backfill over the pipe (if applicable), in layers not exceeding four inches loose thickness, up to approximately 12 inches above the top of the pipe. Each layer shall be thoroughly compacted using manually-guided compaction equipment.

E. Final Trench Backfill shall be placed in layers not exceeding eight inches loose thickness up to final grade. For pipe crossing roads or adjacent to roads, backfill shall be compacted to achieve at least 95 percent of the material's maximum dry density as determined by ASTM D 698. The upper twelve inches of backfill below pavement subgrade shall be compacted to at least 95 percent maximum dry density.

F. Compaction of Final Trench Backfill shall be performed in a manner that does not damage the pipe. Pipe that is damaged shall be replaced at the Contractor's expense.

G. The minimum depth of compacted trench backfill or fill over pipelines shall be as indicated in subsection 3.03 above, or as otherwise shown on the Drawings. Construction traffic shall not be allowed to cross installed pipelines prior to placement of aggregate subbase for the pavement or crushed stone fill (as applicable), unless concrete cover (concrete arch) is provided over the pipe.

3.06 BACKFILL FOR LEACHATE RISER PIPE TRENCH (IF REQUIRED)

A. Place pipe bedding material within trench as shown on the Drawings. Material shall not be compacted.

3.07 BACKFILL AND COMPACTING FOR GEOSYNTHETIC ANCHOR TRENCH

A. Contractor shall place general fill material within geosynthetic anchor trench as shown on the Drawings.

B. Material shall be placed in loose lifts of nine inches.

C. Contractor shall compact fill with power tamper or wheel roll with proper moisture conditioning to meet 95 percent of the maximum dry density of the material at a maximum of six inch lifts, being careful not to damage geosynthetic material.

END OF SECTION

SECTION 02226
PROTECTIVE COVER LAYER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes description of soil protective cover layer over leachate collection blanket layer on landfill floor and above geomembrane liner and geocomposite drainage net on side-slopes and floor of landfill cell.

B. Related Sections

1. Section 02220 - Excavation and Backfilling
2. Section 02277 – Geomembrane
3. Section 02278 - Geotextile and Geocomposite

1.02 REFERENCES

A. *Construction Quality Assurance Plan,* IESI – Cherokee Landfill, dated December 1999 and updated February 2006, Brian Edwards, P.A.

B. American Society for Testing and Materials (ASTM):

1. ASTM D 422, Standard Method for Particle-Size Analysis of Soils.
2. ASTM D 2434, Standard Test Method for Permeability of Granular Soils (Constant Head).
3. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.

1.03 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Test Results: The Contractor shall submit the following information and samples to the Company or the CQA Representative a minimum of 14 days prior to starting construction of the protective cover layer:

1. The proposed material source.

2. The results of a particle-size analysis on the proposed material, conducted in accordance with ASTM D 422.

3. The results of tests conducted in accordance with ASTM D 4373 to determine calcium carbonate content of the proposed material.

4. A 30-lb sample of the proposed material.

C. Submit as-built survey map of installed protective cover layer as shown on Drawings.

PART 2 PRODUCTS

2.01 MATERIAL FOR PROTECTIVE COVER LAYER

A. Landfill Floor

1. All laboratory testing to evaluate the suitability or conformance of materials for the protective cover and barrier protective layer shall be carried out in accordance with the test methods indicated in Section 1.02.

2. The protective cover shall consist of relatively homogeneous sand (or equivalent material) that is free of debris, foreign objects, large rock fragments, roots, and organic. The hydraulic conductivity of the protective cover shall be $K \geq 1 \times 10^{-4}$ cm/sec. If site material does not meet the hydraulic conductivity, then chimney drains will be required.

3. Soil testing will be provided by Owner through the Soils CQA Monitor and the Soils CQA Testing Laboratory.

PART 3 EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the work described in this Section the Contractor shall become thoroughly familiar with the site, the site conditions and all portions of the work falling within this Section.

B. Inspection:

1. Prior to implementing any of the work in this Section, the Contractor shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the installation of this Section may properly commence without adverse impact.

2. If the Contractor has any concerns regarding the installed work of other Sections, he/she should immediately notify the Company or Company's Project Manager in writing within 48 hours of the site visit. Failure to notify the Company or Company's Project Manager in writing or construction of the sump and leachate collection pipe gravel will be construed as Contractor's acceptance *of* the related work of all other Sections.

3.02 INSTALLATION

A. Place material only when underlying leachate drainage layer material, leachate collection system and geosynthetics are completed. The protective cover material shall be placed directly on top of the geosynthetic material.

B. Place to the lines and grades shown on the Drawings.

C. Place material in single uniform lifts of no less than 12 inches. Do not operate any equipment closer than 12 inches to underlying geosynthetics.

D. The protective cover layer shall be finish grade to a tolerance of 0.1 foot of the specified elevations, and shall meet the minimum thickness requirement.

E. Placement of the material will be performed using a low ground-pressure dozer. The tracked equipment shall operate only over previously placed material or granular drainage layer. The Contractor shall not operate equipment directly on geomembrane, geotextile, geonet, or geocomposite.

F. The equipment used to place sand or gravel shall not exert ground pressures exceeding the following:

Allowable Equipment Ground Pressure (psi)	Thickness of Layer Above Geotextile or Geonet (in.)
<5	12
<10	18
<20	24
>20	48

G. Perform survey of approved prepared subgrade for as-built drawing of landfill cell in accordance with Section 01400.

H. Equipment used to place and grade protective cover shall not contain unnecessary accessories (e.g. dozers shall not contain rippers while placing and grading protective cover).

3.03 QUALITY ASSURANCE/QUALITY CONTROL

A. The sand protective cover layer material shall be tested as outlined in Table 02226-1 below.

TABLE 02226-1
SAND PROTECTIVE COVER LAYER MATERIAL
PRE-CONSTRUCTION AND CONSTRUCTION TESTING REQUIREMENTS

TEST	ASTM METHOD	PASSING CRITERIA
Pre-construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Min. 95% passing ¼ - inch sieve and less than 25% passing the No. 200 sieve.
Calcium Carbonate		Maximum 15%
Classification Permeability	D 2487 D 2434	GW, GP, SW, SP, SM, ML 1 x 10^{-4} cm/sec or greater
Construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Min. 95% passing ¼ - inch sieve and less than 25% passing the No. 200 sieve.
Classification Permeability	D 2487 D 2434	GW, GP, SW, SP, SM, ML 1 x 10^{-4} cm/sec or greater

Note: If Chimney drains are utilized, they will consist of washed gravel material that is 1 x 10-3 cm/sec. or greater that is wrapped by an 8 oz. geotextile (See Table 02226-2).

TABLE 02226-2
SAND PROTECTIVE COVER LAYER MATERIAL WITH CHIMNEY DRAINS
PRE-CONSTRUCTION AND CONSTRUCTION TESTING REQUIREMENTS

TEST	ASTM METHOD	PASSING CRITERIA
Pre-construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Min. 100% passing 1 - inch sieve
Classification	D 2487	CL,CH, SW, SP, SM, ML
Construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Min. 100% passing 1 - inch sieve
Classification	D 2487	CL,CH, SW, SP, SM, ML

3.04 PRODUCT PROTECTION

A. After the protective cover layer has been placed, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all prior work and materials and completed work of other Sections.

C. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary, to the approval of the Owner or the CQA Representative and at no additional cost to Owner.

3.03 SURVEY CONTROL

A. The contractor shall be responsible for all layout work. Once the Protective Cover Layer is completed and CQA verified, the Contractor shall be responsible for surveying the location and elevation of the protective cover. Final elevations of the top of Protective Cover surface shall be 0 to +0.1 ft. compared to the grades shown on the Construction Drawings.

B. Owner will provide one survey for certification and documentation of Protective Cover thickness. Any additional surveying will be at the expense of the Contractor.

END OF SECTION

SECTION 02227
WASHED GRAVEL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes description of granular material placed in leachate collection trench and sump in landfill cell floor.

B. Related Sections:

1. Section 02220 - Excavation and Backfilling
2. Section 02226 - Protective Cover Layer
3. Section 02715 - Leachate System Piping

1.02 REFERENCES

A. *Construction Quality Assurance Plan,* IESI – Cherokee Landfill, dated December 1999 and updated February 2006, Brian Edwards, P.A.

B. American Society for Testing and Materials (ASTM):

1. ASTM D 422, Standard Method for Particle-Size Analysis of Soils.
2. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.

1.03 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Test Results: The testing laboratory shall submit written reports of all specified tests, showing conformance of the materials and constructed work with the specifications. Submit test results within three days after samples are obtained.

PART 2 PRODUCTS

2.01 WASHED GRAVEL

A. Washed Gravel material shall be classified as a GP or GW in accordance with the Unified Soil Classification System (USCS) and ASTM D 422.

B. Material shall be obtained from off-site sources and shall be relatively homogeneous, natural granular soils which are free of debris, foreign objects, large rock fragments, roots, and organics.

C. The material shall be washed gravel with a maximum of 5% passing the No. 200 sieve. The maximum particle size shall be three inches in diameter.

PART 3 EXECUTION

3.01 GENERAL

A. Place material only when underlying composite liner system is completed.

B. Place to the lines and grades shown on the Drawings.

C. Place material in single uniform lifts.

D. Do not compact material.

3.02 QUALITY ASSURANCE/QUALITY CONTROL

A. Washed Gravel shall be tested as outlined in Table 02227-1 below.

TABLE 02227-1
WASHED GRAVEL
PRE-CONSTRUCTION AND CONSTRUCTION TESTING REQUIREMENTS

TEST	ASTM METHOD	PASSING CRITERIA
Pre-construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Minimum 95% passing 2-inch sieve Less than 5% passing a number 200 sieve. Maximum particle size of 3 inches
Calcium Carbonate		Maximum 15%
USCS Classification	D2487	GW or GP
Permeability	D 2434	1×10^{-3} cm/sec
Construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Minimum 95% passing 2-inch sieve Less than 5% passing a number 200 sieve. Maximum particle size of 3 inches
Permeability	D 2434	1×10^{-3} cm/sec

END OF SECTION

SECTION 02228
SUBGRADE

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the construction of the subgrade as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. The Contractor shall be prepared to coordinate the construction of the subgrade with other construction activities and subcontractors at the site.

C. Notwithstanding the prequalification of any material sources for the subgrade, the Contractor shall be entirely responsible for meeting the requirements of this Section.

D. The work of this Section shall include, but not necessarily be limited to, the construction of the subgrade component of the liner system.

1.02 RELATED SECTIONS

A. Section 02200 – Earthwork

B. Section 02277 – Geomembrane

C. Section 02278 – Geotextile and Geocomposite

1.03 REFERENCES

A. *Construction Quality Assurance Plan,* IESI – Cherokee Landfill, dated December 1999 and updated February 2006, Brian Edwards, P.A.

B. Latest version of American Society for Testing and Materials (ASTM) standards:

1. ASTM D 422 — Standard Test Method for Particle-Size Analysis of Soils.
2. ASTM D 698 — Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
3. ASTM D 1140 — Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75-µm) Sieve.

4. ASTM D 1556 — Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
5. ASTM D 1557 — Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
6. ASTM D 2216 — Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
7. ASTM D 2487 — Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
8. ASTM D 6938 — Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
9. ASTM D 2937 — Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
10. ASTM D 4220 — Standard Practices for Preserving and Transporting Soil Samples.
11. ASTM D 4318 — Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
12. ASTM D 5084 — Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible-Wall Permeameter.
13. ASTM D 5093 — Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring.

1.04 SUBMITTALS

A. The Contractor shall notify the Owner and CQA Consultant in a minimum of 3 days prior to starting construction of the subgrade. The notice shall state the source of the material to be used, the equipment to be used, the date and time that placement operations shall start, and the name of the person in the field who shall be in charge of the construction of the subgrade.

B. If work is interrupted for reasons other than inclement weather, the Contractor shall notify the Owner and CQA Consultant immediately and provide a plan and schedule for resumption of the work.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. The construction of the subgrade shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. The Contractor shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the construction schedule.

PART 2 - PRODUCT

2.01 MATERIAL FOR SUBGRADE

A. All laboratory testing to evaluate the suitability or conformance of soil materials for the subgrade shall be carried out in accordance with the test methods indicated in Part 1.04 of this Section.

B. The subgrade shall consist of relatively homogeneous, natural soils which are substantially free of debris, foreign objects, large rock fragments, roots, and organics. The soils selected shall not be gap-graded or susceptible to piping. Any material which is found by the CQA Consultant to be unsuitable shall be removed from the work area by the Contractor.

C. Soil testing shall be provided by the Owner through the CQA Consultant.

PART 3 - EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any work of this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this Section and the CQA Plan.

3.02 SUBGRADE PLACEMENT

A. The Contractor shall construct the subgrade to the grades, slopes, and elevations shown on the Drawings and as specified in this Section.

B. No frozen or partially thawed subgrade material shall be placed, spread or compacted.

C. No compacted subgrade material shall be placed or spread while the surface on which the material is to be placed is frozen or thawing, during unfavorable weather conditions, or during periods of precipitation.

D. The subgrade surface shall be made smooth and free from ruts or indentations at the end

of every working day when precipitation is forecast and/or at the completion of the compaction operations in that area.

E. The entire area shall be left in a manner to promote runoff at the end of each day.

F. The final surface of the subgrade shall be compacted using a smooth drum or pneumatic wheel compactor.

G. The subgrade material shall be placed in loose lifts which result in a maximum compacted lift thickness of 6 inches.

H. The subgrade material shall be compacted to at least 95 percent of the maximum dry unit weight as measured according to ASTM D 698. In all cases the moisture content shall be maintained as close to optimum moisture, as measured according to ASTM D 698, in order to meet the compaction requirements. The dry unit weight and moisture content shall be measured in place in accordance with ASTM D 6938 at the frequencies presented in the CQA Plan.

I. The subgrade must have sufficient compaction and strength to enable the placement and compaction of the clay liner. The subgrade also must be stable to prevent large differential settlement that would be conducive to damage of the liner system or the pooling of leachate.

J. The Contractor shall not proceed to the next lift until the current lift has been tested and approved by the CQA representative. The Contractor will be held responsible for proceeding to the next lift without prior approval from the CQA Firm.

3.03 FIELD QUALITY CONTROL AND TESTING

A. Frequency:

1. The frequency of quality control testing is outlined below. The Contractor shall take this testing frequency into account in planning his construction schedule.

   a. The minimum testing frequencies for material evaluation and construction quality evaluation shall be as presented in the CQA Plan.

   b. Sampling locations shall be selected by the CQA Consultant. If necessary, the location of routine in-place moisture content and dry density tests shall be determined using a non-biased sampling plan.

   c. A special testing frequency shall be used at the discretion of the Owner and/or the CQA Consultant when visual observations of construction performance indicate a

potential problem. Additional testing for suspected areas shall be considered when:

i. the rollers slip during rolling operation;

ii. the lift thickness is greater than specified;

iii. the subgrade soil is at improper and/or variable moisture content;

iv. fewer than the specified number of roller passes are made;

v. dirt-clogged rollers are used to compact the material;

vi. the rollers do not have optimum ballast; or

vii. the degree of compaction is doubtful.

d. During construction, the frequency of testing may also be increased in the following situations:

i. adverse weather conditions;

ii. breakdown of equipment;

iii. at the start and finish of grading;

iv. if the material fails to meet specifications; or

v. the work area is reduced.

B. Defective Areas:

1. If a defective area is discovered in the subgrade, the CQA Consultant shall immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate. If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the CQA Consultant shall define the limits and nature of the defect.

2. After determining the extent and nature of a defect, the CQA Consultant shall notify the Contractor and schedule appropriate retests when the work deficiency has been corrected.

3. The Contractor shall correct the deficiency to the satisfaction of the CQA Consultant. The cost of corrective actions shall be borne by the Contractor.

4. All retests recommended by the CQA Consultant must verify that the defect has been corrected before any additional work is performed by the Contractor in the area of the deficiency. The CQA Consultant shall also verify that all installation requirements are

met and that all submittals are provided.

3.04 SURVEY CONTROL

A. The contractor shall be responsible for all layout work. Once the subgrade is completed and CQA verified, the Contractor shall be responsible for surveying the location and elevation of the top of subgrade. Final elevations of the top of subgrade surface shall be 0 to +0.1 ft. compared to the grades shown on the Construction Drawings.

B. Owner will provide one survey for certification and documentation of subgrade elevations. Any additional surveying will be at the expense of the Contractor.

3.05 PRODUCT PROTECTION

A. The Contractor shall use all means necessary to protect all prior work, including all materials and completed work specified in this and other Sections.

B. In the event of damage to prior work or work completed as specified in this section, the Contractor shall immediately make all repairs and replacements necessary to the approval of the Owner and CQA Consultant and at no additional cost to the Owner.

END OF SECTION

SECTION 02230
COMPACTED CLAY

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the construction of the compacted clay as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. The Contractor shall be prepared to coordinate the construction of the compacted clay with other construction activities and subcontractors at the site.

C. Notwithstanding the prequalification of any material sources for the compacted clay, the Contractor shall be entirely responsible for meeting the requirements of this Section.

D. The work of this Section shall include, but not necessarily be limited to, the construction of the composite liner clay component of the lining system.

1.02 RELATED SECTIONS

A. Section 02200 – Excavation and Subgrade Preparation

B. Section 02277 – Geomembrane

C. Section 02278 – Geotextile and Geocomposite

1.03 REFERENCES

A. *Construction Quality Assurance Plan,* IESI – Cherokee Landfill, dated December 1999 and updated February 2006, Brian Edwards, P.A.

B. Latest version of American Society for Testing and Materials (ASTM) standards:

1. ASTM D 422 — Standard Test Method for Particle-Size Analysis of Soils.
2. ASTM D 698 — Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
3. ASTM D 1140 — Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75-µm) Sieve.

4. ASTM D 1556 — Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
5. ASTM D 1557 — Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
6. ASTM D 2216 — Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
7. ASTM D 2487 — Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
8. ASTM D 6938 — Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
9. ASTM D 2937 — Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
10. ASTM D 4220 — Standard Practices for Preserving and Transporting Soil Samples.
11. ASTM D 4318 — Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
12. ASTM D 5084 — Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible-Wall Permeameter.
13. ASTM D 5093 — Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring.

1.04 SUBMITTALS

A. The Contractor shall notify the Owner and CQA Consultant in a minimum of 3 days prior to starting construction of the compacted clay. The notice shall state the source of the material to be used, the equipment to be used, the date and time that placement operations shall start, and the name of the person in the field who shall be in charge of the construction of the compacted clay.

B. If work is interrupted for reasons other than inclement weather, the Contractor shall notify the Owner and CQA Consultant immediately and provide a plan and schedule for resumption of the work.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. The construction of the compacted clay shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. The Contractor shall be aware of the activities outlined in the CQA Plan and shall account

for these activities in the construction schedule.

PART 2 - PRODUCT

2.01 MATERIAL FOR COMPACTED CLAY

A. All laboratory testing to evaluate the suitability or conformance of soil materials for the compacted clay shall be carried out in accordance with the test methods indicated in Part 1.03 of this Section.

B. The compacted clay shall consist of relatively homogeneous, natural soils which are substantially free of debris, foreign objects, large rock fragments, roots, and organics. More than 30% passing a number 200 sieve and less than 20% greater than a number 4 sieve. No particles larger than one inch shall be allowed. The soil shall be classified according to the Unified Soil Classification System (USCS) as CL, CH, or SC material with a PI greater than 10. Regardless of the classification requirements, the material shall meet the requirements of Part 2.01-D of this Section. The soils selected shall not be gap-graded or susceptible to piping. Materials which do not meet all the requirements of this Section shall be segregated at the source and not be permitted at the work area. Any material which is found by the CQA Consultant to be unsuitable shall be removed from the work area by the Contractor at no extra cost to the Owner.

C. The compacted clay shall have a plasticity index (PI) in excess of ten, and the percent passing the No. 200 sieve shall be greater than 30 percent.

D. The compacted clay shall have an in-situ (i.e., after compaction) hydraulic conductivity less than 1.0×10^{-7} cm/sec as measured in the laboratory.

E. Soil testing shall be provided by the Owner through the CQA Consultant.

F. A test pad shall be constructed for each source of compacted clay to verify that the proposed material and procedures shall result in a product complying with this Section. Test pad construction shall be as detailed in Part 3 of this Section. A test pad is not required if the Contractor meets the requirements of Part 2.01-G of this Section.

G. The requirements for a test pad detailed in Part 3 of this Section **may not** be performed if the following conditions are met:
   1. The contractor has successfully completed and documented a minimum of 500,000 square feet of clay liner or final cover barrier construction consistent with the requirements of this section during the last three (3) years, the owner or operator may submit a written request to the Department to waive the test fill requirements of this section.
   2. The proposed materials for the compacted clay:

a. classified as CL, CH, or SC;

b. more than 30% passing through the No. 200 sieve;

c. less than 20% retained on a number 4 sieve and no particle size greater than 1.0 inch in diameter;

d. has a LL of at least 25; and

e. has a PI of at least 10.

PART 3 - TEST PAD

3.01 REGULATORY REQUIREMENTS

A. Unless the requirements of Part 2.01-G of this Section are met, a test pad shall be constructed and tested prior to construction of the full-scale compacted clay.

B. A test pad shall be constructed each time:

1. the dry unit weight of the proposed material changes by at least five pcf, based on a moisture-density relation test results;

2. construction equipment is changed; or

3. construction practices are changed.

3.02 TEST PAD MATERIALS

A. The soil materials to be used for construction of the test pad shall be approved by the Engineer, and it shall be verified by the CQA Consultant that the materials conform to all design specifications. The test pad materials shall meet the requirements of Part 2.01 of this Section. Soil clods shall be broken up so that no clods exceed three inches in maximum size.

3.03 TEST PAD CONSTRUCTION

A. Subgrade Preparation:

1. The area within the limits of the test pad shall be cleared and grubbed of all trees, debris, stumps, and any other vegetation. After clearing and grubbing, the area shall be stripped of topsoil and/or organic materials.

2. The surface of the subgrade shall be proof-rolled to eliminate soft zones, irregularities, and abrupt changes in grade. The finished subgrade surface shall be sloped to

promote drainage. No standing water or excessive moisture shall be allowed to accumulate on the surface of the subgrade. The surface of the subgrade shall be examined by the CQA Consultant prior to commencement of construction of the test pad. The CQA Consultant shall document the condition of the subgrade.

B. Configuration:

1. The test pad shall be constructed with a width at least four times wider than the widest piece of construction equipment, not counting side slopes.

2. The test pad shall be long enough to allow the construction equipment to achieve normal operating speed before reaching the area within the test pad that shall be used for testing, but not less than approximately 100 ft long.

3. The test pad shall consist of at least four lifts of soil. Each lift shall be of uniform thickness, however different lifts may vary in thickness. The total thickness of the test pad shall be a minimum of two ft.

C. Test Pad Placement

1. The test pad shall be constructed using equipment similar to that intended for use in full-scale construction. Each lift of the test pad shall be compacted using a wedge foot compactor, such as a Caterpillar 815C or 825C.

2. First Lift:

   a. the Contractor shall, by trial and error, determine the loosely-placed soil lift thickness which shall result in a maximum compacted lift thickness of approximately nine in. (225 mm), and upon determining this, place the first lift of soil;

   b. the soil moisture content shall be adjusted by the Contractor, as required, to 0 to +4.0 percent above the optimum moisture content as determined by ASTM D 698 (Note: the moisture content for compaction to meet a density criterion shall normally be lower than the moisture content for compaction to meet a permeability criterion, depending on the PI of the soil);

   c. the soil shall be compacted with two one-way passes, using the same compaction equipment intended for the construction of the full-scale compacted clay;

   d. the CQA Consultant shall perform in-situ density tests using the nuclear device, and collect samples for hydraulic conductivity tests as outlined in Part 3.03-C.4.d. of this Section and the CQA Plan;

e. all holes made as a result of sampling or testing shall be repaired in accordance with procedures outlined in the CQA Plan;

f. the lift shall be recompacted (second sequence) by applying two additional one-way passes with the same equipment;

g. the testing, sampling, and repair outlined above shall be repeated at locations adjacent to the first set of tests;

h. the lift shall be recompacted (third sequence) by applying two additional one-way passes with the same equipment;

i. the testing, sampling, and repair outlined above shall be repeated at locations adjacent to the first two sets of tests; and

j. additional sequences of compaction, testing, sampling, and repair shall be carried out until the specified criteria for compaction and permeability are attained.

3. Subsequent Lifts

a. the Contractor shall place a soil lift which shall result in a compacted lift thickness of the target lift thickness;

b. the Contractor shall ensure that a good bond exists between two consecutive lifts, and the CQA Consultant shall verify that the two lifts are intermixed; and

c. additional sequences of compaction, testing, sampling, and repair shall be carried out until the specified criteria for compaction are attained.

4. Final Surface Preparation

a. After compaction of the final lift, the surface of the test pad shall be rolled with a smooth drum or pneumatic wheel compactor so as to be free of irregularities, loose soil, and abrupt changes in grade;

b. All stones projecting more than 0.4 in. from the surface shall be removed;

c. One-half of the prepared soil surface shall be protected against drying. The protective material shall be placed immediately after the completion of surface preparation. Monitoring and documentation of the condition of the surface (e.g., desiccation cracking) shall be performed by the CQA Consultant on the uncovered section of the test pad; and

d. The CQA Consultant shall conduct in-situ hydraulic conductivity testing on the protected portion of the test pad. The in-situ hydraulic conductivity test shall consist of one of the following test methods:

i. sealed double-ring infiltrometer (SDRI), per ASTM D 5093; or

ii. Shelby-tube (carved block) samples for laboratory testing, per ASTM D 5084, using a 2.8-in. (70-mm) diameter tube, with a minimum of three tests required.

PART 4 - EXECUTION

4.01 FAMILIARIZATION

A. Prior to implementing any work of this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this Section and the CQA Plan.

B. Inspection:

1. Prior to implementing any work of this Section, the Contractor shall carefully inspect the installed work of all other Sections and verify that all such work is complete to the point where the installation of this Section may properly commence without adverse impact.

2. If the Contractor has any concerns regarding the installed work of other Sections or the site, the Contractor shall notify the CQA Consultant and Owner in writing within 48 hours of the site inspection. Failure to notify the CQA Consultant and Owner of installation of the compacted clay shall be construed as the Contractor's acceptance of the related work of all other Sections.

4.02 COMPACTED CLAY PLACEMENT

A. The Contractor shall construct the compacted clay to the grades, slopes, and elevations shown on the Drawings and as specified in this Section.

B. No frozen or partially thawed compacted clay material shall be placed, spread or compacted.

C. No compacted clay material shall be placed or spread while the surface on which the material is to be placed is frozen or thawing, during unfavorable weather conditions, or during periods of precipitation.

D. The compacted clay surface shall be made smooth and free from ruts or indentations at the

end of every working day when precipitation is forecast and/or at the completion of the compaction operations in that area.

E. The entire area shall be left in a manner to promote runoff at the end of each day.

F. The compacted clay shall be compacted using the equivalent equipment to that used for construction of the Test Pad. The final surface of the compacted clay shall be compacted using a smooth drum or pneumatic wheel compactor. The equipment shall operate only over previously placed compacted clay material.

G. The compacted clay material shall be placed in loose lifts which result in a maximum compacted lift thickness of 6 in. The total thickness of the compacted clay layer shall not be less than the minimum thickness shown on the Drawings.

H. The Contractor shall not proceed to the next lift until the current lift has been tested and approved by the CQA representative. The Contractor will be held responsible for proceeding to the next lift without prior approval from the CQA Firm.

I. The compacted clay material shall be compacted to at least 95 percent of the maximum dry unit weight as measured according to ASTM D 698. In all cases the moisture content shall be maintained at 0 to +6 percent of the optimum moisture content as measured according to ASTM D 698. The dry unit weight and moisture content shall be measured in place in accordance with ASTM D 6938 at the frequencies presented in the CQA Plan.

J. The compacted clay shall be sampled and tested for in-situ hydraulic conductivity (i.e. after compaction) at the frequencies and procedures outlined in the CQA Plan.

4.03 FIELD QUALITY CONTROL AND TESTING

A. Frequency:

1. The frequency of quality control testing is outlined below. The Contractor shall take this testing frequency into account in planning his construction schedule.

   a. The minimum testing frequencies for material evaluation and construction quality evaluation shall be as presented in the CQA Plan.

   b. Sampling locations shall be selected by the CQA Consultant. If necessary, the location of routine in-place moisture content and dry density tests shall be determined using a non-biased sampling plan.

   c. Undisturbed compacted clay material samples for laboratory hydraulic conductivity testing shall be taken with the assistance of the Contractor such that the sample

tube is inserted vertically into the compacted clay with a continuous smooth stroke from the construction equipment used to drive the sampler.

d. A special testing frequency shall be used at the discretion of the Owner and/or the CQA Consultant when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas shall be considered when:

   i. the rollers slip during rolling operation;

   ii. the lift thickness is greater than specified;

   iii. the compacted clay soil is at improper and/or variable moisture content;

   iv. fewer than the specified number of roller passes are made;

   v. dirt-clogged rollers are used to compact the material;

   vi. the rollers do not have optimum ballast; or

   vii. the degree of compaction is doubtful.

e. During construction, the frequency of testing may also be increased in the following situations:

   i. adverse weather conditions;

   ii. breakdown of equipment;

   iii. at the start and finish of grading;

   iv. if the material fails to meet specifications; or

   v. the work area is reduced.

B. Perforations:

1. Perforations in the compacted clay that must be filled shall include, but not be limited to, the following:

   a. nuclear density test probe locations;

   b. hydraulic conductivity sampling locations; and

   c. test pit locations.

2. Perforations in the compacted clay shall be backfilled with similar clay material and compacted to achieve a hydraulic conductivity less than 1×10^{-7} cm/s. Alternatively, bentonite chips or pellets may be used.

C. Defective Areas:

1. If a defective area is discovered in the compacted clay, the CQA Consultant shall immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate. If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the CQA Consultant shall define the limits and nature of the defect.

2. After determining the extent and nature of a defect, the CQA Consultant shall notify the Contractor and schedule appropriate retests when the work deficiency has been corrected.

3. The Contractor shall correct the deficiency to the satisfaction of the CQA Consultant. The cost of corrective actions shall be borne by the Contractor.

4. All retests recommended by the CQA Consultant must verify that the defect has been corrected before any additional work is performed by the Contractor in the area of the deficiency. The CQA Consultant shall also verify that all installation requirements are met and that all submittals are provided.

4.04 SURVEY CONTROL

A. The contractor shall be responsible for all layout work. Once the Compacted Clay Liner is completed and CQA verified, the Contractor shall be responsible for surveying the location and elevation of the compacted clay. Final elevations of the top of Compacted Clay surface shall be 0 to +0.1 ft. compared to the grades shown on the Construction Drawings.

B. Owner will provide one survey for certification and documentation of Compacted Clay Liner thickness. Any additional surveying will be at the expense of the Contractor.

4.05 PRODUCT PROTECTION

A. The Contractor shall use all means necessary to protect all prior work, including all materials and completed work specified in this and other Sections.

B. In the event of damage to prior work or work completed as specified in this section, the Contractor shall immediately make all repairs and replacements necessary to the approval of the Owner and CQA Consultant and at no additional cost to the Owner.

END OF SECTION

SECTION 02270
RIPRAP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes description of riprap stone and geotextile material placed in stormwater outlet locations as shown on the Drawings.

B. Related Sections

1. Section 02200 - Earthwork

2. Section 02720 - Stormwater Drainage Systems

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM C 535, Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.03 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Test Results: The testing laboratory shall submit written reports of all specified tests, showing conformance of the materials and constructed work with the specifications. Submit test results within three days after samples are obtained.

PART 2 PRODUCTS

2.01 RIPRAP

A. The stone shall be hard, sound, and durable. It shall be free from seams, cracks, and other defects tending to destroy its resistance to weather.

B. The stone shall have less than 45 percent wear in accordance with the Los Angeles abrasion test and shall not weigh less than 140 pounds per cubic feet.

C. The stone shall have at least 50 percent by weight consisting of pieces measuring between seven inches and ten inches in any direction.

D. Dust or fines less than 1/2 inches in maximum cross section accumulated from quarrying or loading operations shall not exceed five percent by weight.

E. Nominal 12 inches graded down.

2.02 GEOTEXTILE FILTER

A. Geotextile Filter used with riprap shall be needlepunch non-woven geotextile, woven geotextile with monofilament yarn or woven geotextile with monofilament and fibrillated yarn meeting the following requirements:

1. Min. permittivity ASTM D4491: 0.2 sec.

2. Survivability (AASHTO M288-9G): Class 2 - woven monofilaments, Class 1 -all other geotextiles.

3. Max. AOS ASTM D4751: 0.25mm.

4. U.V. retardant required.

PART 3 EXECUTION

3.01 GENERAL

A. Riprap shall be provided at all locations shown on the Drawings or as directed by the Engineer. Prior to placing the riprap, install geotextile filter on the prepared subgrade as shown on the Drawings.

B. Key upper geotextile after placement of riprap on slopes. Prepare subgrade to the lines and grades as specified. Provide intimate contact of geotextile with smooth slope. Fill depressions or holes to avoid development of a geotextile bridge.

C. Riprap shall be placed from the bottom up on the geotextile filter in such manner as to produce a reasonably well-graded mass of rock with the minimum practicable percentage of voids and shall be constructed to the lines and grades shown. Maximum drop height of stones should not exceed one foot.

D. The larger stones shall be well distributed and the entire mass of stones in their final position shall be roughly graded to conform to the gradation specified. The

finished riprap layer shall be free from objectionable pockets of small stones and clusters of larger stones.

E. Placing riprap layers will not be permitted. Placing of riprap by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. The desired distribution of the various sizes of stones throughout the mass shall be obtained by selective loading of the material at the quarry or other source; controlled dumping of successive loads during final placing or by other methods of placement which will produce the specified results. Rearranging of individual stones by mechanical equipment or by hand will be required to the extent necessary to obtain a reasonably well graded distribution of stone sizes as specified above.

F. Riprap shall be maintained in a satisfactory condition, as determined by the Engineer, until completion of the project. Damage before completion from any cause shall be repaired or replaced at no cost to the Owner.

G. Articulated concrete mats or other flexible revetment systems may be used in place of stone riprap as approved by the engineer.

END OF SECTION

SECTION 02276
GEOSYNTHETIC CLAY LINER (GCL)

PART 1 GENERAL

1.01 SCOPE

A. This specification covers the technical requirements for the furnishing and installation of the geosynthetic clay liner described herein. All materials used shall meet the requirements of this specification, and all work shall be performed in accordance with the procedures provided herein and the contract drawings.

1.02 DEFINITIONS

A. For the purposes of this specification, the following terms are defined below:

1. *Geosynthetic Clay Liner (GCL). A manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetics.*
2. *Geomembrane. An essentially impermeable geosynthetic composed of one or more geosynthetic sheets.*
3. *Geotextile. Any permeable geosynthetic comprised solely of textiles.*
4. *Minimum Average Roll Value. For geosynthetics, the value calculated as the typical value minus two (2) standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.*
5. *Overlap. Where two adjacent GCL panels contact, the distance measuring perpendicular from the overlying edge of one panel to the underlying edge of the other.*
6. *Typical Value. The mean value calculated from documented manufacturing quality control test results for a defined population obtained from one test method associated with one specific property.*

1.03 UNIT PRICES

A. Measurement will be made of the total surface area in square feet covered by the GCL as shown on the contract drawings. Final quantities will be based on as-built conditions. Allowance will be made for GCL in anchor and drainage trenches but no allowance will be made for waste, overlap, or materials used for the convenience of the Contractor. GCL installed and accepted will be paid for at the respective contract

unit price in the bidding schedule.

1.04 SUBMITTALS

A. With the bid, the Contractor shall furnish the following information:

1. Conceptual description of the proposed plan for placement of the GCL panels over the area of installation;

2. GCL manufacturer's MQC Plan for documenting compliance to Sections 2.01 and 2.03 of these specifications;

3. GCL manufacturer's historical data for reinforced GCL of a) 10,000-hour creep shear testing per Section 2.01 D and 2.03 B) seam flow data at 2 psi confining pressure per Section 2.01 E; and

4. A copy of GCL manufacturer's ISO quality Certificate of Registration.

B. At the Engineer's or Owner's request the Contractor shall furnish:

1. A representative sample of the GCLs; and

2. A project reference list for the GCL(s) consisting of the principal details of at least ten projects totaling at least 10 million square feet (100,000 square meters) in size.

C. Upon shipment, the Contractor shall furnish the GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification.

D. As installation proceeds, the Contractor shall submit certificates of subgrade acceptance, signed by the Contractor and CQA Inspector (see Section 1.7) for each area that is covered by the GCL.

1.05 QUALIFICATIONS

A. GCL Manufacturer must have produced at least 10 million square feet (1 million square meters) of GCL, with at least 8 million square feet (800,000 square meters) installed.

B. The GCL Installer must either have installed at least 1 million square feet (100,000 square meters) of GCL, or must provide to the Engineer satisfactory

evidence, through similar experience in the installation of other types of geosynthetics, that the GCL will be installed in a competent, professional manner.

1.06 CONSTRUCTION QUALITY ASSURANCE (CQA)

A. The Owner and Engineer shall provide third-party inspection for CQA of the GCL installation. The inspector shall be an individual or company who is independent from the manufacturer and installer, who shall be responsible for monitoring and documenting activities, related to the CQA of the GCL, throughout installation. The inspector/company shall have provided CQA services for the installation of the proposed or similar GCL for at least 5 completed projects totaling not less than 1 million square feet (100,000 square meters).

B. Testing of the GCL, as necessary to support the CQA effort, shall be performed by a third party laboratory retained by the Contractor and independent from the GCL manufacturer and installer. The laboratory shall have provided GCL CQA testing of the proposed or similar GCL for at least 5 completed projects totaling not less than 1 million square feet (100,000 square meters).

C. CQA shall be provided in accordance with the *CQA Manual* provided by the engineer.

PART 2 PRODUCTS

A. The GCLs shall consist of a layer of natural sodium bentonite clay encapsulated between two geotextiles and shall comply with all of the criteria listed in this Section. Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. The Contractor also must obtain prior approval of the alternative GCL by the Project Engineer.

B. Reinforced GCL must be used on the sideslope.

2.01 MATERIALS

A. Acceptable reinforced GCL products are Bentomat® ST, as manufactured by CETCO, 1350 West Shure Drive, Arlington Heights, Illinois 60004 USA (847-392-5800), or an engineer-approved equal.

B. Areas requiring reinforced GCL will be furnished with Bentomat® ST. The delineation of these areas shall be agreed by the Installer and the Engineer prior to installation.

C. The reinforced GCL and its components shall have the properties shown in **Table 02276-1**.

D. A 6-inch (150 mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing quality assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

2.02 CONFORMANCE TESTING

A. Samples shall be taken at the frequency as presented in Section 2.02 C, and demonstrate compliance with the parameters shown in **Table 02276-1**

B. Each sample shall be identified by manufacturer's name, product identification, lot number, roll dimensions, and roll number. The machine direction shall be noted on the samples with a waterproof marker.

C. As a minimum, the following conformance tests shall be performed:

a. Bentonite Mass/Area sq. - ASTM D 5993 – 1/100,000 ft^2
b. Grab Strength - ASTM D 6768 - 1/100,000 ft^2
c. Peel Strength - ASTM D 6496 - 1/100,000 ft^2
d. Index Flux and Hydraulic Conductivity - ASTM D 5887 - 1/100,000 ft^2

2.03 PRODUCT QUALITY DOCUMENTATION

A. The GCL manufacturer shall provide the Contractor or other designated party with manufacturing QA/QC certifications for each shipment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer and shall include:

1. Certificates of analysis for the bentonite clay used in GCL production demonstrating compliance with the parameters swell index and fluid loss shown in **Table 02276-1;**

2. Manufacturer's test data for finished GCL product(s) of bentonite mass/area, GCL tensile strength and GCL peel strength (reinforced only) demonstrating compliance with the index parameters shown in **Table 02276-1**; and

3. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

B. Manufacturer's test data for finished GCL product(s) including GCL index flux, permeability and hydrated internal shear strength data demonstrating compliance with the performance parameters shown in **Table 02276-1** is available upon request of the manufacturer.

2.04 PRODUCT LABELING

A. Prior to shipment, the GCL manufacturer shall label each roll, identifying:

1. Product identification information (Manufacturer's name and address, brand product code);

2. Lot number and roll number; and

3. Roll length, width and weight.

2.05 PACKAGING

A. The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.

B. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

2.06 ACCESSORY BENTONITE

A. The granular bentonite sealing clay used for overlap seaming, penetration sealing and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer. Seaming of GCLs shall be conducted in accordance with the manufacturer's guidelines for each particular GCL.

PART 3 EXECUTION

3.01 SHIPPING AND HANDLING

A. The manufacturer assumes responsibility for initial loading the GCL. Shipping will be the responsibility of the party paying the freight. Unloading, on-site handling and storage of the GCL are the responsibility of the Contractor, Installer or other designated party.

B. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be

marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage.

C. The party responsible for unloading the GCL should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

3.02 STORAGE

A. Storage of the GCL rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry and well drained.

B. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four).

C. All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation. Check integrity of the cover at least weekly and after gusty winds.

D. The integrity and legibility of the labels shall be preserved during storage.

3.03 EARTHWORK

A. Any earthen surface upon which the GCL is installed shall be prepared and compacted in accordance with the project specifications and drawings. The surface shall be smooth, firm, and unyielding, and free of:

1. Vegetation;
2. Construction Debris;
3. Sticks;
4. Sharp rocks;
5. Void spaces;
6. Ice;
7. Abrupt elevation changes;
8. Standing water;
9. Cracks larger than one-quarter inch (6 mm) in width; and
10. Any other foreign matter that could contact the GCL.

B. Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch (12 mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor.

C. On a continuing basis, the installer shall certify acceptance of the subgrade before GCL placement.

D. It shall be the installer's responsibility thereafter to indicate to the Engineer any change in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this Section.

E. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated or an equivalent runout shall be utilized in accordance with the project plans and specifications and as approved by the CQA Inspector. When utilizing an anchor trench design, the trench shall be excavated and approved by the CQA Inspector prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

3.04 GCL PLACEMENT

A. Reinforced GCL shall be placed on the sideslopes. Non-reinforced GCL shall be placed on the floor.

B. GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) should be in accordance with the Engineer's recommendations.

C. Equipment, which could damage the GCL, shall not be allowed to travel directly on it. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

D. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

E. The GCL panels shall be placed parallel to the direction of the slope.

F. All GCL panels should lie flat on the underlying surface, with no wrinkles or fold, especially at the exposed edges of the panels.

G. Only as much GCL shall be deployed as can be covered at the end of the working day with soil, a geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it may be necessary to remove and replace the hydrated material. The project Engineer, CQA inspector, and GCL supplier should be consulted for specific guidance if premature hydration occurs.

3.05 ANCHORAGE

A. As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope or an equivalent runout design shall be utilized. When utilizing an anchor trench design, the front edge of the trench should be rounded so as to eliminate any sharp corners. Loose soil should be removed from the floor of the trench. The GCL should cover the entire trench floor but does not extend up the rear trench wall.

3.06 SEAMING

A. The GCL seams are constructed by overlapping their adjacent edges. Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.

B. The minimum dimension of the longitudinal overlap should be 6 inches (150 mm). If the GCL is manufactured with a grooved cut in the nonwoven geotextile that allows bentonite to freely extrude into the longitudinal overlap then no supplemental bentonite is required for this overlap. If the GCL does not have a grooved cut in the nonwoven geotextile longitudinal overlap, then bentonite-enhanced seams are required as described below. End-of-roll overlapped seams should be constructed with a minimum overlap of 24 inches (600 mm). End-of-roll overlapped seams for all reinforced GCL seams require bentonite-enhanced seams as described below.

C. Bentonite-enhanced seams are constructed between the overlapping adjacent panels as follows. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6-inch (150-mm) line. The granular bentonite shall be applied at a minimum application rate of one quarter

pound per lineal foot (0.4 kg/m). A similar bead of granular sodium bentonite is applied at the end-of-roll overlap.

3.07 DETAIL WORK

A. The GCL shall be sealed around penetrations and embedded structures embedded in accordance with the design drawings and the GCL Manufacturer.

B. Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

3.08 DAMAGE REPAIR

A. If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. Granular bentonite or bentonite mastic should be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive to affix the patch in place so that it is not displaced during cover placement.

3.09 COVER PLACEMENT

A. Although the GCL will be covered with a geomembrane and a geocomposite, the cover soils shall be free of angular stones or other foreign matter that could damage the GCL.

B. Soil cover shall be placed over the GCL using construction equipment that minimizes stresses on the GCL. A minimum thickness of 1 foot (300 mm) of cover should be maintained between the equipment tires/tracks and the GCL at all times during the covering process. This thickness recommendation does not apply to frequently trafficked areas or roadways, for which a minimum thickness of 2 feet (600 mm) is required.

C. Although the GCL will be covered with a geomembrane and a geocomposite, soil cover should be placed in a manner that prevents the soil from entering the GCL overlap zones. Cover soil shall be pushed up slopes, not down slopes, to minimize tensile forces on the GCL.

D. Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles (such as 4-wheel all-terrain vehicles) may be used to

facilitate the installation of any geosynthetic material placed over the GCL. The GCL supplier or CQA engineer should be contacted with specific recommendations on the appropriate procedures in this situation.

E. When a textured geomembrane is installed over the GCL, a temporary geosynthetic covering known as a slip sheet or rub sheet can be used to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position.

END OF SECTION

TABLE 02276-1
GCL Materials

Manufacturer's Quality Control				
Test	**Method(1)**	**Testing Frequency**	**Units**	**Min. Requirements**
Reinforced/ Non-Reinforced				**Reinforced/ Non-Reinforced**
Bentonite Swell Index[2]	ASTM D 5890	1 per 100,000 lbs	mL/g	≥ 24 / 2 (min)
Bentonite Fluid Loss[2]	ASTM D 5891	1 per 100,000 lbs	mL	≤ 18 (max)
Bentonite Mass per Area[3]	ASTM D 5993	40,000 ft^2	lb/ft^2	≥ 0.75 (min)
GCL Grab Strength[4]	ASTM D 4632 ASTM D 6768	200,000 ft^2	lbs/in	≥ 30 MARV
GCL Peel Strength[4]	ASTM D 6496	40,000 ft^2	lbs/in	≥ 3.5 / ≥1.0 MARV
GCL Index Flux[5]	ASTM D 5887	Weekly	$m^3/m^2/s$	≤ 1 x 10^{-8} (max)
GCL Permeability[5]	ASTM D 5887	Weekly	cm/sec	≤ 5 x 10^{-9} (max)
GCL Hydrated Internal Shear Strength[6]	ASTM D 5321 ASTM D 6243	Periodic (6)	psf	≥ 500 typical @ 200 psf (min) / ≥ 100 typical @ 200 psf (min)
Conformance Testing by CQA Engineer				**Reinforced/ Non-Reinforced**
Bentonite Mass per Area[3]	ASTM D 5993	100,000 ft^2	lb/ft^2	≥ 0.75 (min)
GCL Grab Strength[4]	ASTM D 4632 ASTM D 6768	100,000 ft^3	lbs/in	≥ 30 MARV
GCL Peel Strength[4]	ASTM D 6496	100,000 ft^4	lbs/in	≥ 3.5 MARV
GCL Permeability[5]	ASTM D 5887	100,000 ft^5	cm/sec	≤ 5 x 10^{-9} (max)

1. Test to be performed according to the latest test method as approved by the certifying engineer.

2. These parameters are for the bentonite incorporated into the GCL and do not necessarily reflect the properties of the bentonite in the finished product.

3. Bentonite mass per area is exclusive of the average weight of the geotextiles and is normalized to 0 percent moisture content per ASTM D 5993.

4. All tensile testing is performed in the machine direction, with results as minimum average roll values unless otherwise indicated.

5. Index flux and permeability testing with desired distilled/deionized water at 80 psi cell pressure, 77 psi headwater pressure and 75 psi tail water pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of 5 x 10-9 cm/sec for typical GCL thickness. This flux value should not be used for equivalency calculations unless gradient used represent field conditions. A flux test using gradients that represent field conditions must be performed to determine equivalency. The last 20 weekly values prior to end of the production date of the supplied GCL may be provided.

6. ASTM D5321-08 (geosynthetics) or D 6243 (GCLs) internal direct shear performed on GCL sample hyddrated under 200 psf normal load and then sheared at 0.2 in./min. max for Procedure A and 0.04 in/min for Procedure B. Use wet conditions as per ASTM D5321. The testing is required prior to construction of the first ECS Cell.

SECTION 02277
GEOMEMBRANE

PART 1 GENERAL

1.01 SUMMARY

Section includes furnishing and installing geomembrane as part of landfill liner and cover system construction, which will be done by others.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM D 6693, Standard Test Method for Tensile Properties of Plastics.
2. ASTM D 746, Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
3. ASTM D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
4. ASTM D 1204, Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
5. ASTM D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastomer.
6. ASTM D 1505, Standard “Test Method for Density of Plastics by the Density-Gradient Technique.
7. ASTM D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
8. ASTM D 4437, Standard Practice for Determining the Integrity of Field Seams Used in joining Flexible Polymeric Sheet Geomembranes.
9. ASTM D 5596, Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
10. ASTM D 5994, Standard Test Method for Measuring Nominal Thickness of Textured Geomembrane.
11. ASTM D 4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

B. FTM Standard Number 101C, Method 2065, Puncture Resistance and Elongation Test (1/8 inch Radius Probe Method).

C. GRI Test Method GM6, "Pressurized Air Channel Test for Dual Seamed Geomembranes".

D. GRI Test Method GM13 “Standard Specification for HDPE Geomembranes”.

E. GRI Test Method GM19 “Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes”.

1.03 SUBMITTALS

A. Submit the following to the CQA Firm, for review and approval, no later than 14 calendar days prior to scheduled shipment of geomembrane:

1. Documentation of manufacturers' qualifications as specified in subsection 1.04.A of this Section.

2. Manufacturer's quality control program manual, or descriptive documentation.

3. List of material properties and samples of the material.

4. Manufacturers' certification that the products to be furnished will comply with all product specifications in this section.

5. Documentation of installers' qualifications, as specified below and in subsection 1.04.E of this Section.

a. Submit a list of at least ten completed facilities. For each installation, provide: name and type of facility; its location; the date of installation; name and telephone number of Owner, Design Engineer, Manufacturer, Fabricator, if applicable; name and telephone number of contact at the facility; thickness of geomembrane and surface area of the installed geomembrane; and type of seaming, patching, and tacking equipment.

b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and all technicians to be assigned to this project.

B. Shop Drawings

1. Submit copies of shop drawings for approval as soon as possible after award of contract. Shop drawings shall show a proposed installation panel layout identifying seams and details. The layout diagram shall indicate the location of pre-assembled panels.

2. Placement of geomembrane will not be allowed to proceed until CQA Firm has received and approved the shop drawings. Any proposed deviation from these documents shall be submitted in writing to the CQA Firm a minimum of one to two working days prior to the scheduled start of geomembrane installation and will be accepted/rejected by the CQA Firm prior to start of installation activities.

C. Submit the following to the CQA Firm for review and approval no later than one calendar day prior to shipment of the products:

1. Origin and quality control certificates from the supplier of the resin used to manufacture the geomembrane, and certification that the properties of the resin meet the requirements for the project.

2. The manufacturers' quality control certifications, including results of source quality control testing of the products, as specified in subsection 2.01 of this Section, to verify that the materials supplied for the project are in compliance with all product specifications in this Section. The certifications shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.

D. No geomembrane shall be deployed until the certifications and quality control certificates are submitted to and approved by the CQA Firm. Should geomembrane material be deployed prior to CQA Firm's approval, it shall be at sole risk of the Geomembrane Installer and Contractor, and if the material does not meet project specifications, it shall be removed from the project at the expense of the Contractor.

E. Additional Submittals (In-Progress and at Completion):

1. Quality Control test results (refer to subsection (2.01.A.4).

2. Manufacturer's warranty (refer to subsection 1.06).

3. Liner installation guarantee (refer to subsection 1.07).
4. Inventory of geomembrane rolls received on-site (refer to subsection 1.05.C).
5. Daily written acceptance of subgrade surface (refer to subsection 3.01.C).
6. Low temperature-seaming procedures, if applicable (refer to subsection 3.03.A).
7. Pre-qualification test seam samples (refer to subsection 3.05.A.3).
8. Non-destructive field seam test results (refer to subsection 3.05.13.1).
9. Destructive field seam test results (refer to subsection 3.05.C.5).
10. As-built survey drawing, as discussed in subsection 3.06.

1.04 QUALITY CONTROL/QUALITY ASSURANCE

A. Owner will retain the services of independent inspection and testing firms (Geosynthetics Quality Assurance Firm and Geosynthetics Quality Assurance Laboratory) to perform quality control and to check conformance of the materials and field seaming with the specification.

B. Codes and Standards: Perform all work in compliance with applicable requirements of governing authorities having jurisdiction.

C. Furnish all labor, materials, equipment, services, incidentals and other items necessary for the placement and installation of geomembrane as shown on the Contract Drawings and as specified herein.

D. Manufacturer's Qualifications: The manufacturer shall be a specialist in the manufacture of geomembrane of the type and shall have at least five years experience in the manufacture of such geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 10,000,000 square feet of the specified type of geomembrane during the last five years.

E. Installer's Qualifications

1. The Geomembrane Installer shall be the manufacturer or an approved contractor trained and licensed to install the manufacturers geomembrane.

2. The Geomembrane Installer shall be a specialist in the installation of geomembranes of the type specified and shall have at least five years experience in the installation of such geomembranes.

3. Installation shall be performed under the constant direction of a single Field Installation Supervisor who shall remain on site and be in responsible charge, throughout the liner installation, for liner layout, seaming, patching, testing, repairs, and all other activities by the Installer.

4. Seaming shall be performed under the direction of a Master Seamer (who may also be the Installation Supervisor or Crew Foreman). The Master Seamer shall have experience in the same type of geomembrane specified, using the same type of seaming apparatus specified in the current project. This Installation Supervisor and/or Master Seamer shall be present whenever seaming is performed.

5. All seaming, patching, other welding operations, and testing shall be performed by qualified technicians trained by the Geomembrane Installer.

1.05 DELIVERY, STORAGE AND HANDLING

A. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall clearly state the manufacturer's name, product identification, lot number, material thickness, roll number, roll dimensions, and roll weight.

B. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

C. Provide all labor and equipment required to assist the CQA Firm in the observation of materials delivered to the site. Generate, update and submit to the CQA Firm an inventory of geomembrane rolls received on-site from the manufacturer/distributor. The inventory shall include all the information appearing on the label of each roll.

D. Rolls shall be stored on a prepared surface (not wooden pallets) and shall not be stacked more than two rolls high.

1.06 MATERIAL WARRANTY

A. Membrane manufacturer shall warrant the membrane material against manufacturing defects and material degradation in the outdoor exposure for a period of 20 years from the date of installation.

B. The manufacturer shall provide new material to replace, on a prorated basis over the remaining life of the membrane, any material, which fails from the above causes within the warranty period.

C. The manufacturer shall furnish the CQA Firm with a written warranty covering the requirements of this paragraph.

1.07 LINER INSTALLATION GUARANTEE

A. Guarantee the membrane installation against defects in installation and workmanship for one year commencing with the date of final acceptance.

B. The guarantee shall include the services of qualified service technicians and all material required for the repairs at no expense to the Owner.

1.08 GEOMEMBRANE PRE-CONSTRUCTION MEETING

A. A Geomembrane Pre-Construction Meeting shall be held at the site prior to installation of the geomembrane. As a minimum, the meeting shall be attended by the Geomembrane Installer, Project Manager, CQA Firm and/or his representative, and Contractor.

B. Topics for this meeting shall include:

1. Responsibilities of each party.
2. Lines of authority and communication.
3. Methods for documenting and reporting, and for distributing documents and reports.
4. Procedures for packaging and storing archive samples.
5. Review of time schedule for all installation and testing.
6. Review of panel layout and numbering systems for panels and seams.
7. Preparation of the as-built panel and seam drawing.

C. The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Manufacturing Quality Control

1. Every effort shall be made to minimize the number of lots of geomembrane needed to complete the work.

2. The following test methods shall be used by the manufacturer for the quality control/quality assurance of the geomembrane prior to delivery.

    a. Density - ASTM D 1505/D 792 (min. one test per 200,000 lbs);

    b. Carbon Black Content - ASTM D 1603 or 4218 (min. one test per 20,000 lbs);

    c. Carbon Black Dispersion - ASTM D 5596 (min. one test per 45,000 lbs);

    d. Thickness - ASTM D 5994 (min. one test per roll);

    e. Tensile Properties - ASTM D 6693 (min. one test per 20,000 lbs); and

    f. Puncture Resistance - ASTM D 4833 (min. one test per 45,000 lbs).

3. Results of environmental stress crack resistance test (ASTM D 5397 - single point). At a minimum, test value shall be 200 hr. and test shall be performed once every resin lot.

4. Quality Control certificates, signed by a responsible party employed by the Manufacturer, shall be submitted to the CQA Firm prior to the installation of the geomembrane. The certificates shall include roll identification numbers, testing procedures, and results of quality control tests.

B. Conformance Testing

1. Upon the delivery of the geomembrane rolls to the project site, a qualified representative of the CQA Firm shall obtain samples of the material at a frequency of at least one sample per 100,000 square feet and at least one sample per lot of material shipped, and forward the samples to the Geosynthetics Quality Assurance Laboratory for conformance testing.

2. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The CQA Finn representative shall mark the machine direction on the samples.

3. Conformance testing shall include the following tests, as a minimum:

    a. Density or Specific Gravity - ASTM D 1505 or ASTM D 792 Method A

    b. Carbon Black Content - ASTM D 1603 or 4218

    c. Carbon Black Dispersion - ASTM D 5596

    d. Thickness - ASTM D 5994 (textured) or ASTM D 5199 (smooth)

e. Tensile Properties (Yield Strength, Break Strength, Elongation at Yield and Elongation at Break) - ASTM D 6693, Type IV or GRI-GM-13

f. Puncture Resistance – ASTM D 4833

g. Tear Resistance - ASTM D 1004, Die C

2.02 GEOMEMBRANE

A. The geomembrane shall consist of new, first quality products designed and manufactured specifically for the purpose of this work, which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes. The geomembrane shall be an unmodified seamless, high-density polyethylene (HDPE) containing no plasticizers, fillers, chemical additives, or extenders. The geomembrane shall be textured on both sides and shall be supplied as a continuous sheet with no factory seams in rolls. The roll length and width shall be maximized to provide the largest manageable sheet for the fewest field seams.

B. The geomembrane material shall be produced free of holes, blisters, undispersed raw materials or any signs of contamination by foreign matter. Defects shall be repaired by replacement and by using the extrudate welding technique in accordance with the manufacturer's recommendations.

C. The geomembrane shall be 60-mil HDPE (textured) for bottom and slope lining.

D. Physical Properties

1. Geomembrane for the bottom lining and final cover systems shall meet or exceed the following specifications as shown in Table 02277-1.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. The subgrade shall be prepared as specified in Section 02200. The subgrade shall be smooth and uniform, and free of all trash and debris, prior to installation of the geomembrane.

B. The Geomembrane Installer and the CQA Firm representative shall walk over the surface to be covered with geomembrane on each day's operations prior to placement of geomembrane.

C. The Geomembrane Installer shall provide to the CQA Firm written acceptance daily for the surface to be covered by geomembrane in that day's operations. The surface shall be maintained as acceptable during geomembrane installation.

D. Subgrade damaged by construction equipment during the geomembrane deployment operation shall be repaired prior to placement of the geomembrane. The repairs shall be approved by the CQA Firm or his representative.

E. Subgrade damaged by erosion, rutting, or other means following geomembrane deployment shall be exposed and the damage repaired. Repairs shall be in accordance with Section 02220. The subgrade shall be re-approved in accordance with subsection 3.01.C of this section.

3.02 GEOMEMBRANE PLACEMENT

A. The geomembrane shall be installed as shown on the Drawings.

B. Panel Nomenclature

1. A field panel is defined as unit of geomembrane, which is to be seamed in the field. A field pane is a roll or a portion of a roll cut in the field. The CQA Firm shall be responsible to ensure that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be as simple and logical as possible and shall be agreed upon by the Project Manager, Installer and CQA Firm.

2. The CQA Firm shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code shall be used for all quality assurance records.

C. Panel Deployment Procedure

1. The CQA Firm shall review the panel deployment progress of the Installer and advise the Project Manager on changes in panel deployment. The CQA Firm shall also review the panel deployment for suitability to actual field condition such as issues relating to wind, rain, soil liner desiccation and other site-specific conditions. The CQA Firm shall verify that the condition of the underlying soil does not change detrimentally during installation. The CQA Firm shall record the identification code, location, and date of installation of each field panel.

D. Deployment Weather Conditions

1. Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment.

2. The normal acceptable weather conditions for seaming are as follows:

   a. Ambient temperature between 32° F and 104° F.

   b. Dry conditions (no precipitation or other excessive moisture).

   c. No excessive winds.

3. Ambient temperature shall be measured and ambient conditions appraised by the CQA Firm in the area in which the panels area to be placed.

4. The CQA Firm shall inform the Project Manager of any weather-related problems, which may not allow geomembrane placement to proceed. The Project Manager will determine if the installation is to be stopped or special procedures are to be used.

E. Method of Deployment

1. Before the geomembrane is handled on site, the CQA Firm shall verify that deployment equipment and method of deployment proposed by the Installer to be used on the site is adequate and does not pose risk of damage to the geomembrane or underlying subgrade. If vehicles are used which must operate on the geomembrane, driver shall proceed with caution during deployment of the geomembrane to prevent spinning of tires, sharp turns and quick stops. During handling, the CQA Firm shall observe and verify that the Installer's personnel handle the geomembrane with care.

2. The CQA Firm shall verify the following:

   a. Equipment used does not damage the geomembrane or underlying subgrade by handling.

   b. The prepared surface underlying the geomembrane is acceptable immediately prior to geomembrane placement.

   c. Geosynthetic elements immediately underlying the geomembrane are clean and free of debris.

d. Personnel do not smoke or wear damaging shoes while working on the geomembrane, or engage in other activities, which could damage the geomembrane.

e. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting roll.

f. The method used to place the panels minimizes wrinkles especially differential wrinkles between adjacent panels.

g. Adequate temporary lading and/or anchoring (such as sandbags or tires), not likely to damage the geomembrane, are placed to prevent uplift by wind. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels.

h. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where repeated traffic use may be expected.

i. Liner has promptly been anchored in trench where applicable.

The CQA Firm shall notify the Project Manager if the above conditions are not fulfilled.

F. Damage and Defects

1. Upon delivery to the site, the CQA Firm shall conduct a surface observation of all rolls for defects and for damage. This examination shall be conducted without unrolling rolls unless defects or damages are found or suspected. The CQA Firm shall advise the Project Manager, in writing, or any rolls or portions of rolls, which should be rejected and removed from the site because they have severe flaws, and/or minor repairable flaws.

2. The CQA Firm shall examine each panel, after placement and prior to seaming, for damage and/or defects. The CQA Firm shall advise the Project Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels, or portions of damaged panels, which have been rejected shall be marked and their removal from the work area recorded by the CQA Firm. Repairs shall be made using procedures described in 3.06 of this section.

G. Writing on the Liner

To avoid confusion, the Installer and the CQA Firm shall each use different colored markers or other materials approved by the Project Manager that are readily visible for writing on the geomembrane. The markers used must be semi-permanent and compatible with the geomembrane. The Installer shall use a white marker to write on the geomembrane while the CQA Firm shall use a yellow marker.

3.03 FIELD SEAMING

A. Seam Layout

1. Before installation begins, the Installer shall provide the Project Manager and the CQA Firm's with a panel layout drawing. The drawing shall present all the proposed seams of the lining system at the facility. The CQA Engineer shall review the panel layout drawing and verify that it is consistent with accepted industry standards.

2. In general, seams should be oriented parallel to the line of maximum slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than five feet from the toe or crest of the slope, or from areas of potential stress concentrations, unless otherwise authorized by the Project Manager.

3. Horizontal seams shall be allowed under the following conditions:

   a. Seams are offset in adjacent panels by one panel width.

   b. Seams are "shingled" downhill.

4. A seam numbering system compatible with the panel numbering system shall be used by the CQA Firm.

B. Accepted Seaming Methods

1. Approved processes for field seaming are fusion and extrusion welding. Proposed alternate processes shall be documented and submitted by the Installer to the Project Manager for approval. The Project Manager shall submit all documentation regarding seaming methods to be used to the CQA Firm for review.

2. Fusion Process

   a. The CQA Firm shall log ambient, seaming apparatus and geomembrane surface temperatures at appropriate intervals and report any noncompliance to the Project Manager.

   b. The CQA Firm shall also verify that:

      i. The Installer maintains on-site the number of spare operable seaming apparatus agreed at the pre-construction meeting.

      ii. Equipment used for seaming is not likely to damage the geomembrane.

      iii. The electrical generator is placed on a smooth base such that no damage occurs to the geomembrane and any fuel spills are promptly cleaned up. Fuel shall not be stored on the liner surface.

      iv. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs to the geomembrane.

      v. A movable protective layer is used as required by the Installer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets and to prevent debris from collecting around the pressure rollers.

      vi. In general, the geomembrane panels shall be aligned to have an overlap of four to six inches for fusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

      vii. No solvent or adhesive is used.

      viii. The geomembrane is protected from damage in heavy traffic areas.

3. Extrusion Process

   a. The CQA Firm shall log ambient, seaming apparatus and geomembrane surface temperatures at appropriate intervals and report any noncompliance to the Project Manager.

b. The CQA Firm shall also verify that:

i. The Installer maintains on-site the number of spare operable seaming apparatus agreed at the pre-construction meeting.

ii. Equipment used for seaming is not likely to damage the geomembrane.

iii. Prior to beginning a seam, the extruder is purged until all heat degraded extrudate has been removed from the barrel.

iv. Clean and dry welding rods or extrudate pellets are used.

v. The electric generator is placed on a smooth base that no damage occurs to the geomembrane.

vi. Grinding is completed no more than one hour prior to seaming.

vii. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs to the geomembrane.

viii. The geomembrane is protected from damage in heavy traffic areas.

ix. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instances shall exposed grinding marks extend more than 1/inch from the finished seamed area.

x. In general, the geomembrane panels are aligned to have a nominal overlap of three inches for extrusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

xi. No solvent or adhesive is used.

xii. The procedure use to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any temporary welding apparatus is controlled such that the geomembrane is not damaged.

C. Seam Preparation

1. The CQA Firm shall verify that prior to seaming; the Installer made the seam area clean and free of moisture, dust, dirt, debris or foreign material of any kind. If seam overlap grinding is required, the CQA Firm must ensure that the process is completed by the Installer according to the Manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane. The CQA Firm shall also verify that seams are aligned by the Installer with the fewest number of wrinkles and "fishmouths".

D. Trial Seams

1. Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once each five hours, for each production seaming apparatus used that day. Trial seams shall be made under the same conditions as production seams.

2. The trial seam sample shall be at least five feet long by one foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in Section 3.03 B. Three specimens shall be cut from the sample with one-inch wide die.

3. The specimens shall be tested in peel and shear using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute. They should not fail in the seam as described in Section 3.05 E. If a specimen fails, the entire trial seam operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. The CQA Firm shall observe all trial seam procedures.

4. The remainder of the successful trial seam sample shall be retained until project completion in the CQA Firm's archives for possible laboratory testing. Each sample shall be assigned a number and marked accordingly by the CQA Firm, who shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.

5. If agreed upon by the Project Manager and the CQA Engineer, and documented by the CQA Engineer in his daily report, the remaining portion of the trial seam sample can be subjected to destructive testing as indicated in Section 3.05 F. If a trial seam sample fails a test conducted by the CQA Laboratory, then a destructive seam test sample shall be taken from each of

the seams completed by the seamer during the **shift related the subject trial** seam. These samples shall be forwarded to the CQA Laboratory and, if they fail the tests, the procedure indicated in Section 3.05 G shall apply. The conditions of this paragraph shall be considered satisfied for a given seam if a destructive seam test sample has already been taken.

E. General Seaming Procedures

1. During general seaming, the CQA Firm shall ensure the following:

   a. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of six inches beyond the cut in all directions.

   b. If seaming operations are carried out at night, adequate illumination shall be provided.

   c. Seaming shall extend to the outside edge of panels placed in the anchor trench.

   d. All cross seam tees should be extrusion welded to a minimum distance of four inches on each side of the tee.

   e. A firm substance may be required to be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

   The CQA Firm shall verify that the above seaming procedures or any other procedures agreed upon and indicated in the project Quality Assurance Plan are followed, and shall inform the Project Manager of any nonconformance.

F. Seaming Weather Conditions

1. Cold Weather Conditions

   a. To ensure a quality installation, if seaming is conducted when the ambient temperature is below 32° F, the following conditions shall be met:

i. Geomembrane surface temperatures shall be determined by the CQA Firm at intervals of at least once per 100 feet of seam length to determine if preheating is required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32° F.

ii. For fusion welding, preheating may be waived by the Project Manager based on a recommendation for the CQA Engineer, if the Installer demonstrates to the CQA Engineer's satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

iii. If preheating is required, the CQA Firm shall observe all areas of geomembrane that have been preheated by a hot air device prior to seaming, to ensure that they have not been overheated.

iv. Care shall be taken to conform that wind chill does not adversely affect the pre-heat requirements specified for welding. It may be necessary to provide wind protection for the seam area.

v. All preheating devices shall be approved prior to use by the Project Manager.

vi. Sheet grinding may be performed before preheating, if applicable.

vii. Trial seaming, as described in Section 3.04 D, shall be conducted under the same ambient temperature conditions as the production seams. At the option of the CQA Firm, additional destructive tests may be required for any suspect areas.

3.04 NON-DESTRUCTIVE SEAM TESTING

A. Concept

The Installer shall nondestructively test all field seams over their full length using an air pressure test (for double fusion seams only), a vacuum test or other approved method. Air pressure testing and vacuum testing are described in Sections 3.04 B and 3.04 C, respectively. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantitative information on seam strength. Nondestructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. For all seams, the CQA Firm shall:

1. Observe nondestructive testing procedures.
2. Record location, data, test unit number, name of tester, and outcome of all testing.
3. Inform the Installer and Project Manager of any required repairs.

B. Air Pressure Testing

1. Air pressure testing is applicable to double fusion welding which produces a double seam with an enclosed space.

   a. The equipment for air pressure testing shall consist of the following:

      i. An air pump (manual or motor driven), equipped with pressure gauge and capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane.

      ii. A rubber hose with fittings and connections.

      iii. A sharp hollow needle or other pressure feed device, approved by Project Manager.

   b. The following procedures shall be followed:

      i. Seal both ends of the seam to be tested.

      ii. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.

      iii. Insert a protective cushion between the air pump and the geomembrane.

      iv. Pressurize the air channel to a pressure of approximately 30 psi. Close valve, allow two minutes for pressure to stabilize, and sustain pressure for at least five minutes.

      v. If loss of pressure exceeds the maximum permissible pressure differential as outlined in the project specifications or does not stabilize, locate faulty area and repair in accordance with Section 3.06 C.

      vi. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Seam the cut end of the air channel.

      vii. Remove needle or other approved pressure feed device and seal the hole in the geomembrane.

C. Vacuum Testing

1. Vacuum testing is applicable to extrusion welding and to non-seam areas of the liner.

   a. The equipment shall consist of the following:

      i. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.

      ii. A pump assembly equipped with a pressure controller and pipe connections.

      iii. A rubber pressure/vacuum hose with fittings and connections.

      iv. A soapy solution. (CQA Firm shall ensure solution makes bubbles when air is passed through. Windshield washer fluid shall be used as anti-freeze in cold weather.)

      v. A bucket and wide paintbrush, or other means of applying the soapy solution.

   b. The following procedures shall be followed:

      i. Wet a strip of geomembrane approximately 12 inches by 48 inches with the soapy solution.

      ii. Place the box over the wetted area.

      iii. Close the bleed valve and open the vacuum valve.

      iv. Ensure that a leak-tight seal is created.

      v. Energize the vacuum/venturi pump and reduce the applied pressure to approximately five psi (10 in of Hg) gauge.

      vi. For a minimum of ten seconds, apply vacuum with the box placed and maintaining a seal, examine the geomembrane through the viewing window for the presence of soap bubbles.

      vii. If no bubble appears after ten seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum three inches overlap, and repeat the process.

      viii. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 3.06 C. D. Test Failure Procedures.

2. The Installer shall complete any required repairs in accordance with Section 3.06. For repairs, the CQA Engineer shall:

a. Observe the repair and testing of the repair.

b. Mark on the geomembrane that the repair has been made.

c. Document the repair procedures and test results.

3.05 DESTRUCTIVE SEAM TESTING

A. Concept

1. The purpose of destructive tests is to evaluate seam strength. Destructive seam tests shall be performed at selected locations. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

B. Location and Frequency

1. The CQA Firm shall select where seam samples will be cut out for laboratory testing. The frequency and locations shall be established as follows:

   a. A minimum frequency of one test location per 500 feet of production seam length. This frequency is to be determined as an average taken throughout the entire facility.

   b. Test locations shall be determined during seaming at the CQA Firm's discretion. Special consideration shall be given to locations where the potential for imperfect welding, such as overheating, contamination, and offset welds exist.

2. The Installer shall not be informed in advance of the locations where the seam samples will be taken.

C. Sampling Procedures

1. The Installer shall cut samples at locations chosen by the CQA Firm as the seaming progresses so that laboratory test results are available before the geomembrane is covered by another material. The CQA Firm shall:

   a. Observe sample cutting.

   b. Assign a number to each sample, and mark it accordingly.

   c. Record sample location on layout drawing.

   d. Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

2. All holes in the geomembrane resulting from destructive seam sampling shall be repaired in accordance with repair procedures described in Section 3.06 C immediately following receipt of successful test results. The continuity of the new seams in the repaired area shall be tested according to Section 3.04 C.

D. Sample Dimensions

1. At each sampling location, two types of samples shall be taken by the Installer. First, two specimens for field-testing should be taken. Each of these samples shall be cut with a one inch wide die, with the seam centered parallel to the width. The distance between these two samples shall be 30 inches. If both samples pass the field test described in Section 3.05 E, a sample for laboratory testing shall be taken.

2. The sample for laboratory testing shall be located between the samples for field-testing. The sample for laboratory testing shall be 12 inches wide by 30 inches long with the seam centered lengthwise. The sample shall be cut into two parts and distributed as follows:

   a. One 12 inches wide by 18 inches long portion for conformance testing by the CQA Laboratory.

   b. One 12 inches wide by 12 inches long portion to the CQA Firm.

3. Final determination of the sample sizes shall be made at the pre-construction meeting.

E. Field Testing

1. The three one inch wide specimens mentioned in Section 3.03 D and Section 3.05D shall be tested in the field using a tensiometer for peel and shear and shall not fail according to the criteria in the project specifications. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If it is non-conforming, the seam should be repaired in accordance with Section 3.05 G. Final judgment regarding seam acceptability, based on the conformance criteria provided in the project specifications, rests with the CQA Engineer.

2. The CQA Firm shall witness all field tests and mark all samples and portions with their number. The CQA Firm shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus

temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

F. Laboratory Testing (on or off-site)

1. Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the CQA Firm in a manner, which will not damage the test sample. The sample shall be shipped as soon as possible to expedite laboratory testing. The CQA Firm will be responsible for storing the archive samples. Test samples shall be tested by the CQA Laboratory.

2. Testing shall include seam strength and peel adhesion (ASTM D4437). The minimum acceptable values to be obtained in these tests are provided in Section 2.02 D. At least four specimens shall be tested successfully, each in both shear and peel. Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear). A passing test shall meet the minimum acceptable values in at least four of the five specimens tested for each method.

3. The CQA Laboratory shall provide test results within 24 hours of receiving the samples. The CQA Engineer shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Project Manager.

G. Destructive Test Failure

1. When a sample fails a destructive test, whether that test is conducted by the CQA Laboratory or by field tensiometer, the Installer has two options:

   a. The Installer can repair the seam between any two passing destructive test locations.

   b. The Installer can trace the welding path to an intermediate location ten feet minimum from the point of the failed test in each direction and take a sample with a one inch wide die for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is repaired between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be repaired.

2. All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing

laboratory destructive tests of trial seam samples taken as indicated in Section 3.03 D may be used as a boundary for the failing seam. In cases exceeding 150 feet of repaired seam, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Section 3.06.

3. The CQA Firm shall document all actions taken in conjunction with destructive test failures.

3.06 DEFECTS AND REPAIRS

A. Identification

1. All seams and non-seam areas of the geomembrane shall be examined by the CQA Firm for identification of defects, holes, blisters, undispersed raw materials, large wrinkles and any sign of contamination by foreign matter. The geomembrane surface shall be cleaned by the Installer prior to examination if the CQA Firm determines that the amount of dust or mud inhibits examination.

B. Evaluation

1. Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Section 3.04. Each location, which fails the nondestructive testing, shall be marked by the CQA Firm and repaired by the Installer. Work shall not proceed with any materials, which will cover locations, which have been repaired until successful nondestructive and/or laboratory tests are obtained.

2. When seaming of the geomembrane is completed, and prior to placing overlying materials, the CQA Firm shall indicate to the Project Manager any large wrinkles, which should be cut and reseamed by the Installer. The number of wrinkles to be repaired should be kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation period, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over on to itself, which is generally a wrinkle that extends 12 inches from the subgrade. Seams produced while repairing wrinkles shall be nondestructively tested.

3. When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of

cover materials shall be observed by the CQA Firm to ensure that wrinkle formation is minimized and that, in all cases, the geomembrane is not folded over on itself.

C. Repair Procedures

1. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Project Manager, Installer, Designer, and CQA Firm.

   a. The repair procedures available include:

      i. Patching, used to repair holes, tears, undispersed raw materials, and contamination by foreign matter.

      ii. Spot welding used to repair pinholes, or other minor, localized flaws.

      iii. Capping, used to repair large lengths of failed seams.

      iv. Extrusion welding the flap, used to repair areas of inadequate fusion seams which have an exposed edge.

      v. Removing bad seam and replacing with a strip of new material welded into place.

   b. For any repair method, the following provisions shall be satisfied:

      i. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be ground no more than one hour prior to the repair.

      ii. All surfaces shall be clean and dry at the time of repair.

      iii. All seaming equipment used in repairing procedures shall meet the requirements of the project Quality Assurance Plan.

      iv. Patches or caps shall extend at least six inches beyond the edge of the defect and all corners of patches shall be rounded with a radius of approximately three inches.

D. Repair Verification

1. The CQA Firm shall observe all nondestructive testing of repairs and shall record the number of each repair, date and test outcome. Each repair shall be nondestructively tested using the methods described in Section 3.04 as appropriate. Repairs, which pass the nondestructive test, shall be taken as an indication of an adequate repair. Repairs more than 150

consecutive feet long require destructive test sampling. Failed tests require that the repair shall be redone and retested until a passing test result.

3.07 GEOMEMBRANE PROTECTION

A. The quality assurance procedures indicated in this Section are intended only to assure that the installation of adjacent materials does not damage the geomembrane. The quality assurances of the adjacent materials themselves are covered in separate Sections of this manual.

B. Soils

1. A copy of the project specifications prepared by the Designer for placement of soils shall be given to the CQA Engineer by the Project Manager. The CQA Engineer shall verify that these project specifications are consistent with geosynthetic state-of-practice such as:

   a. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32° F nor above 104° F unless otherwise specified.

   b. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.

   c. Equipment used for placing soil shall not be driven directly on the geomembrane.

   d. A minimum thickness of one foot of soil is specified between a light dozer, ground pressure of five-psi or lighter, and the geomembrane.

   e. In any areas traversed by construction traffic (any vehicles other than deployment equipment approved by the Project Manager) the soil layer shall have a minimum thickness of three feet. This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.

2. The CQA Firm shall measure soil thickness and verify that the required thickness is present. The CQA Firm must also verify that final thickness is consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage is unlikely. The CQA Engineer shall inform the Project Manager if the above conditions are not fulfilled.

C. Sumps and Appurtenances

1. A copy of the plans and project specifications prepared by the Designer for sumps and appurtenances shall be given by the Project Manager to the CQA Firm. The CQA Firm shall review these plans and verify that:

   a. Installation of the geomembrane in sump and appurtenant areas, and connection of geomembrane to sumps and appurtenances have been made according to project specifications.

   b. Extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas.

   c. The geomembrane has not been visibly damaged while making connections to sumps and appurtenances.

   d. A representative of the CQA Firm shall be present at all times when the Installer is welding geomembrane to appurtenant structures.

2. The CQA Firm shall inform the Project Manager in writing if the above conditions are not fulfilled.

D. Concrete

1. A copy of the project specifications prepared by the Designer for placement of concrete shall be given by the Project Manager to the CQA Firm. The CQA Firm shall verify that these specifications are consistent with the state-of practice, including the use of geosynthetic layers between concrete and geomembrane. The CQA Firm shall verify that geosynthetic layers are placed between the concrete and the geomembrane according to design specifications. The CQA Firm will also verify that construction methods used are not likely to damage the geomembrane.

E. For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test seam. The Geomembrane Installer shall then take more destructive test portions at locations indicated by the CQA Firm and the same laboratory tests required of test seams shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams and all seams represented by the destructive test location shall be repaired with a cap-strip.

The cap-strip shall be non-destructively tested and repaired, as required, until adequacy of the seams is achieved.

F. A passing non-destructive test of field seams and repairs shall be considered to indicate the adequacy of field seams and repairs.

3.08 ANCHOR TRENCH

Construct as specified in Section 02220.

3.09 DISPOSAL OF SCRAP MATERIALS

On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap material in a location approved by the Owner, remove equipment used in connection with the work herein, and shall leave the premises in a neat acceptable manner. No scrap material shall be allowed to remain on the geomembrane surface.

END OF SECTION

TABLE 02277-1
60 mil HDPE Textured Specifications

Test	Method(1)	Testing Frequency	Min. Requirements
Resin Manufacturer			
Density	ASTM D 1505 ASTM 792, Meth B	200,000 lb and per batch	≥ 0.932 g/cm^3
Melt Flow Index	ASTM D 1238 (190°C/2.16 kg)	200,000 lb and per batch	≤ 1.0 g / 10 min.
Manufacturer's Quality Control			
Thickness, nominal	ASTM D 5994	Each Roll	60 mil
Thickness, Min. ave	ASTM D 5994	Each Roll	57 mil
Thickness, lowest indiv. For 8 of 10 spec.	ASTM D 5994	Each Roll	54 mil
Thickness, lowest indiv. For 1 of 10 spec.	ASTM D 5994	Each Roll	51 mil
Asperity Height (Min. ave.)	GRI GM12	Each Roll	10 mil
Density	ASTM D 1505	Per 200,000 lb.	0.94 g/cm^3
Carbon Black Dispersion [2]	ASTM D 5596	Per 45,000 lb	Category 1 or 2
Carbon Black Content	ASTM D 1603 ASTM D 4218	Per 20,000 lb	2 to 3 %
Tensile Properties:			
Break Strength Elongation Yield Strength Elongation	ASTM D 6693 Type IV Dumbbell, 2 ipm G.L. = 2.0 inches	Per 20,000 lb	 90 lb/in 100% 126 lb/in 12%
Tear Resistance	ASTM D 1004	Per 45,000 lb	42 lb
Puncture Resistance	ASTM D 6392	Per 45,000 lb	90 lb
Conformance Testing by CQA Engineer			
Thickness, nominal	ASTM D 5994	1 per 100,000 sf	60 mil
Thickness, Min. ave	ASTM D 5994		57 mil
Thickness, lowest indiv. For 8 of 10 spec.	ASTM D 5994		54 mil
Thickness, lowest indiv. For 1 of 10 spec.	ASTM D 5994		51 mil
Asperity Height (Min. ave.)	GRI GM12	1 per 100,000 sf	16 mil
Density	ASTM D 1505	1 per 100,000 sf	0.94 g/cm^3
Carbon Black Dispersion [2]	ASTM D 5596	1 per 100,000 sf	Category 1 or 2
Carbon Black Content	ASTM D 1603	1 per 100,000 sf	2 to 3 %
Tensile Properties:			
Break Strength Elongation Yield Strength Elongation	ASTM D 6693 Type IV Dumbbell, 2 ipm G.L. = 2.0 inches	1 per 100,000 sf	 115 lb/in 100% 132 lb/in 12%
Tear Resistance	ASTM D 1004	1 per 100,000 sf	45 lb
Trial Seams			
Shear	ASTM D 6392	Every 5 (five) hours of seaming.	Shear 121 ppi
Peel Fusion[3]			Peel 98 ppi
Peel Extrusion[3]			Peel 78 ppi
Destructive Seam Testing			
Shear	ASTM D 6392	1 per 500 linear feet (LF) of seam	Shear 121 ppi
Peel Fusion[3]			Peel 98 ppi
Peel Extrusion[3]			Peel 78 ppi
Non-destructive Seam Field Testing			
Air Pressure	GRI GM6	Dual track fusion weld seams	Min 27 psi, held for 5 minutes; losing ≤ 3 psi; puncture opposite end after test to check for continuity
Vacuum	ASTM D 4437	Extrusion Seams	3 to 5 in Hg held for ≥ 15

1. Test to be performed according to the latest test method as approved by the certifying engineer.
2. Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
3. Four (4) out of five (5) specimens must meet the requirements. For peel adhesion, seam separation shall not extend more than 10 percent in the same interface. Testing shall be discontinued when the sample has visually yielded a sample.

