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# Contract Documents

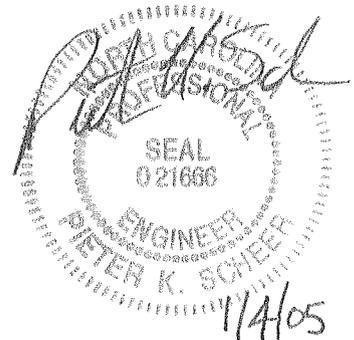
## Johnston County MSW Landfill Phase 4A - Cell 2 Construction Smithfield, North Carolina



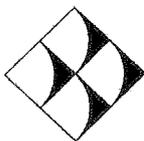
Prepared For:

**Johnston County Department of Public Utilities  
309 E. Market Street  
Smithfield, North Carolina 27577**

**CONSTRUCTION ISSUE DOCUMENTS**



Prepared By:



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November 2004

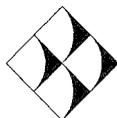
# **Technical Specifications**

## **Johnston County MSW Landfill Phase 4A - Cell 2 Construction**

Prepared for:

**Johnston County Department of Public Utilities**  
Smithfield, North Carolina

**November 2004**



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**JOHNSTON COUNTY  
JOHNSTON COUNTY MSW LANDFILL - PHASE 4A - CELL 2**

**TECHNICAL SPECIFICATIONS**

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SECTION 02110

SITE PREPARATION

Site Preparation: Site Preparation includes clearing, grubbing, and stripping operations which precede the proposed construction.

A. DESCRIPTION

1. General:

a. The Contractor shall furnish all labor, material, and equipment to complete Site Preparation in accordance with the Contract Drawings and these Specifications.

b. Principal items of work include:

1. Notifying all authorities owning utility lines running to or on the property. Protect and maintain all utility lines to remain and cap those that are not required in accordance with instructions of the Utility Companies, and all other authorities having jurisdiction.
2. Clearing the site within the clearing limits, including removal of grass, brush, shrubs, trees, loose debris, and other encumbrances except for trees to remain.
3. Boxing and protecting all areas to be preserved.
4. Removing all topsoil from designated areas and stockpiling on site where directed by the Engineer for future use.
5. Disposing from the site all debris resulting from work under this Section.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Excavation	02222
Embankment	02223

B. MATERIALS Not Used.

C. SUBMITTALS Not Used.

D. CONSTRUCTION

1. Clearing of the Site:

- a. Clearing limits, as shown on the Contract Drawings, shall be established by the Contractor's Surveyor. Once established, the clearing limits shall be inspected and approved by the Engineer prior to clearing the affected areas.
- b. Before removal of topsoil, and start of excavation and grading operations, the areas within the clearing limits shown on the Contract Drawings shall be cleared and grubbed.
- c. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, fallen timber, brush, bushes, rubbish, fencing, and other perishable and objectionable material.

Should it become necessary to remove a tree, bush, brush, or other plants outside the clearing limits, the Contractor shall do so only after permission has been granted by the Engineer.

- d. Excavation resulting from the removal of trees, roots, and the like shall be filled with suitable material, as approved by the Engineer, and thoroughly compacted per the requirements contained in Section 02223, Embankment, of these Specifications.
- e. In temporary construction easement locations, only those trees and shrubs shall be removed which are in actual interference with excavation or grading work under this Contract, and removal shall be subject to approval by the Engineer. However, the Engineer reserves the right to order additional trees and shrubs removed at no additional cost to the Owner, if such, in his opinion, they are too close to the work to be maintained or have become damaged due to the Contractor's operations.

2. Stripping and Stockpiling Existing Topsoil:

- a. Existing topsoil and sod on the site within areas designated on the Contract Drawings shall be stripped to whatever depth it may occur, and stored in locations directed by the Engineer.

- b. The topsoil shall be free of stones, roots, brush, rubbish, or other unsuitable materials before stockpiling.
  - c. Care shall be taken not to contaminate the stockpiled topsoil with any unsuitable materials.
3. Grubbing:
- a. Grubbing shall consist of the removal and disposal of all stumps, roots, logs, sticks, and other perishable materials to a depth of at least 6 inches below ground surfaces.
  - b. Large stumps located in areas to be excavated may be removed during grading operations, subject to the approval of the Engineer.
4. Disposal of Cleared and Grubbed Material:

All trees, stumps, roots, and bushes shall be disposed of by burning (Only if allowed by the Owner and local zoning) or shall be removed from the site and disposed of by the Contractor. The Contractor shall receive written authorization from the Owner prior to burning. Any material other than plant growth shall not be burned. On-site and off-site disposal areas are subject to approval by the Engineer. Ashes and residue from burning operations shall be removed from the site and disposed of by the Contractor. The Contractor shall also obtain all of the required permits for his burning operations, as applicable.

END OF SECTION

**SECTION 02140**

**DEWATERING**

Dewatering: Dewatering refers to controlling and disposing of surface and shallow ground water as is necessary for proper excavation, compaction, and other operations requiring dry conditions.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete Dewatering in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Excavation	02222
Embankment	02223

B. MATERIALS Not Used.

C. SUBMITTALS

Procedures for Dewatering proposed by the Contractor shall be submitted to the Engineer for review prior to any Dewatering operations.

D. CONSTRUCTION

1. The Contractor shall do all Dewatering as required for the completion of the work. All surface or ground water removed by Dewatering operations shall be disposed of in accordance with all applicable regulations.
2. The Dewatering system shall be of sufficient size and capacity as required to control ground water or seepage to permit proper excavation operations, embankment construction and reconstruction, subgrade preparation, and to allow concrete to be placed in a dry condition. The system shall include a sump system or other equipment, appurtenances, and other related earthwork necessary for the required control of surface water. The Contractor shall drawdown ground water

to at least 3 feet below the bottom of excavations at all times in order to maintain a dry and undisturbed condition.

3. The Contractor shall take all the steps that he considers necessary to familiarize himself with the surface and subsurface site conditions, and shall obtain the data that is required to analyze the water and soil environment at the site and to assure that the materials used for the Dewatering systems will not erode, deteriorate, or clog to the extent that the Dewatering systems will not perform properly during the period of Dewatering.
4. The Contractor shall control, by acceptable means, all water regardless of source. Water shall be controlled and its disposal provided for at each berm, structure, etc. when necessary. The entire periphery of the excavation area shall be ditched and diked to prevent surface water from entering the excavation where applicable. The Contractor shall be fully responsible for disposal of the water and shall provide all necessary means at no additional expense to the Owner. The Contractor shall be solely responsible for proper design, installation, proper operation, maintenance, and any failure of any component of the system.
5. The Contractor shall be responsible for and shall repair without cost to the Owner, any damage to work in place and the excavation, including damage to the bottom due to heave and including removal of material and pumping out of the excavated area. The Contractor shall be responsible for damages to any other area or structure caused by his failure to maintain and operate the Dewatering system proposed and installed by the Contractor.

6. Leachate Seeps:

Due to the nature of this project, the Contractor is responsible for the control of leachate seeps which develop within the Contract Limits whether created by his construction activities or not. The method(s) of control for leachate seeps shall be subject to the approval of the Owner and the Engineer.

END OF SECTION

## SECTION 02222

### EXCAVATION

Excavation: Excavation includes excavating, sealing, hauling, scraping, undercutting, removal of accumulated surface water or ground water, stockpiling, and all necessary and incidental items as required for bringing the landfill and related structures to the specified lines and grades.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment required to complete Excavation of the landfill containment area and related structures in accordance with the Contract Drawings and these Specifications, except as noted below:

- a. Clearing and grubbing and removal of topsoil is addressed in Section 02110, Site Preparation, of these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Site Preparation	02110
Dewatering	02140
Embankment	02223
Erosion and Sedimentation Control	02270
CQA Manual	Attached

##### 3. Quality Assurance:

Quality Assurance during Excavation will be provided by the Owner as described in the accompanying Project CQA Manual.

##### 4. Definitions:

- a. Excavation: shall consist of the removal and satisfactory disposal and/or stockpiling of materials located within the limits of construction including widening cuts and shaping of slopes necessary for the preparation of

roadbeds, landfill slope areas, cutting of any ditches, channels, waterways, entrances, and other work incidental thereto.

- b. Borrow: shall consist of approved on-site material required for the construction of embankments/fills or for other portions of the work.
- c. Select Borrow: shall consist of approved off-site material required for the construction of embankments/fills, roadway subgrade, backfilling, or for other portions of the work as shown on Contract Drawings or in these Specifications. The Contractor shall make his own arrangements for obtaining select borrow and pay all costs involved.
- d. Unsuitable Material: is any in-place or excavated material which contains undesirable materials, or is in a state which is not appropriate; in the opinion of the CQA Engineer, for the intended use or support of planned structures, embankment, or excavation. This may include but not be limited to organic material, waste/refuse, soft, or wet material not meeting required specifications, etc.
- e. Unsuitable Materials Excavation (Overexcavation): shall consist of the removal and satisfactory disposal of all unsuitable material located within the limits of construction. Where excavation to the finished grade section shown results in a subgrade or slopes of unsuitable material, the Contractor shall overexcavate such material to below the grade shown on the Contract Drawings or as directed by the Engineer and CQA Engineer.

## B. MATERIALS

Excavation shall include the removal of all soil, weathered rock, boulders, conduits, pipe, and all other obstacles encountered and shown on the Contract Drawings or specified herein.

## C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer before approval is given to proceed:

- 1. Plans of open cut excavations showing side slopes and limits of the excavation at grade.
- 2. List of disposal site(s) for waste and unsuitable materials.
- 3. Descriptive information on Excavation equipment to be used.

D. CONSTRUCTION

1. The Contractor shall conduct Excavation activities in such a manner that erosion of disturbed areas and off site sedimentation is absolutely minimized as outlined in Section 02270, Erosion and Sedimentation Control, of these Specifications.
2. The Contractor shall excavate to the lines and grades shown on the Contract Drawings and stockpile all suitable excavated materials. As the excavation is made, the materials will be examined and identified to the CQA Engineer.

The Contractor will perform all surveys necessary to establish and verify lines and grades for all Excavation, including pipe excavations, soil overexcavation, and anchor trenches.

3. Stockpiling:

The Contractor shall stockpile the materials in appropriate stockpiles as approved by the CQA Engineer.

Stockpiles shall be properly sloped and the surfaces sealed by the Contractor at the end of each working day, or during the day in the event of heavy rain, to the satisfaction of the Engineer.

4. The Contractor shall protect all existing facilities and structures including, but not limited to, existing utilities, monitoring wells, signs, grade stakes, etc. during the grading and stockpiling operations.
5. All excavations shall be made in the dry and in such a manner and to such widths as will give ample room for properly constructing and inspecting the structures and/or piping they are to contain and for such sheeting, timbering, pumping, and drainage as may be required.
6. The Contractor shall be responsible for Dewatering as described in Section 02140, Dewatering, of these Specifications, when necessary.
7. Excavation slopes shall be flat enough to avoid sloughs and slides that will cause disturbance of the subgrade or damage of adjacent areas. Slides and overbreaks which occur due to negligence, carelessness, or improper construction techniques on the part of the Contractor shall be removed and disposed of by the Contractor as directed by the Engineer at no additional cost to the Owner.
8. The intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, shall be uniformly rounded. All protruding roots and other vegetation shall be removed from slopes.

9. The bottom of all excavations for structures and pipes shall be examined by the CQA Engineer for bearing value and the presence of unsuitable material. If, in the opinion of the CQA Engineer, additional Excavation is required due to the low bearing value of the subgrade material, or if the in-place materials are soft, yielding, pumping and wet, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted structural fill, or material directed by the CQA Engineer. No payment will be made for subgrade disturbance caused by inadequate Dewatering or improper construction methods.
10. Any areas excavated below design subgrade elevations by the Contractor, unless directed by the CQA Engineer, shall be brought back to design elevations at no cost to the Owner. The Contractor shall place and compact such material in accordance with Section 02223, Embankment, of these Specifications.
11. The Contractor shall dispose of excess or unsuitable excavation materials on-site at location(s) approved by the Owner.
12. The Contractor shall properly level-off bottoms of all excavations. Proof-rolling shall be conducted with appropriate equipment.
13. Upon reaching subgrade elevations shown in excavation areas, the Contractor shall scarify subgrade soils to a minimum depth of 6" and obtain the CQA Engineer's approval of quality. If unsuitable materials are encountered at the subgrade elevation, perform additional excavations as approved by the CQA Engineer to remove unsuitable materials.
14. Overexcavation and Backfill:

Where subgrade materials are determined to be unsuitable, such materials shall be removed by the Contractor to the lengths, widths and depths approved by the CQA Engineer and backfilled with suitable material in accordance with Section 02223, Embankment, of these Specifications unless further excavation or earthwork is required. No additional payment will be made for such excavation and backfill 1 foot or less than the finished subgrade. Unsuitable material excavation greater than 1 foot beneath the finished subgrade shall be made on a unit price basis for excavation and backfill, only as approved by the Engineer and CQA Engineer prior to the work. Unit price for overexcavation and backfill greater than 1 foot in depth shall include disposal of unsuitable materials.
15. All cuts shall be brought to the grade and cross section shown on the Contract Drawings, or established by the Engineer, prior to final inspection.
16. The Contractor shall protect finished lines and grades of completed excavation against excessive erosion, damage from trafficking, or other causes and shall repair any damage at no additional cost to the Owner.

17. Trench Excavation:

- a. All pipe Excavation and trenching shall be done in strict accordance with these Specifications, all applicable parts of the OSHA Regulations, 29 CFR 1926, Subpart P, and other applicable regulations. In the event of any conflicts in this information, safe working conditions as established by the appropriate OSHA guidelines shall govern.
- b. The minimum trench widths shall be as indicated on the Contract Drawings. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be limited to the maximum dimensions shown on the Contract Drawings, except where a wider trench is needed for the installation of and work within sheeting and bracing.
- c. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.
- d. Hand excavation shall be employed wherever, in the opinion of the Engineer, it is necessary for the protection of existing utilities, poles, trees, pavements, obstructions, or structures.
- e. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the Engineer and, in general, such length shall be limited to approximately one hundred (100) feet.
- f. Pipe Bedding: All pipe bedding shall be as shown on the Contract Drawings, unless otherwise specified herein.

18. Sheeting and Bracing:

- a. The Contractor shall furnish, place, and maintain such sheeting and bracing which may be required to support sides of Excavation or to protect pipes and structures from possible damage and to provide safe working conditions in accordance with current OSHA requirements. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the sole expense of the Contractor. The Contractor shall be responsible for the adequacy of all sheeting and bracing used and for all damage resulting from sheeting and bracing failure or from placing, maintaining, and removing it.

- b. The Contractor shall exercise caution in the installation and removal of sheeting to insure that excessive or unusual loadings are not transmitted to any new or existing structure. The Contractor shall promptly repair at his expense any and all damage that can be reasonably attributed to sheeting installation or removal.
  - c. All sheeting and bracing shall be removed upon completion of the work.
19. If grading operations are suspended for any reason whatsoever, partially completed cut and fill slopes shall be brought to the required slope and the work of seeding and mulching or other required erosion and sedimentation control operations shall be performed at the Contractor's sole expense.

END OF SECTION

## SECTION 02223

### EMBANKMENT

Embankment: Embankment is the on-site compacted fill that provides the foundation and the berms for the containment area, the subgrade for some access roadways and structures, and backfill around structures and piping.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete Embankment including borrowing, hauling, screening, discing, drying, compaction, control of surface and subsurface water, final grading, sealing, and all necessary and incidental items as detailed or required to complete the Embankment, all in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Dewatering	02140
Excavation	02222
Erosion and Sedimentation Control	02270
CQA Manual	Attached

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these Specifications.

ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft <sup>3</sup> ).
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
ASTM D 2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

ASTM D 2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D 2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
ASTM D 2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 2937	Standard Test Method for Density of Soil in Place by the Drive Cylinder Method.
ASTM D 3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
ASTM D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
ASTM D 4959	Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.

4. Quality Assurance:

Quality Assurance during placement of Embankment will be provided by the Owner as described in the accompanying Project CQA Manual.

5. Definitions:

- a. Embankment: Shall include construction of all site earthwork including roadways, subgrade, perimeter berm embankments, including preparation of the areas upon which materials are to be placed. Embankment may also be referred to as structural and/or controlled fill. All Embankment materials may be either (off-site) Select Borrow or (on-site) Borrow unless otherwise noted on Contract Drawings or specified by the Engineer.
- b. Prepared Subgrade: The ground surface after clearing, grubbing, stripping, excavation, scarification, and/or compaction, and/or proof rolling to the satisfaction of the CQA Engineer.
- c. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters. Well-graded is used to define a material type that,

when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

- d. Unclassified Fill: The nature of materials to be used is not identified or described herein but must be approved by the Engineer prior to use.

## B. MATERIALS

1. Embankment materials shall consist of clean well-graded natural soil classified as SM, SP, SC, ML, MH, CL-ML, CL or CH (ASTM D 2488) containing no topsoil or other deleterious material. Other material classifications may be approved by the Engineer.
2. Stones or rock fragments shall not exceed one half the maximum lift thickness as compacted in any dimension.

## C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer before approval is given to proceed:

1. Descriptive information on compaction equipment to be used for construction of Embankment and appurtenant structures.
2. Descriptive information on the location and source of any off-site borrow material to be used for Embankment, where applicable. Information shall include Standard Proctor curves (ASTM D698) for each borrow material.

## D. CONSTRUCTION

1. The Contractor shall conduct Embankment activities in such a manner that erosion of disturbed areas and off-site sedimentation is absolutely minimized as outlined in Section 02270, Erosion and Sedimentation Control, of these Specifications.
2. All placement and compaction of Embankment shall be performed only when the CQA Engineer is informed by the Contractor of intent to perform such work.
3. Embankment shall be placed and compacted to the lines and grades shown on the Contract Drawings. Placement of Embankment outside the construction limits shall occur only as directed and approved by the Engineer.

The Contractor will perform all surveys necessary to establish and verify lines and grades for all Embankment.

4. The Contractor shall protect all existing facilities including, but not limited to, utilities and monitoring wells.
5. Subgrade Preparation:
  - a. The CQA Engineer shall inspect the exposed subgrade prior to placement of Embankment to assure that all rocks, topsoil, vegetation, roots, debris, or other deleterious materials have been removed.
  - b. Prior to placement of Embankment, the exposed subgrade shall be proofrolled using a static smooth-drum roller, loaded tandem axle dump truck, or other suitable equipment in the presence of the CQA Engineer. Any soft or unsuitable materials revealed before or during the in-place compaction shall be removed as directed by the CQA Engineer and replaced with suitable Embankment.
6. Surfaces on which Embankment is to be placed, shall be scarified or stepped in a manner which will permit bonding of the Embankment with the existing surface.
7. The Contractor shall be responsible for preparing the materials for the Embankment, including but not limited to, in-place drying or wetting of the soil necessary to achieve the compaction criteria of these Specifications.
8. The Contractor shall be responsible for Dewatering as described in Section 02140, Dewatering, of these Specifications, when necessary.
9. Embankment materials shall be placed in a manner permitting drainage and in continuous, approximately horizontal layers.
10. Compaction Requirements:
  - a. The Contractor shall compact Embankment in accordance with the requirements shown in Table 1 of this section. If Embankment does not meet the specified requirements, the Contractor shall rework the material, as may be necessary and continue compaction to achieve these requirements, or remove and replace the material to achieve the specified requirements, at Contractor's expense.
  - b. Each lift shall be compacted prior to placement of succeeding lifts. In confined areas, mechanical equipment, suitable for small areas and capable of achieving the density requirements, shall be required.
  - c. Lift compaction shall be performed with an appropriately heavy, properly ballasted, penetrating-foot or smooth-drum vibratory compactor depending

on soil type. Compaction equipment shall be subject to approval by the CQA Engineer.

11. Embankment that becomes excessively eroded, soft, or otherwise unsuitable shall be removed or repaired by the Contractor as directed by the CQA Engineer, at no cost to the Owner.
12. The exposed surface of Embankment shall be rolled with a smooth-drum roller at the end of each work day to protect from adverse weather conditions.
13. Where Embankment is to be placed and compacted on slopes that are steeper than 3:1, the subgrade shall be benched to a minimum depth of 6 inches and the Embankment shall be placed in horizontal lifts.
14. Backfilling for Structures and Piping:
  - a. All structures, including manholes and pipes shall be backfilled with Embankment as shown in the Contract Drawings and as described in these Specifications.
  - b. Where sheeting is used, the Contractor shall take all reasonable measures to prevent loss of support beneath and adjacent to pipes and existing structures when sheeting is removed. If significant volumes of soil cannot be prevented from clinging to the extracted sheets, the voids shall be continuously backfilled as rapidly as possible. The Contractor shall thereafter limit the depth below subgrade that sheeting will be driven in similar soil conditions or employ other appropriate means to prevent loss of support.
  - c. When backfilling around structures, do not backfill until concrete has sufficiently cured (as determined by the CQA Engineer) and is properly supported. Place backfill in a manner to avoid displacement or damage of structures.

**TABLE 1: REQUIRED EMBANKMENT PROPERTIES**

ITEM	Required % Standard Proctor (ASTM D698) <sup>2</sup>	Required Moisture Content (ASTM D 3017) <sup>3</sup>	Maximum Lift Thickness (Compacted) (inches)
Embankment	95	± 4% of Optimum Moisture Content	8
Embankment Beneath Structures and Roads <sup>1</sup>	98		8
Backfill Around Structures	95		8
Backfill in Pipe Trenches	95		6
Unclassified Fill	N/A	N/A	N/A

Notes:

1. Embankment beneath structures shall be considered to include a zone 10 feet out from the foundation of the structure extending down to the natural ground on a 45° slope. Embankment beneath roads shall be considered to include all embankment placed within 2 vertical feet of the final wearing surface and shall also include shoulders.
2. Determine field density using ASTM D 2922, ASTM D 1556, ASTM D 2167, or ASTM D 2937.
3. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959.
4. The Engineer may allow exceptions to the above criteria for areas outside of the containment area which are not subject to significant long-term loads.

END OF SECTION

**SECTION 02240**

**GEOTEXTILES**

Geotextiles: For the proposed construction, a Type GT-S (Separator/Filter) Geotextile is specified. The Type GT-S Geotextile will be placed in the landfill gas system, leachate collection system, as a component of the Drainage Geocomposite, and in some erosion control and drainage applications.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of Geotextiles including all necessary and incidental items as detailed or required for the Contractor to complete the installation in accordance with the Contract Drawings and these Specifications, except as noted below:

- a. Geotextiles used as a Silt Fence is covered under Section 02270, Erosion and Sedimentation Control, of these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Erosion and Sedimentation Control	02270
Drainage Aggregate (Leachate Management)	02710
Drainage Geocomposite	02712
Landfill Gas System	13255
CQA Manual	Attached

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) and the American Association of State Highway and Transportation Officials (AASHTO) are hereby made a part of these specifications.

ASTM D 3786	Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.
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ASTM D 4355	Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
AASHTO M 288	Standard Specification for Geotextiles.

4. Quality Assurance:

Quality Assurance during installation of Geotextiles will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. General:

The materials supplied under these Specifications 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 use, to be suitable and durable for such purposes.

Labels on each roll of Geotextile shall identify the length, width, lot and roll numbers, and name of Manufacturer.

2. The Type GT-S Geotextile shall be a woven, nonwoven spunbonded, or nonwoven needlepunched synthetic fabric consisting of polyester or polypropylene manufactured in a manner approved by the Engineer. Note that

Type GT-S Geotextile used as a component of the Drainage Geocomposite shall be a nonwoven fabric.

3. All Geotextiles shall conform to the properties listed in Table 1 of this section.

#### C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for each type of Geotextile attesting that the Geotextiles meet the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of each Geotextile to be used. The samples shall be labeled with the product name and be accompanied by the Manufacturer's specifications.
2. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.
3. Seaming Procedures:  
  
Submit proposed seaming procedures including proposed method and equipment.
4. Quality Control Certificates: For Geotextiles delivered to the site, quality control certificates, signed by the Manufacturer's quality assurance manager shall be provided which represent every roll of each type of Geotextile supplied. Each certificate shall have the roll identification number(s), test methods, frequency, and test results. At a minimum, the test results and frequency of testing shall be as shown in Table 2 of this section.
5. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

#### D. CONSTRUCTION

1. Shipping, Handling, and Storage:  
  
All Geotextiles shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.
2. Failing CQA Material Control Tests:  
  
Geotextiles that are rejected upon testing shall be removed from the project site and replaced at Contractor's cost. Sampling and CQA testing of Geotextiles

supplied as replacement for rejected material shall be performed by the CQA Engineer at Contractor's cost.

