Prepared for

Sarasota County

Solid Waste Operations

Central County Solid Waste Disposal Complex

4000 Knights Trail Road
Nokomis, Florida 34275

APPLICATION FOR A PERMIT TO CONSTRUCT FLEXIBLE LEACHATE STORAGE CONTAINERS AT CENTRAL COUNTY SOLID WASTE DISPOSAL COMPLEX

Prepared by

GeoSyntec Consultants
14055 Riveredge Drive, Suite 300
Tampa, Florida 33637

Project Number FL0819

November 2006

PDF Doc. # GEAG-06-37

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APPENDICES

APPLICATION FOR A PERMIT TO CONSTRUCT FLEXIBLE LEACHATE STORAGE CONTAINERS AT CENTRAL COUNTY SOLID WASTE DISPOSAL COMPLEX

1. INTRODUCTION

1.1 Terms of Reference

GeoSyntec Consultants (GeoSyntec) has prepared this permit application for the construction and operation of a flexible leachate storage container (FLSC) facility at Central County Solid Waste Disposal Complex (CCSWDC) located in Sarasota County, Florida (west of I-75 and approximately 4 miles northwest of Nokomis). This permit application is submitted to Florida Department of Environmental Protection, Southwest District (FDEP) on behalf of Sarasota County Solid Waste Operations (Sarasota County).

In May 2006, Mr. Ayushman Gupta and Mr. Erik Nelson of GeoSyntec met with Ms. Susan Pelz, Mr. Steve Morgan and Mr. Roger Evans of FDEP regarding the permitting requirements for the proposed FLSC facility. In the meeting, it was agreed that two applications will be submitted to permit the construction and operation of the FLSCs. First, a solid waste application will be submitted to construct the FLSC facility. To operate the FLSCs, a second application will be submitted to modify the existing operation plan for CCSWDC (to include the operations of the FLSCs). In addition, an Environmental Resource Permit (ERP) for the FLSC facility is currently being prepared by GeoSyntec for submittal to FDEP.

The required permit application form, *FDEP Form 62-701-900(1) – Application to Construct, Operate, Modify or Close a Solid Waste Management Facility*, has been completed and is included in Appendix A. This permit application was prepared by Mr. Juan D. Quiroz, Ph.D., P.E. and Mr. Ayushman Gupta, P.E. of GeoSyntec.

1.2 Site Information

CCSWDC is located on a 6,150-acre property at the north end of Knights Trail Road in Nokomis, Sarasota County, Florida in Sections 1 through 4 and 9 through 16 of Township 38S and Range 19E. CCSWDC currently consists of a Class I solid waste landfill. The conceptual master plan for the CCSWDC includes a landfill footprint area of 268 acres, a total waste disposal capacity of about 40 million cubic yards, and an operating life of more than 40 years. The planned CCSWDC landfill development will occur in five phases. In October 1993, FDEP approved the construction permit for Phase 1 of the

CCSWDC landfill, which was subsequently renewed in July 1997. The total landfill footprint of Phase 1 is approximately 60 acres which are divided equally into five 12-acre cells. The operation of Phase 1 started in June 1998.

At present, leachate from Phase 1 is pumped from leachate sumps (located along the northern end of each landfill cell) to a 6 inch diameter high density polyethylene (HDPE) leachate transmission line (i.e., forcemain). The existing leachate transmission line is approximately one mile long and carries leachate from the landfill cells to the site's leachate storage facility located south of the existing landfill. The leachate storage facility consists of a double-contained concrete storage tank. The open-top, cylindrical leachate storage tank has an inside diameter of 100 ft and height of 30 ft, corresponding to a total storage capacity of about 1.8 million gallons. The secondary containment tank has an inside diameter of 130 ft and height of 19 ft. The leachate is currently trucked from the storage tank to a wastewater treatment plant for disposal.

The storm water management system for the site generally consists of sheet flow to surface water drainage channels and then to storm water ponds located throughout the site. Specifically, storm water from Phase 1 and future landfill phases is conveyed via surface water drainage channels (and culverts) along the interior side slope of the existing landfill area perimeter roads to Storm Water Pond Nos. 1 and 2 located northwest and southwest of Phase 1, respectively.

1.3 Organization of the Report

This report is organized into five sections. Following this introductory section:

- Section 2 provides the project background and basis for this permit application;
- Section 3 presents the FLSC facility, specifically the layout and configuration and general operation procedures;
- Section 4 presents the FLSC facility design evaluation and associated calculation packages;
- Section 5 outlines the construction quality assurance (CQA) plan and technical specifications; and
- Section 6 provides a summary of the FLSC design and permit application.

2. PROJECT BACKGROUND

In the last few years Sarasota County has experienced extreme rainfall events that have required more leachate storage capacity than is currently available at CCSWDC to maintain the required minimum head on the bottom liner system of Cells 1 through 4 within the Phase 1 landfill. Under emergency situations, additional leachate storage capacity was potentially provided by Cell 5, a lined landfill cell. However, as waste filling activities progress into Cell 5, an alternative leachate storage system is required for emergency situations.

In addition, the extreme rainfall events have occasionally caused leachate breakouts (from Phase 1) that have impacted storm water in the surface water drainage channel north of Phase 1. In the past, any storm water that may have been impacted by the leachate breakouts was contained within the northern surface water drainage channel until water quality testing was completed to verify whether the "impacted" storm water needs to be treated or could be safely discharged to Storm Water Pond No. 1. As a result, an improved impacted storm water emergency storage system is also desired by Sarasota County.

3. FLEXIBLE LEACHATE STORAGE CONTAINER FACILITY

3.1 Overview

Sarasota County proposes to construct and operate a FLSC facility at CCSWDC to store additional leachate and impacted storm water at the site in emergency situations. The FLSC facility will provide a leachate storage capacity of approximately 600,000 gallons. Accordingly, the total on-site leachate storage capacity will increase from 1.8 million gallons to 2.4 million gallons. The FLSC facility will also provide a 600,000 gallon storage capacity for impacted storm water.

Additional details regarding the proposed FLSC facility are provided in the proposed Permit Drawings titled *Flexible Leachate Storage Containers, Central County Solid Waste Disposal Complex, Sarasota County*, dated November 2006, which are included in Appendix B of this permit application. The following sections discuss the details associated with the layout, configuration and operation of the FLSC facility.

3.2 Layout and Configuration

As shown on Sheet 2 of the Permit Drawings, the proposed FLSC facility will be located at the northwest corner of the open field that lies south of the existing Phase 1 landfill and west of the on-site maintenance building area. The FLSC facility was situated such that it could tie-in to the existing leachate forcemain that runs in a southerly direction from Phase 1 to the existing on-site leachate storage facility. To convey impacted storm water the FLSCs, an approximately 7,950-ft long, 6-inch diameter HDPE conveyance pipe will be installed along the interior side slope of the site's perimeter road from Storm Water Pond No. 1 to the proposed FLSC facility location (see Sheet 2 of the Permit Drawings). The conveyance pipe will eventually cross under the access road that lies just north of the proposed location of the FLSC facility. In addition, weir structures will be constructed at the inlet locations to Storm Water Ponds Nos. 1 and 2. These structures will prevent discharge of impacted storm water into the respective ponds from Phase 1 and future landfill phases.

The FLSC facility will be built-up relative to existing ground, as shown on Sheet 3 of the Permit Drawings. A perimeter berm approximately 7 ft high with 3H:1V side slopes and an 8-ft wide crest will encompass the FLSCs. Interior division berms will also be constructed to provide separation between each individual FLSC unit. The FLSC facility has a footprint of approximately two acres and consists of four individually lined and sealed storage containers. Each FLSC has a maximum storage capacity of approximately 300,000 gallons. Two of the containers (FLSCs 2A and 2B) will provide leachate storage, while the remaining two containers (FLSCs 1A and 1B) will provide impacted storm water storage under emergency situations. FLSCs 1A and 1B will only be used for impacted storm water. However, FLSCs 2A and 2B may also be used for impacted storm water, if needed.

As shown on Sheet 6 of the Permit Drawings, the FLSCs will be constructed of 60-mil high density polyethylene (HDPE) textured geomembrane. The maximum liquid level within each container is approximately 5 ft. Each FLSC is designed as an individual unit with a double-liner system and individual leachate and leakage collection sumps. The double-liner system consists of the following, from top to bottom:

- Double-sided drainage geocomposite (with 8 oz/yd^2 geotextile on both sides);
- 60-mil HDPE textured geomembrane;
- Double-sided drainage geocomposite;
- 60-mil HDPE textured geomembrane; and
- Geosynthetic clay liner (GCL).

3.3 Operation

In general, the FLSC facility will be utilized only in emergency situations when: (i) additional leachate storage capacity is temporarily required; and (ii) potentially impacted storm water is required to be temporarily stored (until water quality testing is completed). The FLSC facility will tie-in to the existing leachate forcemain that conveys leachate from Phase 1 to the existing on-site leachate storage facility. A system of check valves and inflow/outflow pipes will be utilized to convey leachate and/or impacted storm water to and from the FLSC facility (see Sheets 8 through 11). Specific procedures have been developed for each circumstance, and are summarized below.

If additional leachate storage capacity is required, leachate flow can be diverted from the existing leachate forcemain to the designated FLSCs. Once the downstream leachate storage facility is restored to normal operating conditions and can accommodate the leachate volume temporarily stored within the FLSCs, the leachate will be pumped back into the existing leachate management system for disposal. The FLSCs will be emptied and remain empty until additional, emergency storage capacity is required.

If storm water is potentially impacted from Phase 1 or future landfill phases, the weir structures located at the inlet locations of Storm Water Ponds Nos. 1 and 2 (see Sheet 2 of the Permit Drawings) will be raised to prevent discharge to the respective ponds and contain the impacted storm water within the surface water drainage channels. The impacted storm water will then be pumped via the impacted storm water pipeline to the FLSC facility, and sampled for water quality testing. If water quality testing indicates that the "impacted" storm water can be safely discharged, then it will be pumped from the containers to the surface water drainage channel north of and across the road from the FLSC facility. This surface water drainage channel will eventually discharge to Storm Water Pond No. 2. If water quality testing indicates that the impacted storm water requires treatment, then it will be pumped into the existing leachate management system for disposal. The FLSCs will be emptied and remain empty until additional, emergency storage capacity is required.

Additional operation details of the FLSCs will be provided in a second (i.e., permit modification) application that will be submitted to modify the operations plan for CCSWDC and include the operations of the FLSCs.

3.4 Subsurface Investigation and Monitoring Well Installation

A subsurface investigation was conducted to evaluate the subsurface profile and corresponding geotechnical properties of the foundation soils in support of the proposed

FLSC facility. One soil boring, designated as GB-1, was performed at approximately the center of the FLSC facility footprint. Continuous Standard Penetration Tests (SPTs) with a split-spoon barrel were conducted in the hollow-stem augered borehole to provide N-values (blows/ft) and a continuous visual examination of the soil profile. The depth of the SPTs and split-spoon sampling in the boring was continued until refusal (i.e., blows/ft greater than 50) at approximately 20 ft below ground surface. The borehole was subsequently backfilled with Bentonite pellets. The boring was performed on 1 August 2006 by National Environmental Technology, Inc. (Dover, Florida) under the field direction/monitoring of GeoSyntec personnel. The soil boring log is included in Appendix C of this permit application.

The foundation soils beneath the FLSCs generally consist of loose to medium dense fine sands and silty sands. The observed ground water table at the time of the boring was about 3.5 ft below the ground surface. Laboratory geotechnical testing was performed on select soil samples obtained during soil boring GB-1. The laboratory geotechnical tests performed consisted of grain size analyses, which were used to classify the soils and confirm the visual descriptions presented in the soil boring logs. The testing was performed by Excel Geotechnical Testing, Inc. (Roswell, Georgia). The results of the laboratory geotechnical tests are provided in Appendix C of this permit application.

The ground water at the site generally flows in a southwest direction. A shallow monitoring well, designated as MW-13, was installed approximately 50 ft southwest of the outer toe of the proposed FLSC facility perimeter berm (see Sheet 3 of the Permit Drawings), and is located down-gradient with respect to general ground water flow at the site. The monitoring well is approximately 12-ft deep with a screen length of 5 ft along the lower portion of the well (i.e., from a depth of approximately 7 ft to 12 ft below the existing ground surface). The monitoring well was installed on 1 August 2006 by National Environmental Technology, Inc. (Dover, Florida) under the field direction/monitoring of GeoSyntec personnel. The monitoring well installation log and well completion report is provided in Appendix C of this permit application.

4. DESIGN EVALUATIONS

4.1 Overview

The following design aspects were evaluated in support of the proposed FLSC facility: (i) impacted storm water conveyance pipe stability; (ii) liner system anchor trench design; (iii) perimeter berm stability; and (iv) liner system leakage and lateral drainage capacity. A summary of each evaluation is provided below.

4.2 Conveyance Pipe Stability

The structural stability of the impacted storm water conveyance pipe and FLSC facility leachate pipes (see Sheets 2 and 3 of the Permit Drawings) was evaluated with respect to applied overburden and/or traffic loading. The pipe stability analyses are presented in the calculation package titled *Pipe Stability Evaluation*, which is included in Appendix D of this permit application. Based on the pipe stability calculations that consider wall crushing, wall buckling, excessive ring deflection and excessive bending strain, the proposed conveyance pipes provide adequate structural stability with respect to the applied external loads.

4.3 Liner System Anchor Trench Design

The adequacy of the liner system anchor trench design was evaluated for the FLSC facility. As presented on Sheet 6 of the Permit Drawings, the anchor trench located along the top crest of the perimeter berm will be constructed to hold in-place the liner system geosynthetics. The liner system anchor trench design evaluation is presented in the calculation package titled *Anchor Trench Design Evaluation*, which is included in Appendix E of this permit application. Based on the anchorage calculations and FLSC loading conditions, the proposed anchor trench depth of 2 ft is adequate relative to geosynthetic pullout resistance.

4.4 Perimeter Berm Stability

The impact of the FLSCs on the global stability of the perimeter berms was evaluated. Two analyses were performed: (i) sliding stability along the base of the berm; and (ii) rotational (foundation) slope stability of the berm. The stability analyses are presented in the calculation package titled *Perimeter Berm Stability*, which is included in Appendix F of this permit application. The results of the sliding stability analysis indicate that the perimeter berm provides adequate buttressing for the proposed FLSCs. Similarly, the results of the foundation slope stability analysis indicate that the perimeter berm and subsurface soils provide adequate foundation support for the FLSCs.

4.5 Liner System Leakage and Lateral Drainage Capacity

The rate of leakage through the FLSCs, and primary and secondary liner systems (see Sheet 6 of the Permit Drawings) was evaluated. These leakage rates were then utilized to evaluate the conveyance capacity of the proposed primary and secondary leachate collection layers such that specified maximum allowable heads on the liner were not exceeded. Finally, the sump pumps were sized accordingly to prevent head build-up within each leachate collection layer.

The liner system leakage and lateral drainage capacity calculations are presented in the calculation package titled *Liner Leakage and Lateral Drainage Capacity Evaluation*, which is included in Appendix G of this permit application. Based on the liner system leakage calculations, the actual leakage rate through the secondary liner is negligible since the FLSC facility will be used for a limited time under emergency situations only. In addition, the maximum calculated head-on-liner values are less than or equal to the specified maximum allowable heads that were limited to: (i) 12 inches for the primary leachate collection layer; and (ii) the thickness of the lateral drainage layer for the secondary leachate collection layer. These head-on-liner results indicate that the lateral drainage capacity of the proposed leachate collection layers is adequate.

The sumps will be instrumented with leak detection transducers that will activate an alarm light; and pumping of the sumps will be performed on an as needed basis. If a leak is detected in the primary or secondary sump, the accumulated leachate will be pumped back into the respective FLSC. Additional leachate sump operational details are provided in the liner system leakage and lateral drainage capacity calculation package (Appendix G).

5. TECHNICAL SPECIFICATIONS AND CONSTRUCTION QUALITY ASSURANCE PLAN

It is assumed that the FLSCs will be constructed with high quality materials, that good construction practices will be followed, and that a very good construction quality assurance (CQA) program will be implemented. The *Technical Specifications* for all construction materials are presented in Appendix H, and the *CQA Plan* is presented in Appendix I.

APPENDIX A

FDEP Form 62-701-900(1) –
Application to Construct, Operate, Modify or Close a Solid Waste Management Facility

DEP Form # 62-701.900(1)
Form Title Solid Waste Management Facility Permit
Effective Date 05-27-01
DEP Application No. ______ (Filled by DEP)

Florida Department of Environmental Protection
Twin Towers Office Bldg. • 2600 Blair Stone Road • Tallahassee, FL 32399-2400

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

APPLICATION FOR A PERMIT TO CONSTRUCT, OPERATE, MODIFY OR CLOSE A SOLID WASTE MANAGEMENT FACILITY

APPLICATION INSTRUCTIONS AND FORMS

INSTRUCTIONS TO APPLY FOR A SOLID WASTE MANAGEMENT FACILITY PERMIT

I. General

Solid Waste Management Facilities shall be permitted pursuant to Section 403.707, Florida Statutes,(FS) and in accordance with Florida Administrative Code (FAC) Chapter 62-701. A minimum of four copies of the application shall be submitted to the Department's District Office having jurisdiction over the facility. The appropriate fee in accordance with Rule 62-701.315, FAC, shall be submitted with the application by check made payable to the Department of Environmental Protection (DEP).

Complete appropriate sections for the type of facility for which application is made. Entries shall be typed or printed in ink. All blanks shall be filled in or marked "not applicable" or "no substantial change". Information provided in support of the application shall be marked "submitted" and the location of this information in the application package indicated. The application shall include all information, drawings, and reports necessary to evaluate the facility. Information required to complete the application is listed on the attached pages of this form.

II. Application Parts Required for Construction and Operation Permits

A. Landfills and Ash Monofills - Submit parts A,B, D through T
B. Asbestos Monofills - Submit parts A,B,D,E,F,G,J,L,N, P through S, and T
C. Industrial Solid Waste Facilities - Submit parts A,B, D through T
D. Non-Disposal Facilities - Submit parts A,C,D,E,J,N,S and T

NOTE: Portions of some parts may not be applicable.

NOTE: For facilities that have been satisfactorily constructed in accordance with their construction permit, the information required for A,B,C and D type facilities does not have to be resubmitted for an operation permit if the information has not substantially changed during the construction period. The appropriate portion of the form should be marked "no substantial change".

III. Application Parts Required for Closure Permits

A. Landfills and Ash Monofills - Submit parts A,B,M, O through T
B. Asbestos Monofills - Submit parts A,B,N, P through T
C. Industrial Solid Waste Facilities - Submit parts A,B, M through T
D. Non-Disposal Facilities - Submit parts A,C,N,S and T

NOTE: Portions of some parts may not be applicable.

IV. Permit Renewals

The above information shall be submitted at time of permit renewal in support of the new permit. However, facility information that was submitted to the Department to support the expiring permit, and which is still valid, does not need to be re-submitted for permit renewal. Portions of the application not re-submitted shall be marked "no substantial change" on the application form.

V. Application Codes

S	-	Submitted
LOCATION	-	Physical location of information in application
N/A	-	Not Applicable
N/C	-	No Substantial Change

VI. LISTING OF APPLICATION PARTS

PART A: GENERAL INFORMATION

PART B: DISPOSAL FACILITY GENERAL INFORMATION

PART C: NON-DISPOSAL FACILITY GENERAL INFORMATION

PART D: PROHIBITIONS

PART E: SOLID WASTE MANAGEMENT FACILITY PERMIT REQUIREMENTS, GENERAL

PART F: LANDFILL PERMIT REQUIREMENTS

PART G: GENERAL CRITERIA FOR LANDFILLS

PART H: LANDFILL CONSTRUCTION REQUIREMENTS

PART I: HYDROGEOLOGICAL INVESTIGATION REQUIREMENTS

PART J: GEOTECHNICAL INVESTIGATION REQUIREMENTS

PART K: VERTICAL EXPANSION OF LANDFILLS

PART L: LANDFILL OPERATION REQUIREMENTS

PART M: WATER QUALITY AND LEACHATE MONITORING REQUIREMENTS

PART N: SPECIAL WASTE HANDLING REQUIREMENTS

PART O: GAS MANAGEMENT SYSTEM REQUIREMENTS

PART P: LANDFILL CLOSURE REQUIREMENTS

PART Q: CLOSURE PROCEDURES

PART R: LONG TERM CARE REQUIREMENTS

PART S: FINANCIAL RESPONSIBILITY REQUIREMENTS

PART T: CERTIFICATION BY APPLICANT AND ENGINEER OR PUBLIC OFFICER

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
APPLICATION FOR A PERMIT TO CONSTRUCT, OPERATE, MODIFY OR CLOSE
A SOLID WASTE MANAGEMENT FACILITY

Please Type or Print

A. GENERAL INFORMATION

1. Type of facility (check all that apply):

[✓] Disposal
- [ ] Class I Landfill
- [ ] Class II Landfill
- [ ] Class III Landfill
- [✓] Other Describe: **Flexible Leachate Storage Containers**
- [ ] Ash Monofill
- [ ] Asbestos Monofill
- [ ] Industrial Solid Waste

[ ] Non-Disposal
- [ ] Incinerator For Non-biomedical Waste
- [ ] Waste to Energy Without Power Plant Certification
- [ ] Other Describe: ______

NOTE: Waste Processing Facilities should apply on Form 62-701.900(4), FAC;
Land Clearing Disposal Facilities should notify on Form 62-701.900(3), FAC;
Compost Facilities should apply on Form 62-701.900(10), FAC; and
C&D Disposal Facilities should apply on Form 62-701.900(6), FAC

2. Type of application:
- [✓] Construction
- [ ] Operation
- [ ] Construction/Operation
- [ ] Closure

3. Classification of application:
- [✓] New
- [ ] Renewal
- [ ] Substantial Modification
- [ ] Intermediate Modification
- [ ] Minor Modification

4. Facility name: **Central County Solid Waste Disposal Complex**

5. DEP ID number: **00051614** County: **Sarasota County**

6. Facility location (main entrance): **4000 Knights Trail Road, Nokomis, Florida 34275**

7. Location coordinates:

Section: 03 Township: 38 Range: 19

Latitude: 27 ° 12 ' 10.7 " Longitude: 82 ° 23 ' 16.39 "

DEP FORM 62-701.900(1)
Effective 05-27-01

8. Applicant name (operating authority): Sarasota County Solid Waste Operations

Mailing address: 4000 Knights Trail Road, Nokomis, Florida 34275
Street or P.O. Box City State Zip

Contact person: Frank Coggins Telephone: (941) 861-1571

Title: Manager of Solid Waste Operations

fcoggins@scgov.net
E-Mail address (if available)

9. Authorized agent/Consultant: GeoSyntec Consultants, Inc.

Mailing address: 14055 Riveredge Drive, Suite 300, Tampa, Florida 33637
Street or P.O. Box City State Zip

Contact person: Ayushman Gupta Telephone: (813) 558-0990

Title: Senior Engineer

agupta@geosyntec.com
E-Mail address (if available)

10. Landowner(if different than applicant): N/A

Mailing address: N/A
Street or P.O. Box City State Zip

Contact person: N/A Telephone: (___) N/A

N/A
E-Mail address (if available)

11. Cities, towns and areas to be served: N/A

12. Population to be served:

Current: N/A Five-Year Projection: N/A

13. Date site will be ready to be inspected for completion: 4Q of 2007

14. Expected life of the facility: Life of Class I Landfill years

15. Estimated costs:

Total Construction: $ 500,000 Closing Costs: $ N/A

16. Anticipated construction starting and completion dates:

From: 3Q 2007 To: 4Q 2007

17. Expected volume or weight of waste to be received:

N/A yds^3/day N/A tons/day N/A gallons/day

B. DISPOSAL FACILITY GENERAL INFORMATION

1. Provide brief description of disposal facility design and operations planned under this application:

   This application is to construct and operate a flexible leachate storage container (FLSC) facility at CCSWDC which consists of four lined cells. Each cell has a storage capacity of 300,000 gallons. Two of the cells will provide an additional leachate storage capacity and the remaining two cells will provide impacted storm water storage.

2. Facility site supervisor: Frank Coggins

   Title: Manager/Solid Waste Operations Telephone: (941) 650-4160

   fcoggins@scgov.net
   E-Mail address (if available)

3. Disposal area: Total N/A acres; Used N/A acres; Available N/A acres.

4. Weighing scales used: [ ] Yes [✓] No

5. Security to prevent unauthorized use: [✓] Yes [ ] No

6. Charge for waste received: N/A \$/yds^3 N/A \$/ton

7. Surrounding land use, zoning:

[ ] Residential	[ ] Industrial
[ ] Agricultural	[✓] None
[ ] Commercial	[ ] Other Describe: ______

8. Types of waste received: N/A

[ ] Residential	[ ] C & D debris
[ ] Commercial	[ ] Shredded/cut tires
[ ] Incinerator/WTE ash	[ ] Yard trash
[ ] Treated biomedical	[ ] Septic tank
[ ] Water treatment sludge	[ ] Industrial
[ ] Air treatment sludge	[ ] Industrial sludge
[ ] Agricultural	[ ] Domestic sludge
[ ] Asbestos	
[ ] Other Describe: ______	

9. Salvaging permitted: [ ] Yes [ ] No N/A

10. Attendant: [✓] Yes [ ] No Trained operator: [✓] Yes [ ] No

11. Spotters: Yes [ ] No [ ] Number of spotters used: N/A

12. Site located in: [ ] Floodplain [ ] Wetlands [ ] Other N/A

13. Property recorded as a Disposal Site in County Land Records: [✓] Yes [ ] No

14. Days of operation: Monday thru Sunday

15. Hours of operation: 24 hours a day

16. Days Working Face covered: N/A

17. Elevation of water table: 16 Ft. (NGVD 1929)

18. Number of monitoring wells: 1

19. Number of surface monitoring points: N/A

20. Gas controls used: [ ] Yes [✓] No Type controls: [ ] Active [ ] Passive N/A

Gas flaring: [ ] Yes [✓] No Gas recovery: [ ] Yes [✓] No

21. Landfill unit liner type: N/A

[ ] Natural soils
[ ] Single clay liner
[ ] Single geomembrane
[ ] Single composite
[ ] Slurry wall
[ ] Other Describe: ______
[ ] Double geomembrane
[ ] Geomembrane & composite
[ ] Double composite
[ ] None

22. Leachate collection method:

[✓] Collection pipes
[ ] Geonets
[ ] Well points
[ ] Perimeter ditch
[ ] Other Describe: ______
[ ] Sand layer
[ ] Gravel layer
[ ] Interceptor trench
[ ] None

23. Leachate storage method:

[ ] Tanks
[✓] Surface impoundments with flexble storage containers
[ ] Other Describe: ______

24. Leachate treatment method:

[ ] Oxidation
[ ] Secondary
[ ] Advanced
[✓] None
[ ] Other ______
[ ] Chemical treatment
[ ] Settling

25. Leachate disposal method:

[ ] Recirculated
[✓] Transported to WWTP
[ ] Injection well
[ ] Evaporation
[ ] Other ______________________________

[ ] Pumped to WWTP
[ ] Discharged to surface water
[ ] Percolation ponds

26. For leachate discharged to surface waters:

Name and Class of receiving water: ______ N/A ______

27. Storm Water:

Collected: [✓] Yes [ ] No

Type of treatment: Dry and Wet detention ponds___Wet_detention pond____

Name and Class of receiving water: __Class III______________________

28. Environmental Resources Permit (ERP) number or status: _In Preparation________

ERP application will be submitted to FDEP separately._Yes___

C. **NON-DISPOSAL FACILITY GENERAL INFORMATION : N/A**

1. Provide brief description of the non-disposal facility design and operations planned under this application:

____

____

____

____

2. Facility site supervisor: ______________________________

   Title: ____________________ Telephone: (——) ____________________

   ____
   E-Mail address (if available)

3. Site area: Facility __________ acres; Property __________ acres

4. Security to prevent unauthorized use: [ ] Yes [ ] No

5. Site located in: [ ] Floodplain [ ] Wetlands [ ] Other __________

6. Days of operation: ______________________________

7. Hours of operation: ______________________________

8. Number of operating staff: ______________

9. Expected useful life: ________ Years

10. Weighing scales used: [ ] Yes [ ] No

11. Normal processing rate: ________ yd^3/day ________ tons/day ________ gal/day

12. Maximum processing rate: ________ yd^3/day ________ tons/day ________ gal/day

13. Charge for waste received: ______________________________

14. Storm Water Collected: [ ] Yes [ ] No

    Type of treatment: ______________________________

    Name and Class of receiving water: ______________________________

15. Environmental Resources Permit (ERP) number or status: ______________________________

    ____

16. Final residue produced:

    ________ % of normal processing rate ________ % of maximum processing rate

    ________ Tons/day ________ Tons/day

    Disposed of at:

    Facility name: ____________________ County: ____________________

17. Estimated operating costs: $ ________________

Total cost/ton: $ ____________________ Net cost/ton: $ ______________________

18. Provide a site plan, at a scale not greater than 200 feet to the inch, which shows the facility location and identifies the proposed waste and final residue storage areas, total acreage of the site, and any other features which are relevant to the prohibitions or location restrictions in Rule 62-701.300, FAC, such as water bodies or wetlands on or within 200 feet of the site, and potable water wells on or within 500 feet of the site.

19. Provide a description of how the waste and final residue will be managed to not be expected to cause violations of the Department's ground water, surface water or air standards or criteria

20. Provide an estimate of the maximum amount of waste and final residue that will be store on-site.

21. Provide a detailed description of the technology use at the facility and the functions of all processing equipment that will be utilized.. The descriptions shall explain the flow of waste and residue through all the proposed unit operations and shall include: (1) regular facility operations as they are expected to occur; (2) procedures for start up operations, and scheduled and unscheduled shut down operations; (3) potential safety hazards and control methods, including fire detection and control; (4) a description of any expected air emissions and wastewater discharges from the facility which may be potential pollution sources; (5) a description and usage rate of any chemical or biological additives that will be used in the process; and (6) process flow diagrams for the facility operations.

22. Provide a description of the loading, unloading and processing areas.

23. Provide a description of the leachate control system that will be used to prevent discharge of leachate to the environment and mixing of leachate with stormwater. Note: Ground water monitoring may be required for the facility depending on the method of leachate control used.

24. Provide an operation plan for the facility which includes: (1) a description of general facility operations, the number of personnel responsible for the operations including their respective job descriptions, and the types of equipment that will be used at the facility; (2) procedures to ensure any unauthorized wastes received at the site will be properly managed; (3) a contingency plan to cover operation interruptions and emergencies such as fires, explosions, or natural disasters; (4) procedures to ensure operational records needed for the facility will be adequately prepared and maintained; and (5) procedures to ensure that the wastes and final residue will be managed to not be expected to cause pollution.

25. Provide a closure plan that describes the procedures that will be implemented when the facility closes including: (1) estimated time to complete closure; (2) procedures for removing and properly managing or disposing of all wastes and final residues; (3) notification of the Department upon ceasing operations and completion of final closure.

D. **PROHIBITIONS** (62-701.300, FAC) N/A

S	LOCATION	N/A	N/C		
___	___________	_x__	___	1.	Provide documentation that each of the siting criteria will be satisfied for the facility; (62-701.300(2), FAC)
___	___________	_x__	___	2.	If the facility qualifies for any of the exemptions contained in Rules 62-701.300(12) through (16), FAC, then document this qualification(s).
___	___________	_x__	___	3.	Provide documentation that the facility will be in compliance with the burning restrictions; (62-701.300(3), FAC)
___	___________	_x__	___	4.	Provide documentation that the facility will be in compliance with the hazardous waste restrictions; (62-701.300(4), FAC)
___	___________	_x__	___	5.	Provide documentation that the facility will be in compliance with the PCB disposal restrictions; (62-701.300(5), FAC)
___	___________	_x__	___	6.	Provide documentation that the facility will be in compliance with the biomedical waste restrictions; (62-701.300(6), FAC)
___	___________	_x__	___	7.	Provide documentation that the facility will be in compliance with the Class I surface water restrictions; (62-701.300(7), FAC)
___	___________	_x__	___	8.	Provide documentation that the facility will be in compliance with the special waste for landfills restrictions; (62-701.300(8), FAC)
___	___________	_x__	___	9.	Provide documentation that the facility will be in compliance with the special waste for waste-to-energy facilities restrictions; (62-701.300(9), FAC)
___	___________	_x__	___	10.	Provide documentation that the facility will be in compliance with the liquid restrictions; (62-701.300(10), FAC)
___	___________	_x__	___	11.	Provide documentation that the facility will be in compliance with the used oil restrictions; (62-701.300(11), FAC)

E. **SOLID WASTE MANAGEMENT FACILITY PERMIT REQUIREMENTS, GENERAL** (62-701.320, FAC)

S	LOCATION	N/A	N/C		
x	Attahced			1.	Four copies, at minimum, of the completed application form, all supporting data and reports; (62-701.320(5)(a),FAC)
x	Attahced			2.	Engineering and/or professional certification (signature, date and seal) provided on the applications and all engineering plans, reports and supporting information for the application; (62-701.320(6),FAC)
x	Included			3.	A letter of transmittal to the Department; (62-701.320(7)(a),FAC)
x	Included			4.	A completed application form dated and signed by the applicant; (62-701.320(7)(b),FAC)
x	Attahced			5.	Permit fee specified in Rule 62-701.315, FAC in check or money order, payable to the Department; (62-701.320(7)(c),FAC)
x	Attahced			6.	An engineering report addressing the requirements of this rule and with the following format: a cover sheet, text printed on 8 1/2 inch by 11 inch consecutively numbered pages, a table of contents or index, the body of the report and all appendices including an operation plan, contingency plan, illustrative charts and graphs, records or logs of tests and investigations, engineering calculations; (62-701.320(7)(d),FAC)
x	3.3			7.	Operation Plan and Closure Plan; (62-701.320(7)(e)1,FAC)
		x		8.	Contingency Plan; (62-701.320(7)(e)2,FAC)
				9.	Plans or drawings for the solid waste management facilities in appropriate format (including sheet size restrictions, cover sheet, legends, north arrow, horizontal and vertical scales, elevations referenced to NGVD 1929) showing; (62-702.320(7)(f),FAC)
x	PD Sht 2			a.	A regional map or plan with the project location;
x	PD Sht 2			b.	A vicinity map or aerial photograph no more than 1 year old;
		x		C.	A site plan showing all property boundaries certified by a registered Florida land surveyor;

Note:
PD = Permit Drawings

S	LOCATION	N/A	N/C	PART E CONTINUED
x	PD			d. Other necessary details to support the engineering report.
		x		10. Documentation that the applicant either owns the property or has legal authority from the property owner to use the site; (62-701.320(7)(g),FAC)
		x		11. For facilities owned or operated by a county, provide a description of how, if any, the facilities covered in this application will contribute to the county's achievement of the waste reduction and recycling goals contained in Section 403.706,FS; (62-701.320(7)(h),FAC)
		x		12. Provide a history and description of any enforcement actions taken by the Department against the applicant for violations of applicable statutes, rules, orders or permit conditions relating to the operation of any solid waste management facility in this state; (62-701.320(7)(i),FAC)
		x		13. Proof of publication in a newspaper of general circulation of notice of application for a permit to construct or substantially modify a solid waste management facility; (62-702.320(8),FAC)
		x		14. Provide a description of how the requirements for airport safety will be achieved including proof of required notices if applicable. If exempt, explain how the exemption applies; (62-701.320(13),FAC)
		x		15. Explain how the operator training requirements will be satisfied for the facility; (62-701.320(15), FAC)

Note:
PD = Permit Drawings

F. LANDFILL PERMIT REQUIREMENTS (62-701.330, FAC): N/A

S	LOCATION	N/A	N/C		
		X		1.	Vicinity map or aerial photograph no more than 1 year old and of appropriate scale showing land use and local zoning within one mile of the landfill and of sufficient scale to show all homes or other structures, water bodies, and roads other significant features of the vicinity. All significant features shall be labeled; (62-701.330(3)(a),FAC)
		X		2.	Vicinity map or aerial photograph no more than 1 year old showing all airports that are located within five miles of the proposed landfill; (62-701.330(3)(b),FAC)
		X		3.	Plot plan with a scale not greater than 200 feet to the inch showing; (62-701.330(3)(c),FAC)
		X		a.	Dimensions;
		X		b.	Locations of proposed and existing water quality monitoring wells;
		X		c.	Locations of soil borings;
		X		d.	Proposed plan of trenching or disposal areas;
		X		e.	Cross sections showing original elevations and proposed final contours which shall be included either on the plot plan or on separate sheets;
		X		f.	Any previously filled waste disposal areas;
		X		g.	Fencing or other measures to restrict access.
				4.	Topographic maps with a scale not greater than 200 feet to the inch with 5-foot contour intervals showing; (62-701.330(3)(d),FAC):
		X		a.	Proposed fill areas;
		X		b.	Borrow areas;
		X		c.	Access roads;
		X		d.	Grades required for proper drainage;
		X		e.	Cross sections of lifts;

S	LOCATION	N/A	N/C	PART F CONTINUED
		x		f. Special drainage devices if necessary;
		x		g. Fencing;
		x		h. Equipment facilities.
				5. A report on the landfill describing the following; (62-701.330(3)(e),FAC)
		x		a. The current and projected population and area to be served by the proposed site;
		x		b. The anticipated type, annual quantity, and source of solid waste, expressed in tons;
		x		c. The anticipated facility life;
		x		d. The source and type of cover material used for the landfill.
		x		6. Provide evidence that an approved laboratory shall conduct water quality monitoring for the facility in accordance with Chapter 62-160,FAC; (62-701.330(3)(h),FAC)
		x		7. Provide a statement of how the applicant will demonstrate financial responsibility for the closing and long-term care of the landfill; (62-701.330(3)(i),FAC)

G. GENERAL CRITERIA FOR LANDFILLS (62-701.340,FAC): N/A

S	LOCATION	N/A	N/C	
		x		1. Describe (and show on a Federal Insurance Administration flood map, if available) how the landfill or solid waste disposal unit shall not be located in the 100-year floodplain where it will restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain unless compensating storage is provided, or result in a washout of solid waste; (62-701.340(4)(b),FAC)
		x		2. Describe how the minimum horizontal separation between waste deposits in the landfill and the landfill property boundary shall be 100 feet, measured from the toe of the proposed final cover slope; (62-701.340(4)(c),FAC)
		x		3. Describe what methods shall be taken to screen the landfill from public view where such screening can practically be provided; (62-701.340(4)(d),FAC)

H. LANDFILL CONSTRUCTION REQUIREMENTS (62-701.400,FAC)

S	LOCATION	N/A	N/C	
		x		1. Describe how the landfill shall be designed so that solid waste disposal units will be constructed and closed at planned intervals throughout the design period of the landfill; (62-701.400(2),FAC): N/A
				2. Landfill liner requirements; (62-701.400(3),FAC):N/A
				a. General construction requirements; (62-701.400(3)(a),FAC):
		x		(1) Provide test information and documentation to ensure the liner will be constructed of materials that have appropriate physical, chemical, and mechanical properties to prevent failure;
		x		(2) Document foundation is adequate to prevent liner failure;
		x		(3) Constructed so bottom liner will not be adversely impacted by fluctuations of the ground water;
		x		(4) Designed to resist hydrostatic uplift if bottom liner located below seasonal high ground water table;
		x		(5) Installed to cover all surrounding earth which could come into contact with the waste or leachate.
				b. Composite liners; (62-701.400(3)(b),FAC)
		x		(1) Upper geomembrane thickness and properties;
		x		(2) Design leachate head for primary LCRS including leachate recirculation if appropriate;
		x		(3) Design thickness in accordance with Table A and number of lifts planned for lower soil component.