SECTION 02278
GEOTEXTILES AND GEOCOMPOSITES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes furnishing and installing geotextile and geocomposite as part of the Landfill bottom liner and leachate collection construction.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM D 413, Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.
2. ASTM D 7179, Standard Test Method for Determining Geonet Breaking Force.
3. ASTM D 1505, Standard Test Method for Density of Plastics by the Density Gradient Technique.
4. ASTM D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
5. ASTM D 7005, Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites.
6. ASTM D 3786, Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Busting Strength Tester Method.
7. ASTM D 4218, Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
8. ASTM D 4354, Standard Practice for Sampling of Geosynthetics for Testing.
9. ASTM D 4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
10. ASTM D 4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
11. ASTM D 4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.

12. ASTM D 4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

13. ASTM D 4716, Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.

14. ASTM D 4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.

15. ASTM D 4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

16. ASTM D 5199, Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.

17. ASTM D 5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

1.03 SUBMITTALS

A. Submit the following to the CQA Engineer, for review and approval, no later than 14 calendar days prior to scheduled shipment of geotextile and geocomposites:

1. Documentation of manufacturers' qualifications as specified in subsection 1.04.A of this Section.

2. Manufacturer's quality control program manual or descriptive documentation.

3. List of material properties and samples of the material.

4. Manufacturers' certification that the products to be furnished will comply with all product specifications in this section.

5. Documentation of installers' qualifications, as specified in subsection 1.04.13 of this Section.

B. Submit the following to the CQA Engineer for review and approval no later than one calendar day prior to shipment of the products:

1. The manufacturers' quality control certifications, including results of source quality control testing of the products, as specified in subsection 2.01 of this Section, to verify that the materials supplied for the project are in compliance with all product specifications in this Section. The certifications shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or

Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.

C. No geotextile or geocomposite shall be deployed until the manufacturer's quality control certifications are submitted to and approved by the CQA Engineer. Should the material be deployed prior to CQA Engineer's approval, it shall be at sole risk of the Installer and Contractor, and if the material does not meet project specifications, it shall be removed from the project at the expense of the Contractor.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

A. Manufacturer's Qualifications: The manufacturers shall be specialists in the manufacture of geotextile and/or geocomposite, as applicable. Geotextile and drainage geocomposite manufacturers shall have at least five years experience in the manufacture of such material.

B. Installer's Qualifications

1. The Installer shall be the manufacturer or an approved contractor trained and licensed (if applicable) to install the manufacturer's product.

2. The Installer shall have at least five years experience in the installation of the product. The Installer shall have installed at least 1 million square feet of the product during the last five years or shall provide to the CQA Engineer satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the product will be installed in a competent, professional manner.

C. Owner shall retain the services of independent inspection and testing firms (Geosynthetics Quality Assurance Firm and Geosynthetics Quality Assurance Laboratory) to check conformance of the materials and installation with the specifications.

D. Codes and Standards: Perform all work in compliance with applicable requirements of governing authorities having jurisdiction.

1.05 DELIVERY, STORAGE AND HANDLING

A. Store material off of ground, rolled and covered to protect from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

B. Rolls shall be marked or tagged with the following information:

1. Manufacturer's name
2. Product identification
3. Lot number
4. Roll number
5. Roll dimensions

C. Replace defective or torn material at no cost to the Owner.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. The following test methods and frequencies shall be used, at a minimum, by the manufacturer for the quality assurance and control of the geotextiles and geocomposites prior to shipment of each product. Sampling and testing frequency shall conform to ASTM D 4354. Every effort shall be made to minimize the number of lots of each geosynthetic for use in the project.

B. Geotextile Manufacturing QC

1. Geotextile Tests:

a. Mass Per Unit Area - ASTM D 5261

b. Grab Tensile Strength and Grab Tensile Elongation - ASTM D 4632

d. Puncture Resistance - ASTM D 6241

e. Apparent Opening Size - ASTM D 4751

f. Permittivity - ASTM D 4491

g. Trapezoid Tear Strength - ASTM D 4533

Frequency: Minimum of one test per 100,000 square feet and minimum of one test per lot.

C. Geocomposite (geotextile/geonet/geotextile) Manufacturing QC

1. Tests for Geonet Component:

a. Polymer Density - ASTM D 1505
b. Carbon Black Content - ASTM D 4218 or 1603
c. Transmissivity (at gradient = 0.1 and pressure = 10,000 psf) - ASTM D 4716
d. Peak Tensile Strength - ASTM D 7179

e. Thickness – ASTM D5199

Frequency: Minimum of one test per 100,000 square feet and minimum of one test per lot for all except ASTM D 4716, which shall be tested once per 100,000 square feet and minimum of one test per lot.

2. Tests for Geotextile Portion of Geocomposite: same as Section 2.01 B, above. Tests shall be run on product prior to adhering to geonet.

3. Tests for Finished Product:

   a. Geotextile Adhesion to Geonet - ASTM D 413
   b. Thickness - ASTM D 5199
   c. Mass per Unit Area - ASTM D 5261

Frequency: Minimum of one test per 100,000 square feet and minimum of one test per lot.

D. For manufacturer's quality control testing of geotextiles and geocomposites, the sample average test results (weaker principle direction for mechanical tests) for a particular property for any individual roll tested within a lot designated as first quality shall meet or exceed the Minimum Average Roll Value indicated in the manufacturer's certification.

2.02 GEOTEXTILE

A. The geotextile shall be a continuous filament polyester, polypropylene nonwoven needle-punched fabric or a polypropylene, staple fiber, nonwoven needle-punched fabric. The fabric shall be inert to commonly encountered chemicals, biological degradation, hydrocarbons, acids, alkalines and mildew. The fabric shall be resistant to rot, ultraviolet light, insects and rodents.

B. The polyester or polypropylene filaments shall be formed into a stable network such that the filaments retain their relative position.

C. Geotextile for leachate collection trenches shall conform to the following minimum requirements shown on attached Table 02278-1.

D. Minimum roll width shall be 12.5 feet. The roll length shall be maximized in order to minimize seams.

2.03 GEOCOMPOSITE

A. Geocomposite shall be composed of a geonet core material with non-woven geotextile attached to each side of the geonet.

B. The geonet portion of the geocomposite shall be extruded, as a continuous web comprised of two strands of polyethylene to form a three-dimensional structure to provide planar water flow, and conforming to the following minimum requirements as shown in attached Table 02278-2.

C. Geotextile used as part of the geocomposite shall conform to the following minimum requirements as shown in attached Table 02278-2.

D. The geocomposite shall be manufactured by heat bonding the geotextile continuously to the geonet on both sides. No burn through geotextiles shall be permitted. No glue or adhesive shall be permitted.

E. The finished geocomposite product shall conform to the following minimum requirements as shown in attached Table 02278-2.

F. The bond between the geotextile and the geonet shall exhibit minimum average peel strength of one pound per inch, and a typical peel strength of two pounds per inch in accordance with ASTM D 7005.

G. Minimum roll width of the geocomposite shall be 10 feet.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Conformance Testing for Geotextile and Geocomposite Products:

1. Conformance testing samples shall be taken by the independent testing firm upon delivery of each product to site.

2. Samples shall be taken at the following frequency: a minimum of one test per 100,000 square feet and minimum of one test per lot.

3. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width.

4. Each sample shall be identified by manufacturer's name, product identification, lot number, roll dimensions, and roll number. The machine direction shall be noted on the samples with a waterproof marker.

5. As a minimum, the following tests shall be performed for the geotextile product (not part of geocomposite):
   a. Fabric Weight - ASTM D 5261
   b. Grab Strength and Grab Elongation - ASTM D 4632
   c. Puncture Resistance - ASTM D 4833
   d. Permittivity - ASTM D 4491
   e. Apparent Opening Size - ASTM D 4751

6. The following tests shall be performed for the finished geocomposite product:
   a. Transmissivity (Gradient= 0.1 at 10,000 psf - ASTM D 4716)
   b. Geotextile Adhesion to Geonet - ASTM D 7005

B. The CQA Firm shall ensure that the geotextiles and the geocomposite are installed according to manufacturer recommendations and the Contract Documents. The CQA Firm shall observe and document the installation activities.

3.02 PREPARATION

Surfaces to receive geotextile and geocomposites shall be smooth and free of litter, sharp protrusions, and large stones.

3.03 GEOTEXTILE INSTALLATION

A. General

1. All geotextiles shall be weighted with sandbags or the equivalent when required. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

B. Installation

1. The geotextile shall be placed where shown on the Drawings, and placed in such a manner that placement of overlying material will not excessively stretch or tear the fabric.
2. On side slopes, the rolls shall be continuous for the full height of slope, without joints.
3. Overlapping of panels without seaming will be allowed in the leachate collection system and leak detection collection system.
4. Overlapped seams shall have a minimum overlap of 12 inches.

C. Seaming

1. Seaming shall be by sewing, adhesives, fusion or other approved bonds. All seams shall be continuously seamed. Spot seaming may only be considered as a measure against wind uplift. Overlaps shall be oriented in the direction of earth filling. No horizontal seaming shall be allowed on slopes steeper than 10 horizontal to 1 vertical.

2. Any sewing shall be done using polymeric thread with chemical properties equal to or exceeding those of the geotextile.

3.04 GEOTEXTILE REPAIR

A. Holes or tears in the fabric shall be repaired as follows:

1. On steep slopes (steeper than 10 to 1): A fabric patch shall be sewn into place using a double sewn lock stitch (1/4 inch to 3/4 inch apart and no closer than one inch from any edge). Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.

2. Flat Areas (flatter than 10 to 1): A fabric patch shall be spot-seamed in place with a minimum of 36 inches of overlap beyond the perimeter of the tear or damage in all directions.

B. Care shall be taken to remove any soil or other material, which may have penetrated through the torn geotextile.

3.05 GEOCOMPOSITE INSTALLATION

A. Care shall be taken to keep the geocomposite clean and free from debris prior to installation.

B. The geonet portion of the geocomposite between adjacent rolls shall be overlapped by at least four inches.

C. The geonet overlaps shall be tied with plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.

D. The plastic ties shall be installed every five feet along the length at adjacent rolls, every six inches in the anchor trench and every six inches along end-to-end seams.

E. In general, no horizontal seams shall be allowed on side slopes, except as part of a patch. When horizontal seams are necessary, they shall be offset in adjacent panels and shall be "shingled" downhill.

F. The top geotextile of the geocomposite shall be overlapped, and sewn or heat-fused along the entire length of joints in accordance with the manufacturer's recommendations, and sufficient to prevent opening by wind action.

G. At locations where the geocomposite is damaged and soil penetrates the geocomposite material, it shall be removed and replaced with clean, unused geocomposite material.

H. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.

I. During placement of the geocomposite, care shall be taken not to entrap, in or beneath the geotextile portion of the material, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.

END OF SECTION

TABLE 02278-1
Geotextile Materials Summary

Manufacturer's Quality Control			
Test	**Method (1)**	**Testing Frequency**	**Min. Requirements**
Geotextile			
Mass per Unit Area (5)	ASTM D 3776/5261	1/100,000 sf	≥8 oz/sq. yd.
Grab Tensile (5)	ASTM D 4632	1/100,000 sf	220 lbs.
Grab Elongation (5)	ASTM D 4632	1/100,000 sf	50%
Trapezoid Tear Strength (5)	ASTM D 4533	1/100,000 sf	90 lbs.
Puncture Strength (5)	ASTM D 4833	1/100,000 sf	120 lbs.
Permittivity, T (5)	ASTM D 4491	1/560,000 sf	1.26 Sec^{-1}
AOS (largest opening size) (5)	ASTM D 4751	1/560,000 sf	80 Sieve Size
Conformance Testing by CQA Engineer			
Test	**Method**	**Testing Frequency**	**Min. Requirements**
Geotextile			
Mass per Unit Area (5)	ASTM D 3776/5261	1/100,000 sf	≥8 oz/sq. yd.
Grab Tensile (5)	ASTM D 4632	1/100,000 sf	220 lbs.
Grab Elongation (5)	ASTM D 4632	1/100,000 sf	50%
Puncture Strength (5)	ASTM D 4833	1/100,000 sf	120 lbs.
AOS (largest opening size) (5)	ASTM D 4751	1/100,000 sf	80 Sieve Size

1. Test to be performed according to the latest test method as approved by the certifying engineer.
2. Machine Direction
3. Measured using water @ 20° C with a gradient of 0.1, between two steel plates, after 15 minutes. Confining pressure 10,000
4. Transmissivity conformance testing only required on the geonet when the geonet and geotextile are installed separately. If a geocomposite is used, then the transmissivity testing will be performed on the geocomposite material.
5. Minimum Average Roll Value (MARV).

TABLE 02278-2
Geocomposite Materials Summary

Manufacturer's Quality Control			
Geonet			
Test	**Method (1)**	**Testing Frequency**	**Min. Requirements**
Thickness	ASTM D 5199	1/50,000 sf	200±20 mil
Density	ASTM D 1505	1/50,000 sf	0.94 g/cm^3
Tensile Strength (2)	ASTM D 5035/7179	1/50,000 sf	45 lb/in
Transmissivity (3)(5)	ASTM D 4716	1/540,000 sf	2.0 x 10^{-3} m^2/s
Carbon Black Content	ASTM D1603[3]/4218	1/50,000 sf	2%
Geotextile			
Mass per Unit Area (5)	ASTM D 3776/5261	1/90,000 sf	≥6 oz/sq. yd.
Grab Tensile (5)	ASTM D 4632	1/90,000 sf	160 lbs.
Grab Elongation (5)	ASTM D 4632	1/90,000 sf	50%
Trapezoid Tear Strength (5)	ASTM D 4533	1/90,000 sf	65 lbs.
Puncture Strength (5)	ASTM D 4833	1/90,000 sf	95 lbs.
Permittivity, T (5)	ASTM D 4491	1/540,000 sf	1.26 Sec^{-1}
AOS (largest opening size) (5)	ASTM D 4751	1/540,000 sf	70 Sieve Size
Geocomposite			
Ply Adhesion (5)	ASTM D 7005	1/50,000 sf	1.0 lb./in (MARV)
Transmissivity (3) (5)	ASTM D 4716	1/540,000 sf	1.0 x 10^{-4} m^2/s
Conformance Testing by CQA Engineer			
Geonet			
Test	**Method**	**Testing Frequency**	**Min. Requirements**
Thickness	ASTM D 5199	1/100,000 sf	200±20 mil
Density	ASTM D 1505	1/100,000 sf	0.94 g/cm^3
Tensile Strength (1)	ASTM D 5035/7179	1/100,000 sf	45 lb/in
Transmissivity (4) (5)	ASTM D 4716	1/100,000 sf	2.0 x 10^{-3} m^2/s
Carbon Black Content	ASTM D1603/4218	1/100,000 sf	2%
Geotextile			
Mass per Unit Area (5)	ASTM D 3776/5261	1/100,000 sf	≥6 oz/sq. yd.
Grab Tensile (5)	ASTM D 4632	1/100,000 sf	160 lbs.
Grab Elongation (5)	ASTM D 4632	1/100,000 sf	50%
Puncture Strength (5)	ASTM D 4833	1/100,000 sf	95 lbs.
AOS (largest opening size) (5)	ASTM D 4751	1/100,000 sf	70 Sieve Size
Geocomposite			
Ply Adhesion (5)	ASTM D 7005	1/100,000 sf	1.0 lb./in (MARV)
Transmissivity (4) (5)	ASTM D 4716	1/100,000 sf	1.0 x 10^{-4} m^2/s

1. Test to be performed according to the latest test method as approved by the certifying engineer.
2. Machine Direction
3. Measured using water @ 20^{o} C with a gradient of 0.1, between two steel plates, after 15 minutes. Confining pressure 10,000 psf.
4. Transmissivity conformance testing only required on the geonet when the geonet and geotextile are installed separately. If a geocomposite is used, then the transmissivity testing will be performed on the geocomposite material.
5. Minimum Average Roll Value (MARV).

SECTION 02279
GEOTEXTILE USED IN SUBGRADE
(IF REQUIRED)

1.0 GENERAL

1.1 SECTION INCLUDES

A. Geotextile to stabilize and reinforce an aggregate cover material (subbase, base, select embankment, etc.) of an unpaved roadway. The stabilization and reinforcement application is appropriate for unpaved roadways constructed over soft subgrade soils with a California Bearing Ratio (CBR) less than 3 (CBR <3) (shear strength less than approximately 90 kPa).

1.2 RELATED SECTIONS

A. Section 02050 - Basic Site Materials and Methods

B. Section 02200 - Site Preparation

C. Section 02300 - Earthwork

1.3 UNIT PRICES

A. Method of Measurement: See Construction Documents

1.4 REFERENCES

A. AASHTO Standards:

1. T88 - Particle Size Analysis of Soils
2. T90 - Determining the Plastic Limit and Plasticity Index of Soils
3. T99 - The Moisture-Density Relations of Soils Using a 5.5lb (2.5 kg) Rammer and a 12in (305 mm) Drop.
4. M288-96 - Geotextile Specification for Highway Applications

B. American Society for Testing and Materials (ASTM):

1. D 123 - Standard Terminology Relating to Textiles
2. D 276 - Test Method for Identification of Fibers in Textiles
3. D 4354 - Practice for Sampling of Geosynthetics for Testing

4. D 4355 - Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
5. D 4439 - Terminology for Geotextiles
6. D 4491 - Test Methods for Water Permeability of Geotextiles by Permittivity
7. D 4533 - Test Method for Index Trapezoid Tearing Strength of Geotextiles
8. D 4595 - Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
9. D 4632 - Test Method for Grab Breaking Load and Elongation of Geotextiles
10. D 4751 - Test Method for Determining Apparent Opening Size of a Geotextile
11. D 4759 - Practice for Determining the Specification Conformance of Geosynthetics
12. D 4833 - Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
13. D 4873 - Guide for Identification, Storage, and Handling of Geotextiles
14. D 5141 - Test Method to Determine Filtering Efficiency and Flow Rate for Silt Fence Applications Using Site Specific Soils

C. Federal Highway Administration (FHWA) - Geosynthetic Design and Construction Guidelines, Publication No. FHWA HI-95-038, May 1995.

D. American Association for Laboratory Accreditation (A2LA).

E. Geosynthetic Accreditation Institute (GAI) - Laboratory Accreditation Program (LAP).

F. National Transportation Product Evaluation Program (NTPEP).

1.5 DEFINITIONS

A. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

1.6 SUBMITTALS

A. Submit the following:

1. Certification: The contractor shall provide to the Engineer a certificate stating the name of the manufacturer, product name, and style number, chemical composition of the filaments or yarns and other pertinent information to fully describe the geotextile. The Certification shall state that the furnished geotextile meets MARV requirements of the specification as evaluated under the Manufacturer's quality control program. The Certification shall be attested to by a person having legal authority to bind the Manufacturer.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Geosynthetic Accreditation Institute (GAI) - Laboratory Accreditation Program (LAP)

2. American Association for Laboratory Accreditation (A2LA)

1.8 DELIVERY, STORAGE, AND HANDLING

A. Geotextiles labeling, shipment, and storage shall follow ASTM D 4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.

B. Each geotextile roll shall be wrapped with a material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants.

C. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geotextile.

2.0 PRODUCTS

2.1 MANUFACTURERS

A. Mirafi Construction Products
365 South Holland Drive
Pendergrass, GA, USA 30567
1-888-795-0808
1-706-693-2226
1-706-693-2083, fax
www.mirafi.com

2.2 MATERIALS

A. Geotextile:

1. The geotextile shall be woven from high-tenacity long-chain synthetic polymers composed of at least 95 percent by weight of polyolefins or polyesters. They shall form a stable network such that the filaments or yarns retain their dimensional stability relative to each other, including selvages.

2. The geotextile shall meet the requirements of Table 1. All numeric values in Table 1 except AOS represent MARV in the specified direction. Values for AOS represent maximum average roll values.

TABLE 1 - SUBGRADE STABILIZATION GEOTEXTILE

Property	Test Method	Units	Required Value	
Reinforcement Properties			MD[1]	CD[1]
Ultimate Tensile Strength	ASTM D 4595	kN/m (lbs/ft)	47.3 (3240)	39.4 (2700)
Tensile Strength @ 2% Strain	ASTM D 4595	kN/m (lbs/ft)	7.9 (540)	7.9 (540)
Tensile Strength @ 5% Strain	ASTM D 4595	kN/m (lbs/ft)	19.8 (1356)	19.8 (1356)
Coefficient of Interaction -Ci (sand)	ASTM D 5321	--	0.8	
Permittivity	ASTM D 4491	sec^{-1}	0.52	
Apparent Opening Size	ASTM D 4751	mm (U.S. Sieve)	0.6 (30)	
Sewn Seam Strength[2]	ASTM D 4884	kN/m (lbs/ft)	24.6 (1688)	
Survivability Index Values			MD[1]	CD[1]
Grab Tensile Strength	ASTM D 4632	N (lbs)	1780 (400)	1100 (250)
Tear Strength	ASTM D 4533	N (lbs)	800 (180)	440 (100)
Puncture Strength	ASTM D 4833	N (lbs)	800 (180)	
Ultraviolet Stability (after 500 hrs)	ASTM D 4355	%	70	

[1] MD - Machine, or roll, direction; CD - Cross machine direction

[2] When sewn seams are required. Refer to **Section 3 - Execution** for overlap / seam requirements.

3. Approved geotextiles are as follows: Mirafi HP370

2.3 QUALITY CONTROL

A. Manufacturing Quality Control: Testing shall be performed at a laboratory accredited by GAI-LAP and A2LA for tests required for the geotextile, at frequency meeting or exceeding ASTM D 4354.

B. Sewn Seam Strength shall be verified based on testing of either conformance samples obtained using Procedure A of ASTM D 4354, or based on manufacturer's certifications and testing of quality assurance samples obtained using Procedure B of ASTM D 4354. A lot size for conformance or quality assurance sampling shall be considered to be the shipment quantity of the given product or a truckload of the given product, whichever is smaller.

C. Ultraviolet Stability shall be verified by an independent laboratory on the geotextile or a geotextile of similar construction and yarn type.

3.0 EXECUTION

3.1 PREPARATION

A. The installation site shall be prepared by clearing, grubbing, and excavation or filling the area to the design grade. This includes removal of topsoil and vegetation.

3.2 INSTALLATION

A. The geotextile shall be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic. Adjacent geotextile rolls shall be overlapped, sewn or joined as required in the plans. Overlaps shall be in the direction as shown on the plans. See table below for overlap requirements.

Soil CBR	**Method of Joining**
Greater than 3	300 - 450 mm (12 - 18 in) overlap
1 - 3	600 - 1000 mm (24 - 40 in) overlap
0.5 - 1	1000 mm (40 in) overlap or sewn
Less than 0.5	Sewn
All roll ends	1000 mm (40 in) overlap or sewn

B. On curves, the geotextile may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of fill or rock.

C. Prior to covering, the geotextile shall be inspected by a certified inspector of the Engineer to ensure that the geotextile has not been damaged during installation. Damaged geotextiles, as identified by the Engineer, shall be repaired immediately. Cover the damaged area with a geotextile patch which extends an amount equal to the required overlap beyond the damaged area.

D. The subbase shall be placed by end dumping onto the geotextile from the edge of the geotextile, or over previously placed subbase aggregate. On soils with CBR>3, most rubber-tired vehicles can be driven at slow speeds, less than 16 km/h (10 mph) and in straight paths over the exposed geotextile without causing damage to the geotextile. Sudden braking and sharp turning should be avoided. Tracked construction equipment should not be operated directly upon the geotextile. A minimum fill soil thickness of 15cm (6 in) is required prior to operation of tracked vehicles over the geotextile. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geotextile. Turning of vehicles shall not be permitted on the first lift

above the geotextile.

E. On subgrades having a CBR value of less than 1, the subbase aggregate should be spread in its full thickness as soon as possible after dumping to minimize the potential of localized subgrade failure due to overloading of the subgrade.

F. Any ruts occurring during construction shall be filled with additional subbase material, and compacted to the specified density.

G. If placement of the backfill material causes damage to the geotextile, the damaged area shall be repaired as previously described above. The placement procedure shall then be modified to eliminate further damage from taking place.

END OF SECTION

SECTION 02505
GRAVEL ACCESS ROAD

PART 1 GENERAL

1.01 SUMMARY

A. Section includes construction of gravel access roads including grading, testing, and installation of aggregate surface course material.

B. Related Sections:

1. Section 02200 - Earthwork

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM).

1. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
2. ASTM D 1557, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using Ten-Pound (4.54 kg) Hammer and 18-Inch (457 mm) Drop.
3. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
4. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.
5. ASTM D 6938, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

B. Standard Specification for Highway Construction, Arkansas State Highway and Transportation Department (AHTD), P.O. Box 2262, Little Rock, Arkansas 72203.

1. AHTD 303, Aggregate Base Course.

1.03 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Submit written test reports of all specified tests showing conformance of the materials and constructed work with the specifications. Submit test results within three days after samples are obtained.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

Owner will retain the services of an independent inspection and testing firm to determine conformance of earthwork materials and constructed work.

1.05 PROJECT CONDITIONS

A. Work shall be performed in a manner that does not disturb existing environmental monitoring wells or other site facilities not indicated to be removed within the construction limits.

B. Provide temporary controls as specified in Sections 01563 and 01565.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

Proposed materials and source of supply shall be approved for use on this project by the Engineer as specified, prior to use of the materials in the construction.

2.02 GENERAL FILL

General Fill shall be as specified in Section 02200.

2.03 AGGREGATE SURFACE COURSE MATERIAL

Naturally or artificially graded mixture of natural or crushed gravel, or crushed stone shall be free of clay balls, organic material and debris. Material shall be graded with 100 percent passing the 1-1/2 inch sieve and between 3 and 10 percent passing the Number 200 sieve (See Table 303-1 in the AHTD Standard Specification for Highway Construction for detailed particle size requirements) or as shown on Drawings.

PART 3 EXECUTION

3.01 PREPARATION

Prepare road subgrade to the lines, grades and elevations as shown on the Drawings, and as specified in Section 02200, subsection 3.01.

3.02 PLACEMENT OF AGGREGATE SURFACE COURSE

A. Place and grade aggregate surface course material to the dimensions shown on the Drawings.

END OF SECTION

SECTION 02715
LEACHATE COLLECTION SYSTEM PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes furnishing and installing 6-inch diameter high density polyethylene leachate collection system piping (perforated piping, solid piping, and fittings).

B. Related Sections:

1. Section 02223 – Trenching, Backfilling and Compacting

2. Section 02278 - Geotextiles and Geocomposite

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM D 1248, Specification for Polyethylene Plastics Molding and Extrusion Materials.

2. ASTM D 2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

3. ASTM D 3035, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.

4. ASTM D 3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

5. ASTM D 3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

6. ASTM F 714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

1.03 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Submit manufacturer's certificates of conformance with specifications, and product data, for the leachate collection piping, fittings and accessories and the leachate riser pipes.

C. Submit shop drawings for fabrication of leachate piping, riser pipe, and fittings.

D. Submit certification of personnel training in heat fusion procedures, as specified in subsection 1.04.B of this Section.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

A. Pipe manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings specified.

B. Heat fusion of polyethylene piping shall be performed by personnel trained in the pipe manufacturer's recommended procedures. Training shall have been received not more than 12 months prior to start of construction.

1.05 DELIVERY, STORAGE AND HANDLING

A. During loading, transporting, and unloading, exercise care to prevent damage to materials.

B. Pipe shall be marked with manufacturer's identification symbol, size, date of manufacture, class of pipe and applicable product specification identification number.

C. All materials shall be inspected by the Contractor upon delivery to the site. The Contractor shall notify the Engineer of any loss or damage. Damaged or defective materials shall be rejected and shall be replaced with new materials at the supplier's or Contractor's expense.

PART 2 PRODUCTS

2.01 PERFORATED LEACHATE COLLECTION PIPE

A. Materials used for the manufacture of polyethylene pipe and fittings shall be as follows:

1. PE3408 high density polyethylene, with a cell classification of PE345434C in compliance with ASTM D 3350, and material classification Type III, Class C, Category 5, Grade P34 in compliance with ASTM D 1248.

B. Pipe shall be manufactured in accordance with ASTM F 714 or ASTM D 3035. Pipe shall have a standard dimension ratio (SDR) of 17 and an inside diameter of six inches.

C. Molded fittings shall be manufactured in accordance with ASTM D 3261 or ASTM D 2683. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, sheet stock, or molded fittings. Each fabricated fitting shall be rated for internal pressure service equivalent to the full service pressure rating of the pipe to which it is joined.

D. Size and arrangement of perforations shall be as shown on the construction drawing.

2.02 WASHED GRAVEL BACKFILL FOR LEACHATE COLLECTION SYSTEMS

Specified in Section 02227.

2.03 GEOTEXTILE FOR LEACHATE COLLECTION

Geotextile as specified in Section 02278.

PART 3 EXECUTION

3.01 PREPARATION

A. Excavate and grade trenches for leachate collection piping to the width, depth, grade and alignment shown on the Drawings, and as specified in Section 02223.

3.02 GEOTEXTILE INSTALLATION FOR LEACHATE COLLECTION SYSTEMS

A. Place geotextile on the bottom and sides of the pipe trenches as shown on the Drawings.

B. Place geotextile in such a manner that placement of overlying material will not stretch or tear the fabric.

C. Overlaps of adjacent rolls of geotextile and at the top of the gravel backfill shall be approximately three feet, or as otherwise shown on the Drawings.

3.03 LEACHATE COLLECTION PIPE INSTALLATION

A. Examine pipe and fittings before installation and assure no defective materials are incorporated. Keep inside of pipes and fittings free of dirt and debris.

B. Lay piping on firm bedding for entire length of alignment.

C. Installation of all pipe, and fittings shall be subject to the review of the Engineer.

D. Polyethylene pipe and fittings shall be joined by heat fusion (butt fusion, saddle/sidewall fusion, socket fusion or electrofusion).

E. Install piping accurately to line and grade as shown on Drawings unless otherwise approved by the Engineer.

F. Place stone backfill around and over the pipe in trenches and in sumps as indicated on the Drawings.

G. Whenever pipe laying is not actively in progress, the open ends of the piping shall be closed by a temporary plug or cap to prevent soil, and other foreign matter from entering the piping.

H. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

END OF SECTION

SECTION 02930
SEEDING AND MULCHING

PART 1 GENERAL

1.01 SUMMARY

Section includes establishing a stand of grass on all areas disturbed by construction within the construction limits and areas with inactive waste fill.

1.02 QUALITY ASSURANCE/QUALITY CONTROL

Seeding shall be accomplished according to standard local practice and in compliance with requirements of applicable state and federal regulations.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged materials in containers showing weight, analysis and name of manufacturer.

B. Protect materials from deterioration during delivery, and while stored at site.

1.04 PROJECT CONDITIONS

A. Perform seedbed preparation and seeding as soon as possible after completion of grading and compaction in each area.

B. Seeding shall be performed only during the appropriate growing season for the particular seed mix, as recommended by the local agricultural extension office and approved by the Engineer.

PART 2 PRODUCTS

2.01 FERTILIZER

A. Shall be a standard commercial fertilizer, delivered to the project in bags clearly labeled showing percentages of nitrogen, phosphoric acid, and potash nutrients.

2.02 LIME

Shall be ground limestone containing not less than 85 percent total carbonates and of a fineness so that 90 percent will pass through a No. 20 mesh sieve and 50 percent will pass through a No. 100 mesh sieve.

2.03 SEED

A. The following quantities of grass seed to be planted per acre are as follows:

1. ***Spring Planting (March 15 - June 15):***

Bermuda Grass (Common) unhulled	10 lbs.
Bermuda Grass (Common) hulled	5 lbs.
Laspedeza (Korean)	30 lbs.

2. ***Summer Planting (June 16 - August 31):***

Bermuda Grass (Common) unhulled	10 lbs.
Bermuda Grass (Common) hulled	5 lbs.
Buffalo Grass	10 lbs.

3. ***Fall/Winter Planting (September 1 - March 14):***

Annual Rye grass or other Cereal Grasses	100 lbs.
Crimson Clover (Dixie)	20 lbs.
Bermuda Grass (Common) unhulled	30 lbs.
Coreopsis	5 lbs.
Laspedeza (Korean)	30 lbs.

B. The following quantities of grass seed to be planted per acre near the old landfill benches (as shown on the construction drawings) are as follows:

1. ***Spring Planting (March 15 - June 15):***

Weeping Lovegrass (eragrotis curvula, “Ermelo”)	85 lbs.

1. ***Fall Planting (September 1 – November 1):***

Weeping Lovegrass (eragrotis curvula, “Ermelo”)	85 lbs.

2.04 WATER

Clean, potable.

2.05 MULCH AND OTHER EROSION CONTROL

A. Cover material shall be chopped hay mulch generally derived from rice, wheat, oats, barley, or other suitable material free from Johnson grass, weeds, foreign matter detrimental to plant life, and in dry conditions.

PART 3 EXECUTION

3.01 SOIL SAMPLING

A. An independent testing firm retained by the Contractor shall obtain samples of the soil to be seeded and send the samples to a local agricultural extension office for recommendations on fertilizer, lime and seed mix to be used.

B. One sample shall be taken at approximately every five (5) acres of area, or as otherwise determined necessary by the Engineer. Each sample shall be a minimum ten-ounce sample.

3.02 PREPARATION

A. Surface shall be scarified to an approximate depth of three inches to be seeded.

B. Surface shall be reasonably smooth and free of litter, large clods, roots, sharp protrusions, and large stones.

C. The seed mixtures specified in paragraph 2.03A shall be applied to areas disturbed from construction activities.

3.03 APPLICATION METHODS

A. Spread lime (if required) uniformly on soil surface at rate specified in subsection 3.04. Incorporate lime into top three inches of soil.

B. Seed, fertilizer, and mulch materials shall be placed by the method described below, as approved by the Engineer.

1. Hydraulic Method

a. The seed and fertilizer, or seed, fertilizer and mulch shall be mixed in the specified amount of water to produce a slurry. Any of the above combinations may be used, provided that the products are added to the water in the following order as applicable: fertilizer, seed, and mulch.

b. The slurry shall then be uniformly applied under pressure to the areas and at the rates indicated in subsection 3.04 below.

c. Areas inadequately covered shall be re-treated as directed by the Engineer.

2. Dry Method

a. The seed and fertilizer shall be applied uniformly at the specified rate, using power drawn seeders, seed drills, or other mechanical methods approved by the engineer. Hand operated seeding devices may be used on areas which are inaccessible to mechanical seeders.

b. The seed and fertilizer shall be applied separately. Fertilizer shall be incorporated into the full depth of loosened soil to the seeding operation.

3.04 APPLICATION RATES

A. Lime: Two tons per acre for pH 4 to 5, one ton per acre for pH 5 to 6, or as otherwise determined based on soil test results.

B. Fertilizer:

1. Apply at rate of 1,000 pounds of grade 10-20-10 fertilizer per acre or a sufficient quantity of any other acceptable grades of fertilizer that will provide at least 100 pounds of nitrogen, 200 pounds of available phosphoric acid, and 100 pounds of total potash per acre, as computed from the nominal contents of fertilizing ingredients.

2. Other rates of application may be allowed by the Engineer based on soil test results.

C. Seed mixtures for permanent vegetation shall be applied at the rate of approximately 60 pounds per acre or as otherwise directed by the Engineer.

3.05 APPLICATION TIMES

A. Seeding for temporary vegetation shall comply with Section 01565.

B. Seeding for permanent vegetation shall be performed during the first optimum planting season following completion of work in an area. Optimum planting seasons are Spring (March through May) and Fall (September through October).

3.06 MULCHING

A. Spread mulch uniformly over seeded area in a continuous blanket.

B. Mulch may be spread by hand or by machinery. Mulch shall be spread not later than 48 hours after seeding.

3.07 ESTABLISHMENT OF GRASS

A. Begin maintenance immediately after seed placement.

B. Maintain seeded areas not less than 60 days after substantial completion and longer to establish a good stand of grass as per the Engineer.

C. If seeded in Fall, Contractor shall maintain seeded areas throughout Winter and provide a Spring seeding.

D. Carry out watering as needed during the establishment period to maintain moisture in upper four inches of soil.

E. Fill, level, and repair washed or eroded areas as necessary.

F. Re-seed mulch areas larger than one square foot not having a uniform stand of grass.

3.08 ACCEPTANCE

A. Seeded areas will be accepted when a full and uniform stand of grass has become established.

END OF SECTION

CONSTRUCTION DRAWINGS

FOR THE

CHEROKEE SANITARY LANDFILL
CELL B2 CONSTRUCTION
PERMIT NO. 0299-S1; AFIN: 25-00028

JULY 2015

PROJECT NO. - 35147247

PREPARED FOR

IESI - ARKANSAS LANDFILL CORP.
CHEROKEE SANITARY LANDFILL
300 LANDFILL ROAD
CHEROKEE VILLAGE, ARKANSAS 72529
(870) 994-7717

VICINITY MAP
N.T.S.

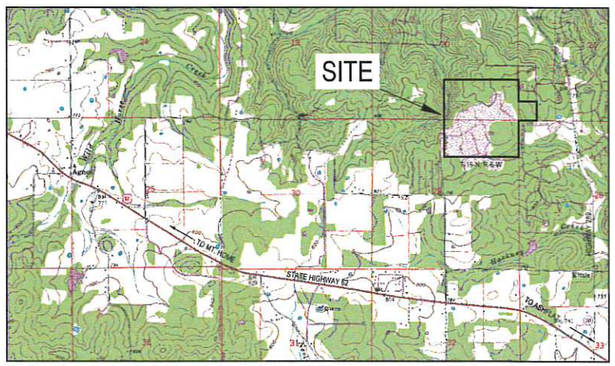
811
Know what's below.
Call before you dig.

PREPARED BY

7.7.15
STATE OF ARKANSAS
REGISTERED PROFESSIONAL ENGINEER
No. 9199
DAVID C. McCORMICK

Terracon
Consulting Engineers and Scientists

25809 I-30 SOUTH BRYANT, ARKANSAS 72022
PH. (501) 847-9292 FAX. (501) 847-9210



MAP PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY. CONTROL BY U.S.G.S. AND NOS/NOAA.
SOURCE DATUM IS NAD-83.

SITE LOCATION MAP
N.T.S.