3. Installation:

- a. The surface receiving the Geotextiles shall be prepared to a relatively smooth condition, free of obstructions, standing water, excessive depressions, debris, and very soft, excessively wet, and/or loose pockets of soil. This surface shall be approved by the CQA Engineer prior to Geotextile placement.
- b. Geotextiles shall be placed to the lines and grades shown on the Contract Drawings. At the time of installation, Geotextiles shall be rejected by the CQA Engineer if they have defects, rips, holes, flaws, evidence of deterioration, or other damage.
- c. The Geotextiles shall be placed smooth and free of excessive wrinkles.
- d. On slopes, Geotextiles shall be anchored at the top and unrolled down the slope. In the presence of wind, all Geotextiles shall be weighted with sandbags or other material as approved by the CQA Engineer. Geotextiles uplifted by wind may be reused upon approval by the CQA Engineer.

4. Seams:

- a. All Geotextile seams shall be continuously sewn or heat bonded with methods approved by the Engineer. Overlapping of seams may also be allowed if approved in advance by the Engineer. All seams must be approved by the CQA Engineer.
- b. On slopes greater than 10 percent, all seams shall be oriented parallel to (in the direction of) the slope unless otherwise approved by the Engineer.
- c. Seams to be sewn shall be sewn using a Type 401 stitch. One or two rows of stitching may be used. Each row of stitching shall consist of 4 to 7 stitches per inch. The minimum distance from the geotextile edge to the stitch line nearest to that edge (seam allowance) shall be 1.5 inches if a Type SSa (prayer or flat) seam is used. The minimum seam allowance for all other seam types shall be 1.0 inches.
- d. Seams to be heat bonded shall be bonded using hot plate, hot knife, ultrasonic, or other approved devices.

5. Repair Procedures:

- a. Any Geotextile that is torn, punctured, or otherwise damaged shall be repaired or replaced, as directed by the CQA Engineer, by the Contractor at no additional cost to the Owner. The repair shall consist of a patch of the same type of Geotextile placed over the failed areas and shall overlap the existing Geotextile a minimum of 18 inches from any point of the rupture. Patches shall be spot sewn or heat bonded so as not to shift during cover placement.
- b. Slopes Less Than or Equal to 10 Percent: Damaged areas of a size exceeding 10 percent of the roll width shall be removed and replaced across the entire roll width with new material. Damaged areas of a size less than 10 percent of the roll width may be patched.
- c. Slopes Greater Than 10 Percent: Geotextile panels which require repair shall be removed and replaced with new material. Replacement material shall be sewn as previously described in this specification.

6. Cover Placement:

Placement of cover over Geotextiles shall be performed in a manner as to ensure that the Geotextiles or underlying materials are not damaged. Cover material shall be placed such that excess tensile stress is not mobilized in the Geotextile.

**TABLE 1: REQUIRED GEOTEXTILE PROPERTIES**

PROPERTY	TEST METHOD	UNITS	VALUE <sup>1</sup>
			TYPE GT-S
Geotextile Construction (NW = Nonwoven) (W = Woven)	-----	-----	NW <sup>2</sup> or W <sup>3</sup> NW <sup>2</sup> (See Note 5)
Mass per Unit Area (Unit Weight)	ASTM D 5261	oz/yd <sup>2</sup>	N/A 6 (See Note 5)
Ultraviolet Resistance (500 hrs)	ASTM D 4355	%	70
Strength Class <sup>4</sup>	AASHTO M 288	Class	2
Grab Tensile Strength	ASTM D 4632	lbs	160 (NW) 250 (W)
Grab Tensile Elongation	ASTM D 4632	%	≥ 50 (NW) < 50 (W)
Puncture Resistance	ASTM D 4833	lbs	55 (NW) 90 (W)
Trapezoidal Tear Strength	ASTM D 4533	lbs	55 (NW) 90 (W)
Burst Strength	ASTM D 3786	psi	200 (NW) 400 (W)
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Sieve	70+
Permittivity	ASTM D 4491	sec <sup>-1</sup>	1.0

Notes:

1. Minimum Average Roll Value (MARV).
2. Nonwoven geotextiles that have been heat calendered are not acceptable, unless approved by the Engineer in advance.
3. Woven geotextiles formed exclusively with slit film fibers are not acceptable.
4. AASHTO M 288 criteria includes the above listed requirements for: Grab Tensile Strength, Grab Tensile Elongation, Puncture Resistance, Trapezoidal Tear Strength, and Burst Strength.
5. Required for Drainage Geocomposite.

**TABLE 2: REQUIRED MANUFACTURER'S QUALITY CONTROL TEST DATA**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>MINIMUM TEST FREQUENCY</b>
Mass per Unit Area (Unit Weight)	ASTM D 5261	200,000 ft <sup>2</sup>
Ultraviolet Resistance (500 hrs)	ASTM D 4355	Periodic
Grab Tensile Strength	ASTM D 4632	200,000 ft <sup>2</sup>
Grab Tensile Elongation	ASTM D 4632	200,000 ft <sup>2</sup>
Burst Strength (Diaphragm Methods)	ASTM D 3786	200,000 ft <sup>2</sup>
Apparent Opening Size (AOS)	ASTM D 4751	Periodic
Permittivity	ASTM D 4491	Periodic
Puncture Resistance	ASTM D 4833	200,000 ft <sup>2</sup>
Trapezoidal Tear Strength	ASTM D 4533	200,000 ft <sup>2</sup>

END OF SECTION

## SECTION 02256

### PROTECTIVE COVER

Protective Cover: The Protective Cover consists of clean fill material. The Protective Cover protects the leachate collection layer and Geomembrane from damage due to the placement of waste.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of the Protective Cover, including borrowing, hauling, screening, removal of surface water and removal of all previously placed material that is unsuitable due to weather conditions, final grading and sealing, and all necessary and incidental items as detailed or required to complete the Protective Cover, all in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Geotextiles	02240
HDPE Pipe	02614
Drainage Aggregate (Leachate Management)	02710
Drainage Geocomposite	02712
HDPE Geomembrane	02775
CQA Manual	Attached

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these Specifications.

ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft <sup>3</sup> ).
ASTM D 2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

4. Quality Assurance:

Quality Assurance during placement of Protective Cover will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. Soil that meets all of the following requirements shall be classified as select soil fill for use in construction of the Protective Cover.
  - a. Soil shall be classified according to the Unified Soil Classification System (USCS) as SW, SP, SM, SM-SC, or SC (ASTM D 2488). Other material classifications may be approved by the Engineer.
  - b. Select soil fill materials shall be reasonably free of gypsum, ferrous, and/or calcareous concretions and nodules, refuse, roots, or other deleterious substances.
  - c. The soil cover shall be uniform, smooth, and free of debris, plant materials, and other foreign material. The maximum rock size shall be 3 inches in diameter. The material should contain no sharp edges.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Before approval is given to proceed, the Contractor shall submit descriptive information on equipment to be used in construction of the Protective Cover.
2. Survey Results:

After completion of a segment of Protective Cover, survey results shall be submitted for review prior to Protective Cover acceptance.

D. CONSTRUCTION

1. The Protective Cover is placed directly over geosynthetics and/or piping; thus, extreme caution shall be exercised by the Contractor to prevent damage to these materials.
2. All placement and compaction of Protective Cover shall be performed only when the CQA Engineer is informed by the Contractor of intent to perform such work.

3. Protective Cover shall be placed over geosynthetics only after areas have been released by the Geosynthetics Installer and the CQA Engineer. Protective Cover shall be placed as specified below:
  - a. Protective Cover shall be placed and spread using tracked equipment. On slopes  $\geq$  6H:1V, low ground pressure (6 psi or less) tracked equipment shall be used. On slopes  $<$  6H:1V, tracked equipment shall have a ground pressure of 12 psi or less. The CQA Engineer shall approve the equipment used to place Protective Cover.
  - b. Tracked equipment used to place and spread Protective Cover shall operate on at least 1 foot of material overlying geosynthetics and/or piping. Sharp turning of tracked equipment on the Protective Cover will not be permitted.
  - c. On slopes  $\geq$  6H:1V, Protective Cover shall be placed and spread from the bottom up unless otherwise approved by the Engineer. No material shall be dumped down a slope.
  - d. Protective Cover shall be placed and compacted to the lines and grades shown on the Contract Drawings with the exception that a 0.15 foot overbuild at Contractor's expense is allowed. The Contractor will perform all surveys necessary to establish and verify lines and grades for all Protective Cover.
  - e. Protective Cover shall be compacted by tracking the final lift with tracked equipment.
4. The Protective Cover shall be spread in a manner that minimizes development of wrinkles or tension in the underlying geosynthetics. Any portion of the underlying geosynthetics that develops excessive wrinkles or crimp or is otherwise damaged shall be repaired by the Geosynthetics Installer at no expense to the Owner.
  - a. Protective Cover shall be placed before noon or at other times when the ambient air temperature is not more than 75°F to minimize wrinkling of underlying geosynthetics unless otherwise approved by the Engineer. Likewise, Protective Cover shall not be placed when conditions are cold enough to produce tension in the underlying geosynthetics.
  - b. If during spreading, excessive wrinkles develop, the Contractor shall adjust placement and spreading methods, or cease until the underlying geosynthetics cool and wrinkles decrease in size.

- c. Wrinkles that exceed approximately 6 inches in height and cannot be eliminated by amended placement and spreading methods or underlying geosynthetics that become crimped shall be cut and repaired by the Geosynthetics Installer in a method approved by the Engineer.
5. Stockpiling of Protective Cover within the limits of the containment area shall be subject to advance approval by the Engineer. Any hauling equipment (dump trucks, etc.) operating over geosynthetics shall have a minimum of 3 feet of separation between the vehicle wheels and the Geomembrane.
6. Protective Cover shall not be placed over the gravel columns without a protective geotextile or other approved means.

The Contractor shall minimize equipment operations directly over coarse aggregate.

7. The CQA Engineer may require removal of Protective Cover and/or other underlying layers at the Contractor's sole expense to allow examination of the underlying geosynthetics and/or piping. Any damage to underlying layers or excessive wrinkling or crimping during placement or compaction of the Protective Cover shall be repaired in accordance with the applicable section of these Specifications at the Contractor's sole expense.
8. Surveying:

After completion of a segment of Protective Cover, the Protective Cover shall be surveyed on 100 foot centers and at slope breaks (including all tops and toes of slope, points of grade change, etc.) to ensure:

- a. The specified thickness has been achieved.
- b. The top of the Protective Cover slopes at grades specified on the Contract Drawings; and
- c. Protective Cover placed more than 0.15 feet beyond the limits of the lines and grades as shown on the Contract Drawings will not be accepted and must be removed at the Contractor's expense if required by the Engineer.

This work shall be performed at the Contractor's cost by a surveyor registered in the State of North Carolina.

END OF SECTION

## SECTION 02270

### EROSION AND SEDIMENTATION CONTROL

Erosion and Sedimentation Control: Erosion and Sedimentation Control is a system of construction practices and engineered structures which act to minimize surface water induced erosion of disturbed areas and resulting sedimentation off-site.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of and maintain Erosion and Sedimentation Control facilities and other construction in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Geotextiles	02240
Rip Rap	02271
Rolled Erosion Control Products	02275
HDPE Pipe	02614
LLDPE Geomembrane	02778
Revegetation	02930

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 3786      Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.

ASTM D 4355      Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).

ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

B. MATERIALS

1. Permanent Ditches, Swales, and Drainage Channels:

Permanent ditches, swales, and drainage channels shall be constructed as shown on the Contract Drawings.

2. Down Chutes:

Down chutes shall be constructed as shown on the Contract Drawings. The LLDPE Geomembrane shall be installed in accordance with Section 02778, LLDPE Geomembrane, of these Specifications with the exception that the Engineer, in his discretion, may allow off-spec materials to be used and may relax some specification criteria.

3. Geotextiles:

Geotextiles shall conform to the requirements of Section 02240, Geotextiles, of these Specifications.

4. Geosynthetic Clay Liner:

Geosynthetic Clay Liner shall conform to the requirements of Section 02776, GCL, of these Specifications.

5. Rip Rap:

Rip Rap shall conform to the requirements of Section 02271, Rip Rap, of these Specifications.

6. Rolled Erosion Control Products (RECPs):

Rolled Erosion Control Products (RECPs) shall conform to the requirements of Section 02275, Rolled Erosion Control Products, of these Specifications.

7. Other Work:

In addition to the erosion control measures shown on the Contract Drawings, the Contractor shall provide adequate means to prevent any sediment from entering any storm drains, drop inlets, ditches, streams, or bodies of water downstream of any area disturbed by construction. Excavation materials shall be placed upstream of any trench or other excavation to prevent sedimentation of off-site areas. In areas where a natural buffer area exists between the work area and the closest stream or water course, this area shall not be disturbed. All paved areas shall be scraped and swept as necessary to prevent the accumulation of dirt and debris. Work associated with this provision shall be considered incidental to the project and no separate payment will be made.

8. Temporary and Permanent Ground Cover:

The Contractor shall provide temporary or permanent ground cover adequate to restrain erosion on erodible slopes or other areas within 15 working days or 30 calendar days (whichever is shorter) following completion of any phase of grading.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all Erosion and Sedimentation Control materials manufactured for the project have been produced in accordance with these Specifications.
2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. Establishment of Erosion Control Devices:

- a. All erosion control structures will be constructed according to the Contract Drawings and these Specifications.

- b. Due to the nature of the work required by this Contract, it is anticipated that the location and nature of the erosion control devices may need to be adjusted on several occasions to reflect the current phase of construction.
- c. Erosion control devices shall be established prior to the work in a given area. Where such practice is not feasible, the erosion control device(s) shall be established immediately following completion of the clearing operation.
- d. The construction schedule adopted by the Contractor will impact the placement and need for specific devices required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and off-site sedimentation.
- e. The location and extent of erosion control devices shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from construction areas. All deviations from the control provisions shown on the Contract Drawings shall have the prior approval of the Engineer.

2. Maintenance of Erosion Control Devices:

- a. The Contractor shall furnish the labor, material, and equipment required for maintenance of all erosion control devices. Maintenance shall be scheduled as required for a particular device to maintain the removal efficiency and intent of the device.
- b. All erosion control devices shall be inspected immediately after each significant rainfall event, and appropriate maintenance conducted.
- c. Maintenance shall include, but not be limited to:
  - (1) The removal and satisfactory disposal of trapped or deposited sediments from basins, traps, barriers, filters, and/or drainage features/devices;
  - (2) Replacement of filter fabrics used for silt fences upon loss of specified efficiency; and
  - (3) Replacement of any other components which are damaged or cannot serve the intended use.
- d. The Contractor shall accept and maintain any existing sediments that are included in existing sediment traps or sediment basins that accept or will

accept stormwater flow and or silt accumulation from all areas within the Contractor's limits of construction.

- e. Sediments removed from erosion control devices shall be disposed of in locations that will not result in off-site sedimentation as approved by the Engineer.
- f. All erosion control structures shall be maintained to the satisfaction of the Engineer until the site has been stabilized.

3. Finish Grading:

All disturbed areas outside of the containment area shall be uniformly graded to the lines, grades, and elevations shown on the Contract Drawings. Finished surfaces shall be reasonably smooth, compacted, and free from irregular surface changes. Unless otherwise specified, the degree of finish shall be that ordinarily obtainable from either blade or scraper operations. Areas shall be finished to a smoothness suitable for application of topsoil.

4. Seeding:

Seeding shall conform to the requirements of Section 02930, Revegetation, of these Specifications.

5. Cleanup:

- a. The Contractor shall remove from the site all subsoil excavated from his work and all other debris including, but not limited to, branches, paper, and rubbish in all landscape areas, and remove temporary barricades as the work proceeds.
- b. All areas shall be kept in a neat, orderly condition at all times. Prior to final acceptance, the Contractor shall clean up the entire landscaped area to the satisfaction of the Engineer.

END OF SECTION

## SECTION 02271

### RIP RAP

Rip Rap: This section includes all rip rap aprons and channel protection.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of Rip Rap for protection of earthen slopes against erosion as indicated, including all necessary and incidental items, in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Geotextiles	02240
Erosion and Sedimentation Control	02270
Geosynthetic Clay Liner	02776

##### 3. Reference Standards:

The latest revision of the following standards of the North Carolina Department of Transportation (NCDOT) are hereby made a part of these Specifications.

NCDOT                      Standard Specifications for Roads and Structures.

#### B. MATERIALS

1. Rip Rap: Rip Rap shall be of the size indicated on the Contract Drawings and shall conform to NCDOT Section 1042, Rip Rap Materials.

2. Geotextiles: Geotextiles shall conform to the requirements outlined in Section 02240, Geotextiles, of these Specifications.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Submit a certification and summary of all required test results prior to installation, that all Rip Rap has been produced in accordance with these Specifications.
2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. Surface Preparation:

- a. Trim and dress all areas to conform to the Contract Drawings as indicated with tolerance of 2 inches from theoretical slope lines and grades.
- b. Bring areas that are below allowable minimum tolerance limit to grade by filling with compacted Embankment material similar to adjacent material.
- c. Geotextiles shall be placed as shown on the Contract Drawings and in accordance with Section 02240, Geotextiles, of these Specifications.
- d. Geosynthetic Clay Liner shall be placed as shown on the Contract Drawings and in accordance with Section 02776, Geosynthetic Clay Liner, of these Specifications.
- e. Do not place any stone material on the prepared surface prior to inspection and approval to proceed from the Engineer.

2. Placing Rip Rap:

Rip Rap shall be placed in accordance with NCDOT Section 868, Rip Rap.

END OF SECTION

## SECTION 02275

### ROLLED EROSION CONTROL PRODUCTS

Rolled Erosion Control Products: Rolled Erosion Control Products (RECPs) include erosion control blankets (ECB) placed on the perimeter berm and turf reinforcement matting (TRM) placed along diversion berms.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of all RECPs in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Erosion and Sedimentation Control	02270
Revegetation	02930

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 1777	Standard Test Method for Thickness of Textile Materials.
ASTM D 4355	Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
ASTM D 5035	Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method).

**B. MATERIALS****1. General:**

The materials supplied under these Specifications 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 use, to be suitable and durable for such purposes.

Labels on each RECP shall identify the length, width, product name, and name of Manufacturer.

**2. Erosion Control Blanket (ECB) (Double Net):**

ECB (double net) shall consist of a machine-produced mat of straw or wood excelsior fiber covered on the top and bottom sides with photodegradable extruded plastic or woven biodegradable nettings. ECB (double net) shall also conform to the properties listed in Table 1 of this section. ECB (double net) shall be S150, as manufactured by North American Green, CURLEX II, as manufactured by American Excelsior Company, or approved equal.

**3. Turf Reinforcement Matting (TRM):**

TRM shall consist of a machine-produced mat of mechanically or melt-bonded polymer nettings, monofilaments, or fibers entangled to form a strong, dimensionally stable, three dimensional permanent vegetation reinforcement structure. The mat shall be crush-resistant, pliable, water-permeable, and highly resistant to chemical and environmental degradation. TRM shall also conform to the properties listed in Table 1 of this section. TRM shall be LANDLOK TRM 435, as manufactured by Synthetic Industries, or approved equal.

**4. anchors: Anchors for RECPs shall consist of machine made staples of No. 8 gage new steel wire formed into a "U" shape. The size when formed shall be not less than 8 inches in length with a throat of not less than 1 inch in width. Longer anchors may be required for loose soils. Other anchors, such as metal pins or plastic pegs, may also be used if approved in advance by the Engineer.****C. SUBMITTALS**

The Contractor shall submit the following to the Engineer:

1. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for each RECP attesting that each RECP meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of each RECP to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.
2. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.
3. Installation Guidelines/Instructions: The Manufacturer's guidelines for installation shall be submitted for review.
4. Furnish copies of delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

All RECPs shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. Installation - General:

- a. Placing of RECPs shall be done immediately following seeding. Seeding shall be performed in accordance with Section 02930, Revegetation, of these Specifications.
- b. RECPs shall be placed to the lines and grades shown on the Contract Drawings. The earth surface shall be smooth and free from stones, clods, or debris which will prevent the contact of the RECP with the soil. Care shall be taken to preserve the required line, grade, and cross section of the area.
- c. RECPs shall be unrolled in the direction of the flow of water and shall be applied without stretching so that it will lie smoothly but loosely on the soil surface.
- d. At the time of installation, RECPs shall be rejected, if they have defects, rips, holes, flaws, evidence of deterioration, or other damage.
- e. The Engineer may require adjustments in the installation requirements to fit individual conditions.

3. Installation - Channels/Diversion Berms:

RECPs installed in channels or diversion berms shall be unrolled parallel to the direction of water flow. The first roll shall be centered longitudinally in the channel and anchored with staples. Subsequent rolls shall be installed outward to the edges of the channel or diversion berm and be lapped to allow installation of a common row of anchors. RECP ends shall be overlapped with the upstream ends on top ("shingled"). Refer to the Manufacturer's installation guidelines for installation details.

4. Installation - Slopes:

RECPs installed on slopes shall be oriented in vertical strips and anchored. Subsequent rolls shall be installed outward to the edge(s) of the original roll and be lapped to allow installation of a common row of anchors. RECP ends shall be shingled. Refer to the Manufacturer's installation guidelines for installation details.

5. Maintenance:

Maintenance of RECPs shall be in accordance with Section 02270, Erosion and Sedimentation Control, of these Specifications.

**TABLE 1: REQUIRED ROLLED EROSION CONTROL PRODUCT PROPERTIES**

PROPERTY	TEST METHOD	UNITS	VALUE <sup>1</sup>
<b>Erosion Control Blanket (ECB) (Double Net)</b>			
Mass per Unit Area (Unit Weight)	ASTM D 5261	lbs/yd <sup>2</sup>	0.5 ± 10% (Straw) 0.8 ± 10% (Excelsior)
Maximum Permissible Shear Stress (Un-Vegetated)	-----	lb/ft <sup>2</sup>	1.65
<b>Turf Reinforcement Matting (TRM)</b>			
Mass per Unit Area (Unit Weight)	ASTM D 5261	oz/yd <sup>2</sup>	8
Thickness	ASTM D 1777	inches	0.35
Tensile Strength <sup>2</sup>	ASTM D 5035	lbs/ft	145 x 110
Tensile Elongation	ASTM D 5035	%	50 (max.)
Porosity	Calculated	%	90
Resiliency	ASTM D 1777	%	80
UV Stability	ASTM D 4355	%	80
Maximum Permissible Velocity (Long-Term Vegetated)	-----	ft/sec	8
Maximum Permissible Shear Stress (Long-Term Vegetated)	-----	lb/ft <sup>2</sup>	3

Notes:

1. Minimum Average Roll Value (MARV).
2. Values for machine and cross machine direction (MD x XD), respectively.

END OF SECTION

SECTION 02614

HIGH DENSITY POLYETHYLENE (HDPE) PIPE

High Density Polyethylene (HDPE) Pipe: HDPE Pipe is used in the landfill gas and leachate collection systems.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of HDPE Pipe in accordance with the Contract Drawings and these Specifications. The Contractor shall also clean and test pipelines where required.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Drainage Aggregate (Leachate Management)	02710
Drainage Geocomposite	02712
HDPE Geomembrane	02775
Landfill Gas System	13255
CQA Manual	Attached

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 638	Standard Test Method for Tensile Properties of Plastics.
ASTM D 790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
ASTM D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.

ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
ASTM D 2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
ASTM D 3035	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
ASTM D 3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
ASTM D 3350	Standard Specification for Polyethylene Plastics Pipe and Fitting Materials.
ASTM F 412	Standard Terminology Relating to Plastic Piping Systems.
ASTM F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
ASTM F 1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.
ASTM F 1473	Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.
ASTM F 2164	Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.

4. Quality Assurance:

Quality Assurance during placement of HDPE Pipe will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. All HDPE Pipe shall be manufactured from new materials meeting the physical requirements shown in Table 1 of this section.
2. All HDPE Pipe shall have smooth interior walls and the SDR and diameter of the pipe shall be as shown on the Contract Drawings.