S	LOCATION	N/A	N/C	PART H CONTINUED
				c. Double liners; (62-701.400(3)(c),FAC)
		x		(1) Upper and lower geomembrane thicknesses and properties;
		x		(2) Design leachate head for primary LCRS to limit the head to one foot above the liner;
		x		(3) Lower geomembrane sub-base design;
		x		(4) Leak detection and secondary leachate collection system minimum design criteria (k $\geq$ 10 cm/sec, head on lower liner $\leq$ 1 inch, head not to exceed thickness of drainage layer);
				d. Standards for geosynthetic components; (62-701.400(3)(d),FAC)
		x		(1) Field seam test methods to ensure all field seams are at least 90 percent of the yield strength for the lining material;
		x		(2) Geomembranes to be used shall pass a continuous spark test by the manufacturer;
		x		(3) Design of 24-inch-thick protective layer above upper geomembrane liner;
		x		(4) Describe operational plans to protect the liner and leachate collection system when placing the first layer of waste above 24-inch-thick protective layer.
		x		(5) HDPE geomembranes, if used, meet the specifications in GRI GM13;
		x		(6) PVC geomembranes, if used, meet the specifications in PGI 1197;
		x		(7) Interface shear strength testing results of the actual components which will be used in the liner system;
		x		(8) Transmissivity testing results of geonets if they are used in the liner system;
		x		(9) Hydraulic conductivity testing results of geosynthetic clay liners if they are used in the liner system;

S	LOCATION	N/A	N/C	PART H CONTINUED
				e. Geosynthetic specification requirements; (62-701.400(3)(e),FAC)
		x		(1) Definition and qualifications of the designer, manufacturer, installer, QA consultant and laboratory, and QA program;
		x		(2) Material specifications for geomembranes, geocomposites, geotextiles, geogrids, and geonets;
		x		(3) Manufacturing and fabrication specifications including geomembrane raw material and roll QA, fabrication personnel qualifications, seaming equipment and procedures, overlaps, trial seams, destructive and nondestructive seam testing, seam testing location, frequency, procedure, sample size and geomembrane repairs;
		x		(4) Geomembrane installation specifications including earthwork, conformance testing, geomembrane placement, installation personnel qualifications, field seaming and testing, overlapping and repairs, materials in contact with geomembrane and procedures for lining system acceptance;
		x		(5) Geotextile and geogrid specifications including handling and placement, conformance testing, seams and overlaps, repair, and placement of soil materials and any overlying materials;
		x		(6) Geonet and geocomposite specifications including handling and placement, conformance testing, stacking and joining, repair, and placement of soil materials and any overlying materials;
		x		(7) Geosynthetic clay liner specifications including handling and placement, conformance testing, seams and overlaps, repair, and placement of soil material and any overlying materials;
				f. Standards for soil components (62-710.400(3)(f),FAC):
		x		(1) Description of construction procedures including overexcavation and backfilling to preclude structural inconsistencies and procedures for placing and compacting soil component in layers;

S	LOCATION	N/A	N/C	PART H CONTINUED
		x		(2) Demonstration of compatibility of the soil component with actual or simulated leachate in accordance with EPA Test Method 9100 or an equivalent test method;
		x		(3) Procedures for testing in-situ soils to demonstrate they meet the specifications for soil liners;
				(4) Specifications for soil component of liner including at a minimum:
		x		(a) Allowable particle size distribution, Atterberg limits, shrinkage limit;
		x		(b) Placement moisture and dry density criteria;
		x		(c) Maximum laboratory-determined saturated hydraulic conductivity using simulated leachate;
		x		(d) Minimum thickness of soil liner;
		x		(e) Lift thickness;
		x		(f) Surface preparation (scarification);
		x		(g) Type and percentage of clay mineral within the soil component;
		x		(5) Procedures for constructing and using a field test section to document the desired saturated hydraulic conductivity and thickness can be achieved in the field.
				3. Leachate collection and removal system (LCRS); (62-701.400(4),FAC): N/A
				a. The primary and secondary LCRS requirements; (62-701.400(4)(a),FAC)
		x		(1) Constructed of materials chemically resistant to the waste and leachate;
		x		(2) Have sufficient mechanical properties to prevent collapse under pressure;
		x		(3) Have granular material or synthetic geotextile to prevent clogging;
		x		(4) Have method for testing and cleaning clogged pipes or contingent designs for rerouting leachate around failed areas;

S	LOCATION	N/A	N/C	PART H CONTINUED
				b. Primary LCRS requirements; (62-701.400(4)(b),FAC)
		x		(1) Bottom 12 inches having hydraulic conductivity $\geq 1 \times 10^{-3}$ cm/sec;
		x		(2) Total thickness of 24 inches of material chemically resistant to the waste and leachate;
		x		(3) Bottom slope design to accomodate for predicted settlement;
		x		(4) Demonstration that synthetic drainage material, if used, is equivalent or better than granular material in chemical compatibility, flow under load and protection of geomembrane liner.
				4. Leachate recirculation; (62-701.400(5),FAC)L: N/A
		x		a. Describe general procedures for recirculating leachate;
		x		b. Describe procedures for controlling leachate runoff and minimizing mixing of leachate runoff with storm water;
		x		c. Describe procedures for preventing perched water conditions and gas buildup;
		x		d. Describe alternate methods for leachate management when it cannot be recirculated due to weather or runoff conditions, surface seeps, wind-blown spray, or elevated levels of leachate head on the liner;
		x		e. Describe methods of gas management in accordance with Rule 62-701.530, FAC;
		x		f. If leachate irrigation is proposed, describe treatment methods and standards for leachate treatment prior to irrigation over final cover and provide documentation that irrigation does not contribute significantly to leachate generation.

S	LOCATION	N/A	N/C	PART H CONTINUED
				5. Leachate storage tanks and leachate surface impoundments; (62-701.400(6),FAC)
				a. Surface impoundment requirements; (62-701.400(6)(b),FAC)
		x		(1) Documentation that the design of the bottom liner will not be adversely impacted by fluctuations of the ground water;
		x		(2) Designed in segments to allow for inspection and repair as needed without interruption of service;
				(3) General design requirements;
x	3.2			(a) Double liner system consisting of an upper and lower 60-mil minimum thickness geomembrane;
x	4.5 & Appx G			(b) Leak detection and collection system with hydraulic conductivity $\geq$ 1 cm/sec;
x	3.2			(c) Lower geomembrane placed on subbase $\geq$ 6 inches thick with k $\leq 1\text{x}10^{-5}$ cm/sec or on an approved geosynthetic clay liner with k $\leq 1\text{x}10^{-7}$ cm/sec;
x	4.5 & Appx G			(d) Design calculation to predict potential leakage through the upper liner;
x	3.3			(e) Daily inspection requirements and notification and corrective action requirements if leakage rates exceed that predicted by design calculations;
		x		(4) Description of procedures to prevent uplift, if applicable;
		x		(5) Design calculations to demonstrate minimum two feet of freeboard will be maintained;
		x		(6) Procedures for controlling disease vectors and off-site odors.

S	LOCATION	N/A	N/C	PART H CONTINUED
				b. Above-ground leachate storage tanks; N/A (62-701.400(6)(c),FAC):
		x		(1) Describe tank materials of construction and ensure foundation is sufficient to support tank;
		x		(2) Describe procedures for cathodic protection if needed for the tank;
		x		(3) Describe exterior painting and interior lining of the tank to protect it from the weather and the leachate stored;
		x		(4) Describe secondary containment design to ensure adequate capacity will be provided and compatibility of materials of construction;
		x		(5) Describe design to remove and dispose of stormwater from the secondary containment system;
		x		(6) Describe an overfill prevention system such as level sensors, gauges, alarms and shutoff controls to prevent overfilling;
				(7) Inspections, corrective action and reporting requirements;
		x		(a) Overfill prevention system weekly;
		x		(b) Exposed tank exteriors weekly;
		x		(c) Tank interiors when tank is drained or at least every three years;
		x		(d) Procedures for immediate corrective action if failures detected;
		x		(e) Inspection reports available for department review.
				c. Underground leachate storage tanks; N/A (62-701.400(6)(d),FAC)
		x		(1) Describe materials of construction;
		x		(2) A double-walled tank design system to be used with the following requirements;

S	LOCATION	N/A	N/C	PART H CONTINUED
		x		(a) Interstitial space monitoring at least weekly;
		x		(b) Corrosion protection provided for primary tank interior and external surface of outer shell;
		x		(c) Interior tank coatings compatible with stored leachate;
		x		(d) Cathodic protection inspected weekly and repaired as needed;
		x		(3) Describe an overfill prevention system such as level sensors, gauges, alarms and shutoff controls to prevent overfilling and provide for weekly inspections;
		x		(4) Inspection reports available for department review.
		x		d. Schedule provided for routine maintenance of LCRS; (62-701.400(6)(e),FAC)
				6. Liner systems construction quality assurance (CQA); (62-701.400(7),FAC)
x	sec 5 & Appx I			a. Provide CQA Plan including:
x	Sec 5 & Appx H			(1) Specifications and construction requirements for liner system;
x	Appx H & I			(2) Detailed description of quality control testing procedures and frequencies;
x	Appx H & I			(3) Identification of supervising professional engineer;
x	Appx H & I			(4) Identify responsibility and authority of all appropriate organizations and key personnel involved in the construction project;
x	Appx I			(5) State qualifications of CQA professional engineer and support personnel;
x	Appx I			(6) Description of CQA reporting forms and documents;

S	LOCATION	N/A	N/C	PART H CONTINUED
x	Appx I			b. An independent laboratory experienced in the testing of geosynthetics to perform required testing;
				7. Soil Liner CQA (62-701.400(8)FAC): N/A
		x		a. Documentation that an adequate borrow source has been located with test results or description of the field exploration and laboratory testing program to define a suitable borrow source;
		x		b. Description of field test section construction and test methods to be implemented prior to liner installation;
		x		c. Description of field test methods including rejection criteria and corrective measures to insure proper liner installation.
				8. Surface water management systems; (62-701.400(9),FAC)
		x		a. Provide a copy of a Department permit for stormwater control or documentation that no such permit is required;
x	3.3			b. Design of surface water management system to isolate surface water from waste filled areas and to control stormwater run-off;
x	3.3			c. Details of stormwater control design including retention ponds, detention ponds, and drainage ways;
				9. Gas control systems; (62-701.400(10),FAC): N/A
		x		a. Provide documentation that if the landfill is receiving degradable wastes, it will have a gas control system complying with the requirements of Rule 62-701.530, FAC;
				10. For landfills designed in ground water, provide documentation that the landfill will provide a degree of protection equivalent to landfills designed with bottom liners not in contact with ground water; (62-701.400(11),FAC): N/A

I. **HYDROGEOLOGICAL INVESTIGATION REQUIREMENTS** (62-701.410(1), FAC)

S	LOCATION	N/A	N/C		
				1.	Submit a hydrogeological investigation and site report including at least the following information:
x	3.4 & Appx C			a.	Regional and site specific geology and hydrogeology;
		x		b.	Direction and rate of ground water and surface water flow including seasonal variations;
		x		c.	Background quality of ground water and surface water;
		x		d.	Any on-site hydraulic connections between aquifers;
		x		e.	Site stratigraphy and aquifer characteristics for confining layers, semi-confining layers, and all aquifers below the landfill site that may be affected by the landfill;
x	3.2, 3.3 & 3.4			f.	Description of topography, soil types and surface water drainage systems;
		x		g.	Inventory of all public and private water wells within a one-mile radius of the landfill including, where available, well top of casing and bottom elevations, name of owner, age and usage of each well, stratigraphic unit screened, well construction technique and static water level;
		x		h.	Identify and locate any existing contaminated areas on the site;
		x		i.	Include a map showing the locations of all potable wells within 500 feet, and all community water suupply wells within 1000 feet, of the waste storage and disposal areas;
x	Attached			2.	Report signed, sealed and dated by PE or PG.

J. GEOTECHNICAL INVESTIGATION REQUIREMENTS (62-701.410(2),FAC)

S	LOCATION	N/A	N/C	
				1. Submit a geotechnical site investigation report defining the engineering properties of the site including at least the following:
x	3.4			a. Description of subsurface conditions including soil stratigraphy and ground water table conditions;
		x		b. Investigate for the presence of muck, previously filled areas, soft ground, lineaments and sink holes;
		x		c. Estimates of average and maximum high water table across the site;
				d. Foundation analysis including:
		x		(1) Foundation bearing capacity analysis;
		x		(2) Total and differential subgrade settlement analysis;
	4.4 & Appx F			(3) Slope stability analysis;
	3.4 & Appx C			e. Description of methods used in the investigation and includes soil boring logs, laboratory results, analytical calculations, cross sections, interpretations and conclusions;
		x		f. An evaluation of fault areas, seismic impact zones, and unstable areas as described in 40 CFR 258.13, 40 CFR 258.14 and 40 CFR 258.15.
x	Attached			2. Report signed, sealed and dated by PE or PG.

K. **VERTICAL EXPANSION OF LANDFILLS** (62-701.430,FAC): N/A

S	LOCATION	N/A	N/C		
		x		1.	Describe how the vertical expansion shall not cause or contribute to leachate leakage from the existing landfill or adversely affect the closure design of the existing landfill;
		x		2.	Describe how the vertical expansion over unlined landfills will meet the requirements of Rule 62-701.400, FAC with the exceptions of Rule 62-701.430(1)(c),FAC;
		x		3.	Provide foundation and settlement analysis for the vertical expansion;
		x		4.	Provide total settlement calculations demonstrating that the final elevations of the lining system, that gravity drainage, and that no other component of the design will be adversely affected;
		x		5.	Minimum stability safety factor of 1.5 for the lining system component interface stability and deep stability;
		x		6.	Provide documentation to show the surface water management system will not be adversely affected by the vertical expansion;
		x		7.	Provide gas control designs to prevent accumulation of gas under the new liner for the vertical expansion.

L. LANDFILL OPERATION REQUIREMENTS (62-701.500,FAC): N/A

___	___	x	___	1.	Provide documentation that landfill will have at least one trained operator during operation and at least one trained spotter at each working face; (62-701.500(1),FAC)
				2.	Provide a landfill operation plan including procedures for: (62-701.500(2), FAC)
___	___	x	___	a.	Designating responsible operating and maintenance personnel;
___	___	x	___	b.	Contingency operations for emergencies;
___	___	x	___	c.	Controlling types of waste received at the landfill;
___	___	x	___	d.	Weighing incoming waste;
___	___	x	___	e.	Vehicle traffic control and unloading;
___	___	x	___	f.	Method and sequence of filling waste;
___	___	x	___	g.	Waste compaction and application of cover;
___	___	x	___	h.	Operations of gas, leachate, and stormwater controls;
___	___	x	___	i.	Water quality monitoring.
___	___	x	___	j.	Maintaining and cleaning the leachate collection system;
___	___	x	___	3.	Provide a description of the landfill operation record to be used at the landfill; details as to location of where various operational records will be kept (i.e. FDEP permit, engineering drawings, water quality records, etc.) (62-701.500(3),FAC)
___	___	x	___	4.	Describe the waste records that will be compiled monthly and provided to the Department quarterly; (62-701.500(4),FAC)
___	___	x	___	5.	Describe methods of access control; (62-701.500(5),FAC)
___	___	x	___	6.	Describe load checking program to be implemented at the landfill to discourage disposal of unauthorized wastes at the landfill; (62-701.500(6),FAC)
				7.	Describe procedures for spreading and compacting waste at the landfill that include: (62-701.500(7),FAC)
___	___	x	___	a.	Waste layer thickness and compaction frequencies;

S	LOCATION	N/A	N/C	PART L CONTINUED
		x		b. Special considerations for first layer of waste placed above liner and leachate collection system;
		x		c. Slopes of cell working face and side grades above land surface, planned lift depths during operation;
		x		d. Maximum width of working face;
				e. Description of type of initial cover to be used at the facility that controls:
		x		(1) Disease vector breeding/animal attraction
		x		(2) Fires
		x		(3) Odors
		x		(4) Blowing litter
		x		(5) Moisture infiltration
		x		f. Procedures for applying initial cover including minimum cover frequencies;
		x		g. Procedures for applying intermediate cover;
		x		h. Time frames for applying final cover;
		x		i. Procedures for controlling scavenging and salvaging.
		x		j. Description of litter policing methods;
		x		k. Erosion control procedures.
				8. Describe operational procedures for leachate management including; (62-701.500(8),FAC)
		x		a. Leachate level monitoring, sampling, analysis and data results submitted to the Department;
		x		b. Operation and maintenance of leachate collection and removal system, and treatment as required;
		x		c. Procedures for managing leachate if it becomes regulated as a hazardous waste;
		x		d. Agreements for off-site discharge and treatment of leachate;
		x		e. Contingency plan for managing leachate during emergencies or equipment problems;

S	LOCATION	N/A	N/C	PART L CONTINUED
		x		f. Procedures for recording quantities of leachate generated in gal/day and including this in the operating record;
		x		g. Procedures for comparing precipitation experienced at the landfill with leachate generation rates and including this information in the operating record;
		x		h. Procedures for water pressure cleaning or video inspecting leachate collection systems.
		x		9. Describe how the landfill receiving degradable wastes shall implement a gas management system meeting the requirements of Rule 62-701.530, FAC; (62-701.500(9),FAC)
		x		10. Describe procedures for operating and maintaining the landfill stormwater management system to comply with the requirements of Rule 62-701.400(9); (62-701.500(10),FAC)
				11. Equipment and operation feature requirements; (62-701.500(11),FAC)
		x		a. Sufficient equipment for excavating, spreading, compacting and covering waste;
		x		b. Reserve equipment or arrangements to obtain additional equipment within 24 hours of breakdown;
		x		c. Communications equipment;
		x		d. Dust control methods;
		x		e. Fire protection capabilities and procedures for notifying local fire department authorities in emergencies;
		x		f. Litter control devices;
		x		g. Signs indicating operating authority, traffic flow, hours of operation, disposal restrictions.
		x		12. Provide a description of all-weather access road, inside perimeter road and other roads necessary for access which shall be provided at the landfill; (62-701.500(12),FAC)
				13. Additional record keeping and reporting requirements; (62-701.500(13),FAC)

S	LOCATION	N/A	N/C	PART L CONTINUED
		x		a. Records used for developing permit applications and supplemental information maintained for the design period of the landfill;
		x		b. Monitoring information, calibration and maintenance records, copies of reports required by permit maintained for at least 10 years;
		x		c. Maintain annual estimates of the remaining life of constructed landfills and of other permitted areas not yet constructed and submit this estimate annually to the Department;
		x		d. Procedures for archiving and retrieving records which are more than five year old.

M. **WATER QUALITY AND LEACHATE MONITORING REQUIREMENTS** (62-701.510, FAC): N/A

S	LOCATION	N/A	N/C	
		X		1. Water quality and leachate monitoring plan shall be submitted describing the proposed ground water, surface water and leachate monitoring systems and shall meet at least the following requirements;
		X		a. Based on the information obtained in the hydrogeological investigation and signed, dated and sealed by the PG or PE who prepared it; (62-701.510(2)(a),FAC)
		X		b. All sampling and analysis preformed in accordance with Chapter 62-160, FAC; (62-701.510(2)(b),FAC)
				c. Ground water monitoring requirements; (62-701.510(3),FAC)
		X		(1) Detection wells located downgradient from and within 50 feet of disposal units;
		X		(2) Downgradient compliance wells as required;
		X		(3) Background wells screened in all aquifers below the landfill that may be affected by the landfill;
		X		(4) Location information for each monitoring well;
		X		(5) Well spacing no greater than 500 feet apart for downgradient wells and no greater than 1500 feet apart for upgradient wells unless site specific conditions justify alternate well spacings;
		X		(6) Well screen locations properly selected;
		X		(7) Procedures for properly abandoning monitoring wells;
		X		(8) Detailed description of detection sensors if proposed.

S	LOCATION	N/A	N/C	PART M CONTINUED
				d. Surface water monitoring requirements; (62-701.510(4),FAC)
		x		(1) Location of and justification for all proposed surface water monitoring points;
		x		(2) Each monitoring location to be marked and its position determined by a registered Florida land surveyor;
		x		e. Leachate sampling locations proposed; (62-701.510(5),FAC)
				f. Initial and routine sampling frequency and requirements; (62-701.510(6),FAC)
		x		(1) Initial background ground water and surface water sampling and analysis requirements;
		x		(2) Routine leachate sampling and analysis requirements;
		x		(3) Routine monitoring well sampling and analysis requirements;
		x		(4) Routine surface water sampling and analysis requirements.
		x		g. Describe procedures for implementing evaluation monitoring, prevention measures and corrective action as required; (62-701.510(7),FAC)
		x		h. Water quality monitoring report requirements; (62-701.510(9),FAC)
		x		(1) Semi-annual report requirements;
		x		(2) Bi-annual report requirements signed, dated and sealed by PG or PE.

N. **SPECIAL WASTE HANDLING REQUIREMENTS** (62-701.520, FAC): N/A

S	LOCATION	N/A	N/C	
		x		1. Describe procedures for managing motor vehicles; (62-701.520(1),FAC)
		x		2. Describe procedures for landfilling shredded waste; (62-701.520(2),FAC)
		x		3. Describe procedures for asbestos waste disposal; (62-701.520(3),FAC)
		x		4. Describe procedures for disposal or management of contaminated soil; (62-701.520(4), FAC)
		x		5. Describe procedures for disposal of biological wastes; (62-701.520(5), FAC)

O. **GAS MANAGEMENT SYSTEM REQUIREMENTS** (62-701.530,FAC): N/A

S	LOCATION	N/A	N/C	
				1. Provide the design for a gas management systems that will (62-701.530(1), FAC):
		x		a. Be designed to prevent concentrations of combustible gases from exceeding 25% the LEL in structures and 100% the LEL at the property boundary;
		x		b. Be designed for site-specific conditions;
		x		c. Be designed to reduce gas pressure in the interior of the landfill;
		x		d. Be designed to not interfere with the liner, leachate control system or final cover.
		x		2. Provide documentation that will describe locations, construction details and procedures for monitoring gas at ambient monitoring points and with soil monitoring probes; (62-701.530(2), FAC):
		x		3. Provide documentation describing how the gas remediation plan and odor remediation plan will be implemented; (62-701.530(3), FAC):
				4. Landfill gas recovery facilities; (62-701.530(5), FAC):
		x		a. Information required in Rules 62-701.320(7) and 62-701.330(3), FAC supplied;
		x		b. Information required in Rule 62-701.600(4), FAC supplied where relevant and practical;
		x		c. Estimate of current and expected gas generation rates and description of condensate disposal methods provided;

PART O CONTINUED

S	LOCATION	N/A	N/C	
		x		d. Description of procedures for condensate sampling, analyzing and data reporting provided;

___ __________ x ___ e. Closure plan provided describing methods to control gas after recovery facility ceases operation and any other requirements contained in Rule 62-701.400(10), FAC;

___ __________ x ___ f. Performance bond provided to cover closure costs if not already included in other landfill closure costs.

P. LANDFILL FINAL CLOSURE REQUIREMENTS (62-701.600,FAC): N/A

1. Closure schedule requirements; (62-701.600(2),FAC)

___ __________ x ___ a. Documentation that a written notice including a schedule for closure will be provided to the Department at least one year prior to final receipt of wastes;

___ __________ x ___ b. Notice to user requirements within 120 days of final receipt of wastes;

___ __________ x ___ c. Notice to public requirements within 10 days of final receipt of wastes.

2. Closure permit general requirements; (62-701.600(3),FAC)

___ __________ x ___ a. Application submitted to Department at least 90 days prior to final receipt of wastes;

b. Closure plan shall include the following:

___ __________ x ___ (1) Closure report;

___ __________ x ___ (2) Closure design plan;

___ __________ x ___ (3) Closure operation plan;

___ __________ x ___ (4) Closure procedures;

___ __________ x ___ (5) Plan for long term care;

___ __________ x ___ (6) A demonstration that proof of financial responsibility for long term care will be provided.

3. Closure report requirements; (62-701.600(4),FAC)

a. General information requirements;

___ __________ x ___ (1) Identification of landfill;

S	LOCATION	N/A	N/C	PART P CONTINUED
		x		(2) Location, description and vicinity map;
		x		(3) Total acres of disposal areas and landfill property;
		x		(4) Legal property description;
		x		(5) History of landfill;
		x		(6) Identification of types of waste disposed of at the landfill.
		x		b. Geotechnical investigation report and water quality monitoring plan required by Rule 62-701.330(3),FAC;
		x		c. Land use information report indicating: identification of adjacent landowners; zoning; present land uses; and roads, highways right-of-way, or easements.
		x		d. Report on actual or potential gas migration at landfills containing degradable wastes which would allow migration of gas off the landfill property;
		x		e. Report assessing the effectiveness of the landfill design and operation including results of geotechnical investigations, surface water and storm water management, gas migration and concentrations, condition of existing cover, and nature of waste disposed of at the landfill;
				4. Closure design requirements to be included in the closure design plan: (62-701.600(5),FAC)
		x		a. Plan sheet showing phases of site closing;
		x		b. Drawings showing existing topography and proposed final grades;
		x		c. Provisions to close units when they reach approved design dimensions;
		x		d. Final elevations before settlement;
		x		e. Side slope design including benches, terraces, down slope drainage ways, energy dissipators and discussion of expected precipitation effects;
				f. Final cover installation plans including:
		x		(1) CQA plan for installing and testing final cover;

S	LOCATION	N/A	N/C	PART P CONTINUED
		x		(2) Schedule for installing final cover after final receipt of waste;
		x		(3) Description of drought-resistant species to be used in the vegetative cover;
		x		(4) Top gradient design to maximize runoff and minimize erosion;
		x		(5) Provisions for cover material to be used for final cover maintenance.
				g. Final cover design requirements:
		x		(1) Protective soil layer design;
		x		(2) Barrier soil layer design;
		x		(3) Erosion control vegetation;
		x		(4) Geomembrane barrier layer design;
		x		(5) Geosynthetic clay liner design if used;
		x		(6) Stability analysis of the cover system and the disposed waste.
		x		h. Proposed method of stormwater control;
		x		i. Proposed method of access control;
		x		j. Description of proposed final use of the closed landfill, if any;
		x		k. Description of the proposed or existing gas management system which complies with Rule 62-701.530, FAC.
				5. Closure operation plan shall include: (62-701.600(6),FAC)
		x		a. Detailed description of actions which will be taken to close the landfill;
		x		b. Time schedule for completion of closing and long term care;
		x		c. Describe proposed method for demonstrating financial responsibility;
		x		d. Indicate any additional equipment and personnel needed to complete closure.

S	LOCATION	N/A	N/C	PART P CONTINUED
		x		e. Development and implementation of the water quality monitoring plan required in Rule 62-701.510, FAC.
		x		f. Development and implementation of gas management system required in Rule 62-701.530, FAC.
		x		6. Justification for and detailed description of procedures to be followed for temporary closure of the landfill, if desired; (62-701.600(7),FAC)

Q. **CLOSURE PROCEDURES** (62-701.610,FAC): N/A

S	LOCATION	N/A	N/C		
		x		1.	Survey monuments; (62-701.610(2),FAC)
		x		2.	Final survey report; (62-701.610(3),FAC)
		x		3.	Certification of closure construction completion; (62-701.610(4),FAC)
		x		4.	Declaration to the public; (62-701.610(5),FAC)
		x		5.	Official date of closing; (62-701.610(6),FAC)
		x		6.	Use of closed landfill areas; (62-701.610(7),FAC)
		x		7.	Relocation of wastes; (62-701.610(8), FAC)

R. **LONG TERM CARE REQUIREMENTS** (62-701.620,FAC): N/A

		x		1.	Maintaining the gas collection and monitoring system; (62-701.620(5), FAC)
		x		2.	Right of property access requirements; (62-701.620(6),FAC)
		x		3.	Successors of interest requirements; (62-701.620(7),FAC)
		x		4.	Requirements for replacement of monitoring devices; (62-701.620(9),FAC)
		x		5.	Completion of long term care signed and sealed by professional engineer (62-701.620(10), FAC).

S. **FINANCIAL RESPONSIBILITY REQUIREMENTS** (62-701.630,FAC)

		x		1.	Provide cost estimates for closing, long term care, and corrective action costs estimated by a PE for a third party performing the work, on a per unit basis, with the source of estimates indicated; (62-701.630(3)&(7), FAC).
		x		2.	Describe procedures for providing annual cost adjustments to the Department based on inflation and changes in the closing, long-term care, and corrective action plans; (62-701.630(4)&(8), FAC).
		x		3.	Describe funding mechanisms for providing proof of financial assurance and include appropriate financial assurance forms; (62-701.630(5),(6),&(9), FAC).

T. CERTIFICATION BY APPLICANT AND ENGINEER OR PUBLIC OFFICER

1. Applicant:

The undersigned applicant or authorized representative of Sarasota County Soild Waste Operations is aware that statements made in this form and attached information are an application for a Construction/Operation Permit from the Florida Department of Environmental Protection and certifies that the information in this application is true, correct and complete to the best of his/her knowledge and belief. Further, the undersigned agrees to comply with the provisions of Chapter 403, Florida Statutes, and all rules and regulations of the Department. It is understood that the Permit is not transferable, and the Department will be notified prior to the sale or legal transfer of the permitted facility.

Frank Coggins
Signature of Applicant or Agent

Frank Coggins, Manager
Name and Title (please type)

fcoggins@scgov.net
E-Mail address (if available)

4000 Knights Trail Road
Mailing Address

Nokomis, FL 34725
City, State, Zip Code

(941) 861-1571
Telephone Number

Date: 10-13-00

Attach letter of authorization if agent is not a governmental official, owner, or corporate officer.

2. Professional Engineer registered in Florida (or Public Officer if authorized under Sections 403.707 and 403.7075, Florida Statutes):

This is to certify that the engineering features of this solid waste management facility have been designed/examined by me and found to conform to engineering principles applicable to such facilities. In my professional judgment, this facility, when properly maintained and operated, will comply with all applicable statutes of the State of Florida and rules of the Department. It is agreed that the undersigned will provide the applicant with a set of instructions of proper maintenance and operation of the facility.

A Gupta
Signature

Ayushman Gupta, Senior Engineer
Name and Title (please type)

54023
Florida Registration Number
(please affix seal)

14055 Riveredge Dr. Suite 300
Mailing Address

Tampa, FL 33637
City, State, Zip Code

agupta@geosyntec.com
E-Mail address (if available)

(813) 558-0990
Telephone Number

Date: 9 Nov 2006

APPENDIX B

Permit Drawings

PERMIT DRAWINGS

The Permit Application is supported by a 13-sheet permit drawing set. The permit drawings entitled *Flexible Leachate Storage Containers, Central County Solid Waste Disposal Complex, Sarasota County, Florida* are an integral part of this Permit Application and are referred to as the Permit Drawings in this application. The Permit Drawings show plans, sections, and details of the proposed construction at CCSWDC. These permit drawings are intended to provide sufficient detail for permit approval.

The Permit Drawings are included under a separate cover. The sheet numbers and titles for the Permit Drawings are listed below.

Sheet No.	*Sheet Title*
1	Title Sheet
2	Site Development Plan
3	Base Grading Plan
4	Final Grading Plan
5	Typical Cross Sections
6	Liner System Details I
7	Liner System Details II
8	FLSC Piping Layout
9	Leachate Management System – Process Diagram Legend Sheet
10	Leachate Management System – Mechanical Flow Diagram
11	Leachate Management System – Process & Instrumentation Diagram
12	Weir Details
13	Miscellaneous Details

APPENDIX C

Subsurface and Monitoring Well Information

Soil Boring and Geotechnical Laboratory Testing

\FL0819\FL0819.02\Figures\FL0819.01F002.dwg, WELL LOG A, 11/7/2006 1:38:30 PM, Endre Csordas, 1:12 ...ntec Consultants, Tampa

GEOLOGIC SOIL BORING DETAIL GB-1

PROJECT: CCSWDD-SARASOTA CO.	DATE COMPLETED: AUGUST 2006
PROJECT NO.: FL0819.02	CONTRACTOR: NET
DATE STARTED: 1 AUGUST 2006	DRILLER: NA
DRILL RIG: NA	SCALE: 1"=5'
METHOD: AUGER BIT	DRAWN BY: ENDRE CSORDAS
GROUND ELEV.: 20 FT	DRAWING NO.: FL0819.01F002
WATER AT INSTALL: 3.5 FT	CHECKED BY: JUAN QUIROZ
GEOLOGIST: JOE TERRY	SHEET: 1 OF: 1

DEPTH (FEET)		% FINES	UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	BLOWS / 6 IN	REC / ATT	LITHOLOGICAL DESCRIPTION
		NA	SP	1 2 4 6	95%	LIGHT TO DARK BROWN FINE SAND W/GRAY AND BLACK ORGANICS (ROOTS) MOIST.
		10.3	SP-SM	14 14 10 9	100%	LIGHT TO DARK BROWN FINE SAND (FEW ROOTS TOWARDS THE TOP), MOIST TO SATURATED
5				3 3 4 5	100%	DARK TO LIGHT BROWN FINE SAND, SATURATED
		10.2	SP-SM	4 3 6 8	100%	LIGHT BROWN AND GRAY SILTY FINE SAND W/ TRACE CLAY, WET
		19.7	SM	2 5 5 5	80%	GRAY SILTY FINE SAND, WET
10	NO WELL INSTALLED	56.3	CL	6 6 15 30	90%	LIGHT BROWN AND GRAY VERY FINE SAND W/LITTLE GRAVEL (AT 11.5 FT) AND TRACE CLAY AT 12 FT, MOIST
				8 12 39 50	98%	LIGHT BROWN TO TAN SILTY CLAY, MOIST
15				10 8 15 26	90%	TAN SILTY CLAY AND LITTLE FINE MATERIAL (GRAVEL) TOWARDS BOTTOM, MOIST
		NA	ML-CL	27 20 14 11	100%	LIGHT BROWN AND TAN FINE SAND SILT W/LITTLE TO SOME CLAY (GREENEISH-BROWN) AND LITTLE GRAVEL, MOIST
				5 7 10 25	90%	TAN MEDIUM TO FINE SAND, SOME SILT AND CLAY (GREENISH GREEN); LIME ROCK (YELLOWISH) W/SILT AND SAND TOWARDS BOTTOM
25.25	20			50		REFUSAL AT 20.25 FT W/50 BLOWS PER FT FOR 3"

TOTAL DEPTH = 20.25 Feet

GEOSYNTEC CONSULTANTS
TAMPA, FLORIDA

FIGURE NO.	—
PROJECT NO.	FL0819.02
FILE NO.	FL0819.01F002

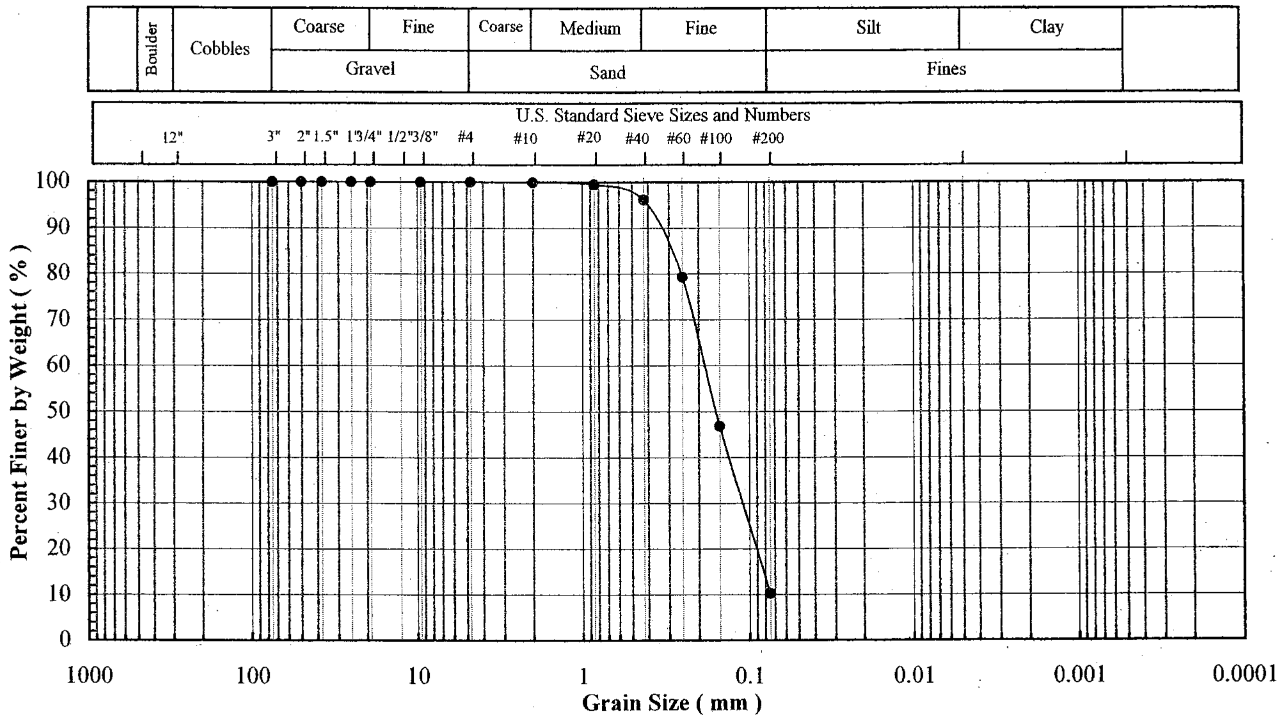
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Sarasota County Soil Testing
Project No:	203
Client Sample ID:	GB1-A (2-6')
Lab Sample No:	H138

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



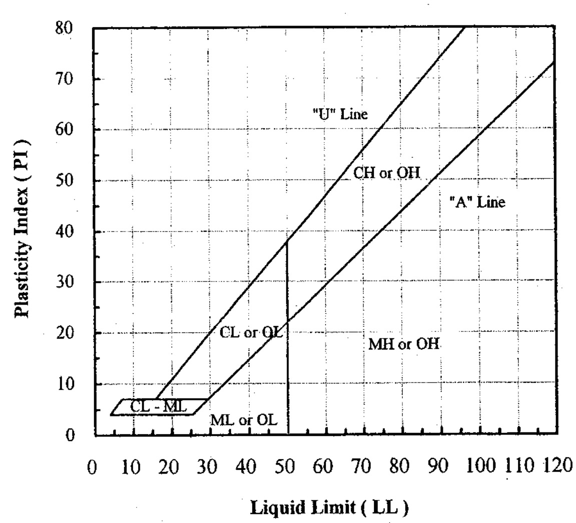
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.9
#20	0.850	99.5
#40	0.425	96.2
#60	0.250	79.3
#100	0.150	46.9
#200	0.075	10.3

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	89.7
Fines (%):	10.3
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	2.6
Coeff. Curv. (Cc):	0.9



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits			Engineering Classification
				LL (-)	PL (-)	PI (-)	
GB1-A (2-6')	H138	18.4	10.3	NP	NP	NP	SP-SM - Poorly graded sand with silt.