INDEX OF DRAWINGS

DRAWING NO.	TITLE
	COVER SHEET
1.	INDEX SHEET
2.	GENERAL SITE PLAN / EXISTING CONDITIONS
3.	CELL SUBGRADE PLAN
4.	CELL LINER GRADING PLAN
5.	CELL PROTECTIVE COVER GRADING PLAN
6.	EAST SIDESLOPE LANDFILL OPERATIONS ROAD GRADING PLAN
7.	CELL CERTIFICATION POINT PLAN
8.	CELL CERTIFICATION POINT TABLE
9.	CELL LINER SYSTEM DETAILS
10.	MISCELLANEOUS DETAILS
11.	OPTIONAL TEMPORARY RAIN FLAP

ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

ADEQ	ARKANSAS DEPARTMENT OF ENVIRONMENTAL QUALITY
CB	CATCH BASIN
DIA	DIAMETER
DWG	DRAWING
ELEV	ELEVATION
EXIST	EXISTING
FT	FEET
HDPE	HIGH DENSITY POLYETHYLENE
HORZ	HORIZONTAL
ID	INSIDE DIAMETER
IN	INCHES
INV	INVERT
MAX	MAXIMUM
MH	MANHOLE
MIN	MINIMUM
MSL	MEAN SEA LEVEL
NOM	NOMINAL
NSPS	NEW SOURCE PERFORMANCE STANDARDS
NTS	NOT TO SCALE
OD	OUTSIDE DIAMETER
℄	PROPERTY LINE
SDR	STANDARD DIMENSION RATIO
TYP	TYPICAL
VERT	VERTICAL
NPDES	NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

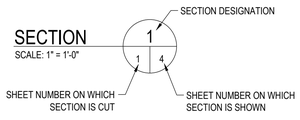
SYMBOLS

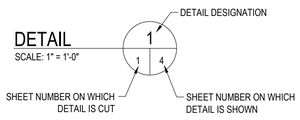
- PROPERTY LINE
- EXISTING FENCE
- PROPOSED SILT FENCE
- EXISTING BUILDING
- EXISTING UNPAVED ROAD
- EXISTING PAVED ROAD
- DRAINAGE WAY
- 320 — EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- 320 — PROPOSED INDEX CONTOUR (COLOR WILL VARY BY LAYER)
- PROPOSED INTERMEDIATE CONTOUR (COLOR WILL VARY BY LAYER)
- OHE — OVERHEAD ELECTRIC
- 3x6FM — 3"x6" LEACHATE FORCEMAIN
- 2x6FM — 2"x6" LEACHATE FORCEMAIN
- LFM — PROPOSED LEACHATE FORCEMAIN
- LFG — LANDFILL GAS LINE
- PROPOSED ACCESS ROAD (GRAVEL)
- W — WATERLINE
- WS=1294.6 — WATER SURFACE ELEVATION
- X 325.8' — EXISTING SPOT ELEVATION
- BM-10 — PERMANENT SURVEY BENCHMARK
- N 1000 / 1000 — SITE GRID MARKER
- LGW-7 — GROUNDWATER MONITORING WELL
- GP-14R — GAS MONITORING PROBE
- POWER POLE
- DRAINAGE CULVERT
- VEGETATION
- GEOMEMBRANE
- GEOTEXTILE
- GEOCOMPOSITE
- GCL (GEOSYNTHETIC CLAY LINER)
- PLYWOOD
- SUBGRADE
- ON-SITE SELECT FILL
- COMPACTED CLAY LINER
- PROTECTIVE SOIL LAYER
- GRAVEL / RIP-RAP
- CONCRETE
- WASTE
- INTERMEDIATE/INTERIM COVER
- TOP SOIL

GENERAL NOTES

1. EXISTING TOPOGRAPHY IS COMPRISED OF A NOVEMBER 21, 2014 CELL AS-S AS-BUILT SURVEY BY HARMON SURVEYING, INC. (IN THE IMMEDIATE VICINITY OF CELL AS-S), AND A JUNE 19, 2014 AERIAL SURVEY BY DALLAS AERIAL SURVEYS, INC (THE REMAINDER OF THE SITE).
2. SURVEY CONTROL POINTS AND CONSTRUCTION CONTROL POINTS LISTED ON THESE DRAWINGS ARE BASED ON STATE PLANE COORDINATES (NAD 83 ARKANSAS SOUTH).
3. PERMANENT BENCHMARKS ARE SHOWN ON APPROPRIATE DRAWINGS AND SHOULD BE FIELD VERIFIED.
4. EXISTING FACILITIES AND FEATURES ARE SHOWN LIGHT-LINED AND OR SCREENED. PROPOSED FACILITIES AND FEATURES ARE SHOWN SOLID AND HEAVY LINED.
5. REFER TO THE PROJECT SPECIFICATIONS, DATED DECEMBER 2014 FOR ALL WORK SHOWN ON THESE DRAWINGS.
6. THE EROSION CONTROL FEATURES REQUIRED BY THESE PLANS ARE THE MINIMUM FEATURES REQUIRED. ADDITIONAL FEATURES MAY BE REQUIRED TO CONTROL EROSION.
7. SLOPES AND GRADES ARE IN UNITS OF HORIZONTAL FEET: VERTICAL FEET, UNLESS OTHERWISE NOTED.
8. THE MATERIAL QUANTITIES SHOWN ON THESE PLANS ARE ESTIMATES ONLY.
9. CONTRACTOR SHALL NOT INTERRUPT OWNER'S DAILY OPERATION OF THE LANDFILL WITH CONSTRUCTION ACTIVITIES.
10. CONTRACTOR SHALL TAKE EXTRA CARE NOT TO DISTURB EXISTING ENVIRONMENTAL MONITORING STRUCTURES (GROUNDWATER WELLS, GAS MONITORING PROBES, ETC.)
11. ENTRANCE TO THE CELL B2 AREA SHALL BE THROUGH THE SITE MAIN ENTRANCE AND USING ON-SITE ROADS, OR SPECIFICALLY DIRECTED BY IESI - AR LANDFILL CORP.
12. CONTRACTOR SHALL BE RESPONSIBLE FOR BRINGING TO THE OWNER'S ATTENTION ANY CONSTRUCTION ELEMENT THAT HAS NOT BEEN ADDRESSED IN THESE DRAWINGS OR SEEN TO BE DIFFERENT FROM THE LIKE ELEMENT DESCRIBED IN THESE DRAWINGS.
13. CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVAL OF ALL CONSTRUCTION RELATED DEBRIS FROM THE CELL B2 AREA AT THE COMPLETION OF THE PROJECT.
14. CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING LOCATION OF UTILITIES PRIOR TO WORKING IN PROJECT AREA. CONTRACTOR SHALL BE RESPONSIBLE FOR DAMAGE TO THE UTILITIES CAUSED BY CONSTRUCTION OPERATIONS.

SITE/DETAIL KEY





CONTACT INFORMATION

OWNER:
IESI - ARKANSAS LANDFILL CORPORATION
CHEROKEE LANDFILL FACILITY
ATTENTION: RONNIE BLACK
300 LANDFILL DRIVE
CHEROKEE VILLAGE, ARKANSAS 72529
PHONE: (870) 994-7717
FAX: (870) 994-2199

ENGINEER:
TERRACON CONSULTANTS, INC.
ATTENTION: DAVID C. McCORMICK, P.E. - SR. PROJECT ENGINEER
25809 I-30 SOUTH
BRYANT, ARKANSAS 72022
PHONE: (501) 847-9292
FAX: (501) 847-9210

REGULATORY AUTHORITY:
ARKANSAS DEPARTMENT OF ENVIRONMENTAL QUALITY
SOLID WASTE MANAGEMENT DIVISION
ATTENTION: SOLID WASTE MANAGEMENT DIVISION CHIEF
5301 NORTHSHORE DRIVE
NORTH LITTLE ROCK, AR 72118-5317
PHONE: (501) 682-0600
FAX: (501) 682-0611

811 Know what's below. Call before you dig.

REV.	DATE	BY	DESCRIPTION
0.3	12/06/14	EJW	PRELIMINARY REVIEW DRAFT
0.4	08/24/15	JDW	ADDED ADDITIONAL SHEET TO SET (DRAWING 11)

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No.9199 — DAVID C. McCORMICK

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH — BRYANT, ARKANSAS 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

IESI

INDEX SHEET

CELL B2 CONSTRUCTION DRAWINGS

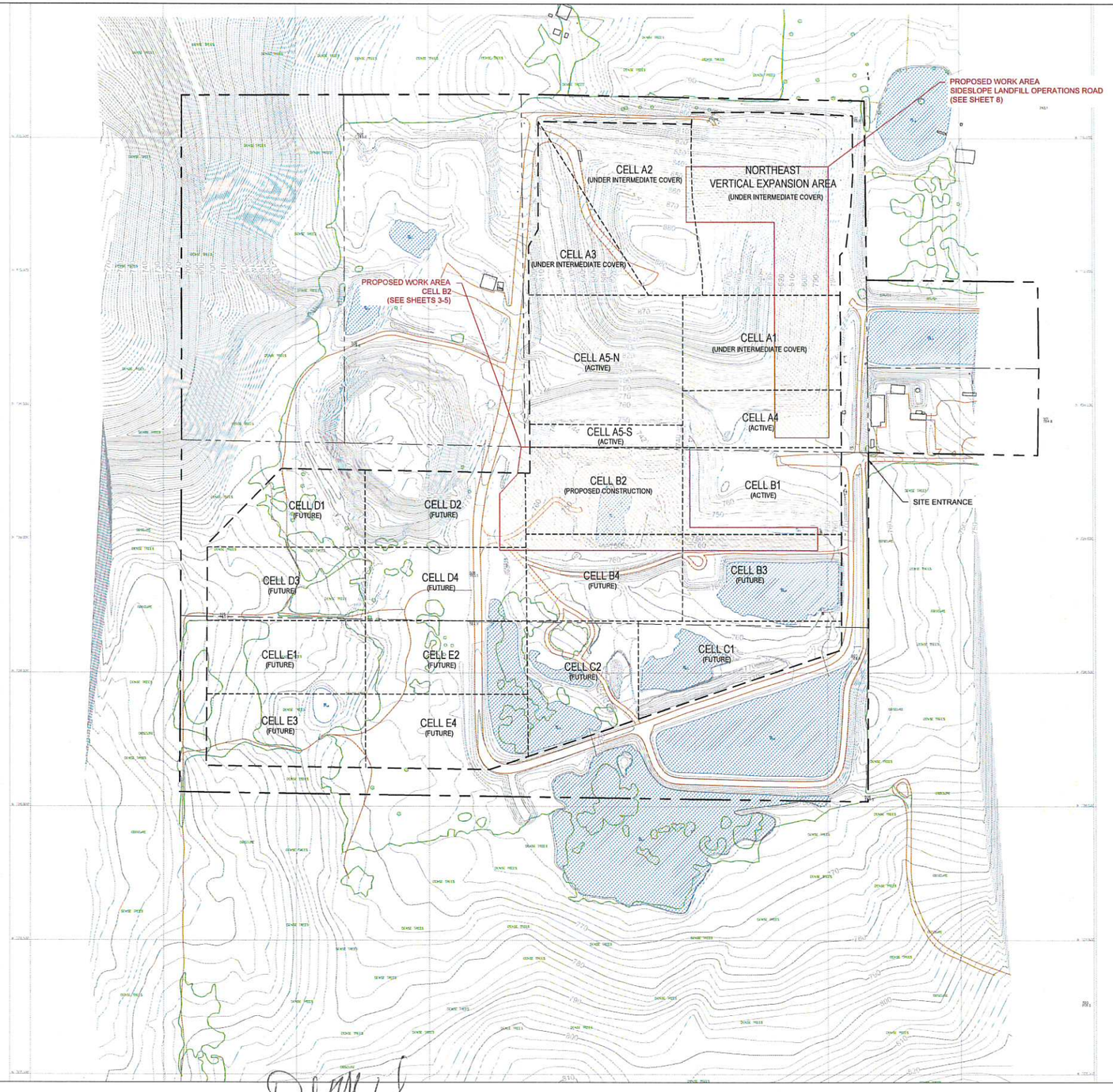
IESI - AR LANDFILL CORPORATION

CHEROKEE CLASS 1 LANDFILL

FULTON COUNTY — ARKANSAS

DRAWING 1

DESIGNED BY:	DCM, EJW
DRAWN BY:	EJW, JDW
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	12/11/2014
JOB NO.	35147247
ACAD NO.	001
SHEET NO.:	1 OF 11



SURVEY REFERENCE POINT SUMMARY		
REFERENCE MONUMENT	COORDINATE NORTHING & EASTING	ELEVATION (FMSL)
BM #1	N 710629.728 E 1419132.414	781.92
BM #3	N 710633.672 E 1417363.579	807.42
BM #4	N 709325.938 E 1419155.807	762.97

NOTES:

1. EXISTING TOPOGRAPHY IS COMPRISED OF A NOVEMBER 21, 2014 CELL A5-S AS-BUILT SURVEY BY HARMON SURVEYING, INC. (IN THE IMMEDIATE VICINITY OF CELL A5-S), AND A JUNE 19, 2014 AERIAL SURVEY BY DALLAS AERIAL SURVEYS, INC (THE REMAINDER OF THE SITE).

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No.9199 — DAVID C. McCORMICK

7.7.15

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH — BRYANT, ARKANSAS 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

IESI

GENERAL SITE PLAN / EXISTING CONDITIONS

CELL B2 CONSTRUCTION DRAWINGS

IESI - AR LANDFILL CORPORATION

CHEROKEE CLASS 1 LANDFILL

FULTON COUNTY — ARKANSAS

DRAWING 2	
DESIGNED BY:	DCM, EJW
DRAWN BY:	EJW, JDW
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	12/11/2014
JOB NO.	35147247
ACAD NO.	002
SHEET NO.:	2 OF 11

CELL A5-N
(ACTIVE)

CELL A1
(UNDER INTERMEDIATE COVER)

CELL A5-S
(ACTIVE)

CELL A4
(ACTIVE)

CELL B1
(ACTIVE)

CELL B2
(PROPOSED CONSTRUCTION)

LIMIT OF PROPOSED LINER CERTIFICATION

CELL B3
(FUTURE)

CELL B4
(FUTURE)

CELL LINER SYSTEM (TYP.) — A 3 9

ANCHOR TRENCH AND WEST PERIMETER CELL TERMINATION — C 3 9

D 3 9 — TIE-IN TO EXISTING CELL LINER SYSTEM

WS 745.2

WS 739.8

WS 755.8

506
763.1

764.7

N

50 0 25 50
SCALE IN FEET

NOTES:

1. EXISTING TOPOGRAPHY IS COMPRISED OF A NOVEMBER 21, 2014 CELL A5-S AS-BUILT SURVEY BY HARMON SURVEYING, INC. (IN THE IMMEDIATE VICINITY OF CELL A5-S), AND A JUNE 19, 2014 AERIAL SURVEY BY DALLAS AERIAL SURVEYS, INC (THE REMAINDER OF THE SITE).

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No. 9199 — DAVID C. McCORMICK

7.7.15

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH — BRYANT, ARKANSAS 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

IESI

CELL SUBGRADE PLAN

CELL B2 CONSTRUCTION DRAWINGS

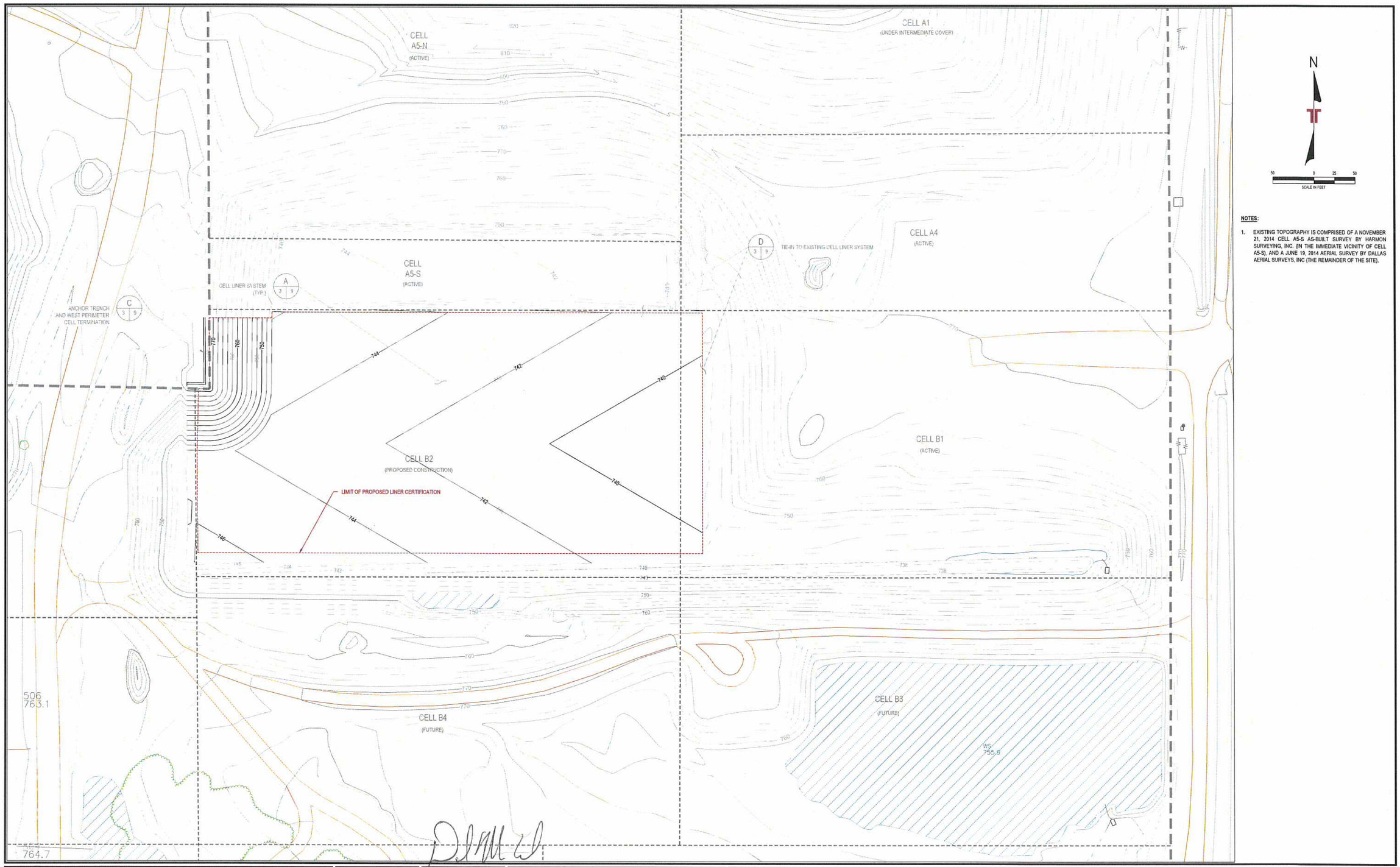
IESI - AR LANDFILL CORPORATION

CHEROKEE CLASS 1 LANDFILL

FULTON COUNTY — ARKANSAS

DRAWING 3

DESIGNED BY:	DCM, EJW
DRAWN BY:	EAN, JDW
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	12/11/2014
JOB NO.	35147247
ACAD NO.	003
SHEET NO.:	3 OF 11



NOTES:

1. EXISTING TOPOGRAPHY IS COMPRISED OF A NOVEMBER 21, 2014 CELL A5-S AS-BUILT SURVEY BY HARMON SURVEYING, INC. (IN THE IMMEDIATE VICINITY OF CELL A5-S), AND A JUNE 19, 2014 AERIAL SURVEY BY DALLAS AERIAL SURVEYS, INC (THE REMAINDER OF THE SITE).

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No.9199 — DAVID E. McCORMICK

7.7.15

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH — BRYANT, ARKANSAS 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

IESI

CELL LINER GRADING PLAN

CELL B2 CONSTRUCTION DRAWINGS

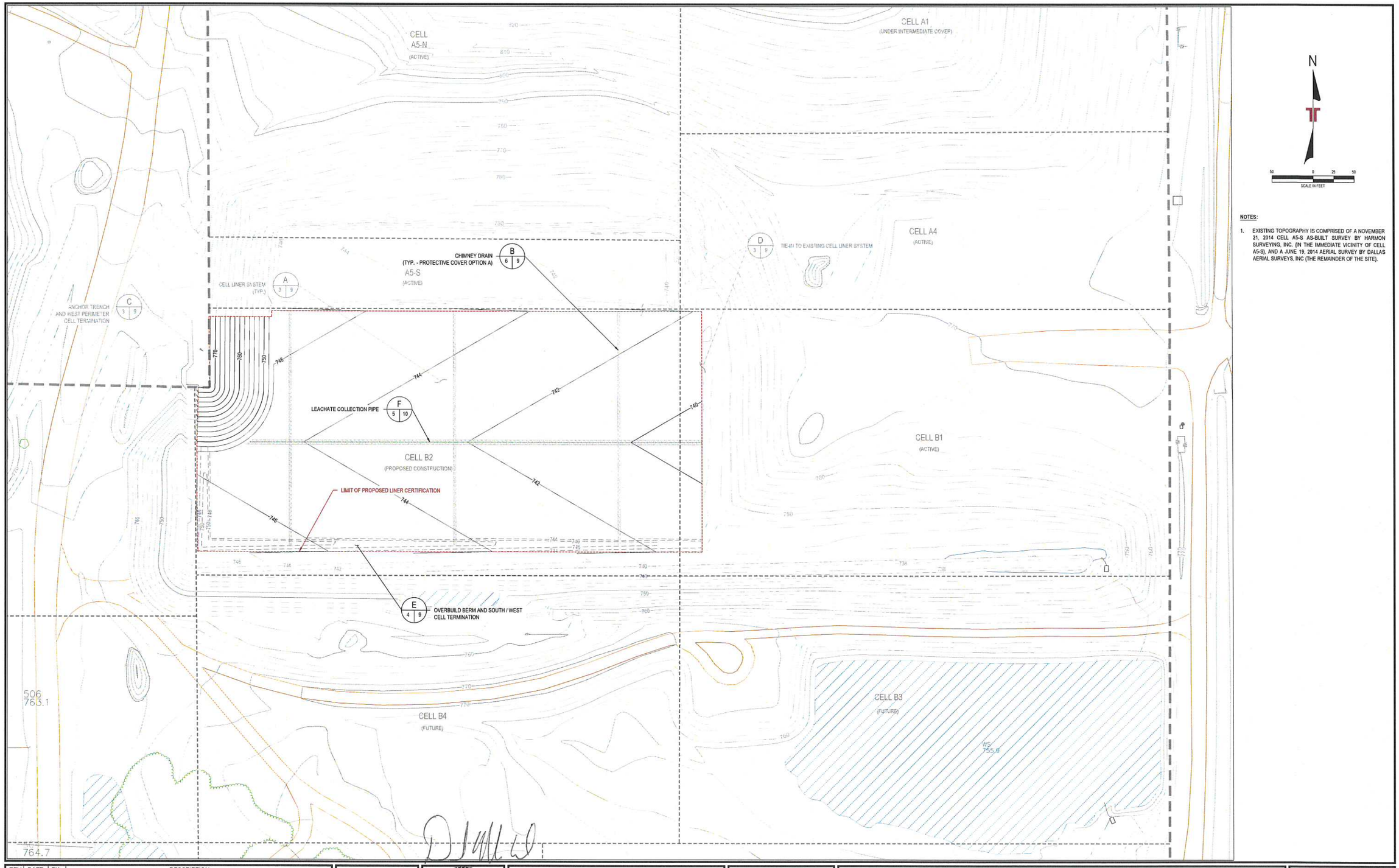
IESI - AR LANDFILL CORPORATION

CHEROKEE CLASS 1 LANDFILL

FULTON COUNTY — ARKANSAS

DRAWING 4

DESIGNED BY:	DCM, EJW
DRAWN BY:	EJW, JDW
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	12/11/2014
JOB NO.	35147247
ACAD NO.	004
SHEET NO.:	4 OF 11



NOTES:

1. EXISTING TOPOGRAPHY IS COMPRISED OF A NOVEMBER 21, 2014 CELL A5-S AS-BUILT SURVEY BY HARMON SURVEYING, INC. (IN THE IMMEDIATE VICINITY OF CELL A5-S), AND A JUNE 19, 2014 AERIAL SURVEY BY DALLAS AERIAL SURVEYS, INC (THE REMAINDER OF THE SITE).

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No.9199 — DAVID C. McCORMICK

7.7.15

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH — BRYANT, ARKANSAS 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

IESI

CELL PROTECTIVE COVER GRADING PLAN

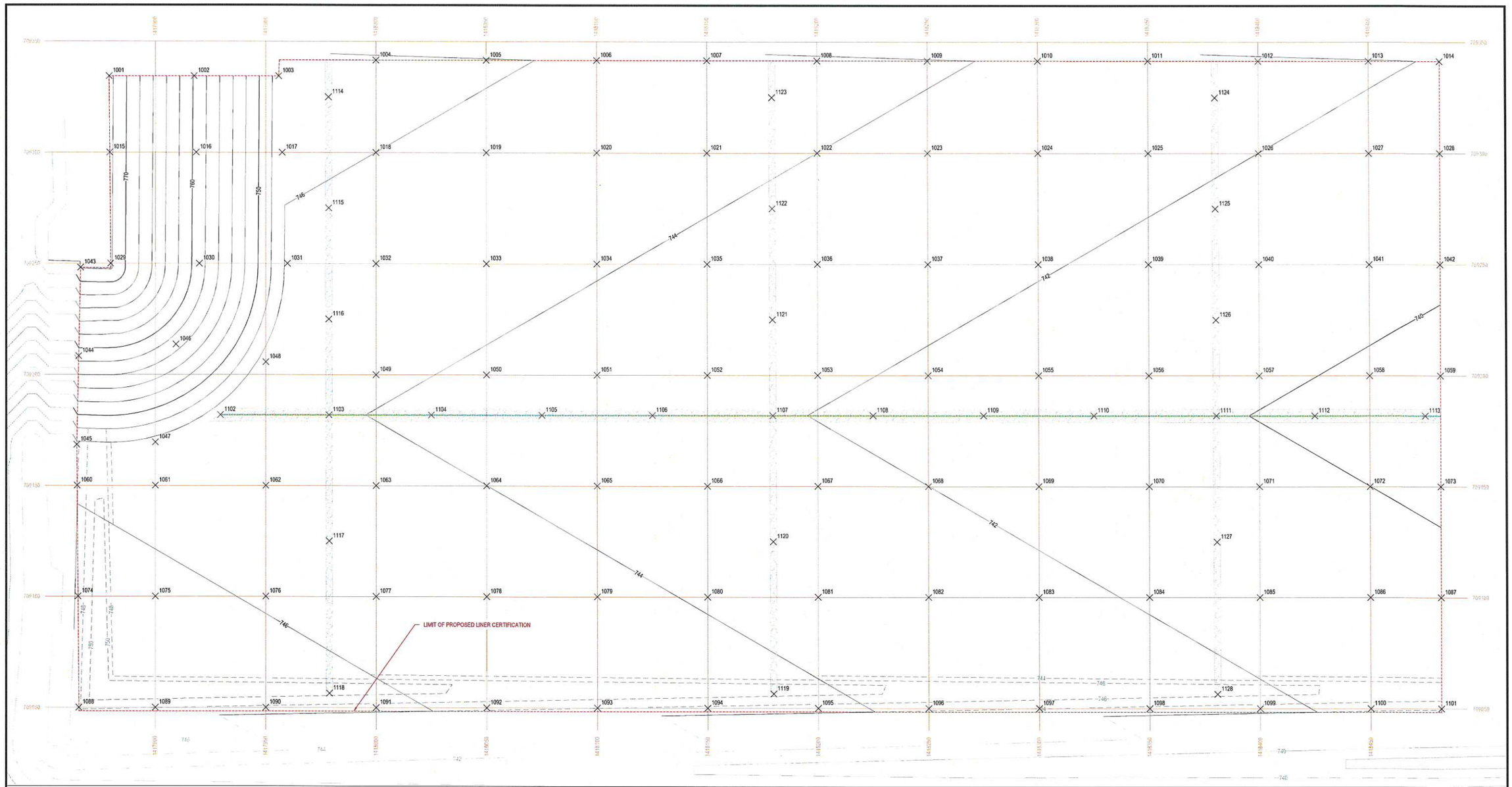
CELL B2 CONSTRUCTION DRAWINGS

IESI - AR LANDFILL CORPORATION

CHEROKEE CLASS 1 LANDFILL

FULTON COUNTY — ARKANSAS

DRAWING 5	
DESIGNED BY:	DCM, EJW
DRAWN BY:	EJW, JDW
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	12/11/2014
JOB NO.	35147247
ACAD NO.	005
SHEET NO.:	5 OF 11



NOTES:

1. PROPOSED CONTOURING DEPICTED REPRESENTS TOP OF PROTECTIVE COVER.

SCALE IN FEET

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No.9199 — DAVID C. McCORMICK

7.7.15

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH — BRYANT, ARKANSAS 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

IESI

CELL LINER SYSTEM CERTIFICATION POINTS

CELL B2 CONSTRUCTION DRAWINGS

IESI - AR LANDFILL CORPORATION

CHEROKEE CLASS 1 LANDFILL

FULTON COUNTY — ARKANSAS

DRAWING 6

DESIGNED BY:	DCM, EJW
DRAWN BY:	EJW, JDW
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	12/1/2014
JOB NO.	35147247
ACAD NO.	006
SHEET NO.:	6 OF 11

POINT NUMBER	NORTHING	EASTING	ELEVATION			DESCRIPTION
			SUBGRADE	CLAY LINER	PROTECTIVE COVER	
1001	709334.34	1417879.05	769.64	771.64	772.64	SLOPE-TOP
1002	709334.34	1417917.45	756.84	758.84	759.84	SLOPE-MID
1003	709334.35	1417955.85	744.04	746.04	747.04	SLOPE-TOE
1004	709341.57	1418000.00	743.72	745.72	746.72	FLOOR
1005	709341.55	1418050.00	743.22	745.22	746.22	FLOOR
1006	709341.53	1418100.00	742.72	744.72	745.72	FLOOR
1007	709341.52	1418150.00	742.22	744.22	745.22	FLOOR
1008	709341.50	1418200.00	741.72	743.72	744.72	FLOOR
1009	709341.48	1418250.00	741.22	743.22	744.22	FLOOR
1010	709341.47	1418300.00	740.72	742.72	743.72	FLOOR
1011	709341.45	1418350.00	740.22	742.22	743.22	FLOOR
1012	709341.44	1418400.00	739.72	741.72	742.72	FLOOR
1013	709341.42	1418450.00	739.22	741.22	742.22	FLOOR
1014	709341.41	1418481.95	738.90	740.90	741.90	FLOOR
1015	709300.00	1417879.34	769.47	771.47	772.47	SLOPE-TOP
1016	709300.00	1417918.40	756.45	758.45	759.45	SLOPE-MID
1017	709300.00	1417957.46	743.42	745.42	746.42	SLOPE-TOE
1018	709300.00	1418000.00	743.00	745.00	746.00	FLOOR
1019	709300.00	1418050.00	742.50	744.50	745.50	FLOOR
1020	709300.00	1418100.00	742.00	744.00	745.00	FLOOR
1021	709300.00	1418150.00	741.50	743.50	744.50	FLOOR
1022	709300.00	1418200.00	741.00	743.00	744.00	FLOOR
1023	709300.00	1418250.00	740.50	742.50	743.50	FLOOR
1024	709300.00	1418300.00	740.00	742.00	743.00	FLOOR
1025	709300.00	1418350.00	739.50	741.50	742.50	FLOOR
1026	709300.00	1418400.00	739.00	741.00	742.00	FLOOR
1027	709300.00	1418450.00	738.50	740.50	741.50	FLOOR
1028	709300.00	1418481.95	738.18	740.18	741.18	FLOOR
1029	709250.00	1417879.77	769.22	771.22	772.22	SLOPE-TOP
1030	709250.00	1417919.79	755.88	757.88	758.88	SLOPE-MID
1031	709250.00	1417959.81	742.54	744.54	745.54	SLOPE-TOE
1032	709250.00	1418000.00	742.13	744.13	745.13	FLOOR
1033	709250.00	1418050.00	741.63	743.63	744.63	FLOOR
1034	709250.00	1418100.00	741.13	743.13	744.13	FLOOR
1035	709250.00	1418150.00	740.63	742.63	743.63	FLOOR
1036	709250.00	1418200.00	740.13	742.13	743.13	FLOOR
1037	709250.00	1418250.00	739.63	741.63	742.63	FLOOR
1038	709250.00	1418300.00	739.13	741.13	742.13	FLOOR
1039	709250.00	1418350.00	738.63	740.63	741.63	FLOOR
1040	709250.00	1418400.00	738.13	740.13	741.13	FLOOR
1041	709250.00	1418450.00	737.63	739.63	740.63	FLOOR
1042	709250.00	1418481.95	737.31	739.31	740.31	FLOOR
1043	709248.21	1417866.18	769.14	771.14	772.14	SLOPE-TOP
1044	709208.32	1417865.31	755.76	757.76	758.76	SLOPE-MID
1045	709168.43	1417864.43	742.54	744.54	745.54	SLOPE-TOE
1046	709213.63	1417909.29	753.82	755.82	756.82	SLOPE-MID
1047	709169.49	1417900.00	742.17	744.17	745.17	SLOPE-TOE
1048	709205.66	1417950.00	741.87	743.87	744.87	SLOPE-TOE
1049	709200.00	1418000.00	741.27	743.27	744.27	FLOOR
1050	709200.00	1418050.00	740.77	742.77	743.77	FLOOR
1051	709200.00	1418100.00	740.27	742.27	743.27	FLOOR
1052	709200.00	1418150.00	739.77	741.77	742.77	FLOOR
1053	709200.00	1418200.00	739.27	741.27	742.27	FLOOR
1054	709200.00	1418250.00	738.77	740.77	741.77	FLOOR
1055	709200.00	1418300.00	738.27	740.27	741.27	FLOOR
1056	709200.00	1418350.00	737.77	739.77	740.77	FLOOR
1057	709200.00	1418400.00	737.27	739.27	740.27	FLOOR
1058	709200.00	1418450.00	736.77	738.77	739.77	FLOOR
1059	709200.00	1418481.95	736.45	738.45	739.45	FLOOR
1060	709150.00	1417864.59	742.86	744.86	745.86	FLOOR
1061	709150.00	1417900.00	742.50	744.50	745.50	FLOOR
1062	709150.00	1417950.00	742.00	744.00	745.00	FLOOR
1063	709150.00	1418000.00	741.50	743.50	744.50	FLOOR
1064	709150.00	1418050.00	741.00	743.00	744.00	FLOOR
1065	709150.00	1418100.00	740.50	742.50	743.50	FLOOR
1066	709150.00	1418150.00	740.00	742.00	743.00	FLOOR
1067	709150.00	1418200.00	739.50	741.50	742.50	FLOOR
1068	709150.00	1418250.00	739.00	741.00	742.00	FLOOR
1069	709150.00	1418300.00	738.50	740.50	741.50	FLOOR
1070	709150.00	1418350.00	738.00	740.00	741.00	FLOOR
1071	709150.00	1418400.00	737.50	739.50	740.50	FLOOR
1072	709150.00	1418450.00	737.00	739.00	740.00	FLOOR
1073	709150.00	1418481.95	736.68	738.68	739.68	FLOOR
1074	709100.00	1417865.02	743.71	745.71	746.71	FLOOR
1075	709100.00	1417900.00	743.37	745.37	746.37	FLOOR
1076	709100.00	1417950.00	742.87	744.87	745.87	FLOOR
1077	709100.00	1418000.00	742.37	744.37	745.37	FLOOR
1078	709100.00	1418050.00	741.87	743.87	744.87	FLOOR
1079	709100.00	1418100.00	741.37	743.37	744.37	FLOOR
1080	709100.00	1418150.00	740.87	742.87	743.87	FLOOR
1081	709100.00	1418200.00	740.37	742.37	743.37	FLOOR
1082	709100.00	1418250.00	739.87	741.87	742.87	FLOOR
1083	709100.00	1418300.00	739.37	741.37	742.37	FLOOR
1084	709100.00	1418350.00	738.87	740.87	741.87	FLOOR
1085	709100.00	1418400.00	738.37	740.37	741.37	FLOOR
1086	709100.00	1418450.00	737.87	739.87	740.87	FLOOR
1087	709100.00	1418481.95	737.55	739.55	740.55	FLOOR
1088	709050.00	1417865.45	744.57	746.57	747.57	FLOOR
1089	709050.00	1417900.00	744.23	746.23	747.23	FLOOR
1090	709050.00	1417950.00	743.73	745.73	746.73	FLOOR
1091	709050.00	1418000.00	743.23	745.23	746.23	FLOOR
1092	709050.00	1418050.00	742.73	744.73	745.73	FLOOR
1093	709050.00	1418100.00	742.23	744.23	745.23	FLOOR
1094	709050.00	1418150.00	741.73	743.73	744.73	FLOOR
1095	709050.00	1418200.00	741.23	743.23	744.23	FLOOR
1096	709050.00	1418250.00	740.73	742.73	743.73	FLOOR
1097	709050.00	1418300.00	740.23	742.23	743.23	FLOOR
1098	709050.00	1418350.00	739.73	741.73	742.73	FLOOR
1099	709050.00	1418400.00	739.23	741.23	742.23	FLOOR
1100	709050.00	1418450.00	738.73	740.73	741.73	FLOOR
1101	709050.00	1418481.95	738.41	740.41	741.41	FLOOR
1102	709181.85	1417929.36	741.66	743.66	744.66	LCP
1103	709181.85	1417978.63	741.17	743.17	744.17	LCP+CHIMNEYDRAIN
1104	709181.86	1418025.00	740.70	742.70	743.70	LCP
1105	709181.86	1418075.00	740.20	742.20	743.20	LCP
1106	709181.86	1418125.00	739.70	741.70	742.70	LCP
1107	709181.87	1418179.64	739.16	741.16	742.16	LCP+CHIMNEYDRAIN
1108	709181.87	1418225.00	738.70	740.70	741.70	LCP
1109	709181.88	1418275.00	738.20	740.20	741.20	LCP
1110	709181.88	1418325.00	737.70	739.70	740.70	LCP
1111	709181.88	1418380.50	737.15	739.15	740.15	LCP+CHIMNEYDRAIN
1112	709181.89	1418425.00	736.70	738.70	739.70	LCP
1113	709181.89	1418475.00	736.20	738.20	739.20	LCP
1114	709325.00	1417978.39	743.65	745.65	746.65	CHIMNEYDRAIN
1115	709275.00	1417978.47	742.78	744.78	745.78	CHIMNEYDRAIN
1116	709225.00	1417978.56	741.91	743.91	744.91	CHIMNEYDRAIN
1117	709125.00	1417978.72	742.15	744.15	745.15	CHIMNEYDRAIN
1118	709056.41	1417978.83	743.33	745.33	746.33	CHIMNEYDRAIN
1119	709056.41	1418179.84	741.32	743.32	744.32	CHIMNEYDRAIN
1120	709125.00	1418179.73	740.14	742.14	743.14	CHIMNEYDRAIN
1121	709225.00	1418179.57	739.90	741.90	742.90	CHIMNEYDRAIN
1122	709275.00	1418179.49	740.77	742.77	743.77	CHIMNEYDRAIN
1123	709325.00	1418179.41	741.64	743.64	744.64	CHIMNEYDRAIN
1124	709325.00	1418380.27	739.63	741.63	742.63	CHIMNEYDRAIN
1125	709275.00	1418380.35	738.76	740.76	741.76	CHIMNEYDRAIN
1126	709225.00	1418380.43	737.90	739.90	740.90	CHIMNEYDRAIN
1127	709125.00	1418380.60	738.13	740.13	741.13	CHIMNEYDRAIN
1128	709056.41	1418380.71	739.31	741.31	742.31	CHIMNEYDRAIN

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No.9199 — DAVID C. McCORMICK

7.7.15

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH — BRYANT, ARKANSAS 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

IESI

CELL LINER SYSTEM CERTIFICATION POINT TABLE

CELL B2 CONSTRUCTION DRAWINGS

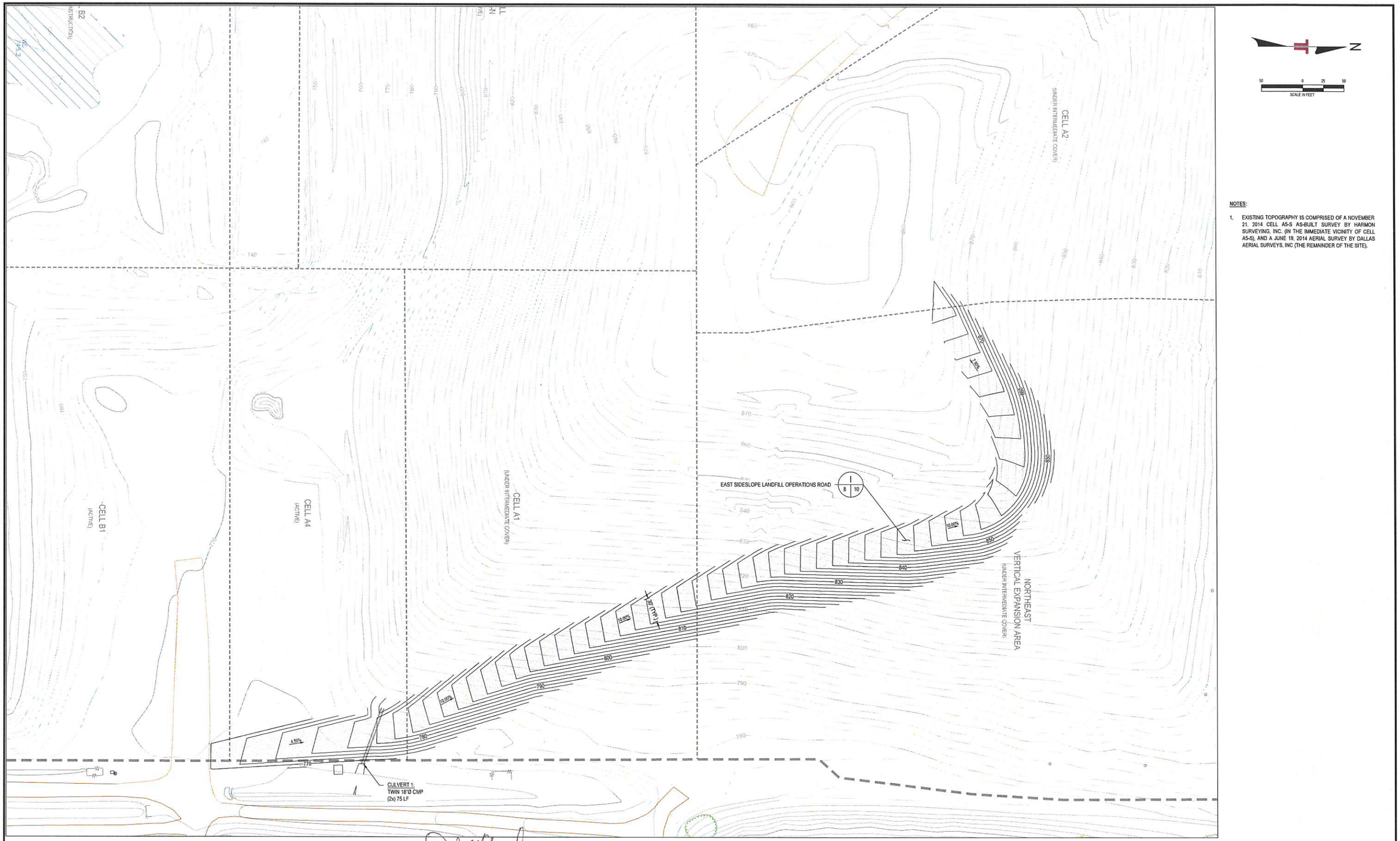
IESI - AR LANDFILL CORPORATION

CHEROKEE CLASS 1 LANDFILL

FULTON COUNTY — ARKANSAS

DRAWING 7

DESIGNED BY:	DCM, EJW
DRAWN BY:	EJW, JDW
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	12/11/2014
JOB NO.	35147247
ACAD NO.	007
SHEET NO.:	7 OF 11



NOTES:

1. EXISTING TOPOGRAPHY IS COMPRISED OF A NOVEMBER 21, 2014 CELL A5-S AS-BUILT SURVEY BY HARMON SURVEYING, INC. (IN THE IMMEDIATE VICINITY OF CELL A5-S), AND A JUNE 19, 2014 AERIAL SURVEY BY DALLAS AERIAL SURVEYS, INC (THE REMAINDER OF THE SITE).