3. All HDPE Pipe having an outside diameter 3.5 inches and larger shall meet the requirements of ASTM F 714. All HDPE Pipe having an outside diameter less than 3.5 inches shall meet the requirements of ASTM D 3035.
4. Visible defects, such as cracks, creases, crazing, non-uniformly pigmented areas, or undispersed raw materials shall not be acceptable and will result in rejection of the pipe by the CQA Engineer.
5. Pipe Perforations: The perforations of the perforated HDPE Pipe shall be as shown on the Contract Drawings.
6. All HDPE Pipe fittings shall be in accordance with ASTM D 3261 and shall be manufactured by the Manufacturer of the HDPE Pipe supplied for the project and shall be pressure rated to match the system piping. The fittings shall be manufactured from the same materials as the pipe itself. The butt fusion outlets of fittings shall be machined to the same SDR as the system piping to which they are to be fused.
7. Materials used as anchorage for pipe cleanouts shall be provided and installed under this section. Concrete used as ballast shall be 3,000 psi (min. 28 day compressive strength).

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all HDPE Pipe manufactured for the project has been produced in accordance with these Specifications.
2. Submit a copy of the HDPE Pipe Manufacturer's recommendations for shipping, handling, and storage of pipe.
3. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.
4. Survey Results:

After placement of HDPE Pipe, survey results shall be submitted for review prior to acceptance.

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

All HDPE Pipe shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. HDPE Pipe Installation:

a. The Contractor shall install HDPE Pipe to the lines and grades shown on the Contract Drawings. Line and grade of piping shall be maintained with laser or approved equivalent. The Contractor shall give the CQA Engineer sufficient notice so that he may observe field location and installation activities.

b. Excavation for leachate discharge lines shall be backfilled as directed by the Engineer as shown on the Contract Drawings. Sand backfill or approved soil backfill compacted to at least 95 percent of the Standard Proctor dry density (ASTM D 698) shall be used.

Sharp stones or other potentially damaging material shall be removed from the base of the trench prior to placement of the piping. A leveling course, as required, shall consist of sand or other approved material.

c. Pipe Connections: Joining of HDPE Pipe shall be as follows:

(1) General pipe sections shall be butt-fusion welded according to the Manufacturer's recommendations and shall be performed by a Manufacturer's authorized, trained fusion technician.

(2) Pipe ends to be butt-fusion welded shall be clean and dry at the time of welding. No welding shall occur during precipitation or excessive moisture.

(3) The Contractor shall grind burrs or other potentially damaging areas in the welds prior to placement of the pipe.

(4) Specified bolted pipe connections shall be made as specified on the Contract Drawings using stainless steel hardware and neoprene gaskets.

(5) Polyethylene stub ends and flanges must be at the ambient temperature of the surrounding soil at the time they are bolted tight to prevent relaxation of the flange bolts and loosening of the joint due to thermal contraction of the polyethylene.

(6) Properly executed electrofusion fittings may be used.

d. Perforated HDPE Pipe shall be placed during construction as shown on the Contract Drawings.

3. Cleaning:

a. All HDPE Pipe shall be cleaned of any accumulation of silt, debris, or foreign matter of any kind and shall be kept clear of such accumulation until final acceptance of the work.

b. Final Flushing: The Contractor shall flush all leachate collection piping accessible by cleanout ports with potable water at or near the completion of the work. Any sediment remaining at collection points (sumps, manholes, etc.) shall be removed and disposed of as directed by the Engineer.

4. Surveying:

The Contractor shall survey all HDPE Pipe on 100 foot centers and at bends to ensure the proper location and grade of the piping.

**TABLE 1: REQUIRED HDPE PIPE PROPERTIES**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>UNITS</b>	<b>VALUE<sup>1</sup></b>
Material Designation	ASTM D 412	-----	PE 3408
Cell Classification	ASTM D 3350	-----	345464 C
Density	ASTM D 1505	g/cm <sup>3</sup>	0.955
Melt Flow Index	ASTM D 1238	g/10 min	0.1
Flexural Modulus	ASTM D 790	psi	130,000
Tensile Strength @ Yield	ASTM D 638	psi	3,200
SCG (PENT)	ASTM F 1473	hrs.	> 100
Hydrostatic Design Basis at 73° F	ASTM D 2837	psi	1,600
UV Stabilizer	ASTM D 1603	% Carbon Black	2 - 3%

Notes:

1. Nominal Values.

END OF SECTION

## SECTION 02710

### DRAINAGE AGGREGATE (LEACHATE MANAGEMENT)

Drainage Aggregate: Drainage Aggregate includes coarse aggregate which is placed around leachate collection pipes (gravel columns) for the purpose of leachate collection and removal.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete the installation of Drainage Aggregate in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Geotextiles	02240
Protective Cover	02256
HDPE Pipe	02614
Drainage Geocomposite	02712
HDPE Geomembrane	02775
CQA Manual	Attached

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) and the North Carolina Department of Transportation (NCDOT) are hereby made a part of these specifications.

ASTM C 136      Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

ASTM D 2434      Standard Test Method for Permeability of Granular Soils (Constant Head).

ASTM D 3042      Standard Test Method for Insoluble Residue in Carbonate Aggregates.

4. Quality Assurance:

Quality Assurance during placement of Drainage Aggregate will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. Coarse Aggregate:

- a. Coarse aggregate (NCDOT No. 57 or alternate gradation if approved by the Engineer) from a non-carbonate source ( $\leq 15\%$  carbonate content by ASTM D 3042) shall be placed around the collection pipes where shown on the Contract Drawings and shall be approved by the CQA Engineer at least four weeks prior to construction.
- b. Coarse aggregate shall consist of rounded or sub-angular or smoother particles and shall be sound, durable, and free from seams, cracks, or other structural defects. The material shall be free of shale, clay, friable materials, and debris. Coarse aggregate consisting of long, thin, angular particles may be rejected at the sole discretion of the Engineer.
- c. Coarse aggregate shall meet the following gradation criteria.

<u>Sieve Size</u>	<u>Percent Passing</u>
1½ Inch	100
1 Inch	95-100
½ Inch	25-60
No. 4	0-10
No. 8	0-5
No. 200	0-2

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

- 1. Before approval is given to proceed, the Contractor shall submit descriptive information on equipment to be used for placement of the Drainage Aggregate.

2. The Contractor shall submit at least two bulk samples each of leachate collection media and coarse aggregate from each material source for approval at least four weeks prior to beginning construction of the leachate collection system. Along with the bulk samples, the Contractor shall also submit a certification from each material source that the materials proposed meet the specified gradation requirements.

D. CONSTRUCTION

1. Failing CQA Material Control Tests:

Drainage Aggregate that is rejected upon testing shall be removed from the project site and replaced at Contractor's cost. Sampling and CQA testing of Drainage Aggregate supplied as replacement for rejected material shall be performed by the CQA Engineer at the Contractor's cost.

2. The Drainage Aggregate is placed directly over geosynthetics and piping; thus, extreme caution shall be exercised by the Contractor to prevent damage to these materials.

Test areas to evaluate potential damage due to equipment operations may be required by the Engineer to assess equipment to be used by the Contractor at the Contractor's sole expense. Test area parameters shall be determined by the Engineer and Contractor in advance of construction of the leachate collection system.

3. All placement of Drainage Aggregate shall be performed only when the CQA Engineer is informed by the Contractor of intent to perform such work.
4. The Contractor shall exercise care in maintaining a true line and grade for all piping during placement and spreading of Drainage Aggregate.
5. Drainage Aggregate shall be placed over geosynthetics and/or piping only after areas have been released by the Geosynthetics Installer and the CQA Engineer. Drainage Aggregate shall be placed as specified below:
  - a. Drainage Aggregate shall be placed and spread using tracked equipment. On slopes  $\geq 6H:1V$ , low ground pressure (6 psi or less) tracked equipment shall be used. On slopes  $< 6H:1V$ , tracked equipment shall have a ground pressure of 12 psi or less. The CQA Engineer shall approve the equipment used to place Drainage Aggregate.
  - b. Tracked equipment used to place and spread Drainage Aggregate shall operate on at least 1 foot of material overlying geosynthetics and/or piping.

Sharp turning of tracked equipment on the Drainage Aggregate will not be permitted.

- c. On slopes  $\geq 6H:1V$ , Drainage Aggregate shall be placed and spread from the bottom up unless otherwise approved by the Engineer. No material shall be dumped down a slope.
  - d. Drainage Aggregate shall not be placed over standing water or ice.
  - e. Drainage Aggregate shall not be compacted within the limits of the containment area.
  - f. Drainage Aggregate shall be placed to the lines and grades as shown on the Contract Drawings except that a 0.15 foot overbuild at the Contractor's expense is allowed. Drainage Aggregate placed beyond these limits shall be removed at the Contractor's sole expense if required by the Engineer.
6. The Drainage Aggregate shall be spread in a manner that minimizes development of wrinkles or tension in the underlying geosynthetics. Any portion of the underlying geosynthetics that develops excessive wrinkles or crimp or is otherwise damaged shall be repaired by the Geosynthetics Installer at no expense to the Owner.
- a. Drainage Aggregate shall be placed before noon or at other times when the ambient air temperature is not more than 75°F to minimize wrinkling of underlying geosynthetics unless otherwise approved by the Engineer. Likewise, Drainage Aggregate shall not be placed when conditions are cold enough to produce tension in the underlying geosynthetics.
  - b. If during spreading, excessive wrinkles develop, the Contractor shall adjust placement and spreading methods, or cease until the underlying geosynthetics cool and wrinkles decrease in size.
  - c. Wrinkles that exceed approximately 6 inches in height and cannot be eliminated by amended placement and spreading methods or underlying geosynthetics that become crimped shall be cut and repaired by the Geosynthetics Installer in a method approved by the Engineer.
7. Stockpiling of Drainage Aggregate within the limits of the containment area shall be subject to advance approval by the Engineer. Any hauling equipment (dump trucks, etc.) operating within the containment area shall have a minimum of 3 feet of separation between the vehicle wheels and the Geomembrane.

The Contractor shall minimize equipment operations directly over coarse aggregate.

8. The CQA Engineer may require removal of Drainage Aggregate and/or other underlying layers at the Contractor's sole expense to allow examination of the underlying geosynthetics and/or piping. Any damage to the underlying layers or excessive wrinkling or crimping during placement of Drainage Aggregate shall be repaired in accordance with the applicable section of these Specifications at the Contractor's sole expense.

END OF SECTION

## SECTION 02712

### DRAINAGE GEOCOMPOSITE

Drainage Geocomposite (DGC): The Drainage Geocomposite consists of a geonet drainage core with a Type GT-S Geotextile bonded to each surface. The purpose of the DGC is to rapidly transmit flow to collection piping.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of DGC, including all necessary and incidental items, in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Geotextiles	02240
Protective Cover	02256
HDPE Pipe	02614
Drainage Aggregate (Leachate Management)	02710
HDPE Geomembrane	02775
Geosynthetic Clay Liner	02776
LLDPE Geomembrane	02778
CQA Manual	Attached

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) and the Geosynthetic Research Institute (GRI) are hereby made a part of these specifications.

ASTM D 413      Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.

ASTM D 1505      Standard Test Method for Density of Plastics by the Density-Gradient Technique.

ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
ASTM D 5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
ASTM D 6243	Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method.
GRI GC7	Determination of Adhesion and Bond Strength of Geocomposites.

4. Quality Assurance:

Quality Assurance during installation of DGC will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. General:

The materials supplied under these Specifications 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 use, to be suitable and durable for such purposes.

Labels on each roll of DGC shall identify the length, width, lot and roll numbers, and name of Manufacturer.

2. The geonet drainage core shall be manufactured by extruding polyethylene strands to form a three dimensional structure to provide planer water flow.
3. A Type GT-S Geotextile shall be heat bonded to both sides of the geonet drainage core. Heat bonding shall be performed by the Manufacturer prior to shipping to the site. The Type GT-S Geotextile shall be a nonwoven needlepunched synthetic fabric meeting the property requirements (Table 1) of Section 02240, Geotextiles, of these Specifications.
4. The geonet drainage core shall contain UV inhibitors to prevent ultraviolet light degradation.
5. Physical properties of the DGC shall be as shown in Table 1 of this section.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for the DGC attesting that the DGC meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of the DGC to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.
2. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.
3. Seaming Procedures:  
  
Submit proposed seaming procedures including proposed method and equipment.
4. Quality Control Certificates: For DGC delivered to the site, quality control certificates, signed by the Manufacturer's quality assurance manager shall be provided which represent every roll of DGC. Each certification shall have the roll identification number(s), test methods, frequency, and test results. At a minimum, the test results and frequency of testing shall be as shown in Table 2 of this section.
5. Furnish copies of delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

All DGC shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. Failing CQA Material Control Tests:

DGC that is rejected upon testing shall be removed from the project site and replaced at Contractor's cost. Sampling and quality assurance testing of DGC supplied as replacement for rejected material shall be performed by the CQA Engineer at Contractor's cost.

3. Installation:

- a. The DGC shall be placed only on Geomembrane that has been approved by the Geomembrane Installer and accepted by the CQA Engineer. The Contractor shall remove debris, including sediment to the degree possible, from the Geomembrane prior to placement of the DGC.
- b. DGC shall be placed to the lines and grades shown on the Contract Drawings. At the time of installation, the DGC shall be rejected, if it has defects, rips, holes, flaws, evidence of deterioration, or other damage.
- c. The DGC shall be placed smooth and free of excessive wrinkles.
- d. The Contractor shall provide temporary anchorage of the DGC at the top of perimeter and interior berms during installation as necessary to prevent movement during construction. Such anchorage may include sandbags and the like, as approved by the CQA Engineer. Permanent bonding to the Geomembrane shall be prohibited.

4. Seams:

- a. All seams constructed on slopes  $\geq 6H:1V$  or within 10 feet of the toe of a slope  $\geq 6H:1V$  shall be vertical seams, except where slope lengths exceed standard roll lengths and elsewhere as approved in advance by the Engineer. Where allowed by the Engineer, end seams on slopes  $\geq 6H:1V$  shall be staggered a minimum of 5 feet between adjacent rolls.
- b. Geonet Drainage Core: The geonet drainage core shall be laid with a 3 inch minimum overlap seam along roll edges and a 6 inch minimum overlap seam along roll ends and shall be secured using plastic ties. For DGC placed on slopes  $\geq 6H:1V$ , the ties shall be placed every 5 feet along

roll edges; for slopes < 6H:1V, tie spacing shall be every 10 feet. For roll ends, tie spacing shall be every 2 feet.

- c. Geotextile Component(s): Where applicable, the bottom geotextile of the DGC shall be overlapped with the same of the adjacent rolls. The top geotextile of the DGC shall be continuously sewn or heat bonded to the same of the adjacent rolls with methods approved by the Engineer. Refer to Section 02240, Geotextiles, of these Specifications for additional information on the sewing or heat bonding of geotextiles.

5. Repairs:

Any DGC that is torn, crushed, punctured, or otherwise damaged shall be repaired or replaced, as directed by the CQA Engineer, by the Contractor at no additional cost to the Owner. The repair shall consist of a patch of the same type of material, placed over the damaged area and shall overlap the existing material a minimum of 12 inches from any point of the damage. The patch shall be connected to the geonet drainage core of the damaged material using plastic cable ties at a 6 inch spacing and the upper geotextile of the patch shall be spot sewn or heat bonded to the upper geotextile of the damaged material. A geotextile patch, spot sewn or heat bonded to the damaged material, may be used where damage is to only that portion of the DGC.

6. Cover Placement:

Placement of materials over DGC shall be performed in a manner as to ensure that DGC and the underlying geosynthetics are not damaged; minimal slippage of DGC on the underlying geosynthetics occurs; no excess tensile stresses occur in the DGC; and that no portion of the DGC develops excessive wrinkles or crimp. Wrinkles that exceed approximately 6 inches in height and cannot be eliminated by amended placement and covering methods or DGC that becomes crimped shall be cut and repaired by the Geosynthetics Installer in a method approved by the Engineer.

**TABLE 1: REQUIRED DRAINAGE GEOCOMPOSITE PROPERTIES**

PROPERTY	TEST METHOD	UNITS	VALUE
Thickness (geonet only)	ASTM D 5199	inches	0.25
Density (geonet only)	ASTM D 1505	g/cm <sup>3</sup>	0.94
Ply Adhesion	ASTM D 413/ GRI GC7	lb/inch	2.0 Typ. 1.0 Min. Avg.
Transmissivity:	ASTM D 4716	m <sup>3</sup> /m/sec	2.5 x 10 <sup>-4</sup> (See Note 1)
Interface Shear Strength (Peak) <sup>2,3</sup>	ASTM D 5321 ASTM D 6243 (GCL)	psf	125 psf (Load = 200 psf) 800 psf (2,000 psf) 1,600 psf (4,000 psf) 3,200 psf (8,000 psf)

**TABLE 2: REQUIRED MANUFACTURER'S QUALITY CONTROL TEST DATA**

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
Thickness (geonet only)	ASTM D 5199	50,000 ft <sup>2</sup>
Density (geonet only)	ASTM D 1505	50,000 ft <sup>2</sup>
Grab Tensile Strength (geotextile only)	ASTM D 4632	200,000 ft <sup>2</sup>
Puncture Resistance (geotextile only)	ASTM D 4833	200,000 ft <sup>2</sup>
Apparent Opening Size (AOS) (geotextile only)	ASTM D 4751	600,000 ft <sup>2</sup>
Ply Adhesion	ASTM D 413/ GRI GC7	100,000 ft <sup>2</sup>
Transmissivity	ASTM D 4716	100,000 ft <sup>2</sup> (See Note 4)
Interface Shear Strength	ASTM D 5321 ASTM D 6243 (GCL)	(See Note 2)

Notes:

1. Leak Detection System/Leachate Collection System:  
Conduct test for transmissivity at a normal compressive load of 7,000 psf and at a hydraulic gradient of 0.25 after a seating period of at least 100 hours. Boundary conditions are soil (sand) interface on the upper Type GT-S Geotextile and textured HDPE geomembrane against the lower Type GT-S Geotextile.  
Landfill Gas System:  
Conduct test for transmissivity at a normal compressive load of 500 psf and at a hydraulic gradient of 0.25 after a seating period of at least 1 hour (Optionally run test at 250 psf for 24 hours). Boundary conditions are soil (sand) interface on the upper Type GT-S Geotextile and textured LLDPE geomembrane against the lower Type GT-S Geotextile.
  
2. Test each interface to be used on this project using representative samples of materials to be supplied under normal loads indicated and using test parameters as specified by the Engineer. For this project, interfaces to be tested are:
  - A. Textured LLDPE-GM (40 mil) against existing cover soils;
  - B. Drainage Geocomposite against textured LLDPE-GM (40 mil);
  - C. Geosynthetic Clay Liner against Drainage Geocomposite;
  - D. Textured HDPE-GM (60 mil) against Geosynthetic Clay Liner;
  - E. Drainage Geocomposite against textured HDPE-GM (60 mil); and
  - F. Protective Cover against Drainage Geocomposite.

If there are material differences in the surface of any of the geosynthetic materials from one side to the other, then all possible combinations of interfaces shall be tested. This testing shall be performed at Contractor cost by an independent GAI accredited laboratory and submitted to the Engineer for review prior to shipping. Upon review of test results, the Engineer may allow exceptions to the above criteria.

For tests involving textured geomembranes, the laboratory shall also report the asperity height (GRI GM12) for the material samples used in the actual direct shear tests.

3. DGC shall have adequate adhesion against adjacent materials under low normal loads to achieve the successful installation of overlying components without slippage.
  
4. The required Manufacturer's quality control testing for transmissivity may be reduced to one test per resin lot or one test per 500,000 ft<sup>2</sup> (whichever provides the larger number of tests) if the minimum measured transmissivity is at least 50% greater than specified.

END OF SECTION

SECTION 02775

HDPE GEOMEMBRANE

HDPE Geomembrane (HDPE-GM): The HDPE Geomembrane serves as the primary hydraulic containment barrier for the leachate to be developed in the landfill. In conjunction with the Geosynthetic Clay Liner, the HDPE-GM forms a composite containment barrier. Thus, it is of great importance that the HDPE-GM be free from defects and installed free from damage.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of HDPE-GM including all necessary and incidental items as detailed or required to complete the installation in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Embankment	02223
Protective Cover	02256
Drainage Aggregate (Leachate Management)	02710
Drainage Geocomposite	02712
Geosynthetic Clay Liner	02776
CQA Manual	Attached

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) and the Geosynthetic Research Institute (GRI) are hereby made a part of these Specifications.

ASTM D 792            Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

ASTM D 1004        Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.

ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
ASTM D 5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
ASTM D 5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
ASTM D 5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
ASTM D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
ASTM D 5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.
ASTM D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
ASTM D 6243	Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method.
ASTM D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
ASTM D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Flexible Polyethylene and Nonreinforced Polypropylene Geomembranes.
GRI GM9	Cold Weather Seaming of Geomembranes.
GRI GM12	Asperity Measurement of Textured Geomembranes Using a Depth Gage.

4. Quality Control:

The Geomembrane Installer shall follow the procedures and requirements described in the accompanying Project CQA Manual during installation of HDPE-GM including performing and documenting trial seams, nondestructive and destructive Quality Control tests, and repairs.

5. Quality Assurance:

Quality Assurance during installation of HDPE-GM will be provided by the Owner as described in the accompanying Project CQA Manual.

6. Manufacturers Qualifications:

The Manufacturer shall have previously demonstrated his ability to produce the required HDPE-GM by having successfully manufactured a minimum of 10,000,000 ft<sup>2</sup> of HDPE-GM for hydraulic containment purposes.

7. Installer Qualifications:

- a. Installation of the HDPE-GM shall be performed by an Installer that has installed a minimum of 5,000,000 ft<sup>2</sup> of the material within the past five (5) years in similar landfill installations.
- b. All Installation Supervisors assigned to the Project shall have previously managed the installation of at least 2,000,000 ft<sup>2</sup> of HDPE-GM using the same techniques to be used on site.
- c. All welding machine operators shall have shown proven performance on previous HDPE-GM installations. All welding machine operators shall perform a demonstration of their welding technique and provide test data demonstrating the acceptability of the test welds which they have performed prior to performing any welding on the project.

8. Warranties:

- a. General: Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for repair and/or relocation and replacement of the HDPE-GM.
- b. Workmanship: The Contractor shall furnish the Owner a warranty from the Installer of the HDPE-GM which warrants their workmanship to be free of defects on a prorata basis for five (5) years after the final acceptance of the Work. This warranty shall include but not be limited to

all field-welded seams, anchor trenches, attachments to appurtenances, and penetration seals, as applicable.

- c. Manufacturer's Warranty: The Contractor shall furnish the Owner a warranty from the HDPE-GM Manufacturer for the materials used. The material warranty shall be for defects or failures related to manufacture on a prorata basis for five (5) years after the date of shipment.

## B. MATERIALS

### 1. General:

The materials supplied under these Specifications 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 use, to be suitable and durable for such purposes. The HDPE-GM and HDPE-GM Manufacturer shall be approved by the Engineer prior to the Contract award.

The HDPE-GM shall be supplied in rolls which shall have a minimum width of 22 feet. The roll length shall be maximized to provide the largest manageable sheet for the fewest seams. However, no factory seaming of HDPE-GM panels shall be accepted. Labels on the roll shall identify the thickness, length, width, lot and roll numbers, and name of Manufacturer.

### 2. HDPE-GM Materials:

- a. Resin Properties: The resin shall be high-density polyethylene (HDPE) and shall be new, first-quality, compounded and manufactured specifically for producing HDPE-GM. The resin shall not consist of mixed resin types. Recycled material reworked from the manufacturing process shall not exceed 5% by weight.
- b. HDPE-GM Sheet Properties: The HDPE-GM sheeting shall be manufactured to meet the following requirements:
  - (1) Provide finished product free from holes, pin holes, bubbles, blisters, excessive gels, undispersed resins and/or carbon black, contamination by foreign matter, and nicks or cuts on edges.
  - (2) Physical properties of the HDPE-GM shall be as shown in Table 1 of this section.

3. Extrusion Resin/Typical Extrudate:

Extrusion resin/typical extrudate used for extrusion welding of HDPE-GM shall be high density polyethylene (HDPE). Physical properties shall be the same as the HDPE-GM sheet. The extrudate's additives shall be thoroughly dispersed throughout the rod or bead. The extrudate shall be free of contamination by moisture or foreign matter and shall be recommended for use with the associated sheet material.

4. Texturing:

Textured HDPE-GM, where required, shall be fabricated using coextrusion or impingement methods and not by lamination or embossing methods. Texturing applied to HDPE-GM using impingement methods shall be bonded securely to the parent HDPE-GM. All texturing shall be uniform in appearance and coverage on the finished sheet. Physical properties of textured HDPE-GM shall be as shown in Table 1 of this section.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Pre-Installation Requirements:

Prior to HDPE-GM installation the Contractor shall submit the following:

- a. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for the HDPE-GM attesting that the HDPE-GM meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of the HDPE-GM to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.
- b. Qualifications:
  - (1) Submit list of equipment and personnel proposed for the Project. Include equipment type and quantities. Include personnel experience on similar projects.
  - (2) Submit resume and references of Installation Supervisor to be assigned to the Project, including data and duration of employment and pertinent experience information.