Note(s):

Not enough soil available to perform an Atterberg Limits test on the fines portion of the sample; fines appear to be ML-MH.

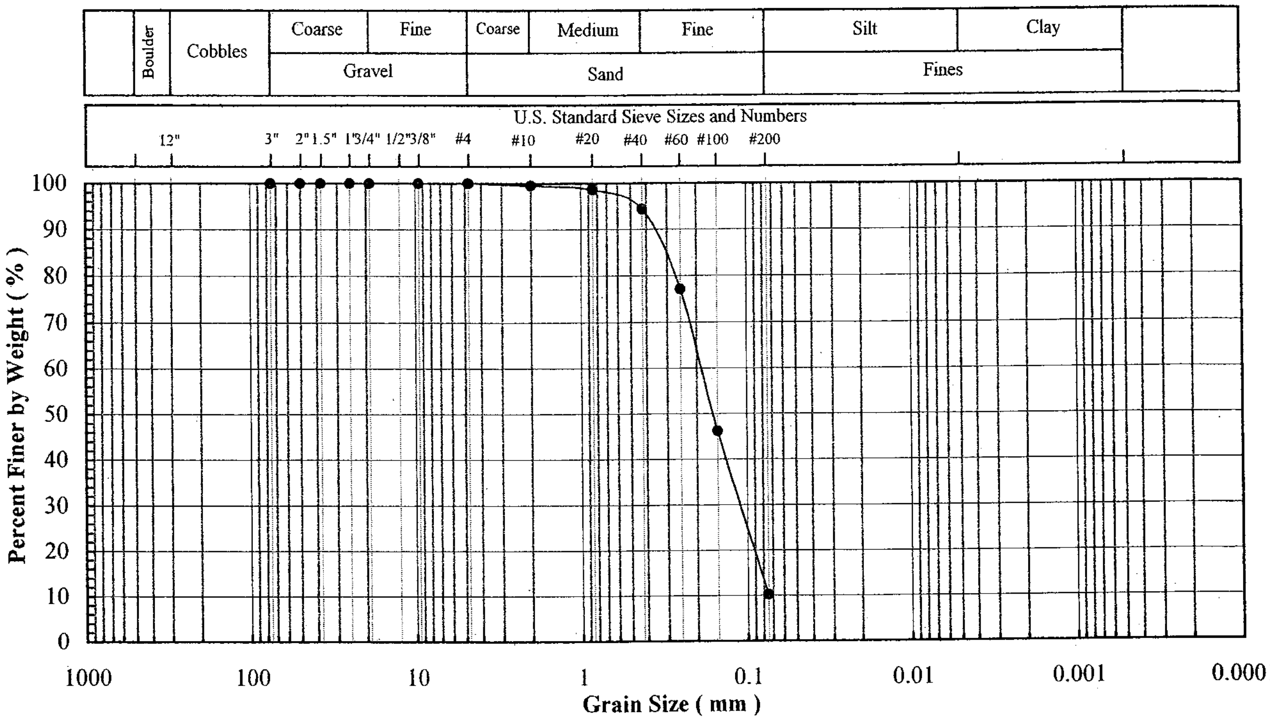
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Sarasota County Soil Testing
Project No:	204
Client Sample ID:	GB1-B (6-8')
Lab Sample No:	H139

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



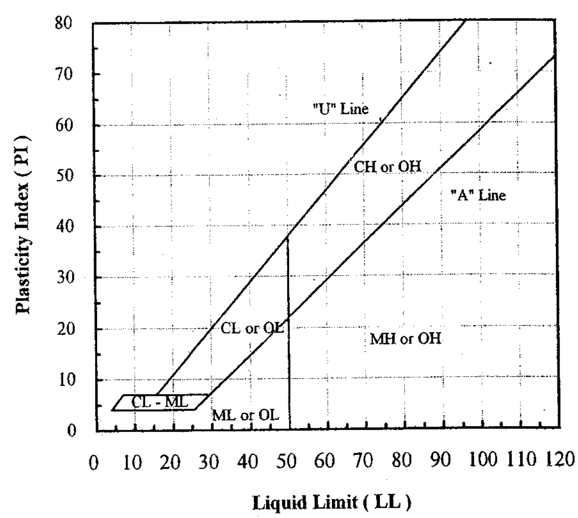
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.5
#20	0.850	98.6
#40	0.425	94.4
#60	0.250	77.1
#100	0.150	46.2
#200	0.075	10.2

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	89.8
Fines (%):	10.2
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	2.6
Coeff. Curv. (Cc):	0.8



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GB1-B (6-8')	H139	17.5	10.2	NP	NP	NP	SP-SM - Poorly graded sand with silt.

Note(s):

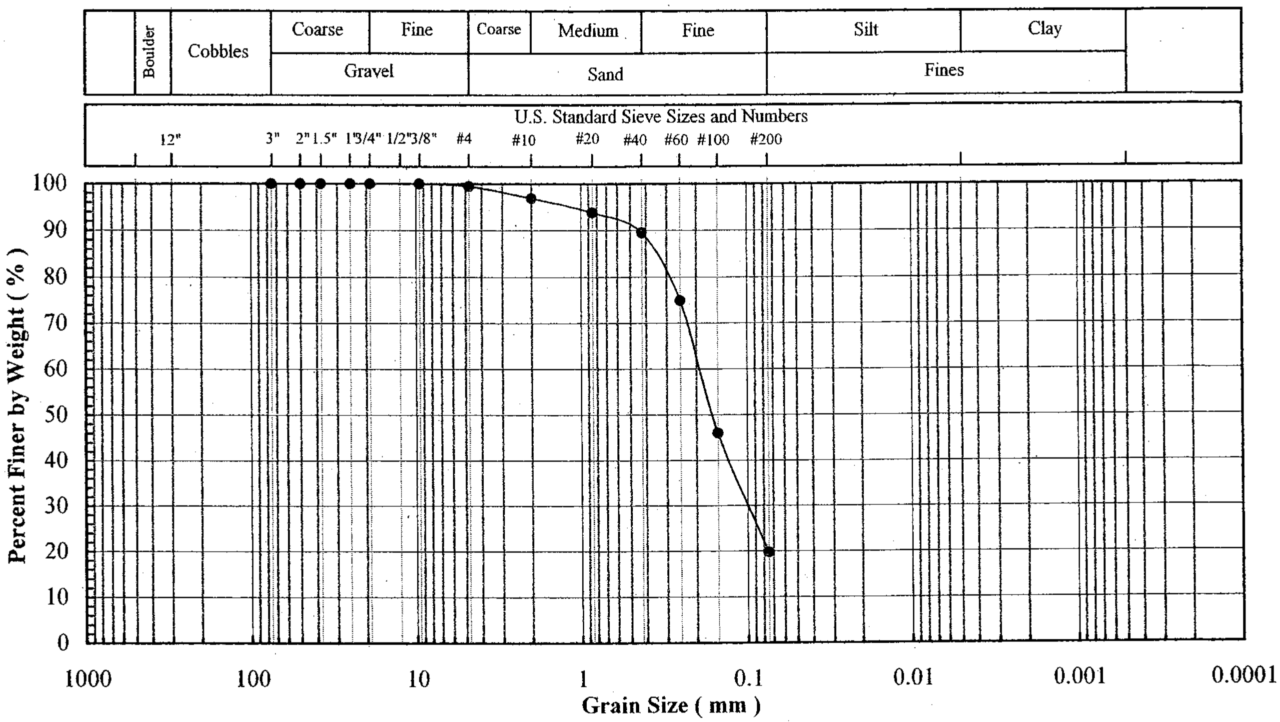
Not enough soil available to perform an Atterberg Limits test on the fines portion of the sample; fines appear to be ML-MH.

Excel Geotechnical Testing, Inc. "Excellence in Testing" 941 Forrest Street, Roswell, Georgia 30075 Tel: (770) 650 1666 Fax: (770) 650 5786	**Project Name:** Sarasota County Soil Testing **Project No:** 204 **Client Sample ID:** GB1-C (8-10') **Lab Sample No:** H140

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



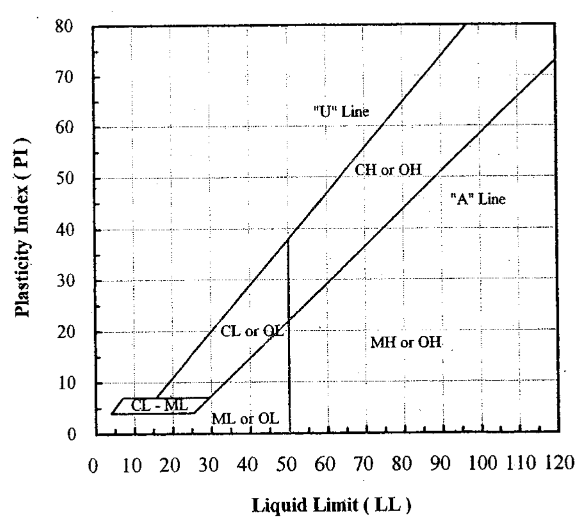
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	99.4
#10	2.00	96.9
#20	0.850	93.8
#40	0.425	89.5
#60	0.250	74.9
#100	0.150	46.0
#200	0.075	19.7

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	0.6
Sand (%):	79.7
Fines (%):	19.7
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GB1-C (8-10')	H140	17.9	19.7	NP	NP	NP	SM - Silty sand

Note(s):

Not enough soil available to perform an Atterberg Limits test on the fines portion of the sample; fines appear to be ML-MH.

Excel Geotechnical Testing, Inc.

"Excellence in Testing"

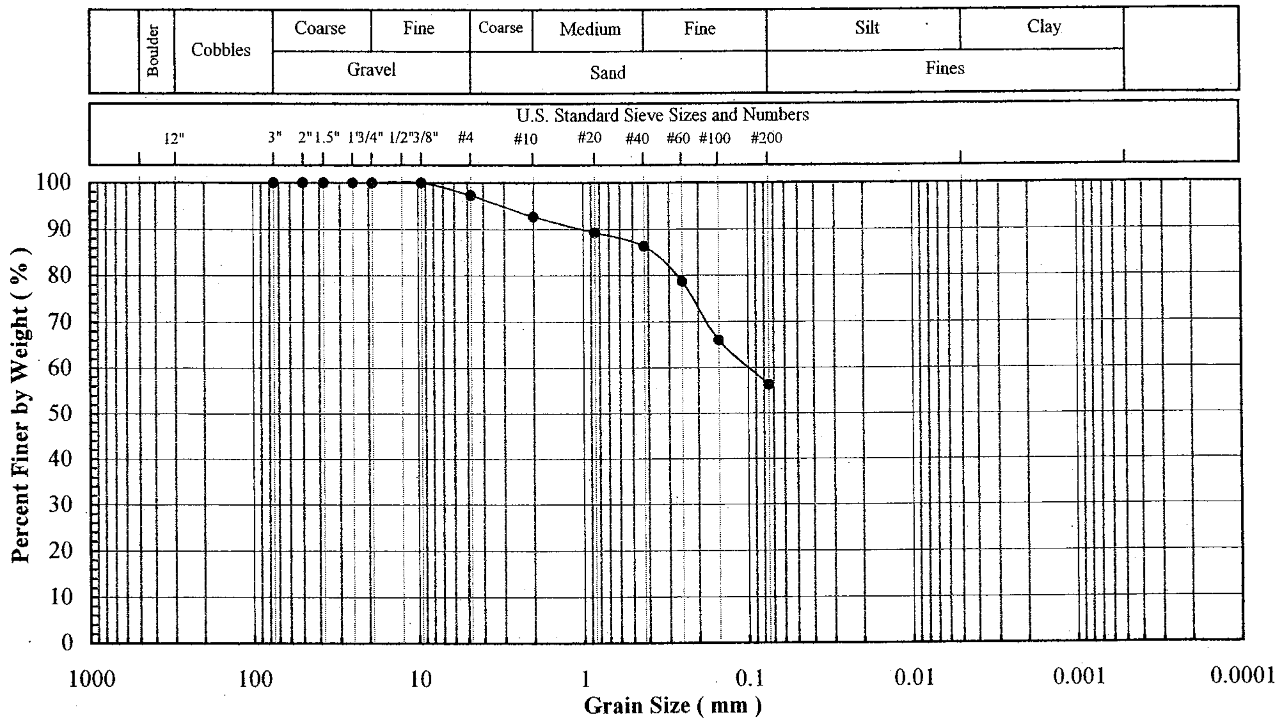
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name:	Sarasota County Soil Testing
Project No:	204
Client Sample ID:	GB1-D (10-16')
Lab Sample No:	H141

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



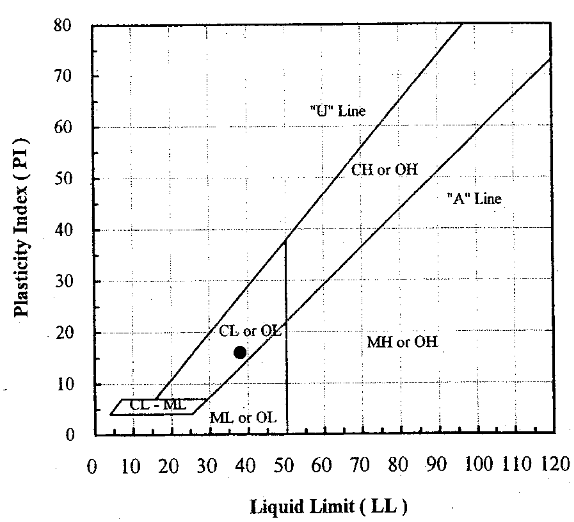
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	97.3
#10	2.00	92.8
#20	0.850	89.3
#40	0.425	86.3
#60	0.250	78.7
#100	0.150	66.0
#200	0.075	56.3

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	2.7
Sand (%):	41.0
Fines (%):	56.3
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GB1-D (10-16')	H141	18.3	56.3	38	22	16	CL - Sandy lean clay

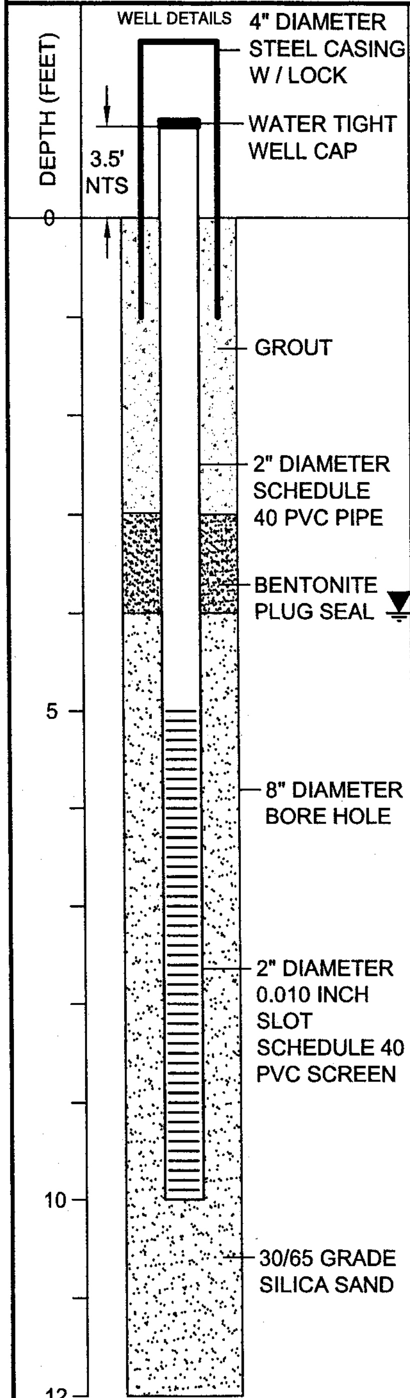
Note(s):

Soil sample contained some hard soil particles which could not be broken down utilising ASTM Standard procedural effort.

Monitoring Well Log and Well Completion Report

MONITORING WELL CONSTRUCTION DETAIL MW-13

PROJECT:	CCSWDC-SARASOTA COUNTY	DATE COMPLETED:	8/1/06
PROJECT NO.:	FL0819.02	CONTRACTOR:	NET, INC
DATE STARTED:	8/1/06	DRILLER:	NA
DRILL RIG:	NA	VERTICAL SCALE:	1in = 2ft
METHOD:	HOLLOW STEM AUGER	DRAWN BY:	E. CSORDAS
GROUND ELEV.:	APPROX 20'	DRAWING NO.:	FL0819.02F003
WATER AT INSTALL:	4 FT	CHECKED BY:	JUAN QUIROZ
TECHNICIAN:	JOE TERRY	SHEET: 1	OF: 1



UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	BLOWS / 6 IN	REC / ATT	LITHOLOGICAL DESCRIPTION
SP-SM	1 2 5 6	95%	LIGHT TO DARK BROWN FINE SAND, UPPER 0-5 FT CONTAINS ORGANIC MATERIAL, MOIST
SP-SM	4 7 14 14	95%	UPPER FOOT - DARK BROWN FINE SAND, MOIST LOWER FOOT - GRAY MEDIUM TO FINE SAND, MOIST
SP-SM	8 8 12 10	100%	GRAY TO DARK BROWN FINE SAND, SATURATED
SP-SM	5 6 6 6	100%	GRAY TO BROWN SILTY FINE SAND, SATURATED
SM	2 3 4 4	100%	GRAY SILTY TO CLAYEY FINE SAND, WET
CL	4 5 7 10	80%	LIGHT BROWN TO GRAY SILTY FINE SAND W/TRACE GRAVEL AND CLAY, SATURATED BORING TERMINATED AT 12 FT

TOTAL DEPTH = 12 Feet

GEOSYNTEC CONSULTANTS
TAMPA, FLORIDA

FIGURE NO.	X
PROJECT NO.	FL0819.02
FILE NO.	FL0819.02F003

STATE OF FLORIDA PERMIT APPLICATION TO CONSTRUCT, REPAIR, MODIFY, OR ABANDON A WELL

☑ Southwest
☐ Northwest
☐ St. Johns River
☐ South Florida
☐ Suwannee River

CHECK BOX FOR APPROPRIATE DISTRICT ADDRESS ON BACK OF PERMIT FORM

THIS FORM MUST BE FILLED OUT COMPLETELY.

The water well contractor is responsible for completing this form and forwarding the permit to the appropriate delegated county where applicable.

Permit No. 744562.01
Florida Unique I.D. V06-2121
Permit Stipulations Required (See attached)
39 ,, 13 , 23 , 01
62-524 Quad # ______ Delineation # ______
CUP/WUP Application No. ______
ABOVE THIS LINE FOR OFFICIAL USE ONLY

Fold at this line in order that address is visible through envelope window

1. SARASOTA COUNTY SOLID WASTE OPERRINGLING BLVD — SARASOTA FL — 34236 — (813) 558-0990
Owner, Legal Name of Entity if Corportation — Address — City — Zip — Telephone Number

2. 4000 KNIGHTS TRAIL ROAD, NOKOMIS
Well Location _ Address, Road Name or number, City
Parcel # (Pin) 0301-00-2000

3. Ross Chinander — 11093 — (813) 655-3612
Well Drilling Contractor — License No. — Telephone No.

12435 Jess Walden Road
Address

4. 4 1/4 of 4 1/4 of Section 26 3
(smallest) (biggest)
(Indicate Well on Chart)

Dover — FL — 33527
City — State — Zip

5. Township 37 38 Range 19

NW NE SW SE ✓

6. SARASOTA | | M & B | |
County — Subdivision Name — Lot — Block — Unit

7. Number of proposed wells 1 Check the use of well: (See back of permit for additional choices) ______ Domestic Monitor (type) ✓

______ Irrigation (Type) (See Back) Public Water Supply (type) ______ (See Back) List Other ______

Distance from septic system ______ ft. Description of facility LANDFILL Estimated start of construction date 8/2/2006

8. Application for: ✓ New Construction ______ Repair/Modify ______ Abandonment ______ (Reason for Abandonment)

Date Stamp

9. Estimated: Well Depth 35 Casing Depth 30 Screen Interval from 30 to 35
Casing Material: XXXXXX / XX / PVC Casing Diameter 2 (smallest) Seal Material Cement

10. If applicable: Proposed Grouting Interval
From 0 to 25 Seal Material Cement
From ______ to ______ Seal Material ______
From ______ to ______ Seal Material ______

SWFWMD Rec'd Date 07/19/2006

Draw a map of well location and indicate well site with an "X" identify known roads and landmarks: provide distances betwen well and landmarks.

North — West — East — South

I-75 TO LAUREL ROAD EAST TO KNIGHTS TRAIL ROAD NORTH TO SCALE HOUSE. SITE IS 1/4 MILE ENE OF SCALE HOUSE.

SEE STIPES FOR LANDFILL

11. Telescope Casing ____ or Liner ____ (check one) Diameter ______
Blk-Steel / Galvanized / PVC Other (specify:) ______

12. Method of Construction: ______ Rotary ______ Cable Tool ______ Combination
✓ Auger ______ Other (specify:) ______

13. Indicate total No. of wells on site 12 List number of unused wells on site 0

14. Is this well or any other well or water withdrawal on the owner's contiguous property covered under a Consumptive/Water Use Permit (CUP/WUP) or CUP/WUP Application? ✓ No ___ Yes
(IF YES, COMPLETE THE FOLLOWING) CUP/WUP No. ______

District well I.D. No. ______

Latitude ______ Longitude ______

Data obtained from GPS ____ or map ____ or survey ____ *(map datum NAD 27 __ NAD 83 __)*

15. I hereby certify that I will comply with the applicable rules of Title 40, Florida Administrative Code and that a water use permit or artificial recharge permit, if needed, has been or will be obtained prior to commencement of well construction. I further certify that all information provided on this application is accurate and that I will obtain necessary approval from other federal, state, or local governments, if applicable. I agree to provide a well completion report to the District within 30 days after drilling or the permit expiration, whichever occurs first.

I certify that I am the owner of the property, that the information provided is accurate, and that I am aware of my responsibilities under Chapter 373, Florida Statutes, to maintain or properly abandon this well; or, I certify that I am the agent for the owner, that the information provided is accurate, and that I have informed the owner of his responsibilities as stated above. Owner consents to personnel of the WMD or a representative access to the well site.

Digitally Signed — 11093 — Digitally Signed — 7/19/2006
Signature of Contractor — License No. — Owner's or Agent's Signature — Date

DO NOT WRITE BELOW THIS LINE - FOR OFFICIAL USE ONLY

Approval Granted By: ______ Issue Date: 07 / 20 / 2006 Hydrologist Approval ______ Initials

Owner Number: ______ Fee Received: $ 75.00 Receipt No.: 1476431 Check No.: ______

THIS PERMIT NOT VALID UNTIL PROPERLY SIGNED BY AN AUTHORIZED OFFICER OR REPRESENTATIVE OF THE WMD. IT SHALL BE AVAILABLE AT THE WELL SITE DURING ALL DRILLING OPERATIONS. *This permit is valid for 90 days from the date of issue.*

FORM 41.10 - 410 (1) REV. 12/04

WHITE: ORIGINAL FILE
YELLOW: DRILLING CONTRACTOR
PINK: OWNER

WELL COMPLETION REPORT (Please complete in black ink or type.)

PERMIT #: 744562.01 CUP/WUP#: ______ DID#: ______

Indicate the number of wells drilled/abandoned for this report: 1

Indicate the number of wells permitted but not drilled/abandoned that are being cancelled: 0

WATER WELL CONTRACTOR'S SIGNATURE Digitally Signed License # 11093

I certify that the information provided in this report is accurate and true.

Grout	No. of Bags	From (ft.)	To (ft.)
Neat Cement:	1	0	5
Bentonite:			
(Other)			

WELL LOCATION: County Sarasota

4 1/4 of 4 1/4 of Section 3, Township 38, Range 19

Latitude: ______, Longitude: ______

DATE STAMP

Official Use Only

Sketch of well location on property

Give distances from septic tank and house, or other reference points

CHEMICAL ANALYSIS WHEN REQUIRED

Iron: ____ppm Sulfate: ____ppm

Chlorides: ____ ppm TDS ____ mg/l

Conductivity ______ umhos/cm

[ ] Lab Test [ ] Field Test Kit

Pump Type

[ ] Centrifugal [ ] Jet [ ] Submersible [ ] Turbine

Horsepower: ______ Capacity: ______ GPM: ______

Pump Depth: ______ft. Intake Depth: ______ft.

Form LEG-R.005.00(10/05)

OWNER'S NAME: SARASOTA COUNTY SOLID WASTE OPERA

COMPLETETION DATE: 08/01/2006 Florida Unique I.D.: ______

Parcel # (Pin): 0301-00-2000

WELL USE:

[ ] Public Supply [ ] Irrigation [ ] Domestic [X] Monitor

[ ] Injection [ ] Other

DRILL METHOD:

[ ] Rotary [ ] Cable Tool [ ] Combination

[ ] Jet [X] Auger [ ] Other ______

Measured Static Water Level: 1.50 Measured Pumping Water Level: 10

After 5 Hours at 1 GPM. Measuring Pt. (Describe): GROUND SURFACE

Which is ____ft. [ ] above [ ] below land surface

Casing: [ ] Black Steel [ ] Galvanized [X] PVC [ ] Other: ______

[ ] Open Hole / [X] Screen	Depth (feet)		DRILL CUTTINGS LOG — Examine cuttings every 20 ft. or at formation changes. Note cavities, depth to producing zones.
Casing Diameter and Depth (ft.)	From	To	Color | Grain Size | Type of Material
Diameter: 2 From: 0 To: 5	0	4	black silty fine sand
	4	8	dark brown silty fine sand
	8	10	gray sandy clay
Diameter: ____ From: ____ To: ____			
Liner [ ] or Casing [ ] Diameter: ____ From: ____ To: ____			

Driller's Name (print or type): ______

SARASOTA COUNTY HEALTH DEPARTMENT

STIPULATION #23 - TEST/MONITOR WELL

A. All monitor wells constructed at any facility that has been designated as a ground water contamination site or a possible ground water contamination site shall adhere to the construction standards set forth by The Department of Environmental Protection and other applicable rules.

B. The well(s) shall be constructed in a manner to prevent the unauthorized interchange of water between different water bearing zones (i.e., breaching of confining beds, clays or hardpan intervals) as per Chapter 62-532.500 (2)©, Florida Administrative Code (F.A.C.)

C. There shall be no injection of fluids into the monitor well without prior written approval from the SWFWMD. This includes, but is not limited to, treated ground water or the introduction of microbes for in-Situ aquifer restoration.

D. Prior written approval from the SWFWMD shall be required if the monitor well(s) will be pumped for use in hydrodynamic control and/or contaminant plume management, if quantities reach or exceed requirement of a Water Use Permit.

E. The well(s) are to be converted into a production well(s), an additional permit shall be obtained.

F. In the event the well(s) needs to be abandoned, an abandonment permit shall be obtained prior to commencing with abandonment operations.

G. An observer from the SCHD is required on all abandonment's to ensure compliance with Chapter 62-532, Chapter 40D-3 Florida Administrative Code and Sarasota County Code of Ordinance No. 2006-032, Chapter 381-392.

H. Please contact the appropriate Water Well Permitting Section Office for additional information:

Sarasota (941) 861-6133 North of Blackburn Point Road

Venice (941) 861-3310 South of Blackburn Point Road.

SWFWMD Permit #: 744562

COPY TO OWNER

SARASOTA COUNTY HEALTH DEPARTMENT

STIPULATION #13 – LANDFILL

This well site is located near a landfill site. The well casing should have an adequate seal to prevent any contaminants from entering the well.

SWFWMD Permit #: 744562

Stip#13

COPY TO OWNER

SARASOTA COUNTY HEALTH DEPARTMENT

STIPULATION #1 - SALT WATER INTRUSION

A. The location of the well is marginal due to potential salt-water encroachment. It may or may not yield water of acceptable quality in the near future. Therefore, this permit is granted with the understanding that if the well does not produce acceptable water, it will be properly abandoned.

B. In the event the well needs to be abandoned, an abandonment permit shall be obtained prior to commencing with abandonment procedures.

C. An observer from the Sarasota County Health Department is required on all abandonment's to ensure compliance with Chapter 62-532, Florida Administrative Code.

D. Please contact the appropriate Water Well Permitting Section Office for additional information:
   Sarasota (941) 861-6133 North of Blackburn Point Road
   Venice (941) 861-3310 South of Blackburn Point Road.

SWFWMD Permit #: 744562

Stip#1
(08/03)

COPY TO OWNER

APPENDIX D

Conveyance Pipe Stability Calculation Package

A Gupta
9 NOV 2006

Written by: Jay Eun Date: 7 November 2006 Reviewed by: Juan Quiroz Date:

Client: Sarasota County Project: Flexible Leachate Storage Containers Project No.: FL0819 Phase No.: 2

CONVEYANCE PIPE STRUCTURAL STABILITY EVALUATION
FLEXIBLE LEACHATE STORAGE CONTAINERS
CENTRAL COUNTY SOLID WASTE DISPOSAL COMPLEX
SARASOTA COUNTY SOLID WASTE OPERATIONS
SARASOTA COUNTY, FLORIDA

INTRODUCTION

The purpose of this calculation package is to present the structural stability of the pipes associated with the proposed Flexible Leachate Storage Containers (FLSCs) at Central County Solid Waste Disposal Complex (CCSWDC) located in Sarasota County, Florida. Calculations were performed to evaluate the ability of the pipes to withstand applied external loads.

The subsequent sections present several aspects of the pipe design evaluation and include the following items:

- Pipe data that was used for the design evaluation;
- Calculation of stresses applied on the pipes due to traffic and FLSC loading;
- Potential failure mechanisms (e.g., wall crushing, wall buckling, excessive ring deflection, and excessive bending strain) of the proposed pipe and corresponding calculated factors of safety; and
- Summary of the pipe design evaluation.

PIPE DATA

The typical proposed conveyance pipe consists of a 6-inch diameter plastic pipe. Attachment 1 provides typical size and material property data for the high density polyethylene (HDPE) pipe that will be used for this project. The following table presents a summary of the pipe data that was used in the structural stability design evaluation:

Written by: Jay Eun Date: 7 November 2006 Reviewed by: Juan Quiroz Date:

Client: Sarasota County Project: Flexible Leachate Storage Containers Project No.: FL0819 Phase No.: 2

Data	Pipe
Material	HDPE
Nominal Diameter	6 inches
Standard Dimension Ratio (SDR)	11
Outer Diameter	6.625 inches
Average Inner Diameter	5.349 inches
Minimum Wall Thickness	0.602

CALCULATION OF APPLIED STRESSES

A 6-inch diameter HDPE conveyance pipe will be installed along the interior side slope of the existing landfill area perimeter road located to the east and southeast of the existing Class I landfill. The pipe will cross the roadway at two locations (see Sheet 2 of the Permit Drawings), and will thereby be subjected to both traffic and soil backfill (overburden) loading. Both 6 and 4-inch diameter HDPE leachate conveyance pipes will also be subjected to loading within the FLSCs. The following two sections present applied stress calculations for: (i) traffic and overburden loading; and (ii) FLSC loading.

Stress Due to Traffic

This case conservatively considers the 6-inch diameter HDPE pipe that crosses the roadway and is subjected to traffic loading resulting from a 35 ton truck with a wheel load of 20,000 lbs, and 1 ft of overburden material. The assumed 1 ft of overburden is a conservative assumption that leads to critical loading conditions. Therefore, the total stress on the pipe can be calculated as described by ASCE [1979] as follows:

$$\sigma_t = \gamma_p D_p + C_s \frac{PF}{LD_{od}} \qquad \text{Equation 1}$$

where:

$\gamma_p =$ average unit weight of the overburden materials, pcf;
$D_p =$ thickness of the overburden materials;
$D_{od} =$ pipe outer diameter, ft;
$C_s =$ load coefficient, see Attachment 2 [Chevron, 1994];
$P =$ concentrated load, lb;
$F =$ impact factor accounting for dynamic loads, assume 2 [Chevron, 1994];

L = effective length of pipe equal to 3 ft if the pipe is longer than 3 ft, or equal to the actual pipe length if the pipe is shorter than 3 ft [ASCE, 1979]; and

σ_t = stress on the pipe due to traffic, psf.

The table below shows a summary of the parameters used and the applied stress due to traffic calculated for the 6-inch diameter HDPE pipe:

Data	Traffic and 6-inch HDPE Pipe
γ_p	120 pcf
D_p	1 ft
D_{od}	6.625 inch = 0.552 ft
C_s	0.324
P	20,000 lb
F	2
L	3 ft
σ_t	**7,945 psf = 55 psi**

Stress Due to FLSC Loading

The stress applied to the 6 and 4-inch diameter HDPE pipes within the FLSCs is due to the overburden materials above the pipe. The pipe sections subjected to the greatest applied overburden stress are those located within the leachate collection sumps. The applied overburden stress is calculated with Equation 2.

$$\sigma_{ov} = \gamma_{ov} D_{ov} \qquad \text{Equation 2}$$

The assumed overburden consists of approximately 2 ft of drainage gravel plus approximately 5 ft of liquid with an assumed density of 62.4 pcf. This is a conservative assumption since 5 ft of storage depth is the maximum liquid depth that can be stored in the FLSCs. The following table summarizes the parameters used and the applied stress calculated due to overburden materials:

Data	FLSC
γ_{ov}	62.4 pcf (liquid) 135 pcf (drainage gravel)
D_{ov}	5 ft of liquid and 2 ft of drainage gravel
σ_{ov}	**582 psf = 4 psi**

POTENTIAL FAILURE MECHANISMS

From the above stress calculations, the applied stress on the 6-inch diameter HDPE pipe due to traffic loading yields the most critical condition. As such, the applied stress used to evaluate pipe structural stability was 7,945 psf (55 psi).

Wall Crushing

Wall crushing occurs when the stress in the pipe wall due to external pressures exceeds the compressive strength of the pipe material. The maximum wall crushing stress which may be withstood by the pipe can be calculated by Equation 3 [Phillips 66, 1991]:

$$\sigma_{crush} = \frac{2\sigma_y}{(SDR-1)} \qquad \text{Equation 3}$$

where σ_y is the compressive strength of the pipe material, based on PE 3408 HDPE pipe; and SDR is the standard dimension ratio of the pipe. A typical value of σ_y for HDPE pipe is approximately 1,500 psi [Sharma and Lewis, 1994; ISCO Industries, 2000 (see Attachment 1)]. The parameters used and the results calculated by Equation 3 are as follows:

Data	6-inch HDPE Pipe
σ_y	1500 psi
SDR	11
$\boldsymbol{\sigma_{crush}}$	**300 psi** (> 55 psi)
FS	5.5

Wall Buckling

Wall buckling occurs when the external vertical pressure exceeds the critical buckling pressure of the pipe/bedding aggregate system. The maximum wall buckling stress that may be withstood by the pipe can be calculated by Equation 4 [Phillips 66, 1991]:

$$\sigma_{buckle} = 1.2\left[\frac{E'E}{SDR^3}\right]^{1/2} \qquad \text{Equation 4}$$

where E is the modulus of elasticity of the pipe material; E' is the modulus of soil reaction for the pipe bedding material; and SDR is the standard dimension ratio of the pipe.