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No.9199 — DAVID C. McCORMICK

D.C.M.

7.7.15

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH — BRYANT, ARKANSAS 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

IESI

EAST SIDESLOPE LANDFILL OPERATIONS ROAD

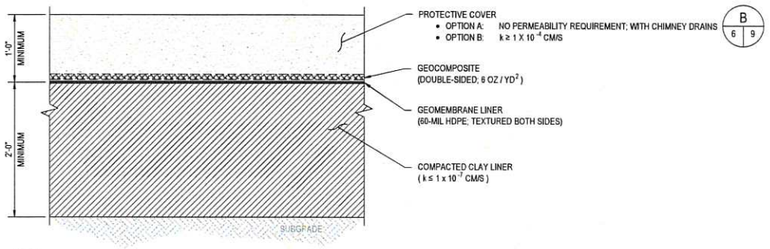
CELL B2 CONSTRUCTION DRAWINGS

IESI - AR LANDFILL CORPORATION

CHEROKEE CLASS 1 LANDFILL

FULTON COUNTY — ARKANSAS

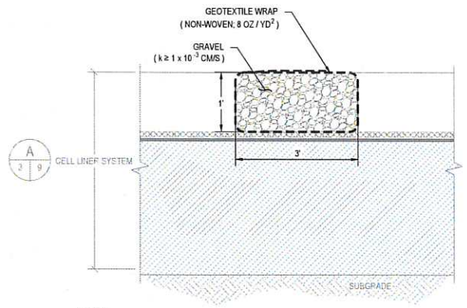
DRAWING 8	
DESIGNED BY:	DCM, EJW
DRAWN BY:	EJW, JDW
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	12/11/2014
JOB NO.	35147247
ACAD NO.	008
SHEET NO.:	8 OF 11



NOTES:

1. A GEOSYNTHETIC CLAY LINER (GCL) MAY BE SUBSTITUTED FOR THE THE 2' COMPACTED CLAY LINER. THE SAME PROTECTIVE COVER AND LINER ELEVATIONS WILL BE RETAINED AS FOR THE COMPACTED CLAY LINER OPTION (RESULTING IN REDUCED EXCAVATION TO SUBGRADE).
2. THE FINISHED SUBGRADE SUREFACE BELOW THE GCL SHOULD BE FIRM AND UNYIELDING, WITHOUT ABRUPT ELEVATION CHANGES, VOIDS, CRACKS, ICE OR STANDING WATER. ADDITIONALLY, THE SUBGRADE SURFACE MUST BE SMOOTH AND FREE OF VEGETATION, SHARP-EDGED ROCKS, STONES, STICKS, CONSTRUCTION DEBRIS, AND OTHER FOREIGN MATERIAL THAT COULD CONTACT THE LINE. THE SUBGRADE SHOULD BE ROLLED WITH A SMOOTH-DRUM COMPACTOR TO REMOVE ANY WHEEL RUTS, FOOTPRINTS, OR OTHER ABRUPT GRADE CHANGES. ALL PROTRUSIONS EXTENDING MORE THAN 0.5 INCH (12MM) FROM THE SUBGRADE SURFACE SHALL BE MANUALLY REMOVED, CRUSHED, OR PUSHED INTO AND FLUSH WITH THE SURFACE.
3. THE SOIL MUST CONSIST OF RELATIVELY HOMOGENEOUS, FINE GRAINED SOILS WHICH ARE FREE OF DEBRIS, FOREIGN OBJECTS, EXCESS SILT/SAND, AND ORGANIC SUBSTANCES.
4. THE SOILS MUST BE COMPACTED TO A MINIMUM OF 95% STANDARD PROCTOR MAXIMUM DRY DENSITY AT -3 TO +6 PERCENT OPTIMUM MOISTURE CONTENT, AS DETERMINED BY ASTM D698 UNLESS OTHERWISE NOTED IN THE PROJECT SPECIFICATIONS. THE SUBGRADE WILL BE TESTED A MINIMUM OF EVERY 10,000 SQ FT.
5. MATERIAL GREATER THAN THE #4 SIEVE MUST COMPOSE LESS THAN 20 PERCENT OF SOIL BY WEIGHT WITH NO PARTICLE SIZES GREATER THAN 1.0 INCHES IN DIAMETER.
6. STANDARD PROCTOR ASTM D698 MUST BE PERFORMED 1 TEST PER 20,000 YD 3 OR CHANGE IN MATERIAL OR BORROW AREA. A MINIMUM OF 1 TEST PER 100,000 SF.
7. ATTERBERG LIMITS ASTM D4318 MUST BE PERFORMED 1 TEST PER 20,000 YD 3 OR CHANGE IN MATERIAL OR BORROW AREA. A MINIMUM OF 1 TEST PER 100,000 SF.
8. SIEVE ANALYSIS ASTM C136 MUST BE PERFORMED 1 TEST FOR 20,000 YD 3 OR CHANGE IN MATERIAL OR BORROW AREA. A MINIMUM OF 1 TEST PER 100,000 SF.

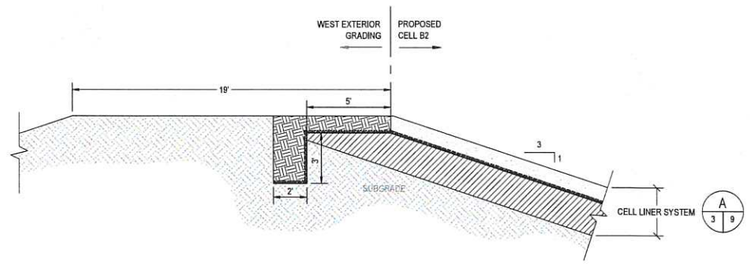
CELL LINER SYSTEM
DETAIL A (3 9) — SCALE: N.T.S.



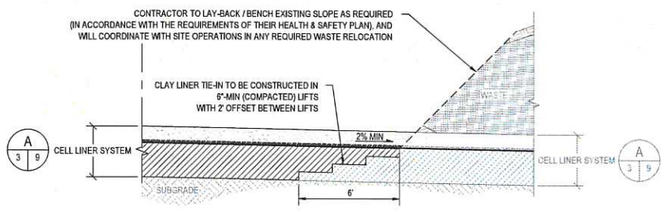
NOTES:

1. CHIMNEY DRAINS WILL BE USED IF PROTECTIVE COVER SOIL TO BE USED DOES NOT MEET THE PROTECTIVE COVER OPTION *B* PERMEABILITY REQUIREMENT.
2. MAXIMUM CHIMNEY DRAIN SPACING WILL BE 200 FT O.C.

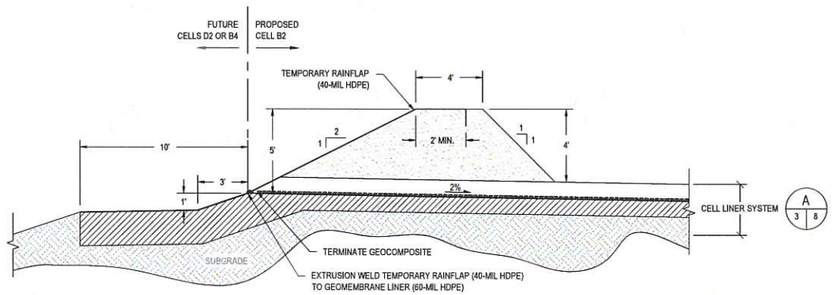
CHIMNEY DRAIN (SUPPLEMENTAL TO PROTECTIVE COVER OPTION A)
DETAIL B (6 9) — SCALE: N.T.S.



ANCHOR TRENCH AND WEST / PERIMETER CELL TERMINATION
DETAIL C (3 9) — SCALE: N.T.S.



TIE-IN TO EXISTING CELL LINER SYSTEM
DETAIL D (3 9) — SCALE: N.T.S.



NOTES:

1. NOMINAL 2% LINER SLOPE IS ACTUALLY 1.7% ALONG THIS CROSS-SECTION DETAIL ALIGNMENT, AND 2.0% IN THE DIRECTION OF THE LINER SLOPE.

OVERBUILD BERM AND SOUTH/WEST CELL TERMINATION
DETAIL E (6 8) — SCALE: N.T.S.

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No.9199 — DAVID C. McCORMICK

7.7.15

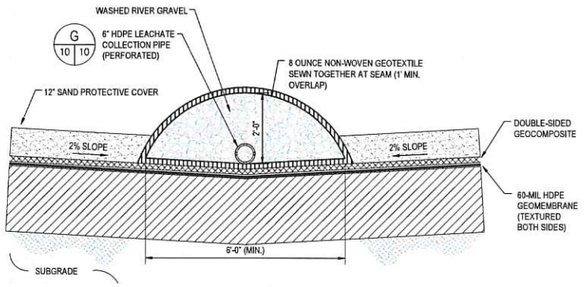
Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH — BRYANT, ARKANSAS 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

IESI

CELL LINER SYSTEM DETAILS
CELL B2 CONSTRUCTION DRAWINGS
IESI - AR LANDFILL CORPORATION
CHEROKEE CLASS 1 LANDFILL
FULTON COUNTY — ARKANSAS

DRAWING 9

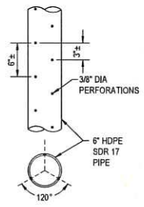
DESIGNED BY:	DCM, EJW
DRAWN BY:	EJW, JDW
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	12/11/2014
JOB NO.	35147247
ACAD NO.	609
SHEET NO.:	9 OF 11



LEACHATE COLLECTION PIPE

DETAIL F (5 | 10)

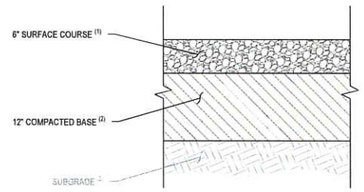
SCALE: N.T.S.



LEACHATE COLLECTION PIPE PERFORATION

DETAIL G (10 | 10)

SCALE: N.T.S.



NOTES:

1. 6" THICK AGGREGATE SURFACE COURSE SHALL CONSIST OF EITHER GRAVEL AND/OR CRUSHED STONE SO PROPORTIONED AS TO QUALIFY AS A CLASS 5, 6, 7, OR 8 MATERIAL IN ACCORDANCE WITH AASHTO T11 AND T27 AND CRUSHING REQUIREMENTS (AHTD TEST METHOD 304) AS SHOWN ON THIS SHEET.
2. VIBRATORY COMPACTION SHALL BE USED TO COMPACT THE BASE SOILS TO 95% STANDARD PROCTOR MAXIMUM DRY DENSITY AT A MOISTURE CONTENT OF 3% BELOW AND 3% ABOVE THE SOIL OPTIMUM MOISTURE CONTENT.
3. THE SUBGRADE SURFACE SHALL BE SCARIFIED AS NECESSARY FOR SHAPING, AND COMPACTED TO THE REQUIRED GRADE. THE FOUNDATION SHALL BE STABLE AND REASONABLY FREE OF DUST POCKETS, WHEEL RUTS, OR OTHER DEFECTS. ALL SOFT AND YIELDING MATERIAL AND OTHER PORTIONS OF THE SUBGRADE THAT WILL NOT COMPACT READILY WHEN ROLLED OR TAMPED SHALL BE REMOVED. HOLES OR DEPRESSIONS MADE BY THE REMOVAL OF UNSUITABLE MATERIAL SHALL BE FILLED WITH APPROVED MATERIAL AND THE ENTIRE SUBGRADE BROUGHT TO THE LINES, GRADE, AND CROSS SECTIONS SHOWN ON THESE PLANS.

GRAVEL PAVING

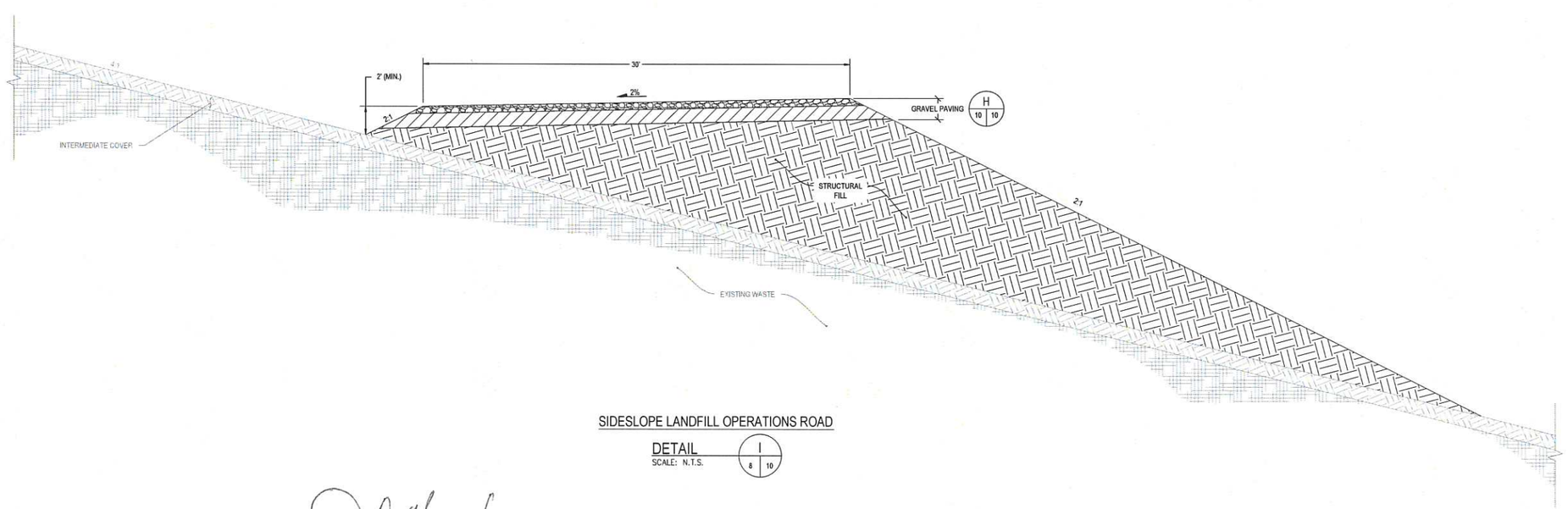
DETAIL H (10 | 10)

SCALE: N.T.S.

AGGREGATE BASE COURSE GRADING (AASHTO T 11 AND T 27) AND CRUSHING REQUIREMENTS (AHTD TEST METHOD 304)

SIEVE, mm	CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 5	CLASS 6	CLASS 7	CLASS 8
	PERCENT PASSING							
75 (3")	100	100	100					
50 (2")	95-100	95-100	95-100					
37.5 (1-1/2")			85-100	100	100	100	100	
25.0 (1")								100
19.0 (3/4")	60-100	60-100	60-100	60-100	60-100	50-90	50-90	65-100
9.5 (3/8")	40-80	40-80	40-80	40-80	40-80			
4.75 (#4)	30-60	30-60	30-60	30-60	30-60	25-55	25-55	25-55
2.00 (#10)	20-50	20-50	20-45	20-45	20-45			
0.425(#40)	10-35	10-35	10-35	10-35	10-35	10-30	10-30	10-30
0.075(#200)	3-15	3-15	3-12	3-12	3-12	3-10	3-10	3-10
MAX. PLASTICITY INDEX (MINUS 0.425 MATL.) (#40)	13	10	6	6	6	6	6	6
MINIMUM PERCENT CRUSHED (RETAINED ON 4.75mm (#4) SIEVE)					15			
MINIMUM PERCENT CRUSHER-RUN MATERIAL						90	90	90

RE: STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION; ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT (1996 EDITION)



SIDESLOPE LANDFILL OPERATIONS ROAD

DETAIL I (8 | 10)

SCALE: N.T.S.

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No.9199 — DAVID C. McCORMICK

7.7.15

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH — BRYANT, ARKANSAS 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

IESI

MISCELLANEOUS DETAILS

CELL B2 CONSTRUCTION DRAWINGS

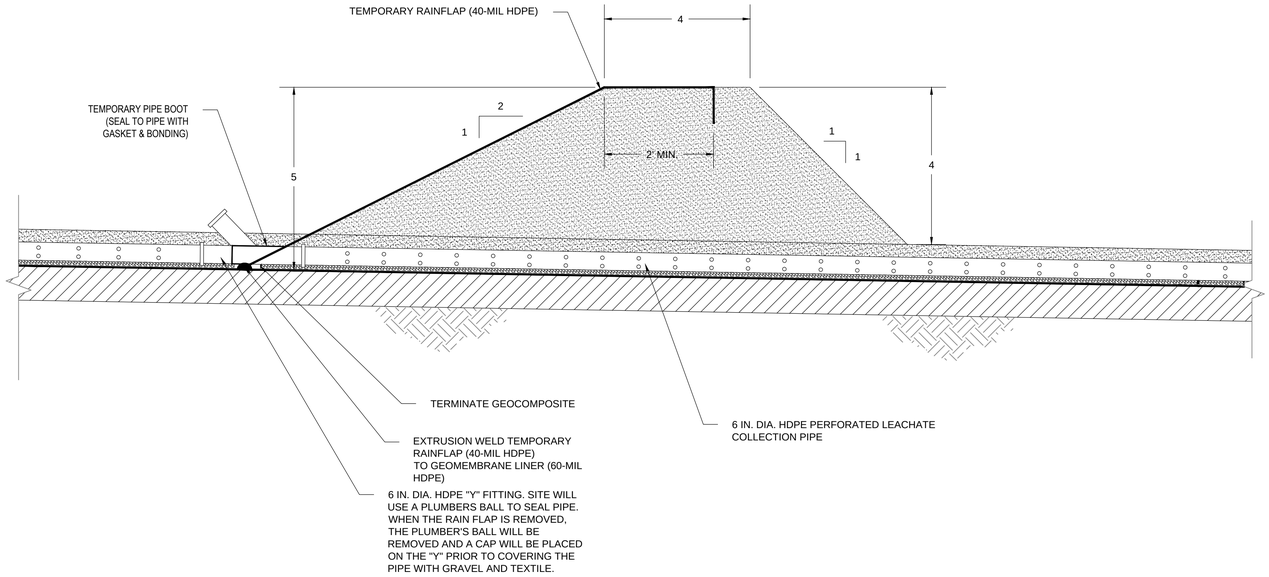
IESI - AR LANDFILL CORPORATION

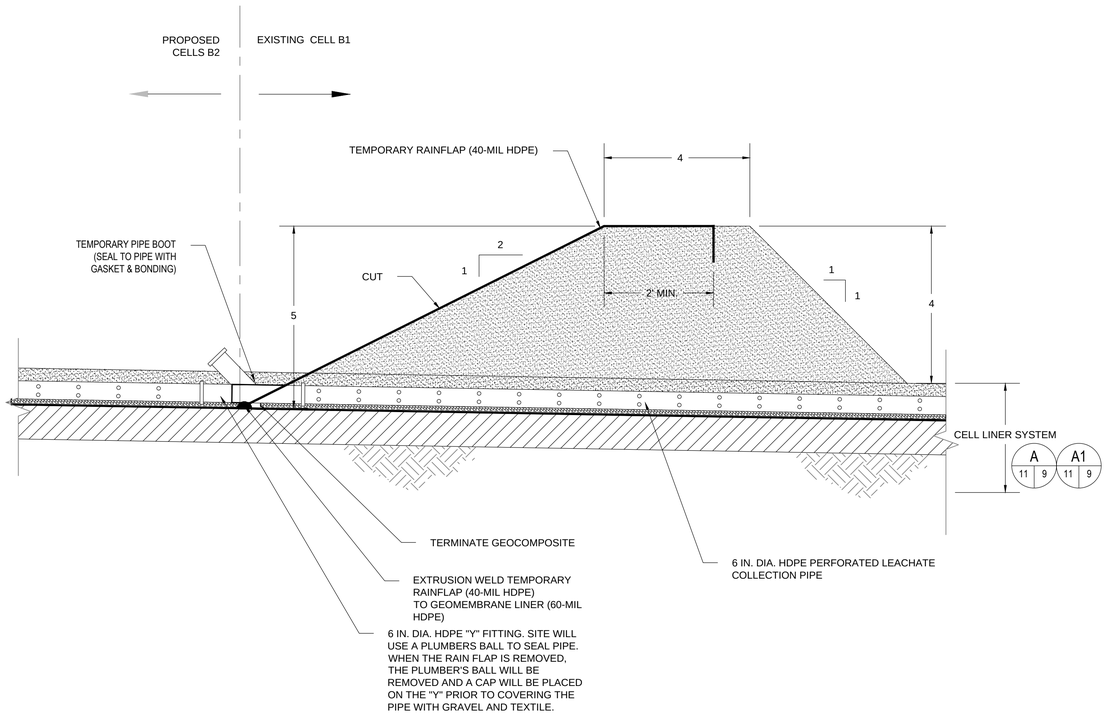
CHEROKEE CLASS 1 LANDFILL

FULTON COUNTY — ARKANSAS

DRAWING 10

DESIGNED BY:	DCM, EJW
DRAWN BY:	EJW, JDW
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	12/11/2014
JOB NO.	35147247
ACAD NO.	010
SHEET NO.:	10 OF 11





OPTIONAL TEMPORARY RAINFLAP

DETAIL J — 11

SCALE: N.T.S.

NOTES:

1. AFTER WASTE IS ACCEPTED THE SITE WILL REMOVE THE TEMPORARY RAINFLAP.

REV.	DATE	BY	DESCRIPTION
0.3	12/06/14	EJW	PRELIMINARY REVIEW DRAFT
0.4	8/21/15	JDW	REPLACED 6" SOLID PIPE WITH "Y" FITTING @ TOE OF RAINFLAPS

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No.9199 — DAVID C. McCORMICK

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH — BRYANT, ARKANSAS 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

IESI

TEMPORARY RAINFLAP

CELL B2 CONSTRUCTION DRAWINGS

IESI - AR LANDFILL CORPORATION

CHEROKEE CLASS 1 LANDFILL

FULTON COUNTY — ARKANSAS

DRAWING 11

DESIGNED BY:	DCM, EJW
DRAWN BY:	EJW, JDW
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	12/11/2014
JOB NO.	35147247
ACAD NO.	011
SHEET NO.:	11 OF 11

SECTION VII
CONSTRUCTION QUALITY CONTROL PLAN

Project # IESI-AR-CSL-06-04

Set # _____

BOTTOM LINER AND FINAL COVER SYSTEM

CONSTRUCTION QUALITY ASSURANCE PLAN

CHEROKEE SANITARY LANDFILL

CLASS 1 WASTE DISPOSAL AREA

Permit # 299-S1; CSN # 25-0028

Edwards

Released for Construction

PREPARED FOR:

IESI-AR LANDFILL CORPORATION
CHEROKEE SANITARY LANDFILL
300 LANDFILL ROAD
CHEROKEE VILLAGE, ARKANSAS 72529
(870) 994-7717
FAX: (870) 994-2199

PREPARED BY:

EDWARDS ENGINEERING, P.A.
9802 Maumelle Blvd.
North Little Rock, AR 72113
(501) 219-2808
FAX: (501) 219-2809

TABLE OF CONTENTS

SECTION #1 - GENERAL

SECTION #4 - GEOSYNTHETICS CONSTRUCTION QUALITY ASSURANCE

LIST OF TABLES

APPENDICES

SECTION #1
GENERAL

1.0 INTRODUCTION

Bottom liner systems and final cover systems for municipal solid waste landfills (MSWLF) are very critical components as they provide a barrier between waste derivatives and the surrounding environment. Arkansas Regulation 22 (Sections 22.428) requires all Class 1 Landfills in Arkansas to develop a written Construction Quality Assurance (CQA) plan associated with the installation of liner systems and final cover systems. The plan is to be made a part of the Facility Permanent Operating Record and detail quality assurance methods for all aspects of liner and final cover system construction. In accordance with Section 22.428 of Arkansas Regulation 22, this document incorporates the minimum standards set forth in Regulation 22 and the *Generic Construction Quality Assurance Plan for Lining and Cover Systems (Geosyntec, 1992)*. The Cherokee Sanitary Landfill (CSL) has adopted the following CQA standards as the facility CQA Plan to be used as a reference and directive associated with all future liner and cover system construction at the site.

CQA of the selection, evaluation, treatment, placement, and compaction of soils for earthworks, low-permeability soil liners, and granular drainage systems is included in the scope of this plan. CQA applicable to manufacturing, fabricating, shipping, handling, and installation of all geosynthetics is also included. This CQA Plan does not address design guidelines, installation specifications, or selection of soils, geomembranes, and other geosynthetics (which include chemical compatibility between geosynthetics). In particular, this document addresses the requirements for CQA monitoring, testing and documentation of all activities related to the production, construction, and installation of the area lining systems, leachate collection systems, and cover systems in relation to the Class 1 Landfill. When applicable and deemed appropriate by the Arkansas Department of Environmental Quality (ADEQ), deviations from this plan must be consistent with changes in applicable State and Federal regulations, facility permit conditions, and/or accepted practices in the field of engineering.

The CQA Plan includes references to test procedures of the American Society for Testing and Materials (ASTM), Corps of Engineers (COE), the Federal Test method Standards (FTMS) and the "Standards for Flexible Membrane Liners" of the National Sanitation Foundation (NSF). Where applicable, terms, practices, methods, and procedures were derived from the following references and guidance documents:

1. Generic Construction Quality Assurance Plan for the Lining and Cover Systems; Geosyntec Consultants; September 1992,

2. ASTM Standards and Other Specifications and Test Methods on the Quality Assurance of Landfill Liner Systems; ASTM; 1916 Race Street; Philadelphia, PA 19103; 1994,

3. "Arkansas Regulation 22"; Arkansas Department of Pollution Control and Ecology (ADEQ); April, 1995,

4. Geotextile Testing and the Design Engineer; Joseph E. Fluet, Jr.; ASTM STP 952; A symposium sponsored by ASTM Committee D-35 on Geotextiles, Geomembranes, and Related Products; Los Angeles, CA; June 1985,

5. Geoenvironment 2000; Characterization, Containment, Remediation, and Performance in Environmental Geotechnics; Edited by Yalcin B. Acar and David E. Daniel; Geotechnical Special Publication No. 46; Sponsored by the ASCE; New Orleans, LA; 1995,

6. Geosynthetics '95 Conference Proceedings; Nashville, TN; Sponsored by the International Geosynthetics Society; 1995,

7. Waste Containment Facilities-Guidance for Construction, Quality Assurance and Quality Control of Liner and Cover Systems; David E. Daniel and Robert M. Koerner; 1995.

2.0 DEFINITIONS RELATED TO CQA

This section describes Construction Quality Assurance (CQA) associated with the construction of liner and cover systems and defines terminology used throughout this document. **APPENDIX 1** defines terminology commonly used in this document and in the field of CQA.

2.1 Construction Quality Assurance and Quality Control

This CQA Plan is devoted to Construction Quality Assurance and, regarding the soils components only, to Construction Quality Control. In the context of this CQA Plan, Construction Quality Assurance and Construction Quality Control are defined as follows:

Construction Quality Assurance (CQA) - A planned and systematic pattern of all means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements, and will perform satisfactorily in service.

Construction Quality Control (CQC) - Those actions which provide a means to measure and control the characteristics of an item or service to contractual and regulatory requirements.

2.2 Use of the Terms in This Plan

In the context of this plan:

- CQA refers to means and actions employed by the CQA Consultant to assure conformity of the lining and cover system component production and installation with this CQA Plan, the project plans, and the project specifications. CQA is provided by a party independent from production and installation.
- CQC refers to those actions taken by manufacturers, fabricators, or installers to insure that the materials and the workmanship meet the requirements of the project plans and specifications. In the case of soils, CQC is combined with CQA and is provided by the CQA consultant. In the case of geosynthetics, CQC is provided by the manufacturers, fabricators, and Installers or the various geosynthetics.

Detailed definitions of terminology used in this plan are provided in **APPENDIX 1** of this document.

3.0 CQA PARTIES

As with any construction project, it is important to define the project objectives and determine each party's role early in the project. There should not be any confusion as to each party's responsibilities and the overall chain of command. This section summarizes the CQA parties that will be involved in any liner/cover system installation corresponding to the CSL. **FIGURE 1** illustrates the general chain of command that will be utilized associated with liner and final cover system installations at the CSL.

3.1 Description of CQA Parties

The following section summarizes the CQA parties who will be either directly or indirectly involved in the construction/installation associated with any liner or final cover system corresponding to the CSL. Where applicable, the CSL will be responsible for insuring that each of the parties selected have the necessary experience and qualifications associated with liner and final cover system installations. In addition, each party should be aware of its obligations and responsibilities as defined in this plan.

3.1.1 Owner

The Owner owns, and/or is responsible for, the facility including components constructed within the scope of this document. Unless otherwise noted, IESI-AR Landfill Corporation (IESI) will be the owner of any liner/final cover system constructed in at the CSL. IESI will ultimately be responsible for negotiating contracts between other CQA parties, and for insuring that qualified agencies, firms, contractors, etc. are selected who will satisfy the requirements of this CQA Plan and who will be responsible for insuring that the project is completed in accordance with applicable project plans, specifications, regulations.

3.1.2 Project/Site Manager

The Project/Site Manager is the official representative of the Owner, who is responsible for managing all aspects of the project including planning, cost control, design, permitting, regulatory liaison, contract acquisitions, construction oversight, quality control, and certification. As indicated in **FIGURE 1**, the Project/Site Manager, along with the Design Engineer will act as the focal point for the project, and will be the central point of contact for the Owner and CQA consultant. Depending on the size or scope of the project, the Project/Site Manager may be a 3rd party firm or agency contracted directly with the CSL to oversee the project. In some situations, the Project/Site Manager may act jointly as the Project/Site Manager and Design Engineer. The Owner and/or Project/Site Manager shall carefully consider the size and scope of the project when determining whether or not it is necessary to have separate individuals to fill the role of the CQA Certifying Engineer and Project/Site Manager. It should be noted, that Arkansas Regulation 22 requires that the CQA Consultant be represented as a firm/agency independent of the Owner (ie, 3rd Party).

3.1.3 Design Engineer

The Design Engineer is responsible for the design of the liner and/or cover systems, and for the preparation of the project plans and specifications. All plans and specifications are to be prepared consistent with proven and accepted engineering and construction practices.

3.1.4 CQA Consultant

The CQA Consultant is directly responsible for insuring that construction materials, practices, and procedures, are consistent with the requirements of this plan, the project specifications, plans, and applicable regulations. The CQA Consultant shall consist of a CQA Certifying Engineer, CQA Monitor, and CQA Manager. Depending on the size of the project, these duties may be performed by a single qualified individual. The CQA Consultant shall be a 3rd party firm or agency independent from the Owner.

3.1.4.1 Soils CQA Laboratory

The Soils CQA Laboratory is responsible for conducting tests in the field and in the laboratory on samples of soils associated with liner and cover system installations. Depending on the size and/or scope of the project, the Soils CQA Laboratory may also serve as the CQA Consultant.

3.1.4.2 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory is a party, independent from the Owner, manufacturer, fabricator, and installer, that is responsible for conducting tests on samples of geosynthetics taken from the site. Depending on the size and/or scope of the project, the Geosynthetics CQA Laboratory may also serve as the CQA Consultant.

3.1.5 Soils Supplier

The Soils Supplier excavates and/or delivers soil material to the Earthwork Contractor and/or project site. Depending on the size and/or scope of the Project, the Earthwork Contractor may also serve as the Soils Supplier.

3.1.6 Earthwork Contractor

The Earthwork Contractor is responsible for the preparation of the supporting soil on which the lining system is to be installed, and may also be responsible for constructing the test pad, and placing the soils components of the lining and/or cover systems.

3.1.7 Resin Supplier

The Resin Supplier produces and delivers the resin to the Geosynthetics Manufacturer.

3.1.8 Geosynthetics Manufacturer

The Geosynthetics Manufacturer is responsible for the production of geomembranes, geocomposite, geotextile, and geogrid rolls from resin or fibers (geotextiles).

3.1.9 Geosynthetics Installer

The Geosynthetics Installer (Installer) is responsible for field handling, storing, placing, seaming, loading, and other aspects of the geosynthetics installation. The Installer may also be responsible for transportation of these materials to the site and for construction of the anchor trenches if so defined in the project specifications.

3.1.10 Geosynthetics Transporter

The Geosynthetics Transporter transports the geosynthetics, including rolls or factory panels of geomembranes, geotextiles, and Geocomposites between the Manufacturer and the site; or between the Manufacturer and the Fabricator, and/or between the Fabricator and the site.

3.2 Qualifications of the Parties

The following qualifications shall be required of all parties involved with the design, manufacture, fabrication, installation, transportation, and CQA of all lining and cover system materials to be utilized associated with the CSL.

3.2.1 Project/Site Manager

The selection of the Project/Site Manager is the direct responsibility of the Owner. Qualifications for this position are therefore determined by the Owner independently of the CQA Plan and should be based on the objectives and constraints of the project as defined by the Owner.

3.2.2 Design Engineer

The Design Engineer shall be a qualified professional engineer with registration in the State of Arkansas. The Design Engineer shall have demonstrated experience associated with similar solid waste projects in Arkansas. In particular, the Design Engineer shall have a history which demonstrates familiarity with geosynthetics and/or soils, including detailed design and construction methods commonly used in the field of civil/sanitary engineering.

3.2.3 CQA Consultant

The CQA Consultant shall be a designated firm or agency independent of the Owner with demonstrated knowledge and experience with geosynthetics (including polyethylene geomembranes, geocomposites, geogrids, and geotextiles), and soil liner/cover systems. The CQA Consultant shall be experienced in providing CQA services for soils, including low-permeability and high-permeability soils. The CQA Consultant shall be experienced in quality assurance including installation quality assurance of polyethylene geomembranes, geocomposites, and geotextiles. The CQA Consultant shall be experienced in the preparation of quality assurance documentation including quality assurance forms, reports, certifications, and manuals.

The CQA Consultant shall provide the following, in writing, to the Owner (if requested) before entering into contractual agreements with the Owner:

- Corporate background and information
- Quality assurance capabilities:
  - a summary of the firm's experience with soils and geosynthetics, including geomembranes, geocomposites, and geotextiles;
  - a summary of the firm's experience in quality assurance, including installation quality assurance of soils, geomembranes, geocomposites, and geotextiles; and ; and
  - a summary of the CQA documentation and methods used by the firm, including sample CQA forms, reports, certifications, and manuals prepared by the firm.

The CQA Consultant shall provide the following, in writing, to the Project/Site Manager before beginning work on this project:

- Resumes of personnel to be involved in the project including the CQA Certifying Engineer, CQA Manager, and CQA Monitors;
- Proof of Professional Engineering registration in Arkansas as well as proof of B.S., M.S., or Ph.D. engineering degree; and
- Proof of quality assurance experience associated with applicable CQA personnel.

3.2.3.1 CQA Certifying Engineer

The CQA Certifying Engineer will ultimately be responsible for certifying that the liner/final cover system construction is completed in accordance with the specifications, plans, CQA Plan, and applicable regulations. The CQA Certifying Engineer should visit the construction site as necessary to review progress. The CQA Certifying Engineer shall also coordinate all CQA activities.

3.2.3.2 CQA Manager

The CQA Manager shall represent a designated firm or agency independent of the Owner with demonstrated knowledge and experience with geosynthetics and soil liner/cover systems. The CQA Manager will be responsible for directing the implementation of the CQA Program.

3.2.3.3 CQA Monitor

The CQA Monitor will represent the CQA Consultant in the field and will review all construction procedures and methods. The CQA Monitor will also arrange and coordinate testing.

3.2.3.4 Soils CQA Laboratory

The Soils CQA Laboratory shall have experience in soils testing, meet all regulatory requirements, and have demonstrated experience utilizing the ASTM and Corps of Engineers (COE) standards specified in this Plan. The Soils CQA Laboratory shall be capable of providing test results in accordance with the test methods described in the specifications. **The soils CQA Laboratory shall be capable of providing permeability test results in writing in six (6) calendar days or less from the date samples are delivered to the laboratory**.

3.2.3.5 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory shall have experience in testing geosynthetics and be familiar with American Society for Testing and Materials (ASTM), National Sanitation Foundation (NSF), and other applicable test methods. The Geosynthetics CQA Laboratory shall be capable of providing test results within 24 hours of receipt of samples (Destructive Tests) and shall maintain that standard throughout the installation. Conformance Test results shall be made available within 72 hours after samples are delivered to the laboratory.

3.2.4 Soils Supplier

Qualifications of the soils supplier are specific to the construction contract. The soils supplier shall have a demonstrated history of providing soils with consistent properties (when applicable).

3.2.5 Earthwork Contractor

Qualifications of the Earthwork Contractor are specific to the construction contract. The Earthwork Contractor shall have a demonstrated history of successful earthworks construction. In particular, the Contractor shall have successfully completed a total of 500,000 square feet (11.5 acres) of clay liner/cover systems for solid waste, hazardous

waste, or surface water containment. Documentation of this experience shall be submitted with the Contractors Bid to the Project/Site Manager.

3.2.6 Resin Supplier

Qualifications of the Resin Supplier are specific to the manufacturer's requirements. The Resin Supplier shall have a demonstrated history of providing resin with consistent properties.

3.2.7 Geosynthetics Manufacturer

The Geosynthetics Manufacturer shall be able to provide sufficient production capacity and qualified personnel to meet the demands of the project. The Geomembrane Manufacturer, in particular, shall be pre-qualified and approved by the Engineer and Owner. The qualifications presented by the Geomembrane Manufacturer shall, at a minimum include:

- Corporate background and information
- Manufacturing capabilities:
  - information on plant size, equipment, personnel, number of shifts per day and capacity per shift;
  - daily production quantity available for this contract;
  - quality control manual for manufacturing; and
  - list of material properties including certified test results, to which are attached geomembrane samples.
- A list of at least ten completed facilities, totaling a minimum of 9,290,304 m^2 (100,000,000 ft^2), for which the Geomembrane Manufacturer has manufactured a geomembrane of the type to be used for this project. For each facility, the following information shall be provided:
  - name and purpose of facility, its location, and date of installation;
  - name of owner, Project/Site Manager, designer, fabricator (if any), and installer;
  - thickness and surface area of geomembrane manufactured; and
  - available information on the performance of the lining system and the facility.

3.2.8 Geosynthetics Installer

The Geosynthetics Installer shall be trained and qualified to install geosynthetics. The Geomembrane Installer, in particular, shall be approved and/or licensed by the Geomembrane Manufacturer and/or the Geomembrane Fabricator. A copy of the approval letter or license shall be submitted by the Geomembrane Installer to the Project/Site Manager. Prior to confirmation of any contractual agreements, the Geomembrane Installer shall provide the Project/Site Manager with the following written information:

- Corporate background and information.

- Installation capabilities:
- Equipment and personnel;
- Daily anticipated production;
- Quality control manual for installation; and
- Samples of field seams and certified test results.
- A list of at least five completed facilities, each totaling a minimum of 185,807 m^2 (2,000,000 ft^2), for which the Geomembrane Installer has installed a polyethylene geomembrane. For each installation, the following information shall be provided:
  - name and purpose of facility, its location, and date of installation;
  - name of owner, Project/Site Manager, designer, manufacturer, and fabricator (if any);
  - name and qualifications of the supervisor(s) of the Installer's crew(s),
  - thickness of geomembrane and surface area of the installed geomembrane,
  - type of seaming and type of seaming apparatus used;
  - duration of installation; and
  - available information on the performance of the lining system and the facility.

All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. At least one seamer shall have experience seaming a minimum of 464,500 m^2 (5,000,000 ft^2) of polyethylene geomembrane using the same type of seaming apparatus as to be used for this project. The most experienced seamer, the "master seamer", shall provide direct supervision, as required, over less experienced seamers. No field seaming shall take place without the master seamer present.

The Geomembrane Installer shall provide the Project/Site Manager with a list of proposed seaming personnel and their professional records. All quality control technicians shall have a minimum 5,000,000 ft^2 of experience installing polyethylene-lining systems. All other seaming personnel shall have a minimum of 1,500,000 ft^2 of experience installing geomembranes. This document shall be reviewed by the Project/Site Manager/Project Engineer and the Geosynthetics CQA Consultant. Any proposed seaming personnel deemed insufficiently experienced will not be accepted or shall be invited to pass a seaming test.

The Installer shall designate one representative as the Superintendent, who shall represent the Installer at all site meetings and be responsible for acting as the Installer's spokesman on site. This Superintendent shall be pre-qualified for this role, on the basis of experience, management ability, and authority. The appointment will be approved by the Project/Site Manager and the Geosynthetics CQA Consultant.

3.2.9 Geosynthetics Transporter

All personnel responsible for the loading, transport, and unloading of the geosynthetics must be fully aware of the consequences of geosynthetics damage, and be familiar with the handling/ transport constraints required by the Manufacturer and/or Fabricator.

3.3 Duties of the CQA Personnel

In this CQA Plan, the roles of the various CQA Consultant team members are detailed. Specifically, the team members will include the CQA Certifying Engineer, CQA Manager, and CQA Monitor.

- CQA Certifying Engineer oversees the execution of the CQA project and provides quality control of the CQA personnel.
- CQA Manager directs CQA activities from the offices of the CQA Consultant's firm and visits the site periodically; The CQA Managers will report directly to the CQA Certifying Engineer.
- CQA Monitors will report directly to the CQA Manager or CQA Certifying Engineer and will be on site during all aspects of construction pertaining to the liner/cover system installation.

The CQA Manager may also serve as the CQA Monitor depending on the size and/or scope of the project. In any event, the CQA Certifying Engineer will ultimately have managing authority over the execution of the project CQA Program.

3.3.1 CQA Certifying Engineer

The CQA Certifying Engineer will be responsible for:

- review of all project related design plans and specifications;
- review of all other site-specific documentation, including bid documents, proposed layouts, soils and groundwater investigation reports, and for geosynthetics, the manufacturer's and installer's literature;
- attends the resolution meetings;
- administers the CQA program (i.e., assigns and manages all CQA personnel, reviews all field reports, and provides engineering review of all CQA related issues);
- provides quality control of the CQA personnel, including site visits;
- reviews all changes to the design, plans, and specifications;
- prepares/approves the final certification report, including a review of the Record Drawing(s); and
- reviews all CQA Monitors' daily reports and logs.