(3) Submit resumes and references of installation welders who will perform seaming operations, including dates and durations of employment and pertinent experience information.

c. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.

d. Delivery Date: Submit notification of the scheduled delivery dates for the materials.

e. Installation Procedures and Drawings:

Submit installation procedures and (shop) drawings for carrying out the work.

(1) Installation procedures to be addressed shall include but not be limited to material installation, repair, and protection to be provided in the event of rain or strong winds.

(2) Shop drawings shall have HDPE-GM sheet layout with proposed size, number, position, and sequence of placing all panels, and indicating the location of all field seams. Shop drawings shall also show complete details and/or methods for anchoring the HDPE-GM, making field seams, and making seals around pipes and structures penetrating the HDPE-GM (if applicable).

Following review, these procedures and drawings will be used for installation of the HDPE-GM. Any deviations from these procedures and drawings must be approved by the Engineer and CQA Engineer.

f. Quality Control Certificates: For HDPE-GM delivered to the site, quality control certificates, signed by the Manufacturer's quality assurance manager shall be provided which represent every roll of HDPE-GM. Each certificate shall have the roll identification number(s), test methods, frequency, and test results. At a minimum, the test results and frequency of testing shall be as shown in Table 2 of this section.

g. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

2. Post-Installation Requirements:

Upon completion of the HDPE-GM installation, the Contractor shall submit the following:

- a. Certificate stating that the HDPE-GM has been installed in accordance with the Drawings, Specifications, and the Manufacturer's recommendations.
- b. Completed Manufacturer's and workmanship warranties.
- c. Record Information: Record information shall include but not be limited to:
  - (1) CQC Documentation: Includes trial weld logs, panel placement logs, panel seaming logs, non-destructive seam testing report forms, field destructive seam testing report forms, and repair logs.
  - (2) As-Built Drawing: Includes the requirements listed in Paragraph D.8 (Surveying) of this Specification.

Finalization of payment for HDPE-GM installation shall not be made until the above submittals have been reviewed by the CQA Engineer.

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

The HDPE-GM shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

1. Failing CQA Material Control Tests:

HDPE-GM that is rejected upon testing shall be removed from the project site and replaced at Contractor's cost. Sampling and CQA testing of HDPE-GM supplied as replacement for rejected material shall be performed by the CQA Engineer at Contractor's cost.

3. Subgrade Preparation:

- a. The surface of the subgrade (surface of GCL) shall be smooth, uniform, free from sudden changes in grade (such as vehicular ruts), rocks or stones, debris, and deleterious materials. During actual placing and seaming of the HDPE-GM, the subgrade shall be kept free of all standing water. If the subgrade below the HDPE-GM becomes excessively wet and unstable as determined by the CQA Engineer, it shall be dried and recompacted, and replaced if needed. Likewise, GCL which becomes hydrated shall be removed and replaced at Contractor expense.

- b. Before an individual panel of HDPE-GM is installed; the Contractor and Installer shall verify in writing and submit to the CQA Engineer:
  - (1) Lines and grades are in conformance with the Contract Drawings and Specifications.
  - (2) The surface area to be lined has been rolled and compacted, free of irregularities and abrupt changes in grade.
- c. The Contractor shall not proceed with HDPE-GM installation until a complete report on all GCL CQA testing has been submitted and approved by the CQA Engineer. If the Contractor proceeds with HDPE-GM installation prior to completion of these tests, the Contractor will do so at his own risk. If any tests fail, the Contractor will be required to remove HDPE-GM and reconstruct the underlying components to specification requirements. All costs associated with such actions (including the costs of additional testing) will be paid for entirely by the Contractor.

4. HDPE-GM Placement:

a. Weather Conditions:

HDPE-GM placement shall not proceed at an ambient temperature below 32° F or above 100° F unless otherwise authorized, in writing, by the Engineer. Installation of HDPE-GM at temperatures below 32° F, if authorized by the Engineer, shall follow GRI GM9. HDPE-GM placement shall not be performed during precipitation, excessive moisture, in an area of ponded water, or in excessive winds. Any portion of HDPE-GM or subgrade damaged due to weather conditions shall be repaired at the Contractor's cost.

b. Method of Placement:

- (1) Each panel of the HDPE-GM shall be installed in accordance with the approved shop drawings prepared by the Contractor. The layout shall be designed to keep field seaming of the HDPE-GM to a minimum, shall avoid seams parallel to and under leachate collection piping, and shall be consistent with proper methods of HDPE-GM installation.
- (2) Panels shall be oriented perpendicular to the line of the slope crest (i.e., down and not across slope).
- (3) The HDPE-GM shall be placed smooth and free of excessive wrinkles.

- (4) HDPE-GM rolls shall be placed using proper spreader and rolling bars with cloth slings. If a sheet must be displaced a distance greater than its width, a slip sheet shall be used.
- (5) The CQA Engineer shall inspect each panel, after placement and prior to seaming, for damage and/or defects. Defective or damaged panels shall be replaced or repaired, as approved by the CQA Engineer and as described in this section.
- (6) The Installer shall avoid dragging the HDPE-GM on rough soil subgrades.
- (7) All HDPE-GM shall be anchored as shown on the Contract Drawings and consistent with Manufacturer's recommendations.
- (8) Personnel working on the HDPE-GM shall not smoke, wear damaging shoes, or involve themselves in any activity that may damage the HDPE-GM, in the opinion of the CQA Engineer.
- (9) The HDPE-GM shall be properly weighted to avoid uplift due to wind.
- (10) Vehicular traffic across the HDPE-GM shall not be allowed, except that four-wheel (or greater) all-terrain vehicles (ATVs) with low ground pressure may be allowed if approved in advance by the Engineer. The Contractor shall submit proposed equipment and procedures for use of ATVs to the CQA Engineer as part of his submittals. If ATVs are allowed by the Engineer, each ATV will be operated such that no sudden stops, starts, or turns are made.
- (11) All damage shall be recorded and located on the record drawings.
- (12) When tying into existing HDPE-GM, excavation of previously installed geosynthetics shall be performed in a manner that minimizes damage to the existing geosynthetics and as approved by the Engineer. All damage to the existing geosynthetics shall be repaired by the Geosynthetics Installer at the Contractor's sole expense.
- (13) The HDPE-GM shall be kept free of debris, unnecessary tools, and materials. In general, the HDPE-GM area shall remain neat in appearance.

5. Field Seams:

- a. Individual panels of HDPE-GM shall be laid out and overlapped by a minimum of 4 inches prior to welding. The area to be welded shall be cleaned and prepared in accordance with the Manufacturer's recommendations.
- b. Single or double track hot wedge fusion welds shall be used for straight seams.
- c. Extrusion welds shall be used for cross seam tees, patches, repairs, and penetration boots. To limit overgrinding, the amount of grinding exposed after an extrusion seam is completed should be less than ¼ inch.
- d. The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the HDPE-GM so as to ensure that changes in environmental conditions will not affect the integrity of the weld.
- e. All seams shall have a seam number that corresponds with the panel layout numbers. The numbering system shall be used in the development of the record drawings. Seam numbers shall be derived from the combination of the two panel numbers that are to be welded together.
- f. All fusion welded "T" seams (i.e., the result of panels placed perpendicular to each other) shall be double welded where possible. The extrusion process shall be used for the second weld.
- g. All extrudate shall be free of dirt, dry, and protected from damage.
- h. If an extrusion welder is stopped for longer than one minute, it shall be purged to remove heat-degraded extrudate. All purged extrudate shall be placed on a sacrificial sheet and disposed of.
- i. Where horizontal seams are required on sloped surfaces, the panels shall be placed such that the "upstream" panel forms the upper panel and overlaps the "downstream" panel in order to minimize infiltration potential. All seams constructed on slopes  $\geq 6H:1V$  shall be vertical seams, except where slope lengths exceed standard roll lengths and elsewhere as approved in advance by the Engineer.
- j. All vertical panels placed on slopes  $\geq 6H:1V$  shall extend a minimum of 5 feet beyond the grade break with a slope  $< 6H:1V$ .

- k. All end seams shall be staggered a minimum of 5 feet in length between contiguous panels.
- l. To prevent moisture buildup during fusion welding, it may be necessary to place a movable protective layer of plastic directly below each overlap of HDPE-GM that is to be seamed.
- m. If required, a firm substrate shall be provided by using a flat board or similar hard surface directly under the seam overlap to achieve proper support.
- n. All seams shall extend to the full extent of the anchor trench.
- o. All seams (including repairs) shall meet seam strength requirements specified in Table 3 of this section.
- p. No overlying material (i.e., leachate collection layer) shall be placed over the HDPE-GM until approved by the CQA Engineer.

6. Anchor Trench:

- a. The anchor trench shall be constructed as shown on the Contract Drawings and as specified herein. The anchor trench shall be maintained by the Contractor.
- b. Slightly rounded corners shall be provided in the trench to avoid sharp bends in the HDPE-GM.
- c. The anchor trench shall be adequately drained to prevent water ponding and softening to adjacent soils. The anchor trench shall be backfilled with Embankment material and compacted to 90% standard Proctor dry density (ASTM D 698).
- d. If the anchor trench is located in a clay susceptible to desiccation, the amount of trench open at any time shall be limited to one day of HDPE-GM installation capacity.
- e. Edge of Liner Markers: The Contractor shall place edge of liner markers where shown on the Contract Drawings at the edge of the anchor trench. These markers shall be considered incidental to the HDPE-GM installation.

7. Repair Procedures:

- a. Any portion of the HDPE-GM exhibiting signs of defect or failing a nondestructive or a destructive test, shall be repaired by the Geomembrane Installer. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be made by the CQA Engineer. The procedures available include:
- (1) Patching - Apply a new piece of HDPE-GM sheet over, and at least 6-inches beyond the limits of a defect. The patch shall be extrusion seamed to the underlying HDPE-GM. This method should be used to repair holes, tears, destructive test locations, undispersed raw materials, contamination by foreign matter, dents, pinholes, and pressure test holes.
  - (2) Capping - Apply a new strip of HDPE-GM along the length of a delineated faulty seam. The cap strip shall extend at least 6-inches beyond the limit of the seam and the edges will be extrusion seamed to the underlying HDPE-GM. This method should be used to repair lengths of extrusion or fusion seams.
  - (3) Replacement - The faulty seam is removed and replaced.
- b. In addition, the following provisions shall be satisfied:
- (1) Surfaces of the HDPE-GM which are to be repaired will be abraded no more than one hour prior to the repair;
  - (2) All surfaces must be clean and dry at the time of the repair;
  - (3) All seaming equipment used in repairing procedures must be approved;
  - (4) The repair procedures, materials, and techniques will be approved in advance of the specific repair by the CQA Engineer;
  - (5) Extrusion welding of flaps of double track hot wedge fusion welded seams is not acceptable. A patch or cap strip shall be used; and
  - (6) Patches or caps will extend at least 6-inches beyond the edge of the defect, and all patch corners will be rounded.

8. Surveying:

- a. After completion of a segment of HDPE-GM, the Contractor shall survey HDPE-GM to obtain the following information:
  - (1) Location and numbering of all panels/seams.
  - (2) Location of all repairs/patches;
  - (3) Location of all destructive test locations; and
  - (4) Location of all pipe penetrations and other appurtenances (if applicable).
- b. No overlying materials shall be placed before survey information is obtained.
- c. The Contractor shall provide the CQA Engineer with updated survey information when requested by the CQA Engineer to verify that the required information is being obtained.

9. Cover Placement:

Placement of materials over HDPE-GM shall be performed in a manner as to ensure that HDPE-GM and the underlying geosynthetics are not damaged; minimal slippage of HDPE-GM on the underlying geosynthetics occurs; no excess tensile stresses occur in the HDPE-GM; and that no portion of the HDPE-GM develops excessive wrinkles or crimp. Wrinkles that exceed approximately 6 inches in height and cannot be eliminated by amended placement and covering methods or HDPE-GM that becomes crimped shall be cut and repaired by the Geosynthetics Installer in a method approved by the Engineer.

**TABLE 1: REQUIRED HDPE-GM PROPERTIES**

PROPERTY	TEST METHOD	UNITS	VALUE
			TEXTURED <sup>1</sup> HDPE-GM
Thickness <sup>2</sup>	ASTM D 5994	mils	60
Asperity Height (typ.)	GRI GM12	mils	20 (See Note 3)
Density	ASTM D 1505/D 792	g/cm <sup>3</sup>	≥ 0.940
Carbon Black Content <sup>4</sup>	ASTM D 1603	%	2.0-3.0
Carbon Black Dispersion <sup>4</sup>	ASTM D 5596	category	See Note 5
Tensile Properties:	ASTM D 6693 Type IV (See Note 6)		
Tensile Strength at Yield		lb/inch	≥ 126
Tensile Strength at Break		lb/inch	≥ 90
Elongation at Yield		%	≥ 12
Elongation at Break		%	≥ 100
Tear Resistance	ASTM D 1004	lbs.	≥ 42
Stress Crack Resistance	ASTM D 5397 (App.)	hrs.	≥ 300
Interface Shear Strength (Peak) <sup>7</sup>	ASTM D 5321 ASTM D 6243 (GCL)	psf	125 psf (Load = 200 psf) 800 psf (2,000 psf) 1,600 psf (4,000 psf) 3,200 psf (8,000 psf)

Notes:

1. Textured HDPE-GM is textured on both sides.
2. For textured HDPE-GM, the lowest individual thickness for 8 out of 10 values = -10%; the lowest individual thickness of any of the 10 values = -15%.
3. Or as otherwise required to satisfy interface shear strength criteria.
4. Carbon black content and carbon black dispersion are applicable to black HDPE sheet only. Where white HDPE is used or where a white HDPE layer is coextruded with a black HDPE layer, the white HDPE shall be UV stabilized.
5. Carbon black dispersion for 10 different views:
  - minimum 8 of 10 in Categories 1 or 2
  - all 10 in Categories 1, 2, or 3.

6. Yield elongation calculated with a gauge length of 1.3 inches. Break elongation calculated with a gauge length of 2.0 inches.
7. Textured HDPE-GM shall have adequate adhesion against adjacent materials under low normal loads to achieve the successful installation of overlying components without slippage.

**TABLE 2: REQUIRED MANUFACTURER'S QUALITY CONTROL TEST DATA**

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
Thickness	ASTM D 5199/D 5994	Every Roll
Asperity Height (Textured Only)	GRI GM12	Every 2 <sup>nd</sup> Roll (See Note 1)
Density	ASTM D 1505/D 792	200,000 lb
Carbon Black Content	ASTM D 1603	20,000 lb
Carbon Black Dispersion	ASTM D 5596	45,000 lb
Tensile Properties	ASTM D 6693 Type IV	20,000 lb
Tear Resistance	ASTM D 1004	45,000 lb
Stress Crack Resistance	ASTM D 5397 (App.)	1 Per Resin Lot (Smooth Sample)
Interface Shear Strength	ASTM D 5321 ASTM D 6243 (GCL)	(See Note 2)

Notes:

1. Alternate the measurement side for double sided textured sheet.
2. Test each interface to be used on this project using representative samples of materials to be supplied under normal loads indicated and using test parameters as specified by the Engineer. For this project, interfaces to be tested are:
  - A. Textured LLDPE-GM (40 mil) against existing cover soils;
  - B. Drainage Geocomposite against textured LLDPE-GM (40 mil);
  - C. Geosynthetic Clay Liner against Drainage Geocomposite;
  - D. Textured HDPE-GM (60 mil) against Geosynthetic Clay Liner;
  - E. Drainage Geocomposite against textured HDPE-GM (60 mil); and
  - F. Protective Cover against Drainage Geocomposite.

If there are material differences in the surface of any of the geosynthetic materials from one side to the other, then all possible combinations of interfaces shall be tested. This testing shall be performed at Contractor cost by an independent GAI accredited laboratory and submitted to the Engineer for review prior to shipping. Upon review of test results, the Engineer may allow exceptions to the above criteria.

For tests involving textured geomembranes, the laboratory shall also report the asperity height (GRI GM12) for the material samples used in the actual direct shear tests.

**TABLE 3: REQUIRED SEAM STRENGTH PROPERTIES**

PROPERTY	TEST METHOD	MINIMUM VALUE
Bonded Shear Strength	ASTM D 6392	121 lb/inch and FTB <sup>1</sup>
Seam Peel Adhesion	ASTM D 6392	98 lb/inch and FTB <sup>1</sup> (Fusion Welds) 78 lb/inch and FTB <sup>1</sup> (Extrusion Welds)

Notes:

1. FTB = Film-Tear-Bond = Tearing in the membrane itself before ply separation of the seam.

END OF SECTION

SECTION 02776

GEOSYNTHETIC CLAY LINER (GCL)

Geosynthetic Clay Liner (GCL): The GCL is used as a secondary hydraulic barrier beneath the HDPE Geomembrane.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of GCL in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Drainage Geocomposite	02712
HDPE Geomembrane	02775
CQA Manual	Attached

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 1777	Standard Test Method for Thickness of Textile Materials.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
ASTM D 5887	Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.

ASTM D 5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
ASTM D 5993	Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners.
ASTM D 6243	Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method.
ASTM D 6496	Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners.

4. Quality Assurance:

Quality Assurance during installation of GCL will be provided by the Owner as described in the accompanying Project CQA Manual.

5. Manufacturer Qualifications:

The GCL shall be furnished by a Manufacturer that has previously produced a minimum of 10,000,000 square feet of the material for use in similar projects.

6. Installer Qualifications:

The GCL Installer shall have installed a minimum of 500,000 square feet of GCL in the past two (2) years in similar landfill installations.

7. Warranties:

- a. General: Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for repair and/or relocation and replacement of the GCL.
- b. Workmanship: The Contractor shall furnish the Owner a warranty from the GCL Installer which warrants their workmanship to be free of defects on a prorata basis for five (5) years after the final acceptance of the Work. This warranty shall include but not be limited to overlapped seams, anchor trenches, attachments to appurtenances, and penetration seals, as applicable.
- c. Manufacturer's Warranty: The Contractor shall furnish the Owner a warranty from the GCL Manufacturer for the materials used. The material

warranty shall be for defects or failures related to manufacture on a prorata basis for five (5) years after date of shipment.

B. MATERIALS

1. General:

The GCL shall consist of bentonite encased, top and bottom, with 6 oz./square yard non-woven geotextiles needle-punched together for reinforcement. The materials supplied under these Specifications shall be first quality products designed and manufactured specifically for the purposes of this work.

The GCL shall be supplied in rolls which have a minimum width of 14 feet. The roll length shall be maximized to provide the largest manageable sheet for the fewest overlaps. Labels on the roll shall identify the length, width, lot and roll numbers, name of Manufacturer, proper direction of unrolling, and minimum recommended overlap.

2. Physical Properties:

Physical properties of GCL shall be as shown in Table 1 of this section.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Pre-Installation Requirements:

Prior to GCL installation the Contractor shall submit the following:

a. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for the GCL attesting that the GCL meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of the GCL to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.

b. Qualifications:

(1) Submit list of equipment and personnel proposed for the Project. Include equipment type and quantities. Include personnel experience on similar projects.

(2) Submit resume and references of Installation Supervisor to be assigned to the Project, including data and duration of employment and pertinent experience information.

c. Shipping, Handling, and Storage Instructions: The Manufacturer's recommendations for shipping, handling, and storage shall be submitted for review.

d. Delivery Date: Submit notification of the scheduled delivery date for the materials.

e. Installation Procedures and Drawings:

Submit installation procedures and (shop) drawings for carrying out the work. Procedures addressed by the Contractor shall include but not be limited to material installation, repair, and protection to be provided in the event of rain. Submit drawings showing typical details including pipe penetrations (if applicable). Following review, these procedures and drawings will be used for installation of the GCL. Any deviations from these procedures and drawings must be approved by the Engineer and CQA Engineer.

f. Quality Control Certificates: For GCL delivered to the site, quality control certificates, signed by the Manufacturer's quality assurance manager shall be provided which represent every roll of GCL. Each certificate shall have the roll identification number(s), test methods, frequency, and test results. At a minimum, the test results and frequency of testing shall be as shown in Table 2 of this section.

g. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

2. Post-Installation Requirements:

Upon completion of GCL installation the Contractor shall submit the following:

a. A certificate stating that the GCL has been installed in accordance with the Drawings, Specifications, and the Manufacturer's recommendations.

b. Completed Manufacturer's and Workmanship Warranties.

Finalization of payment for GCL installation shall not be made until the above submittals have been reviewed by the CQA Engineer.

D. CONSTRUCTION

1. Shipping , Handling, and Storage:

The GCL shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. Failing CQA Material Control Tests:

GCL that is rejected upon testing shall be removed from the project site and replaced at Contractor's cost. Sampling and CQA testing of GCL supplied as replacement for rejected material shall be performed by the CQA Engineer at Contractor's cost.

3. Installation of GCL:

- a. The surface receiving the GCL shall be prepared to a relatively smooth condition, free of obstructions, standing water, excessive depressions, debris, and very soft, excessively wet, and/or loose pockets of soil. This surface shall be approved by the CQA Engineer prior to GCL placement.
- b. GCL shall be placed to the lines and grades shown on the Contract Drawings. At the time of installation, GCL shall be rejected by the CQA Engineer if it has defects, rips, holes, flaws, evidence of deterioration, or other damage.
- c. The GCL shall not be placed during precipitation. Any material that becomes hydrated shall be removed and replaced at Contractor expense.
- d. The GCL shall be placed smooth and free of excessive wrinkles.
- e. Where horizontal seams are required on sloped surfaces, the panels shall be placed such that the "upstream" panel forms the upper panel and overlaps the "downstream" panel in order to minimize infiltration potential. All seams constructed on slopes  $\geq 6H:1V$  shall be vertical seams, except where slope lengths exceed standard roll lengths and elsewhere as approved in advance by the Engineer.
- f. All vertical panels placed on slopes  $\geq 6H:1V$  shall extend a minimum of 5 feet beyond the grade break with a slope  $< 6H:1V$ .
- g. The GCL shall be laid with a 6 inch minimum overlap seam along roll edges and a 12 inch minimum overlap seam along roll ends. Granular sodium bentonite shall be added between all overlapped seams at a rate of approximately 0.25 lbs/linear foot.

- h. GCL shall be temporarily secured in a manner approved by the CQA Engineer prior to placement of overlying materials.
- i. Any GCL that is torn, punctured, or otherwise damaged shall be repaired or replaced as directed by the CQA Engineer, by the Contractor at no additional cost to the Owner. The repair shall consist of a patch of GCL placed over the damaged areas and shall overlap the existing GCL a minimum of 12 inches from any point of the damage.
- j. GCL shall be covered with the overlying HDPE Geomembrane or otherwise protected from hydration due to rainfall (i.e. temporary tarps, scrap geomembrane) within 24 hours of GCL placement, or sooner if rain is imminent.
- k. Penetrations: All penetrations of GCL shall be made in accordance with the Contract Drawings and/or as directed by the Engineer.

4. Cover Placement:

Placement of materials over GCL shall be performed in a manner as to ensure that GCL and the underlying geosynthetics are not damaged; minimal slippage of GCL on the underlying geosynthetics occurs; no excess tensile stresses occur in the GCL; and that no portion of the GCL develops excessive wrinkles or crimp. Wrinkles that exceed approximately 6 inches in height and cannot be eliminated by amended placement and covering methods or GCL that becomes crimped shall be cut and repaired by the Geosynthetics Installer in a method approved by the Engineer.