Since HDPE exhibits a tensile creep behavior, the value of E is dependent upon the applied tensile stress and the duration of load application as shown in the tensile creep curves presented by Plastic Pipe Institute [1993], see Attachment 2. The tensile stress intensity can be estimated using the applied overburden stress and the following equation (Phillips 66, 1991):

$$S_A = \frac{(SDR-1)\ \sigma_{vo}}{2} \qquad \text{Equation 5}$$

where SDR is the pipe standard dimension ratio; and σ_{vo} is the maximum applied overburden stress. Assuming an applied load duration (t) of 50 years and using the calculated tensile stress intensity (S_A), the modulus of elasticity of the HDPE pipe can be obtained from the appropriate tensile creep curve. The following table presents the input parameters utilized to calculate modulus of elasticity, E, of the HDPE pipe.

Data	6-inch HDPE Pipe
SDR	11
σ_{vo}	55 psi
S_A	275 psi
t	50 yrs
E	**25,000 psi**

The modulus of soil reaction (E') is calculated using Young's modulus (E_s), Poisson's ratio (v) and an empirical factor (k) which may vary from 0.7 to 2.3. The Young's modulus and Poisson ratio were interpolated from data presented by Selig [1990] for soils at various overburden stress levels, see Attachment 2. Assuming the bedding material consists of silty sand (i.e., SM per Unified Soil Classification System), the Young's modulus of the soil will vary between 975 to 4,000 psi under a stress level of 55 psi. Therefore, a Young's modulus of 2,400 psi and Poisson's ratio of 0.36 were conservatively chosen. Equations 6 and 7 [Selig, 1990] were used to obtain the modulus of soil reaction:

$$M_s = \frac{E_s(1-\nu)}{(1+\nu)(1-2\nu)} \qquad \text{Equation 6}$$

$$E' = k * M_s \qquad \text{Equation 7}$$

where:

M_s = constrained modulus, psi;

E_s = Young's modulus, psi;
ν = Poisson's ratio;
E'= Modulus of soil reaction, psi; and
k = Empirical factor, assume average value of 1.5.

The following table presents the input parameters utilized to calculate the modulus of soil reaction, E_s:

Data	6-inch HDPE Pipe
E_s	2,400 psi
ν	0.36
M_s	4,034 psi
k	1.5
E'	**6,050 psi**

The following table presents the maximum wall buckling stress that can be withstood by the pipe, based on the calculated input parameters and Equation 4:

Data	6-inch HDPE Pipe
SDR	11
E	25,000 psi
E'	6,050 psi
σ_{buckle}	**405 psi** (> 55 psi)
FS	7.4

Under the maximum (i.e., traffic) loading condition, the 6-inch diameter HDPE pipe is capable of resisting the maximum applied stress with respect to wall buckling.

Ring Deflection

Excessive ring deflection is a horizontal over-deflection of the pipe causing a reversal of curvature in the pipe wall. This can occur if large external vertical pressures are applied to the pipe/bedding system. Excessive ring deflection can also lead to a substantial loss in flow capacity. The horizontal increase in pipe diameter (ΔX) that is used to evaluate ring deflection is calculated using the Modified Iowa Equation [Koerner, 1998]:

$$\Delta X = \frac{D_L K W_c}{\frac{EI}{r^3} + (0.061E')} \qquad \text{Equation 8}$$

where:

D_L = deflection lag factor typically varying between 1 and 1.5 [Koerner, 1998];
K = bedding constant with values from 0.083 to 0.11, see Attachment 2 [Wilson-Fahmy and Koerner, 1994];
W_c = Martson prism load per unit length (applied overburden stress times the pipe outside diameter), i.e., 55 psi × 6.625 in = 364 lb/in;
E = modulus of elasticity of the pipe material;
E'= modulus of soil reaction for the bedding material;
I = moment of inertia of the pipe wall per unit length = $t^3/12$ where t is the pipe wall thickness;
r = mean radius of the pipe = $[(D_{od}\text{-}t) \div 2]$ where D_{od} = outer diameter of the pipe and t = pipe wall thickness; and
ΔX = horizontal deflection.

Ring deflection is calculated by dividing the horizontal increase in pipe diameter (ΔX) by the pipe outside diameter (D_{od}). The allowable ring deflection for 6-inch HDPE pipe is 3.0 percent [Koerner, 1998]. The table below presents the input parameters and the resulting ring deflection.

Data	6-inch HDPE Pipe
D_L	1.25
K	0.11
W_c	364 lb/in
E	25,000 psi
I	0.018 in^3
r	3.012 in
E'	6,050 psi
ΔX	0.130 in
Ring Deflection	**2%** (< 3.0%)

Under the maximum (i.e., traffic) loading condition, the 6-inch diameter HDPE pipe is capable of sustaining the maximum applied stress with respect to ring deflection.

Bending Strain

When a pipe deflects under load, bending strains are induced in the pipe wall. Bending strain occurs in the pipe wall as external pressures are applied to the pipe/bedding aggregate system. Bending strain is calculated using the following equation [Mosher, 1990]:

$$\varepsilon_b = f_d \frac{t\Delta_y}{D^2} \times 100\% \qquad \text{Equation 9}$$

where:

ε_b = bending strain, percent;
f_d = deformation shape factor, assume 6 for design [Chevron, 1994];
t = minimum wall thickness, inches;
Δ_y = vertical deflection, inches (using ring deflection, $\Delta_y = \Delta X$); and
D = inside pipe diameter, inches.

An allowable bending strain of 5 percent is recommended by Wilson-Fahmy and Koerner [1994] based on AASHTO guidelines for long-term use of smooth polyethylene pipes; and an allowable bending strain of 4.2 percent is conservatively recommended in Chevron [1994]. It is noted that acceptable strains up to 8 percent are reported in the literature for a design period of 50 years. For the purposes of this calculation package, the allowable bending strain is 4.2%.

The following table presents the input parameters and resulting bending strain that was calculated using Equation 9:

Data	6-inch HDPE Pipe
f_d	6
t	0.602 in
Δ_y	0.130
D	5.349 in
ε_b	**1.6 %** (< 4.2 %)

Under the maximum (i.e., traffic) loading condition, the 6-inch diameter HDPE pipe is capable of sustaining the maximum applied stress with respect to bending strain.

SUMMARY

Based on the calculations for wall crushing, wall buckling, ring deflection, and bending strain under the assumed maximum applied traffic loading, the proposed 6-inch (and 4-inch) diameter SDR 11 HDPE conveyance pipe provides adequate structural stability. The proposed 4-inch diameter SDR 11 HDPE pipes within the FLSCs are subjected to a substantially smaller loading stress compared to the 6-inch diameter HDPE pipe, i.e., 4 psi vs. 55 psi, respectively.

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ATTACHMENT 1

HDPE PIPE SIZE AND MATERIAL PROPERTIES

PERFORMANCE PIPE
A DIVISION OF CHEVRON PHILLIPS CHEMICAL COMPANY LP

PERFORMANCE PIPE Municipal & Industrial Series/IPS Pipe Data

Pipe weights are calculated in accordance with PPI TR-7. Average inside diameter calculated using nominal OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary. When designing components to fit the pipe ID, refer to pipe dimensions and tolerances in applicable pipe specifications.

Pressure Ratings are for water at 73.4 °F. For other fluid and service temperature, ratings may differ. Refer to Engineering Manual for Chemical and Environmental Considerations.

Pressure Rating		255 psi DR 7.3			200 psi DR 9.0			160 psi DR 11.0			130 psi DR 13.5			
IPS Pipe Size	Nominal OD (in)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	IPS Pipe Size
1 1/4"	1.660	0.227	1.179	0.44	0.184	1.270	0.37	0.151	1.340	0.31	0.123	1.399	0.26	1 1/4"
1 1/2"	1.900	0.260	1.349	0.58	0.211	1.453	0.49	0.173	1.533	0.41	0.141	1.601	0.34	1 1/2"
2"	2.375	0.325	1.686	0.91	0.264	1.815	0.76	0.216	1.917	0.64	0.176	2.002	0.53	2"
3"	3.500	0.479	2.485	1.98	0.389	2.675	1.66	0.318	2.826	1.39	0.259	2.951	1.15	3"
4"	4.500	0.616	3.194	3.27	0.500	3.440	2.74	0.409	3.633	2.29	0.333	3.794	1.90	4"
5 3/8"	5.375	0.736	3.815	4.66	0.597	4.109	3.90	0.489	4.338	3.27	0.398	4.531	2.72	5 3/8"
5"	5.563	0.762	3.948	5.00	0.618	4.253	4.18	0.506	4.490	3.51	0.412	4.690	2.91	5"
6"	6.625	0.908	4.700	7.09	0.736	5.065	5.93	0.602	5.349	4.97	0.491	5.584	4.13	6"
7 1/8"	7.125	0.976	5.056	8.20	0.792	5.446	6.86	0.648	5.751	5.75	0.528	6.006	4.78	7 1/8"
8"	8.625	1.182	6.119	12.01	0.958	6.594	10.05	0.784	6.963	8.42	0.639	7.270	7.00	8"
10"	10.750	1.473	7.627	18.66	1.194	8.219	15.61	0.977	8.679	13.09	0.796	9.062	10.87	10"
12"	12.750	1.747	9.046	26.25	1.417	9.746	21.97	1.159	10.293	18.41	0.944	10.749	15.29	12"
13 3/8"	13.375	1.832	9.491	28.88	1.486	10.225	24.18	1.216	10.797	20.26	0.991	11.274	16.84	13 3/8"
14"	14.000	1.918	9.934	31.64	1.556	10.701	26.50	1.273	11.301	22.20	1.037	11.802	18.44	14"
16"	16.000	2.192	11.353	41.33	1.778	12.231	34.60	1.455	12.915	29.00	1.185	13.488	24.09	16"
18"	18.000	2.466	12.772	52.31	2.000	13.760	43.79	1.636	14.532	36.69	1.333	15.174	30.48	18"
20"	20.000	2.740	14.191	64.58	2.222	15.289	54.05	1.818	16.146	45.30	1.481	16.860	37.63	20"
22"	22.000	3.014	15.610	78.14	2.444	16.819	65.40	2.000	17.760	54.82	1.630	18.544	45.56	22"
24"	24.000	3.288	17.029	93.00	2.667	18.346	77.85	2.182	19.374	65.24	1.778	20.231	54.21	24"
26"	26.000				2.889	19.875	91.36	2.364	20.988	76.57	1.926	21.917	63.62	26"
28"	28.000				3.111	21.405	105.95	2.545	22.605	88.78	2.074	23.603	73.78	28"
30"	30.000				3.333	22.934	121.62	2.727	24.219	101.92	2.222	25.289	84.69	30"
32"	32.000							2.909	25.833	115.97	2.370	26.976	96.35	32"
34"	34.000							3.091	27.447	130.93	2.519	28.660	108.81	34"
36"	36.000							3.273	29.061	146.80	2.667	30.346	121.98	36"
42"	42.000										3.111	35.405	166.00	42"
48"	48.000													48"
54"	54.000													54"

Performance Pipe can produce to specialized pipe dimensions. Check with your Performance Pipe contact for availability of dimensions not listed.

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DriscoPlex® PE 3408 HDPE

Piping Systems

Typical Material Physical Properties of DriscoPlex® HDPE
High Density Polyethylene Materials

Property	Unit	Test Procedure	Typical Value
Material Designation	---	ASTM F 412	PE 3408
Cell Classification	---	ASTM D-3350	345464C (black) 345464E (color)
Density	g/cm^3	ASTM D-1505	0.955 (black) 0.947 (color)
Melt Index	g/10 minutes	ASTM D-1238	0.1
Flexural Modulus	psi	ASTM D-790	> 130,000
Tensile Strength	psi	ASTM D-638	3200
SCG (PENT)	hours	ASTM F-1473	> 100
HDB at 73.4°F (23°C)	psi	ASTM D-2837	1600
Color; UV Stabilizer	---	ASTM D-3350	Black with minimum 2% carbon black
Color; UV Stabilizer	---	ASTM D-3350	Color with UV stabilizer
Linear Thermal Expansion	inch/inch/°F	ASTM D-696	9×10^{-5}
Elastic Modulus	psi	ASTM D-638	110,000
Brittleness Temperature	°F (°C)	ASTM D-746	< -180 (<-118)
Hardness	Shore D	ASTM D-2240	65

Bulletin: PP 109

Revision Date June, 2006

Another quality product from
Chevron Phillips Chemical Company LP
The Woodlands, Texas

High Density Polyethylene

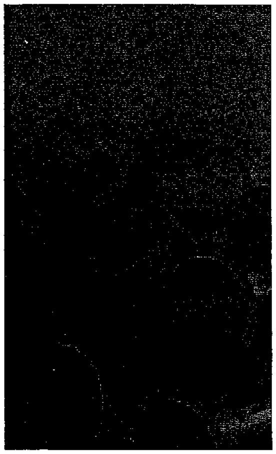
TYPICAL PROPERTIES

HDPE CHARACTERISTICS
TYPICAL PROPERTIES
CHEMICAL RESISTANCE CHART
SIZE AND DIMENSION CHARTS BY APPLICATION
CALCULATION PROGRAMS

HIGH DENSITY POLYETHYLENE PIPE
Typical Physical Properties***

Property	Specification	Unit	Nominal Value
Material Designation	PPI / ASTM		PE 3408
Material Classification	ASTM D-1248		III C 5 P34
Cell Classification	ASTM D3350-99		345464C
-Density (3)	ASTM D-1505	gm/cm3	0.955
-Melt Index (4)	ASTM D-1238 (216 kg/190iC)	gm/10 min.	0.11*
-Flex Modulus (5)	ASTM D-790	psi	135,000
-Tensile Strength (4)	ASTM D-638	psi	3,200
PENT (6)	ASTM F-1473	Hours	>100
-HDB @73i F (4)	ASTM D-2837	psi	1,600
-HDB @ 140 Deg F	ASTM D-2837	psi	800
-U-V Stabilizer (C)	ASTM D-1603	% C	2.5
Hardness	ASTM D-2240	Shore "D"	65
Compressive Strength (yield)	ASTM D-695	psi	1,600
Tensile Strength @ Yield (Type IV Spec.)	ASTM D-638 (2"/min.)	psi	3,200
Elongation @ Yield	ASTM D-638	%, minimum	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D-638	psi	5,000
Elongation @ Break	ASTM D-638	%, minimum	750
Modulus of Elasticity	ASTM D-638	psi	130,000
PENT (6)	ASTM F-1473	Hours	>100
(Cond. A, B, C: Mold. Slab)	ASTM D-1693	Fo, Hours	>5,000
(Compressed Ring - pipe)	ASTM F-1248	Fo, Hours	>3,500
Slow Crack Growth	Battelle Method	Days to Failure	>64
Impact Strength (IZOD) (.125Ó Thick)	ASTM D-256 (Method A)	In-lb / in notch	42
Linear Thermal Expansion Coef.	ASTM D-696	in / in/iF	1.2x10-4
Thermal Conductivity	ASTM D-177	BTU-in/ft2/ hrs/ degreesF	2.7
Brittleness Temp.	ASTM D-746	degrees F	< -180
Vicat Soft. Temp.	ASTM D-1525	degrees F	257
Heat Fusion Cond.	ASTM D-1525	@ psi degrees F	75 @ 400

*** This list of typical physical properties is intended for basic characterization of the material and does not represent specific determinations of specifications. The physical properties values reported herein were determined on compression molded specimens prepared in accordance with Procedure



C of ASTM D 1928 and may differ from specimens taken from pipe.
** Tests were discontinued because no failures and no indication of stress crackinitiation.
* Average Melt Index value with a standard deviation of 0.01

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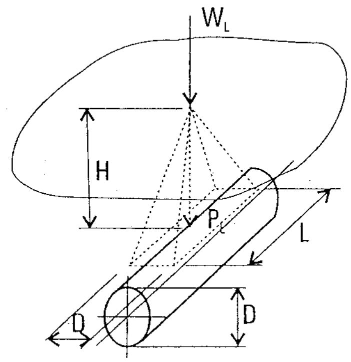
< PREVIOUS PAGE NEXT PAGE >

ATTACHMENT 2

LOAD COEFFICIENT, C_s
MODULUS OF ELASTICITY FOR HDPE PIPE, E
MODULUS OF SOIL REACTION, E_s
BEDDING CONSTANT, K

$\boxed{C_s = \text{LOAD COEFFICIENT}}$

Table 7-4 **Load Coefficient, C_H, for Holl's Integration of Boussineq's Equation**



6 in HDPE pipe :

$$\frac{D}{2H} = \frac{6.625''}{2(1 \times 12'')} = 0.28$$

$$\frac{L}{2H} = \frac{3'}{2(1')} = 1.5$$

$\longrightarrow$ $C_s = 0.324$ (interpolated from table)

D/2H	L/2H						
	0.1	0.2	0.3	0.4	0.5	0.6	0.7
0.1	0.019	0.037	0.053	0.067	0.079	0.089	0.097
0.2	0.037	0.072	0.103	0.131	0.155	0.174	0.189
0.3	0.053	0.103	0.149	0.190	0.224	0.252	0.274
0.4	0.067	0.131	0.190	0.241	0.284	0.320	0.349
0.5	0.079	0.155	0.224	0.284	0.336	0.379	0.414
0.6	0.089	0.174	0.252	0.320	0.379	0.428	0.467
0.7	0.097	0.189	0.274	0.349	0.414	0.467	0.511
0.8	0.103	0.202	0.292	0.373	0.441	0.499	0.546
0.9	0.108	0.211	0.306	0.391	0.463	0.524	0.574
1.0	0.112	0.219	0.318	0.405	0.481	0.544	0.597
1.2	0.117	0.229	0.333	0.425	0.505	0.572	0.628
1.5	0.121	0.238	0.346	0.442	0.525	0.596	0.655
2.0	0.124	0.244	0.355	0.454	0.540	0.613	0.674
20.0	0.127	0.248	0.361	0.462	0.550	0.625	0.688

D/2H	L/2H						
	0.8	0.9	1.0	1.2	1.5	2.0	20.0
0.1	0.103	0.108	0.112	0.117	0.121	0.124	0.127
0.2	0.202	0.211	0.219	0.229	0.238	0.244	0.248
0.3	0.292	0.306	0.318	0.333	0.346	0.355	0.361
0.4	0.373	0.391	0.405	0.425	0.442	0.454	0.462
0.5	0.441	0.463	0.481	0.505	0.525	0.540	0.550
0.6	0.499	0.524	0.544	0.572	0.596	0.613	0.625
0.7	0.546	0.574	0.597	0.628	0.655	0.674	0.688
0.8	0.584	0.615	0.639	0.674	0.703	0.725	0.740
0.9	0.615	0.647	0.673	0.711	0.743	0.766	0.783
1.0	0.639	0.673	0.701	0.740	0.775	0.800	0.818
1.2	0.674	0.711	0.740	0.783	0.821	0.849	0.871
1.5	0.703	0.743	0.775	0.821	0.863	0.895	0.920
2.0	0.725	0.766	0.800	0.849	0.895	0.930	0.960
20.0	0.740	0.783	0.818	0.871	0.920	0.960	1.000

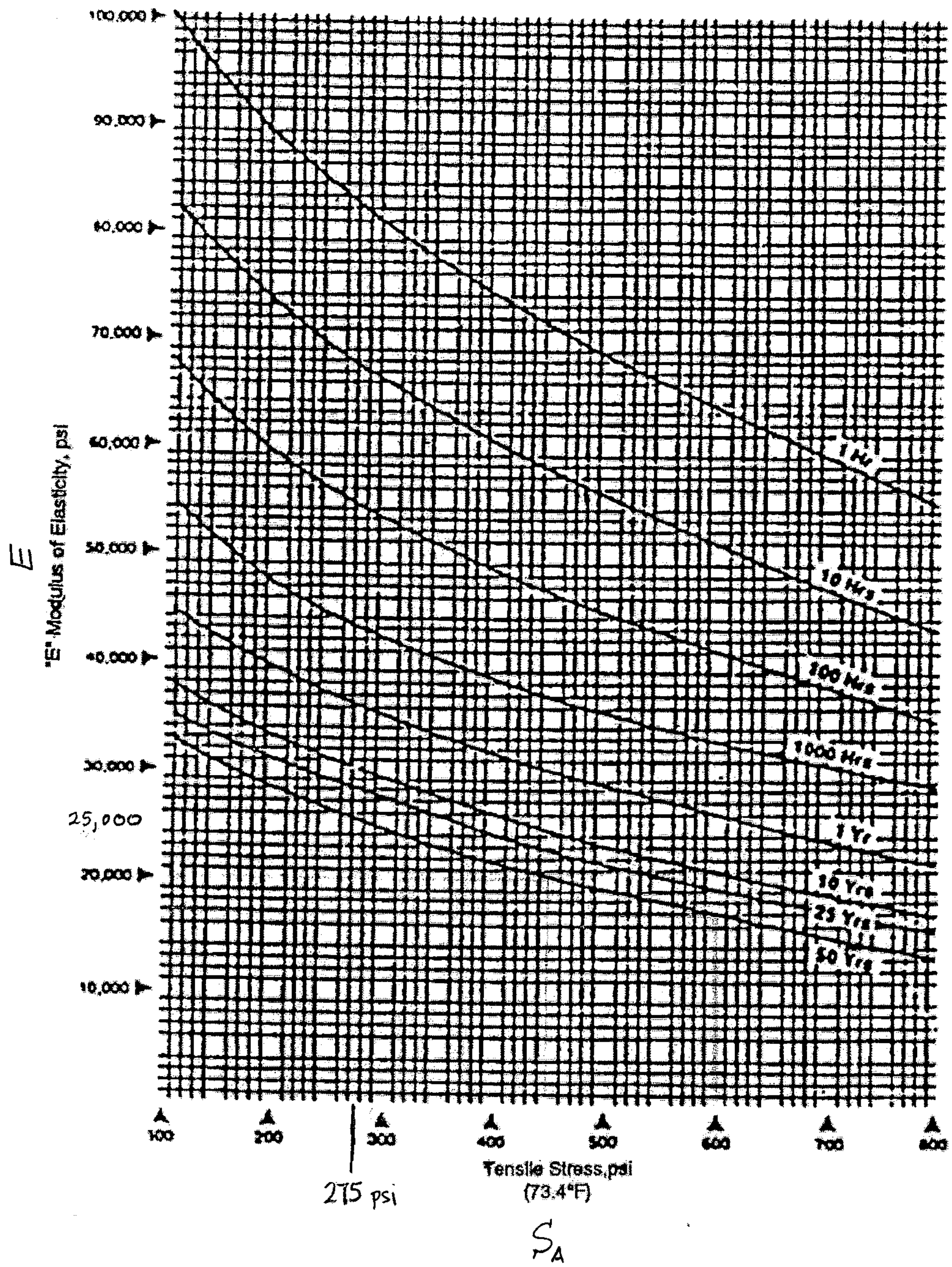
REF: "Plexco/Spirolite Eng. Manual, 2. System Design", Chevron Chemical Company, 1994.

Information on this page rev. 8/92— supersedes all previous issues.

E= MODULUS OF ELASTICITY FOR HDPE PIPE

Figure 4

MODULUS OF ELASTICITY (E) FOR HDPE PIPE
(Plastic Pipe Institute Handbook of Polyethylene Pipe, 1993)



6" HDPE Pipe

$$S_A = \frac{(SDR-1)\,\sigma_{vo}}{2}$$

$$= \frac{(11-1) \times 55\ psi}{2}$$

$$= \underline{\underline{275\ psi}}$$

005/223

E' = MODULUS OF SOIL REACTION

Modulus of Soil Reaction (E') for Pipe Bedding Material. (from Selig, 1990)

SOIL TYPE = SM
$\sigma_V = 55$ psi

1975 psi < E_s < 4,000 psi
0.34 < ν_s < 0.40

⇒ ASSUME
$E' = 2400$ psi
∴ $\nu_s = 0.36$

Soil Type: SW, SP, GW, GP

σ_V = Stress level psi (kPa)	95% D698 E_s	95% D698 B	95% D698 ν_s	85% D698 E_s	85% D698 B	85% D698 ν_s
1 (7)	1600 (11)	2800 (19)	0.40	1300 (9)	900 (6)	0.26
5 (34)	4100 (28)	3300 (23)	0.29	2100 (14)	1200 (8)	0.21
10 (70)	6000 (41)	3900 (27)	0.24	2600 (18)	1400 (10)	0.19
20 (140)	8600 (59)	5300 (37)	0.23	3300 (23)	1800 (12)	0.19
40 (280)	13000 (90)	8700 (60)	0.25	4100 (28)	2500 (17)	0.23
60 (410)	16000 (110)	13000 (90)	0.29	4700 (32)	3500 (24)	0.28

Soil Type: GM, SM, ML, and GC, SC with < 20% fines

Stress level psi (kPa)	95% D698 E_s	95% D698 B	95% D698 ν_s	85% D698 E_s	85% D698 B	85% D698 ν_s
1 (7)	1800 (12)	1900 (13)	0.34	600 (4)	400 (3)	0.25
5 (34)	2500 (17)	2000 (14)	0.29	700 (5)	450 (3)	0.24
10 (70)	2900 (20)	2100 (14)	0.27	800 (6)	500 (3)	0.23
20 (140)	3200 (22)	2500 (17)	0.29	850 (6)	700 (5)	0.30
40 (280)	3700 (25)	3400 (23)	0.32	900 (6)	1200 (8)	0.38
60 (410)	4100 (28)	4500 (31)	0.35	1000 (7)	1800 (12)	0.41

Soil Type: CL, MH, GC, SC

Stress level psi (kPa)	95% D698 E_s psi	95% D698 B psi	95% D698 ν_s	85% D698 E_s	85% D698 B	85% D698 ν_s
1 (7)	400 (3)	800 (6)	0.42	100 (1)	100 (1)	0.33
5 (34)	800 (6)	900 (6)	0.35	250 (2)	200 (1)	0.29
10 (70)	1100 (8)	1000 (7)	0.32	400 (3)	300 (2)	0.28
20 (140)	1300 (9)	1100 (8)	0.30	600 (4)	400 (3)	0.25
40 (280)	1400 (10)	1600 (11)	0.35	700 (5)	800 (6)	0.35
60 (410)	1500 (10)	2100 (14)	0.38	800 (6)	1300 (9)	0.40

Note: Units of E_s and B are psi (MPa).

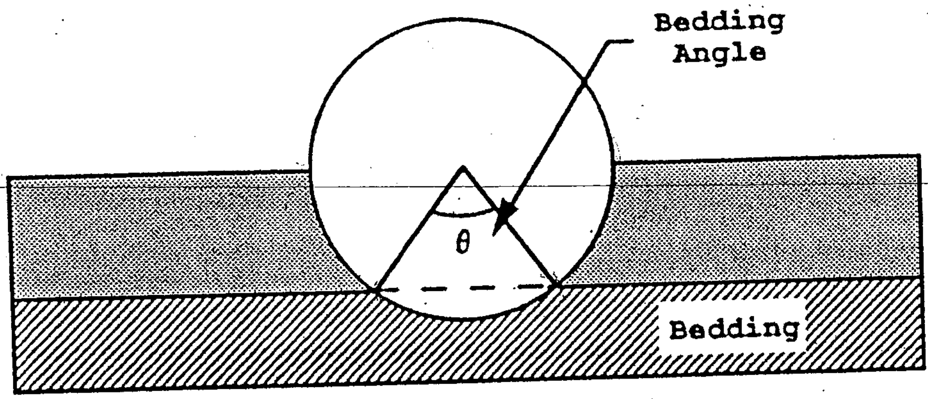
Deflections of buried flexible pipe are commonly calculated using the Iowa formula [1] which uses the modulus of soil reaction (E') as the parameter representing soil stiffness. Since E' is not a directly measureable soil parameter, but must be determined by back-calculation using observed pipe deflections, studies have been carried out to seek a correlation between E' and soil stiffness parameters such as Young's modulus (E_s) and constrained modulus (M_s), where E_s and M_s are related

REF: SELIG, E.T., "SOIL PROPERTIES FOR PLASTIC PIPE INSTALLATIONS," BURIED PLASTIC PIPE TECHNOLOGY, ASTM STP 1093, BUZCALA AND CASSIDY, EDS., 1990.

K = BEDDING CONSTANT

Values of Bedding Constant

Bedding Angle (degrees)	K
* 0	0.110 *
30	0.108
45	0.105
60	0.102
90	0.096
120	0.090
180	0.083



(from Wilson-Fahmy and Koerner, 1994)

APPENDIX E

Anchor Trench Design Calculation Package

A Gupta
9 NOV 2006

ANCHOR TRENCH DESIGN EVALUATION
FLEXIBLE LEACHATE STORAGE CONTAINERS
CENTRAL COUNTY SOLID WASTE DISPOSAL COMPLEX
SARASOTA COUNTY SOLID WASTE OPERATIONS
SARASOTA COUNTY, FLORIDA

INTRODUCTION

The purpose of this calculation package is to present the adequacy of the anchor trench design associated with the proposed Flexible Leachate Storage Containers (FLSCs) at Central County Solid Waste Disposal Complex (CCSWDC) located in Sarasota County, Florida. Calculations were performed to evaluate the anchorage provided by the perimeter anchor trench along the top of the FLSC berm. The anchor trench will be constructed to hold in-place the geosynthetics [i.e., geomembrane layers and geosynthetic clay liner (GCL)] utilized for the FLSCs and corresponding liner system.

The subsequent sections present several aspects of the anchor trench design evaluation and include the following items:

- Input parameters and assumptions used for the anchor trench analysis including the proposed anchor trench geometry, and geosynthetic and soil material properties;
- Static force equilibrium methodology utilized to evaluate the anchor trench design; and
- Results of the anchor trench calculations and adequacy of the proposed design.

INPUT PARAMETERS AND ASSUMPTIONS

Anchor Trench and FLSC Configuration

Sheet 6 of the Permit Drawings presents the typical anchor trench configuration proposed for the FLSCs. The side slopes are inclined at 3H:1V and the geosynthetics are anchored in a 2 ft by 2 ft trench along the top of the outer perimeter berm which is approximately 6 to 7 ft high. The run-out length (L_{RO}) from the top of the side slope to the edge of the anchor trench is 2 ft. The geomembrane layers are also laid horizontally along the bottom of the anchor trench for added pullout resistance. The geosynthetic layers that are anchored in the trench consist of, from top to bottom, three 60 mil high density polyethylene (HDPE) textured geomembrane layers, underlain by a GCL.

General Fill Material Properties

The type of soil used to construct the perimeter berm for the FLSCs (and anchor trenches) will be general fill with an assumed unit weight of 120 pcf. In addition, a cohesion (c) of zero and angle of internal friction (ϕ) of 32° were selected to establish the shear strength of the soil. These material properties generally represent values typical of compacted general fill.

HDPE Geomembrane Material Properties

The tensile strength of the geomembrane is required to evaluate the pullout resistance provided by the anchor trench, is discussed below. The minimum tensile strength of the proposed 60 mil HDPE textured geomembrane was based on the guidance provided by the Geosynthetic Research Institute, specifically *GRI Test Method GM-13 – Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes* (GRI, 2003). Minimum strength values as established by GRI GM-13 have been provided in Attachment 1 and indicate a minimum break or rupture strength (i.e., ultimate tensile strength, T_u), of 90 lb/in. For a factor of safety of 2 against rupture, the resulting allowable tensile strength (T_{allow}) is 45 lb/in.

Interface Friction Values

Interface friction (δ) values between geosynthetic-geosynthetic or soil-geosynthetic interfaces are required to evaluate the pullout resistance provided by the anchor trench, as will be discussed below. A summary of typical interface friction values for various geosyntethic and soil interfaces is provided in Attachment 2. Limited published data is available on geomembrane-geomembrane interfaces. As such, a δ value of 8° was conservatively utilized for these interfaces based on the values presented for textured geomembrane-geonet interfaces. This lower bound interface friction value was assumed to represent plastic to plastic (i.e., HDPE to HDPE) interfaces.

External Loads Imposed on Geosynthetic Layers

The external loads imposed on the FLSC geosynthetic layers are related to the conditions under which the FLSCs will be operated. When the storage containers are empty, there will be essentially no loading on the geosynthetics within the anchor trench except for self-weight of the geosynthetic materials. When the FLSCs are full, the geosynthetic layers (below the FLSC top geomembrane) will be subjected to a confining pressure imposed by the fluid within the FLSC. The hydrostatic confining pressure acts perpendicular to the plane of the geosynthetic layers, and thereby imposes no downward loading along the side slope geosynthetics.

METHOD OF ANALYSIS

Anchor Trench Pullout Calculations

The methodology utilized to evaluate the proposed anchor trench design was based on the approach presented by Koerner (1998). [Note: As mentioned above and shown on Sheet 6 of the Permit Drawings, the three geomembrane layers will be placed horizontally along the bottom of the anchor trench for added pullout resistance. The analysis presented herein will not consider this added resistance; and therefore represents a conservative analysis.] Ideally, the anchor trench is designed to pull out the geosynthetics slightly rather than tear or rupture the geosynthetics. So if pullout has occurred, it is easier to restore the anchor trench configuration than actually repair/replace a torn geosynthetic. Therefore, the holding capacity of the anchor trench should be less than the ultimate (tear) tensile strength of the geosynthetic to be anchored, irrespective of the applied loads.

The two basic elements associated with a typical anchor trench design are: (i) run-out length (L_{RO}), which is the length of geosynthetic from the crest of the side slope to the edge of the anchor trench; and (ii) depth of anchor trench (d_{AT}). As shown on Sheet 6 of the Permit Drawings, the proposed design consists of L_{RO} = 2 ft and d_{AT} = 2 ft. For the given configuration and, as will be shown in the calculations, L_{RO} will drop out of the solution for d_{AT}. As such, if the calculated d_{AT} is less than what is proposed, then the design is adequate.

Static force equilibrium, including passive and active earth pressure theory, was utilized to establish one equation with two unknowns, L_{RO} and d_{AT}. The assumed free-body diagram developed by Koerner (1998) is presented in Attachment 3, and the solution in terms of the two variables is defined as follows:

$$T_{allow} \cos\beta = F_{U\sigma} + F_{L\sigma} + F_{LT} - P_A + P_P$$

where

T_{allow} = allowable tensile force in the geomembrane
= σ_{allow} t;

$F_{U\sigma}$ = shear force above geomembrane due to cover soil
= $\sigma_n \tan\delta_U (L_{RO})$ [assume negligible];
$F_{L\sigma}$ = shear force below geomembrane due to cover soil
= $\sigma_n \tan\delta_L (L_{RO})$;
F_{LT} = shear force below geomembrane due to vertical component of T_{allow}
= $T_{allow} \sin\beta \tan\delta_L$;
P_A = active earth pressure against the backfill side of the anchor trench
= $(0.5\gamma_{AT}d_{AT} + \sigma_n) K_A d_{AT}$;
P_P = passive earth pressure against the in-situ side of the anchor trench
= $(0.5\gamma_{AT}d_{AT} + \sigma_n) K_P d_{AT}$;
γ_{AT} = unit weight of soil in anchor trench;
σ_n = applied normal stress from cover soil;
K_A = coefficient of active earth pressure = $\tan^2 (45 - \phi/2)$;
K_P = coefficient of passive earth pressure = $\tan^2 (45 + \phi/2)$;
ϕ = internal friction angle of soil;
L_{RO} = run-out length;
d_{AT} = depth of anchor trench.

Since there is no cover soil layer above the geosynthetics (i.e., $\sigma_n = 0$) and the weight of the geosynthetic layers is negligible, the equation presented above further reduces to:

$$T_{allow} \cos\beta = F_{LT} - P_A + P_P$$

or

$$T_{allow} \cos\beta = T_{allow} \sin\beta \tan\delta - (0.5\gamma_{AT} d_{AT}) K_A d_{AT} + (0.5\gamma_{AT} d_{AT}) K_P d_{AT}$$

The resulting equation shows that L_{RO} is no longer a variable and does not contribute to pullout resistance.

The critical geosynthetic layers correspond to the upper-two textured HDPE geomembrane layers because they will be subjected to minimal interface friction resistance compared to the other interfaces.

ANCHOR TRENCH DESIGN EVALUATION RESULTS

Calculations were performed to evaluate the adequacy of the anchor trench design associated with the proposed FLSCs, and are included in Attachment 4. For the given configuration presented on Sheet 6 of the Permit Drawings and the geosynthetic material properties presented above, a minimum anchor trench depth (d_{AT}) of 1.75 ft was calculated. This values is less than the proposed d_{AT} of 2 ft, which indicates that the proposed design is adequate.

CONCLUSIONS

The results of the anchor trench design evaluation indicate that the proposed depth of anchor trench (d_{AT}) of 2 ft is adequate relative to geosynthetic pullout resistance. A minimum required d_{AT} of 1.75 ft was calculated.

REFERENCES

GeoSynthetic Research Institute (GRI), *GRI Test Method GM-13 – Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes*, GRI, Folsom, PA, 2003.

Koerner, R.M., *Designing with GeoSynthetics*. 4th Ed. Prentice Hall, New Jersey, 1998.

Koerner, R.M., Martin, J.P., and Koerner, G.R., "Shear Strength Parameters Between Geomembranes and Cohesive Soils," Journal of Geotextiles and Geomembranes, Vol. 4, No. 1, pp. 21-30, 1986.

Long, J. H., Daly, J. and Gilbert, R., "Structural Integrity of Geosynthetic Liner and Cover Systems for Solid Waste Landfills, Appendices A-K", Office of Solid Waste Research, Institute for Environmental Studies, University of Illinois at Urbana-Champaign, May, 1993.