3.3.2 CQA Manager

The CQA Manager may also be the CQA Certifying Engineer depending on the size and/or scope of the project and will be responsible for:

- acts as the primary representative of the CQA Consultant;
- familiarizes himself and/or all CQA Monitors with the site and the project requirements;
- manages the daily activities of the CQA Program;
- attends all CQA-related meetings, i.e., resolution, pre-construction, daily, weekly, etc.;

- prepares or oversees the ongoing preparation of the Record Drawings(s);
- assigns locations for testing and sampling;
- verifies the calibration and condition of on-site CQA equipment;
- oversees collection and shipping of all laboratory test samples;
- reviews results of laboratory testing and makes appropriate recommendations;
- reports to the Project/Site Manager, and logs in his daily field report any relevant observations reported by the CQA Monitors;
- prepares a daily construction progress report;
- designates a senior CQA Monitor to act on his behalf whenever he is absent from the site while operations are ongoing;
- reports any unresolved deviations from the CQA Plan to the CQA Certifying Engineer; and
- periodically checks stockpile or borrow pit sources for variability of the soils, and insures that conformance testing is carried out;
- reviews the qualifications of the Contractor's equipment operators, to insure that care is taken to protect other portions of the work; and
- establishes additional test requirements beyond those in the specifications, where necessary to confirm permeability or density requirements.
- performs site visit and review of manufacturing plant facilities (when possible), methods, and quality control;
- reviews all Supplier, Manufacturer, and Installer certifications and documentation and makes appropriate recommendations;
- reviews the Installer's personnel qualifications for conformance with those pre-approved for work on site; and
- notes any on-site activities that could result in damage to the geosynthetics.
- prepares the final CQA report with the CQA Certifying Engineer.

3.3.3 CQA Monitors

The duties of the CQA Monitors include, as assigned by the CQA Manager and or CQA Certifying Engineer: monitoring, logging, and/or documenting all appropriate construction operations. The duties to be performed, and operations to be monitored by the CQA Monitors include:

- soils delivery, dumping, and placement;
- soils moisture content, and moisture conditioning, if required;
- compaction of soils, and in situ testing of compacted density and moisture content;
- collection of samples for laboratory testing for moisture/density relationships, permeability, and other testing as outlined in the specifications;
- operations to protect completed areas before the covering materials are placed;
- measurement of loose and compacted lift thickness;
- verification of bonds between lifts;

- observation of equipment type, number of passes and equipment contact pressure;
- examination of the soil surface for signs of excessive wetting, desiccation, or other disturbance prior to placement of any cover materials; and
- scarification, rewetting, recompaction, or proof rolling required to repair deteriorated areas.

The operations to be monitored by the CQA Monitors, for all geosynthetics include:

- material delivery and "spotting";
- unloading and on-site transport and storage;
- on-site conformance testing to verify thickness of geomembranes and Geocomposites;
- marking samples for conformance testing;
- sampling for conformance testing by the Geosynthetics CQA Laboratory;
- all placement operations;
- condition of panels as placed;
- all joining and/or seaming operations;
- repair operations.
- trial seams;
- seam preparation;
- seaming;
- nondestructive seam testing;
- sampling for destructive testing;
- field tensiometer testing;
- laboratory sample marking; and
- repair operations.

Specifically, for geotextiles, operations to be performed by CQA Monitors include visual examination by walkover. In addition to these specific duties, all CQA Monitors shall take note of any on-site activities that could result in damage to the soils or geosynthetics components of the lining system. Any observations so noted shall be reported as soon as possible to the CQA Manager and/or CQA Certifying Engineer.

4.0 SITE AND PROJECT CONTROL

In order to coordinate various aspects of the construction project and develop time frames for efficient completion of the project, various project coordination meetings will be required associated with all liner/cover system installations.

4.1 Resolution Meeting

Following the completion of the design plans, and specifications for the project, a Resolution Meeting shall be held. This meeting shall include all parties then involved, including the Owner, Project/Site Manager, Design Engineer, and CQA Certifying Engineer.

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties and delays in construction, and, above all, review the CQA Plan with all the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all. The first part of the Resolution Meeting may be devoted to a review of the design drawings and specifications for completeness and clarity. This is different from the peer review of the design, including design calculations, which shall have been carried out previously. This meeting should include all of the following activities:

- communicate to all parties any relevant documents;
- review critical design details of the project;
- review the seam layout drawing provided by the Designer, the Fabricator, or the Installer;
- review the project-specific CQA Plan;
- make any appropriate modifications to the CQA Plan to insure that it specifies all CQA activities that are necessary;
- make any appropriate modifications to the design criteria, plans, and specifications so that the fulfillment of all design specifications or performance standards can be determined through the implementation of the site-specific CQA Plan;
- reach a consensus on the CQA Plan and quality control procedures, especially on methods of determining the acceptability of the soils and geosynthetics comprising the lining system;
- assign the responsibilities of each party;
- decide the number of spare seaming units for geomembranes to be maintained on site by the Installer (this number depends on the number of seaming crews and on the type of seaming equipment);
- decide the number of soil density testing units to be maintained on site;
- establish work area security and safety protocol;
- select testing equipment and review protocols for testing and placement of soil materials;
- confirm the methods for documenting and reporting, and for distributing documents and reports; and

- confirm the lines of authority and communication.

A person designated at the beginning of the meeting shall document the meeting, and minutes shall be transmitted to all parties.

4.2 Pre-Construction Meeting

A Pre-Construction Meeting shall be held at the site. At a minimum, the meeting shall be attended by the Owner, Project/Site Manager, Design Engineer, CQA Certifying Engineer, CQA Manager, Earthwork Contractor, and Geosynthetics Installer. If deemed appropriate by the Project/Site Manager, the Pre-Construction Meeting may be separated into two separate meetings; one for the Earthwork Contractor and one for the Geosynthetics Installer.

Specific topics considered for this meeting include:

- modifications to the CQA Plan (if any);
- review the responsibilities of each party;
- review lines of authority and communication;
- review methods for documenting and reporting, and for distributing documents and reports;
- establish protocols for testing;
- establish protocols for handling deficiencies, repairs, and retesting;
- review the time schedule for all operations;
- establish rules for writing on the geomembrane, i.e., who is authorized to write, what can be written and in which color;
- outline procedures for packaging and storing archive samples;
- review panel layout and numbering systems for panels and seams;
- establish procedures for use of the extrusion welding apparatus;
- establish procedures for use of the fusion welding apparatus, if applicable;
- finalize field cutout sample sizes;
- review seam testing procedure;
- review repair procedures;
- conduct a site walk-around to verify material storage locations;
- establish soil stockpiling locations; and
- review precautions to be taken against clay deterioration, due to wetting or desiccation.

A person designated at the beginning of the meeting shall document the meeting, and minutes shall be transmitted to all parties.

4.3 Progress Meetings

Weekly progress meetings shall be held between the CQA Manager, the Installer's superintendent, the Project/Site Manager, and any other concerned parties. This meeting shall discuss current progress, planned activities for the next week, and any new business or revisions to the work. The CQA Manager shall log any problems, decisions, or questions arising at this meeting in their daily reports. Any matter requiring action, which is raised in this meeting, shall be reported to the appropriate parties. The CQA Manager's logs shall be submitted to the CQA Certifying Engineer for inclusion in the Certification Report if deemed pertinent and appropriate.

4.4 Problem or Work Deficiency Meetings

A special meeting shall be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting shall be attended by the affected contractor(s), the Project/Site Manager, and the appropriate CQA Manager(s). If the problem requires a design modification, the Design Engineer and CQA Certifying Engineer should also be present. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency and review alternative solutions; and
- implement an action plan to resolve the problem or deficiency.

The meeting shall be documented by a person designated at the meeting and minutes shall be transmitted to affected parties.

4.5 Project Control Visits

4.5.1 Periodic Visits

Periodically, the construction site shall be visited by the CQA Manager and the CQA Certifying Engineer. This visit should be coordinated with a similar visit by the Design Engineer when appropriate. State regulatory officials may also be informed of designated inspection dates if deemed appropriate by a Project/Site Manager or Owner.

4.5.2 Manufacturing Plant Visits

A geomembrane manufacturing plant visit may be carried out by a representative of the Owner, Project/Site Manager, CQA Certifying Engineer, or CQA Manager in order to verify manufacturing practices or quality control procedures. These visits will be arranged on an "as needed" basis if deemed appropriate by the Project/Site Manager. Project specific plant visits for the manufacture and fabrication of the geomembrane, as well as the other geosynthetics (geotextiles and geocomposites) are optional. These plant visits shall be carried out at the discretion of the Owner, by the Owner, or his designated alternate.

5.0 CERTIFICATION AND REPORTING

Upon completion of the construction project, the CQA Manager and/or the CQA Certifying Engineer shall compile a comprehensive CQA Certification Report for submittal to the Arkansas Department of Environmental Quality (ADEQ). The Certification Report shall contain the seal of the Certifying Engineer and shall provide a written record of all construction activity, data, and as-built drawings.

SECTION #2
SURVEYING CONSTRUCTION QUALITY ASSURANCE

1.0 INTRODUCTION

Surveying of lines and reference elevations is conducted on an ongoing basis during the construction of the soil liner materials, synthetic liner system, and leachate collection system components. Accurate surveying is absolutely essential to insure that the liner/cover and hydraulic transport systems function as they were designed. The Contractor will be responsible for establishing the necessary grade control in addition to the preparation of accurate record drawings (as builts). The CQA Consultant will be responsible for reviewing all surveying activity performed by the Contractor to insure that construction adheres to the project plans and specifications.

2.0 SURVEY CONTROL

There are three permanent benchmarks established for the project at locations convenient for reference during construction. The reference datum is in relation to the Arkansas State-Plane Coordinate system. The reference monuments consist of aluminum caps set in concrete. Horizontal and vertical coordinate data are permanently stamped on the aluminum caps. All construction to be completed at the CSL shall be in reference to the facility survey control system.

3.0 PRECISION AND ACCURACY

A wide variety of survey equipment is available for use in projects of this type. The survey instruments used for this work should be sufficiently precise and accurate to meet the needs of the project. All survey instruments should be capable of reading to a precision of 0.1 feet with a setting accuracy of $\pm$ 0.8 sec. (2.2×10^{-3} degrees).

4.0 LINES AND GRADES

The following surfaces shall be surveyed by the Contractor and verified by the CQA Consultant to document the lines and grades achieved during placement and compaction.

- For the berms and other earthworks:
  - original grade surface
  - compacted surface of cut slopes
  - finished grade surface
- For soil liners:
  - original contours
  - prepared subgrade surface
  - finished clay liner surface
- For the soil cover materials
  - prepared surface
  - finished soil cover surface

In addition, the lateral and vertical extent of all synthetic liner components as well as critical leachate collection system components shall be provided on the record drawings for future reference (if necessary).

5.0 FREQUENCY AND SPACING

All surveying should be carried out immediately upon completion of a given installation to facilitate progress and avoid delaying commencement of the next installation. Any surveying conducted by the CQA team, is to be conducted as a check on the Contractor, but is not intended to alleviate the Contractor from his responsibilities for insuring that all construction is within the required grades and lines shown in the project plans and specifications.

At a minimum, the following spacings and locations should be provided for survey points:

- all "flat" surfaces, such as the base of the landfill, with gradients less than 10 percent, should be surveyed on a square grid not wider spaced than 50 feet
- on all slopes greater than 10 percent, a square grid not wider than 50 feet should be used, but in any case, a line at the crest, midpoint, and toe of the slope should be taken;
- a line of survey points no further than 50 feet apart must be taken along any slope break (this will include the inside edge and outside edge of any bench on a slope);
- a line of survey points no further than 50 feet apart must be taken at the invert of any pipes or other appurtenances to the liner;
- at the corners and midpoints of the top and bottom of all sumps; and
- at the midpoint of the crest of the outside berms.

6.0 DOCUMENTATION

Copies of all field survey notes should be retained by the Surveying CQA Managing Engineer. The findings from the field surveys should be documented on a set of as built drawings.

The record drawings should include the following information when applicable:

1. Site Layout Drawing showing:

    - Layout of Prepared Area in Relation to Permitted Boundaries;
    - Property boundaries and/or corners;
    - Monitoring wells and piezometers (if scale permits);
    - Leachate risers, manholes and collection piping related to the specific cell and/or construction;
    - Limits of existing/future refuse disposal areas;
    - Any gas monitoring facilities or wells in the area
    - Labeling and miscellaneous information
        - Descriptions of what each line style represents
        - Drawing scale
        - Legend
        - North arrow
    - Existing contours (prior to construction activity corresponding to this project);
    - A key map showing the location of the construction related to the permitted design, along with an identification of areas previously constructed and areas yet to be constructed
    - Any other features deemed significant

2. Subgrade Drawing showing:

    - Prepared subgrade surface (plan view);
    - The limits of excavation including all slopes
    - The location of slope breaks, leachate sump and trenches, berms
    - Any other features deemed significant

3. Top of Compacted Clay Liner System showing:

    - The top of liner elevations referenced to the site grid coordinate system
    - The location of slope breaks, leachate sump and trenches, berms
    - Any other features deemed significant

4. Top of Drainage Layers or Liner Protection Layers showing:

    - If a granular blanket is utilized in the design, top of blanket elevation should be identified
    - The location of slope breaks, leachate sump and trenches, berms
    - Any other features deemed significant

The Contractor will be responsible for submitting these record drawings (as builts) to the CQA Consultant for review. The record drawings are to be included in the Certification Report along with the CQA Consultant's Certifying Engineer's seal. The

report shall then be submitted to the Project Engineer for review prior to being submitted to the ADEQ.

SECTION #3
EARTHWORK CONSTRUCTION QUALITY ASSURANCE

1.0 INTRODUCTION

This CQA document addresses five types of soil related construction scenarios that may be encountered associated with bottom liner and/or final cover installations at the Cherokee Sanitary Landfill (CSL). More specifically, the following types of earthwork construction and related quality assurance are addressed in this section.

1) In-Situ clay liners;
2) Compacted clay liners/ barrier layers;
3) Compacted fill (ie. berms)
4) Liner protective cover layers
5) Topsoil (soil demonstrating the ability to support plant growth)
6) Miscellaneous Earthwork (Anchor Trenches, etc.)

2.0 GENERAL SOIL MATERIAL REQUIREMENTS

Except when otherwise noted in the project specifications or plans, soil materials to be utilized in each component of the liner and/or final cover system shall conform to the following minimum requirements in relation to quality assurance and quality control.

2.1 In-Situ Clay Liners

The in-situ soils require treatment in the form of grading and surface compaction prior to the placement of any of the geosynthetic lining system materials. If the clay is disturbed, through undercutting of unsuitable material etc., the clay is to be replaced and compacted to 95% of Standard Proctor density at a moisture content of 0 to 6% wet of the optimum moisture content. When possible, the clay surface should be relatively smooth and free of large rocks, sticks, or other debris which could compromise the composite liner system.

The upper portion of the in-situ clay can be damaged by excess moisture (causing softening) and insufficient moisture (causing desiccation and shrinkage), or by freezing. At a minimum, the Soils CQA Monitor shall determine the suitability and condition of the in-situ clay liner by:

- continuous visual inspection during proof-rolling;
- pocket penetrometer or Torvane shear tests in suspect soil areas;
- other tests identified in **TABLES 1** and **2**;

The main requirement for the in-situ clay liner is it must have sufficient compaction and strength to enable the placement of the composite liner system while supporting the weight of the landfill. The in-situ clay liner also must be stable enough to prevent large differential settlements that would be conducive to damage of the liner system or the pooling of leachate. Strengthening of the liner may be established by the incorporation of geogrids as part of the liner system. The clay liner material shall exhibit a maximum hydraulic conductivity as per the specifications when tested in an in-situ condition. If the in-situ clay material does not meet the permeability standards the clay shall be moisture conditioned, reworked, and recompacted.

2.2 Compacted Clay Liners/ Barrier Layers

The soil components to be used for the compacted liner and barrier layer systems shall consist of the following minimum specifications. The values and numbers presented herein are to be considered the minimum criteria for all materials utilized in the construction of compacted clay liner systems and compacted clay barrier layers:

1) the soil must consist of relatively homogeneous, fine grained soils which are free of debris, foreign objects, excess silt/sand, and organic substances;

2) the hydraulic conductivity (permeability) of the compacted clay liners shall not exceed 1.0 x 10^{-7} cm/s for Class 1 liners and compacted clay barrier layers;
3) The soil must be compacted to a minimum of 95% Standard Proctor maximum dry density, at 0 to 6 percent above the optimum moisture content, as determined by ASTM D698 unless otherwise noted in the project specifications;
4) Fines content of soil (material passing a #200 sieve) must be greater than 30 percent;
5) Material greater than the #4 sieve must compose less than 20 percent of soil by weight with no particle sizes greater than 1.0 inches in diameter;
6) Any soil clods must be broken up into 4 inch or smaller size pieces;
7) The soil must be classified by the Unified Soil Classification System (USC) as either a CL, CH, or SC material;
8) The Plasticity Index (PI) must be greater than 10;
9) Any moisture conditioning that is required shall be conducted in such a manner as to preserve the homogeneity of the soil and insure that moisture contents throughout the soil mass are relatively uniform;

Regardless of the properties of the soil materials comprising the soil components of the compacted clay liners and/or compacted clay covers, sampling and laboratory testing shall verify the hydraulic conductivity. The clay liner shall not be considered acceptable under any circumstances before this criterion is met.

2.3 Compacted Clay Fill (ie. berms, roads, etc.)

Compacted clay fill shall consist of the placement and compaction of clay for the purpose of establishing berms, dikes, and levees as called for in the project plans or specifications. Compacted clay fill materials shall consist of soils that are relatively free of organics, debris, or other deleterious matter. The clay material to be used for the construction of berms, levees, roads, etc. shall have a PI between 10-30 and shall be compacted to 95% standard proctor density at a moisture content between 3% below to 3% above the optimum moisture content.

2.4 Liner Protective Cover Layer

Protective cover materials above and in contact with the geosynthetic liner and/or leachate collection systems are addressed herein. In some instances, the liner protective layer also serves as the lateral drainage layer. The protective cover materials used to protect either the primary geomembrane and/or the leachate collection system, shall consist of fine grained sandy soils or gravels that can demonstrate a minimum hydraulic conductivity of 1x10^-4 cm/s. If the protective cover layer is also to act as a lateral drainage layer as part of the leachate collection system design then the material chosen shall demonstrate a minimum hydraulic conductivity as

generated using the Hydrologic Evaluation of Landfill Performance (HELP, Version 3.0) Model. This value should be determined by the Project Engineer and included in the project specifications. In no instance shall a material be utilized for a "lateral drainage layer" with a hydraulic conductivity of less than 1x10^-3 cm/s. All particles in excess of 0.25 inches should be relatively smooth, with no sharp edges.

2.5 Vegetative Soil Cover

Vegetative soil cover material generally consists of medium-textured soils capable of supporting vegetative growth. Establishment of vegetation reduces cover erosion due to water and wind, and protects the soil and/or geosynthetic cover against damage. The vegetation also enhances the aesthetic appearance of the landfill.

Site-specific criteria for the vegetative layer shall be specified in the project specifications. Alternative cover designs in certain climatic regions may not require a vegetative soil cover. In such cases, the site-specific project specifications are to be used instead of this Section as a guide for construction quality assurance purposes.

2.6 Miscellaneous Earthwork (Anchor Trenches, etc.)

All anchor trench systems will be excavated by the earthwork contractor (unless) otherwise specified) in accordance with the lines and widths as shown on the contract drawings, before geosynthetics placement. The Geosynthetics CQA Consultant shall verify that the anchor trench has been constructed according to the design drawings.

If the anchor trench is excavated in a clay liner susceptible to desiccation, no more than the amount of trench required for the geomembrane to be anchored in one day shall be excavated (unless otherwise specified) to minimize desiccation potential of the anchor trench clay soils. The corners of the anchor trench where geosynthetic enters the trench should be slightly rounded to avoid sharp bends in the geosynthetics. No loose soil shall be allowed to underlie the geomembrane in the anchor trench. No large rocks or clay lumps will be allowed to underlie the geomembrane in the anchor trench.

Backfilling of the anchor trench shall be conducted utilizing suitable backfill materials as deemed appropriate by the CQA Manager. All anchor trenches shall be backfilled in 6" compacted lifts at 95% Standard Proctor Density (3% below to 3% above optimum moisture content) unless otherwise indicated in the project specifications.

2.7 Soils Testing

2.7.1 Test Methods

All testing used to evaluate the suitability or conformance of soil materials shall be carried out in accordance with the current version of the corresponding American Society for Testing and Materials (ASTM) test procedures. The test methods indicated in **TABLES 1 and 2** are to be utilized for evaluating soil materials (when applicable) for adherence to the project specifications and the materials standards specified in this CQA Plan.

TABLE 1
TEST REQUIREMENTS FOR PRECONSTRUCTION TESTING OF EARTHWORK

TEST NAME & METHOD	Soil Classification ASTM D2487	Standard Proctor ASTM D698	Atterberg Limits ASTM D4318	Percent Passing No. 200 Sieve ASTM D1140	Moisture ASTM D854	*Permeability ASTM D5084
In-Situ Clay Liners	1 test per 20,000 yd^3 or change of material	–	1 test per 20,000 yd^3 or change of material	1 test per 20,000 yd^3 or change of material	1 test per 20,000 yd^3 or change of material	1 test per 20,000 yd^3 or change of material
Compacted Clay Liners/ Covers	1 test per 20,000 yd^3 or change of material or borrow area	1 test per 20,000 yd^3 or change of material or borrow area	1 test per 20,000 yd^3 or change of material or borrow area	1 test per 20,000 yd^3 or change of material or borrow area	1 test per 20,000 yd^3 or change of material or borrow area	1 test per 20,000 yd^3 or change of material or borrow area
Compacted Clay Fill	1 test per 20,000 yd^3 or change of material or borrow area	1 test per 20,000 yd^3 or change of material or borrow area	1 test per 20,000 yd^3 or change of material or borrow area	–	1 test per 20,000 yd^3 or change of material or borrow area	–
Liner Protective Cover	1 test per 20,000 yd^3 or change of material or borrow area	1 test per 20,000 yd^3 or change of material or borrow area	–	1 test per 20,000 yd^3 or change of material or borrow area	–	1 test per 20,000 yd^3 or change of material or borrow area
Topsoil	-	-	-	-	-	-
Miscellaneous Earthwork (ie. Anchor Trenches)	1 test per 20,000 yd^3 or change of material or borrow area	1 test per 20,000 yd^3 or change of material or borrow area	1 test per 20,000 yd^3 or change of material or borrow area	–	–	–

*Note: Tests are to be run at +/95% SP, when assessing compacted clay liner materials. All tests should be run at a moisture content wet of optimum moisture content.
*Note: All minimum standards and frequency of testing may be amended by permit conditions, ADEQ regulations and permit plans and specifications when applicable.

TABLE 2
TESTING REQUIREMENTS FOR CONSTRUCTION TESTING OF EARTHWORK

TEST NAME & TEST METHOD	In-Situ Clay Liners	Compacted Clay Liners/ Covers	Compacted Clay Fill	Liner Protective Cover	Top-soil	Miscellaneous Earthwork (ie. Anchor Trenches)
In-Place Field Density/Moisture (Subgrade) ASTM D2922	–	1 test per 10,000 ft^2 per lift of liner placed (minimum of six per lift)	1 test per 10,000 ft^2 per lift of soil placed or 1 per 100 linear feet	–	–	–
In-Place Field Density/Moisture (Clay Liner) ASTM D2922	–	1 test per 10,000 ft^2 per lift of liner placed (minimum of six per lift)	1 test per 10,000 ft^2 per lift of soil placed or 1 per 100 linear feet	–	–	1 test per 100 linear feet
Soil Classification ASTM D2487	1 test per 5,000 yd^3 or change of material or borrow area	1 test per 5,000 yd^3 or change of material or borrow area	1 test per 5,000 yd^3 or change of material or borrow area	1 test per 5,000 yd^3 or change of material or borrow area	–	–
Soil Moisture ASTM D584		1 test per 5,000 yd^3 or change of material or borrow area	1 test per 5,000 yd^3 or change of material or borrow area	1 test per 5,000 yd^3 or change of material or borrow area	–	–
Standard Proctor ASTM D698		1 test per 5,000 yd^3 or change of material or borrow area	1 test per 5,000 yd^3 or change of material or borrow area	–	–	1 test per 5,000 yd^3 or change in material
Atterberg Limits ASTM D4318	1 test per 5,000 yd^3 or change of material or borrow area	1 test per 5,000 yd^3 or change of material or borrow area	1 test per 5,000 yd^3 or change of material or borrow area	–	–	1 test per 5,000 yd^3 or change of material or borrow area
Percent Passing No. 200 Sieve ASTM D1140	1 test per 5,000 yd^3 or change of material or borrow area	1 test per 5,000 yd^3 or change of material or borrow area	1 test per 5,000 yd^3 or change of material or borrow area	1 test per 5,000 yd^3 or change of material or borrow area	–	–
Permeability · ASTM D5084	1 test per 40,000 s.f. per 6" of liner thickness	1 test per 40,000 s.f. per 6" compacted lift placed	–	1 test per 5,000 c.y. or change in borrow area	–	–

*Note: All minimum standards and frequency of testing may be amended by permit conditions, ADEQ regulations and permitted plans and specifications.

2.7.2 Soils Testing Requirements

All soils testing shall be conducted under the direct supervision of the Soils CQA Consultant and/or qualified Soils CQA Laboratory. Nuclear densometer methods shall be used for field density testing in all cases. The drive cylinder (ASTM D2937) tests shall be used in cases of uncertainty, or as a check of the machine calibration. Any conflict over the results shall be resolved by the Soils CQA Consultant and/or CQA Manager.

The test frequencies presented in **TABLES 1 and 2** are specified as minimum test frequencies. The actual frequency of testing required can be increased by the CQA Manager or Soils CQA Consultant as necessary in order to insure adequate quality control associated with all earthwork related construction. For example, the actual test frequencies may be increased in order to consider local soil variability (if applicable).

3.0 EARTHWORK CQA

Construction Quality Assurance monitoring will be performed during the entire process of the earthwork construction phase. The construction will be required to meet all criteria governing the project. This includes applicable state and federal regulations (Regulation 22 and Subtitle D respectively), permit conditions, and the project specifications. The process of acceptance or rejection of the construction shall consist of the following procedures.

1) Visual observations made by the field CQA Monitor;
2) Investigations into the adequacy of layer bonding:
3) Field and laboratory testing;
4) Surveying;

All field and laboratory tests shall be conducted on samples taken from material during the course of work. A more detailed explanation of what consists of each of these procedures is as follows.

3.1 Visual Observations

Monitoring construction associated with the clay liner system includes the following:

- monitoring the thickness of each lift (if applicable)
- observations of the action of the compaction and heavy hauling equipment on the construction surface (sheepsfoot penetration, pumping, cracking, etc.)
- noting the liner material for any change in soil properties (including soil consistency, color, layers of silt or sand, etc.)

3.2 Evaluation of Layer Bonding

The Soils CQA Task Manager will check for layer bonding as needed (when applicable). This can be checked through excavation of backhoe test pits. The pits should penetrate the layer below adequately to determine if the two layers are bonding together properly. After being excavated, these pits will be backfilled and compacted according to all the specifications required for the placement of the original compacted clay material. This can be accomplished through the use of hand equipment or other methods approved by the Soils CQA Consultant.

3.3 Field and Laboratory Tests

The field and laboratory test methods and testing frequencies presented in **TABLES 1 and 2** shall apply to all earthwork systems constructed associated with the CSL. All test methods will adhere to ASTM Standards and other applicable regulations.

The construction area will be divided into a grid or other type of system so that the approximate location of the sampling or testing area can be determined. All the sampling and testing locations should be determined at random or in areas where the Soils CQA Consultant determines that there is a possibility of inadequate compaction, material, thickness, etc. At locations where the field-testing indicates densities below the requirements of the specification, the failing area or grid shall be reworked and retested. The size of the area to be reworked is determined by the closest edge of the area with passing results. This area is determined by the Soils CQA Manager. For clay liners where the field-testing indicates the moisture content is below the requirements, the area shall be scarified, moisture-conditioned, and recompacted. For areas where the compaction is inadequate the area will be compacted further until a passing result is obtained.

3.4 Construction Testing Frequency

All pre-construction testing shall be conducted in accordance with the project specifications or as directed by the Project/Site Manager and/or CQA Manager. Testing methods, as previously identified, shall be observed by the Soils CQA Monitor. Pre-construction testing shall be conducted on material samples obtained from the designated borrow location and/or from the stockpile(s) of the materials to be utilized in the construction of the earthwork component. The required frequency of pre-construction testing is presented in **TABLE 1**.

Sampling locations shall be selected by the Soils CQA Consultant. If necessary, the location of routine in-place density tests shall be determined using a non-biased sampling plan. A special testing frequency shall be used at the discretion of the Owner and/or his Soils CQA representative when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas shall be considered when:

- rollers slip during rolling operation;
- lift thickness is greater than specified;
- earthfill is at improper and/or variable moisture content;
- less than specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- rollers may not have used optimum ballast;
- fill materials differ substantially from those specified;
- the degree of compaction is doubtful; and
- as directed by the Owner or the Soils CQA Monitor.

During construction, the frequency of testing may also be increased in the following situations:

- adverse weather conditions;
- breakdown of equipment;

- at the start and finish of grading;
- material fails to meet specifications; and
- the work area is reduced.

3.5 Clay Liner Perforations

Perforations that must be filled shall include, but not be limited to, the following:

- nuclear density test probe locations (clay liners and barrier layers);
- permeability sampling locations; and
- test pit locations.

Construction permeability samples shall be taken such that the sample tube is inserted into the liner normal (perpendicular) to the plane of the constructed surface. Unless otherwise noted in the project specifications, or as directed by the Owner or his representative, all perforations of the clay liner by probe or sample tube shall be backfilled with a soil having similar index properties and moisture content as the extruded sample. The soil will be compacted in-place with a tamping rod, Modified or Standard Proctor hammer as specified, or hand tamper, depending on the size of the perforation. Test pit excavations shall be backfilled with the same material being tested or examined.

3.6 Deficiencies

If a defect is discovered in the earthwork product, the Soils CQA Consultant shall immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate. If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the CQA Consultant shall define the limits and nature of the defect.

3.6.1 Notification

After determining the extent and nature of a defect, the Soils CQA Task Manager shall notify the Project/Site Manager and/or CQA Manager and schedule appropriate retests when the work deficiency is to be corrected.

3.6.2 Repairs and Retesting

The Earthwork Contractor shall correct the deficiency to the satisfaction of the CQA Consultant. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA Consultant shall develop and present to the CQA Consultant suggested solutions for his approval. All retests recommended by the CQA Consultant must verify that the defect has been corrected before any additional work is performed by the Contractor in the area of the deficiency. The CQA Consultant shall also verify that all installation requirements are met and that all submittals are provided.

4.0 DOCUMENTATION

An effective CQA plan depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA Manager shall document that all quality assurance requirements have been addressed and satisfied.

The CQA Manager shall provide the Project/Site Manager with signed descriptive remarks, data sheets, and logs to verify that all monitoring activities have been carried out. The CQA Manager shall also maintain at the job site a complete file of plans and specifications, a CQA Plan, checklists, test procedures, daily logs, and other pertinent documents.

4.1 Daily Recordkeeping

Standard reporting procedures shall include preparation of a daily report which, at a minimum, will consist of: (a) field notes, including memoranda of meetings and/or discussions with the Earthwork Contractor; (b) observation logs and testing data sheets; and (c) construction problems and solution data sheets. This information will be regularly submitted to and reviewed by the Project/Site Manager.

4.1.1 Memorandum of Discussion with Earthwork Contractor or Subcontractors

A memorandum will be prepared, summarizing discussions between the CQA Consultant and Earthwork Contractor. At a minimum, the memorandum will include the following information:

- date, project name, location, and other identification;
- name of parties to discussion;
- relevant subject matter or issues;
- activities planned;
- constraints or suggestions;
- schedule; and
- signature of the CQA Engineer and/or CQA Manager.

4.1.2 Observation Logs and Testing Data Sheets

Observation and testing data sheets shall be prepared daily. At a minimum, these data sheets shall include the following information:

- an identifying sheet number for cross referencing and document control;
- date, project name, location, and other identification;

- data on weather conditions;
- a reduced-scale site plan showing all proposed work areas and test locations;
- descriptions and locations of ongoing construction;
- equipment and personnel in each work area, including subcontractors;
- descriptions and specific locations of areas of work being tested and/or observed and documented (identified by lift and location);
- locations where tests and samples were taken;
- a summary of test results;
- calibration or recalibrations or test equipment, and actions taken as result of recalibration;
- off-site materials received, including quality verification documentation;
- decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality; and
- the CQA Monitor signature.

In any case, all logs must be completely filled out with no items left blank.

4.2 Construction Problems and Solution Data Sheets

Sheets describing special construction situations shall be cross-referenced with specific observation logs and testing data sheets, and must include the following information, where available:

- an identifying sheet number for cross-referencing and document control;
- a detailed description of the situation or deficiency;
- the location and probable cause of the situation or deficiency;
- how and when the situation or deficiency was found or located;
- documentation of the response to the situation or deficiency;
- final results of any responses;
- any measures taken to prevent a similar situation from occurring in the future; and
- the signature of the CQA Task Manager/Monitor and signature indicating concurrence from the Project/Site Manager.

The Project/Site Manager shall be made aware of any significant recurring non-conformance with specifications. The Project/Site Manager shall then determine the cause of the non-conformance and recommend appropriate changes in procedures or specifications. When this type of evaluation is made, the results must be documented, and any revision to procedures or specifications shall be approved by the Owner and the Project Engineer.
A summary of all supporting data sheets, along with final testing results and the CQA Manager's approval of the work, shall be required upon completion of construction.

4.3 Photographic Reporting Data Sheets

Photographic reporting data sheets, where used, shall be cross-referenced with observation and testing data sheet(s), and/or construction problems and solution data sheet(s). These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain color prints; negatives will also be stored in a separate file in chronological order. These records shall be presented to the Project/Site Manager upon completion of the project.

4.4 Design and/or Specifications Changes

Design and/or specifications changes may be required during construction. In such cases, the CQA Manager shall notify the Project/Site Manager and the Project Engineer. Design and/or specifications changes shall be made only with written agreement from the Project/Site Manager and the Project Engineer, and shall take the form of an addendum to the specifications.

4.5 Progress Reports

The CQA Manager shall prepare a summary progress report each month, or at time intervals established at the pre-construction meeting. As a minimum, this report shall include the following information:

- a unique identifying sheet number for cross-referencing and document control;
- the date, project name, location, and other information;
- a summary of work activities during progress reporting period;
- a summary of construction situations, deficiencies, and/or defects occurring during progress reporting period;
- a summary of test results, failures and retests; and
- the signature of the CQA Manager.

4.6 Signatures and Final Report

At the completion of the work, the CQA Certifying Engineer shall submit to the Project/Site Manager and/or Project Engineer a signed final report. This report shall certify that the work has been performed in compliance with the plans and specifications, and physical sampling and testing, except as properly authorized and implemented, and that the summary document provides the necessary supporting information.

At a minimum, this report shall include: (a) summaries of all construction activities; (b) observation logs and testing data sheets including sample location plans; (c) construction problems and solutions data sheets; (d) changes from design and material specifications; (e) record drawings; and (f) a summary statement sealed and signed by a licensed professional engineer. The record drawings shall include scale drawings depicting the location of the construction details pertaining to the extent of construction

(depths, plan dimensions, elevations, soil component thickness, etc.). This document shall be prepared by the CQA Consultant (based on "as-built" drawings provided by the Contractor) and included as part of the CQA documentation.

SECTION #4
GEOSYTHETICS CONSTRUCTION QUALITY ASSURANCE

1.0 GEOMEMBRANES

1.1 Manufacturing

1.1.1 Raw Material

The raw material to be utilized in the manufacturing of the geomembrane shall be first quality polyethylene resin containing no more than 2% clean recycled polymer by weight. The base polyethylene resin will be mixed with 2.0 to 3.0 percent by weight of carbon black and a proprietary additive package of heat stabilizers and anti-oxidants that will not exceed 0.5 percent of the finished product weight.

The raw material shall be first quality polyethylene resin containing no more than 2% clean recycled polymer by weight, and shall be tested by the manufacturer for the following specifications:

TABLE 3
TESTING REQUIREMENTS
FOR POLYETHYLENE GEOMEMBRANE RAW MATERIALS

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING[1]	MINIMUM TEST STANDARDS[1]
Specific Gravity	ASTM D1505	per batch	≥ 0.935
Melt Index	ASTM D1238 Condition E 190°C/2.16 kg	per batch	0.1 - 1.1 g/min

Raw materials (resin, carbon black, and additive package) may be mixed during the production stage using a "masterbatch" carrier resin containing the carbon black and other additives or during a compounding process prior to production.

Conformance testing shall be carried out by the manufacturer to demonstrate that the product meets this specification. At the Owner's discretion, additional testing may be carried out for purposes of conformance by the Geosynthetics CQA Laboratory, and paid for by the Owner. If the results of the manufacturer's and the Geosynthetics CQA Laboratory's testing differ, the testing shall be repeated by the Geosynthetics CQA Laboratory, and the manufacturer shall be allowed to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods have been followed.

Prior to the installation of any geomembrane material, the manufacturer shall provide the Project/Site Manager and the Geosynthetics CQA Task Manager with the following information:

1) The origin (resin supplier's name and resin production plant), identification (brand name, number) and production date of the resin

2) A copy of the quality control certificates issued by the resin supplier to include specific gravity (ASTM D1505) and melt index (ASTM D1238 Condition E, 190^{O}C/2.16 kg)

3) A statement that no reclaimed polymer is added to the resin (however, the use of polymer recycled during the manufacturing process may be permitted if done with appropriate cleanliness and if recycled polymer does not exceed 2% by weight)

The CQA Manager shall review these documents and shall report any discrepancies with the above requirements to the CQA Certifying Engineer.

1.1.2 Geomembrane Manufacturing

The Project/Site Manager shall provide to the CQA Manager the plans, specifications and drawings for the lining system as prepared by the Design Engineer. **TABLES 3 and 4** provide the frequency of testing for the geomembrane. The Geosynthetics CQA Task Manager shall verify that the specifications include at least all properties listed in **TABLES 3 and 4**, measured with the same methods or equivalent.

If the specifications do not fulfill the above conditions, the required alterations of the specifications shall be completed by the Design Engineer. The Geomembrane Manufacturer shall provide the Project/Site Manager and the CQA Manager with the following:

- a properties sheet including, at a minimum, all specified properties measured using test methods indicated in the specifications, or equivalent;
- a list of quantities and descriptions of materials other than the base polymer which comprise the geomembrane;
- the sampling procedures and results of testing; and
- a certification that property values given in the properties sheet are guaranteed by the geomembrane manufacturer.

TABLE 4
CONFORMANCE TESTING REQUIREMENTS
FOR POLYETHYLENE GEOMEMBRANE

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING[1]	MINIMUM TEST STANDARDS[1]	
			40 mil VLDPE	60 mil HDPE
Density	ASTM D792	1 test per 100,000 ft^2 or 1 test per resin lot	0.91-0.929 g/cm^3	0.94-0.96 g/cm^3
Tensile Strength at Yield	ASTM D638	1 test per 100,000 ft^2 or 1 test per resin lot	140 ppi	140 ppi
Tensile Strength at Break	ASTM D638	1 test per 100,000 ft^2 or 1 test per resin lot	126 ppi	240 ppi
Elongation at Yield	ASTM D638	1 test per 100,000 ft^2 or 1 test per resin lot	126%	13%
Elongation at Break	ASTM D638	1 test per 100,000 ft^2 or 1 test per resin lot	500%	560%
Melt Flow Index	ASTM D1238	1 test per 100,000 ft^2 or 1 test per resin lot	<1.0 g/10 min	<1.0 g/10 min
Tear Resistance	ASTM D1004	1 test per 100,000 ft^2 or 1 test per resin lot	18 lbs	45 lbs
Carbon Black Content	ASTM D1603	1 test per 100,000 ft^2 or 1 test per resin lot	2% - 3%	2% - 3%
Carbon Black Dispersion	ASTM D3015	1 test per 100,000 ft^2 or 1 test per resin lot	A1 or A2	A1 or A2
Average Thickness	ASTM D1503	1 test per 100,000 ft^2 or 1 test per resin lot	40 mils	60 mils (ave) 54 mils (min)

*Note: The above standards are considered minimum unless otherwise stated in the project specifications.

The CQA Manager shall verify that:

- the property values certified by the geomembrane manufacturer meet all of the specifications; and
- the measurements of properties by the geomembrane manufacturer are properly documented and that the test methods used are acceptable.

In addition, the CQA Manager may, at the request of the owner, undertake a manufacturing plant visit, preferably during the production of the particular geomembrane for this project, in order to evaluate the manufacturer's quality control procedures.

1.1.3 Rolls

Prior to shipment, the Geomembrane Manufacturer shall provide the Project/Site Manager and the CQA Consultant with a quality control certificate for every roll of geomembrane to be provided for the particular project. The quality control certificate shall be signed by a responsible party employed be the geomembrane manufacturer, such as the production manager. The quality control certificates shall include:

- roll numbers and identification; and
- sampling procedures and results of quality control tests - at a minimum, results shall be given for thickness, tensile strength, and tear resistance, evaluated in accordance with the methods indicated in the specifications or equivalent methods approved by the designer.

The CQA Manager shall:

- verify that the quality control certificates have been provided at the specified frequency, and that each certificate identifies the rolls related to it; and
- review the quality control certificates and verify that the certified roll properties meet the specifications.

1.2 Roll Label Requirements

All rolls delivered to the site must be labeled containing the following information:

1) Roll Number
2) Material Type
3) Nominal Thickness
4) Batch Number

The geomembrane rolls are to be packaged with a label placed on the outside of the roll and one within the roll core. If both of these labels are missing or illegible the roll will be rejected.

1.3 Shipping, Handling, and Storage Requirements

1.3.1 Shipping

Shipping the geomembrane is the responsibility of the geomembrane manufacturer, fabricator, installer, or other party as agreed upon. All handling on site is the responsibility of the installer.