**TABLE 1: REQUIRED GCL PROPERTIES**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>UNITS</b>	<b>VALUE<sup>1</sup></b>
Hydraulic Conductivity	ASTM D 5084/D 5887	cm/s	5 x 10 <sup>-9</sup>
Bentonite Content	ASTM D 5993	psf	0.75 (@ 0% moisture)
Bentonite Swell Index	ASTM D 5890	mL/2g	24
Thickness	ASTM D 1777	inches	0.20
Grab Tensile Strength	ASTM D 4632	lbs	150
Peel Strength <sup>2</sup>	ASTM D 6496	lbs	25
Minimum Shear Strength <sup>3</sup> (Hydrated) (Peak)	ASTM D 6243	psf	500
Interface Shear Strength (Hydrated) (Peak) <sup>4,5</sup>	ASTM D 6243	psf	125 psf (Load = 200 psf) 800 psf (2,000 psf) 1,600 psf (4,000 psf) 3,200 psf (8,000 psf)

**TABLE 2: REQUIRED MANUFACTURER'S QUALITY CONTROL TEST DATA**

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
Hydraulic Conductivity	ASTM D 5084/D 5887	Weekly
Bentonite Content	ASTM D 5993	50,000 ft <sup>2</sup>
Bentonite Swell Index	ASTM D 5890	100,000 lbs
Thickness	ASTM D 1777	Periodic
Grab Tensile Strength	ASTM D 4632	200,000 ft <sup>2</sup>
Peel Strength <sup>2</sup>	ASTM D 6496	50,000 ft <sup>2</sup>
Minimum Shear Strength <sup>3</sup> (Hydrated)	ASTM D 6243	Periodic
Interface Shear Strength	ASTM D 6243	(See Note 4)

Notes:

1. Minimum Average Roll Values (MARV).
2. Based on a 4 inch wide sample/4 inch grip width. Alternatively, a value of 15 lbs is acceptable based on a 4 inch wide sample/1 inch grip width. Also, a value of 35 lbs is acceptable using ASTM D 4632 in lieu of ASTM D 6496.
3. Peak value measured at a normal load of 200 psf.
4. Test each interface to be used on this project using representative samples of materials to be supplied under normal loads indicated and using test parameters as specified by the Engineer. For this project, interfaces to be tested are:
  - A. Textured LLDPE-GM (40 mil) against existing cover soils;
  - B. Drainage Geocomposite against textured LLDPE-GM (40 mil);
  - C. Geosynthetic Clay Liner against Drainage Geocomposite;
  - D. Textured HDPE-GM (60 mil) against Geosynthetic Clay Liner;
  - E. Drainage Geocomposite against textured HDPE-GM (60 mil); and
  - F. Protective Cover against Drainage Geocomposite.

If there are material differences in the surface of any of the geosynthetic materials from one side to the other, then all possible combinations of interfaces shall be tested. This testing shall be performed at Contractor cost by an independent GAI

accredited laboratory and submitted to the Engineer for review prior to shipping. Upon review of test results, the Engineer may allow exceptions to the above criteria.

For tests involving textured geomembranes, the laboratory shall also report the asperity height (GRI GM12) for the material samples used in the actual direct shear tests.

5. GCL shall have adequate adhesion against adjacent materials under low normal loads to achieve the successful installation of overlying components without slippage.

END OF SECTION

## SECTION 02778

### LLDPE GEOMEMBRANE

LLDPE Geomembrane (LLDPE-GM): The LLDPE Geomembrane serves as a secondary hydraulic barrier in the landfill liner system. It is of great importance that the LLDPE-GM be free from defects and installed free from damage.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of LLDPE-GM including all necessary and incidental items as detailed or required to complete the installation in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Excavation	02222
Embankment	02223
Drainage Geocomposite	02712
CQA Manual	Attached

##### 3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) and the Geosynthetic Research Institute (GRI) are hereby made a part of these Specifications.

ASTM D 792	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D 1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.

ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
ASTM D 5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
ASTM D 5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
ASTM D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
ASTM D 5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.
ASTM D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
ASTM D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
ASTM D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Flexible Polyethylene and Nonreinforced Polypropylene Geomembranes.
GRI GM9	Cold Weather Seaming of Geomembranes.
GRI GM12	Asperity Measurement of Textured Geomembranes Using a Depth Gage.

4. Quality Control:

The Geomembrane Installer shall follow the procedures and requirements described in the accompanying Project CQA Manual during installation of LLDPE-GM including performing and documenting trial seams, nondestructive and destructive Quality Control tests, and repairs.

5. Quality Assurance:

Quality Assurance during installation of LLDPE-GM will be provided by the Owner as described in the accompanying Project CQA Manual.

6. Manufacturers Qualifications:

The Manufacturer shall have previously demonstrated his ability to produce the required LLDPE-GM by having successfully manufactured a minimum of 5,000,000 ft<sup>2</sup> of LLDPE-GM for hydraulic containment purposes.

7. Installer Qualifications:

- a. Installation of the LLDPE-GM shall be performed by an Installer that has installed a minimum of 5,000,000 ft<sup>2</sup> of LLDPE-GM (or similar material) within the past five (5) years in similar landfill installations.
- b. All Installation Supervisors assigned to the Project shall have previously managed the installation of at least 2,000,000 ft<sup>2</sup> of LLDPE-GM (or similar material) using the same techniques to be used on site.
- c. All welding machine operators shall have shown proven performance on previous LLDPE-GM installations. All welding machine operators shall perform a demonstration of their welding technique and a test of the welds which they have performed prior to any welding on the project.

8. Warranties:

- a. General: Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for repair and/or relocation and replacement of the LLDPE-GM.
- b. Workmanship: The Contractor shall furnish the Owner a warranty from the Installer of the LLDPE-GM which warrants their workmanship to be free of defects on a prorata basis for five (5) years after the final acceptance of the Work. This warranty shall include but not be limited to all field-welded seams, anchor trenches, attachments to appurtenances, and penetration seals, as applicable.
- c. Manufacturer's Warranty: The Contractor shall furnish the Owner a warranty from the LLDPE-GM Manufacturer for the materials used. The material warranty shall be for defects or failures related to manufacture on a prorata basis for five (5) years after the date of shipment.

B. MATERIALS

1. General:

The materials supplied under these Specifications 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 use, to be suitable and durable for such purposes. The LLDPE-GM and LLDPE-GM Manufacturer shall be approved by the Engineer prior to the Contract award.

The LLDPE-GM shall be supplied in rolls which shall have a minimum width of 22 feet. The roll length shall be maximized to provide the largest manageable sheet for the fewest seams. Labels on the roll shall identify the thickness, length, width, lot and roll numbers, and name of Manufacturer.

2. LLDPE-GM Materials:

- a. Resin Properties: The resin shall be linear low density polyethylene (LLDPE) and shall be new, first-quality, compounded and manufactured specifically for producing LLDPE-GM. The resin shall not consist of mixed resin types. Recycled material reworked from the manufacturing process shall not exceed 5% by weight.
- b. LLDPE-GM Sheet Properties: The LLDPE-GM sheeting shall be manufactured to meet the following requirements:
  - (1) Provide finished product free from holes, pin holes, bubbles, blisters, excessive gels, undispersed resins and/or carbon black, contamination by foreign matter, and nicks or cuts on edges.
  - (2) Physical properties of the LLDPE-GM shall be as shown in Table 1 of this section.
- c. Materials classified as Very Flexible Polyethylene (VFPE) which otherwise meet the requirements of this section are also acceptable.

3. Extrusion Resin/Typical Extrudate:

Extrusion resin/typical extrudate used for extrusion welding of LLDPE-GM shall be linear low density polyethylene (LLDPE). Physical properties shall be the same as the LLDPE-GM sheet. The extrudate's additives shall be thoroughly dispersed throughout the rod or bead. The extrudate shall be free of contamination by moisture or foreign matter and shall be recommended for use with the associated sheet material.

4. Texturing:

Textured LLDPE-GM, where required, shall be fabricated using coextrusion or impingement methods and not by lamination or embossing methods. Texturing applied to LLDPE-GM using impingement methods shall be bonded securely to the parent LLDPE-GM. All texturing shall be uniform in appearance and

coverage on the finished sheet. Physical properties of textured LLDPE-GM shall be as shown in Table 1 of this section.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Pre-Installation Requirements:

Prior to LLDPE-GM installation the Contractor shall submit the following:

- a. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for the LLDPE-GM attesting that the LLDPE-GM meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of the LLDPE-GM to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.
- b. Qualifications:
  - (1) Submit list of equipment and personnel proposed for the Project. Include equipment type and quantities. Include personnel experience on similar projects.
  - (2) Submit resume and references of Installation Supervisor to be assigned to the Project, including data and duration of employment and pertinent experience information.
  - (3) Submit resumes and references of installation welders who will perform seaming operations, including dates and durations of employment and pertinent experience information.
- c. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.
- d. Delivery Date: Submit notification of the scheduled delivery dates for the materials.
- e. Installation Procedures and Drawings:

Submit installation procedures and (shop) drawings for carrying out the work.

- (1) Installation procedures to be addressed shall include but not be limited to material installation, repair, and protection to be provided in the event of rain or strong winds.
- (2) Shop drawings shall have LLDPE-GM sheet layout with proposed size, number, position, and sequence of placing all panels, and indicating the location of all field seams. Shop drawings shall also show complete details and/or methods for anchoring the LLDPE-GM, making field seams, and making seals around pipes and structures penetrating the LLDPE-GM (if applicable).

Following review, these procedures and drawings will be used for installation of the LLDPE-GM. Any deviations from these procedures and drawings must be approved by the Engineer and CQA Engineer.

- f. Quality Control Certificates: For LLDPE-GM delivered to the site, quality control certificates, signed by the Manufacturer's quality assurance manager shall be provided which represent every roll of LLDPE-GM. Each certificate shall have the roll identification number(s), test methods, frequency, and test results. At a minimum, the test results and frequency of testing shall be as shown in Table 2 of this section.
- g. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

2. Post-Installation Requirements:

Upon completion of the LLDPE-GM installation, the Contractor shall submit the following:

- a. Certificate stating that the LLDPE-GM has been installed in accordance with the Drawings, Specifications, and the Manufacturer's recommendations.
- b. Completed Manufacturer's and workmanship warranties.
- c. Record Information: Record information shall include but not be limited to:
  - (1) CQC Documentation: Includes trial weld logs, panel placement logs, panel seaming logs, non-destructive seam testing report forms, field destructive seam testing report forms, and repair logs.

- (2) As-Built Drawing: Includes the requirements listed in Paragraph D.8 (Surveying) of this Specification.

Finalization of payment for LLDPE-GM installation shall not be made until the above submittals have been reviewed by the CQA Engineer.

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

The LLDPE-GM shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. Failing CQA Material Control Tests:

LLDPE-GM that is rejected upon testing shall be removed from the project site and replaced at Contractor's cost. Sampling and CQA testing of LLDPE-GM supplied as replacement for rejected material shall be performed by the CQA Engineer at Contractor's cost.

3. Subgrade Preparation:

a. The surface of the subgrade shall be smooth, uniform, free from sudden changes in grade (such as vehicular ruts), rocks or stones greater than ½ inch in size, debris, and deleterious materials. During actual placing and seaming of the LLDPE-GM, the subgrade shall be kept free of all standing water. If the subgrade below the LLDPE-GM becomes excessively wet and unstable as determined by the CQA Engineer, it shall be dried and recompacted, and replaced if needed.

b. Before an individual panel of LLDPE-GM is installed; the Contractor and Installer shall verify in writing and submit to the CQA Engineer:

(1) Lines and grades are in conformance with the Drawings and Specifications.

(2) The surface area to be lined has been rolled and compacted, free of irregularities and abrupt changes in grade.

4. LLDPE-GM Placement:

a. Weather Conditions:

LLDPE-GM placement shall not proceed at an ambient temperature below 32° F or above 100° F unless otherwise authorized, in writing, by the

Engineer. Installation of LLDPE-GM at temperatures below 32° F, if authorized by the Engineer, shall follow GRI GM9. LLDPE-GM placement shall not be performed during precipitation, excessive moisture, in an area of ponded water, or in excessive winds. Any portion of LLDPE-GM or subgrade damaged due to weather conditions shall be repaired at the Contractor's cost.

b. Method of Placement:

- (1) Each panel of the LLDPE-GM shall be installed in accordance with the approved shop drawings prepared by the Contractor. The layout shall be designed to keep field seaming of the LLDPE-GM to a minimum and consistent with proper methods of LLDPE-GM installation.
- (2) Panels shall be oriented perpendicular to the line of the slope crest (i.e., down and not across slope).
- (3) The LLDPE-GM shall be placed smooth and free of excessive wrinkles.
- (4) LLDPE-GM rolls shall be placed using proper spreader and rolling bars with cloth slings. If a sheet must be displaced a distance greater than its width, a slip sheet shall be used.
- (5) The CQA Engineer shall inspect each panel, after placement and prior to seaming, for damage and/or defects. Defective or damaged panels shall be replaced or repaired, as approved by the CQA Engineer and as described in this section.
- (6) The Installer shall avoid dragging the LLDPE-GM on rough soil subgrades.
- (7) All LLDPE-GM shall be anchored as shown on the Contract Drawings and consistent with Manufacturer's recommendations.
- (8) Personnel working on the LLDPE-GM shall not smoke, wear damaging shoes, or involve themselves in any activity that may damage the LLDPE-GM, in the opinion of the CQA Engineer.
- (9) The LLDPE-GM shall be properly weighted to avoid uplift due to wind.
- (10) Vehicular traffic across the LLDPE-GM shall not be allowed, except that four-wheel (or greater) all-terrain vehicles (ATVs) with

low ground pressure may be allowed if approved in advance by the Engineer. The Contractor shall submit proposed equipment and procedures for use of ATVs to the CQA Engineer as part of his submittals. If ATVs are allowed by the Engineer, each ATV will be operated such that no sudden stops, starts, or turns are made.

- (11) All damage shall be recorded and located on the record drawings.
- (12) The LLDPE-GM shall be kept free of debris, unnecessary tools, and materials. In general, the LLDPE-GM area shall remain neat in appearance.

5. Field Seams:

- a. Individual panels of LLDPE-GM shall be laid out and overlapped by a minimum of 4 inches prior to welding. The area to be welded shall be cleaned and prepared in accordance with the Manufacturer's recommendations.
- b. Single or double track hot wedge fusion welds shall be used for straight seams.
- c. Extrusion welds shall be used for cross seam tees, patches, repairs, and penetration boots. To limit overgrinding, the amount of grinding exposed after an extrusion seam is completed should be less than ¼ inch.
- d. The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the LLDPE-GM so as to ensure that changes in environmental conditions will not affect the integrity of the weld.
- e. All seams shall have a seam number that corresponds with the panel layout numbers. The numbering system shall be used in the development of the record drawings. Seam numbers shall be derived from the combination of the two panel numbers that are to be welded together.
- f. All fusion welded "T" seams (i.e., the result of panels placed perpendicular to each other) shall be double welded where possible. The extrusion process shall be used for the second weld.
- g. All extrudate shall be free of dirt, dry, and protected from damage.
- h. If an extrusion welder is stopped for longer than one minute, it shall be purged to remove heat-degraded extrudate. All purged extrudate shall be placed on a sacrificial sheet and disposed of.

- i. Where horizontal seams are required on sloped surfaces, the panels shall be placed such that the "upstream" panel forms the upper panel and overlaps the "downstream" panel in order to minimize infiltration potential. All seams constructed on slopes  $\geq 6H:1V$  shall be vertical seams, except where slope lengths exceed standard roll lengths and elsewhere as approved in advance by the Engineer.
  - j. All vertical panels placed on slopes  $\geq 6H:1V$  shall extend a minimum of 5 feet beyond the grade break with a slope  $< 6H:1V$ .
  - k. All end seams shall be staggered a minimum of 5 feet in length between contiguous panels.
  - l. To prevent moisture buildup during fusion welding, it may be necessary to place a movable protective layer of plastic directly below each overlap of LLDPE-GM that is to be seamed.
  - m. If required, a firm substrate shall be provided by using a flat board or similar hard surface directly under the seam overlap to achieve proper support.
  - n. All seams shall extend to the full extent of the anchor trench.
  - o. All seams (including repairs) shall meet seam strength requirements specified in Table 3 of this section.
  - p. No overlying material shall be placed over the LLDPE-GM until approved by the CQA Engineer.
6. Anchor Trench:
- a. The anchor trench shall be constructed as shown on the Contract Drawings and as specified herein. The anchor trench shall be maintained by the Contractor.
  - b. Slightly rounded corners shall be provided in the trench to avoid sharp bends in the LLDPE-GM.
  - c. The anchor trench shall be adequately drained to prevent water ponding and softening to adjacent soils. The anchor trench shall be backfilled with controlled fill material and compacted to 90% standard Proctor dry density (ASTM D 698).

- d. If the anchor trench is located in a clay susceptible to desiccation, the amount of trench open at any time shall be limited to one day of LLDPE-GM installation capacity.

7. Repair Procedures:

- a. Any portion of the LLDPE-GM exhibiting signs of defect or failing a nondestructive or a destructive test, shall be repaired by the Geomembrane Installer. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be made by the CQA Engineer. The procedures available include:
  - (1) Patching - Apply a new piece of LLDPE-GM sheet over, and at least 6-inches beyond the limits of a defect. The patch shall be extrusion seamed to the underlying LLDPE-GM. This method should be used to repair holes, tears, destructive test locations, undispersed raw materials, contamination by foreign matter, dents, pinholes, and pressure test holes.
  - (2) Capping - Apply a new strip of LLDPE-GM along the length of a delineated faulty seam. The cap strip shall extend at least 6-inches beyond the limit of the seam and the edges will be extrusion seamed to the underlying LLDPE-GM. This method should be used to repair lengths of extrusion or fusion seams.
  - (3) Replacement - The faulty seam is removed and replaced.
- b. In addition, the following provisions shall be satisfied:
  - (1) Surfaces of the LLDPE-GM which are to be repaired will be abraded no more than one hour prior to the repair;
  - (2) All surfaces must be clean and dry at the time of the repair;
  - (3) All seaming equipment used in repairing procedures must be approved;
  - (4) The repair procedures, materials, and techniques will be approved in advance of the specific repair by the CQA Engineer;
  - (5) Extrusion welding of flaps of double track hot wedge fusion welded seams is not acceptable. A patch or cap strip shall be used; and

- (6) Patches or caps will extend at least 6-inches beyond the edge of the defect, and all patch corners will be rounded.

8. Surveying:

- a. After completion of a segment of LLDPE-GM, the Contractor shall survey LLDPE-GM to obtain the following information:
  - (1) Location and numbering of all panels/seams.
  - (2) Location of all repairs/patches;
  - (3) Location of all destructive test locations; and
  - (4) Location of all pipe penetrations and other appurtenances (if applicable).
- b. No overlying materials shall be placed before survey information is obtained.
- c. The Contractor shall provide the CQA Engineer with updated survey information when requested by the CQA Engineer to verify that the required information is being obtained.

9. Cover Placement:

Placement of materials over LLDPE-GM shall be performed in a manner as to ensure that LLDPE-GM and the underlying geosynthetics are not damaged; minimal slippage of LLDPE-GM on the underlying geosynthetics occurs; no excess tensile stresses occur in the LLDPE-GM; and that no portion of the LLDPE-GM develops excessive wrinkles or crimp. Wrinkles that exceed approximately 6 inches in height and cannot be eliminated by amended placement and covering methods or LLDPE-GM that becomes crimped shall be cut and repaired by the Geosynthetics Installer in a method approved by the Engineer.

**TABLE 1: REQUIRED LLDPE-GM PROPERTIES**

PROPERTY	TEST METHOD	UNITS	VALUE
			40 mil Textured <sup>1</sup>
Thickness <sup>2</sup>	ASTM D 5994	mils	40
Asperity Height (typ.)	GRI GM12	mils	20 (See Note 3)
Density	ASTM D 1505/D 792	g/cm <sup>3</sup>	≤ 0.939
Carbon Black Content	ASTM D 1603	%	2.0-3.0
Carbon Black Dispersion	ASTM D 5596	category	See Note 4
Tensile Properties:	ASTM D 6693 Type IV (See Note 5)		
Tensile Strength at Break		lb/inch	≥ 60
Elongation at Break		%	≥ 250
Tear Resistance	ASTM D 1004	lbs	≥ 22
Interface Shear Strength (Peak) <sup>6</sup>	ASTM D 5321	psf	125 psf (Load = 200 psf) 800 psf (2,000 psf) 1,600 psf (4,000 psf) 3,200 psf (8,000 psf)

Notes:

1. Textured LLDPE-GM is textured on both sides.
2. For textured LLDPE-GM, the lowest individual thickness for 8 out of 10 values = -10%; the lowest individual thickness of any of the 10 values = -15%.
3. Or as otherwise required to satisfy interface shear strength criteria.
4. Carbon black dispersion for 10 different views:
  - minimum 8 of 10 in Categories 1 or 2
  - all 10 in Categories 1, 2, or 3.
5. Break elongation calculated with a gauge length of 2.0 inches at 2.0 in/min.
6. Textured LLDPE-GM shall have adequate adhesion against adjacent materials under low normal loads to achieve the successful installation of overlying components without slippage.

**TABLE 2: REQUIRED MANUFACTURER'S QUALITY CONTROL TEST DATA**

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
Thickness	ASTM D 5199/D 5994	Every Roll
Asperity Height	GRI GM12	Every 2 <sup>nd</sup> Roll (See Note 1)
Density	ASTM D 1505/D 792	200,000 lb
Carbon Black Content	ASTM D 1603	45,000 lb
Carbon Black Dispersion	ASTM D 5596	45,000 lb
Tensile Properties	ASTM D 6693 Type IV	20,000 lb
Tear Resistance	ASTM D 1004	45,000 lb
Interface Shear Strength	ASTM D 5321	(See Note 2)

Notes:

1. Alternate the measurement side for double sided textured sheet.
2. Test each interface to be used on this project using representative samples of materials to be supplied under normal loads indicated and using test parameters as specified by the Engineer. For this project, interfaces to be tested are:
  - A. Textured LLDPE-GM (40 mil) against existing cover soils;
  - B. Drainage Geocomposite against textured LLDPE-GM (40 mil);
  - C. Geosynthetic Clay Liner against Drainage Geocomposite;
  - D. Textured HDPE-GM (60 mil) against Geosynthetic Clay Liner;
  - E. Drainage Geocomposite against textured HDPE-GM (60 mil); and
  - F. Protective Cover against Drainage Geocomposite.

If there are material differences in the surface of any of the geosynthetic materials from one side to the other, then all possible combinations of interfaces shall be tested. This testing shall be performed at Contractor cost by an independent GAI accredited laboratory and submitted to the Engineer for review prior to shipping. Upon review of test results, the Engineer may allow exceptions to the above criteria.

For tests involving textured geomembranes, the laboratory shall also report the asperity height (GRI GM12) for the material samples used in the actual direct shear tests.

**TABLE 3: REQUIRED SEAM STRENGTH PROPERTIES**

PROPERTY	TEST METHOD	MINIMUM VALUE
		40 mil
Bonded Shear Strength	ASTM D 6392	56 lb/inch and FTB <sup>1</sup>
Seam Peel Adhesion	ASTM D 6392	48 lb/inch and FTB <sup>1</sup>

Notes:

1. FTB = Film-Tear-Bond = Tearing in the membrane itself before ply separation of the seam.

END OF SECTION

SECTION 02782

GEOSYNTHETIC RAIN COVER

Geosynthetic Rain Cover (GRC): The Geosynthetic Rain Cover serves to minimize infiltration of precipitation within inactive portions of the landfill into the underlying leachate collection system. It is of great importance that the GRC be free from defects and installed free from damage.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to install GRC including all necessary and incidental items as detailed or required to complete the installation in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Protective Cover	02256
Drainage Aggregate (Leachate Management)	02710
CQA Manual	Attached

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these Specifications.

ASTM D 638            Standard Test Method for Tensile Properties of Plastics.

ASTM D 751            Standard Test Methods for Coated Fabrics.

ASTM D 792            Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

ASTM D 1004           Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.

ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
ASTM D 5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
ASTM D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
ASTM G 154	Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

4. Quality Assurance:

Quality Assurance during installation of GRC will be provided by the Owner as described in the accompanying Project CQA Manual.

5. Manufacturers Qualifications:

The Manufacturer shall have previously demonstrated his ability to produce the required GRC by having successfully manufactured a minimum of 5,000,000 ft<sup>2</sup> of GRC (or similar material) for hydraulic containment purposes.

6. Installer Qualifications:

The GRC Installer shall have installed a minimum of 500,000 ft<sup>2</sup> of GRC (or similar material) in similar landfill installations.

7. Warranties:

- a. General: Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for repair and/or relocation and replacement of the GRC.

- b. Material Performance: The Contractor shall furnish the Owner a warranty from the Installer of the GRC which warrants the material performance on a non-prorata basis for one (1) year after the final acceptance of the Work. This warranty shall include but not be limited to defects related to workmanship and manufacturing and damage caused by exposure and wind.

B. MATERIALS

1. General:

The materials supplied under these Specifications shall consist of first-quality products designed and manufactured specifically for the purpose of this work, which shall have been satisfactorily demonstrated, by prior use, to be suitable and durable for such purposes.

The GRC shall be supplied in panels which shall be of maximum size to provide the largest manageable sheet for the fewest seams. Labels on the panels shall identify the thickness, length, width, lot and panel numbers, and name of Manufacturer.