Martin, J.P., Koerner, R.M., and Whitty, J.E., "Experimental Friction Evaluation of Slippage Between Geomembranes and Geotextiles," Proceedings of the International Conference on Geomembranes, Denver, Colorado, pp. 191-196, 1984.

Williams, N.D., and Houlihan, M.F., "Evaluation of Friction Coefficients Between Geomembranes, Geotextiles, and Related Products," Proceedings of the 3rd International Conference on Geotextiles, IFAI, Vienna, 1986.

Zornberg, J.G., McCartney, J.S. and Swan, R.H., Jr., "Analysis of a Large Database of GCL Internal Shear Strength Results," Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Vol. 131, No. 3, pp. 367-380.

ATTACHMENT 1

GRI Test Method GM-13, Table 2(a)

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	GM 12	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	63 lb/in. 45 lb/in. 12% 100%	84 lb/in. 60 lb/in. 12% 100%	105 lb/in. 75 lb/in. 12% 100%	126 lb/in. 90 lb/in. 12% 100%	168 lb/in. 120 lb/in. 12% 100%	210 lb/in. 150 lb/in. 12% 100%	252 lb/in. 180 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(7), (8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	 N.R. *(10)* 50%	per each formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils
(2) Alternate the measurement side for double sided textured sheet
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches
(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3
(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

GEOSYNTHETIC RESEARCH INSTITUTE (2003), "GRI TEST METHOD GM-13 – TEST PROPERTIES, TESTING FREQUENCY AND RECOMMENDED WARRANTY FOR HIGH DENSITY POLYETHYLENE (HDPE) SMOOTH AND TEXTURED GEOMEMBRANES," REVISION 6, GEOSYNTHETIC RESEARCH INSTITUTE, FOLSOM, PA.

ATTACHMENT 2

Typical Interface Friction Values

Summary of Documented Interface Friction Values
Flexible Leachate Storage Containers
Central County Solid Waste Disposal Complex
Sarasota County Solid Waste Disposal Operations
Sarasota County, Florida

Geosynthetic / Geosynthetic	δ (°)
Textured HDPE Geomembrane / Nonwoven Geotextile	15 to 35
Textured HDPE Geomembrane / Geocomposite Drainage Layer	17 to 29
Textured HDPE Geomembrane / Geonet	8 to 15
Textured HDPE Geomembrane / GCL (hydrated)	18 to 37
Geonet / Nonwoven Geotextile	14 to 22
Internal Friction Angle of GCL	$\phi = 10°$ to $18°$
Geosynthetic / Soil	**tan δ / tan ϕ**
Textured HDPE Geomembrane / Clay	0.8 to 0.9
Textured HDPE Geomembrane / Sand	0.7 to 0.8
Needle-punched Geotextile / Sand	0.8 to 1.0
Needle-punched Geotextile / Angular Gravel	0.7 to 0.9
Needle-punched Geotextile / Rounded Gravel	0.6 to 0.8
Needle-punched Geotextile / Silty Sands	0.96
Geogrid / Soil	1.0
GCL / Sand	$\delta = 17°$ to $35°$

Notes:
1. δ = interface friction angle; ϕ= soil internal friction angle.
2. Adapted from tests by Martin et al. (1984), Williams and Houlihan (1986), Koerner et al. (1986), Long et al. (1993), Koerner (1999), Zornberg et al. (2005), manufacturers literature, and unpublished results from GeoSyntec Consultants.

ATTACHMENT 3

Anchor Trench Free Body Diagram (Koerner, 1998)

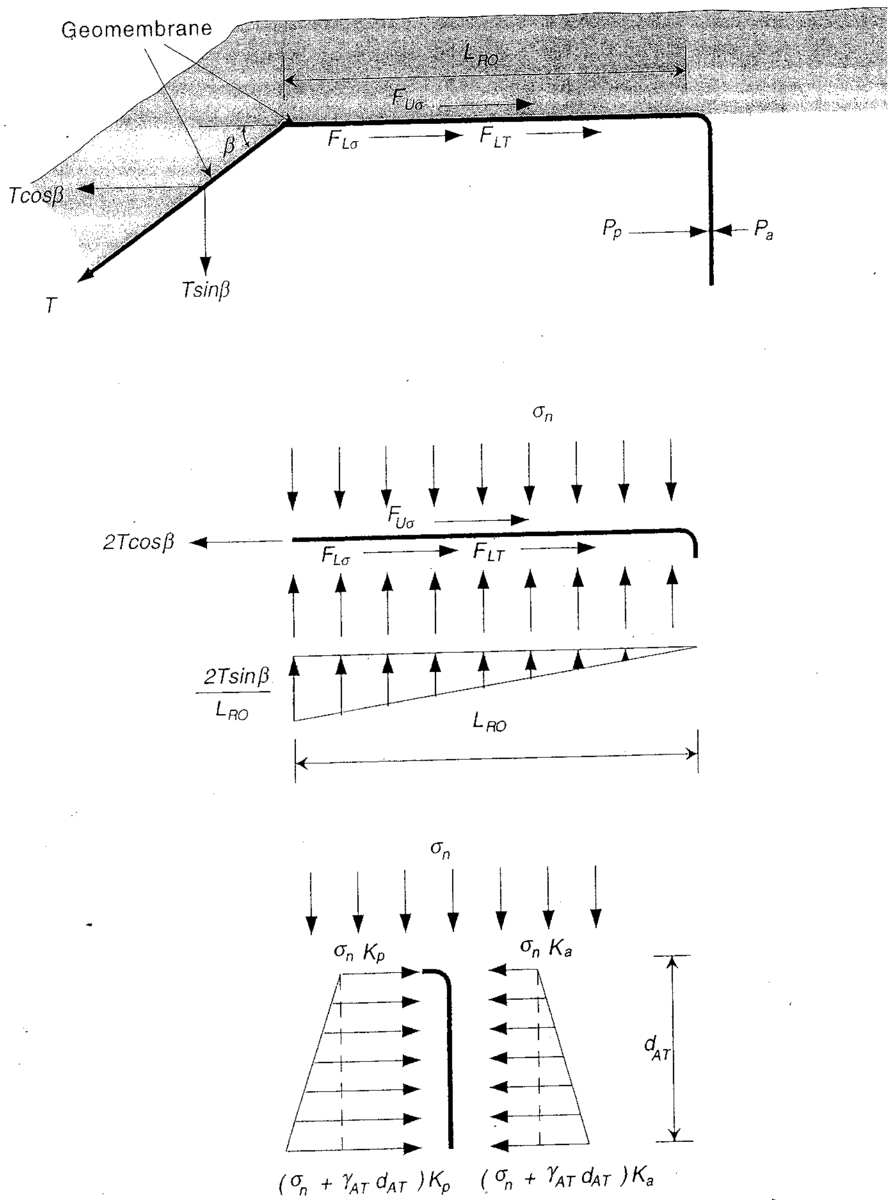


Figure 5.31 Cross section of geomembrane runout section with anchor trench and related stresses and forces involved.

be shown, this passive earth pressure is very effective in providing a resisting force (see Holtz and Kovacs [44]). Using the free-body diagram in Figure 5.31,

$$\Sigma F_x = 0$$

$$T_{\text{allow}} \cos\beta = F_{U\sigma} + F_{L\sigma} + F_{LT} - P_A + P_P \tag{5.26}$$

KOERNER (1998). DESIGNING W/GEOSYNTHETICS. 4TH ED.

ATTACHMENT 4

Anchor Trench Pullout Calculations

Written by: Juan Quiroz Date: 06 / 07 / 15 (YY MM DD) Reviewed by: Ayushman Gupta Date: ___/___/___ (YY MM DD)

Client: Sarasota County Project: FLSCs Project/Proposal No.: FL0819 Task No.: ________

FLSC CONFIGURATION

$3H:1V \Rightarrow \beta = 18.43^\circ$

$\delta_{MIN} = 8^\circ$ (Geomembrane - Geomembrane Interfaces)

$\phi_{SOIL} = 32^\circ \Rightarrow K_A = \tan^2(45 - \phi/2) = 0.307$

$K_p = \tan^2(45 + \phi/2) = 3.26$

$\gamma_{AT} = 120$ PCF

$\sigma_n = 0$ (NO COVER SOIL)

$T_u = 90 \frac{lb}{in}$ per GRI GM-13 $\Rightarrow$ FOR FS = 2, $T_{ALLOW} = \frac{90\ lb/in}{2} = 45 \frac{lb}{in}$

$= 540\ lb/FT$

PROPOSED $d_{AT} = 2$ FT

SOLUTION

$$T_{ALLOW} \cos\beta = F_{LT} - P_A + P_P$$

$$T_{ALLOW} \cos\beta = T_{ALLOW} \sin\beta \tan\delta - (0.5\gamma_{AT} d_{AT}) K_A d_{AT} + (0.5\gamma_{AT} d_{AT}) K_P d_{AT}$$

$$540 \frac{lb}{FT} \cos 18.43^\circ = 540 \frac{lb}{FT} \sin 18.43^\circ \tan 8^\circ - \overbrace{(0.5 \times 120\ pcf \times d_{AT})\ 0.33}^{19.8}\ d_{AT} + \overbrace{(0.5 \times 120\ pcf \times d_{AT})\ 3}^{180}\ d_{AT}$$

$$488.3 \frac{lb}{FT} = 160.2 \frac{lb}{FT^3} d_{AT}^2$$

$$d_{AT}^2 = 3.05\ FT^2$$

$$\underline{d_{AT} = 1.75\ FT}$$

$\therefore$ PROPOSED $d_{AT} = 2$ FT IS ADEQUATE.

APPENDIX F

Perimeter Berm Stability Calculation Package

A Gupta
9 NOV 2006

Written by: Juan Quiroz Date: 7 November 2006 Reviewed by: Ayushman Gupta Date:

Client: Sarasota County Project: Flexible Leachate Storage Containers Project No.: FL0819 Phase No.: 02

PERIMETER BERM STABILITY ANALYSIS FLEXIBLE LEACHATE STORAGE CONTAINERS CENTRAL COUNTY SOLID WASTE DISPOSAL COMPLEX SARASOTA COUNTY SOLID WASTE OPERATIONS SARASOTA COUNTY, FLORIDA

INTRODUCTION

The purpose of this calculation package is to present the stability analyses for the perimeter berm of the proposed Flexible Leachate Storage Containers (FLSCs) at Central County Solid Waste Disposal Complex (CCSWDC) located in Sarasota County, Florida. The stability analyses were performed to evaluate the stability of theFLSC perimeter/containment berm.

The subsequent sections present several aspects of the FLSC perimeter berm stability analyses and include the following items:

- Input parameters and assumptions used for the stability analyses;
- Methodology utilized to evaluate perimeter berm stability; and
- Results of the stability analyses for the representative cross-section analyzed.

INPUT PARAMETERS AND ASSUMPTIONS

FLSC Configuration

Attachment 1 presents the plan view configuration of the perimeter berm for the proposed FLSCs. A perimeter berm with 3H:1V side slopes and an 8-ft wide crest at El. 27 ft, will encompass the FLSCs. The maximum liquid level within the FLSCs corresponds to El. 25 ft, and the bottom of the containers is at approximately El. 20 ft.

A representative cross section along the western portion of the FLSCs was selected for outward (i.e., failure away from the FLSCs) stability analysis, see Attachment 1. It is noted that the representative cross section also takes into account the lateral force imposed by the liquid within the FLSCs, which was simulated by a linear hydrostatic pressure acting perpendicular to the interior berm side slope.

Subsurface Profile and Material Properties

The subsurface profile and associated geotechnical properties of the subsurface (i.e., foundation) soils were developed based on a local soil boring, designated as GB-1 and located within the FLSC footprint (as presented in Attachment 1). Continuous Standard Penetration Tests (SPTs) with a split-spoon barrel were conducted in a hollow-stem augered borehole to provide N-values (blows/ft) and a continuous visual examination of the soil profile. The depth of the SPTs and split-spoon sampling in the boring was continued until refusal at approximately 20 ft below ground surface. The boring was performed on 1 August 2006 by National Environmental Technology, Inc. (Dover, Florida) under the field direction/monitoring of GeoSyntec personnel.

The soil boring log for GB-1 is included in Attachment 1. The foundation soils beneath the FLSCs generally consist of loose to medium dense fine sands and silty sands. The subsurface profile was assigned shear strength parameters, i.e., angle of internal friction (ϕ), based on corresponding SPT N-values as presented by Meyerhoff [1956] for cohesionless soils. As a function of depth below ground surface, the following ϕ values were utilized: (i) from zero to 10 ft, $\phi = 33°$; and (ii) from 10 to 20 ft, $\phi = 37.5°$. The total unit weight of the subsurface soils was assumed to be 120 pcf, and the ground water table was observed to be approximately 3.5 ft below ground surface according to the soil boring log.

Perimeter Berm Fill Properties

The unit weight of constructed granular soil layers was estimated based on local construction experience using similar soils. General fill will be well compacted fine sand to silty sand; therefore, a total unit weight of 120 pcf was selected. An estimated ϕ value of 32° was selected to represent fill placed under well-compacted conditions (e.g., 95% standard Proctor maximum dry density).

METHOD OF ANALYSIS

Two analyses were performed to evaluate the global stability of the FLSC perimeter berms: (i) sliding stability along the base of the berm; and (ii) rotational (foundation) slope stability of the berm. The representative cross-section was evaluated using limit equilibrium methods. Sliding stability was based on the sliding-block methodology. Foundation slope stability was evaluated using the slope stability software SLIDE (Rocscience, 2004). This program performed automatic search routines using Spencer's method of slices for finding the critical circular failure surface and minimum factor of safety.

STABILITY RESULTS

Sliding Stability

The calculations for the sliding stability analyses are included Attachment 2. Based on the proposed perimeter berm configuration and input parameters presented above, the factor of safety against sliding failure is 19.5, which is greater than the typical minimum factor of safety of 1.5 against sliding failure.

Foundation Slope Stability

The input and output files of the foundation slope stability analyses for the representative cross-section are presented in Attachment 2. Based on the proposed perimeter berm configuration and input parameters presented above, the minimum calculated factor of safety is 2.84, which is greater than the minimum regulatory requirement of 1.5 for slope stability.

CONCLUSIONS

The results of the sliding stability analysis indicate that the perimeter berm provides adequate buttressing for the proposed FLSCs. Similarly, the results of the foundation slope stability analysis indicate that the perimeter berm soils and subsurface soils beneath the FLSCs provide adequate structural and foundation support relative to the proposed construction. The resulting calculated factor of safety values for sliding and slope stability exceeded the minimum factor of safety requirements of 1.5 against sliding failure and slope stability.

Written by: Juan Quiroz Date: 7 November 2006 Reviewed by: Ayushman Gupta Date: ____________

Client: Sarasota County Project: Flexible Leachate Storage Containers Project No.: FL0819 Phase No.: 02

REFERENCES

Meyerhoff, G.G., "Penetration Tests and Bearing Capacity of Cohesionless Soils," *Journal of Geotechnical Engineering*, ASCE, Vol. 82, No. SM1, 1956.

Rocscience, "SLIDE – 2-D Limit Equilibrium Slope Stability for Soil and Rock Slopes," User's Guide, Rocscience Software, Inc., Toronto, Ontario, Canada, 2004.

Spencer, E., "The Thrust Line Criterion in Embankment Stability Analysis," *Géotechnique*, Vol. 23, No. 1, pp. 85-100, March 1973.

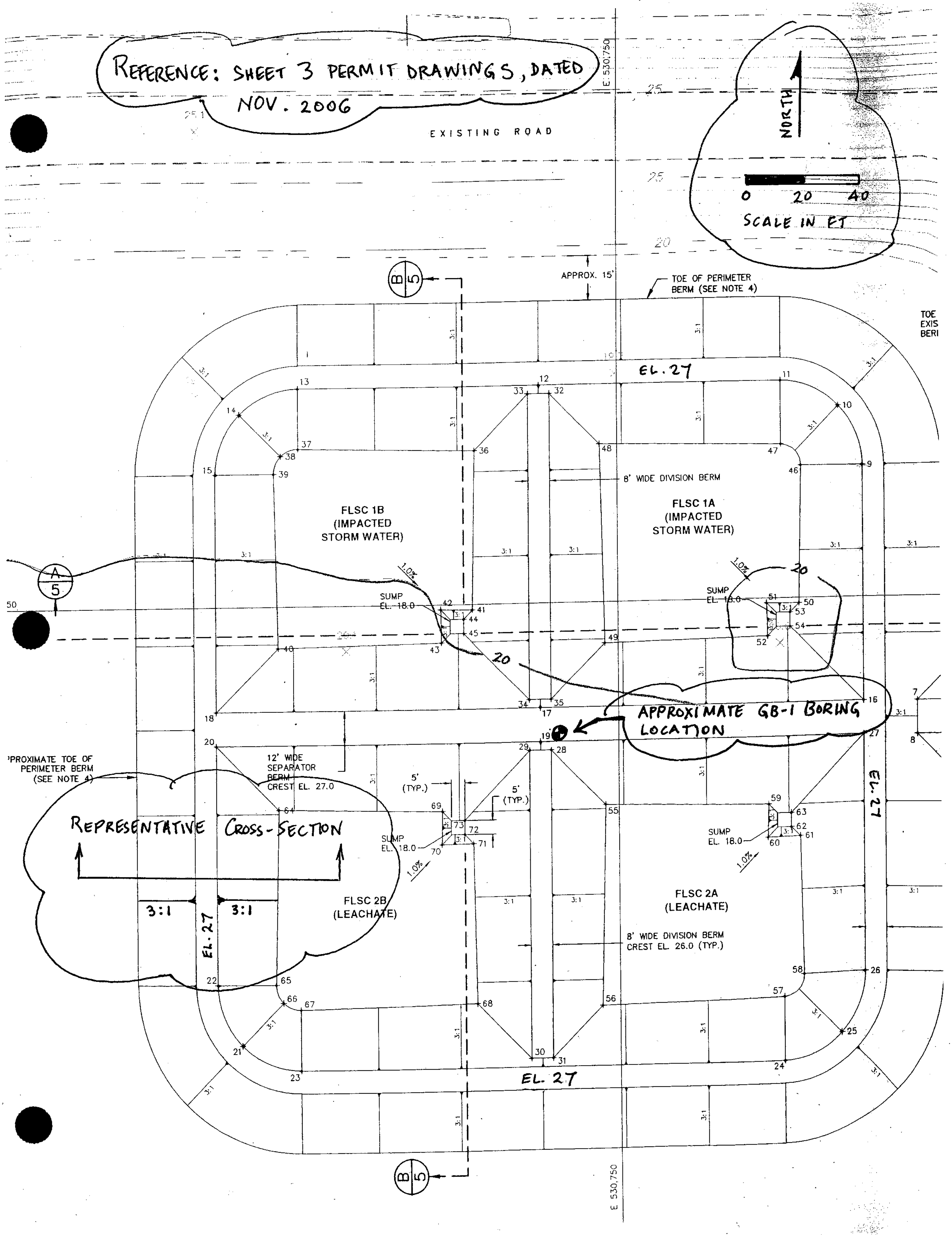
ATTACHMENT 1

PLAN VIEW CONFIGURATION

REPRESENTATIVE CROSS SECTION

GB-1 SOIL BORING LOG

SPT N-VALUE – ϕ CORRELATION [MEYERHOFF, 1956]

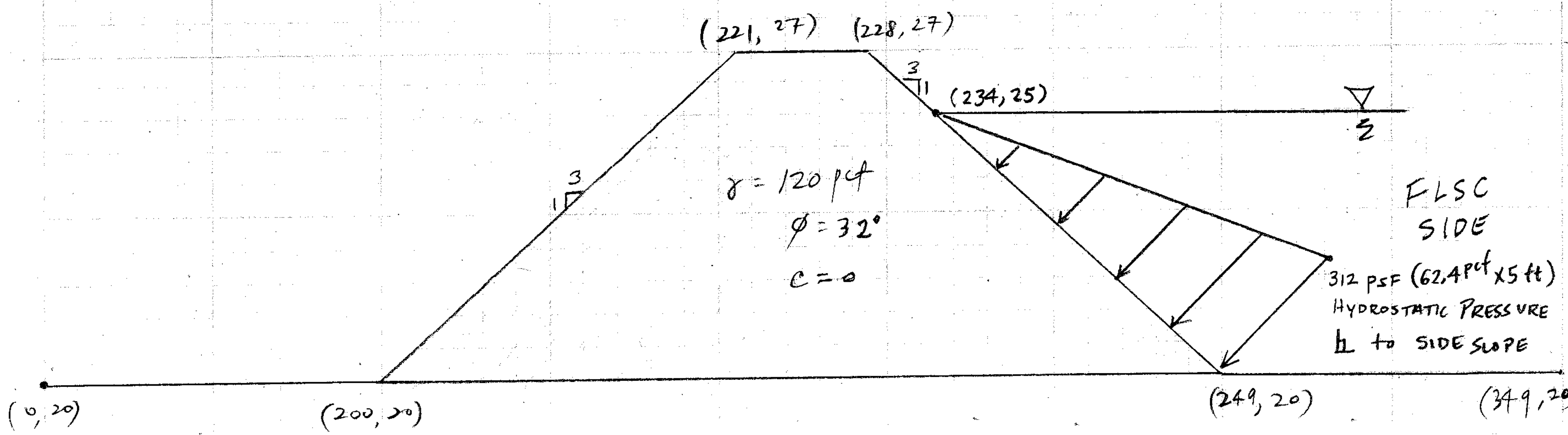


REFERENCE: SHEET 3 PERMIT DRAWINGS, DATED NOV. 2006
E 530,750
EXISTING ROAD
NORTH
0
20
40
SCALE IN FT
APPROX. 15'
TOE OF PERIMETER BERM (SEE NOTE 4)
EL. 27
8' WIDE DIVISION BERM
FLSC 1B (IMPACTED STORM WATER)
FLSC 1A (IMPACTED STORM WATER)
SUMP EL. 18.0
1.0%
20
APPROXIMATE GB-1 BORING LOCATION
APPROXIMATE TOE OF PERIMETER BERM (SEE NOTE 4)
12' WIDE SEPARATOR BERM CREST EL. 27.0
5' (TYP.)
REPRESENTATIVE CROSS-SECTION
3:1
FLSC 2B (LEACHATE)
FLSC 2A (LEACHATE)
8' WIDE DIVISION BERM CREST EL. 26.0 (TYP.)
TOE EXIS BERI

Written by: Jay Eun Date: 06 / 08 / 28 (YY/MM/DD) Reviewed by: ________ Date: __/__/__ (YY/MM/DD)

Client: Sarasota Project: FLSC Project/Proposal No.: ________ Task No.: ________

REPRESENTATIVE CROSS-SECTION



EL. 16.5

6
~~24~~
7
9
10

$N_{Avg} = 8 \longrightarrow \phi = 33°$

LOOSE FINE SAND & SILTY SAND

$\gamma = 120$ pcf

(0, 10)

21
~~51~~
23
34
17

$N_{Avg} = 24 \longrightarrow N = 15 + (N' - 15)/2$ for $N' > 15$

$N = 15 + 9/2$

$N = 20 \longrightarrow \phi = 37.5°$

MEDIUM DENSE SILTY SAND $\gamma = 120$ pcf

(0, 0)

GEOLOGIC SOIL BORING DETAIL GB-1

PROJECT:	CCSWDD-SARASOTA CO.	DATE COMPLETED:	AUGUST 2006
PROJECT NO.:	FL0819.02	CONTRACTOR:	NET
DATE STARTED:	1 AUGUST 2006	DRILLER:	NA
DRILL RIG:	NA	SCALE:	1"=5'
METHOD:	AUGER BIT	DRAWN BY:	ENDRE CSORDAS
GROUND ELEV.:	20 FT	DRAWING NO.:	FL0819.01F002
WATER AT INSTALL:	3.5 FT	CHECKED BY:	JUAN QUIROZ
GEOLOGIST:	JOE TERRY	SHEET: 1	OF: 1

DEPTH (FEET)		% FINES	UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	BLOWS / 6 IN	N-VALUE	REC / ATT	LITHOLOGICAL DESCRIPTION
	NO WELL INSTALLED	NA	SP	1 2 4 6	6	95%	LIGHT TO DARK BROWN FINE SAND W/GRAY AND BLACK ORGANICS (ROOTS) MOIST.
		10.3	SP-SM	14 14 10 9	24	100%	LIGHT TO DARK BROWN FINE SAND (FEW ROOTS TOWARDS THE TOP), MOIST TO SATURATED
5				3 3 4 5	7	100%	DARK TO LIGHT BROWN FINE SAND, SATURATED
		10.2	SP-SM	4 3 6 8	9	100%	LIGHT BROWN AND GRAY SILTY FINE SAND W/ TRACE CLAY, WET
		19.7	SM	2 5 5 5	10	80%	GRAY SILTY FINE SAND, WET
10		56.3	CL	6 6 15 30	21	90%	LIGHT BROWN AND GRAY VERY FINE SAND W/LITTLE GRAVEL (AT 11.5 FT) AND TRACE CLAY AT 12 FT, MOIST
				8 12 39 50	51	98%	LIGHT BROWN TO TAN SILTY CLAY, MOIST
15				10 8 15 26	23	90%	TAN SILTY CLAY AND LITTLE FINE MATERIAL (GRAVEL) TOWARDS BOTTOM, MOIST
		NA	ML-CL	27 20 14 11	34	100%	LIGHT BROWN AND TAN FINE SAND SILT W/LITTLE TO SOME CLAY (GREENEISH-BROWN) AND LITTLE GRAVEL, MOIST
20				5 7 10 25	17	90%	TAN MEDIUM TO FINE SAND, SOME SILT AND CLAY (GREENISH GREEN); LIME ROCK (YELLOWISH) W/SILT AND SAND TOWARDS BOTTOM
25.25				50			REFUSAL AT 20.25 FT W/50 BLOWS PER FT FOR 3"

TOTAL DEPTH = 20.25 Feet

N-VALUE

GEOSYNTEC CONSULTANTS
TAMPA, FLORIDA

FIGURE NO.	—
PROJECT NO.	FL0819.02
FILE NO.	FL0819.01F002

Relationship among relative density, SPT N value, and internal friction angle of cohesionless soils (after Meyerhof, 1956).

State of Packing	**Relative Density (%)**	**Standard Penetration Resistance, N (blows/300 mm)**	**Friction angle, ϕ' (°)**
Very loose	<20	<4	< 30
Loose	20-40	4-10	30-35
Compact	40-60	10-30	35-40
Dense	60-80	30-50	40-45
Very dense	>80	>50	>45

Note: $N = 15 + (N' - 15) / 2$ for $N' > 15$ in saturated very fine or silty sand, where N' = measured blow count and N = blow count corrected for dynamic pore pressure effects during the SPT.

REFERENCE: MEYERHOFF, G.G., "PENETRATION TESTS AND BEARING CAPACITY OF COHESIONLESS SOILS," JOURNAL OF GEOTECHNICAL ENGINEERING, ASCE, VOL. 82, NO. SM1, 1956.

ATTACHMENT 2

SLIDING STABILITY ANALYSIS

ROTATIONAL FOUNDATION STABILITY ANALYSIS

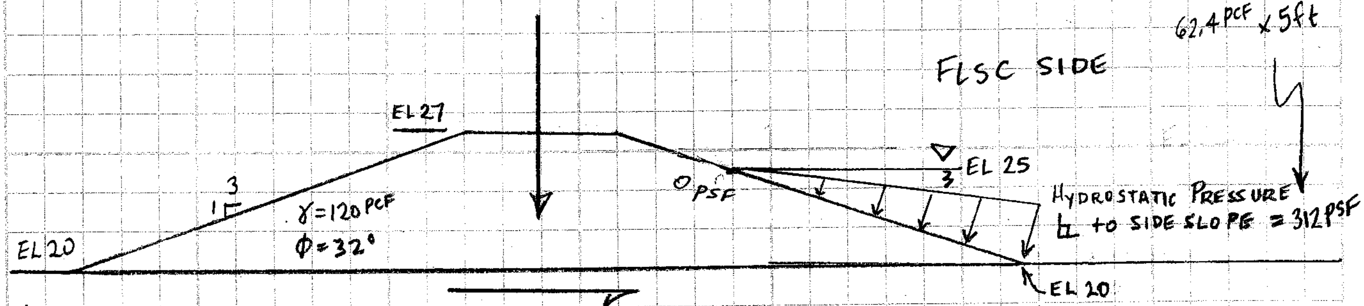
GEOSYNTEC CONSULTANTS Page ____ of ____

Written by: Juan Quiroz Date: 06 / 08 / 29 (YY MM DD) Reviewed by: ________ Date: __/__/__ (YY MM DD)

Client: Sarasota County Project: Flex. Leach. Stor. Cont. Project/Proposal No.: FL0819 Task No.: ________

FLSC PERIMETER BERM SLIDING ANALYSIS

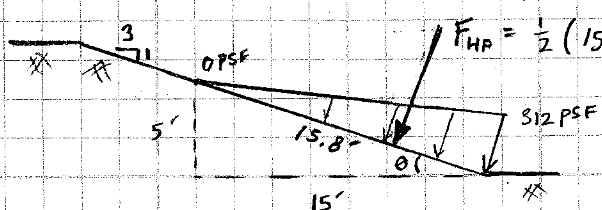
$$N = \Big[\underbrace{2\left(\tfrac{1}{2} \times 7' \times 21'\right)}_{147\,ft^2} + \underbrace{8' \times 7'}_{56\,ft^2}\Big]\,120^{pcf} = 24{,}360\ \#/ft$$



LOOSE FINE SAND AND SILTY SAND $\gamma = 120$ pcf $\phi = 33°$

$$T = N \tan\phi = 24{,}360\ \#/ft \ \tan 32° = 15{,}222\ \#/ft$$

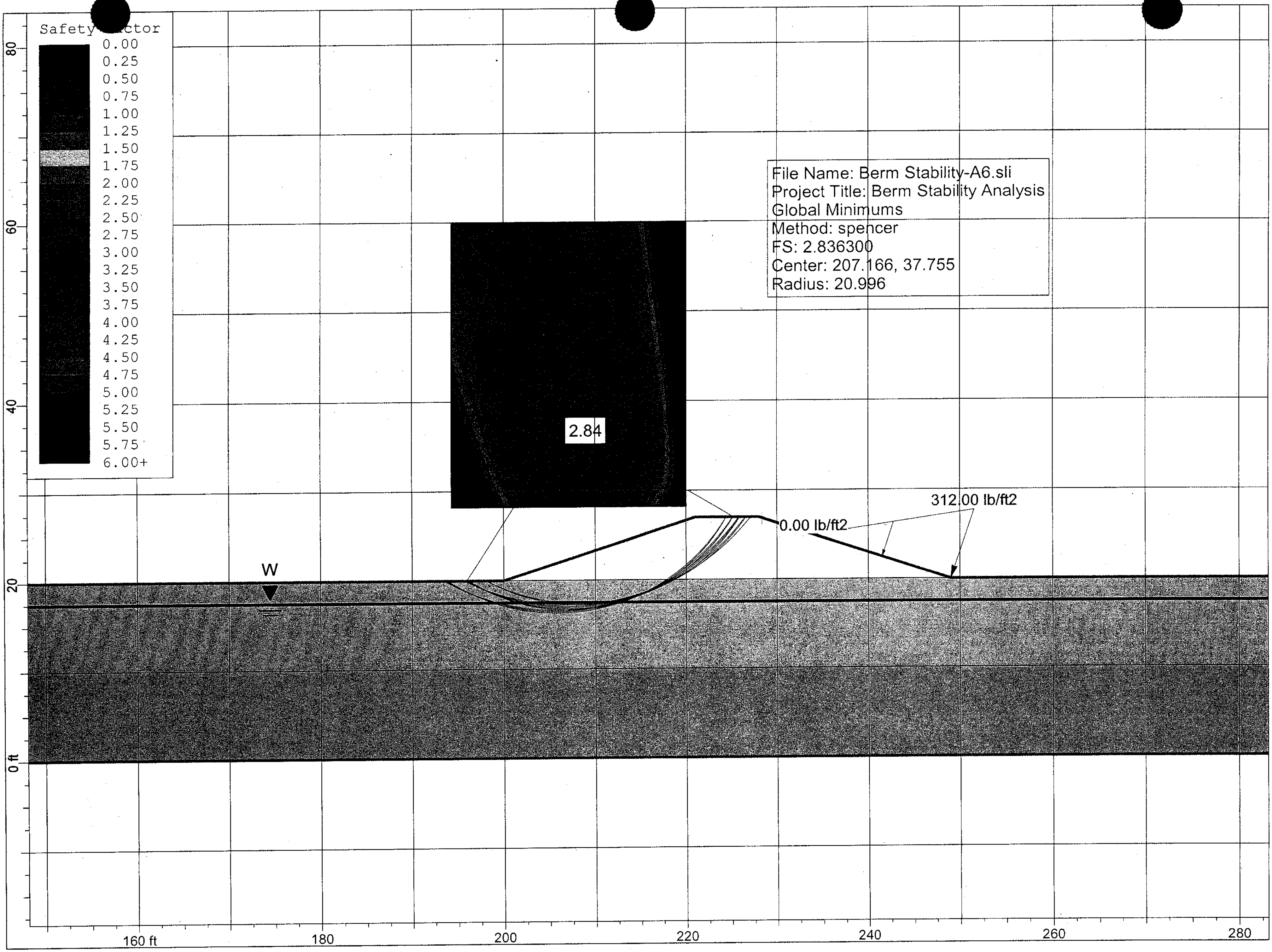
- HORIZONTAL COMPONENT OF HYDROSTATIC PRESSURE APPLIED TO BERM SIDE SLOPE



$$F_{HP} = \tfrac{1}{2}\left(15.8' \times 312\,PSF\right) = 2{,}465\ \#/ft \quad (\perp \text{ to slope})$$

$$F_{HPx} = 2{,}465\ \#/ft \left(\underbrace{\frac{5'}{15.8'}}_{\sin\theta}\right) = 780\ \#/ft$$

- $$FS_{SLIDING} = \frac{T}{F_{HPx}} = \frac{N\tan\phi}{F_{HPx}} = \frac{15{,}222\ \#/ft}{780\ \#/ft} = \underline{\underline{19.5}}$$


Safety Factor
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
4.00
4.25
4.50
4.75
5.00
5.25
5.50
5.75
6.00+
File Name: Berm Stability-A6.sli
Project Title: Berm Stability Analysis
Global Minimums
Method: spencer
FS: 2.836300
Center: 207.166, 37.755
Radius: 20.996
2.84
312.00 lb/ft2
0.00 lb/ft2
W
80
60
40
20
0 ft
160 ft
180
200
220
240
260
280

Slide Analysis Information

Document Name

File Name: Berm Stability-A6.sli

Project Settings

Project Title: Berm Stability Analysis
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius increment: 20
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: 0
Minimum Depth: Not Defined

Loading

1 Distributed Load present:
Distributed Load Triangular Distribution, Orientation: Normal to boundary, Magnitudes 1,2: 312 and 0 lb/ft2

Material Properties

Material: Berm
Strength Type: Mohr-Coulomb

Unit Weight: 115 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Loose Fine Sand & Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 0 psf
Friction Angle: 33 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Med. Dense Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 120 lb/ft3
Cohesion: 0 psf
Friction Angle: 37.5 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: spencer
FS: 2.836300
Center: 207.166, 37.755
Radius: 20.996
Left Slip Surface Endpoint: 195.959, 20.000
Right Slip Surface Endpoint: 225.198, 27.000
Resisting Moment=211828 lb-ft
Driving Moment=74684.6 lb-ft
Resisting Horizontal Force=9262.26 lb
Driving Horizontal Force=3265.61 lb

Valid / Invalid Surfaces

Method: spencer
Number of Valid Surfaces: 8835
Number of Invalid Surfaces: 426
Error Codes:
Error Code -102 reported for 7 surfaces
Error Code -103 reported for 416 surfaces
Error Code -111 reported for 3 surfaces

Error Codes

The following errors were encountered during the computation:

-102 = Two surface / slope intersections,
but resulting arc is actually outside soil region.

-103 = Two surface / slope intersections,
but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

-111 = safety factor equation did not converge

List of All Coordinates

Search Grid

194.332	28.222
220.000	28.222
220.000	60.000
194.332	60.000

Material Boundary

200.000	20.000
249.000	20.000

Material Boundary

0.000	10.000
349.000	10.000

External Boundary

349.000	0.000
349.000	10.000
349.000	20.000
249.000	20.000
228.000	27.000
221.000	27.000
200.000	20.000
0.000	20.000
0.000	10.000
0.000	0.000

Water Table

0.000	17.500
349.000	17.500

Distributed Load

249.000	20.000
234.000	25.000

APPENDIX G

Liner System Leakage and Lateral Drainage Capacity Calculation Package

AGupta
9 NOV 2006

Written by: Juan Quiroz Date: 06/ 11/07 Reveiwed by: Ayushman Gupta Date: ____________
YY MM DD YY MM DD

Client: Sarasota County Project: Flexible Leachate Storage Containers Project/Proposal No.: FL0819 Task No.: 02

LINER SYSTEM LEAKAGE AND LATERAL DRAINAGE CAPACITY EVALUATION FLEXIBLE LEACHATE STORAGE CONTAINERS CENTRAL COUNTY SOLID WASTE DISPOSAL COMPLEX SARASOTA COUNTY SOLID WASTE OPERATIONS SARASOTA COUNTY, FLORIDA

1. INTRODUCTION

The purpose of this calculation package is to present the liner system leakage evaluation associated with the proposed Flexible Leachate Storage Containers (FLSCs) at Central County Solid Waste Disposal Complex (CCSWDC) located in Sarasota County, Florida. Calculations were performed to estimate the rate of leakage through (see Sheet 6 of the Permit Drawings): (i) the bottom of the FLSCs; and (ii) the primary and secondary liner systems. Based on these leakage rates, the conveyance capacity of the primary and secondary leachate collection layers (i.e., geocomposite drainage layers) was also evaluated. Finally, the sump pumps were sized accordingly to prevent head build-up within each (primary and secondary) leachate collection layer corresponding to each FLSC.