Upon delivery at the site, the installer and the Geosynthetics CQA Consultant shall conduct a surface observation of all rolls or factory panels for defects and for damage. This inspection shall be conducted without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The Geosynthetics CQA Consultant shall indicate to the Project/Site Manager:

- rolls, factory panels, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- rolls or factory panels which include minor repairable flaws.

1.3.2 Handling

The geomembrane temporary tagging area on site should be coordinated with the CQA manager and the Installer to insure ease of transportation and placement in an area were the geomembrane will not be damaged or in the way of daily operations of the Solid Waste Management Facility. Two high-strength carrying straps must be placed around the outside of the roll to assist in to transportation and handling of the material on the construction site.

1.3.3 Storage Area Requirements

The installer shall be responsible for the storage of the geomembrane on site. The Project/Site Manager shall provide storage space in a location (or several locations) such that on-site transportation and handling are optimized if possible. Storage space should be protected from theft, vandalism, passage of vehicles, etc. If the geomembrane is to be exposed to the weather for an extended period of time it should be covered until installed. The designated storage area should be a firm, smooth surface free of large and/or sharp stones or any other sharp objects that could damage the liner. If the area is sloped or the rolls are stacked, precautions should be taken to insure that the rolls will not shift or move causing possible damage to the rolls or injuring workers.

1.4 Conformance Testing of Geomembrane

1.4.1 Testing Requirements

Upon delivery of the rolls of geomembrane, the Geosynthetics CQA Task Manager shall insure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to insure conformance to both the design specifications and the list of guaranteed properties. The test procedures shall be as indicated in **TABLE 4** or as specified in the project specifications.

1.4.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first three lineal feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The Geosynthetics CQA Task Manager shall mark the machine direction on the samples with an arrow. The required minimum sampling frequencies are provided in **TABLES 3 and 4.**

1.4.3 Test Results

The CQA Manager shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project/Site Manager. All tests must conform to the minimum specifications listed in **TABLE 3 and 4** or as specified in the project plans.

2.0 INSTALLATION OF GEOMEMBRANE

2.1 Earthwork

2.1.1 Subgrade Preparation

The Geosynthetics CQA Manager shall verify that:

- a qualified land surveyor has verified all lines and grades
- a qualified geotechnical engineer, normally the CQA Consultant has verified that the supporting soil meets the destiny specification and has a minimum unconfined compressive strength of 100 kPa
- the surface to be lined has been rolled and compacted so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade
- the surface of the supporting soil does not contain stones which may be damaging to the geomembrane
- there is no area excessively softened by high water content

The installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance shall be given by the installer to the Project/Site Manager prior to commencement of geomembrane installation in the area under consideration. The CQA Consultant shall be given a copy of this certificate by the Project/Site Manager.

After the supporting soil has been accepted by the installer, it shall be the installer's responsibility to indicate to the Project/Site Manager any change in the supporting soil condition that may require repair work. If the CQA Manager concurs with the installer, then the Project/Site Manager shall insure that the supporting soil is repaired.

At any time before and during the geomembrane installation, the CQA Manager shall indicate to the Project/Site Manager locations which may not provide adequate support to the geomembrane.

2.1.2 Anchor Trench System

All anchor trench systems will be excavated by the earthwork contractor (unless) otherwise specified) in accordance with the lines and widths as shown on the contract drawings, before geosynthetics placements. The Geosynthetics CQA Consultant shall verify that the anchor trench has been constructed according to design drawings.

If the anchor trench is excavated in a clay material susceptible to desiccation, no more than the amount of trench required for the geomembrane to be anchored in one day shall be excavated (unless otherwise specified) to minimize desiccation potential of the anchor trench clay soils. The corners of the anchor trench where geosynthetic enters the trench should be slightly rounded to avoid sharp bends in the geosynthetics. No

loose soil shall be allowed to underlie the geomembrane in the anchor trench. No large rocks or clay lumps will be allowed to underlie the geomembrane in the anchor trench.

Backfilling of the anchor trench shall be conducted utilizing suitable backfill materials as deemed appropriate by the CQA Manager. All anchor trenches shall be backfilled in 6" compacted lifts at 95% Standard Proctor Density (0 to 6% wet of optimum moisture content).

2.2 Geosynthetic Placement

2.2.1 Installation Schedule

Field panels may be installed using any one of the following schedules:

- all field panels are placed prior to field seaming (in order to protect the subgrade from erosion by rain)
- field panels are placed one at a time and each field panel is seamed immediately after its placement (in order to minimize the number of unseamed filed panels exposed to wind)
- any combination of the above

If a decision is reached to place all field panels prior to field seaming, it is usually beneficial to begin at the high point area and proceed toward the low point with "shingle: overlaps to facilitate drainage in the event of precipitation. It is also usually beneficial to proceed in the direction of prevailing winds. Accordingly, an early decision regarding installation scheduling should be made if and only if weather conditions can be predicted with certainty. Otherwise, scheduling decisions must be made during installation, in accordance with varying conditions. In any event, the Installer is fully responsible for the decision made regarding placement procedures.

The CQA Manager shall evaluate every change in the schedule proposed by the Installer and advise the Project/Site Manager on the acceptability of that change. The CQA Manager shall verify that the condition of the supporting soil has not changed detrimentally during installation. The CQA Manager shall record the identification code, location, and date of installation of each field panel.

2.2.2 Field Panel Location and Identification

Field panels are to be located by the CQA Manager in a manner consistent with the specifications and in a manner best suited to existing site conditions (i.e., a field panel is a roll or a portion of roll cut in the field).

A field panel is the unit area of geomembrane which is to be seamed in the field. Two cases can be considered:

- If the geomembrane is fabricated into panels in a factory, a field panel is a factory panel or a portion of factory panel cut in the field.

- If the geomembrane is not fabricated into factory panels, a field panel is a roll or a portion of roll cut in the field.

It shall be the responsibility of the CQA Manager to insure that each field panel is given an "identification code" (number or letter-number) consistent with the layout plan. This identification code shall be agreed upon by the Project/Site Manager, Installer and CQA Manager. This field panel identification code shall be as simple and logical as possible. (Note that roll numbers established in the manufacturing plant must be traceable to the field panel identification code.)

The CQA Consultant shall establish documentation showing correspondence between roll numbers, factory panels, and field panel identification codes. The field panel identification code shall be used for all quality assurance records. The Geosynthetics CQA Consultant shall verify that field panels are installed at the location indicated in the designer's layout plan, as approved or modified.

2.2.3 Weather Conditions

Geomembrane placement shall not proceed at an ambient temperature below 5°C (40° F) unless otherwise authorized. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of pounded water, or in the presence of excessive winds.

The CQA Manager shall verify that the above conditions are fulfilled. Additionally, the CQA Consultant shall verify that the supporting soil has not been damaged by weather conditions. The CQA Manager shall inform the Project/Site Manager if the above conditions are not fulfilled.

2.2.4 Method of Placement

The CQA Manager shall verify the following:

- Construction equipment used to deploy geomembranes should not create excessive rutting in the subgrade
- If the substrata is a geosynthetic material, deployment may be by hand, by use of small jack lifts on pneumatic tires having low ground contact pressure, or by use of all-terrain vehicles (ATVs) having low ground contact pressure
- Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means
- The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement
- Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris
- All personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane

- The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil
- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels)
- Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, continuous loading, e.g., adjacent sand bags, is recommended along edges of panels to minimize risk of wind flow under the panels)
- Direct contact with the geomembrane is minimized; i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected

The CQA Manager shall inform the Project/Site Manager if the above conditions are not fulfilled.

2.2.5 Damage

The CQA Manager shall inspect each panel, after placement and prior to seaming, for damage. The CQA Manager shall advise the Project/Site Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected shall be marked and their removal from the work area recorded by the CQA Consultant. Repairs shall be made according to procedures outlined in the CQA Plan and/or technical specifications.

2.3 Seaming and Joining

2.3.1 Seam Layout

The installer shall provide the Project/Site Manager and the Geosynthetics CQA Task Manager with a seam layout drawing, i.e., a drawing of the facility to be lined showing all expected seams. The CQA Manager shall review the seam layout drawing and verify that it is consistent with accepted state of practice. No panels may be seamed in the field without the Project/Site Manager's approval. In addition, no panels not specifically shown on the seam layout drawing may be used without the Project/Site Manager's prior approval.

Seams will be made by overlapping sheets approximately three inches for extrusion welding and approximately four inches for hot wedge welding. In general, seams should be oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope, in corners and odd shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet from the toe of the slope, or areas of potential stress concentrates, unless otherwise authorized.

A seam numbering system compatible with the panel numbering system shall be agreed upon at the Resolution and/or Pre-Construction Meeting.

2.3.2 Requirements of Personnel

All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. At least one seamer shall have experience seaming a minimum of 5,000,000 ft^2 of polyethylene geomembrane using the same type of seaming apparatus to be used to fabricate the site-specific geomembrane. The most experienced seamer, the "master seamer", shall provide direct supervision over less experienced seamers.

The installer shall provide the Project/Site Manager and the CQA Consultant with a list of proposed seaming personnel and their experience records. This document shall be reviewed by the Project/Site Manager and the CQA Manager.

2.3.3 Seaming Equipment and Products

The approved processes for field seaming are extrusion welding and hot wedge (fusion) welding. Proposed alternate processes will be documented and submitted to the Owner or his representative for approval. The hot wedge welding system is generally the primary system for geomembrane installation and the extrusion welding system is utilized for repairs and detail work. Only apparatus which have been specifically approved by make and model shall be used. The Project/Site Manager and the CQA Manager shall approve all seaming processes and apparatus.

The installer will verify the following general conditions during the seaming of the liner:

- Equipment used for seaming is not likely to damage the geomembrane
- The electric generator is placed on a smooth base such that no damage occurs to the geomembrane
- A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage
- The geomembrane is protected from damage in heavily trafficked areas
- An insulating plate or fabric is placed beneath the hot welding apparatus

2.3.3.1 Hot Wedge Welding/Fusion System

The hot wedge welding apparatus (typically called a fusion welder) is self-propelled and produces a double seam with an enclosed air channel for testing. The fusion welding consists of placing two heated wedge mounted self-propelled units between two overlapped sheets of polyethylene liner. The heated plate heats and fuses the two sheets together. The fusion welder must meet the following requirements

- A temperature readout device that continuously monitors the temperature of the wedge
- For cross seams, the edge of the cross seam is ground to a smooth incline (top and bottom) prior to welding

- A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage
- The geomembrane is protected from damage in heavily trafficked areas
- An insulating plate or fabric is placed beneath the hot welding apparatus

2.3.3.2 Extrusion (Fillet) Welding System

The extrusion-welding apparatus shall be equipped with gauges giving the extrudate temperature in the apparatus and at the nozzle. The installer shall provide documentation regarding the extrudate to the Project/Site Manager and the CQA Manager, and shall certify that the extrudate is compatible with the specifications, and in any event is comprised of the same resin as the geomembrane sheeting.

The CQA Manager and the installer shall log apparatus temperatures, extrudate temperatures, ambient temperatures, and geomembrane surface temperatures at appropriate intervals. The CQA Manager shall verify that the extruder is purged prior to beginning a seam until all heat degraded extrudate has been removed from the barrel. The welder also must be equipped with gauges giving the temperature in the apparatus and the preheat temperature at the nozzle.

2.3.4 Seam Preparation

The Installer shall insure that:

- Before seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material
- If seam overlap grinding is required, the process is completed according to the geomembrane manufacturer's instructions, within one hour of the seaming operation and in a way that does not damage the geomembrane
- Seams are aligned with the fewest possible number of wrinkles and "fishmouths"

2.3.5 Seaming in Various Weather Conditions

The high temperature limit for welding is based on two factors:

1) The well being of the crew. Black lining material will get very hot when exposed to sunlight. It is possible that the elevated sheet temperature in conjunction with immoderate ambient conditions could place the well being of the crew at risk. (It is the responsibility of the installer to determine if their crew can work in the weather conditions at the site).

2) Material capability.

The highest temperature at which the material can be welded is dependent upon such things as ambient temperature, wind, subgrade conditions exposure to light, material type, and material thickness.

Thinner materials and low-density products are the most difficult to seam at high liner temperatures. The problem typically is characterized by frequent burnouts (places in the liner weld where the rollers lose traction and the machine stops moving causing the wedge to burn through the liner). Adjusting the speed or the temperature at which the welder is operating can often reduce the number of burnouts. If the installer determines the sheet temperature has reached a temperature in which to large a number of burnouts occurs they can stop welding until favorable conditions return.

The lowest allowable temperature at which welding may be permitted is also dependent on ambient temperature, wind, subgrade conditions, exposure to light, material type, and material thickness. Typically during cold weather it is necessary to reduce the welders speed and increase the temperature. Pre-heating the liner in advance of the welding apparatus may also be done by using a hot air blower.

At low temperatures special attention must be made to the pre-weld destructive samples. In cold conditions it is even more critical that these trial welds be performed under the same conditions that will be seen during actual seaming conditions. The lowest temperature at which welding may occur is at the temperature which consistent passing trial seams can be performed under actual seaming conditions. In order to obtain passing results, it may be necessary to preheat the sheet in advance and/or shield the sheets from the wind. This is allowable as long as it is done during the actual welding of the liner.

The normally required weather conditions for seaming are as follows:

- Unless authorized in writing by the Project/Site Manager, no seaming shall be attempted at an ambient temperature below 5°C (40°F) or above 40°C (104°F).
- Between ambient temperatures of 5°C (40°F) and 10°C (50°F), seaming is possible if the geomembrane is preheated by either sun or hot air device, and if there is no excessive cooling resulting from wind.
- In all cases, the geomembrane shall be dry and protected from wind.

If the installer wishes to use methods which may allow seaming at ambient temperature below 5°C (40°F) or above 40°C (104°F), the installer shall demonstrate and certify that such methods produce seams which are entirely equivalent to seams produced at ambient temperatures above 5°C (40°F), and that the overall quality of the geomembrane is not adversely affected. In addition, an addendum to the contract between the Owner and the installer is required which specifically states that the seaming procedure does not cause any physical or chemical modification to the geomembrane that will generate any short or long term damage to the geomembrane. Then, the temperatures in the above quality assurance procedure shall be modified accordingly.

The CQA Manager shall verify that these weather conditions are fulfilled and will advise the Project/Site Manager if they are not. The Project/Site Manager shall then decide if the installation shall be stopped or postponed.

2.3.6 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period, and at least once each four hours, for each seaming apparatus used that day. Also, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

An extrusion welded trial seam sample shall be at least 3 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Fusion welded trial seam samples shall be at least 15 feet long by 1 foot wide (after seaming) with the seam centered lengthwise.

Two adjoining specimens, each 1-inch wide, shall be cut from the trial seam sample by the Installer. The specimens shall be tested respectively in shear and peel using a gauged tensiometer and they should not fail in the seam. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams achieved.

The CQA Consultant shall observe all trial seam procedures. The remainder of the successful trial seam samples shall be assigned a number and marked accordingly by the CQA Consultant, who shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. The sample itself shall be cut into three pieces, one to be retained in the Owner's archives, one to be given to the installer, and one to be retained by the CQA Consultant. At the discretion of the CQA Consultant, samples of trial seams may be submitted to the Geosynthetics Laboratory for analysis.

After completion of the above-described tests, the remaining portion of the trial seam sample can be discarded. Alternatively, if agreed upon between the parties involved and documented by the CQA Manager in his daily report, the remaining portion of the trial seam sample can be subjected to destructive testing. If a trial seam sample fails a test conducted by the CQA Laboratory, then a destructive test seam sample shall be taken from each of the seams completed by the seamer during the shift related to the considered trial seam. These samples shall be forwarded to the CQA Laboratory and, if they fail the tests, the procedure indicated in Section 2.3.9.5 shall apply. The conditions of this paragraph shall be considered as met for a given seam if a destructive seam test sample has already been taken.

2.3.7 Seaming Procedures

Unless otherwise specified, the general seaming procedure used by the installer shall be as follows:

- For fusion welding, a movable protective layer of plastic may be required to be placed directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture build-up between the sheets to be welded
- The rolls of the membrane will be overlapped wide enough to weld at test properly, this is usually 3" for extrusion welding and 4" for fusion welding
- Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any position where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions
- If seaming operations are carried out at night, adequate illumination shall be provided at the Contractor's expense
- Seaming shall extend to the outside edge of panels to be placed in the anchor trench

The CQA Consultant shall verify that the above seaming procedures are followed, and shall inform the Project/Site Manager if they are not.

2.3.8 Non-Destructive Testing

The Installer shall non destructively test all field seams over their full length using a vacuum test unit or air pressure test (for double fusion seams only), or other approved method. The purpose of nondestructive tests is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

The CQA Monitor shall:

- observe all continuity testing
- record location, date, test unit number, name of tester, and outcome of all testing
- inform the Installer and Project/Site Manager of any required repairs
- observe the repair and re-testing of the repair
- mark on the geomembrane that the repair has been made
- document the results

The seam number, date of observation, name of tester, and outcome of the test or observation shall be recorded by the Geosynthetics CQA Consultant.

2.3.8.1 Vacuum Testing

The equipment shall be comprised of the following:

- A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge
- A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections
- A rubber pressure/vacuum hose with fittings and connections
- A bucket and wide brush, mop or spray assembly
- A soapy solution

The following procedures shall be followed:

- energize the vacuum pump
- wet a strip of geomembrane (approximately 12" X 48") with the soapy solution;
- place the box over the wetted area
- close the bleed valve and open the vacuum valve
- ensure that a leak tight seal is created
- for a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles
- if no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 75 mm (3 in.) overlap, and repeat the process
- all areas where soap bubbles appear shall be marked and repaired.

2.3.8.2 Air Pressure Testing (Double Track Fusion Welder only)

The following procedures are applicable to those processes which produce a double seam with an enclosed space. The equipment shall be comprised of the following:

- an air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure of 30 psi and mounted on a cushion to protect the geomembrane
- a rubber hose with fittings and connections
- a sharp hollow needle, or other approved pressure feed device

The following procedures shall be followed:

- seal both ends of the seam to be tested
- insert needle or other approved pressure feed device into the tunnel created by the fusion weld
- insert a protective cushion between the air pump and the geomembrane
- energize the air pump to a pressure of 30 psi, close valve, and sustain pressure for approximately 5 minutes

- if loss of pressure exceeds 3 psi or does not stabilize, locate faulty area and repair in accordance with Section 4.2.4
- cut opposite end of tested seam are after completion of the 5 minute pressure hold period to verify complete testing of the seam, if the pressure gauge does not indicate a release of pressure, locate blockage of the air channel and retest until entire seam is tested.
- remove needle or other approved pressure feed device and seal.

2.3.9 Destructive Testing

Destructive testing is important because it provides direct evaluation of seam strength and bonding efficiency which indicates seam strength and durability. Destructive seam tests shall be performed at selected locations. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

Destructive testing involves two techniques (1) shear testing and (2) peel testing. Shear testing applies a tensile stress from the top of the sheet through the weld and into the bottom sheet. Peel testing, on the other hand, peels the top sheet back against the overlapped edge of the bottom of the sheet in order to observe how separation occurs. The peel test indicates whether or not the sheets are continuously and homogeneously connected through the seam.

2.3.9.1 Location and Frequency

The CQA Manager shall select locations where seam samples will be cut out for laboratory testing. Those locations shall be established as follows:

- A minimum frequency of one test location per 500 feet of seam length as indicated in **TABLE 5**. This minimum frequency is to be determined as an average taken throughout the entire facility.
- A maximum frequency shall be agreed upon by the Installer, Project/Site Manager and Geosynthetics CQA Manager at the Resolution and/or Pre-Construction Meeting.
- Test locations shall be determined during seaming at the Geosynthetics CQA Manager's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding.

The installer shall not be informed in advance of the locations where the seam samples will be taken.

TABLE 5
GEOMEMBRANE SEAM
TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING	MINIMUM TEST STANDARDS[1]	
			40 mil LDPE	60 mil HDPE
Peal Adhesion	ASTM D4437	1 test per 500 feet seam length	TABLE 6	TABLE 6

Bond Seam Strength	ASTM D4437	1 test per 500 feet seam length	TABLE 6	TABLE 6
Vacuum Testing	See Section 4.2.3.8.1	100% of extrusion welded seams	pass/fail	pass/fail
Air Pressure Testing	See Section 4.2.3.8.2	100% of hot wedge welded seams	pass/fail	pass/fail

*1 For peel adhesion, seam separation shall not extend more than 10 percent in the same interface. Testing shall be discontinued when the sample has visually yielded a sample.

*2 For shear tests, the sheet shall yield before failure of the seam. For either test, sample failure shall be a Film Tear Bond (FTB) as outlined in NSF 54, ATTACHMENT A.

TABLE 6
GEOMEMBRANE SEAM
TESTING SPECIFICATIONS FOR SEAM STRENGTHS

Type of Material	Peel Extrusion	Peel Fusion	Shear Extrusion	Shear Fusion
40 mil HDPE	35 ppi	49 ppi	63 ppi	63 ppi
60 mil HDPE	70 ppi	98 ppi	126 ppi	126 ppi
40 mil VLDPE	40 ppi	40 ppi	44 ppi	44 ppi
40 mil VLT	40 ppi	40 ppi	44 ppi	44 ppi
60 mil HDT	63 ppi	88 ppi	113 ppi	113 ppi

2.3.9.2 Sampling Procedure

Samples shall be cut by the installer as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The CQA Manager shall:

- observe sample cutting
- assign a number to each sample, and mark it accordingly
- record sample location on layout drawing
- record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane)

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Section 4.2.4. The continuity of the new seams in the repaired area shall be tested according to Section 4.2.3.8.1. At a given sampling location, two types of samples shall be taken by the installer.

First, two samples for field-testing should be taken. Each of these samples shall be 1 inch wide by 12 inch long, with the seam centered parallel to the width. The distance

between these two samples shall be 42 inches. If both samples pass the field test described in Section 2.3.9.3, a sample for laboratory testing shall be taken. The sample for laboratory testing shall be located between the two samples for field testing. The sample for laboratory testing shall be 12 inches wide by 42 inches long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

- one portion to the Installer for laboratory testing, (12 in. x 12 in.)
- one portion for Geosynthetics CQA Laboratory testing, (12 in. x 18 in.)
- one portion to the Owner for archive storage, (12 in. x 12 in.).

Final determination of the sample sizes shall be made at the Pre-Construction Meeting.

2.3.9.3 Field Testing

The two 1 inch wide strips mentioned in Section 2.3.9.2 shall be tested in the field, by gauged tensiometer, for peel and shear respectively and shall not fail in the seam in addition to meeting the requirements outlined in the specifications. If any field test sample fails to pass, then the procedures outlined in Section 2.3.9.5 shall be followed.

The CQA Manager shall witness all field tests and mark all samples and portions with their number. The CQA Manager shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description.

2.3.9.4 Laboratory Testing

Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the CQA Manager in a manner which will not damage the test sample. The Project/Site Manager will verify that packing and shipping conditions are acceptable. The Project/Site Manager will be responsible for storing the archive samples. This procedure shall be fully outlined at the Resolution Meeting. Test samples shall be tested by the CQA Laboratory. The CQA Laboratory shall be selected by the CQA Consultant with the concurrence of the Project/Site Manager.

Testing shall include "Bonded Seam Strength and Peel Adhesion". At least 5 specimens shall be tested for each test method. A passing test shall meet the minimum required values in at least 4 out of 5 specimens.

The CQA Laboratory shall provide test results no more than 24 hours after they receive the samples. The CQA Manager shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Project/Site Manager.

The Installer's laboratory test results shall be presented to the Project/Site Manager and the CQA Manager for comments.

2.3.9.5 Procedures for Destructive Test Failure

The following procedures shall apply whenever a sample fails a destructive test, whether that test conducted by the CQA Laboratory, the Installer's laboratory, or be gauged tensiometer. The Installer has two options:

- The Installer can reconstruct the seam between any two passed test locations.
- The Installer can trace the welding path to an intermediate location at 10 feet minimum from the point of the failed test in each direction and take a small sample for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

All acceptable seams must be bonded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 feet of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing. Repairs shall be made in accordance with Section 2.4. The CQA Manager shall document all actions taken in conjunction with destructive test failures.

2.4 Defects and Repairs

2.4.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the CQA Manager for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be broomed or washed by the Installer if the amount of dust or mud inhibits examination.

2.4.2 Evaluation

Each suspect location both in seam and non-seam areas shall be non-destructively tested using the methods described in Section 2.3.8.1 as appropriate. Each location which fails the non-destructive testing shall be marked by the CQA Manager and repaired by the installer. Work shall not proceed with any materials which will cover locations which have been repaired until laboratory test results with passing values are available.

2.4.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon

between the Project Manger, Installer, and CQA Manager. The procedures available include:

- Patching - used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter
- Buffing and re-welding - used to repair small sections of extruded seams
- Spot welding or seaming - used to repair small tears, pinholes, or other minor, localized flaws
- Capping, used to repair large lengths of failed seams;
- Removing bad seam and replacing with a strip of new material welded into place (used with large lengths of fusion seams).
- Welding of the flap, used to make a new extrusion weld adjacent to an unsatisfactory fusion weld (this procedure may be used only if the flap created by the overlap of the top and bottom panels beyond the fusion weld has not been cut back to the outer edge of the fusion weld).

In addition, the following provisions shall be satisfied:

- Surfaces of the geomembrane which are to be repaired shall be abraded no more than in hour prior to the repair;
- All surfaces must be clean and dry at the time of the repair;
- All seaming equipment used in repairing procedures must be approved;
- The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the Project/Site Manager, Construction Quality Assurance Manager, and Installer;
- Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches

2.4.4 Repairs - Non-destructive Testing

Each repair will be non-destructively tested using the methods described in Section 2.3.8.1 as appropriate. Repairs which pass the non-destructive test will be taken as an indication of an adequate repair. Failed test indicate that the repair must be redone and retested until a passing result is obtained.

2.5 Backfilling of Anchor Trenches

The anchor trench, if any, shall be adequately drained, to prevent ponding or otherwise softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled and compacted by the Earthwork Contractor of the Installer, as outlined in the specifications and/or bid documents. Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The Geosynthetics and/or Soils CQA Task Manager shall observe the backfilling operation and advise the Project/Site Manager of any problems.

Since backfilling the anchor trench can affect material bridging at the toe of the slope, consideration should be given to backfilling the liner at its most contracted state, preferably during the cool of the morning or extended period of overcast skies.

2.6 Lining System Acceptance

The Installer and the Manufacturers shall retain all ownership and responsibility for the geosynthetics in the lining system until acceptance by the Owner. The geosynthetic lining system shall be accepted by the Owner when:

- The installation of all materials are deployed and welded
- Verification of the adequacy of all seams and repairs, including associated testing, is complete
- All documentation of installation is completed including the Geosynthetics CQA Consultant's final report
- Certification, including "as built" drawing(s), sealed by a registered professional engineer has been received by the Project/Site Manager.

The CQA Manager shall certify that installation has proceeded in accordance with the Geosynthetics CQA Plan for the project except as noted to the Project/Site Manager.

2.7 Materials in Contact with the Geomembrane

The quality assurance procedures indicated in this section are only intended to assure that the installation of these materials does not damage the geomembrane. Additional quality assurance procedures would be necessary to assure that systems built with these materials would be constructed in such a way to enable proper performance.

2.7.1 Soils

A copy of the specifications prepared by the designer for placement of soils shall be given to the CQA Consultant by the Project/Site Manager. The CQA Consultant shall verify that these specifications are consistent with the state of the art such as:

- Placement of soils on the geomembrane shall not proceed at an ambient temperature below 40°F nor above 104°F unless otherwise specified
- A geotextile or other cushion approved by the designer may be installed between angular aggregate and the geomembrane
- Equipment used for placing soil shall not be driven directly on the geomembrane
- A minimum thickness of 1 foot of soil is specified between a light track-mounted dozer (such as a wide pad caterpillar D-3 or lighter) and the geomembrane
- A minimum thickness of 3 feet of soil is specified between rubber-tired vehicles and the geomembrane
- In heavily trafficked areas such as access ramps, soil thickness should be at least 3 feet

2.7.2 Concrete

A copy of the specifications prepared by the Project Engineer for placement of concrete shall be given by the Project/Site Manager to the CQA Manager. The CQA Manager shall verify that these specifications are consistent with the state of the art, including the use of geosynthetic layers between concrete and geomembrane. The CQA Consultant shall verify the geosynthetic layers are placed between the concrete and the geomembrane according to design specifications. He will also verify that construction methods used are not likely to damage the geomembrane.

2.7.3 Sumps and Appurtenances

A copy of the specifications prepared by the Design Engineer for sumps and appurtenances shall be given by the Project/Site Manager to the CQA Manager. The CQA Manager shall review these specifications and verify the use of geosynthetic layers between concrete and geomembranes.

The CQA Manager shall verify that:

- installation of the geomembrane in sump and appurtenance areas, and connection of geomembrane to sumps and appurtenances have been made according to specifications;
- extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas;
- the geomembrane has not been visible damaged while making connections to sumps and appurtenances; and
- all sumps are tested for primary and secondary geomembrane integrity by filling them with water and making appropriate observations.

The CQA Manager shall inform the Project/Site Manager if the above conditions are not fulfilled.

3.0 GEOCOMPOSITES

3.1 Manufacturing

The geocomposite, unless otherwise specified, the geocomposite will be made from the same type of resins used to manufacture HDPE geomembranes. The raw material will consist of polyethylene resin, 2.0 to 3.0 percent by weight carbon black, and no more than 0.5 percent heat stabilizers and anti-oxidant additives.

The geocomposite manufacturer will provide the Project/Site Manager with a list of guaranteed "minimum average roll value" properties for the type of geocomposite to be delivered. The geocomposite manufacturer shall also provide the Project/Site Manager with a written quality control certification signed by a responsible party employed by the manufacturer that the materials actually delivered have property "minimum average roll values" which meet or exceed all property values guaranteed for that type of geocomposite. The quality control certificates shall include:

1) roll identification numbers
2) resin batch numbers
3) nominal thickness
4) sampling procedures
5) results of quality control testing
   - Polymer-specific gravity
   - Mass per unit area
   - Thickness

These conformance tests shall be performed in accordance with the test methods specified in the project specifications. Other conformance tests may be required by the project specifications.

Quality control tests must be performed in accordance with the test methods specified in for every 100,000 ft.^{2} of geocomposite produced for the project. The geocomposite manufacturer shall also provide the origin, identification, and production date of the resin and quality control certificates for the resin used in the manufacture of the Geocomposites.

The CQA Consultant shall examine all manufacturer's certifications to insure that the property values listed on the certifications meet or exceed those specified and the measurements of properties by the manufacturer are properly documented, test methods acceptable and the certificates have been provided at the specified frequency properly identifying the rolls related to testing. Any deviations shall be reported to the Project/Site Manager.

3.2 Roll Label Requirements

The geocomposite manufacturer shall identify all rolls of Geocomposites with the following:

- manufacturer's name
- product identification
- lot number
- roll number
- roll dimensions

The CQA Manager shall examine rolls upon delivery and any deviation form the above requirements shall be reported to the Project/Site Manager.

3.3 Shipping, Handling, and Storage

Protecting the geocomposite for cleanliness is important for the proper drainage characteristics of the geocomposite. The geocomposite rolls should be wrapped in polyethylene sheets or otherwise protected against dust and dirt during shipping and storage.

The wrapping should be removed just prior to the deployment of the rolls. The CQA Consultant shall verify that Geocomposites are free of dirt and dust just before installation. The CQA Consultant shall report the outcome of this verification to the Project/Site Manager, and if the Geocomposites are judged dirty, dusty, they shall be cleaned by the installer prior to installation.

3.4 Conformance Testing

3.4.1 Testing Requirements

Upon delivery of the rolls of Geocomposites, the CQA Consultant shall take conformance samples of the geocomposite, to ensure conformance to both the design specifications and the list of guaranteed properties. The tests presented in **TABLE 7** will be performed at the discretion of the CQA Manager.

TABLE 7 GEOCOMPOSITE CONFORMANCE TESTING REQUIREMENTS			
TEST NAME	**TEST METHOD**	**MINIMUM FREQUENCY OF TESTING[1,2]**	**MINIMUM TEST STANDARDS[1]**
Carbon Black Content	ASTM D1603	1 test per 100,000 ft^2 or 1 per lot whichever is less	2%-3%
Density	ASTM D1505	1 test per 100,000 ft^2 or 1 per lot whichever is less	0.94 g/cc
Thickness	ASTM D1777	1 test per 100,000 ft^2 or 1 per lot whichever is less	as specified
Transmissivity	ASTM 4716	1 test per 100,000 ft^2 or 1 per lot whichever is less	10 gal/min/ft or as specified
Mass per Unit Area	ASTM D3776	1 test per 100,000 ft^2 or 1 per lot whichever is less	as specified

Unless otherwise specified, samples shall be taken at a rate of one per lot or one per 100,00 ft^2, whichever is least, as indicated in **TABLE 7**.

3.4.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first linear meter (three feet). Unless otherwise specified, samples shall be 3 ft wide by the roll width.

3.4.3 Test Results

The CQA Manager shall examine all results form laboratory conformance testing and shall report any non-conformance to the Project/Site Manager. Any lots not meeting conformance testing specifications will result in the rejection of the lot.

4.0 INSTALLATION OF GEOCOMPOSITE

4.1 Handling and Placement

The Installer shall take whatever steps are necessary to insure that any underlying layers are not damaged during the placement of the geocomposite or that the geocomposite is damaged in any way, which shall include but is not limited to the following conditions.

- During placement of Geocomposites, care shall be taken not to entrap in the geocomposite, dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane, If dirt or excessive dust is entrapped in the geocomposite, it should be hosed clean prior the placement of the next material on top of it. In this regard, care should be taken with the handling of sandbags, to prevent rupture of damage of the sandbag.
- Geocomposites shall only be cut using scissors or curved blade (hook blade) utility knife that will not damage underlying geosynthetics.
- On slopes, the Geocomposites shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles. Geocomposites can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., a the toe of a slope, if an extra layer of geocomposite is required, this extra layer of geocomposite can be placed in the horizontal direction). Such locations shall be identified by the Designer in design drawings. Designers should note that placement of layers of Geocomposites at 90 degree angles to each other will result in a partial loss of effective thickness and transitivity.
- In the presence of wind, all Geocomposites shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material..
- Unless otherwise specified, Geocomposites shall not be welded to geomembranes.

The CQA Manager will note any deficiencies or non-compliance and report it to the Project/Site Manager.

4.2 Stacking Geocomposites

When several layers of Geocomposites are stacked, care should be taken to prevent strands from one layer from penetrating the channels of the next layer, thereby significantly reducing the transmissivity. This cannot happen if stacked Geocomposites are placed in the same direction. A stacked geocomposite shall never be laid in perpendicular directions to the underlying geocomposite (unless otherwise specified by the Designer). In the corners of side slopes of rectangular landfills, adjacent overlapping Geocomposites are usually perpendicular and special precautions shall be taken as discussed below.

4.3 Joining and Splicing

Adjacent geocomposites shall be joined according to construction drawings and specifications. As a minimum, the following requirements shall be met. Geocomposites may be butt joined or lapped if specified. Nylon/plastic cable ties will be applied to the net edge at five-foot intervals along the edge. End splices will be made as follows:

- On slopes, the ends will overlap two feet with the uphill panel on top with two rows of cable ties applied
- In flat areas, the end will be overlapped a minimum of two inches and one row of cable ties applied

The CQA Manager shall note any non-compliance and report it to the Project/Site Manager.

4.4 Defects and Repairs

If the geocomposite is damaged it can be repaired by the following methods at the discretion of the CQA Manager. Placing a patch extending 2 feet beyond edges of the hole or tear shall repair holes and tears in the geocomposite. The patch shall be secured to the original geocomposite by spot welding or tying every 6 inches. If the hole or tear width across the roll is more the 50% the width of the roll, the damaged area shall be cut out and the two portions of the geocomposite shall be joined.

The CQA Manager shall observe any repair, note any non-compliance with the above requirements and report them to the Project/Site Manager.

5.0 GEOTEXTILES

5.1 Manufacturing

The geotextile manufacturer will provide the Project/Site Manager with a list of guaranteed "minimum average roll value" properties for the type of geotextile to be delivered. The geotextile manufacturer shall also provide the Project/Site Manager with a written quality control certification signed by a responsible party employed by the manufacturer that the materials actually delivered have property "minimum average roll values" which meet or exceed all property values guaranteed for that type of geocomposite. The quality control certificates shall include:

- roll identification numbers;
- sampling procedures; and
- results of quality control testing.

The geotextile manufacturer shall provide, at a minimum, test results for the following:

- mass per unit area;
- grab strength;
- tear strength;
- burst strength;
- puncture strength;
- wide strip tensile strength;
- thickness; and
- permeability and apparent opening size.

Quality control tests must be performed in accordance with the test methods specified in **TABLE 8** for every 100,000 ft^2 of geotextile produced for the project. The geotextile manufacturer shall also provide a written certification that the nonwoven, needle-punched geotextiles are continuously inspected and found to be needle-free.

The CQA Consultant shall examine all manufacturer certifications to insure that the property values listed on the certifications meet or exceed those specified for the particular type of geotextile and the measurements of properties by the Manufacturer are properly documented, test methods acceptable and the certificates have been provided at the specified frequency properly identifying the rolls related to testing. Any deviations shall be reported to the Project/Site Manager.

5.2 Roll Label Requirements

The geotextile manufacturer and the geocomposite manufacturer shall identify all rolls of geotextile and geocomposite with the following:

- manufacturer's name
- product identification;
- lot number;
- roll number; and
- roll dimensions.

Additionally, if any special handling of the geotextile is required, it shall be so marked on the top surface of the geotextile, e.g., " This Side Up" or " This Side Against Geocomposite". The CQA Manager shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project/Site Manager.

5.3 Shipping, Handling & Storage

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. To that effect, geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings.

Geotextiles shall not be exposed to precipitation prior to being installed. Wrappings protecting geotextile rolls shall be removed less than one hour prior to unrolling the geotextile. After the wrapping has been removed, a geotextile shall not be exposed to sunlight for more than 15 days, unless otherwise specified and guaranteed by the geotextile manufacturer.

The CQA Consultant shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Project/Site Manager. Any damaged rolls shall be rejected and replaced at no cost to the Owner.

5.4 Conformance Testing

Upon delivery of the rolls of geotextiles and geocomposites, the CQA Manager shall insure that samples are removed and forwarded to the CQA Laboratory for testing to ensure conformance to both the design specifications and the list of guaranteed properties. As a minimum, the following tests shall be performed on geotextiles:

- mass per unit area;
- grab strength;
- tear strength;

- burst strength;
- puncture strength;
- wide strip tensile test;
- thickness; and
- permeability and apparent opening size.

These conformance tests shall be performed in accordance with the tests methods specified in the project specifications. Other conformance tests may be required by the specifications. Testing frequency for the geotextiles is presented in **TABLE 8.**

These conformance tests shall be performed, at the discretion of the CQA manager, in accordance with the test methods specified in the project specifications. Other conformance tests may be required by the specifications.

TABLE 8
GEOTEXTILE CONFORMANCE TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING[1,2]	MINIMUM TEST STANDARDS[1]
Mass per Unit Area	ASTM D3776	1 test per 100,00 ft.^{2}	>7 oz/yd^2 or as specified
Puncture Resistance	ASTM D4833	1 test per 100,00 ft.^{2}	as specified
Permeability (Filter Application only)	ASTM D4491	1 test per 100,00 ft.^{2}	as specified
Apparent Opening (Filter Application only)	ASTM D4751	1 test per 100,00 ft.^{2}	as specified
Trapezoidal Tear Strength	ASTM D4533	1 test per 100,00 ft.^{2}	as specified
Thickness	ASTM D1777	1 test per 100,00 ft.^{2}	as specified
Grab Strength	ASTM D4362	1 test per 100,00 ft.^{2}	as specified
Mullen Burst	ASTM D3786	1 test per 100,00 ft.^{2}	as specified

Note: Testing shall be carried out at a frequency of one per lot or at listed frequency, whichever is less.

5.4.1 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first linear three feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The CQA Manager shall mark the machine direction on the samples with an arrow. Unless otherwise specified, samples shall be taken at a rate of one per lot or one per 100,000 ft^2, whichever is least, as indicated in **TABLE 8** for geotextiles.

5.4.2 Test Results

The Geosynthetics CQA Consultant shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project/Site Manager.

6.0 INSTALLATION OF GEOTEXTILES/GEOCOMPOSITES

6.1 Handling and Placement

The installer shall handle all geotextiles and geocomposites in such a manner as to ensure they are not damaged in any way, and the following shall be complied with:

- On slopes, the geotextiles and the geocomposites shall be securely anchored in the anchor trench and then rolled down the slope in such a manner as to continually keep the geotextile or the geocomposite sheet in tension.
- In the presence of wind, all geotextiles and geocomposites shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with earth cover material.
- Geotextiles shall be cut using an approved geotextile cutter only. Geocomposites shall be cut using scissors only. If in place, special care must be taken to protect other materials from damage which could be caused by the cutting of the geotextiles or the geocomposites.
- The installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile or the geocomposite.

In addition, the following applies to geotextiles only:

- During placement of geotextiles, care shall be taken not to entrap in the geotextile stones, excessive dust, or moisture that could damage the geomembrane, generate clogging of drains or filters, or hamper subsequent seaming.
- A visual examination of the geotextile shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.

6.2 Seams and Overlaps

On slopes steeper than 10 horizontal/1 vertical, all geotextiles shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped 0.15m (6 in.) prior to seaming. No horizontal seams shall be allowed on side slopes (i.e. seams shall be along, not across, the slope), except as part of a patch.

On bottom and slopes shallower than 10/1 (horizontal/vertical), geotextiles can be either seamed as indicated above, or thermally bonded. The installer shall pay particular attention at seams to insure that no earth cover material could be inadvertently inserted beneath the geotextile. Any sewing shall be done using polymeric thread with chemical and ultraviolet resistance properties equal to or exceeding those of the geotextile.