2. GRC Materials:

GRC shall be manufactured to meet the following requirements:

- a. Provide finished product free from holes, pin holes, bubbles, blisters, excessive gels, undispersed resins and/or carbon black, contamination by foreign matter, and nicks or cuts on edges.
- b. GRC shall be either a high density polyethylene (HDPE) unreinforced geomembrane, a reinforced geomembrane composed of a polyethylene, polypropylene, or polyvinyl chloride (PVC) based material, or a woven coated polyethylene material. GRC shall have the physical properties as shown in Table 1 of this section
- c. GRC shall be impermeable, capable of repelling water with no absorption.

3. Seaming Materials:

Materials used for seaming GRC (if used) shall be as recommended by the Manufacturer and approved by the Engineer.

4. Ballast System:

In addition to anchoring the edges of the GRC within the Protective Cover (as shown on the Contract Drawings, or, if not shown, in a 1 foot by 1 foot min. anchor trench), the Contractor shall place tires (typical auto - off rim) (or other ballast as approved by the Owner and Engineer) on top of the GRC on 8 foot centers over the entire area covered by the GRC. Ballast shall have sufficient UV resistance to maintain its integrity over the Contractor's Performance Warranty period. The Owner anticipates receiving an adequate supply of used tires on-site (at convenience center) during the duration of the project which the Contractor may use as ballast. The Contractor shall coordinate with the Owner to collect and move these tires as required by the Owner.

For slopes  $\geq 5H:1V$ , the Contractor shall tie tires together with  $\frac{3}{8}$  inch min. nylon rope on a horizontal and vertical grid with anchors at the top of the slopes for the rope. Anchors shall be 1 inch by 1 inch (actual dimensions) by 2 foot long treated wood stakes, or approved equal.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Pre-Installation Requirements:

Prior to GRC installation the Contractor shall submit the following:

- a. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for the GRC attesting that the GRC meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of the GRC to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.
- b. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.
- c. Installation Procedures:

Submit installation procedures for carrying out the work. Installation procedures to be addressed shall include but not be limited to material installation, repair, and protection to be provided in the event of rain or strong winds. With regard to protection, the Contractor shall provide a plan of anchoring the GRC sufficient to satisfy the Contractor's Performance Warranty. At a minimum, this plan shall meet the criteria

described in Paragraph B.4 above and shall indicate the selected spacing and weight of the ballast to be used. This plan shall be approved by the Engineer prior to construction.

- d. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

2. Post-Installation Requirements:

Upon completion of the GRC installation, the Contractor shall submit the following:

- a. Completed material performance warranty.

Finalization of payment for GRC installation shall not be made until the above submittals have been reviewed by the CQA Engineer.

#### D. CONSTRUCTION

1. Shipping, Handling, and Storage:

The GRC shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. Subgrade Preparation:

The surface of the subgrade shall be smooth, uniform, free from sudden changes in grade (such as vehicular ruts), rocks or stones greater than ½ inch in maximum size (except for gravel columns), debris, and deleterious materials. During actual placing and seaming of the GRC, the subgrade shall be kept free of all standing water. If the subgrade below the GRC becomes excessively wet and unstable, as determined by the CQA Engineer it shall be dried and recompacted, and replaced if needed.

3. GRC Placement:

- a. Weather Conditions:

GRC placement shall not proceed at an ambient temperature below 32° F or above 100° F unless otherwise authorized, in writing, by the Engineer. GRC placement shall not be performed during precipitation, excessive moisture, in an area of ponded water, or in excessive winds. Any portion of GRC or subgrade damaged due to weather conditions shall be repaired at the Contractor's cost.

b. Method of Placement:

- (1) Each panel of the GRC shall be installed in accordance with the Manufacturer's recommendations.
- (2) The CQA Engineer shall inspect each panel, after placement and prior to seaming, for damage and/or defects. Defective or damaged panels shall be replaced or repaired, as approved by the CQA Engineer and as described in this section.
- (3) The Installer shall avoid dragging the GRC on rough soil subgrades.
- (4) Personnel working on the GRC shall not smoke, wear damaging shoes, or involve themselves in any activity that may damage the GRC, in the opinion of the CQA Engineer.
- (5) The GRC shall be properly weighted to avoid uplift due to wind.
- (6) Vehicular traffic across the GRC shall not be allowed.
- (7) The GRC shall be kept free of debris, unnecessary tools, and materials. In general, the GRC area shall remain neat in appearance.

c. Pipe Penetrations:

All pipe penetrations through the GRC shall consist of a GRC boot which is banded to the penetrating pipe so as to prevent the intrusion of water or wind beneath the GRC. All pipe penetrations shall be approved by the CQA Engineer.

4. Field Seams:

- a. Field seams shall be made according to the Manufacturer's recommendations and may include fusion welding, taping, chemical fusion, or other methods as appropriate for the selected material and as approved by the Engineer.
- b. Individual panels of GRC shall be laid out and overlapped by a minimum of 4 inches prior to seaming. The area to be seamed shall be cleaned and prepared in accordance with the Manufacturer's recommendations.
- c. All seams constructed on sloped surfaces shall be vertical seams. Where horizontal seams are required and no other option is available on sloped

surfaces, the panels shall be placed such that the "upstream" panel forms the upper panel and overlaps the "downstream" panel in order to minimize infiltration potential.

5. Repair Procedures:

- a. Any portion of the GRC exhibiting signs of defect shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be made by the CQA Engineer.

6. Ballasting:

The Contractor shall add ballasting in accordance with the approved plan.

7. No overlying material shall be placed over the GRC until approved by the CQA Engineer.

**TABLE 1: REQUIRED GRC PROPERTIES**

PROPERTY	TEST METHOD	UNITS	VALUE <sup>6</sup>
<b>Unreinforced Geomembranes:</b>			
Thickness (Nominal) <sup>2</sup>	ASTM D 5199	mils	20
Density	ASTM D 1505/D 792	g/cm <sup>3</sup>	≥ 0.940
Carbon Black Content <sup>2</sup>	ASTM D 1603	%	2.0-3.0
Carbon Black Dispersion <sup>2</sup>	ASTM D 5596	category	See Note 3
Tensile Properties:	ASTM D 638 Type IV (See Note 4)		
Tensile Strength at Yield		lb/inch	≥ 30
Tensile Strength at Break		lb/inch	≥ 60
Elongation at Yield		%	≥ 10
Elongation at Break		%	≥ 500
Tear Resistance	ASTM D 1004	lbs.	≥ 10
Puncture Resistance	ASTM D 4833	lbs.	≥ 36
Stress Crack Resistance	ASTM D 5397 (App.)	hrs.	≥ 400
<b>Reinforced Geomembranes/Woven Coated Polyethylene Materials:</b>			
Thickness (Nominal) (Measured Across Reinforcement)	ASTM D 5199	mils	12
Grab Tensile Strength	ASTM D 751 Proc. A	lbs.	≥ 200 MD ≥ 170 CD (See Note 5)
Mullen Burst	ASTM D 751	psi	≥ 300
Trapezoidal Tear	ASTM D 4533	lbs.	≥ 45 MD ≥ 35 CD (See Note 5)
Accelerated Weathering (2,000 Hours)	ASTM G 154	%	≥ 95% Strength Retained

Notes:

1. The lowest individual thickness of 10 values = -10%.
2. Carbon black content and carbon black dispersion are applicable to black HDPE sheet only. Where white HDPE is used or where a white HDPE layer is coextruded with a black HDPE layer, the white HDPE shall be UV stabilized.
3. Carbon black dispersion for 10 different views:
  - minimum 8 of 10 in Categories 1 or 2
  - all 10 in Categories 1, 2, or 3.
4. Yield elongation calculated with a gauge length of 1.3 inches. Break elongation calculated with a gauge length of 2.0 inches.
5. MD = Machine Direction; CD = Cross Direction.
6. The Engineer may allow alternates to these requirements.

END OF SECTION

## SECTION 02930

### REVEGETATION

Revegetation: Revegetation includes permanent Revegetation of all site areas disturbed by the Contractor whether inside the Contract Limits or not.

#### A. DESCRIPTION

##### 1. General:

The Contractor shall furnish all labor, material, and equipment to complete Revegetation in accordance with the Contract Drawings and these Specifications.

##### 2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Embankment	02223
Protective Cover	02256
Erosion and Sedimentation Control	02270
Rolled Erosion Control Products	02275

##### 3. Warranty:

The Contractor shall be responsible for the satisfactory establishment and growth of a permanent stand of vegetation for a period of one year following the final seeding as judged by the Engineer. During this period, the Contractor shall be responsible for the maintenance items described in Paragraph D.4 (Maintenance) of this Specification.

#### B. MATERIALS

1. Limestone: Unless otherwise defined by specific soil tests, supply agricultural grade ground limestone conforming to the current "Rules, Regulations, and Standards of the Fertilizer Board of Control."

2. Fertilizer: Unless otherwise defined by specific soil tests, supply commercial fertilizer of 10-20-10 analysis, meeting applicable requirements of State and Federal law. Do not use cyanamic compounds of hydrated lime. Deliver fertilizer in original containers labeled with content analysis.

3. Grass Seed: Supply fresh, clean, new-crop seed as specified in Table 1 of this section. Do not use seed which is wet, moldy, or otherwise damaged. Deliver seed in standard sealed containers labeled with producer's name and seed analysis, and in accord with US Department of Agriculture Rules and Regulations under Federal Seed Act.
4. Mulch: Supply clean, seed-free, threshed straw of oats, wheat, barley, rye, beans, or other locally available mulch material.
  - a. Do not use mulch containing a quantity of matured, noxious weed seeds or other species that will be detrimental to seeding, or provide a menace to surrounding land.
  - b. Do not use mulch material which is fresh or excessively brittle, or which is decomposed and will smother or retard growth of grass.
5. Binder: Supply emulsified asphalt or synthetic binder.
6. Water: Supply potable, free of substances harmful to growth.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Results of soil tests performed and proposed modifications, if any, to the specified requirements.
2. Certificates for each grass seed mixture, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed. Certify that each container of seed delivered is fully labeled in accordance with Federal Seed Act and equals or exceeds specification requirements.
3. Copies of invoices for fertilizer, showing grade furnished and total quantity applied.

D. CONSTRUCTION

1. The Contractor shall establish a smooth, healthy, uniform, close stand of grass from the specified seed. Prior to Revegetation, the Contractor shall adequately test the soils to be revegetated to ensure the adequacy of the specified requirements. Any modifications to these requirements deemed necessary after the review of soil test results, shall be at the Contractor's sole expense. The Engineer will perform the observations to determine when successful Revegetation is achieved.

2. Soil Preparation:

- a. Limit preparation to areas which will be planted soon after preparation.
- b. Loosen surface to minimum depth of four (4) inches.
- c. Remove stones, sticks, roots, rubbish and other extraneous matter over three (3) inches in any dimension.
- d. Spread lime uniformly over designated areas at the rate specified in Table 1 of this section.
- e. After application of lime, prior to applying fertilizer, loosen areas to be seeded with double disc or other suitable device if soil has become hard or compacted. Correct any surface irregularities in order to prevent pocket or low areas which will allow water to stand.
- f. Distribute fertilizer uniformly over areas to be seeded at the rate specified in Table 1 of this section.
  - (1) Use suitable distributor.
  - (2) Incorporate fertilizer into soil to depth of a least two (2) inches.
  - (3) Remove stones or other substances which will interfere with turf development or subsequent mowing.
- g. Grade seeded areas to smooth, even surface with loose, uniformly fine texture.
  - (1) Roll and rake, remove ridges and fill depressions, as required to meet finish grades.
  - (2) Fine grade just prior to planting.

3. Seeding:

- a. Use approved mechanical power driven drills or seeders, mechanical hand seeders, or other approved equipment.
- b. Distribute seed evenly over entire area at the rate specified in Table 1 of this section.

- c. Stop work when work extends beyond most favorable planting season for species designated, or when satisfactory results cannot be obtained because of drought, high winds, excessive moisture, or other factors.
- d. Resume work only when favorable condition develops, or as directed by the Engineer.
- e. Lightly rake seed into soil followed by light rolling or cultipacking.
- f. Immediately protect seeded areas against erosion by mulching or placing Rolled Erosion Control Products in accordance with Section 02275 of these Specifications, where applicable.
  - (1) Spread mulch in a continuous blanket at the rate specified in Table 1 of this section.
  - (2) Immediately following spreading mulch, secure with evenly distributed binder at the rate specified in Table 1 of this section.

4. Maintenance:

The Contractor shall be responsible for maintaining all seeded areas through the end of his warranty period. The Contractor shall provide, at his expense, protection of all seeded areas against damage at all times until acceptance of the work. Maintenance shall include, but not be limited to, the following items:

- a. Regrade and revegetate all eroded areas until adequately stabilized by grass.
- b. Remulch with new mulch in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose. Anchor as required to prevent displacement.
- c. Replant bare areas using same materials specified.

**TABLE 1: SEEDING SCHEDULE**

MATERIAL	SEED TYPE	APPLICATION RATE <sup>1</sup>
Lime	-----	4,000 lbs/acre
Fertilizer	-----	1,000 lbs/acre
Seed		
Permanent:	Kentucky 31 Tall Fescue	80 lbs/acre
	Pensacola Bahiagrass	50 lbs/acre
	Sericea Lespedeza <sup>3</sup>	30 lbs/acre
	Kobe Lespedeza	10 lbs/acre
	Seasonal Nurse Crop <sup>2</sup>	See Note 2
Temporary:	Seasonal Nurse Crop <sup>2</sup>	See Note 2
Mulch	-----	4,000 - 5,000 lbs/acre
Binder	-----	150 gallons/acre

Notes:

1. Application rates and/or chemical analysis shall be confirmed or established by a soil test.
2. Use seasonal nurse crop in accordance with seeding dates as stated below:

April 15 - August 15	10 lbs/acre German Millet or 15 lbs/acre Sudangrass
August 16 - April 14	25 lbs/acre Rye (grain).
3. From September 1 - March 1, use unscarified Sericea seed.

END OF SECTION

SECTION 13255

LANDFILL GAS SYSTEM

Landfill Gas System: The Landfill Gas System includes a network of surface collector trenches and landfill gas flares installed under the piggyback liner system in order to collect and vent/burn landfill gas, which builds up due to the decomposition of waste.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of the Landfill Gas System in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

<u>Work</u>	<u>Section</u>
Excavation	02222
Geotextiles	02240
HDPE Pipe	02614
Drainage Geocomposite	02712

3. Reference Standards:

The latest revision of the following standards of the North Carolina Department of Transportation (NCDOT) are hereby made a part of these specifications.

NCDOT Standard Specifications for Roads and Structures.

B. MATERIALS

1. All pipe used for construction of Landfill Gas System shall be either solid (riser pipe) or perforated (collector pipe) HDPE Pipe in accordance with Section 02614, HDPE Pipe, of these Specifications. The pipe SDR and diameter shall be as shown on the Contract Drawings.
2. Backfill for collector trenches shall be NCDOT #57 stone.

3. Geotextiles used for collector trenches shall conform to the requirements outlined in Section 02240, Geotextiles, of these Specifications.
4. Drainage Geocomposite used for collector trenches shall conform to the requirements outlined in Section 02712, Drainage Geocomposite, of these Specifications.
5. Landfill Gas Utility Flares: Landfill gas utility flares shall be solar ignited. Utility flares shall be Model CF-5 as manufactured by Landfill Technologies, Inc., or approved equal.

C. SUBMITTALS

1. Submit a certification and summary of all required test results, prior to installation, that all Landfill Gas System components manufactured for the project have been produced in accordance with these Specifications.
2. Submit Shop Drawings for all components and accessories prior to installation. Submittals shall include all layout dimensions, size and materials of construction for all components, information on support and anchoring where necessary, and complete descriptive information to demonstrate full compliance with the Contract Documents.
3. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.
4. Operation and maintenance manuals and installation instructions shall be submitted for all utility flares and accessories. The Manufacturer(s) shall delete all information which does not apply to the equipment being furnished.

D. CONSTRUCTION

1. All Landfill Gas System components shall be constructed at the locations and according to the details shown on the Contract Drawings. Care shall be taken to ensure that these locations are not in areas which are prone to pond water.
2. The depth of surface collector trenches shall be adjusted such that the perforated HDPE piping and stone backfill breaches the existing final/intermediate cover or to a maximum depth of four feet if no waste is encountered.
3. The Contractor shall exercise caution as excavations will extend into existing municipal solid waste. The Contractor shall construct surface collector trenches such that Contractor personnel are not required to enter the excavation.

4. All waste materials removed during construction of Landfill Gas System components shall be disposed of on site in the active lined landfill as directed by the Owner and Engineer. The Contractor shall weigh waste materials at the facility scales prior to disposal. No tipping fee will be charged to the Contractor for disposal of these wastes.

END OF SECTION

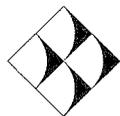
# **Construction Quality Assurance Manual**

## **Johnston County MSW Landfill Phase 4A - Cell 2 Construction**

Prepared for:

**Johnston County Department of Public Utilities**  
Smithfield, North Carolina

**November 2004**



**G.N. Richardson & Associates, Inc.**

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**JOHNSTON COUNTY  
JOHNSTON COUNTY MSW LANDFILL - PHASE 4A - CELL 2**

**CONSTRUCTION QUALITY ASSURANCE MANUAL**

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## SECTION 1.0 GENERAL

### 1.1 INTRODUCTION

This Construction Quality Assurance (CQA) Manual has been prepared to provide the Owner, (Design) Engineer, and CQA Engineer the means to govern the construction quality and to satisfy landfill certification requirements under current solid waste management regulations.

More specifically, this CQA Manual addresses the soils and geosynthetics components of the liner system and the leachate management system. The liner system, as referenced herein, consists of a soil subgrade and a double composite liner (including layers of LLDPE geomembrane, geosynthetic clay liner (GCL), and HDPE geomembrane). The leachate management system consists of a leak detection system (LDS) and a leachate collection system (LCS), which both consist of granular and geosynthetic drainage materials and perforated collection piping.

The CQA Manual is divided into the following sections:

- Section 1.0      General
- Section 2.0      CQA Documentation
- Section 3.0      Earthwork CQA
- Section 4.0      Geosynthetic Clay Liner CQA
- Section 5.0      Geomembrane CQA
- Section 6.0      Leachate Management System CQA
- Section 7.0      Geotextile CQA
- Section 8.0      Drainage Geocomposite CQA

### 1.2 DEFINITIONS RELATING TO CONSTRUCTION QUALITY

#### 1.2.1 Construction Quality Assurance (CQA)

In the context of this Manual, Construction Quality Assurance is defined as a planned and systematic program employed by the Owner to assure conformity of the liner and leachate management systems installation with the project drawings and the project specifications. CQA is provided by the CQA Engineer as a representative of the Owner and is independent from the Contractor and all manufacturers. The CQA program is designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service.

#### 1.2.2 Construction Quality Control (CQC)

Construction Quality Control refers to actions taken by manufacturers, fabricators, installers, and/or the Contractor to ensure that the materials and the workmanship meet the requirements of the project drawings and the project specifications. The manufacturer's

specifications and quality control (QC) requirements are included in this CQA Manual by reference only. A complete updated version of each geosynthetic component manufacturer's QC Plan shall be incorporated as part of the Contractor's CQC Plan.

### **1.2.3 CQA Certification Document**

At the completion of construction, a certification document will be prepared by the CQA Engineer and submitted to State Solid Waste Regulators. The certification report will include all QC testing performed by the Geosynthetics Manufacturers, all CQC testing performed by the Geosynthetic Installers, and all CQA testing performed by the CQA Engineer.

### **1.2.4 Discrepancies Between Documents**

The Contractor is instructed to bring discrepancies to the attention of the CQA Engineer who shall then notify the Engineer for resolution. The Engineer has the sole authority to determine resolution of discrepancies existing within the Contract Documents (this may also require the approval of State Solid Waste Regulators). Unless otherwise determined by the Engineer, the more stringent requirement shall be the controlling resolution.

## **1.3 PARTIES TO CONSTRUCTION QUALITY ASSURANCE**

### **1.3.1 Description of the Parties**

The parties to Construction Quality Assurance and Quality Control include the Owner, Engineer, Contractor, Geosynthetics Manufacturer, Geosynthetics Installer, CQA Engineer, Geosynthetics CQA Laboratory, and Soils CQA Laboratory.

#### **1.3.1.1 Owner**

The Owner is Johnston County, NC, who owns and/or is responsible for the facility.

#### **1.3.1.2 Engineer**

The Engineer is responsible for the engineering design, drawings, and project specifications for the liner and leachate management systems. The Engineer is an official representative of the Owner. The Engineer serves as communications coordinator for the project, initiating the meetings outlined in **Section 1.7**. The Engineer shall also be responsible for proper resolution of all quality issues that arise during construction. The Engineer is G.N. Richardson & Associates, Inc.

#### **1.3.1.3 Contractor**

The Contractor is responsible for the construction of the subgrade, earthwork, and for placement of the liner and leachate management systems. The Contractor is

responsible for the overall CQC on the project and coordination of submittals to the CQA Engineer. Additional responsibilities of the Contractor are defined by the project specifications.

#### 1.3.1.4 Geosynthetics Manufacturer

The Geosynthetics Manufacturer(s) is (are) responsible for the production of the geosynthetic components used in landfill construction. The Manufacturer(s) is (are) responsible for Quality Control (QC) during manufacture of the geosynthetic components, certification of the properties of the geosynthetic components, and field installation criteria.

#### 1.3.1.5 Geosynthetics Installer

The Geosynthetics Installer(s) is (are) routinely a subcontractor of the Contractor and is (are) responsible for field handling, storing, placing, seaming, protection of (against wind, etc.), and other aspects of the geosynthetics installations. The Installer may also be responsible for transportation of these materials to the site, and for the preparation and completion of anchor trenches.

#### 1.3.1.6 CQA Engineer

The CQA Engineer is a representative of the Owner, is independent from the Contractor, and is responsible for observing, testing, and documenting activities related to the CQA of the earthworks at the site, and the installation of the soil and geosynthetic components of the liner and leachate management systems. The CQA Engineer may make field observations and review submittals for the Engineer and is responsible for notifying the Owner and Engineer of all quality issues that arise during construction. The CQA Engineer is also responsible for issuing a facility certification report, sealed by a Professional Engineer registered in The State of North Carolina.

#### 1.3.1.7 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory is a party, independent from the Owner, that is responsible for conducting tests on conformance samples of geosynthetics used in the liner and leachate management systems. The Geosynthetics CQA Laboratory service cannot be provided by any party involved with the manufacture, fabrication, or installation of any of the geosynthetic components. The services of the Geosynthetics CQA Laboratory are coordinated by the CQA Engineer and are paid for by the Owner.

#### 1.3.1.8 Soils CQA Laboratory

The Soils CQA Laboratory is a party, independent from the Owner, that is responsible for conducting geotechnical tests on conformance samples of soils and aggregates used in structural fills and the liner and leachate management systems. The services of the Soils CQA Laboratory are coordinated by the CQA Engineer and are paid for by the Owner.

### 1.3.2 Qualifications of the Parties

The following qualifications are required of all parties involved with the manufacture, fabrication, installation, transportation, and CQA of all materials for the liner and leachate management systems. Where applicable, these qualifications must be submitted by the Contractor to the Owner and Engineer for review and approval.

#### 1.3.2.1 Contractor

Qualifications of the Contractor are specific to the construction contract and independent of this CQA Manual.

#### 1.3.2.2 Geosynthetics Manufacturers

Each Geosynthetics Manufacturer must satisfy the qualifications presented in the project specifications.

#### 1.3.2.3 Geosynthetic Installer(s)

The Geosynthetic Installer(s) will be trained and qualified to install the geosynthetics components of the liner and leachate management systems. Each Geosynthetics Installer must meet the requirements of the project specifications and be approved by the Engineer. The Geomembrane Installer must be approved by the Geomembrane Manufacturer.

#### 1.3.2.4 CQA Engineer

The CQA Engineer will act as the Owner's Quality Assurance Representative. The CQA Engineer will perform CQA testing to satisfy the requirements of this CQA Manual and will prepare the CQA certification document. The CQA Engineer will have experience in the CQA aspects of the construction and testing of landfill liner and leachate management systems, and be familiar with ASTM and other related industry standards. The activities of the CQA Engineer will be performed under the supervision of a Registered Professional Engineer.