The subsequent sections present several aspects of the liner leakage evaluation and include the following items:

- Theory and methodology utilized to evaluate the rate of leakage through the primary and secondary liner systems, and the leachate conveyance capacity of lateral drainage layers;
- Input parameters and assumptions used for the liner leakage analyses including construction quality assurance implications, head of liquid on liner, and size and frequency of geomembrane defects;
- Results of the liner leakage calculations, as well as the conveyance capacity of the primary and secondary leachate collection layers underlying the FLSCs; and
- Sump pump recommendations based on the calculated leakage rates.

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2. LINER LEAKAGE THEORY

2.1 Overview

The rate of leakage through a geomembrane is primarily due to leakage through defects (e.g., holes) [Giroud and Bonaparte, 1989a]. As shown by Giroud and Bonaparte [1989a], leakage due to permeation through geomembranes can be considered negligible for landfills. This section presents equations for: (i) rate of leakage through a defect in a geomembrane underlain by a permeable medium; (ii) rate of leakage through a composite liner system; and (iii) leachate flow in leachate collection layers due to geomembrane defects.

2.2 Rate of Leakage through a Geomembrane underlain by a Permeable Medium

The rate of leakage through a geomembrane is given by the following classical Bernoulli equation for free flow through an orifice:

$$Q_B = 0.15\pi\ d^2\sqrt{2gh} \qquad \text{Equation 1}$$

where: Q_B (m^3/s) = rate of leakage due to a defect in the geomembrane; h (m) = hydraulic head on top of the geomembrane; d (m) = diameter of the geomembrane defect; and g = acceleration of gravity = 9.81 m^2/s.

As shown by Giroud et al. [1997], Equation 1 is valid when the hydraulic conductivity of the medium underlying the geomembrane (k_{UM}) is greater than:

$$k_B = 10^5 d^2 \qquad \text{Equation 2}$$

where: k_B (m/s) = minimum hydraulic conductivity for Equation 1 to be valid; and d (m) = diameter of the geomembrane defect. For example, k_B = 0.4 m/s for a given geomembrane defect diameter of 2 mm.

However for practical purposes, Giroud et al. [1997] further indicated that Bernoulli's equation (Equation 1) provides rates of leakage that are close to the interpolation method (not presented in this calculation package) for hydraulic conductivity values that are greater than k_{UMmin}, which is defined as $k_B/100$. Therefore, the practical limit of Bernoulli's equation (Equation 1) is 100 times smaller than the theoretical limit k_B. Accordingly, k_{UMmin} = 0.004 m/s for a given geomembrane defect diameter of 2 mm.

2.3 Rate of Leakage through a Composite Liner

The leakage rate through a defect in the geomembrane component of a composite liner can be calculated as follows [Giroud, 1997; Giroud et al., 1998]:

$$Q = 0.976\, C_{qo}\, [1 + 0.1(h/t_{UM})^{0.95}]\, d^{0.2}\, h^{0.9}\, k_{UM}^{0.74} \qquad \text{Equation 3}$$

where: Q (m^3/s) = rate of leakage through the composite liner due to defects in the geomembrane; h (m) = hydraulic head on top of the geomembrane; t_{UM} (m) = thickness of the low-permeability medium underlying the geomembrane; d (m) = defect diameter; k_{UM} (m/s) = hydraulic conductivity of the low-permeability medium underlying the geomembrane; and C_{qo} = dimesnionless coefficient that characterizes the quality of contact between the geomembrane and the underlying medium.

For Equation 3 to be valid, the hydraulic conductuvuty of the underlying medium, k_{UM}, should be less than or equal to k_G, where k_G is defined as follows [Giroud et al., 1998]:

$$k_G = \left\{ \frac{0.3891\ d^{1.8}}{\left[C_{qo} \left(1 + 0.1 \left(\frac{h}{t_{UM}} \right)^{0.95} \right) h^{0.4} \right]} \right\}^{1/0.74} \qquad \text{Equation 4}$$

where: k_G (m/s) = maximum or upper bound hydraulic conductivity; h (m) = hydraulic head on top of the geomembrane; d (m) = diameter of the geomembrane defect; t_{UM} (m) = thickness of the low-permeability medium underlying the geomembrane; and C_{qo} = dimensionless coefficient that characterizes the quality of contact between the geomembrane and the underlying medium.

2.4 Lateral Flow in Leachate Collection Layers

Since the number of defects is generally limited, the lateral flow of leachate generally flows only in portions of the leachate (or leakage) collection layer called the wetted zone. In plan view the wetted zone is approximately parabolic as leachate flows in a downslope direction, and the maximum head occurs directly under the defect [Giroud et al., 1997]. Leachate head within the wetted zone varies from one point to another; and head outside the wetted zone is obviously zero.

An average head within the wetted zone can be calculated; however, in this calculation package, the maximum head above the liner was conservatively utilized to estimate the rate of leakage.

Giroud et al. [1997] developed equations for lateral flow through a leachate collection layer for two conditions: (i) when the leachate collection layer is not full (i.e., maximum leachate thickness, t_o, is less than or equal to the thickness of the leachate collection layer, t_{LCL}); and (ii) when the leakage collection layer is full (i.e., t_o is greater than t_{LCL}). Each equation is defined below:

Case 1: $Q = k\ t_o^2$ for $t_o \le t_{LCL}$ Equation 5

Case 2: $Q = k\ t_{LCL}\left(2\ t_o - t_{LCL}\right)$ for $t_o > t_{LCL}$ Equation 6

where: Q (m^3/s) = lateral flow through a leachate collection layer; k (m/s) = hydraulic conductivity of the leachate collection layer; t_o = maximum thickness of the leachate head; and t_{LCL} = thickness of the leachate collection layer.

Equations 5 and 6 were used to evaluate the conveyance capacity of the leachate and leakage collection layers, and calculate the maximum leachate thickness above the liner. For design and analysis purposes, the corresponding maximum leachate head (h_o) above the liner was limited to: (i) 12 inches within the primary leachate collection layer; and (ii) the thickness of the leakage collection layer within the secondary leachate collection system. It is noted that leachate thickness is measured perpendicular to the slope and leachate head is measured vertically from the slope. The following relationship is used to calculate the maximum head above the liner (h_o) [Giroud et al., 1997]:

$h_o = t_o \cos\beta$ Equation 7

where: h_o = maximum leachate head above the liner; t_o = maximum thickness of the leachate head; and β (°) = slope angle of the leachate collection layer.

3. INPUT PARAMETERS AND ASSUMPTIONS

3.1 Overview

The following assumptions were made for the rate of leakage analysis. Justifications for many of these assumptions are given by the USEPA [1987a; 1987b] and Giroud and Bonaparte [1989a].

3.2 Construction Quality

It is assumed that the liner system will be constructed with high quality materials, that good construction practices will be followed, and that a good Construction Quality Assurance (CQA) program will be implemented. The CQA Plan and technical specifications submitted as part of this application package includes manufacturing quality control (MQC) procedures, at the manufacturing plant, to verify that there are no holes or thin spots in the geomembrane. This is followed by field quality assurance (QA) inspections for any holes, thin spots, or defects in any of the geomembrane rolls delivered to the project site.

Leakage rates through composite liners are a function of many parameters, including hydraulic head, size of the considered geomembrane defect, thickness, hydraulic conductivity of the soil layer underlying the geomembrane, and quality of contact between the geomembrane and the underlying soil. As indicated by the USEPA [1987a] and Giroud and Bonaparte (1989b], the latter parameter plays an essential role. Bonaparte et al. [1989] defined the quality of contact between the geomembrane and the underlying soil as follows:

- The *good contact condition* corresponds to a geomembrane installed, with as few wrinkles as possible, on top of a low-permeability soil layer that has been adequately compacted and has a smooth surface. In the case of *good contact*, the dimensionless coefficient that characterizes the quality of contact between the geomembrane and the underlying medium (C_{qo}) is 0.21.
- The *poor contact condition* corresponds to a geomembrane that has been installed with a certain number of wrinkles, and/or placed on a low-permeability soil that has not been well compacted and does not appear smooth. In the case of *poor contact*, the dimensionless coefficient C_{qo} is 1.15.

3.3 Size and Frequency of Geomembrane Defects

The average size and frequency of defects considered in the analysis were assumed as follows:

- *Defect Size*. USEPA [1987a] and Giroud and Bonaparte [1989a] present case-study data which provide information on the size of defects that may occur in geomembranes at properly designed and constructed facilities, with good CQA. Using these data, a defect size of 3.1 mm^2 (0.005 in^2) has been selected to calculate leakage rates. The corresponding diameter for an assumed circular defect area is 2 mm.

- *Defect Frequency.* Based on forensic analyses of the frequency of defects in geomembrane liners [Giroud and Fluet, 1986], a frequency of 1 defect per acre (4,000 m^2) can be practically assumed for liner leakage rate analyses. The FLSC facility is divided into four equal cells. The footprint area of the bottom of each FLSC is approximately 0.15 acres, which corresponds to a total acreage of 0.6 acres. One defect was assumed to exist over the total bottom footprint area of the FLSCs; thus the selected defect frequency was approximately 1.7 defects per acre.

3.4 Head of Liquid on Liners

As shown on Sheet 6 of the Permit Drawings, the design of the FLSC facility for the CCSWDC is such that the maximum head of liquid within the FLSCs is 5 ft (1.52 m). However, the leachate head on the primary geomembrane liner is a function of the rate of leakage through the bottom of the FLSCs as discussed above, see Section 2. Similarly, the leachate head on the secondary liner is a function of the rate of leakage through the primary geomembrane liner.

As previously mentioned, for design and analysis purposes, the maximum leachate head (h_o) above the liner was limited to: (i) 12 inches within the primary leachate collection layer; and (ii) the thickness of the leakage collection layer within the secondary leachate collection system.

4. METHODOLOGY

The following procedure outlines the methodology utilized to evaluate: (i) the rate of leakage through the FLSCs and primary and secondary liners (see Sheet 6 of the Permit Drawings); and (ii) the leachate conveyance capacity of the primary and secondary leachate collection layers.

Step 1: Using Equation 1, calculate the rate of leakage through the bottom of the FLSC which consists of a 60-mil textured high density polyethylene (HDPE) geomembrane underlain by a proposed double-sided drainage geocomposite with a geonet thickness of 200 mils (0.005 m) and an assumed field transmissivity (θ_{field}) of 1.72×10^{-4} m^2/s. The maximum hydraulic head (h) within the FLSC is 1.52 m (= 5 ft).

Step 2: Using Equation 5, calculate leachate flow (Q) through the proposed double-sided drainage geocomposite.

- If Q is greater than or equal to the calculated rate of leakage from Step 1, then the maximum leachate thickness is contained within the thickness of the drainage geocomposite, and Equation 5 is valid.

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- If Q is less than the calculated rate of leakage from Step 1, then the maximum leachate thickness is greater than the thickness of the drainage geocomposite, and Equation 6 is valid.

Step 3: Using the rate of leakage calculated in Step 1 and Equation 5 or 6 as verified from Step 2, calculate the maximum leachate thickness (t_o) above the liner, and convert it to the maximum head above the liner (h_o) using Equation 7 where $\beta = 0.57°$ (= 1% slope). Establish whether the maximum head (h_o) is less than or equal to 12 inches (0.3 m).

Note: Using a factor of safety of 2 based on Narejo and Richardson [2003] and reduction factors presented by Richardson et al. [2000] for geocomposite lateral drainage layers, adjust the assumed field transmissivity (θ_{field}) to establish the required lab transmissivity (θ_{lab}) for manufacturer quality control (MQC) and construction quality assurance (CQA), i.e., material technical specifications. The applied normal stress during transmissivity testing will be 500 psf which is greater than the expected maximum normal stress of 312 psf (5 ft × 62.4 pcf) imposed by the FLSCs when full with liquid. This represents a conservative normal testing stress, since generally, the transmissivity decreases as the applied normal stress increases.

Step 4: Using Equation 1 and the maximum head above the primary geomembrane liner (h_o) obtained in Step 3, calculate the rate of leakage through the primary liner which consists of a 60-mil textured HDPE geomembrane underlain by a proposed double-sided drainage geocomposite with a geonet thickness of 200 mils (0.005 m) and an assumed field transmissivity (θ_{field}) of 1.72×10^{-4} m^2/s.

Step 5: Using Equation 5, calculate leachate flow (Q) through the proposed double-sided drainage geocomposite.

- If Q is greater than or equal to the calculated rate of leakage from Step 4, then the maximum leachate thickness is contained within the thickness of the drainage geocomposite, and Equation 5 is valid.
- If Q is less than the calculated rate of leakage from Step 4, then the maximum leachate thickness is greater than the thickness of the drainage geocomposite, and Equation 6 is valid.

Step 6: Using the rate of leakage calculated in Step 4 and Equation 5 or 6 as verified from Step 5, calculate the maximum leachate thickness (t_o) above the secondary liner, and convert it to the maximum head above the liner (h_o) using Equation 7 where $\beta = 0.57°$ (= 1% slope). Establish whether the maximum head (h_o) is less than or equal to the thickness of the drainage geocomposite (i.e., t_{LCL}).

Step 7: Using Equation 3 and the maximum head above the liner (h_o) obtained in Step 6, calculate the rate of leakage through the secondary composite liner system which consists of a 60-mil textured high density polyethylene (HDPE) geomembrane underlain a geosynthetic clay liner (GCL) with a thickness of 6.35 mm (0.25 inches) and an assumed hydraulic conductivity of 5×10^{-11} m/s.

5. RESULTS

5.1 Overview

The calculations for rate of leakage and leachate conveyance capacity of the primary and secondary (leakage) leachate collection layers are included in Attachment 1. The total FLSC cell floor area is approximately 0.6 acres. The assumed defect diameter was 2 mm and the frequency of defects (holes) was approximately 1.7 defects per acre (i.e., 1 hole per 0.6 acres).

5.2 Rates of Leakage

The calculated rates of leakage through the bottom of the FLSC, primary geomembrane liner and secondary composite liner system are 164 gallons per day (gpd), 20 gpd and 3×10^{-4} gpd, respectively, as presented in Table 1. For leakage through the secondary composite liner system consisting of a geomembrane underlain by a GCL, the total amount of leakage corresponds to about 1.8 cups per year. However, note that theses rates of leakage are based on a constant hydraulic head of 1.52 m (5 ft) within the FLSCs. Since the proposed FLSCs will be used for a limited time period under emergency situations only, the actual leakage quantity will be considerably less than the 1.8 cups per year mentioned above and can be considered a negligible amount for all practical purposes.

5.3 Head on Liner

The calculated maximum head (h_o) above the primary and secondary liners was 0.023 m and 0.005 m, respectively, as presented in Table 1. These head values are less than or equal to the maximum allowable heads that were limited to: (i) 0.3 m (12 inches) for the primary leachate collection layer; and (ii) the thickness of the lateral drainage layer for the secondary leachate (leakage) collection layer.

5.4 Leachate Sump Pump Recommendations

The total volume for the 2-ft deep primary and secondary leachate sump is approximately 132 ft^3 (987 gal) and 99 ft^3 (741 gal), respectively; and as shown on Sheet 6 of the permit Drawings, the sumps will be filled with gravel. Assuming a gravel porosity (volume of voids ÷ total volume) of

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0.4 [Holtz and Kovacs, 1981], the available capacity within each sump is 395 gal and 296 gal, respectively. Based on the calculated leakage rates presented above, it will take approximately 58 hours (2.4 days) and 355 hours (14.8 days) to completely fill the primary and secondary leachate sumps, respectively.

The sumps will be instrumented with leak detection transducers that will activate an alarm light. If a leak is detected in the primary or secondary sump, the accumulated leachate will be pumped back into the FLSC via a simple connection to the incoming leachate transmission line. Pumping of the sumps will be performed on an as needed basis. The proposed sump pump will have a minimum design discharge capacity of approximately 2.8 gpm at 15 ft of head that is capable of emptying the full primary and secondary sumps in approximately 2.4 and 1.8 hrs, respectively. Attachment 2 provides product and technical specifications for a comparable submersible pump.

6. SUMMARY

The following is a summary of the leakage rate and lateral drainage capacity analyses performed for the proposed FLSC facility at CCSWDC located in Sarasota County, Florida, and includes the FLSC sump pump recommendations:

- The leakage rates through the proposed FLSC facility and corresponding primary and secondary liner system are 164 gpd, 20 gpd and 3×10^{-4} gpd, respectively.
- The leakage through the secondary composite liner system (geomembrane underlain by a GCL) corresponds to about 1.8 cups per year. The actual amount will be considerably less since the FLSCs will be used for a limited time under emergency conditions only, and will be negligible for all practical purposes.
- The GCL within the proposed secondary composite liner system will have a maximum hydraulic conductivity of 5×10^{-9} cm/s.
- The calculated maximum head (h_o) above the primary and secondary liners was 0.023 m and 0.005 m, respectively. These head values are less than or equal to the maximum allowable heads that were limited to: (i) 0.3 m (12 inches) for the primary leachate collection layer; and (ii) the thickness of the lateral drainage layer for the secondary leachate (leakage) collection layer.
- The proposed double-sided drainage geocomposite for the primary and secondary leachate collection system will provide adequate conveyance capacity and minimize the heads above the liner. The proposed double-sided drainage geocomposite will

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consist of a 200-mil thick geonet core between needle-punched non-woven 8 oz/sy geotextiles and have a lab transmissivity of 5×10^{-4} m^2/s.

- The FLSC sumps will be instrumented with leak detectors and pumping will be performed on an as needed basis. Any accumulated leachate within the sumps will be pumped back into the respective FLSCs using a simple pump with a minimum design discharge capacity of 2.8 gpm at 15 ft of head.

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YY MM DD YY MM DD

Client: Sarasota County Project: Flexible Leachate Storage Containers Project/Proposal No.: FL0819 Task No.: 02

Richardson, G.N., Giroud, J.P. and Zhao, A., "Design of Lateral Drainage Systems for Landfills," Draft, 2000.

USEPA, "*Background Document: Proposed Liner and Leak Detection Rule*", EPA/530-SW-87-015, Prepared by GeoServices Inc., May 1987a, 526 p.

USEPA, "*Background Document: Bottom Liner Performance in Double-Lined Landfills and Surface Impoundments*", EPA/530-SW-87-013, Prepared by GeoServices Inc., Apr. 1987b, 301 p.

TABLES

Table 1
Rate of Leakage and Head on Liner Summary
Flexible Leachate Storage Containers
Central County Solid Waste Disposal Complex
Sarasota County Solid Waste Operations
Sarasota County, Florida

FLSC System Component	Calculated Rate of Leakage (m^3/s)	Calculated Rate of Leakage (gpd)	Maximum Head on Liner h_o (m)
Bottom of FLSC (Geomembrane)	7.2E-06	164	1.52
Primary Geomembrane Liner	8.9E-07	20	0.023
Secondary Composite Liner	1.3E-11	3.0E-04	0.005

Notes:

1. The rate of leakage calculations are based on a constant hydraulic head of 1.52 m (5 ft) within the FLSCs. Since the proposed FLSCs will be used for a limited time period under emergency situations only, the actual leakage rates will be considerably less than those calculated above.

2. For leakage through the secondary composite liner and a total bottom FLSC facility footprint area of 0.6 acres, the total amount of leakage corresponds to about 1.8 cups per year. The amount of potential leakage will be considerably less since the FLSCs will be used for a limited time period under emergency situations only.

ATTACHMENT 1

Rate of Leakage Calculations
and
Lateral Drainage Capacity Evaluation

Step 1: Rate of Leakage Calculations through Bottom of FLSC
Flexible Leachate Storage Containers
Central County Solid Waste Disposal Complex
Sarasota County Solid Waste Operations
Sarasota County, Florida

Input Parameter	Value	Units
Area of Defect	3.10	mm^2
Diameter of Defect (d)	0.002	m
Leachate Head (h)	1.52	m
θ_{field} = geocomposite transmissivity	1.72E-04	m^2/s
t_{UM} = geocomposite thickness	0.005	m
K_{UM} (= k_{equiv} = θ_{field}/t_{UM})	0.0339	m/s
g (acceleration of gravity)	9.81	m^2/s
k_B	0.39	m/s
K_{UMmin}	0.004	m/s

Leakage Calculations	Values	Units
Q_B	7.19E-06	m^3/s
Q_{Defect}	**7.19E-06**	m^3/s

Steps 2 and 3: Primary Leachate Collection Layer Flow and Head Calculations
Flexible Leachate Storage Containers
Central County Solid Waste Disposal Complex
Sarasota County Solid Waste Operations
Sarasota County, Florida

Input Parameter	Value	Units
Q_{Defect} (Step 1)	7.19E-06	m^3/s
θ_{field}	1.72E-04	m^2/s
t_{LCL}	0.005	m
β	0.573	°
Factor of Safety (FS)	2	
RF_{in}	1.1	
RF_{cc}	1.1	
RF_{bc}	1.2	
$\Pi(RF)*FS$	2.90	

Leachate Flow / Head Calculations	Values	Units
$k_{equiv} = \theta_{field}/t_{LCL}$	3.39E-02	m/s
Q (Equation 3, assuming $t_o = t_{LCL}$)	8.74E-07	m^3/s
$Q > Q_{Defect} \Rightarrow t_o \leq t_{LCL}$	NO	
$Q \leq Q_{Defect} \Rightarrow t_o > t_{LCL}$	Equation 6	
t_o	0.0234	m
h_o	**0.0234**	**m**
$h_o \leq$ 12 inches (= 0.3 m)	YES	
$\theta_{lab}^{(3)} = \theta_{field} * \Pi(RF)*FS$	**5.0E-04**	**m^2/s**

Notes:
1. RF_{in} = reduction factor for elastic deformation or intrucion of the geotextiles into the drainage channel.
   RF_{cc} = reduction factor for chemical clogging or precipitation of chemicals into the drainage core space.
   RF_{bc} = reduction factor for biological clogging in the drainage core space.
   Reduction factors are based on Richardson et al. [2000].
2. Factor of safety is based on Narejo and Richardson [2003].
3. The normal testing stress for θ_{lab} is 500 psf.

Step 4: Rate of Leakage Calculations through the Primary Liner
Flexible Leachate Storage Containers
Central County Solid Waste Disposal Complex
Sarasota County Solid Waste Operations
Sarasota County, Florida

Input Parameter	Value	Units
Area of Defect	3.10	mm^2
Diameter of Defect (d)	0.002	m
Leachate Head (h) (Step 3)	0.0234	m
θ_{field} = geocomposite transmissivity	1.72E-04	m^2/s
t_{UM} = geocomposite thickness	0.005	m
K_{UM} (= k_{equiv} = θ_{field}/t_{UM})	0.0339	m/s
g (acceleration of gravity)	9.81	m^2/s
k_B	0.39	m/s
K_{UMmin}	0.004	m/s

Leakage Calculations	Values	Units
Q_B (1)	8.92E-07	m^3/s
Q_{Defect}	**8.92E-07**	**m^3/s**

Steps 5 and 6: Leakage Collection Layer Flow and Head Calculations
Flexible Leachate Storage Containers
Central County Solid Waste Disposal Complex
Sarasota County Solid Waste Operations
Sarasota County, Florida

Input Parameter	Value	Units
Q_{Defect} (Step 4)	8.92E-07	m^3/s
θ_{field} = geocomposite transmissivity	1.72E-04	m^2/s
t_{LCL} = geocomposite thickness	0.005	m
β	0.573	°
Factor of Safety (FS)	2	
RF_{in}	1.1	
RF_{cc}	1.1	
RF_{bc}	1.2	
Π(RF)*FS	2.90	

Leachate Flow / Head Calculations	Values	Units
$k_{equiv} = \theta_{field}/t_{LCL}$	3.39E-02	m/s
Q (Equation 3, assuming $t_o = t_{LCL}$)	8.74E-07	m^3/s
$Q > Q_{Defect} \Rightarrow t_o \le t_{LCL}$	NO	
$Q \le Q_{Defect} \Rightarrow t_o > t_{LCL}$	Equation 6	
t_o	0.005	m
h_o	**0.005**	**m**
$h_o \le t_{LCL}$	YES	
$\theta_{lab}^{(3)} = \theta_{field} * \Pi(RF)*FS$	**5.0E-04**	**m^2/s**

Notes: 1. RF_{in} = reduction factor for elastic deformation or intrucion of the geotextiles into the drainage channel.
RF_{cc} = reduction factor for chemical clogging or precipitation of chemicals into the drainage core space.
RF_{bc} = reduction factor for biological clogging in the drainage core space.
Reduction factors are based on Richardson et al. [2000].
2. Factor of safety is based on Narejo and Richardson [2003].
3. The normal testing stress for θ_{lab} is 500 psf.

Step 7: Rate of Leakage Calculations through the Secondary Composite Liner
Flexible Leachate Storage Containers
Central County Solid Waste Disposal Complex
Sarasota County Solid Waste Operations
Sarasota County, Florida

Input Parameter	Value	Units
Area of Defect	3.10	mm^2
Diameter of Defect (d)	0.002	m
Leachate Head (h) (Step 6)	0.005	m
t_{UM} = GCL thickness	0.006	m
K_{UM}	5.0E-11	m/s
C_{qo} (good contact)	0.21	

Leakage Calculations	Values	Units
K_G	9.58E-06	m/s
$K_{UM} \leq K_G$	YES	
Q_{Defect}	1.32E-11	m^3/s

ATTACHMENT 2

Typical Submersible Pump Technical Specifications

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Submersible pumps (Single)

- Used and trusted within the groundwater industry for more than 15 years
- Recommended by drillers, hydrologists and field technicians
- High quality at a competitive price
- Practical for dedicated use and disposal
- Cuts labour costs and saves time
- Attach 13 mm (1/2") or 11 mm (3/8") tubing and lower into well
- Connect leads to 12V DC power source and pump is energized

*

Description:	Submersible 881	Submersible 881	Submersible 881
ProductCode:	GP8815	GP8825	GP9216
Voltage:	12V DC	24V DC	12V DC
Recommended Fuse Size:	5 amp automotive	3 amp automotive	8 amp automotive
Hose Connections:	To suit 10 mm or 13 mm ($^3/_8$" or ½") Bore Flexible Hose		
Connection to Quick Connect 15 mm:	Use WX1511 Adaptor and then WX1504		
Materials:	ABS plastic, stainless steel, Nitrile		PC ABS Copolymer + PBT, stainless steel, Nitrile

Model:	Current Draw:	Output Performance (in gals per minute) at Head (in ft)												
		0	5	10	15	20	25	30	35	40	45	50	55	60
GP8815*	1.4-3.1 amp	3.5	3.0	2.3	1.9	1.3	0.7	0.2						
GP9216*	3.0-6.5 amp	4.0	3.6	3.2	2.8	2.6	2.3	2.0	1.8	1.5	1.1	0.9	0.6	0.3

* Pumps attached with 37" of cable
Note. Tests carried out with ½" ID tubing

Submersible	A	B	D	E
881	21 mm	97 mm	118 mm	36 mm
	$^{13}/_{16}$"	3 $^{13}/_{16}$"	4 $^{5}/_{8}$"	1 $^{7}/_{16}$"
921	25 mm	141 mm	166 mm	40 mm
	1"	5 $^{11}/_{16}$"	6 $^{9}/_{16}$"	1 $^{9}/_{16}$"

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APPENDIX H

Technical Specifications

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FLEXIBLE LEACHATE STORAGE CONTAINERS

TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS

SECTION 02100

SURVEYING

PART 1 GENERAL

1.01 SCOPE

A. This section describes the requirements for surveying during construction, production of "as-built" documents, and calculating quantities for payment purposes. Survey work will be required to delineate areas for stripping; perform earthwork for the prepared subgrade; installation of composite liner system and the flexible leachate storage containers; installation of impacted stormwater pipeline and associated structures; and to perform other work, as needed, to complete various construction activities.

1.02 RELATED SECTIONS AND PLANS

A. Section 02110 - Stripping

B. Section 02200 - Earthwork

C. Section 02215 - Trenching and Backfilling

D. Section 02715 - HDPE Pipes and fittings

E. Construction Quality Assurance (CQA) Plan.

1.03 REFERENCES

A. National Geodetic Survey Standards.

1.04 SUBMITTALS

A. Interim surveys performed shall be submitted to the ENGINEER with each payment request to substantiate the quantities claimed.

B. CONTRACTOR will be required to submit survey notes during construction upon request by the ENGINEER.

1.05 PROJECT RECORD DOCUMENTS

A. CONTRACTOR shall maintain on-site, a complete and accurate survey log documenting the survey work performed.

B. CONTRACTOR shall maintain on-site, a plan clearly showing all site reference points, survey control points, and benchmarks.

C. CONTRACTOR shall maintain on-site an accurate and current set of marked-up drawings indicating the as-built conditions.

D. As-built surveys, stamped and signed, by a State of Florida Licensed/Registered Land Surveyor or Professional Engineer shall be submitted immediately following the completion of any applicable construction activity. Complete as-built surveys shall be submitted upon substantial completion of each phase of construction and are a prerequisite for contract closeout.

E. Upon completion of each work item, the CONTRACTOR shall prepare and/or update the as-built drawings.

PART 2 PRODUCTS

2.01 MATERIALS AND SURVEY EQUIPMENT

A. Provide materials and survey equipment as required to properly perform the surveys, including, but not limited to, instruments, tapes, rods, measures, mounts, and tripods, stakes and hubs, nails, ribbons, other reference markers, and all else as required.

B. The survey instruments used for this work shall be precise and accurate to meet the needs of the work described. All survey instruments should be capable of reading to a precision of 0.001 ft and with a setting accuracy of ± 0.8 seconds.

PART 3 EXECUTION

3.01 GENERAL

A. Maintain accurate and complete notes of surveys:
   1. Handwritten survey notes and information shall be written with lead pencil(s) and entered in "write in rain" notebooks. A copy of the numbered, dated, and signed field book pages shall be provided to the ENGINEER upon request for use in checking the work.
   2. Electronic field survey information shall be collected and backup equipment shall be available in the event of equipment malfunction.
      a. Electronic format for printed output of data collector field survey notes shall be compatible with the approved fieldbook notation format.
      b. Electronic format for printed output of data collector field work shall be compatible with the CONTRACTOR's and ENGINEER's computer equipment and software for verifying and checking the work. A copy of the data disk shall be submitted to the ENGINEER upon request.

B. During construction, survey notes shall be retained by the CONTRACTOR and shall be submitted to the ENGINEER for review upon request. Prior to the placement of successive soil layer, the CONTRACTOR shall submit a written statement certifying compliance of the preceding layer thickness and grades to the ENGINEER. Surveys will be required from the CONTRACTOR prior to approval by the ENGINEER for the placement of overlying materials.

C. Conformance check surveys for elevation and for horizontal coordinates shall be to the nearest 0.01 ft and for angles shall be to the nearest 20 seconds.

D. Measurement and payment surveys for elevation and for horizontal distances shall be to the nearest 0.1 ft $\pm$ 0.05 ft.

E. Perform construction layout surveys in advance of scheduled construction activities. At completion of a survey, provide a copy of the field notes, drawings, or sketches to the ENGINEER for review. The CONTRACTOR shall allow the CQA Consultant and/or ENGINEER three calendar days for review. The CONTRACTOR is responsible for rework and/or construction delays caused by survey or staking errors.

F. Set slope stakes in accordance with accepted surveying practices.

G. Set grade stakes required for construction activities as the work progresses. Set fine grade stakes on all items for which the Construction Drawings specify a definite grade line.

H. Upon completion of the work, the CONTRACTOR shall provide the ENGINEER with all original surveying field notes, layouts, computations, and electronic files in standard bound survey notebooks. Electronic file information shall be compatible with the ENGINEER's computer equipment and software as requested.

I. Protect survey control points and replace disturbed survey control points at no additional cost to the OWNER.

3.02 SPECIFIC FIELD REQUIREMENTS

A. Establish temporary control points, as necessary, to support construction activities.

B. Survey Documentation:

1. Record the following information in survey notebooks for each control point established and for all other surveying:
   a. control point designation;
   b. northing and easting in State Plane North American Datum (NAD);
   c. elevation in National Geodetic Vertical Datum (NGVD);
   d. date of establishment;
   e. description and sketch of the control point location; and
   f. a minimum of three reference features that can be seen from the control point.
2. Document survey work in the field notebooks using the format and procedures described below:
   a. title and consecutive number on the front cover;
   b. consecutively numbered pages;
   c. table of contents, indicated by survey task, on the first numbered page;
   d. legend indicating symbols used in survey notes;
   e. names of survey team for each task;
   f. notes on weather and equipment;
   g. date and time on each page to indicate when work was recorded;
   h. notes in a uniform character such that they can be interpreted and used by anyone with survey knowledge; and
   i. description and/or sketches of the survey control used.

C. Preliminary Surveys:
1. Earthwork Staking: Stakes for cut and fill limits shall establish the exterior limits of excavations and berms. The maximum staking interval shall be 50 feet. Stakes shall be prominently noted with description of point, vertical distance to design elevation, and offset distance as applicable.
2. Structures: Stake structure centerlines so that the orientation, position, limits, and foundation elevation(s) are positively identified. Mark stakes to reflect the design elevation and offset distance as applicable.
3. Ditches and Channels: Stake ditches and channels such that the layout remains undisturbed during construction.
4. Pipes and Culverts: Stake pipes and culverts on 50-ft maximum stationing. Place offset stakes beyond excavation limits and material stockpiles. Continuously check invert elevation during placement.

D. Final Surveys:
1. Final topography shall be staked at nominal 50-foot intervals. Additionally, the following points shall be staked and noted as applicable.
   a. Grade breaks.
   b. Mid-point of slopes less than 50 ft.
   c. Points of horizontal curvature and tangency.
   d. Points of stationing equation.
2. Pipes and culverts: Survey alignment and elevations at all changes in direction or grade, at all fittings, and otherwise along the pipe alignment at 50-ft maximum stations.

3.03 SURVEYS FOR MEASUREMENT AND PAYMENT

A. Perform surveys to evaluate quantities of work performed and percent of completed work.

B. Calculate and certify quantities and submit survey results, calculations, and certification to the ENGINEER for review and evaluation.

3.04 SURVEYS FOR CONFORMANCE CHECKS AND AS-BUILT DOCUMENTS

A. Survey the following surfaces to verify the lines and grades achieved during construction:
1. for berms, ditches, drainage swales, roads, trenches, and other earthwork:

a. original grade surface;
b. compacted surface of slopes;
c. top of general fill; and
d. finished grade surface.

2. for the composite liner system and flexible leachate storage containers:
   a. prepared subgrade;
   b. top of drainage layers; and
   c. limit of geomembrane liner.

B. Perform earthwork conformance checks and as-built surveying immediately upon completion of a given installation to verify compliance with the Construction Drawings, facilitate progress, and avoid delaying commencement of the next installation. Provide the following minimum spacing and locations for survey points:
   1. surfaces with gradients less than 10 percent, survey on a square grid spaced not wider than 50 ft;
   2. on slopes greater than 10 percent, a square grid spaced not wider than 50 ft shall be used, but in all cases, a line at the crest, midpoint, and toe of the slope shall be taken;
   3. a line of survey points spaced not more than 50 ft apart shall be taken along any slope break (this will include the inside edge and outside edge of any bench on a slope); and
   4. a line of survey points spaced not more than 50 ft apart and at each end shall be taken at the top of any pipes, culverts, discharge structures, or other appurtenances.

[END OF SECTION]

SECTION 02110

STRIPPING

PART 1 – GENERAL

1.01 SCOPE

A. This section describes the requirements for stripping activities. Stripping will be required prior to earthwork for construction of the flexible leachate storage containers.

1.02 RELATED SECTIONS AND PLANS

A. Section 02100 – Surveying

B. Section 02200 – Earthwork

C. Construction Quality Assurance (CQA) Plan

1.03 COMPLIANCE WITH REGULATIONS

A. It is the sole responsibility of the CONTRACTOR to be completely familiar with and to follow all local, state, and federal regulations pertaining to the work required in this Section.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Stripping operations shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. The CONTRACTOR shall be aware of the activities set forth in the CQA Plan and shall account for these activities in the construction schedule.

C. The CONTRACTOR shall assist CQA personnel in every manner necessary for the proper performance of activities set forth in the CQA Plan.

D. CQA testing or inspections in no manner relieves the CONTRACTOR of the responsibility to perform all work in conformance with to the Construction Drawings and Specifications.

E. If quality control or quality assurance tests indicate work does not meet specified requirements, the CONTRACTOR shall perform the work as directed by the CQA Consultant at no additional cost to the OWNER.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Materials to be stripped include grass, topsoil, and other foreign matter, as needed, to develop the work area and enable construction activities.

B. Vegetative stabilization and erosion control of stripped soil stockpiles shall be as specified in Section 02930.

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the work described in this section, the CONTRACTOR shall become thoroughly familiar with the site, the site conditions, and all portions of the work described in this section.

B. CONTRACTOR shall note that the elevation of groundwater is at or near the existing ground surface for areas covered under this Contract. Some areas may also be inundated with water at the start of construction. CONTRACTOR is responsible for any dewatering required to execute the required work.

C. Inspection:

1. Prior to implementing any of the work in this section, the CONTRACTOR shall carefully inspect and verify that related work required by other sections is complete to the point where the work described in this section may properly commence without adverse impact.
2. If the CONTRACTOR has any concerns regarding the related work required by other Sections, he shall notify the ENGINEER in writing prior to the commencement of operations. Failure to notify the ENGINEER will be construed as CONTRACTOR acceptance of the related work of all other sections.

3.02 SEDIMENT AND EROSION CONTROL

A. Prior to implementing any work described in this section, the CONTRACTOR shall install all sediment and erosion controls in the relevant area(s) of construction.