6.3 Defects and Repairs

Any holes or tears in the geotextile shall be repaired as follows:

- On slopes: A patch made form the same geotextile shall be double seamed into place [with each seam 5 mm to 20 mm (1/4 in. to 3/4 in.) apart and no closer than 25 mm (1 in.) from any edge]. Should any tear exceed 10% of the width of the roll, that roll shall be removed from the slope and replaced.
- Non-slopes: A patch made form the same geotextile shall be spot-seamed in place with a minimum of 0.60m (24 in.) overlap in all directions.

Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile. The CQA Consultant shall observe any repair, note any non-compliance with the above requirements and report them to the Project/Site Manager.

6.4 Placement of Soil Materials

The Installer shall place all soil materials located on top of a geotextile or a geocomposite, in such a manner as to insure:

- no damage of the geotextile or geocomposite;
- minimal slippage of the geotextile or geocomposite on underlying layers;
- no excess tensile stresses in the geotextile.

Unless otherwise specified by the Designer, all lifts of soil material shall be in conformance with the following guidelines:

TABLE 9
Required Lift Thickness of Soil Materials Based on Equipment Ground Pressure

Equipment Ground Pressure	Minimum Loose Lift Thickness
psi	inches
< 9	9
9 - 16	18
>16	24

Any non-compliance shall be noted by the Geosynthetics CQA Consultant and reported to the Project/Site Manager. If portions of the geotextile or the geocomposite are exposed, the Geosynthetics CQA Consultant shall periodically place two (or more, at his discretion) marks on the geotextile or the geocomposite 3m (10 ft.) apart along the slope and measure the elongation of the geotextile or the geocomposite during the placement of soil. The Designer shall relate this elongation to the tensile stress in the geotextile or the geocomposite.

7.0 GEOSYNTHETIC CLAY LINERS

At the owner's discretion, a geosynthetic clay liner (GCL) may be used in place of a compacted clay liner and/or compacted clay barrier layer. The following sections summarize construction quality assurance measures to be taken in the event that a GCL is to be utilized.

7.1 Manufacturing

The CQA Consultant shall examine all manufacturer's certifications to insure that the property values listed on the certifications meet or exceed those specified. In addition, the measurements of properties by the manufacturer must be properly documented and the certificates are provided at the specified frequency properly identifying the rolls related to testing. Any deviations shall be reported to the Project/Site Manager.

7.2 Roll Label Requirements

The geosynthetic clay liner (GCL) manufacturer shall identify all rolls of GCLs with the following:

- manufacturer's name
- product identification
- lot number
- roll number
- roll dimensions

The CQA Manager shall examine rolls upon delivery and any deviation form the above requirements shall be reported to the Project/Site Manager.

7.3 Shipping, Handling, and Storage

Protecting the GCL from damage is very important. The GCL rolls should be wrapped in polyethylene sheets or otherwise protected against dust, dirt, and moisture during shipping and storage.

The wrapping should be removed just prior to the deployment of the rolls. The CQA Consultant shall verify that GCL has not been exposed to moisture just before installation. The CQA Consultant shall report the outcome of this verification to the Project/Site Manager. In some cases, a GCL roll may be rejected for use if it has not been properly protected and is rendered damaged by the CQA Consultant.

7.4 Conformance Testing

7.4.1 Testing Requirements

Upon delivery of the rolls of GCL, the CQA Consultant shall take conformance samples to ensure conformance to both the design specifications and the list of guranteed properties. The tests presented in TABLE 10 will be performed at the discretion of the CQA Manager.

TABLE 10
Geosynthetic Clay Liner Specifications

Manufacturer's Quality Control				
Test	**Method(1)**	**Testing Frequency**	**Units**	**Min. Requirements**
Reinforced/Non-Reinforced				**(Reinforced/ Non-Reinforced)**
Bentonite Swell Index[2]	ASTM D 5890	1 per 100,000 lbs	mL/g	≥ 24 / 2 (min)
Bentonite Fluid Loss[2]	ASTM D 5891	1 per 100,000 lbs	mL	≤ 18 (max)
Bentonite Mass per Area[3]	ASTM D 5993	40,000 ft^2	lb/ft^2	≥ 0.75 (min)
GCL Grab Strength[4]	ASTM D 4632 ASTM D 6768	200,000 ft^2	lbs/in	≥ 30 MARV
GCL Peel Strength[4]	ASTM D 6496	40,000 ft^2	lbs/in	≥ 3.5 / ≥ 1.0 MARV
GCL Index Flux[5]	ASTM D 5887	Weekly	$m^3/m^2/s$	≤ 1 x 10^{-8} (max)
GCL Permeability[5]	ASTM D 5887	Weekly	cm/sec	≤ 5 x 10^{-9} (max)
GCL Hydrated Internal Shear Strength[6]	ASTM D 5321 ASTM D 6243	Periodic (6)	psf	≥ 500 typical @ 200 psf (min) / ≥ 150 typical @ 200 psf (min)
Conformance Testing by CQA Engineer				**(Reinforced/Non-Reinforced)**
Bentonite Mass per Area[3]	ASTM D 5993	100,000 ft^2	lb/ft^2	0.75 (min)
GCL Grab Strength[4]	ASTM D 4632 ASTM D 6768	100,000 ft^2	lbs/in	≥ 30 MARV
GCL Peel Strength[4] (reinforced	ASTM D 6496	100,000 ft^2	lbs/in	≥ 3.5 MARV / NA
GCL Permeability[5]	ASTM D 5887	100,000 ft^2	cm/sec	5 x 10^{-9} (max)

1. Test to be performed according to the latest test method as approved by the certifying engineer.

2. These parameters are for the bentonite incorporated into the GCL and do not necessarily reflect the properties of the bentonite in the finished product.

3. Bentonite mass per area is exclusive of the average weight of the geotextiles and is normalized to 0 percent moisture content per ASTM D 5993.

4. All tensile testing is performed in the machine direction, with results as minimum average roll values unless otherwise indicated.

5. Index flux and permeability testing with deaired distilled/deionized water at 80 psi cell pressure, 77 psi headwater pressure and 75 psi tail water pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of 5 x 10-9 cm/sec for typical GCL thickness. This flux value should not be used for equivalency calculations unless gradient used represent field conditions. A flux test using gradients that represent field conditions must be performed to determine equivalency. The last 20 weekly values prior to end of the production date of the supplied GCL may be provided.

6. ASTM D5321-08 (geosynthetics) or D 6243 (GCLs) internal direct shear performed on GCL sample hyddrated under 200 psf normal load and then sheared at 0.2 in./min. max for Procedure A and 0.04 in/min for Procedure B. Use wet conditions as per ASTM D5321. The testing is required prior to construction of the first ECS Cell.

7.4.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first linear yard (three feet). Unless otherwise specified, samples shall be 3 ft wide by the roll width.

7.4.3 Test Results

The CQA Manager shall examine all results form laboratory conformance testing and shall report any non-conformance to the Project/Site Manager. Any lots not meeting conformance testing specifications will result in the rejection of the lot.

8.0 INSTALLATION OF GCL

8.1 Handling and Placement

The finished subgrade surface should be firm and unyielding, without abrupt elevation changes, voids, cracks, ice, or standing water. Additionally, the subgrade surface must be smooth and free of vegetation, sharp-edged rocks, stones, sticks, construction debris, and other foreign matter that could contact the liner. The subgrade should be rolled with a smooth-drum compactor to remove any wheel ruts, footprints, or other abrupt grade changes. All protrusions extending more than 0.5 inch (12mm) from the subgrade surface shall be manually removed, crushed, or pushed into and flush with the surface. The surface will be accepted by the installer and CQA representative prior to installation of the GCL.

The Installer shall take whatever steps are necessary to insure that any underlying layers are not damaged during the placement of the GCL or that the GCL is damaged in any way, which shall include but is not limited to the following conditions.

- During placement of GCLs, care shall be taken no to entrap in the GCL, dirt or excessive dust that could cause clogging of the geotextile fabric, and/or stones that could damage the adjacent geomembrane.
- On slopes, the GCLs shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the GCL sheep in tension. If necessary, the GCL shall be positioned by hand after being unrolled to minimize wrinkles. GCLs can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., a the toe of a slope, if an extra layer of GCL is required, this extra layer of GCL can be placed in the horizontal direction). Such locations shall be identified by the Designer in design drawings.

The CQA manager will note any deficiencies or non-compliance and report it to the Project/Site Manager.

8.2 Stacking GCLS

When several layers of GCLs are stacked, care should be taken to prevent damage to the GCL. A stacked GCL shall never be laid in perpendicular directions to the underlying GCL (unless otherwise specified by the Designer). In the corners of side slopes of rectangular landfills, adjacent overlapping GCLs are usually perpendicular and special precautions shall be taken as discussed below.

8.3 Overlaps

Adjacent GCLs shall be overlapped a minimum of 6" and the seam covered with powdered bentonite. The CQA Manager shall note any non-compliance and report it to the Project/Site Manager.

8.4 Defects and Repairs

If the GCL is damaged it can be repaired by the following methods at the discretion of the CQA Manager. Placing a patch extending 2 feet beyond edges of the hole or tear shall repair holes and tears in the GCL. The patch shall be secured to the original GCL by covering the edges of the patch with powdered bentonite. If the hole or tear width across the roll is more the 50% the width of the roll, the damaged areal shall be cut out and the t portions of GCL shall be overlapped and powdered bentonite applied.

The CQA Manager shall observe any repair, note any non-compliance with the above requirements and report them to the Project/Site Manager.

9.0 GEOGRID REINFORCEMENT

The following sections summarize construction quality assurance measures to be taken in the event that geogrids are to be utilized at the CSL (ie, Cells A2 and A4) at the CSL.

9.1 Manufacturing

The CQA Consultant shall examine all manufacturer's certifications to insure that the property values listed on the certifications meet or exceed those specified. In addition, the measurements of properties by the manufacturer must be properly documented and the certificates are provided at the specified frequency properly identifying the rolls related to testing. Any deviations shall be reported to the Project/Site Manager.

9.2 Roll Label Requirements

The geogrid manufacturer shall identify all rolls of geogrids with the following:

- manufacturer's name
- product identification
- lot number
- roll number
- roll dimensions

The CQA Manager shall examine rolls upon delivery and any deviation form the above requirements shall be reported to the Project/Site Manager.

9.3 Shipping, Handling, and Storage

The CQA Consultant shall verify that GCL has not been damaged in any way just before installation. The CQA Consultant shall report the outcome of this verification to the Project/Site Manager. In some cases, a geogrid roll may be rejected for use if it has not been properly protected and is rendered damaged by the CQA Consultant.

9.4 Conformance Testing

9.4.1 Testing Requirements

Upon delivery of the rolls of geogrid, the CQA Consultant shall take conformance samples to ensure conformance to both the design specifications and the list of guaranteed properties. The tests presented in **TABLE 11** will be performed at the discretion of the CQA Manager.

TABLE 11 GEOGRID REINFORCEMENT TESTING REQUIREMENTS			
TEST NAME	**TEST METHOD**	**MINIMUM FREQUENCY OF TESTING[1,2]**	**MINIMUM TEST STANDARDS[1]**
Structure		1 per 10,000 s.f.	All layers of bi-oriented geogids must be sewn together
Polypropylene	ASTM D 4101	1 per 10,000 s.f.	99%
Carbon Black Content	ASTM D 4218	1 per 10,000 s.f.	0.50%

Unless otherwise specified, samples shall be taken at a rate of one per lot or one per 10,000 ft^2, whichever is less, as indicated in **TABLE 11**.

9.4.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first linear yard (three feet). Unless otherwise specified, samples shall be 3 ft wide by the roll width.

9.4.3 Test Results

The CQA Manager shall examine all results form laboratory conformance testing and shall report any non-conformance to the Project/Site Manager. Any lots not meeting conformance testing specifications will result in the rejection of the lot.

10.0 INSTALLATION OF GEOGRIDS

10.1 Handling and Placement

1. The engineer shall verify the subgrade is ready for geogrid deployment, and that elevations are as indicated on the Contract Drawings.

2. The surface shall be fairly smooth and free of sharp objects and debris that may damage the geogrid.

3. Unroll geogrids on the subgrade and apply tension by hand to eliminate wrinkles.

4. Geogrid panel overlap requirements, either side by side, or end to end, shall depend on the strength of the subgrade. For very soft subgrade (with CBR < 1), 3 feet overlap is recommended; for soft subgrade (with CBR = 1-2), 2 feet, and for firm subgrade (CBR > 2), 1 foot of overlap is recommended.

5. Adjacent geogrid rolls should be overlapped in the direction of anticipated fill spreading.

6. Plastic ties shall be used at 10 feet interval to secure the overlaps.

7. During the installation of geogrid over firm ground (CBR > 2), the fill material must be back dumped, end dumped, or belly dumped. When applying the fill material over firm ground, rubber tire trucks can drive directly on the geogrid at very slow speeds (less than 5 mph) and dump the fill material as they go. Operators must not turn or make any sudden stops when driving across the geogrid. Tracked equipment cannot be driven directly across the geogrid. A minimum of four (4) inches of fill material shall be placed between equipment tracks and geogrids.

8. Any ruts developed during spreading or compacting must be filled with additional fill material to reach the design thickness.

10.2 Defects and Repairs

Geogrid sections damaged during installation must be cut and removed. Replacement sections shall be overlapped by three (3) feet on all sides and secured with plastic ties to prevent slipping.

10.3 Protection

The geogrid shall be protected from long-term exposure to direct sunlight during transport and storage. Also after placement, the geogrid shall not be left uncovered for more than three (3) weeks.

11.0 DOCUMENTATION

11.1 Daily Reports

Each of the CQA Monitors shall complete a daily report and/or logs on prescribed forms, outlining all of his or her monitoring activities for that day. The precise areas, panel numbers, seams completed and approved, and measures taken to protect unfinished areas overnight should be identified. Failed seams or other panel areas requiring remedial action must be identified with regard to the nature of action, required repair, and precise location. Repairs completed must also be identified. Any problems or concerns with regard to operations on site should be noted. This report must be completed at the end of each monitor's shift, prior to leaving the site, and submitted to the CQA Manager.

The CQA Manager shall review the daily reports submitted by the CQA Monitors, and incorporate summary of their reports into his own daily report. Any matters requiring action by the Project/Site Manager should be highlighted. This report must be completed daily, summarizing the previous day's activities, and a copy submitted to the Project/Site Manager at the beginning of the day following the report date.

11.2 Destructive Test Reports

The destructive test reports from all sources should be collated by the CQA Manager. This includes field tests, installer's laboratory tests, and CQA Laboratory tests. A summary list of test samples pass/fail results should be prepared by the CQA Manager on an ongoing basis, and submitted with the periodic progress reports.

11.3 Progress Reports

Progress Reports shall be prepared by the CQA Manager and submitted to the Owner. These reports shall be submitted every two weeks, starting the second Friday of geosynthetics installation on site. This report should include: an overview of progress to date; an outline of any changes made to the plans, drawing, or specifications; any problems or deficiencies in operations at the site, and an outline of any action taken to remedy the situation(s); a summary of weather conditions; and a brief description of activities anticipated for the next reporting period. All Destructive Test Reports for the period should be appended to each Progress Report.

11.4 Construction Problem and Solution Data Sheets

Sheets describing special construction situations shall be cross-referenced with specific observation logs and testing data sheets, and must include the following information, where available:

- an identifying sheet number for cross-referencing and document control

- a detailed description of the situation or deficiency;
- the location and probable cause of the situation or deficiency;
- how and when the situation or deficiency was found or located;
- documentation of the response to the situation or deficiency;
- final results of any responses;
- any measures taken to prevent a similar situation for occurring in the future; and
- the signature of the CQA Manager/Monitor and signature indicating concurrence the Project/Site Manager.

The Project/Site Manager shall be made aware of any significant recurring non-conformance with specifications. The Project/Site Manager shall then determine the cause and recommend appropriate changes in procedures or specifications. When this type of evaluation is made, the results must be documented, and any revision to procedures of specifications shall be approved by the Owner and Project Engineer.

A Summary of all supporting data sheets, along with final testing results and the CQA Certifying Engineer's approval of the work, shall be required upon completion of construction.

11.5 Design and/or Specification Changes

Design and/or specifications changes may be required during construction. In such cases, the CQA Certifying Engineer shall notify the Project/Site Manager and Project Engineer. Design and/or specifications changes shall be made only with written agreement of the Project/Site Manager and the Project Engineer, and shall take the form of an addendum to the specifications.

11.6 Record Drawings

Record drawings should be prepared by the Contractor and approved by the CQA Consultant. The record drawings should include the following information for geomembranes:

- dimensions of all geomembrane field panels;
- location, as closely as possible, of each panel relative to the surveyors plan (furnished by the Owner);
- identification of all seams and panels with appropriate number or "identification codes" (see Section 4.2.2.1);
- location of all patched and repairs; and
- location of all destructive testing samples.

The Record drawing shall address each layer of geomembrane, and, if necessary, another drawing shall identify problems or unusual conditions of the geotextile or

geocomposite layers. In addition, applicable cross-sections shall show layouts of Geocomposites, geotextiles or geocomposites which are unusual or differ from the design drawings.

11.7 Photographic Reporting Data Sheets

Photographic reporting data sheets, where used, shall be cross-referenced with observation and testing data sheet(s) and /or construction problem and solution data sheets(s).

These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain color prints; negatives will also be stored in a separate file in chronological order. These records shall be presented to the Project/Site Manager upon completion of the project.

11.8 Final Report

A final report shall be submitted upon completion of the work. This report shall include all reports prepared by the CQA Consultant personnel, summarize the activities of the project, and document all aspects of the quality assurance program performed. The final report shall include as a minimum the following information:

- personnel involved with the project;
- scope of work;
- outline of project;
- construction quality assurance methods;
- test results (destructive and non-destructive, including laboratory tests);
- sealed and signed by a registered professional engineer; and
- record drawings, sealed and signed by a registered professional engineer.

11.9 Storage of Records

During construction, the CQA Manager shall be responsible for submitting the facility record drawings. The document originals shall be stored by the owner/operator in a manner that will allow for easy access. An additional copy should also be kept at the facility.

SECTION #5
OTHER

1.0 OTHER PROJECT CONSTRUCTION

The CQA Consultant shall be responsible for reviewing, verifying and testing all aspects of the construction project. The scope of the CQA Consultant's responsibilities shall include the review and quality control testing of all road installations, concrete structure installations, and other construction addressed in the project specifications, but not discussed in this CQA Plan. Performance criteria, and quality control testing frequencies for construction not associated with the landfill footprint is addressed in applicable sections of the project specifications.

1.0 Interface Testing of Bottom Liner and Final Cover Systems

It should be noted, prior to the installation of any bottom liner and/or final cover system components, it will be necessary to conduct the following test for the most critical interfaces. In the bottom liner system, the interface friction angle and adhesion associated with the textured 60-mil HDPE geomembrane vs. the compacted clay liner and protective cover vs. geocomposite interfaces shall be verified for conformance with the project specifications. In the final cover system, the geomembrane vs. clay and protective cover vs. geocomposite interfaces shall be tested to determine if the specified interfaces demonstrate sufficient interface strength in accordance with the project specifications.

ASTM D5321-92- Standard Test method for determining the coefficient of soil and geosynthetic or geosynthetic and geosynthetic friction by the direct shear method. A minimum of 1 test per interface will be required.

Materials utilized in the test shall conform to the actual materials and manufacturers to be utilized in the bottom liner and/or final cover systems. As the use of geosynthetics is an emerging technology, geosynthetic products should be considered at the time of construction which meet or exceed the minimum standards contained in the plans and specifications. If these standards are not met, additional slope stability analysis must be performed to assure there is no potential for a slope failure at the geosynthetic interfaces.

APPENDIX 1
GLOSSARY OF TERMS

A.1 SOIL RELATED TERMS

Aggregate - any combination of sand, gravel and crushed stone in their natural or processed state.

Atterberg limits - The liquid limit, plastic limit, and shrinkage limit for soil. The water content where the soil behavior changes from liquid to the plastic state is the liquid limit; from plastic to semisolid state is plastic limit; and from the semisolid to the solid state is the shrinkage limit.

Backfill - Soil material placed back into an area that has been excavated, such as against structures, in anchor trenches and in pipe trenches

Borrow - Soil material obtained from an off-site source for the clay liner, leachate collection layer, daily cover, or other construction projects.

Clays - Very small soil particles having a crystalline (layer structure, created as the result of the chemical alteration of primary rock minerals. Since the clay particles are very small, the air voids are very small and the flow of water through the soil material is very slow.

Coarse Aggregate - is generally considered to be a crushed stone or gravel almost all of which is retained on a No. 4 sieve.

Compaction - The process of increasing the density or unit weight of a soil by rolling, tamping, vibrating, or other mechanical means.

Density - The mass per unit volume

Fine Aggregate - is considered to be any aggregate material that will pass a 3/8 in. sieve and essentially all of which will pass a No. 4 sieve and is predominately retained on a No. 4 sieve.

Liquid Limit - The water content where the soil behavior changes from liquid to the plastic state.

Hydraulic Conductivity - the property that reflects the ability of a material to conduct a fluid or vapor through a porous media such as soil or geotextiles.

In situ - Refers to soil when it is at its natural location in the earth and in its natural condition

Permeability - A generic term for the property that reflects the ability of a material to conduct a fluid or vapor through a porous media such as soil or geotextiles. Properly called *hydraulic conductivity.*

Plastic Limit - The water content where the soil behavior changes from plastic to semisolid state.

Plasticity - Term applied to fine-grained soils (particularly clays) to indicate the soils' (plus included waster's) ability to flow or be remolded without raveling or breaking apart.

Sand - The category of coarse-grained soil whose particles size range between about 0.07 mm and 5 mm in diameter.

Silt - The category of fine-grained soil particles whose mineralogical composition remains similar to the rock they were derived from.

Shrinkage Limit - The water content where the soil behavior changes from the semisolid to the solid state.

Sump - Small excavation or pit provided in the floor of a structure, or in the earth, to serve as a collection basin for surface water and leachate.

Water content - The ratio of the quantity of water in a soil (by weight) to the weight of the soil solid (dry soil), typically expressed as a percentage.

A.2 GEOTEXTILE AND GEOTEXTILE-RELATED* TERMS

Actinic degradation The strength of fibers and fabrics due to exposure to sunlight or an accelerated weathering light source.

Arching The formation of soil particles upstream of a geotextile where the particles arch (or bridge) over the fabrics' voids.

Basis weight* A deprecated term for *mass per unit area*.

Blinding The condition in which soil particles block the voids at the surface of a geotextile, thereby reducing the hydraulic conductivity of the geotextile.

Blocking A synonym for *blinding*.

Bonding The process of combining fibers, filaments, or films into sheets, webs, or bats by means of mechanical, thermal, or chemical binding.

Clogging The movement by mechanical action or hydraulic flow of soil particles into the voids of a fabric and retention therein, thereby reducing the hydraulic conductivity of a geotextile.

Composite *See* Fabric, composite.

Cross-plane The direction of a geosynthetic which is perpendicular to the plane of its manufactured direction. Referred to in hydraulic situations.

Deformation The change in length of a geosynthetic under load from its original manufactured dimensions.

Denier The weight in grams of 9000 m of yarn.

Density* The mass per unit volume.

Direction, cross-machine The direction perpendicular to the long, machine, or manufactured direction (synonyms: *woven geotextiles, weft direction*).

Direction, machine In textiles, the direction in a machine-made fabric parallel to the direction of movement the fabric followed in the manufacturing process (synonym: *lengthwise,* or *long direction*, and for woven geotextiles, *wrap direction*).

Downstream The direction of the opposite side of a geotextile from which liquid is moving.

Elongation The increase in length produced in the gage length of the test specimen by a tensile load.

Elongation at break The elongation corresponding to the maximum load.

Elongation, percent For geosynthetics, the increase in length of a specimen expressed as a percentage of the original gage length (i.e., engineering strain).

Fabric Term used interchangeably with geotextile, particularly after placement in the manner described in this book.

Fabric, composite A textile structure produced by combining nonwoven, woven, or knit manufacturing methods.

Fabric, knit A textile structure produced by interlooping one or more ends of yarn or comparable material.

Fabric, nonwoven For geotextiles, a planar and essentially random textile structure produced by bonding, interlocking of fibers or both, accomplished by mechanical, chemical, thermal, or solvent means and combinations thereof.

Fabric, woven A planar textile structure produced by interlacing two or more sets of elements, such as yarns, fibers, rovings, or filaments, where the elements pass each other, usually at right angles, and one set of elements are parallel to the fabric axis.

Filament yarn The yarn made from continuous filament fibers.

Fill A deprecated term for *filling*.

Filing The yarn running from selvedge to selvedge at right angles to the wrap in a woven fabric.

Filling Direction *See* Direction, cross-machine. *Note*: For use with woven fabrics only.

Filter cake The soil structure developed upstream of a geotextile by separating the suspended soil from liquid as the mixture attempts to pass through a soil fabric system.

Filter cloth A deprecated term for *geotextile*.

Geocell A three-dimensional structure filled with soil, thereby forming a mattress for increased stability when used with loose or compressible subsoils.

Geocomposite A manufactured material using geotextiles, geogrids, geonets, and/or geomembranes in laminated or composite form.

Geogrid A deformed or nondeformed gridlike polymeric material formed by intersecting ribs joined at the junctions used for reinforcement with foundations, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human-made project structure or system.

Geomembrane An essentially impermeable membrane used a s liquid or vapor barrier with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human-made project, structure, or system.

Geonet A netlike polymeric material formed form intersecting ribs integrally joined at the junctions used for drainage with foundation, soil, rock, earth, or any other geotechnical-related material as an integral part of a human-made project, structure, or system.

Geopipe Any plastic pipe used with foundation, soil, rock, earth, or any other subsurface related material as an integral part of a human-made project, structure, or system.

Geosynthetic clay liner (GCL) Factory-manufactured hydraulic barriers consisting of a layer of bentonite clay or other very low permeability material supported by geotextiles and/or geomembranes, and mechanically held together by needling, stitching, or chemical adhesives.

Geosynthetics The generic term for all synthetic materials used in geotechnical engineering applications; it includes geotextiles, geogrids, geonets, geomembranes, and geocomposites.

Geotechnical engineering* The engineering application of geotechnics.
Geotechnics* The application of scientific methods and engineering principles to the acquisition, interpretation, and use of knowledge of materials of the earth's crust to the solution of engineering problems, it embraces the filed of

soil mechanics, rock mechanics, and many of the engineering aspects of geology, geophysics, hydrology, and related sciences.

Geotextile* Any permeable textile used with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human-made project, structure, or system.

Gradient The degree of slope or a rate of change of a parameter measured over distance.

Heat bonded Thermally bonded by melting the fibers to form weld points.

Hydrophilic A material's attraction to water.

Hydrophobic A material's repulsion of water.

In-plane The direction of a geosynthetic that is parallel to its long, manufactured, or machine direction. Referred to in hydraulic situations.

Knit *See* Fabric, knit.

Mass per unit area The proper term to represent and compare to the amount of material per unit area (units are oz./yd^2 or g/m^2). Often incorrectly called "weight" or "basis weight."

Melt bounded *See* Heat bonded.

Modulus of elasticity The initial linear portion of the stress-versus-strain test of a geosynthetic during its evaluation in a tensile strength test (units are lb./in.^{2}, kPa, lb./in., or kN/m).

Needle-punched Mechanically bonded by needling with barbed needles.

Nonwoven *See* Fabric, nonwoven.

Normal direction* For geotextiles, the direction perpendicular to the plane of a geotextile.

Permeability A generic term for the property that reflects the ability of a material to conduct a fluid or vapor through a porous media such as soil or geotextiles. Properly called *hydraulic conductivity*.

Permittivity For a geotextile, the volumetric flow rate of water per unit cross-section area, per unit head, under laminar flow conditions, in the normal direction through the fabric.

pH A measure of the acidity or alkalinity of a material, liquid, or solid. pH is represented on a scale of 0 to 14; 7 represents a neutral state; 0 represents the most acid, and 14 the most alkaline.

Resin bonded The joining of fibers at their intersection points by resin in the formation of a nonwoven geotextile or geocomposites.

Siphoning The transferring of a liquid to a lower level over an intermediate higher elevation than both of the endpoints, which can be achieved by saturated geotextiles in planar flow.

Staple Short fibers in the range 0.5 to 3.0 in. (1 cm to 8 cm) long.

Staple yarn Yarn made from staple fibers.

Tenacity The fiber strength on a grams per denier basis.

Tex Denier multiplied by 9 and is the weight in grams of 1000 m of yarn.

Transmissivity For a geotextile, the volumetric flow rate per unit thickness under laminar flow conditions, within the in-plane direction of the fabric.

Transverse direction A deprecated term for *cross-machine direction*.

Ultraviolet degradation The breakdown of polymeric structure when exposed to natural light.

Upstream The direction from which flowing liquid approaches a filter or drain.

Voids The open spaces in a geosynthetic material through which flow can occur.

Wrap The yarn running the length of the fabric in the machine direction when manufacturing woven fabrics.

Wrap direction *See* Direction, machine. *Note:* For use with woven fabrics only.

Water table (1) The upper limit of the part of the soil or underlying rock material that is wholly saturated with water. (2) The upper surface of the zone of saturation in ground water in which the hydrostatic pressure is equal to atmospheric pressure.

Weft The cross-machine direction when manufacturing woven geotextiles.

Width For a geotextile, the cross-direction edge-to-edge measurement of a fabric in a relaxed condition on a flat surface.

Woof A deprecated term for *cross-machine direction*.

Woven *See* Fabric, woven.

Woven, monofilament The woven fabric produced with monofilament yarns.

Woven, multifilament The woven fabric produced with multifilament yarns.

Woven, slit-film The woven fabric produced with yarns produced from slit film.

Yarn* A generic term for continuous strands of textile fibers or filaments in a form suitable for knitting, weaving, or otherwise intertwining to form a textile fabric. *Yarn* may refer to (1) a number of fibers twisted together, (2) a number of filaments laid together without twist (a zero-twist yarn), (3) a number of filaments laid together with more or less twist, or (4) a single filament with or without twist (a monofilament).

* Those items marked by an asterisk (*) are from ASTM's Committee D35 on Geotextiles *Tentative Terminology Standard*.

A.3 GEOMEMBRANE AND GEOMEMBRANE-RELATED* TERMS

Adhesion The state in which two surfaces are held together by interfacial forces which may consist of molecular forces or interlocking action or both. Measured in shear and peel modes.

Air lance A device used to test, in the field, the integrity of field seams in plastic sheeting, It consists of a wand or tube through which compressed air is blown.

Alloys, polymeric A blend of two or more polymers (e.g., a rubber and plastic) to improve a given property (e.g., impact strength).

Antioxidants Primary types include phenols and amines that scavenge extraneous free radicals. Secondary types decompose peroxides as a source of free radicals.

Berm The upper edge of an excavation on which the ends of a geomembrane are buried to hold it in place or to anchor the material.

Blocking Unintentional adhesion usually occurring during storage or shopping between plastic films or between a film and another surface.

Bodied solvent adhesive An adhesive consisting of a solution of the geomembrane compound used in the seaming of geomembranes.

Boot A bellows-type covering to exclude dust, dirt, moisture, etc., from a geomembrane protrusion.

Breaking factor Tensile strength at break in force per unit of width. Expressed in Newtons per meter or pounds per inch.

Calender A machine equipped with three or more heavy internally heated or cooled rolls, revolving in opposite directions. Used for preparation of continuous sheeting or plying up of polymer compounds and frictioning or coating of fabric with rubber or plastic compounds.

* Many of these terms are from *Lining of Waste Impoundment and Disposal Facilities*, by Matrecon, Inc., for U.S. EPA Municipal Environmental Research Laboratory, Cincinnati, OH, R. Landreth, Project Officer, 1984, EPA/SW870, March 1983, G.P.O. No. 055-000-00231-2.

Catalysts Used in the polymerization process to make plastics. Generally they do not become part of the polymers. Typical examples are metal oxides (to make polyolefins) and the Ziegler-Natta systems containing aluminum allklys and transition metal salts.

Chlorosulfonated polyethylene (CSPE) Family of polymers that is produced y polyethylene reacting with chlorine and sulfur dioxide. Present CSPEs contain 25 to 43% chlorine and 1.0 to 1.4% sulfur. They are used in both vulcanized and nonvulcanized forms. Most membranes based on CSPE are nonvulcanized. (ASTM designation for this polymer is CSM.)

Coated fabric Fabric that has been impregnated and/or coated with a rubbery or plastic material in the form of a solution, dispersion, hot melt, or powder. The term also applies to materials resulting from the application of a performed film to a fabric by means of calendering.

Creep The slow change in length or thickness of a material under prolonged stress.

Cross-linking A general term referring to the formation of chemical bonds between polymeric chains to yield an insoluble, three-dimensional polymeric structure. Cross-linking of rubbers is vulcanization. *See also* Vulcanization.

Curing *See* Vulcanization.

Denier A unit used in the textile industry to indicate the fineness of continuous filaments. Fineness in deniers equals the mass in grams of 9000-m length of the filament.

Dielectric seaming *See* Heat seaming.

Elasticity The property of matter by virtue of which it tends to return to its original size and shape after removal of the stress that caused the deformation.

Elastomer *See* Rubber.

EPDM A synthetic elastomer based on ethylene, propylene, and a small amount of a nonconjugated diene to provide sites for vulcanization.

EVA A family of copolymers of ethylene and vinyl acetate used for adhesives and thermoplastic modifiers. They posses a wide range of melt indexes.

Extruder A machine with a driver screw for continuous forming of polymeric compounds by forcing through a die; regularly used to manufacture geomembranes.

Fabric reinforcement A fabric, scrim, and so on, used to add structural strength to a two-ply (or more) polymeric sheet. Such sheeting is referred to as *supported*.

Fill As used in textile technology refers to the threads or yarns in a fabric running at right angles to the wrap. Also called *filler threads*.

Film Sheeting having norminal thickness not greater than 10 mils.

Heat seaming The process of joining two or more thermoplastic geomembranes by heating areas in contact with each other to the temperature at which fusion occurs. The process is usually aided by a controlled pressure (synonym: *heat fusion*).

Hot wedge Common method of heat seaming of thermoplastic geomembranes by a fusing process wherein heat is delivered by a hot wedge passing between the opposing surfaces to be bonded.

Lapped seam A seam made by placing one surface to be joined partly over another surface and bonding the overlapping portions.

Leachate Liquid that has percolated through or drained from solid waste or other human-emplaced materials and contains soluble, partially soluble, or miscible components removed from such waste.

Leno fabric An open fabric in which two warp yarns wrap around each fill yarn to prevent the warp or fill yarns from sliding over each other.

Liner A layer of emplaced materials beneath a surface impoundment or landfill which serves to restrict the escape of waste or its constituents from the impoundment or landfill [*Fed. Regist.*].

Membrane A continuous sheet of material, whether prefabricated as a flexible polymeric sheeting or sprayed or coated in the field, such as a sprayed-on asphalt (synonym: *geomembrane*).

Modulus The stress on deforming a material to a given strain value (e.g., E_{50} and E_{100}).

Modulus of elasticity The ratio of stress to strain within the elastic range, also known as Young's modulus [ASTM].

Nylon Generic name for a family of polyamide polymers characterized by the presence of the amide group, $CONH_2$. Used as a scrim in fabric-reinforced geomembranes.

Plastic A material that contains as an essential ingredient one or more organic polymeric substances of large molecular weight, is solid in its finished state, and at some stage in its manufacture or processing into finished articles can be shaped by flow.

Plasticizer A plasticizer is a material, frequently solvent-like, incorporated in a plastic or a rubber to increase its ease of workability, its flexibility, or distensibility. Adding the plasticizer may lower the melt viscosity, the temperature of the second-order transition, or the elastic modules of the polymer. Plasticizer may be monomer liquids (phthalate esters), low-molecular-weight liquid polymers (polyesters), or rubbery high polymers (EVA). The most important use of plasticizers is with PVC geomembranes, where the choice of plasticizer will dictate under what conditions the liner may be used.

Polyester fiber Generic name for a manufactured fiber in which the fiber-forming substance is any long-chain synthetic polymer composed of an ester of a dihydric alcohol and terephthalic acid. Scrims made of polyester fibers are used for fabric reinforcement.

Polyethylene A polyolefins formed by bulk polymerization (for low density) or solution polymerization (for high density) where the ethylene monomer is placed in a reactor under high pressure and temperature. The oxygen produces free radicals which initiate the chain polymerization. For solution polymerization the monomer is first dissolved in an inert solvent. Catalysts are sometime required to initiate the reaction.

Polymer A macromolecular material formed by the chemical combination of monomers having either the same or different chemical composition. Plastics, rubbers, and textile fibers are all high-molecular-weight polymers.

Polymeric liner Plastic or rubber sheeting used to line disposal sites, pits, pounds, lagoons, canals, and so on.

Polyolefin A family of polymeric materials that includes polypropylene and polyethylene, the former being very common in geotextiles, the latter in geomembranes. Many variations of each exist.

Polyvinyl chloride (PVC) A synthetic thermoplastic polymer prepared from vinylchloride, PVC can be compounded into flexible and rigid forms through the use of plasticizers, stabilizers, fillers, and other modifiers; rigid forms used in pipes and well screens; flexible forms used in manufacture of geomembranes.

Puncture resistance Extent to which a material is able to withstand the action of a sharp object without perforation.

Quality assurance (QA) A planned system of activities whose purpose it to provide a continuing evaluation of the quality control program, initiating corrective action were necessary. It is applicable to both the manufactured product and its field installation.

Quality control (QC) Actions that provide a means of controlling and measuring the characteristics of (both) the manufactured and the field installed product.

Roll goods A general term applied[lied to rubber and plastic sheeting, whether fabric reinforced or not. It is usually furnished in rolls.

Rubber A polymeric material which, at room temperature, is capable of recovering substantially in shape and size after removal of a deforming force. Refers to both synthetic and natural rubber. Also called an *elastomer.*

Scrim A woven, open-mesh reinforcing fabric made from continuous-filament yarn, that is, a high-percent--open-area geotextile. Used in the reinforcement of some geomembranes.

Seam strength Strength of a seam of geomembrane material measured either in shear or peel modes. Strength of the seam is reported either in absolute units (e.g., pounds per inch of width) or as percent of the strength of the sheet.

Sheeting A form of plastic or rubber in which the thickness is very small in proportion to length and width and in which the polymer compound is present as a continuous phase throughout, with or without fabric (synonym: *geomembrane*).

Slope Deviation of a surface from the horizontal expressed as a percentage, by a ration, or in degrees, In engineering, usually expressed as a percentage of vertical to horizontal change [EPA].

Spread coating A manufacturing process whereby a polymeric material is spread in a continuous fashion on a fabric substrate thereby forming a reinforced geomembrane composite.

Strikethrough A term used in the manufacture of fabric-reinforced polymeric sheeting to indicate that two layers of polymer have made bonding contact through the scrim.

Support sheeting *See* Fabric reinforcement.

Surface cure Curing or vulcanization that occurs in a thin layer on the surface of a manufactured polymeric sheet or other items.

Tear strength The maximum force required to tear a specified specimen, the force acting substantially parallel to the major axis of the test specimen. Measured in both initiated and uninitiated modes. Obtained value is dependent on specimen geometry, rate of extension, and type of fabric reinforcement. Values are reported in force (e.g., pounds) of force per unit of thickness (e.g., pounds per inch).

Tensile strength The maximum force required to cause tension failure in a given test specimen. The obtained value is dependent on specimen geometry, rate of extrusion and property of material.. Values are reported in maximum stress (e.g., pounds per square inch) or force per unit thickness (e.g., pound per inch width).

Thermoplastic elastomers New materials that are being developed and that are probably related to elasticized polyolefins. Polymers of this type behave similarly to cross-linked rubber. They have a limited upper-temperature service range which, however, is substantially above the temperature encountered in waste disposal sites (200°F may be too high for some TPEs).

Thread count The number of threads per inch in each direction with the warp mentioned first and the fill second. A thread count of 20 X 10 means 20 threads per inch in the warp and 10 threads per inch in the fill direction.

Ultimate elongation The elongation of a stretched specimen at the time of break. Usually reported as percent of the original length. Also called *elongation at break* (synonym: *engineering strain at failure*).

Unsupported sheeting A polymeric sheeting consisting of one or more plies without a reinforcing-fabric layer or scrim.

Vacuum box A device used to asses the integrity of field seams in geomembrane installations.

Vulcanize Used to denote the product of the vulcanization of a rubber compound without reference to shape or form.

Vulcanization An irreversible process during which a rubber compound, through a change in its chemical structure (cross-linking), becomes less plastic and more resistant to swelling by organic liquids, and during which elastic properties are conferred, improved, or extended over a greater range of temperature.

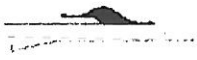
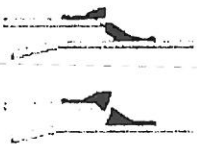
Warp In textiles, the lengthwise yarns in a woven fabric.

Water vapor transmission (WVT) Water vapor flow normal to two parallel surfaces of a material, through a unit area, under the conditions of a specified test such as ASTM E96.

APPENDIX 2
TYPICAL SEAM FAILURES

POLY-FLEX, INC.
Geomembrane Lining Systems

Locus-of-Break codes for Fillet Extrusion Weld Seams Tested for Sean Strength in Shear and Peel Modes.

Type of Break	Code	Break Description
	AD-1	Failure in adhesion. Specimens may also delaminate under the bead and break through the thin extruded material in the outer area.
	AD-2	Failure in adhesion.
	AD-WLD	Break through the fillet.
	SE-1	Break at seam edge in the bottom sheet. (Applicable to shear tests on
	SE-2	Break at seam edge in the top sheet. (Applicable to shear tests only.)
	SE-3	Break at seam edge in the bottom sheet. (Applicable to peel tests only.)
	BRK-1	Break in the bottom sheeting. A "B" in parenthesis after the code means the specimen broke in the buffed area.
	BRK-2	Break in the top sheeting. A "B" in parenthesis after the code means the specimen broke in the buffed area.
	AD-BRK	Break in the bottom sheeting after some adhesion failure between the fillet and the bottom sheet.
	HT	Break at the edge of the hot tack for specimens which could not be delaminated in the hot tack.
	SIP	Separation in the plane of the sheet.

(1) Acceptance of AD-Weld breaks depends on whether test values meet a minimum specification valu

APPENDIX 3
APPLICABLE REGULATIONS