#### 1.3.2.5 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory should be certified by the Geosynthetics Accreditation Institute, will have experience in testing geosynthetics, and be familiar with ASTM, GRI, and other applicable test standards. The Geosynthetics CQA Laboratory will be capable of providing test results within 24 hours or a reasonable time after receipt of samples depending on the test(s) to be conducted, as agreed to at the outset of the project by affected parties, and will maintain that standard throughout the installation.

#### 1.3.2.6 Soils CQA Laboratory

The Soils CQA Laboratory will have experience in testing structural fills and aggregates, and be familiar with ASTM and other applicable test standards. The Soils CQA Laboratory will be capable of providing test results within 24 hours or a reasonable time after receipt of samples depending on the test(s) to be conducted, as agreed to at the outset of the project by affected parties, and will maintain that standard throughout the installation.

### **1.4 SCOPE OF CONSTRUCTION QUALITY ASSURANCE MANUAL**

The scope of this CQA Manual includes the CQA of the soils and geosynthetic components of the liner and leachate management systems for the subject facility. The CQA for the selection, evaluation, and placement of the soils is included in the scope.

### **1.5 UNITS**

In this CQA Manual, all properties and dimensions are expressed in U.S. units.

### **1.6 REFERENCES**

The CQA Manual includes references to the most recent version of the test procedures of the American Society of Testing and Materials (ASTM) and/or the Geosynthetic Research Institute (GRI). **Appendix A** contains a list of these procedures.

### **1.7 CQA MEETINGS**

To facilitate the specified degree of quality during installation, clear, open channels of communication are essential. To that end, meetings are critical.

#### **1.7.1 Geosynthetics CQA Meeting**

A CQA Meeting will be held at the site prior to placement of the geosynthetics. At a minimum, the meeting will be attended by the Engineer, the CQA Engineer, the Contractor, and the Geosynthetic Installation Superintendent(s).

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 Manual to all of the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all.

This meeting should include all of the activities referenced in the project specifications.

The meeting will be documented by the Engineer and minutes will be transmitted to all parties. The Soil Liner CQA Meeting and the Geosynthetics CQA Meeting may be held as one meeting or separate meetings, depending on the direction of the Engineer.

### **1.7.2 CQA Progress Meetings**

Progress meetings will be held between the Engineer, the CQA Engineer, the Contractor, the Geosynthetic Installation Superintendent(s), and representatives from any other involved parties at the frequency dictated in the project specifications or, at a minimum, once every two weeks during active construction. These meetings will discuss current progress, planned activities for the next week, and any new business or revisions to the work. The CQA Engineer will log any problems, decisions, or questions arising at this meeting in his daily or periodic reports. Any matter requiring action which is raised in this meeting will be reported to the appropriate parties. These meetings will be documented by the Engineer and minutes will be transmitted to affected parties.

### **1.7.3 Problem or Work Deficiency Meetings**

A special meeting will be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting will be attended by the Engineer, the CQA Engineer, the Contractor, and representatives from any other involved parties. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency;
- review alternative solutions; and
- implement an action plan to resolve the problem or deficiency.

The meeting will be documented by the Engineer and minutes will be transmitted to affected parties.

## **1.8 CONTROL VERSUS RECORD TESTING**

### **1.8.1 Control Testing**

In the context of this CQA Manual, Control Tests are those tests performed on a material prior to its actual use in construction to demonstrate that it can meet the requirements of the project plans and specifications. Control Test data may be used by the Engineer as the basis for approving alternative material sources.

## 1.8.2 Record Testing

Record Tests are those tests performed during the actual placement of a material to demonstrate that its in-place properties meet or exceed the requirements of the project drawings and specifications.

## SECTION 2.0 CQA DOCUMENTATION

### 2.1 DOCUMENTATION

An effective CQA plan depends largely on recognition of 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 Engineer will document that quality assurance requirements have been addressed and satisfied.

The CQA Engineer will provide the Owner and Engineer with his daily and weekly progress reports including signed descriptive remarks, data sheets, and logs to verify that required CQA activities have been carried out. These reports shall also identify potential quality assurance problems. The CQA Engineer will also maintain at the job site a complete file of project drawings, reports, project specifications, a CQA Manual, checklists, test procedures, daily logs, and other pertinent documents.

### 2.2 DAILY CQA REPORT

The CQA Engineer's reporting procedures will include preparation of a daily report which, at a minimum, will include the following information, where applicable:

- a unique 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;
- descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;
- locations where tests and samples were taken;
- a summary of test results;
- calibrations or recalibrations of test equipment, and actions taken as a 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;
- summaries of pertinent discussions with the Contractor and/or Geosynthetic Installers; and
- the CQA Engineer's signature.

The daily report must be completed at the end of each CQA Engineer's shift, prior to leaving the site. This information will be submitted weekly to and reviewed by the Owner and Engineer.

### **2.3 CQA PROGRESS REPORTS**

The CQA Engineer will prepare a summary progress report each week, or at time intervals established at the pre-construction meeting. As a minimum, this report will include the following information, where applicable:

- 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 the progress reporting period;
- a summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period;
- summary of all test results, failures and retests, and
- signature of the CQA Engineer.

The CQA Engineer's progress reports must summarize the major events that occurred during that week. Critical problems that occur shall be communicated verbally to the Engineer immediately as well as being included in the weekly reports. The CQA Engineer's weekly report must be submitted to the Owner and Engineer no later than the Monday following the week reported.

### **2.4 CQA PHOTOGRAPHIC REPORTING**

Photographs shall be taken by the CQA Engineer at regular intervals during the construction process and in all areas deemed critical by the CQA Engineer.

These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. These records will be presented to the Engineer upon completion of the project.

In lieu of photographic documentation, videotaping may be used to record work progress,

problems, and mitigation activities. The Engineer may require that a portion of the documentation be recorded by photographic means in conjunction with videotaping.

## **2.5 DEFICIENCIES**

The Owner and Engineer will be made aware of any significant recurring nonconformance with the project specifications. The Engineer will then determine the cause of the non-conformance and recommend appropriate changes in procedures or specification. When this type of evaluation is made, the results will be documented, and any revision to procedures or project specifications will be approved by the Owner and Engineer.

## **2.6 DESIGN AND/OR PROJECT TECHNICAL SPECIFICATION CHANGES**

Design and/or project specification changes may be required during construction. In such cases, the CQA Engineer will notify the Engineer. The Engineer will then notify the appropriate agency, if necessary.

Design and/or project specification changes will be made only with the written agreement of the Engineer, and will take the form of an addendum to the project specifications. All design changes shall include a detail (if necessary) and state which detail it replaces in the plans.

## **2.7 FINAL CQA REPORT**

At the completion of each major construction activity at the landfill unit, the CQA Engineer will certify all required forms, observation logs, field and laboratory testing data sheets including sample location plans, etc. The CQA Engineer will also provide a final report which will certify that the work has been performed in compliance with the plans and project technical specifications, and that the supporting documents provide the necessary information.

The CQA Engineer will also provide summaries of all the data listed above with the report. The Record Drawings will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thicknesses, etc.). All surveying and base maps required for development of the Record Drawings will be done by the Contractor's Construction Surveyor. These documents will be certified by the Contractor and delivered to the CQA Engineer and included as part of the final CQA (Certification) report.

It may be necessary to prepare interim certifications, as allowed by the regulatory agency to expedite completion and review.

At a minimum, the items shown in **Table 2.1** shall be included in the Final CQA Report.

## 2.8 STORAGE OF RECORDS

All handwritten data sheet originals, especially those containing signatures, will be stored by the CQA Engineer in a safe repository on site. Other reports may be stored by any standard method which will allow for easy access. All written documents will become property of the Owner.

**TABLE 2.1A: FINAL CQA REPORT GENERAL OUTLINE (LINER SYSTEM)**

- 1.0 Introduction
- 2.0 Project Description
- 3.0 CQA Program
  - 3.1 Scope of Services
  - 3.2 Personnel
- 4.0 Earthwork CQA
- 5.0 GCL CQA
- 6.0 Geomembrane CQA
- 7.0 Leachate Management System CQA
- 8.0 Geotextile CQA
- 9.0 Drainage Geocomposite CQA
- 10.0 Summary and Conclusions
- 11.0 Project Certification

### Appendices

- Appendix A Design Clarifications and Modifications
- Appendix B CQA Reporting
  - B1. CQA Reports
  - B2. CQA Meeting Minutes
- Appendix C Earthwork CQA Data
  - C1. CQA Test Results - Control Tests
  - C2. CQA Test Results - Record Tests
- Appendix D Interface Shear Strength Test Data
- Appendix E GCL CQA Data
  - E1. Manufacturer's Product Data Submittals and Quality Control Certificates
  - E2. Geosynthetics Inventory - GCL
  - E3. CQA Test Results - Material Control Tests
  - E4. GCL Installation Certification
- Appendix F Geomembrane CQA Data
  - F1. Manufacturer's Product Data Submittals and Quality Control Certificates
  - F2. Geosynthetics Inventory - Geomembrane(s)
  - F3. CQA Test Results - Material Control Tests
  - F4. Subgrade Acceptance Certificates
  - F5. Trial Weld Logs
  - F6. Panel Placement Logs
  - F7. Panel Seaming Logs

**TABLE 2.1A (CONTINUED):**

	F8.	CQC Test Results - Nondestructive Seam Testing Report Forms
	F9.	CQC Test Results - Destructive Seam Testing Report Forms (Field)
	F10.	CQA Test Results - Destructive Seam Testing Report Forms (Laboratory)
	F11.	Repair Logs
	F12.	Geomembrane Installation Certification
Appendix G		Leachate Management System CQA Data
	G1.	Manufacturer's Product Data Submittals and Quality Control Certificates
	G2.	CQA Test Results - Drainage Aggregate
	G3.	CQA Test Results - Protective Cover
Appendix H		Geotextile CQA Data
	H1.	Manufacturer's Product Data Submittals and Quality Control Certificates
	H2.	Geosynthetics Inventory - Geotextiles
	H3.	CQA Test Results - Material Control Tests
Appendix I		Drainage Geocomposite CQA Data
	I1.	Manufacturer's Product Data Submittals and Quality Control Certificates
	I2.	Geosynthetics Inventory - Drainage Geocomposite
	I3.	CQA Test Results - Material Control Tests
Appendix J		Record Drawings
	J1	Subgrade As-Built
	J2	LLDPE Geomembrane As-Built
	J3	HDPE Geomembrane As-Built
	J4	HDPE Pipe As-Built
	J5	Protective Cover As-Built

## SECTION 3.0 EARTHWORK CQA

### 3.1 INTRODUCTION

This section of the CQA Manual addresses earthwork (excavation and embankment) and outlines the soils CQA program to be implemented with regard to material approval, subgrade approval, field control and record tests, and resolution of problems.

### 3.2 EMBANKMENT MATERIAL APPROVAL

All material to be used as compacted embankment shall be approved in advance by the CQA Engineer. Approval is based upon successful completion of CQA control testing outlined below. Such testing can be performed either during excavation and stockpiling or from existing stockpiles prior to use.

#### 3.2.1 Control Tests

The procedure for CQA testing during excavation and stockpiling (including existing stockpiles) is outlined below.

Each load of soil will be examined either at the borrow source or the stockpile area. Any unsuitable material will be rejected or routed to separate stockpiles consistent with its end use. Appropriate entries shall be made in the daily log.

During stockpiling operations, control tests, as shown on **Table 3.1**, will be performed by the CQA Engineer prior to placement of any compacted embankment.

### 3.3 SUBGRADE APPROVAL

The CQA Engineer shall verify that the compacted embankment subgrade is constructed in accordance with the project specifications.

### 3.4 EARTHWORK CONSTRUCTION

#### 3.4.1 Construction Monitoring

- A. Earthwork shall be performed as described in the project specifications.
- B. Only soil previously approved by the CQA Engineer (see **Section 3.2**) shall be used in construction of the compacted embankment. Unsuitable material will be removed prior to acceptance by the CQA Engineer.
- C. All required field density and moisture content tests shall be completed before the overlying lift of soil is placed. The surface preparation (e.g. wetting, drying,

scarification, etc.) shall be completed before the CQA Engineer will allow placement of subsequent lifts.

- D. The CQA Engineer shall monitor protection of the earthwork during and after construction.

### **3.4.2 Control Tests**

The control tests, as shown on **Table 3.2**, will be performed by the CQA Engineer prior to placement of compacted embankment.

### **3.4.3 Record Tests**

The record tests, as shown on **Table 3.2**, will be performed by the CQA Engineer during placement of compacted embankment.

#### **3.4.3.1 Record Test Failure**

Recompaction of the failed area shall be performed and retested until the area meets or exceeds requirements outlined in the specifications.

### **3.4.4 Judgmental Testing**

During construction, the frequency of control and/or record testing may be increased at the discretion of the CQA Engineer when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the rollers slip during rolling operation;
- the lift thickness is greater than specified;
- the fill material is at an improper moisture content;
- fewer than the specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the rollers may not have used optimum ballast;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

## **3.5 DEFICIENCIES**

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 3.1: CQA TESTING PROGRAM FOR EMBANKMENT MATERIAL APPROVAL**

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
<b>CONTROL TESTS:</b>		
Visual Classification	ASTM D 2488	Each Soil
Moisture-Density Relationship	ASTM D 698	5,000 CY per Each Soil

**TABLE 3.2: CQA TESTING PROGRAM FOR COMPACTED EMBANKMENT**

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
<b>CONTROL TESTS: (See Table 3.1)</b>		
<b>RECORD TESTS:</b>		
Lift Thickness	-----	Each Lift
In-Place Density	ASTM D 2922 <sup>1</sup>	20,000 ft <sup>2</sup> per lift & 1 per 500 LF/lift of Berms (< 200 ft. base width)
Moisture Content	ASTM D 3017 <sup>2</sup>	20,000 ft <sup>2</sup> per lift & 1 per 500 LF/lift of Berms (< 200 ft. base width)

Notes:

1. Optionally use ASTM D 1556, ASTM D 2167, or ASTM D 2937. For every 10 nuclear density tests perform at least 1 density test by ASTM D 1556, ASTM D 2167, or ASTM D 2937 as a verification of the accuracy of the nuclear testing device.
2. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959. For every 10 nuclear moisture tests perform at least 1 moisture test by ASTM D 2216, ASTM D 4643, or ASTM D 4959 as a verification of the accuracy of the nuclear testing device.

## SECTION 4.0 GEOSYNTHETIC CLAY LINER (GCL) CQA

### 4.1 INTRODUCTION

This section of the CQA Manual addresses geosynthetic clay liner (GCL) and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

### 4.2 GCL MANUFACTURER AND INSTALLER APPROVAL

The Contractor shall submit the qualifications of the GCL Manufacturer and the GCL Installer, as described in the specifications, to the CQA Engineer for approval.

### 4.3 GCL MATERIAL APPROVAL

#### 4.3.1 GCL Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

#### 4.3.2 Shipment And Storage

During shipment and storage, GCL will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

#### 4.3.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and
- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

#### 4.3.4 GCL Material Control Tests

Samples for material control tests, as shown on **Table 4.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the GCL. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA

Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all GCL. The CQA Engineer will examine all results from laboratory testing.

#### 4.3.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

- A. The Geosynthetic Installer will replace the roll of GCL that is in nonconformance with the project specifications with a roll that meets project specifications.
- B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

## 4.4 GCL INSTALLATION

### 4.4.1 Handling And Placement

The Geosynthetic Installer will handle and place all GCL in such a manner as required by the project specifications.

### 4.4.2 Seams And Overlaps

All GCL will be seamed or overlapped in accordance with project specifications or as approved by the CQA Engineer and Engineer.

### 4.4.3 Repairs

Any holes or tears in the GCL will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

#### 4.4.4 Placement Of Overlying Materials

All soil materials located on top of the GCL shall be placed in accordance with the project specifications.

#### 4.5 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 4.1: CQA TESTING PROGRAM FOR GCL MATERIAL APPROVAL**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>TEST FREQUENCY</b>
<b>CONTROL TESTS:</b>		
Hydraulic Conductivity	ASTM D 5084/D 5887	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Bentonite Content	ASTM D 5993 (@ 0% moisture)	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Grab Tensile Strength	ASTM D 4632	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>

Notes:

1. Whichever provides the larger number of tests.

## SECTION 5.0 GEOMEMBRANE CQA

### 5.1 INTRODUCTION

This section of the CQA Manual addresses the geomembrane components of the liner system and outlines the CQA program to be implemented with regard to manufacturer and installer approval, material approval, subgrade approval, field and laboratory control and record tests, repairs, and resolution of problems.

### 5.2 GEOMEMBRANE MANUFACTURER AND INSTALLER APPROVAL

The Contractor shall submit the qualifications of the Geomembrane Manufacturer and the Geomembrane Installer, as described in the specifications, to the CQA Engineer for approval.

### 5.3 GEOMEMBRANE MATERIAL APPROVAL

#### 5.3.1 Geomembrane Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

#### 5.3.2 Shipment And Storage

During shipment and storage, all geomembrane will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

#### 5.3.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls or sheets related to it; and
- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

#### 5.3.4 Material Control Tests

Samples for material control tests, as shown on **Table 5.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the geomembrane. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll or sheet width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All control test results must be available at the site prior to the deployment of all geomembrane. The CQA Engineer will examine all results from laboratory conformance testing.

#### 5.3.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

- A. The Geomembrane Installer will replace the roll or sheet of geomembrane that is in nonconformance with the project specifications with a roll or sheet that meets project specifications.
- B. The Geomembrane Installer will remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll or sheet on both sides of the failed roll or sheet. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll or sheet will be tested until a passing roll or sheet is found. This additional conformance testing will be at the expense of the Geomembrane Installer. If either of the two closest rolls or sheets fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

## 5.4 GEOMEMBRANE INSTALLATION

### 5.4.1 Handling

The Geosynthetic Installer will handle all geomembrane in such a manner as required by the project specifications.

### 5.4.2 Earthwork

#### 5.4.2.1 Surface Preparation

The Geomembrane Installer will certify in writing that the surface on which the geomembrane will be installed meets line and grade, and the surface preparation requirements of the project specifications. The certificate of acceptance will be given to the CQA Engineer prior to commencement of geomembrane installation in the area under consideration. The CQA Engineer will give a copy of this certificate

to the Engineer.

To ensure a timely covering of the subgrade surface, the Engineer may allow subgrade acceptance in areas as small as one acre. After the supporting soil has been accepted by the Geomembrane Installer, it will be the Geomembrane Installer's responsibility to indicate to the Engineer and CQA Engineer any change in the supporting soil condition that may require repair work. If the CQA Engineer concurs with the Geomembrane Installer, then the Engineer will ensure that the supporting soil is repaired.

#### 5.4.2.2 Anchorage System

The CQA Engineer will verify that anchor trenches have been constructed and backfilled according to project specifications and design drawings.

### 5.4.3 Geomembrane Placement

#### 5.4.3.1 Field Panel Identification

The CQA Engineer will document that the Geomembrane Installer labels each field panel with an "identification code" (number or letter-number consistent with the layout plan) agreed upon by the Geomembrane Installer and CQA Engineer at the Geosynthetics CQA Meeting (see **Section 1.7.2**).

The Geomembrane Installer will establish a table or chart showing correspondence between roll or sheet numbers and field panel identification codes. This documentation shall be submitted to the CQA Engineer weekly for review and verification. The field panel identification code will be used for all quality control and quality assurance records.

#### 5.4.3.2 Field Panel Placement

5.4.3.2.1 Location: The CQA Engineer will verify that field panels are installed at the location indicated in the Geomembrane Installer's layout plan, as approved or modified in **Section 5.4.3.1**.

5.4.3.2.2 Installation Schedule: The CQA Engineer will evaluate every change in the schedule proposed by the Geomembrane Installer and advise the Engineer on the acceptability of that change.

The CQA Engineer will record the identification code, location, and date of installation of each field panel.

5.4.3.2.3 Placement of Geomembrane: The CQA Engineer will verify that project specification related restrictions on placement of geomembrane are fulfilled. Additionally, the CQA Engineer will verify that the supporting soil has not been damaged by weather conditions.

5.4.3.2.4 Damage: The CQA Engineer will visually observe each panel, after placement and prior to seaming, for damage. The CQA Engineer will advise the Engineer which panels, or portion of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected will be marked and their removal from the work area recorded by the CQA Engineer. Repairs will be made according to procedures described in this section.

As a minimum, the CQA Engineer will document that:

- the panel is placed in such a manner that it is unlikely to be damaged; and
- any tears, punctures, holes, thin spots, etc. are either marked by the Geomembrane Installer for repair or the panel is rejected.

#### **5.4.4 Field Seaming**

##### 5.4.4.1 Seam Layout

The Geomembrane Installer will provide the CQA Engineer with a seam layout drawing, i.e., a drawing of the area to be lined showing all expected seams. The CQA Engineer and Engineer will review the seam layout drawing and verify that it is consistent with the accepted state of practice and this CQA Manual. In addition, no panels not specifically shown on the seam layout drawing may be used without the Engineer's prior approval.

A seam numbering system compatible with the panel numbering system will be agreed upon at the Geosynthetics CQA Meeting (see **Section 1.7.2**). An on-going written record of the seams and repair areas shall be maintained by the Geomembrane Installer with weekly review by the CQA Engineer.

##### 5.4.4.2 Requirements of Personnel

The Geomembrane Installer will provide the CQA Engineer with a list of proposed seaming personnel and their experience records. This document will be reviewed

by the CQA Engineer for compliance with project specifications.

#### 5.4.4.3 Seaming Equipment and Products

Field seaming processes must comply with project specifications. Proposed alternate processes will be documented and submitted to the Engineer and CQA Engineer for their approval. Only seaming apparatus which have been specifically approved by make and model will be used. The CQA Engineer will submit all documentation to the Engineer for his concurrence.

### 5.4.5 Field Seam Control Tests

#### 5.4.5.1 Trial Seams

- A. Prior to production seaming, after four (4) hours of continuous seaming, and/or when significant changes in geomembrane or ambient temperature occurs, the Geomembrane Installer shall perform passing trial seams for each welder to be used to verify that seaming conditions and procedures are adequate. Trial seams shall be performed by each operator of extrusion welders and by the primary operator of each fusion welder.
- B. Trial seams shall be made on appropriate sized pieces of identical or equivalent geomembrane material.
- C. Fusion welded trial seams shall be approximately 72" x 12" with the seam centered lengthwise. For extrusion welding, the trial seams shall be approximately 36" x 12" with the seam centered lengthwise. A minimum of four coupons will be tested in peel and shear (two each) (ASTM D 6392) by the Geomembrane Installer using a field tensiometer. All coupons shall meet the minimum seam strength requirements as shown in the project specifications.
- D. Each trial seam shall be assigned a number and the test results recorded in the appropriate log by the Geomembrane Installer. The CQA Engineer shall observe all trial seams and compile all trial seam logs.

### 5.4.6 Field Seam Record Tests

#### 5.4.6.1 Nondestructive Seam Continuity Testing

The Geomembrane Installer shall test and document all seam welds continuously over their full length using one of the following nondestructive seam tests. This testing shall be performed simultaneously with geomembrane deployment as the work progresses and not at the completion of all field seaming.

- A. Vacuum Testing shall conform to ASTM D 5641 requirements.
- B. Air Pressure Testing (for double seam with an enclosed space) shall conform to ASTM D 5820 requirements and the requirements listed in **Table 5.2**.

The CQA Engineer shall observe the nondestructive testing on a full time basis to ensure conformance with this CQA Manual and the project specifications.

#### 5.4.6.2 Field Destructive Seam Testing

- A. The Geomembrane Installer will obtain 12" x 24" (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per 500 linear feet of weld. The sample shall be cut into two equal-length pieces, one for field destructive seam testing by the Geosynthetics Installer and one given to the CQA Engineer as an archive sample. The date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer.
- B. The Geomembrane Installer will perform and document field destructive seam testing using a field tensiometer. A minimum of five coupons each will be tested in peel and shear (ASTM D 6392). Four of five coupons shall meet the minimum seam strength requirements as shown in the project specifications.
- C. The CQA Engineer or the Owner may require additional random samples to be taken for testing in areas which visually appear defective and not in accordance with the project requirements.
- D. All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in this manual.

#### 5.4.6.3 Geosynthetics CQA Laboratory Destructive Testing

- A. The Geomembrane Installer will obtain 12" x 24" (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per day to confirm field destructive seam tests. The sample shall be cut into two equal-length pieces, both to be given to the CQA Engineer for laboratory destructive seam testing and as an archive sample. The date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer.