B. CONTRACTOR is solely responsible for selecting, implementing, and maintaining proper and fully adequate sediment and erosion controls at all times during construction.

3.03 STRIPPING

A. Stripping shall be performed in areas identified in this section or as directed by the ENGINEER. All sediment and erosion controls shall be in place before the start of stripping. Stripping shall include removal of all vegetation, organics, and other deleterious materials as required by the ENGINEER. Stripping depth shall be a minimum of 6 inches.

B. If soil or weather conditions are unsuitable for stripping, as determined by the ENGINEER, the CONTRACTOR shall cease stripping activities until permission to resume work is obtained from the ENGINEER.

C. Equipment and methods of operation shall be selected by the CONTRACTOR to minimize disturbance to the surrounding areas.

D. All stripped material shall be stockpiled in the areas designated by the ENGINEER. Stockpiled material shall be sloped and grassed as required in the Specifications or as directed by the ENGINEER.

3.04 SURVEYING AND CONSTRUCTION TOLERANCES

A. The CONTRACTOR shall retain a Surveyor who shall be responsible for providing survey control for the work. All surveying shall be performed in accordance with Section 02100 of the Specifications.

3.05 PROTECTION OF WORK

A. The CONTRACTOR shall protect all prior work, including all materials and related work of other Sections.

B. In the event of damage, the CONTRACTOR shall immediately make all necessary repairs and replacements necessary, as directed and approved by the ENGINEER, at no additional cost to the OWNER.

[END OF SECTION]

SECTION 02200

EARTHWORK

PART 1 GENERAL

1.01 SCOPE

A. This section includes the requirements for site preparation, excavation, surface water control, excavation dewatering, stockpiling, subgrade preparation, general fill, and earthwork materials. This section also includes the requirements to maintain the prepared subbase surface until the geosynthetics installer has completed construction of the liner system.

1.02 RELATED SECTIONS AND PLANS

A. Section 02100 – Surveying

B. Section 02110 – Stripping

C. Section 02215 – Trenching and Backfilling

D. Section 02290 – Erosion and Sediment Control

E. Section 02930 – Vegetation

F. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

A. Latest version of American Society of Testing and Materials (ASTM) Standards.
   1. ASTM D 698. Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using a 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop.

2. ASTM D 2487 Standard Test Method for Classification of soils for Engineering Purposes.

1.04 SUBMITTALS

A. Within 15 calendar days from Notice to Proceed, submit to the Engineer for review an Earthwork Work Plan. The Earthwork Work Plan shall include, at a minimum:
   1. list of equipment proposed for the construction activities including earthwork and for scope of work specified in Sections 02215, 02230, 02235, and 02240;
   2. construction methods for each construction activity;
   3. dewatering methods and techniques;
   4. coordination of survey requirements for the earthwork;
   5. proposed locations of temporary soil stockpile areas;
   6. coordination of earthwork activities with surface water management and erosion and sediment control measures;
   7. schedule for earthwork activities; and
   8. dust control measures.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. The earthwork will be monitored and tested by the CQA Consultant as required in the CQA Plan.

B. The CQA Consultant will perform soil conformance testing on general fill to establish compliance with this Section. Provide equipment and labor to assist the CQA Consultant in obtaining conformance samples from excavations and stockpiles.

C. The CQA Consultant will perform soil performance testing on the subgrade surface and general fill lifts to evaluate compliance with this Section. The CQA Consultant will indicate any portion of the earthwork that does not meet the requirements of this Section and will delineate the extent of the nonconforming area.

D. The Contractor shall correct all deficiencies and nonconformances identified by the CQA Consultant at no additional cost to the Owner.

E. The Contractor shall be aware of the activities required of the CQA Consultant by the CQA Plan and shall account for these activities in the construction schedule.

1.06 EXISTING CONDITIONS

A. Existing site surface and subsurface conditions, based on available site data, are indicated on the Construction Drawings.

B. Contractor shall verify existing conditions as indicated in Section 02100.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Obtain material for general fill from the borrow sources designated by the Engineer.

B. General fill material shall be free of debris, foreign objects, large rock fragments, organics, and other deleterious materials. General fill material shall classify as SW, SP, SC or SM according to the Unified Soil Classification System (per ASTM D 2487). General fill material having the indicated classification is expected to be available from designated borrow sources. Soils having other classifications are acceptable as general fill, if approved by the Engineer.

C. General fill material used in the top 6-inches of the prepared subgrade shall be free of sharp materials or any materials larger than one-half inch.

2.02 EQUIPMENT

A. Furnish compaction equipment to achieve the required minimum soil dry density within the range of acceptable moisture contents.

B. Furnish hand compaction equipment, such as a walk-behind compactor, hand tampers, or vibratory plate compactor, for compaction in areas inaccessible to large compaction equipment.

C. Furnish water trucks, pressure distributors, or other equipment designed to apply water uniformly and in controlled quantities to variable surface widths for required in-place moisture adjustment, to prevent drying of soil surfaces, and for dust control.

D. Furnish equipment such as excavators, scrapers, compactors, loaders, dozers, earth hauling equipment and all other equipment, as required for earthwork construction.

PART 3 EXECUTION

3.01 GENERAL

A. All general fill material to be compacted shall be at a moisture content that will readily facilitate effective compaction.

3.02 SITE PREPARATION

A. Install construction fence and barricades around open trenches and excavated areas.

B. Install erosion and sediment controls in relevant areas of construction and as required by Section 02290. Maintain the erosion and sediment controls for the duration of the Contract and until the contained areas are vegetated in accordance with Section 02930. Accumulated sediment behind silt fences and from drainage swales and structures shall be removed as required or as directed by the Engineer.

C. Prior to any earthwork activity, perform stripping as indicated on the Construction Drawings and in accordance with Section 02110.

3.03 SURAFCE WATER CONTROL

A. Installation of surface water and erosion controls shall be in accordance with approved Surface Water Management and Erosion Control Plan as specified in Section 02290.

B. Install surface water and erosion controls in and around work areas to control runoff and erosion and to prevent surface water runon into excavations. Perimeter controls may include shallow ditches, berms, or localized regrading.

3.04 EXCAVATION

A. Excavate designated areas to the subgrade elevations or excavation limits indicated on the Construction Drawings. Stockpile excavated material in areas designated by the Construction Manager for use in subsequent construction.

3.05 EXCAVATION DEWATERING

A. Anticipate seepage of groundwater into, and accumulation of surface water runoff in excavations. Manage groundwater and surface water in excavations in accordance with this section.

B. Prevent surface water run-on from adjacent areas from entering the excavation.

C. All fill operations, except hydraulic filling, shall be performed in the dry. Contractor shall expect that groundwater is at or near the existing ground surface and shall be prepared to lower the groundwater in local areas as required to construct sumps and drainage structures. Contractor shall expect that work areas may be inundated with water and be prepared to dewater as required to perform work.

3.06 STOCKPILING

A. Separate stockpiles by material type.

B. Stockpile excavated soils at the areas indicated on the Construction Drawings or as designated by the Engineer.

C. Construct stockpiles no steeper than 3H:1V (horizontal:vertical), grade to drain, seal by tracking perpendicular to the slope contours with a dozer, and dress daily during periods when fill is taken from the stockpile.

D. Silt fence or berms shall be constructed at the base of stockpiles that will not be immediately used.

E. Restore all areas used for stockpiling when stockpiles are removed.

3.07 SUBGRADE PREPARATION

A. Subgrade material shall consist of soil relatively free of debris, foreign objects, organics and other deleterious materials.

B. Compact all subgrade within the limits of flexible leachate storage containers to a minimum 95 percent of the Standard Proctor (ASTM D 698) maximum dry density at a moisture content approved by the Engineer.

C. Perform subgrade proof rolling by driving a loaded dump truck (minimum weight of 10 tons per axle and minimum loaded weight of 20 tons) or other pneumatic-tired vehicle, back and forth across the area to confirm the firmness of subgrade surface. Overlap the passes such that one set of tires on each pass runs between the two sets of tire tracks from the previous pass. Soils shall not exhibit pumping or develop ruts more than two inches in depth. Minor rutting, defined as less than two inches in depth, shall be regarded or covered with general fill to match finish grade.

D. Subgrade for general fill shall be scarified to a depth of 2 inches using equipment identified in this section.

E. Unsuitable soils shall be removed and replaced with general fill to a minimum depth of 2 feet below the proposed subgrade elevation. Suitable soil exhibiting pumping or developing ruts more than two inches in depth will be removed to a minimum depth of 1 foot or dried in place, if feasible. Compact the general fill and liner subbase materials to a minimum 95 percent of standard Proctor (ASTM D 698) maximum dry density at a moisture content approved by the Engineer.

F. In excavations or other areas where water accumulates, implement measures to remove the water in accordance with this section. Maintain the subgrade surface free of standing water and in firm condition to meet proof rolling requirements of this section. Maintain dewatered areas until overlying construction is complete.

G. Manage surface water as described in Section 02290.

3.08 PREPARED SUBGRADE SOILS

A. Use fill that meets the requirements of general fill listed in this Section. Place fill to the limits and grades shown on the Construction Drawings.

B. Place general fill material on surfaces that are free of debris, vegetation, or other deleterious material.

C. Place general fill material in loose lifts with a thickness of 8 inches ± 1 inch. In areas where compaction is to be performed using hand operated equipment, place the fill material in loose lifts with a loose thickness of 4 inches ± 1 inch.

D. Prior to placing a succeeding lift of material over a previously compacted lift, thoroughly scarify the previous lift to a depth of 2 inches by discing, raking, or tracking with a dozer. Moisture condition the preceding lift if not within the acceptable moisture range.

E. The trafficking of scarified surfaces by trucks or other equipment, except compaction equipment, is not permitted.

F. Except as specified in this section, compact general fill in each lift to at least 95 percent of its standard Proctor maximum dry density (ASTM D 698). Compact general fill at moisture content as required to attain the specified density or as approved by the Engineer.

G. Do not place fill during periods of precipitation. Placement may occur during periods of misting or drizzle, but only as authorized by the Engineer.

H. Dust shall be controlled by the application of water to the general fill surfaces.

I. CONTRACTOR shall coordinate the final surface of subbase general fill within the footprint ot the flexible storage containers with the geosynthetics installer. CONTRACTOR is responsible for maintenance of the subbase until acceptance by the geosynthetics installer.

3.09 SURVEY CONTROL

A. Survey limits and elevations of subgrade, excavations, and top of prepared subgrade in accordance with Section 02100.

3.10 TOLERANCES

A. Perform the earthwork construction related to the composite liner system to within ±0.1 ft. of the elevations and within 10 percent of the slopes shown or indicated on the Construction Drawings.

B. Positively draining slopes shall be maintained in all cases.

[END OF SECTION]

SECTION 02215

TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 SCOPE

A. This section describes the requirements for trenching, backfilling, placing, and compacting materials and to perform other work as directed by the ENGINEER.

1.02 RELATED SECTIONS AND PLANS

A. Section 02100 - Surveying

B. Section 02200 - Earthwork

C. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

A. Latest version of American Society for Testing and Materials (ASTM) Standards:
   1. ASTM D 698. Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixture using a 5.5 Pound Rammer and a 12-inch Drop.

B. Standard Specifications for Road and Bridge Construction, Florida Department of Transportation, 2000 Edition (FDOT Specifications).

C. Latest version of Occupational Safety and Health Administration (OSHA) Construction Standards.

1.04 SUBMITTALS

A. Submit a list of equipment for trenching and backfilling to the ENGINEER no less than 15 calendar days prior to construction/installation.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. The trenching and backfilling will be monitored by the CQA Consultant as required in the CQA Plan.

B. The CONTRACTOR shall be aware of the activities required of the CQA Consultant in the CQA Plan and shall account for these activities in the construction schedule.

C. The CONTRACTOR shall correct all deficiencies and non-conformances identified by the CQA Consultant at no additional cost to the OWNER.

1.06 EXISTING CONDITIONS

A. In advance of trenching in an area, verify the accuracy of existing conditions indicated on the Construction Drawings. Immediately notify the ENGINEER in writing of deviations from the existing conditions indicated on the Construction Drawings.

B. The approximate locations of all known underground utilities, above ground utilities, and other structures, if any, are indicated on the Construction Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Embedment material and backfill material shall be obtained from the on-site borrow area and shall meet the material requirements for general fill as specified in Section 02200.

2.02 EQUIPMENT

A. Provide, operate, and maintain all equipment necessary to perform the work described in this section.

PART 3 EXECUTION

3.01 GENERAL

A. In areas of trenching and backfilling, maintain and protect existing underground utilities, above ground utilities, and other structures, if any.

B. Do not damage or disturb, if possible, the existing work/systems that must remain after trenching and backfilling is completed. If damaged or disturbed, these systems shall be restored to the condition existing prior to the trenching and backfilling operations.

3.02 TRENCHING

A. Trench soils for geosynthetics anchor trench and piping to the depths and minimum dimensions indicated on the Construction Drawings. Fill material shall be placed and compacted with a hand tamper so as not to damage the geosynthetics or to displace pipe.

B. Protect and maintain the trench bottom. Remove rock fragments or raveled materials that collect on the trench bottom. Backfill excess excavation with general fill or other approved materials. Excavate any soft subgrade soils encountered at the trench bottom and backfill and compact general fill to subgrade elevation.

C. Dewater trenches and excavations as needed. Perform dewatering in accordance with Section 02200.

D. Stockpile excess material from trenching in accordance with Section 02200.

3.03 BACKFILLING

A. General:
   1. do not backfill with saturated material;
   2. do not backfill over wet or soft subgrade;
   3. do not disturb or damage the installed pipes during backfilling; and
   4. do not use heavy compaction equipment which exerts greater than 5 pounds per square inch ground pressure over pipes that are covered by less than 12 inches of backfill material.

B. Placement of backfill material:
   1. place the first lift of backfill material in a 12-inch loose lift. Place subsequent lifts of trench backfill material in 8-inch ±1-inch loose lifts; and

2. compact each lift to 95 percent of the maximum standard Proctor dry unit weight at a moisture content generally within ±3 percent of the optimum moisture content as determined by ASTM D 698, or as directed by the ENGINEER.

3.04 SURVEY CONTROL

A. Survey the limits of the anchor trench in accordance with Section 02100.

B. Survey the limit and elevations of the top of all pipes at each change in direction and grade and a maximum of every 50-feet in accordance with Section 02100.

3.05 TOLERANCES

A. Install pipes to within ±0.1 ft of the elevations and within 10 percent of the slopes indicated on the Construction Drawings.

[END OF SECTION]

SECTION 02235

GRANULAR DRAINAGE MATERIAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes the requirements for granular drainage material in the primary and secondary leachate detection layers and sumps.

1.02 RELATED SECTIONS AND PLANS

A. Section 02100 - Surveying

B. Section 02720 - Geotextiles

C. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

A. Latest version of American Society for Testing and Materials (ASTM) Standards:
1. ASTM C 136. Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D 448. Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
3. ASTM D 2434. Standard Test Method for Permeability of Granular Soils (Constant Head).
4. ASTM D 3042 Standard Test Method for Insoluble Residue in Carbonate Aggregate

1.04 SUBMITTALS

A. For each source of drainage gravel, submit the following to the Engineer for review not less than 21 calendar days prior to use:
1. source of the material;

2. test results conducted on each material such that the material is fully represented in accordance with ASTM C 136, ASTM D3042 and ASTM D 2434; and
3. a 50-pound representative sample of the material.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the granular drainage material will be monitored by the CQA Consultant as required in the CQA Plan.

B. The CQA Consultant will perform material conformance testing and installation quality control testing on the granular drainage materials as required in the CQA Plan.

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

D. The Contractor shall correct all deficiencies and nonconformances identified by the CQA Consultant at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 MATERIALS

2.02 DRAINAGE GRAVEL

A. Furnish granular drainage gravel consisting of homogeneous crushed or natural stones that is free of materials that, due to their nature or size, are deleterious to the intended use as determined by the Engineer.

B. Granular drainage gravel in the primary and secondary leachate detection sumps shall be rounded natural stone with a gradation (per ASTM C 136) that meets the requirements for a No. 4 stone (per ASTM D 448) and shall have a minimum hydraulic conductivity of 10 cm/sec based on laboratory permeability testing conducted in accordance with the ASTM D 2434.

C. Furnish granular drainage gravel having less than 5 percent loss by weight when tested in accordance with ASTM D 3042.

2.03 EQUIPMENT

A. Furnish, operate, and maintain equipment necessary to transport, place, and spread the granular drainage materials without damage to adjacent geosynthetics.

PART 3 EXECUTION

3.01 MATERIAL PLACEMENT

A. Do not commence placement of the granular drainage material until the CQA Consultant has completed conformance evaluation of the material and evaluation of previous work, including evaluation of the Contractor's survey results for previous work.

B. Place the granular drainage material to the minimum thicknesses and limits indicated on the Construction Drawings.

C. Surround granular drainage material with geosynthetic material as indicated on the Construction Drawings. Care shall be taken to avoid damage to geosynthetics during granular drainage material placement.

3.02 SURVEY CONTROL

A. Survey the limits and elevations of the top of the granular drainage material in accordance with Section 02100.

3.03 TOLERANCES

A. Construct the granular drainage material to the minimum thicknesses indicated on the Construction Drawings.

[END OF SECTION]

SECTION 02290

SEDIMENT AND EROSION CONTROL

PART 1 GENERAL

1.01 SCOPE

A. The CONTRACTOR shall furnish all labor, materials, tools, and incidentals required to install and maintain the temporary sediment and erosion control measures and structures including, but not limited to, silt fence, straw bales, check dams, and sediment traps, throughout the duration of the construction work. The CONTRACTOR shall also be responsible for removing the temporary sediment and erosion control measures and structures after the construction work is completed.

1.02 RELATED SECTIONS AND PLANS

A. Section 02100 – Surveying

B. Section 02110 – Stripping

C. Section 02200 – Earthwork

D. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

A. The Florida Stormwater, Erosion, and Sedimentation Control Inspector's Manual, First Edition, January 1999.

1.04 COMPLIANCE WITH REGULATIONS

A. It is the sole responsibility of the CONTRACTOR to be completely familiar and comply with all local, state, and federal regulations pertaining to the work required in this section.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. Sediment and erosion control activities shall be monitored as outlined in the CQA Plan.

B. The CONTRACTOR shall be aware of the activities set forth in the CQA Plan and shall account for these activities in the construction schedule.

C. The CONTRACTOR shall assist the CQA Consultant in every manner necessary for the proper performance of activities set forth in the CQA Plan.

D. CQA testing or inspections does not relieve the CONTRACTOR of the responsibility to construct all work in conformance with the Construction Drawings and Specifications.

E. If quality control or quality assurance tests indicate work does not meet specified requirements, the CONTRACTOR shall remove, replace, and retest the work at no additional cost to the OWNER.

1.06 SUBMITTALS

A. The CONTRACTOR shall submit samples and manufacturer's product data sheets and recommended methods of installation for the proposed silt fence to the ENGINEER at least 14 days prior to starting installation. The manufacturer's product data sheets shall provide documentation and certification that the silt fence products meet or exceed the requirements specified in Para. 2.01 of this Section.

PART 2 PRODUCTS

2.01 SILT FENCE

A. Furnish silt fence with either woven or nonwoven fabric. Silt fence shall:

1. be woven fabric consisting of slit films of polypropylene treated with ultraviolet light stabilizers or nonwoven fabric consisting of long chain polymeric filaments or polyester yarns;
2. be inert to hydrocarbons and chemicals commonly found in soils;
3. be resistant to mildew, rot, insects, and rodent attack;
4. have fence post of minimum 2" x 2" lumber and with minimum length of 36 inches spaced a maximum distance of 6 ft along fabric; and
5. have minimum fabric width of 36 inches.

2.02 VEGETATION

A. Vegetation shall be as specified in Section 02930 of these Specifications.

PART 3 EXECUTION

3.01 INSTALLATION

A. Silt fence shall be installed in accordance with the manufacturer's recommendations as needed or as directed by the ENGINEER, prior to any construction activities. Minimum fabric burial depth shall be 6 inches or as recommended by the manufacturer, whichever is greater.

B. The exterior slopes of berms and road shoulders disturbed for pipe installation shall be grassed immediately after final grading and shaping.

C. The CONTRACTOR shall use straw bales to contain sediment and water from dewatering operations and promote infiltration. Accumulated sediment shall be removed and stockpiled for reuse in an area designated by the ENGINEER.

3.02 PROTECTION OF WORK

A. The CONTRACTOR shall protect all prior work, including materials and related work of other sections.

B. In the event of damage, the CONTRACTOR shall immediately make all repairs and replacements necessary, as directed and approved by the ENGINEER, at no additional cost to the OWNER.

[END OF SECTION]

SECTION 02715

HIGH DENSITY POLYETHYLENE (HDPE) PIPES AND FITTINGS

PART 1 GENERAL

1.01 SCOPE

A. This section includes requirements for high-density polyethylene (HDPE) pipes and fittings installation and products.

1.02 RELATED SECTIONS AND PLANS

A. Section 02100 - Surveying

B. Section 02215 - Trenching and Backfilling

C. Section 02235 - Granular Drainage Materials

D. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

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

1. ASTM D 638. Test Method for Tensile Properties of Plastics.
2. ASTM D 790. Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
3. ASTM D 1238. Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
4. ASTM D 1248. Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
5. ASTM D 1505. Test Method for Density of Plastics by the Density-Gradient Technique.
6. ASTM D 1603. Standard Test Method for Carbon Black in Olefin Plastics.
7. ASTM D 1693. Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
8. ASTM D 2122. Method for Determining Dimensions of Thermoplastic Pipes and Fittings.

9. ASTM D 2657. Standard Practice for Heat Joining Polyolefin Pipe and Fittings.
10. ASTM D 2837. Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
11. ASTM D 3350. Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
12. ASTM F 714. Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
13. ASTM F 1055. Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.

B. Latest version of the American National Standards Institute (ANSI) standards:
   1. ANSI B16.1. Standard Specifications for Cast-Iron Pipe Flanges and Flange Fittings.

C. Latest version of the American Society of Mechanical Engineers (ASME) standard:
   1. ASME B31.9 Building Services Piping. §937.1 through 937.3

1.04 SUBMITTALS

A. Submit the following to the Engineer for review not less than 30 calendar days prior to first installation of material under this section:
   1. detailed shop drawings of all HDPE pipes, fittings, supports, and other appurtenances;
   2. a list of materials to be furnished;
   3. the names of the suppliers and the proposed dates of delivery of the materials to the site;
   4. detailed procedures to be used for hydrostatic testing of the pipes and fittings;
   5. documentation demonstrating that the manufacturer has adequate quality control procedures to ensure that fabrication of the HDPE pipes and fittings complies with the requirements of this section;
   6. origin (resin supplier's name, resin production plant) and identification (brand name, number) of the polyethylene resin used; and
   7. certification of minimum values and the corresponding test procedures for HDPE material properties listed in Tables 02715-1.

B. Submit at least 30 calendar days prior to installation of any material covered by this section, manufacturer's written certification of compliance with these Specifications for that material.

C. Submit at least 14 calendar days prior to installation, documentation of training and certification of personnel qualified for performing HDPE pipe joining operations.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. The installation of HDPE pipe and fittings shall be monitored by the CQA Consultant as required by the CQA Plan.

B. The CQA Consultant may perform material conformance testing and installation quality assurance evaluations of the HDPE pipe and fittings.

C. The Contractor shall be aware of the activities required of the CQA Consultant by the CQA Plan and shall account for these activities in the installation schedule.

D. The Contractor shall correct all deficiencies and nonconformances identified by the CQA Consultant at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 GENERAL

A. Design and proportion all parts to have adequate strength and stiffness and to be adapted for the purposes shown on the Construction Drawings.

2.02 HDPE COMPOUND

A. Furnish HDPE pipe and fittings manufactured from new HDPE resin conforming to ASTM D 1248 (Type III, Class C Category 5, Grade P34), ASTM D 3350 (minimum cell classification as shown in Table 02715-2), and having a Plastic Pipe Institute (PPI) Rating of PE 3408. Furnish material having minimum certifiable property values listed in Table 02715-1.

2.03 HDPE PIPES AND FITTINGS

A. Unless otherwise shown on the Construction Drawings, furnish HDPE pipe and fittings that have a SDR of 11 and conform to ASTM F 714.

B. Furnish HDPE pipes in standard laying lengths not exceeding 50 feet.

C. Furnish HDPE pipes and fittings that are homogeneous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and are uniform in color, density, melt index, and other physical properties.

D. Furnish HDPE end caps at the end of pipes as shown on the Construction Drawings.

E. Furnish electrofusion couplings meeting the requirements of ASTM F 1055 and as recommended by the electrofusion coupling manufacturer.

F. Perforate pipe by factory drilling at locations shown on the Construction Drawings.

2.04 IDENTIFICATION

A. Continuously indent print on the HDPE pipe, or space at intervals not exceeding 5 feet the following:
   1. name and/or trademark of the HDPE pipe manufacturer;
   2. nominal HDPE pipe size;
   3. standard dimension ratio (e.g., SDR-11);
   4. the letters PE followed by the polyethylene grade per ASTM D 1248, followed by the Hydrostatic Design Stress in 100's of psi (e.g., PE 3408);
   5. Manufacturing Standard Reference (e.g., ASTM F 714); and
   6. a production code from which the date and place of manufacture can be determined.

2.05 EMBEDMENT FILL AND BACKFILL MATERIALS

A. Furnish embedment fill materials in accordance with Section 02215.

B. Furnish trench backfill materials in accordance with Section 02215.

PART 3 EXECUTION

3.01

A. Perform HDPE pipe installation and joining operations with trained and certified personnel.

3.02 HDPE PIPE, FITTINGS, AND APPURTENANCES

A. Deliver HDPE pipe, fittings, and appurtenances to the site at least 10 calendar days prior to the planned installation date.

B. Provide proper handling and storage of the HDPE pipe, fittings, and appurtenances at the site. Protect materials from excessive heat or cold, dirt, moisture, cutting, or other damaging or deleterious conditions. Provide any additional storage procedures required by the Manufacturer.

C. Exercise care when transporting, handling, and placing HDPE pipe and fittings. Use rope, fabric, or nylon slings and straps when handling HDPE pipe. Do not position slings, straps, at butt-fusion joints or at fittings.

D. The maximum allowable depth of cuts, gouges or scratches on the exterior surface of HDPE pipe, fittings, or appurtenances is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. Replace any HDPE pipe and fittings that become gouged, twisted, or crimped. Remove from the work area damaged pipes and fittings.

E. Whenever pipe laying is not actively in progress, close the open ends of all installed pipes using watertight plugs.

F. Perform trenching and backfilling of all installed pipe, fittings, and appurtenances in accordance with Section 02215.

G. Perform testing of all installed pipe, fittings, and appurtenances in accordance with this section.

3.03 HDPE PIPE AND FITTINGS INSTALLATION

A. Carefully examine HDPE pipe and fittings for cracks, damage or defects before installation. Do not use cracked, damaged, or defective material.

B. Inspect the interior of all pipe and fittings and remove any foreign material from the pipe interior before the pipe is moved into final position.

C. Perform field-cutting of pipes, where required, with a machine specifically designed for cutting pipe. Make cuts carefully without damage to pipe, so as to leave a smooth end at right angles to the axis of pipe. Taper cut ends and smooth sharp edges. Flame cutting is not allowed.

D. Do not lay pipe until the CQA Consultant has verified the bedding conditions.

E. Install HDPE pipe and fittings in accordance with the Manufacturer's recommendations and the requirements of this section.

F. Install pipe and fittings to the lines and grades shown on the Construction Drawings.

G. Place and compact embedment fill and trench backfill material as shown on the Construction Drawings and in accordance with Section 02215.

H. Provide all necessary adapters and/or fittings required when connecting different types and sizes of pipe or when connecting pipe made by different manufacturers.

3.04 HDPE PIPE, FITTINGS, AND APPURTENANCES CONNECTIONS

A. Personnel performing joining operations shall demonstrate proficiency to the satisfaction of the CQA Consultant.

B. Weather Conditions for Joining:
1. Do not join HDPE pipes and fittings at ambient temperatures below 40 degrees Fahrenheit (°F) or above 104°F, unless authorized in writing by the Construction Manager. For cold (<40°F) or hot (>104°F) weather joining, use the additional procedures authorized in writing by the Construction Manager.
2. Measure ambient temperatures at fusion machine.
3. Do not join HDPE pipe and fittings during any precipitation, in the presence of heavy fog or dew, or in areas of ponded water.

C. Prior to joining, clean the joint area to be free of moisture, dust, dirt, debris of any kind, and foreign material.

D. Joining equipment shall be approved for the applicable field joining processes. Fusion-welding apparatus shall be an automated device equipped with gauges giving the applicable temperatures and pressures.

E. Join HDPE pipe with thermal butt-fusion joints or electrofusion adapters. Fabricate joints in compliance with ASTM D 2657, ASTM F 1055, the manufacturer's recommendations, and the requirements of this section.

F. Install flanged connections of HDPE pipe and fittings as shown on the Construction Drawings and as follows:
   1. Thermally butt-fuse HDPE flange connection (flange adapter) to HDPE pipe.
   2. Use Type 316 stainless steel lap joint flange. Outside diameter and drillings shall comply with American National Standards Institute (ANSI) B16.1.
   3. Use Type 316 stainless steel flange bolts, nuts and washers that meet the requirements of ANSI B16.1. Lubricate bolt threads prior to attaching nuts. Tighten bolts to a torque of 100 ±5 foot-pounds.

G. Bolt HDPE flange adapter and stainless steel lap joint flanges at the ambient temperature of the surrounding soil to prevent relaxation of the flange bolts and loosening of the joint due to thermal contraction of the polyethylene. Draw bolts up evenly and in line. Retighten bolts 1 and 4 hours after initial tightening.

3.05 FIELD TESTING AND INSPECTION

A. Notify the CQA Consultant a minimum of 24 hours in advance of pipe testing or pipe inspection.

B. HDPE Pipe and Fittings Hydrostatic Testing:
   1. Provide testing apparatus, including pumps, hoses, gauges, taps, plugs, drains, temporary connections, and fittings to perform testing in accordance with this Section.

   2. HDPE Pipe and Fittings Hydrostatic Testing:
      a. Pressure test all installed HDPE solid wall pipe prior to placing fill over the pipes.
      b. Perform tests in the presence of the CQA Consultant and in accordance with the detailed test procedure submitted by the Contractor in accordance with this section.

c. Test HDPE solid wall pipes at 130 psi internal pressure. Test pipes in accordance with ASME B31.9 §937.1 through §937.3.
d. Test pipes at the required internal pressure for a minimum of one hour after the pressure in the pipe has stabilized. The test duration does not include the initial expansion phase after the pipe is first pressurized. The duration of the expansion phase shall be as recommended by the manufacturer.
e. Identify any leaks, remove the water, and make repairs to the pipe.
f. Retest the pipe until acceptance criteria are achieved in accordance with the approved procedures for testing prior to placing backfill over the pipe.
g. Test gauges shall be calibrated within one year of date of test. Calibration shall be traceable to national or industry standards where possible.
h. Acceptance criteria for hydrostatic testing is zero leakage for the stabilized pressure for the minimum duration of the test.

C. HDPE Pipe Inspection
1. Inspect fusion joints for evidence of excess or insufficient bead size, contamination, offset, or any other evidence of inadequate joining. The surface of the HDPE pipe shall be clean at the time of inspection. Wipe or wash the HDPE pipe surface if surface contamination inhibits inspection.
2. Repair any pipe sections where greater than 4 percent pipe diameter deflection from vertical is observed.

D. Defects and Repairs:
1. Repair Procedures:
   a. Repair any portion of the HDPE pipe exhibiting a flaw, or poor quality fusion joint by removing bad joint or pipe section and replacing with a new pipe section.
   b. When making repairs, satisfy the following:
      (1) clean and dry all pipe surfaces immediately prior to repair; and
      (2) only use approved fusion equipment or electrofusion fitting.
2. Repair Verification:
   a. Inspect each repair using the methods described in the this Section. Repair areas that fail the inspection.

3.06 SURVEY CONTROL

A. Survey the top of HDPE pipe at each change in direction or grade and on no greater than 50-foot centers and at all inlets and outlets in accordance with Section 02100.

3.07 TOLERANCES

A. Install all HDPE pipes to within ±0.1 feet of bottom of pipe elevations as indicated on the Construction Drawings.

B. Provide positive slope of gravity lines at all locations to within ±10 percent of the values indicated on the Construction Drawings.

TABLE 02715-1

REQUIRED HDPE PIPE AND FITTINGS PROPERTIES ASTM D 3350 CELL CLASSIFICATION PROPERTIES AND RANGES

Properties	Cell Range	Qualifiers	Units	Specified Values	Test Method
Specific Gravity	3	minimum	N/A	0.94	ASTM D 1505
Melt Flow Index	4 or 5	maximum	g/10 min	<0.15	ASTM D 1238 (Condition E)
Flexural Modulus	5	minimum	lb/in^2	110,000	ASTM D 790
Tensile Strength	4 or 5	minimum	lb/in^2	3,000	ASTM D 638
Environmental Stress Crack	3	minimum	hrs	$F_{20} > 192$	ASTM D 1693
Hydrostatic Design Basis at 73°F	4	minimum	lb/in^2	1,600	ASTM D 2837
UV Stabilizer	C	minimum	% Carbon Black	2	ASTM D 1603

[END OF SECTION]

SECTION 02720

GEOTEXTILES

PART 1 GENERAL

1.01 SCOPE

A. This section includes the requirements for geotextile products and installation.

1.02 RELATED SECTIONS AND PLANS

A. Section 02215 - Trenching and Backfilling

B. Section 02235 - Granular Drainage Materials

C. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

A. Latest version of American Society for Testing and Materials (ASTM) Standards:

1. ASTM D 3786. Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabric-Diaphragm Bursting Strength Test Method.
2. ASTM D 4355. Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water.
3. ASTM D 4491. Standard Test Method for Water Permeability of Geotextiles by Permittivity.
4. ASTM D 4533. Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
5. ASTM D 4632. Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).
6. ASTM D 4751. Standard Test Method for Determining Apparent Opening Size of a Geotextile.
7. ASTM D 4833. Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
8. ASTM D 4873. Standard Guide for Identification, Storage, and Handling of Geotextiles.
9. ASTM D 5261. Standard Test Method for Measuring Mass Per Unit Area of Geotextiles.

B. Federal Standard No. 751a - Stitches, Seams, and Stitching.

1.04 SUBMITTALS

A. Submit the following to the Engineer for review not less than 21 calendar days prior to use.
   1. geotextile Manufacturer and product name;
   2. certification of minimum average roll values and the corresponding test procedures for all geotextile properties listed in Table 02720-1; and
   3. projected geotextile delivery dates.

B. Submit to the Engineer for review at least 14 calendar days prior to geotextile placement, manufacturing quality control certificates for each roll of geotextile as specified in this section.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. The installation of geotextiles will be monitored by the CQA Consultant as required in the CQA Plan.

B. The CQA Consultant will perform material conformance testing of the geotextiles as required in the CQA Plan.

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

D. The Contractor shall correct all deficiencies and nonconformances identified by the CQA Consultant at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 GEOTEXTILE

A. Furnish geotextile products with minimum average roll values (95 percent lower confidence limit) meeting or exceeding the required property values in Tables 02720-1.

B. Furnish geotextiles that are stock products.

C. Furnish geotextiles that are manufactured from first quality polymers, with not more than 20 percent reclaimed polymer used in production.

D. Furnish polymeric threads for stitching that are ultra-violet (UV) light stabilized to at least the same requirements as the geotextile to be sewn. Furnish polyester or polypropylene threads that have a minimum size of 2,000 denier.

2.02 MANUFACTURING QUALITY CONTROL

A. Sample and test the geotextile to demonstrate that the material conforms to the requirements of this section.

B. Perform manufacturing quality control tests to demonstrate that the geotextiles properties conform to the values specified in Table 02720-1. Perform as a minimum, the following manufacturing quality control tests at a minimum frequency of once per 100,000 square feet:

Test	Procedure
Mass per unit area	ASTM D 5261
Grab strength	ASTM D 4632
Tear strength	ASTM D 4533
Puncture strength	ASTM D 4833
Burst strength	ASTM D 3786

C. Perform additional manufacturing quality control tests on the geotextile filter at a minimum frequency of once per 250,000 square feet, to demonstrate that its apparent opening size (ASTM D 4751) and permittivity (ASTM D 4491) conform to the values specified in Table 02720-1.

D. Submit quality control certificates signed by the geotextile manufacturer quality control manager. The certificates shall state that the geotextiles are continuously inspected and are needle-free. The quality control certificates shall also include: lot, batch, and roll number and identification; and results of manufacturing quality control tests including description of test methods used.

E. Do not supply any geotextile roll that does not comply with the manufacturing quality control requirements.

F. If a geotextile sample fails to meet the quality control requirements of this section, sample and test rolls manufactured at the same time or in the same lot as the failing roll. Continue to sample and test the rolls until the extent of the failing rolls are bracketed by passing rolls. Do not supply failing rolls.

2.03 PACKAGING AND LABELING

A. Supply geotextiles in rolls wrapped in relatively impermeable and opaque protective wrapping. Wrapping which becomes torn or damaged shall be repaired with similar materials.

B. Mark or tag geotextile rolls in accordance with ASTM D 4873 with the following information:
   1. manufacturer's name;
   2. product identification;
   3. lot or batch number;
   4. roll number; and
   5. roll dimensions.

C. Geotextile rolls not labeled in accordance with this section or on which labels are illegible upon delivery to the site shall be rejected and replaced at no expense to the Owner.

2.04 TRANSPORTATION

A. Deliver geotextiles to the site at least 14 calendar days prior to the planned deployment date to allow the CQA Consultant adequate time to perform conformance testing on the geotextile samples as described in the CQA Plan.