- B. Laboratory destructive test samples will be packaged and shipped to the Geosynthetics CQA Laboratory by the CQA Engineer in a manner that will not damage the test sample.
- C. A minimum of five coupons each will be tested in peel and shear (ASTM D 6392) by the Geosynthetics CQA Laboratory. Four of five coupons shall meet the minimum seam strength requirements as shown in the project specifications.
- D. All geomembrane destructive test samples that fail to meet project specifications shall be saved and sent to the CQA Engineer for observation.
- E. The CQA Engineer will review laboratory test results as soon as they become available.

#### 5.4.6.4 Field Seam Record Test Failure

For noncomplying tests, the CQA Engineer will:

- observe continuity testing of the repaired areas performed by the Geomembrane Installer;
- confirm the record location, date, test unit number, name of tester, and compile the record of testing provided by the Geomembrane Installer;
- provide a walk-through inspection of all impacted seam areas and verify that the areas have been tested in accordance with the CQA Manual and project specifications; and
- verify that the Geomembrane Installer has marked repair areas with the appropriate color-coded marking pencil.

#### 5.4.6.5 Defining Extent of Field Seam Record Test Failure

All defective seam test failures must be bounded by acceptable destructive tests. The CQA Engineer will document repair actions taken in conjunction with all seam test failures.

### 5.4.7 Repairs & Verification

#### 5.4.7.1 Repair Procedures

- A. All repair procedures shall be in accordance with the project specifications. The CQA Engineer will observe all repair procedures.

- B. All surfaces shall be clean and dry at the time of the repair.
- C. After an extrusion weld is made, no more than ¼ inch of abrasion shall be visible beyond the weld.

#### 5.4.7.2 Repair Verification

- A. Each repair shall be numbered and logged by the Geomembrane Installer.
- B. Each repair shall be non-destructively tested by the Geomembrane Installer using the methods described above. Repairs which pass non-destructive testing shall be taken as an indication of an adequate repair.
- C. Repairs more than 150 feet long may be of sufficient length to require destructive test sampling, at the discretion of the CQA Engineer. A failed test indicates that the repair shall be redone and retested until passing test results are achieved.

## 5.5 LINER SYSTEM ACCEPTANCE

The Geomembrane Installer and the Geosynthetic Manufacturers will retain all ownership and responsibility for the geosynthetics in the landfill unit until acceptance by the Owner.

The geomembrane component of the liner system will be accepted by the Owner when:

- the installation is finished;
- verification of the adequacy of all seams and repairs, including associated testing, is complete;
- CQA Engineer provides the Engineer with a final copy of the nondestructive test documentation, repair information, and as-built drawings, as submitted by the Geomembrane Installer.
- CQA Engineer furnishes the Engineer with a certification, submitted by the Geomembrane Installer that the geomembrane was installed in accordance with the Geomembrane Manufacturer's recommendations as well as the project drawings and project specifications;
- all documentation of the installation is completed including the CQA Engineer's final report; and
- certification by the CQA Engineer, including Record Drawing(s), sealed by a Professional Engineer registered in the state in which the project is located, has been received by the Engineer.

The CQA Engineer will certify that the installation has proceeded in accordance with this CQA Manual and the project specifications for the project except as noted to the Engineer.

## **5.6 MATERIALS IN CONTACT WITH GEOMEMBRANES**

The quality assurance procedures indicated in this subsection are only intended to assure that the installation of these materials does not damage the geomembrane. All reasonable measures to protect the geomembrane and provide additional quality assurance procedures are necessary to assure that systems built with these materials will be constructed to ensure proper performance.

### **5.6.1 Soils**

Prior to placement, the CQA Engineer will visually confirm that all soil materials to be placed against the geomembrane comply with project specifications. The Geomembrane Installer will provide the CQA Engineer a written surface acceptance certificate in accordance with **Section 5.4.2**. All soil materials shall be placed and compacted in accordance with project specifications.

### **5.6.2 Sumps and Appurtenances**

The CQA Engineer will verify that:

- installation of the geomembrane in appurtenance areas, and connection of the geomembrane to appurtenances have been made according to the project specifications;
- extreme care is taken while seaming around appurtenances since neither nondestructive nor destructive testing may be feasible in these areas; and
- the geomembrane or appurtenances have not been visibly damaged while making connections to appurtenances.

## **5.7 DEFICIENCIES**

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 5.1: CQA TESTING PROGRAM FOR GEOMEMBRANE MATERIAL APPROVAL**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>TEST FREQUENCY</b>
Thickness	ASTM D 5199/D 5994	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Density	ASTM D 1505/D 792	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Carbon Black Content	ASTM D 1603	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Carbon Black Dispersion	ASTM D 5596	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Tensile Properties:	ASTM D 6693 (Type IV)	
Tensile Strength at Yield		100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Tensile Strength at Break		100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Elongation at Yield		100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Elongation at Break		100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Tear Resistance	ASTM D 1004	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>

Notes:

1. Whichever provides the larger number of tests.

**TABLE 5.2 AIR PRESSURE TEST REQUIREMENTS**

<b>MATERIAL</b>	<b>MIN. PRESSURE (PSI)</b>	<b>MAX. PRESSURE DROP (PSI) AFTER 5 MINUTES</b>
40 Mil LLDPE	20	3
≥ 60 Mil HDPE	25	3

## SECTION 6.0 LEACHATE MANAGEMENT SYSTEM CQA

### 6.1 INTRODUCTION

This section of the CQA Manual addresses the components of the leachate management system including components of the leak detection and leachate collection systems (LDS and LCS, respectively) (drainage aggregate, collection pipe, protective cover, and geosynthetic rain cover). By reference to **Sections 7.0 and 8.0** of this CQA Manual, this section also addresses the geotextiles and drainage geocomposite that are components of the LDS and LCS. This section outlines the CQA program to be implemented with regard to material approval, construction monitoring, and resolution of problems.

### 6.2 LEACHATE MANAGEMENT SYSTEM MATERIAL APPROVAL

The CQA Engineer shall verify that the following are provided and installed in accordance with the project drawings, specifications, and this CQA Manual.

#### 6.2.1 Coarse Aggregate (Drainage Aggregate)

- A. Receipt of Contractor's submittals on coarse aggregate.
- B. Review of submittals for coarse aggregate for conformity to the project specifications.
- C. Verify that coarse aggregate in stockpiles or at borrow sources conforms to the project specifications.
- D. Conduct material control tests in accordance with **Table 6.1**.

#### 6.2.2 High Density Polyethylene (HDPE) Pipe

- A. Receipt of Contractor's submittals on HDPE pipe.
- B. Review of submittals for HDPE pipe for conformity to the project specifications.

#### 6.2.3 Geotextiles (Verify for each type of Geotextile)

The CQA program for geotextiles is presented in **Section 7.0** of this CQA Manual.

#### 6.2.4 Drainage Geocomposite

The CQA program for drainage geocomposite is presented in **Section 8.0** of this CQA Manual.

### **6.2.5 Protective Cover**

- A. Review the proposed source of protective cover for conformance with the project specifications.
- B. Conduct material control tests in accordance with **Table 6.1**.

### **6.2.6 Geosynthetic Rain Cover**

- A. Receipt of Contractor's submittals on Geosynthetic Rain Cover.
- B. Review of submittals for Geosynthetic Rain Cover for conformity to the project specifications.

## **6.3 LEACHATE MANAGEMENT SYSTEM INSTALLATION**

### **6.3.1 Leak Detection System (LDS) and Leachate Collection System (LCS)**

The CQA Engineer will allow installation of the LDS and LCS to proceed only after he has been provided certification of the underlying geosynthetics (as applicable).

The CQA Engineer will monitor and document the construction of all LDS and LCS components for compliance with the project specifications. Monitoring the construction work includes the following:

- monitoring the minimum vertical buffer maintained between field equipment and the geomembranes;
- monitoring that the placement of the LDS and LCS components does not fold or damage the geomembrane or other underlying layers; and
- witness and verify the installation of collection piping and gravel columns.

## **6.4 DEFICIENCIES**

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 6.1: CQA TESTING PROGRAM FOR LEACHATE MANAGEMENT SYSTEM**

COMPONENT	PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
<b>CONTROL TESTS:</b>			
<b>Coarse Aggregate:</b>	Gradation	ASTM C 136	5,000 CY
	Carbonate Content	ASTM D 3042	1 per source
<b>Protective Cover:</b>	Visual Classification	ASTM D 2488	Each Load

## SECTION 7.0 GEOTEXTILE CQA

### 7.1 INTRODUCTION

This section of the CQA Manual addresses geotextiles and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

### 7.2 GEOTEXTILE MATERIAL APPROVAL

#### 7.2.1 Geotextile Product Data

For each type of geotextile to be used, the CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

#### 7.2.2 Shipment And Storage

During shipment and storage, all geotextiles will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

#### 7.2.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and
- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

#### 7.2.4 Geotextile Material Control Tests

Samples for material control tests, as shown on **Table 7.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the geotextiles. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all geotextiles. The

CQA Engineer will examine all results from laboratory testing.

#### 7.2.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

- A. The Geosynthetic Installer will replace the roll of geotextile that is in nonconformance with the project specifications with a roll that meets project specifications.
- B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

### **7.3 GEOTEXTILE INSTALLATION**

#### **7.3.1 Handling And Placement**

The Geosynthetic Installer will handle and place all geotextiles in such a manner as required by the project specifications.

#### **7.3.2 Seams And Overlaps**

All geotextiles will be seamed or overlapped in accordance with project specifications or as approved by the CQA Engineer and Engineer.

#### **7.3.3 Repairs**

Any holes or tears in the geotextile will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

#### **7.3.4 Placement Of Overlying Materials**

All soil materials located on top of a geotextile shall be placed in accordance with the project specifications.

## 7.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 7.1: CQA TESTING PROGRAM FOR GEOTEXTILE MATERIAL APPROVAL**

PROPERTY	TEST METHOD	TEST FREQUENCY
<b>CONTROL TESTS:</b>		
Grab Tensile Strength	ASTM D 4632	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Puncture Resistance	ASTM D 4833	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Trapezoidal Tear Strength	ASTM D 4533	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Apparent Opening Size (AOS) (Type GT-S Geotextile Only)	ASTM D 4751	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>

Notes:

1. Whichever provides the larger number of tests.
2. CQA testing is not required for geotextiles placed outside of the containment area.

## SECTION 8.0 DRAINAGE GEOCOMPOSITE CQA

### 8.1 INTRODUCTION

This section of the CQA Manual addresses drainage geocomposite (DGC) and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

### 8.2 DGC MATERIAL APPROVAL

#### 8.2.1 DGC Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

#### 8.2.2 Shipment And Storage

During shipment and storage, all DGC will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

#### 8.2.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and
- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

#### 8.2.4 DGC Material Control Tests

Samples for material control tests, as shown on **Table 8.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the DGC. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all DGC. The CQA

Engineer will examine all results from laboratory testing.

#### 8.2.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

- A. The Geosynthetic Installer will replace the roll of DGC that is in nonconformance with the project specifications with a roll that meets project specifications.
- B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

### **8.3 DGC INSTALLATION**

#### **8.3.1 Handling And Placement**

The Geosynthetic Installer will handle and place all DGC in such a manner as required by the project specifications.

#### **8.3.2 Stacking And Joining**

When several layers of DGC are stacked, care should be taken to ensure that stacked DGC are placed in the same direction. Stacked DGC will never be laid in perpendicular directions to the underlying DGC (unless otherwise specified by the Engineer). The CQA Engineer will observe the stacking of DGC.

Adjacent rolls of DGC will be joined according to construction drawings and project specifications.

#### **8.3.3 Repairs**

Any holes or tears in the DGC will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

### 8.3.4 Placement Of Overlying Materials

All soil materials located on top of DGC shall be placed in accordance with the project specifications.

## 8.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies shall be properly documented by the CQA Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer shall observe all retests on repaired defects.

**TABLE 8.1: CQA TESTING PROGRAM FOR DGC MATERIAL APPROVAL**

PROPERTY	TEST METHOD	TEST FREQUENCY
<b>CONTROL TESTS:</b>		
Thickness (geonet only)	ASTM D 5199	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Density (geonet only)	ASTM D 1505	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Ply Adhesion	ASTM D 413/ GRI GC7	100,000 ft <sup>2</sup> or 1 per Lot <sup>1</sup>
Transmissivity	ASTM D 4716 <sup>2</sup>	1 per Resin Lot

Notes:

1. Whichever provides the larger number of tests.
2. Conduct tests for transmissivity in accordance with the conditions given in the project specifications.

## **Appendix A**

### **Reference List of Test Methods**

**JOHNSTON COUNTY  
JOHNSTON COUNTY MSW LANDFILL - PHASE 4A - CELL 2**

**CQA MANUAL  
APPENDIX A: REFERENCE LIST OF TEST METHODS**

**American Society American Society of Testing and Materials (ASTM):**

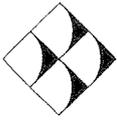
ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 413	Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.
ASTM D 422	Standard Test Method for Particle Size Analysis of Soils.
ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft <sup>3</sup> ).
ASTM D 792	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D 1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
ASTM D 2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
ASTM D 2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
ASTM D 2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

ASTM D 2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 2937	Standard Test Method for Density of Soil in Place by the Drive Cylinder Method.
ASTM D 3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
ASTM D 3042	Standard Test Method for Insoluble Residue in Carbonate Aggregates.
ASTM D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
ASTM D 4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 4959	Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.
ASTM D 5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
ASTM D 5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
ASTM D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

ASTM D 5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
ASTM D 5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.
ASTM D 5887	Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
ASTM D 5993	Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners.
ASTM D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
ASTM D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
ASTM D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Flexible Polyethylene and Nonreinforced Polypropylene Geomembranes.

**Geosynthetic Research Institute (GRI):**

GRI GC7	Determination of Adhesion and Bond Strength of Geocomposites.
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December 3, 2004

**ADDENDUM NO. 1  
TO THE  
CONTRACT DOCUMENTS  
FOR  
JOHNSTON COUNTY MSW LANDFILL - PHASE 4A - CELL 2**

**ISSUED FOR BIDS: NOVEMBER 2004**

To All Plan Holders:

The following revisions, additions, and clarifications are hereby made part of the Contract Documents for the above referenced project and shall be taken into account in the preparation of all Bids and the execution of all Work. Bidders shall acknowledge receipt of the Addendum in the appropriate space on the Proposal Form. Failure to do so may result in your Bid being considered non-responsive.

**I. PRE-BID MEETING SUMMARY**

Please find attached a copy of a summary of the pre-bid meeting, which was held Wednesday December 1, 2004.

**II. BIDDING AND CONTRACT REQUIREMENTS**

**A. Proposal - Base Bid Schedule:**

1. **DELETE** Pay Item Number 4.5 (New LFG Flare).
2. Under Pay Item Number 4.4 (Relocate LFG Flares), **CHANGE** estimated quantity from "2" to "3".

**III. TECHNICAL SPECIFICATIONS**

**A. Specification Section 02776 (GCL):**

**ADD** the following to Paragraph B.1:

"GCLs with a lighter non-woven geotextile on one side may be considered by the Engineer as long as all other criteria are met."

**B. Specification Section 13255 (Landfill Gas System):**

**ADD** Paragraph D.5 as follows:

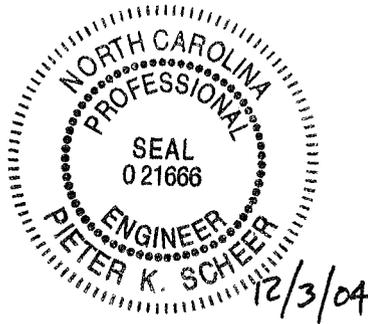
- “5. The Contractor shall furnish and install guy wires as required for the proper installation of LFG utility flares (including relocated flares). The guy wires shall be anchored so as to not damage any geosynthetic materials.”

**END OF ADDENDUM**

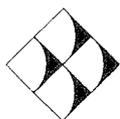
Submitted by,  
**G.N. Richardson & Associates, Inc.**



Pieter K. Scheer, P.E.  
Project Manager



Attachment (Pre-Bid Meeting Summary)



## MEMORANDUM

**TO:** Planholders  
**FROM:** Pieter K. Scheer, P.E. *PKS*  
**DATE:** December 3, 2004  
**SUBJECT:** Johnston County MSW Landfill Phase 4A - Cell 2  
Pre-Bid Meeting Summary

A pre-bid meeting was held at the site offices of the Johnston County Landfill on December 1, 2004 at 2:00 p.m.

### Attendees:

<u>Name</u>	<u>Company/Agency</u>	<u>Phone</u>	<u>Fax</u>
Pieter Scheer	G.N. Richardson & Associates	919-828-0577	919-828-3899
Byron Hackney	G.N. Richardson & Associates	919-828-0577	919-828-3899
Lonnie J. Burgess	T&K Construction	256-734-6611	256-734-4977
Jamie Jenkins	T&K Construction	256-734-6611	256-734-4977
Christian Caldwell	Morgan Corp.	704-598-9117	704-598-5973
John Jacobs	Comanco Environmental	813-988-8829	813-988-3720
John Cochran	Envoronmental Fabrics Inc.	803-551-5700	803-551-5701
Ted Hoey	E.S.I.	412-337-2100	724-495-7214
David Page	ES&J Enterprises, Inc.	910-567-6138	910-567-2891
Jason Mayer	Rifenburg Construction Inc.	919-598-6921	919-598-1810
Rick Proctor	Johnston County	919-938-4750	919-989-7152
Haywood Phthisic	Johnston County	919-989-5075	
Allen Best	Johnston County	919-938-4750	919-989-7152

### Introduction:

Mr. Scheer introduced GNRA and County personnel and the Johnston County Phase 4A - Cell 2 Landfill Project. In the discussion of the project, he noted the following:

- The pre-bid meeting is non-mandatory for bidding on the project.
- The Phase 4A - Cell 2 project is a 6.1 acre lined lateral expansion of a "piggyback" landfill (a lined landfill over an unlined landfill).
- Borrow soil is available from the on site borrow area (Borrow Area E). Excavations will need to drain to the existing sediment basins and some revegetation efforts may be required depending on the scheduled use of the borrow area by Johnston County.

- The schedule for the project is 120 (consecutive calendar) days with the Contract Award likely on January 3, 2005. Depending on weather, the County may allow the project to start later (February or March).
- A Monday through Saturday - 7 a.m. to 7 p.m. (or as daylight allows) work week is allowed in the contract. This schedule can be modified by approval of Johnston County. Sunday work will only be allowed if scheduled in advance and if there is good reason.
- Liquidated damages are included in the project in the amount of \$500.00 per day.

Mr. Scheer then proceeded through the project drawings and commented on certain aspects of the project as follows:

- Drawing S1 - A staging area on top of Phase 1&2 is available so long as operations do not rut the existing cover.
- Drawing S2 - Note the liner section shown in the lower left corner (also presented as Detail 1/L1); There is some flexibility for the base grades as this is a piggyback landfill although the Contractor must remove an existing soil diversion berm and fill low spots in general concurrence with the base grades shown; Grading requirements are discussed in Section 01010 of the General Specifications (see Paragraph F.9); Note the presence of electrical conduits in the vicinity of Drainage Channel 6 coming from the existing leachate collection/leak detection side risers.
- Drawing L1 - Detail 2/L1 - Note that the thickness of the existing Phase 3 soil cover is typically about 3 feet on the side slopes.
- Drawing L1 - Detail 5/L1 - Note the 8' spacing of tires to be used as ballast on the rain cover.
- Drawing LC1 - Detail 1/LC1 - All leachate collection piping on this project is 8" diam. HDPE (SDR 13.5) pipe. Thicker walled pipe (i.e. SDR 11) would also be acceptable.
- Drawing LC1 - Detail 3/LC1 - Note the configuration of the gravel column. Also note that a down chute (see Detail 4/EC2) will be placed at the low point of the channel that is created behind the gravel column.
- Drawing EC1 - Details the drainage and diversion channels included in this project. Note that Drainage Channels 2 and 4 will have a GCL underliner and Drainage Channel 6 will have a geotextile underliner.
- Drawing LFG1 - The passive landfill gas system will be one of the first landfill components to be installed. This system includes collector trenches and header lines that will be tied into the existing system and routed to solar flares for prevention of excessive gas pressure under the liner system. Note the tie in of the existing LFG well to the nearest collector trench.
- Drawing LFG2 - Detail 3/LFG2 - A maximum of four (4) feet of excavation is required for gas trenches which do not intersect with the underlying waste.
- Drawing LFG3 - Detail 2/LFG3 - Careful excavation shall be done in the vicinity of the edge of the existing GCL and drainage geocomposite on top of Phase 3. Also note that utility flares may require some concrete support.

#### **Coordination:**

Mr. Scheer explained that certain items in the project will require close coordination between the Contractor and Johnston County as follows:

- Landfill operations will continue in the Phase 4A - Cell 1 (existing MSW) and the C&D landfill units throughout the duration of the construction project and day to day landfill operations must not be obstructed due to construction efforts.
- The Contractor will need to coordinate with site staff on the use of Borrow Area E as the County will also be using this area.

**Landfill Safety:**

Mr. Scheer explained that there will be certain inherent safety considerations for working on and around existing landfills as follows:

- The Contractor and subcontractors are prohibited from smoking on/around landfill areas and should use caution when working on/around the landfill areas.
- Excavated waste will need to be promptly taken to the active landfill face by the Contractor (will require weighing on scales). The waste will be accepted by the County at no charge to the Contractor. The capacity of the County's scale is 100 tons.
- Exposed waste in trenches must be tarped or covered in some fashion at the close of each day to prevent exposure to vectors. This requirement is based on State landfill regulations.

**Surveying:**

Mr. Scheer noted the following regarding surveying:

- Previous ground survey information has been prepared by Mr. Dennis Lee R.L.S. (business has closed) and Adrian Ball Professional Land Surveying of Selma (919-965-0077).
- Note the list of as-built drawing information required (ref. Spec. Section 01010 - Summary of Work).

**Security:**

Mr. Scheer noted the following regarding security:

- When work is conducted after landfill service hours (landfill closes at 4:45 p.m.), the Contractor must maintain site security by locking the front gate and/or preventing access by the public. The Contractor shall provide his own lock and shall lock his lock into the County's lock. The County will revoke the privilege of working after landfill hours if the gate is found open and unattended when the landfill is closed.

**Other Items:**

Mr. Scheer then concluded with a few additional comments as follows:

- GNRA provided a CD with sitework drawings with the bid documents in AutoCAD 2000 format. Please contact GNRA if you have any questions, need a different version, etc.
- Water (if required) is available at the hydrant near the site entrance. A temporary hydrant permit is required from the County. The County may also have available reclaimed water for the Contractor's use but that is not certain at this time.
- Please contact Mr. Rick Proctor at the landfill (919-938-4750) for coordinating site visits.

**Question and Answer:**

Mr. Scheer then opened the meeting up to questions as follows (note some questions are addressed in the above information):

Q: Will proof rolling be required?

A: Proof rolling of the landfill side slopes will consist of an observation of the equipment being used for subgrade preparation. These areas will need to be firm similar to normal landfill final covers. In the event of soft areas, the contract includes a pay item for over-excavation and backfill, which may be used.

Q: What are the minority bid requirements?

A: A good faith effort is required in accordance with NC General Statutes. Bidders will be required to provide the requested information and fill out the appropriate affidavit(s).

Q: Is there a contact person at the County to inquire about minority contractors?

A: The County does not currently have a contact person or maintain a listing of minority contractors. Bidders may wish to contact the other sources (Minority Business Development Agency & NC Institute of Minority Economic Development) listed in the Instructions to Bidders.

Q: What is the last day for receiving questions regarding the bid?

A: In accordance with the Instructions to Bidders, all questions must be received at least 5 days prior to the date of the Bid Opening (to allow time for a formal written response if deemed necessary). Mr. Scheer noted that he will likely be available beyond that time to answer last minute questions. Note, however, that only questions answered by written Addenda are binding.

Mr. Scheer then adjourned the meeting in the landfill offices and conducted a tour of the site. During the tour additional questions were as follows:

Q: How will the existing litter control fence at the top west side of Phase 3 be relocated?

A: The County will relocate this fence to the east side of the top of Phase 3 (along the Contract Limits) prior to/in conjunction with the start of the work on site.

Q: Where will the clearing material be taken?

A: The clearing material may be taken to the old borrow area to the east of Phase 3 and placed in an area to be designated by County staff.

Q: How will existing passive gas vents at the top of Phase 3 be abandoned?

A: The Contractor will be required to cut down and cap (at least one foot below finished grade) the three or four existing passive gas vents (6 or 8" diam. SCH 80 PVC) which will be impacted by construction of the perimeter berm. This work will be considered part of Site Preparation activities. Note that one of these vents has a utility flare which will be relocated per Addendum No. 1.