2.05 HANDLING AND STORAGE

A. Protect geotextiles from sunlight, moisture, excessive heat or cold, puncture, mud, dirt, and dust or other damaging or deleterious conditions. Follow all geotextile manufacturer recommendations for handling and storage.

B. Store geotextile rolls on pallets or other elevated structures. Do not store geotextile rolls directly on the ground.

C. Outdoor storage of geotextile rolls shall not exceed the manufacturer's recommendation or longer than 6 months, whichever is less.

PART 3 EXECUTION

3.01 PLACEMENT

A. Do not commence geotextile installation until the CQA Consultant completes conformance evaluation of the geotextiles and performance evaluation of previous work, including evaluation of Contractor's survey results for previous work.

B. Handle geotextiles so as to ensure they are not damaged in any way.

C. Take necessary precautions to prevent damage to underlying layers including rutting during placement of the geotextiles.

D. After unwrapping the geotextiles from its opaque cover, do not leave them exposed for a period in excess of 30 calendar days.

E. If white colored geotextiles are used, take precautions against "snowblindness" of personnel.

F. Examine the geotextile surface after installation to ensure that no potentially harmful foreign objects are present. Remove any such objects and replace any damaged geotextiles.

3.02 SEAMS AND OVERLAPS

A. Continuously overlap a minimum of 6 inches and sew filter geotextiles (i.e., spot sewing is not allowed) using a "single prayer" seam. Sew seams using Stitch Type 401 as per Federal Standard No. 751a. In lieu of sewing, geotextile filters may be overlapped a minimum of two feet.

B. Do not install horizontal seams on slopes that are steeper than 10 horizontal to 1 vertical. Seams shall be along, not across, the slopes.

C. Overlap separator geotextiles a minimum of 12 inches and ensure that the overlap is maintained.

3.03 REPAIR

A. Repair any holes or tears in the geotextiles using a patch made from the same geotextile material. Extend geotextile patches a minimum of 1 foot beyond the damaged area. Sew geotextile patches into place no closer than 1 inch from any panel edge. Should any tear exceed 50 percent of the width of the roll, remove and replace that roll.

B. Remove any soil or other material that may have penetrated the torn geotextiles.

3.04 PLACEMENT OF SOIL MATERIALS

A. Place soil materials on top of geotextiles in such a manner as to ensure that:
   1. the geotextiles and the underlying materials are not damaged; and
   2. slippage does not occur between the geotextile and the underlying layers during placement.

B. Spread soil on top of the geotextile to cause the soil to cascade over the geotextile rather than be shoved across the geotextile.

C. Place aggregate over geotextile separators as indicated on the Construction Drawings prior to trafficking.

D. Place soil over geotextile filters as indicated on the Construction Drawings prior to trafficking.

TABLE 02720-1

REQUIRED PROPERTY VALUES FOR GEOTEXTILE

PROPERTIES	QUALIFIER	UNITS	SPECIFIED[1] VALUES	TEST METHOD
Type				
nonwoven needlepunched				(-)
Polymer composition	minimum	%	95 polypropylene or polyester by weight	(-)
Mass per unit area	minimum	oz/yd^2	8`	ASTM D 5261
Filter Requirements				
Apparent opening size (O_{95})	maximum	mm	0.21	ASTM D 4751
Permittivity	minimum	sec^{-1}	0.5	ASTM D 4491
Mechanical Requirements				
Grab strength	minimum	lb	180	ASTM D 4632[2]
Tear strength	minimum	lb	75	ASTM D 4533[3]
Puncture strength	minimum	lb	75	ASTM D 4833[4]
Burst strength	minimum	psi	350	ASTM D 3786
Durability				
Ultraviolet Resistance	minimum	%	70	ASTM D 4355

Notes:

(1) All values represent minimum average roll values.
(2) Minimum of values measured in machine and cross machine directions with 1 inch clamp on Constant Rate of Extension (CRE) machine.
(3) Minimum value measured in machine and cross machine direction.
(4) Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.
(5) mm = millimeter
% = percent
oz/yd^2 = ounce per square yard
sec = second
lb = pound
psi = pound per square inch

[END OF SECTION]

SECTION 02740

GEOCOMPOSITE

PART 1 GENERAL

1.01 SCOPE

A. This section includes requirements for geocomposite drainage layer product and installation.

1.02 RELATED SECTIONS AND PLANS

A. Section 02770 – Geomembranes

B. Section 02780 – Geosynthetic Clay Liner

C. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

A. Latest version of American Society for Testing and Materials (ASTM) standards:
1. ASTM D 1505. Standard Test Method for Density of Plastics by the Density-Gradient Technique.
2. ASTM D 1603. Standard Test Method for Carbon Black in Olefin Plastics.
3. ASTM D 1777. Standard Method for Measuring Thickness of Textile Materials.
4. ASTM D 3786. Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabric - Diaphragm Bursting Strength Tester Method.
5. ASTM D 4491. Standard Test Method for Water Permeability of Geotextiles by the Permittivity Method.
6. ASTM D 4533. Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
7. ASTM D 4632. Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).

8. ASTM D 4716. Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
9. ASTM D 4751. Standard Test Method for Determining Apparent Opening Size of a Geotextile.
10. ASTM D 4833. Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
11. ASTM D 5261. Standard Test Method for Measuring Mass Per Unit Area of Geotextiles.
12. ASTM F 904. Standard Test Method for Comparison of Bond Strength or Ply Adhesion of Similar Laminates Made from Flexible Materials.

B. Federal Standard No. 751a - Stitches, Seams, and Stitching.

1.04 SUBMITTALS

A. Submit the following to the Engineer for review at least 21 calendar days prior to use:
   1. geocomposite Manufacturer and product names;
   2. certification of minimum average roll values and the corresponding test procedures for all geocomposite properties listed in Table 02740-1; and
   3. projected geocomposite delivery dates.

A. Submit to the Engineer for review at least 14 calendar days prior to geocomposite placement, manufacturing quality control certificates for each roll of geocomposite as specified in this section.

B. For each proposed geocomposite material, the Contractor shall submit to the Engineer for review at least 14 calendar days prior to transporting the geocomposite to site the results of manufacturing quality control testing and certification that the geocomposite is manufactured to meet the minimum interface shear strength criteria when tested in compliance with requirements of this section.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the geocomposite drainage layers will be monitored by the CQA Consultant as required by the CQA Plan.

B. The CQA Consultant will perform material conformance testing of the geocomposite as required by the CQA Plan.

C. The Contractor shall be aware of the activities required of the CQA Consultant by the CQA Plan and shall account for these activities in the installation schedule.

D. The Contractor shall correct all deficiencies and nonconformances identified by the CQA Consultant at no additional cost to the Owner.

PART 2 PRODUCT

2.01 GEOCOMPOSITE

A. Furnish geocomposite drainage layer materials consisting of a polyethylene geonet core with a needle-punched nonwoven geotextile heat laminated to each side of the geonet core.

B. Furnish geocomposite having properties meeting the required property values shown in Table 02740-1. Required geocomposites properties shall be considered minimum average roll values (95 percent lower confidence limit).

C. Furnish geocomposite that are stock products.

D. In addition to the property values listed in Table 02740-1, the geocomposite shall:
   1. retain their structure during handling, placement, and long-term service; and
   2. be capable of withstanding outdoor exposure for a minimum of 30 days with no measurable deterioration.

E. Furnish polymeric threads for stitching that are ultra-violet (UV) light stabilized to at least the same requirements as the geotextile to be sewn. Furnish polyester or polypropylene threads that have a minimum size of 2,000 denier.

2.02 MANUFACTURING QUALITY CONTROL

A. Sample and test the geotextile and geonet components of the geocomposite to demonstrate that these materials conform to the requirements of this section.

B. Perform manufacturing quality control tests to demonstrate that the geotextile properties conform to the values specified in Table 02740-1. Perform as a minimum, the following manufacturing quality control tests at a minimum frequency of once per 50,000 square feet:

Test	Procedure
Mass per unit area	ASTM D 5261
Grab strength	ASTM D 4632
Tear strength	ASTM D 4533
Puncture strength	ASTM D 4833
Burst strength	ASTM D 3786

C. Perform additional manufacturing quality control tests on the geotextile, at a minimum frequency of once per 50,000 square feet, to demonstrate that its apparent opening size (per ASTM D 4751) and permittivity (per ASTM D 4491) conform to the values specified in Table 02740-1.

D. Perform manufacturing quality control tests to demonstrate that the geonet drainage core properties conform to the values specified in Table 02740-1. Perform as a minimum, the following manufacturing quality control tests at a minimum frequency of once per 50,000 square feet:

Test	Procedure
Polymer density	ASTM D 1505
Carbon black	ASTM D 1603
Thickness	ASTM D 1777

E. Perform additional manufacturing quality control tests, at a minimum frequency of once per 50,000 square feet, to demonstrate that the geocomposite drainage layers conform to the hydraulic transmissivity (per ASTM D 4716) and peel strength (per ASTM F 904) requirements of Table 02740-1.

F. Submit quality control test certificates signed by the geotextile, geonet, and geocomposite manufacturer quality control manager. The quality control certificates shall include:
   1. lot, batch, and roll number and identification; and
   2. results of manufacturing quality control tests including description of test methods used.

G. Do not supply any geocomposite roll that does not comply with the manufacturing quality control requirements.

H. If a geotextile, geonet, or geocomposite sample fails to meet the quality control requirements of this section, sample and test rolls manufactured at the same time or in the same lot as the failing roll. Continue to sample and test the rolls until the extent of the failing rolls are bracketed by passing rolls. Do not supply failing rolls.

2.03 PACKING AND LABELING

A. The geocomposite shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.

B. Geocomposite rolls shall be labeled with the following information.
   1. Fabricator's name;
   2. product identification;
   3. lot or batch number;
   4. roll number; and
   5. roll dimensions.

C. Geocomposite rolls not labeled in accordance with this section or on which labels are illegible upon delivery to the site shall be rejected and replaced with properly labeled rolls at no additional cost to the Owner.

D. If any special handling is required, it shall be so marked on the geotextile component e.g., "This Side Up" or "This Side Against Soil To Be Retained".

2.04 TRANSPORTATION

A. Geocomposite shall be delivered to the site at least 21 days prior to the planned deployment date to allow the CQA Consultant adequate time to perform conformance testing on the geocomposite samples as required by the CQA Plan.

2.05 HANDLING AND STORAGE

A. The Contractor shall be responsible for storage of the geocomposite at the site.

B. Handling and care of the geocomposite prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damage to the materials incurred prior to final acceptance by the Owner.

C. The geocomposite shall be stored off the ground and out of direct sunlight, and shall be protected from excessive heat or cold, mud, dirt, and dust. Any additional storage procedures required by the manufacturer shall be the Contractor's responsibility.

PART 3 EXECUTION

3.01 PLACEMENT

A. The Contractor shall not commence geocomposite installation until the CQA Consultant completes conformance evaluation of the geocomposite and quality assurance evaluation of previous work, including evaluation of Contractor's survey results for previous work.

B. The Contractor shall handle the geocomposite in such a manner as to ensure the geocomposite is not damaged in any way.

C. The Contractor shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.

D. The geocomposite shall only be cut using manufacturer's recommended procedures.

E. In the presence of wind, all geocomposite panels shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

F. Care shall be taken during placement of geocomposite not to entrap dirt or excessive dust in the geocomposite that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. Care shall be exercised when handling sandbags, to prevent rupture or damage of the sandbags.

G. If necessary, the geocomposite shall be positioned by hand after being unrolled over a smooth rub sheet.

H Tools shall not be left on, in, or under the geocomposite.

I. After unwrapping the geocomposite from its opaque cover, the geocomposite shall not be left exposed for a period in excess of 30 days.

J. If white colored geotextile is used in the geocomposite, precautions shall be taken against "snowblindness" of personnel.

3.02 SEAMS AND OVERLAPS

A. The components of the geocomposite (i.e., geotextile, geonet, and geotextile) are not bonded together at the ends and edges of the rolls. Each component will be secured or seamed to the like component of adjoining panels.

B. Geotextile Components:
   1. The bottom layers of geotextile shall be overlapped. The top layers of geotextiles shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped a minimum of 6 inches prior to seaming.
   2. No horizontal seams shall be allowed higher than one-third the slope height on slopes steeper than 10 horizontal to 1 vertical.
   3. Polymeric thread, with chemical resistance properties equal to or exceeding those of the geotextile component, shall be used for all sewing. The seams shall be sewn using Stitch Type 401 per Federal Standard No. 751a. The seam type shall be Federal Standard Type SSN-1.

C. The geonet component of adjacent geocomposite panels shall be overlapped a minimum of 4-inches along the geocomposite panels and 12-inches across end (butt) seams. The geonet component shall be fastened together using nylon or plastic fasteners approved by the Manufacturer. The geonet shall be fastened at a minimum spacing of 10-ft on surfaces 10:1 or flatter, every 5-ft on surfaces steeper than 10:1, and every 1-ft along end (butt) seams.

3.03 REPAIR

A. Any holes or tears in the geocomposite shall be repaired by placing a patch extending 2 ft beyond the edges of the hole or tear. The patch shall be secured by tying fasteners through the bottom geotextile and the geonet of the patch, and through the top geotextile and geonet on the slope. The patch shall be secured every 6 inches with approved tying devices. The top geotextile component of the patch shall be heat sealed to the top geotextile of the geocomposite needing repair. If the hole or tear width across the panel is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geonet shall be joined in accordance with this section.

B. All repairs shall be performed at no additional cost to the Owner.

3.04 PLACEMENT OF SOIL MATERIALS

A. The Contractor shall place all soil materials in such a manner as to ensure that:
1. the geocomposite and underlying geosynthetic materials are not damaged;
2. minimal slippage occurs between the geocomposite and underlying layers; and
3. excess tensile stresses are not produced in the geocomposite.

B. Spread soil on top of the geocomposite from the bottom of slopes upward to cause the soil to cascade over the geocomposite rather than be shoved across the geocomposite.

C. For geocomposite overlying the geomembrane, do not place overlying soil material at ambient temperatures below 40 degrees Fahrenheit (F) or above 104°F, unless authorized in writing by the Engineer. For cold (<40°F) and hot

(>104°F) weather placement operations, use the additional procedures authorized in writing by the Engineer.

D. Do not drive equipment directly on the geocomposite. Only use equipment above a geocomposite overlying a geomembrane that meets the following ground pressure requirements above the geomembrane:

Maximum Allowable Equipment Ground Pressure (pounds per square inch)	Minimum Thickness of Overlying Soil (inches)
<5	12
<10	18
<20	24
>20	36

[END OF SECTION]

SECTION 02770

GEOMEMBRANE

PART 1 GENERAL

1.01 SCOPE

A. The section includes requirements for geomembrane products and installation.

1.02 RELATED SECTIONS AND PLANS

A. Section 02100 - Surveying

B. Section 02200 - Earthwork

C. Section 02215 - Trenching and Backfilling

D. Section 02740 - Geocomposites

E. Section 02780 - Geosynthetic Clay Liner (GCL)

F. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

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

1. ASTM D 638. Standard Test Method for Tensile Properties of Plastics.
2. ASTM D 746. Standard Test Method for Brittleness, Temperature of Plastics and Elastomers by Impact.
3. ASTM D 792. Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
4. ASTM D 1004. Standard Test Method of Initial Tear Resistance of Plastic Film and Sheeting.
5. ASTM D 1204. Standard Plastics Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.

6. ASTM D 1238. Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
7. ASTM D 1505. Standard Test Methods for Density of Plastics by Density-Gradient Technique.
8. ASTM D 1603. Standard Test Method for Carbon Black in Olefin Plastics.
9. ASTM D 1693. Standard Test Method for Environmental Stress Cracking of Ethylene Plastics
10. ASTM D 4437. Standard Test Methods for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Geomembranes.
11. ASTM D 5199. Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
12. ASTM D 5397. Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
13. ASTM D 5596. Recommended Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
14. ASTM D 5994. Standard Test Method for Measuring the Core Thickness of Textured Geomembranes.
15. ASTM D 6392. Standard Test Methods for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
16. ASTM E96-00. Standard Test Methods for Water Vapor Transmission of Materials (Procedure BW).

B. Latest version of the Geosynthetic Research Institute (GRI) test methods:
   1. GRI-GM13 Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

C. Latest version of Federal Test Method Standard (FTMS).
   1. FTMS 101/2065 Federal Test Method Standard for Puncture Resistance and Elongation Test (1/8 Inch Radius Probe Method).

1.04 WARRANTY

A. Furnish a 20-year written warranty against defects in materials. Warranty conditions concerning limits of liability will be evaluated by, and be acceptable to, the Engineer.

1.05 SUBMITTALS

A. Submit the following information to the Engineer for review not less than 45 calendar days prior to geomembrane use.
   1. Geomembrane manufacturer capabilities, including:
      a. daily production capacity available for this Contract; and
      b. manufacturing quality control procedures.
   2. A list of 10 completed facilities for which the manufacturer has supplied a minimum total of 10,000,000 square feet of polyethylene geomembrane. Provide the following information for each facility:
      a. name, location, purpose of facility, and date of installation;
      b. names of owner, project manager, design engineer, and installer; and
      c. thickness and surface area of geomembrane provided.
   3. Origin (resin supplier's name, resin production plant) and identification (brand name, number) of the polyethylene resin used.
   4. Certification of minimum average roll values (95 percent lower confidence limit) for physical, mechanical, and environmental properties and the corresponding test procedures for the geomembrane properties listed in Table 02770-1. Submit values that are specific to the resin used in manufacture.
   5. Certification that welding rod or granules are compatible with the specifications and the resin of the geomembrane furnished for this project
   6. Manufacturer warranty as specified in this section.

B. Submit to the Engineer for review not less than 30 calendar days prior to geomembrane use the following documentation on the resin used to manufacture the geomembranes:
   1. Copies of quality control certificates issued by the resin supplier including the production dates and origin of the resin used to manufacture the geomembrane for this Contract.
   2. Results of tests conducted by the manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the project.
   3. Certification that no reclaimed polymer is added to the resin during the manufacturing of the geomembrane to be used for this project.

C. Submit to the Engineer for review the following documentation on geomembrane roll production at least 14 calendar days prior to transporting any geomembrane to the site.

1. Manufacturing certificates for each shift's production of geomembrane, signed by the manufacturer quality control manager.
2. Certificate shall include:
   a. roll numbers and identification;
   b. sampling procedures; and
   c. results of manufacturer quality control tests, including descriptions of the test methods used (the manufacturer quality control tests to be performed are given in Part 2 of this section).

D. Submit to the Engineer for review the following information from the installer at least 14 calendar days prior to mobilization of the installer to the site.
1. Layout drawings showing the installation layout identifying geomembrane panel configurations, dimensions, details, locations of seams, as well as any variance or additional details which deviate from the Construction Drawings. The layout drawings shall be adequate for use as a construction plan and shall include dimensions, details, etc. The layout drawings, as modified and/or approved by the Engineer, shall become part of the contract.
2. Installation schedule.
3. Copy of installer's letter of approval or license by the manufacturer.
4. Installation capabilities, including:
   a. information on equipment proposed for this project;
   b. average daily production anticipated for this project; and
   c. quality control procedures to include quality control organization.
5. A list of 10 completed facilities for which the installer has installed a minimum of 5,000,000 square feet of polyethylene geomembrane. The following information shall be provided for each facility:
   a. the name and purpose of the facility, its location, and dates of installation;
   b. the names of the owner, project manager, and geomembrane manufacturer;
   c. name and qualifications of the supervisor of the installation crew;
   d. thickness and surface area of installed geomembrane;
   e. type of seaming and type of seaming apparatus used; and
   f. duration of installation.
6. Resumes of the installer superintendent and quality control chief to be assigned to this project, including dates and duration of employment.
7. Resumes of all personnel who will perform seaming operations on this project, including dates and duration of employment.
8. Evidence that the installation crew has the following experience.
   a. The superintendent shall have supervised the installation of a minimum of 2,000,000 square feet of polyethylene geomembrane.

b. At least one seamer shall have experience seaming a minimum of 500,000 square feet of polyethylene geomembrane using the same type of seaming apparatus to be used at this site. Seamers with such experience will be designated "master seamers" and shall provide direct supervision over less experienced seamers.

c. All other seaming personnel shall have seamed at least 100,000 square feet of polyethylene geomembrane using the same type of seaming apparatus to be used at this site. Personnel who have seamed less than 100,000 square feet of seams shall be allowed to seam only under the direct supervision of the master seamer or Superintendent.

E. Submit to the Engineer for review at least 14 days prior to geomembrane placement, a certificate of calibration less than 12 months old for the field tensiometer. Tensiometer shall be calibrated within one year of date of test. Calibration shall be traceable to national or industry recognized standards where possible.

F. Submit subgrade acceptance certificates, signed by the Installer, for each area to be covered by the geomembrane prior to that area being covered by geomembrane.

G. Within 14 calendar days of completion of the geomembrane installation, submit to the Engineer the executed installation warranty as specified in this section.

1.06 CONSTRUCTION QUALITY ASSURANCE

A. The construction of the geomembrane component of the liner system system will be monitored by the CQA Consultant as required in the CQA Plan.

B. The CQA Consultant will perform material conformance testing of geomembrane materials and installation quality assurance testing of the geomembrane liner seams.

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

D. The Contractor shall correct all deficiencies and nonconformances identified by the CQA Consultant at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 RESIN

A. Provide geomembrane manufactured from new, first-quality polyethylene resin. Do not add reclaimed polymer to the resin. The use of polymer recycled during the manufacturing process is permitted if performed with appropriate cleanliness and if the recycled polymer during the manufacturing process does not exceed 2 percent by weight of the total polymer weight.

B. Use high density polyethylene (HDPE) resin for liner system geomembranes having the following properties:
1. Specific Gravity: 0.932 minimum (ASTM D 792 Method A, or ASTM D 1505)
2. Melt Index: 1.0 g/10 min., maximum (ASTM D 1238 Condition E)

2.02 GEOMEMBRANE PROPERTIES

A. Furnish 60-mil HDPE textured geomembranes having properties that comply with the required values shown in Table 02770-1.

B. In addition, furnish geomembrane that:
1. contains a maximum of 1 percent by weight of additives, fillers, or extenders not including carbon black;
2. does not have striations, pinholes, bubbles, blisters, nodules, undispersed raw materials, or any sign of contamination by foreign matter on the surface or in the interior;
3. is free of holes, blisters, modules, undispersed raw materials, or any sign of contamination by foreign matter; and
4. is manufactured in a single layer (thinner layers shall not be welded together to produce the final required thickness).

2.03 MANUFACTURING QUALITY CONTROL

A. Resin:
1. Sample and test resin at a minimum frequency of one test per rail car to demonstrate that the resin complies with the requirements of this section. Perform tests on resin after the addition of additives to the virgin resin. Certify in writing that the resin meets the requirements of this section.
2. Do not use any noncomplying resin.

B. Rolls:
1. Continuously monitor for geomembrane defects during manufacture. Geomembranes shall be subjected to continuous spark testing by the Manufacturer at the factory.

2. Do not supply geomembrane that exhibits any defects.
3. Regularly monitor for geomembrane thickness during manufacture.
4. Do not supply geomembrane that fails to meet the specified thickness.
5. Sample and test the geomembrane, to demonstrate that its properties conform to the values specified in Table 02770-1. Perform the following quality control tests at a minimum of once every 50,000 square feet, with the exception of thickness, which shall be measured for each roll:

Test	Procedure
thickness	ASTM D 5199 (smooth) or ASTM D 5994 (textured)
yield strength	ASTM D 638
yield elongation	ASTM D 638
tensile strength	ASTM D 638
tensile elongation	ASTM D 638
tear resistance	ASTM D 1004
carbon black	ASTM D 1603
carbon black dispersion	ASTM D 5596
specific gravity	ASTM D 792, Method A or ASTM D 1505

6. If a geomembrane sample fails to meet the quality control requirements of this Section, sample and test rolls manufactured, in the same resin batch, or at the same time, as the failing roll. Continue to sample and test the rolls until the extent of the failing rolls are bracketed by passing rolls. Do not supply any failing rolls.
7. The following tests shall be run a minimum of once per every 250,000 square feet. Provide written certification that the geomembrane meets the material requirements as per the following test procedures. Provide written certification that these tests have been performed on geomembrane samples representative of rolls delivered to the site.

Test	Procedure
SP-NCTL	ASTM D 5397

C. Permit the CQA Consultant and/or Engineer to visit the manufacturing plant for project specific visits. If possible, such visits will be prior to, or during, the manufacturing of the geomembrane rolls for this project.

2.04 LABELING

A. Label the geomembrane rolls with the following information.
   1. thickness of the material;
   2. length and width of the roll;
   3. name of Manufacturer;
   4. product identification;
   5. lot number; and
   6. roll number.

B. Geomembrane rolls not labeled in accordance with this Section or on which labels are illegible upon arrival at the site will be rejected and replaced at no additional expense to the Owner.

2.05 TRANSPORTATION, HANDLING AND STORAGE

A. Deliver geomembranes to the site at least 14 calendar days prior to the planned deployment date to allow the CQA Consultant adequate time to perform conformance testing on the geomembrane samples as described in the CQA Plan.

B. Provide proper handling and storage of the geomembrane at the site. Protect the geomembrane from excessive heat or cold, dirt, puncture, cutting, or other damaging or deleterious conditions. Provide any additional storage procedures required by the Manufacturer.

C. Store geomembrane rolls on pallets or other elevated structures. Do not store geomembrane rolls directly on the ground surface. Do not store more than 3 rolls high.

PART 3 EXECUTION

3.01 FAMILIARIZATION

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

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

2. If the Contractor has any concerns regarding the installed work of other sections, the Contractor shall immediately notify the Engineer in writing. Failure to inform the Engineer in writing or continuance of installation of the geomembrane will be construed as the Contractor's acceptance of the related work of all other sections.

3.02 SUBGRADE SURFACE PREPARATION

A. The Contractor shall provide certification in writing that the surface on which the geomembrane will be installed is acceptable. Where a GCL is installed on the subgrade prior to the geomembrane, the Contractor shall inspect the subgrade prior to GCL installation. This certification of acceptance shall be given to the CQA Consultant prior to commencement of geomembrane installation in the area under consideration.

B. Special care shall be taken to maintain the prepared surface.

C. No geomembrane shall be placed onto areas of standing water or hydrated GCL

D. Any damage to the GCL or prepared subgrade caused by installation activities shall be repaired at the Contractor's expense.

3.03 GEOMEMBRANE DEPLOYMENT

A. General:
1. Textured geomembrane is to be used for all liner construction indicated on the Construction drawings.
2. The Contractor shall produce layout drawings prior to geomembrane deployment. These drawings shall indicate the geomembrane configuration, dimensions, details, locations of seams, etc. The layout drawings must be approved by the Engineer prior to the installation of any geomembranes. The layout drawings, as modified and/or approved by the Engineer, shall become part of these specifications.
3. Do not deploy geomembrane until the layout drawings are approved by the Engineer.
4. Do not deploy a geomembrane panel in an area until the CQA Consultant has been provided with a certificate of subgrade acceptance for that area.
5. Do not deploy geomembranes until CQA Consultant completes conformance evaluation of the geomembrane and performance evaluation of previous work, including evaluation of Contractor's survey results for previous work.
6. Deploy each geomembrane panel in accordance with the approved layout drawings.

B. Field Panel Identification:
1. A geomembrane field panel is a roll or a portion of roll cut in the field.

2. Give each field panel an identification code (number or letter-number). This identification code shall be agreed upon by the CQA Consultant and the Installer.

C. Field Panel Placement:
   1. Place each geomembrane panel one at a time and seam each panel immediately after its placement.
   2. Use temporary rub sheets as required to prevent displacement or damage to underlying geosynthetics. High spots in geomembrane-backed geosynthetic clay liners shall be covered by a temporary rub sheets during placement of geomembrane.
   3. Do not place geomembrane panels when the ambient temperature is below 40° Fahrenheit (F), unless authorized in writing by the Engineer. For cold weather (<40°F) deployment, use the additional procedures authorized in writing by the Engineer.
   4. Do not place geomembranes during any precipitation, in the presence of heavy fog or dew, in an area of ponded water, or in the presence of high wind.
   5. Ensure that:
      a. No vehicular traffic drives directly on the geomembrane.
      b. Equipment used does not damage the geomembrane by handling, trafficking, or leakage of hydrocarbons (i.e., fuels).
      c. Personnel working on the geomembrane do not smoke, bring glass onto the geomembrane, or engage in other activities that could damage the geomembrane.
      d. The method used to unroll the panels does not scratch or crimp the geomembrane and does not damage lower geosynthetics or the supporting soil.
      e. The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels). The method used to place the panels results in intimate contact with geosynthetic clay liner. Adjust or repair any area of geomembrane wrinkles where the wrinkle height, measured perpendicular to the slope during the hottest portion of the day, is more than 4 inches.
      f. The method used to place the panels does not cause the panels to lift up or trampoline during the coolest portion of the day.
      g. The geomembrane is anchored or weighted with sandbags, or the equivalent, to prevent damage or uplift from wind. Install sufficient anchoring or weighting to prevent uplift and maintain such system until overlying material is placed.
   6. Replace any field panel or portion thereof that becomes damaged (torn, twisted, or crimped). Remove from the work area damaged panels or portions of damaged panels.

D. Do not install geomembrane between one hour before sunset and one hour after sunrise unless approved by the Engineer.

3.04 FIELD SEAMING

A. Personnel shall be experienced as specified in this section. Do not perform seaming unless a "master seamer" and the CQA Consultant are on-site.

B. Orient seams parallel to the line of maximum slope (i.e., oriented down, not across, the slope). Minimize the number of seams in corners and at odd-shaped geometric locations. No horizontal seam shall be less than 10 feet from the toe of the slope, except where approved by the Engineer. Do not locate seams at an area of potential stress concentration.

C. Weather Conditions for Seaming:
   1. Do not seam geomembrane at ambient temperatures below 40°F or above 104°F, unless authorized in writing by the Engineer. For cold (<40°F) or hot (>104°F) weather seaming, use the additional procedures authorized in writing by the Engineer.
   2. Measure ambient temperatures between 0 to 6 inches above the geomembrane surface.
   3. In all cases the geomembrane seam areas shall be dry and protected from wind.

D. Overlapping and Temporary Bonding:
   1. Sufficiently overlap geomembrane panels for welding and to allow peel tests to be performed on the seam. Any seams that cannot be destructively tested because of insufficient overlap are failing seams.
   2. Control the temperature of the air at the nozzle of heat bonding apparatus such that the geomembrane is not damaged.

E. Seam Preparation:
   1. Prior to seaming, clean the seam area and ensure that area to be bonded is free of moisture, dust, dirt, debris of any kind, and foreign material.
   2. If seam overlap grinding is required, complete the process according to the Manufacturer's instructions or within 60 minutes of the seaming operation. Do not grind to a depth that exceeds ten percent of the geomembrane thickness. Grinding marks shall not appear beyond 0.25 inch of the extrudate after it is placed.
   3. Align seams with the fewest possible number of wrinkles and "fishmouths".

F. General Seaming Requirements:

1. Extend seams to the outside edge of panels to be placed in the anchor trench.
2. If required, place a firm substrate such as a flat board or similar hard surface directly under the seam overlap to achieve proper support.
3. Cut fishmouths or wrinkles at the seam overlaps along the ridge of the wrinkle to achieve a flat overlap. Seam the cut fishmouths or wrinkles and patch any portion where the overlap is less than 6 inches with an oval or round patch of geomembrane that extends a minimum of 6 inches beyond the cut in all directions.
4. Place the electric generator used for power supply to the welding machines outside the area to be lined or mount it on soft tires such that no damage occurs to the geomembrane. Properly ground the electric generator. Place a smooth insulating plate or fabric beneath the hot welding apparatus after use.

G. Seaming Process:
   1. Approved processes for field seaming are extrusion welding and fusion welding. The primary method of welding shall be fusion. Seaming equipment shall not damage the geomembrane. Use only geomembrane Manufacturer-approved equipment.
   2. Extrusion Equipment and Procedures:
      a. Maintain at least one spare operable seaming apparatus on site.
      b. Equip extrusion welding apparatus with gauges giving the temperature in the apparatus and at the nozzle.
      c. Prior to beginning a seam, purge the extruder until all heat-degraded extrudate has been removed from the barrel. Whenever the extruder is stopped, purge the barrel of all heat-degraded extrudate.
   3. Fusion Equipment and Procedures:
      a. Maintain at least one spare operable seaming apparatus on site.
      b. Fusion-welding apparatus shall be automated self-propelled devices equipped with gauges giving the applicable temperatures and pressures.
      c. Fusion-welding apparatus shall produce a double-track seam.
      d. Abrade the edges of cross seams to a smooth incline (top and bottom) prior to extrusion welding.

H. Trial Seams:
   1. Make trial seams on excess pieces of geomembrane to verify that seaming conditions are adequate. Conduct trial seams on the same material to be installed and under similar field conditions as production seams. Conduct trial seaming at the beginning of each seaming period, and at least once each five hours, for each seaming apparatus used that day prior to seaming. Also, each seamer shall make at least one trial seam each day, for each day that seaming is performed by that seamer. Conduct trial seaming under the same conditions as the actual seaming. Prepare

trial seams that are at least 15 feet long by 1 foot wide (after seaming) with the seam centered lengthwise for fusion equipment and at least 3 feet long by 1 foot wide for extrusion equipment. Prepare seam overlap as indicated in the "Overlapping and Temporary Bonding" Article of this Part.

2. Cut four specimens, each 1.0 inch wide, from the trial seam sample. Test two specimens in shear and two in peel, using a field tensiometer. The test specimens shall not fail in the seam. If a specimen fails, repeat the entire operation. If the additional specimen fails, do not accept the seaming apparatus or seamer until the deficiencies are corrected and two consecutive successful trial seams are achieved. A seamer may start production seaming prior to testing of the trial seams. In the event the trial seam fails, all production seams by the seamer are failed seams.

I. Nondestructive Seam Continuity Testing:
   1. Nondestructively test field seams for continuity over their full length. Perform continuity testing as the seaming work progresses, not at the completion of field seaming. Complete any required repairs in accordance with the "Defects and Repairs" Article of this Part. Apply the following procedures:
      a. use vacuum testing for extrusion welds; and
      b. use air pressure testing for double-track fusion seams.
   2. Vacuum Testing:
      a. Use the following equipment:
         i. A vacuum box assembly consisting of a stiff housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.
         ii. A system for applying 5 pound per square inch (psi) gauge suction to the box.
         iii. A bucket of soapy solution and applicator.

      b. Follow these procedures:
         i. Energize the vacuum pump and reduce the tank pressure to 5 ±1 psi gauge.
         ii. Wet an area of the geomembrane seam larger than the vacuum box with the soapy solution.
         iii. Place the box over the wetted area.
         iv. Close the bleed valve and open the vacuum valve.
         v. Ensure that a leak tight seal is created.
         vi. Examine the geomembrane through the viewing window for the presence of soap bubbles for not less than 20 seconds.

vii. If no bubbles appear after 20 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inch overlap, and repeat the process.

viii. Mark all areas where soap bubbles appear with a marker that will not damage the geomembrane and repair in accordance with the "Defects and Repairs" Article of this Part.

3. Air Pressure Testing:
   a. Use the following equipment:
      i. an air pump (manual or motor driven) or air reservoir, equipped with a pressure gauge, capable of generating and sustaining a pressure between 25 and 30 pounds per square inch;
      ii. a rubber hose with fittings and connections; and
      iii. a hollow needle, or other approved pressure feed device..
   b. Follow these procedures:
      i. Seal both ends of the seam to be tested.
      ii. Insert needle, or other approved pressure feed device, into the tunnel created by the fusion weld.
      iii. Insert a protective cushion between the air pump and the geomembrane.
      iv. Energize the air pump to a pressure between 25 and 30 pounds per square inches, close valve, and sustain the pressure for not less than 5 minutes.
      v. If loss of pressure exceeds 3 pounds per square inches, or does not stabilize, locate faulty area and repair in accordance with the "Defects and Repairs" Article of this Part.
      vi. Cut opposite end of air channel from pressure gauge and observe release of pressure to ensure air channel is not blocked.
      vii. Remove needle, or other approved pressure feed device, and seal both ends in accordance with the "Defects and Repairs" Article of this Part.

J. Destructive Testing:
1. Perform destructive seam tests to evaluate seam strength and integrity. Perform destructive testing as the seaming work progresses, not at the completion of field seaming.
2. Sampling and Testing:
   a. Collect destructive test samples at a minimum average frequency of one test location per 200 feet of seam length and at additional locations of suspected nonperformance. The CQA Consultant will select test locations, including locations with evidence of excess geomembrane crystallinity, contamination, offset seams, or any other evidence of inadequate seaming.

b. Cut samples at the locations designated by the CQA Consultant at the time the locations are designated. Number each sample and identify the sample number and location on the panel layout drawing. Immediately repair all holes in the geomembrane resulting from the destructive seam sampling in accordance with the repair procedures described in the "Defects and Repairs" Article of this Part. Test the continuity of the new seams in the repaired areas according to "Nondestructive Seam Continuity Testing" Article of this Part.
c. Cut two strips 1 inch wide and 12 inch long with the seam centered parallel to the width from either side of the sample location. Test the two 1-inch wide strips in the field tensiometer in the peel mode. The CQA Consultant may request an additional test in the shear mode. If these samples pass the field test, prepare a laboratory sample at least 1 foot wide by 3.5 feet long with the seam centered lengthwise. Cut the laboratory sample into three parts and distribute as follows:
   i. one portion 1 foot long to the Installer;
   ii. one portion 1.5 feet long to the CQA Consultant for testing; and
   iii. one portion 1 foot long to the Engineer for archival storage.

3. In the event of failing field or laboratory test results, the Contractor may reconstruct the entire seam between two passing destructive tests; otherwise, the CQA Consultant will identify the extent of the nonconforming area following the procedures given in the CQA Plan. Obtain additional samples for testing as requested by the CQA Consultant.

K. Defects and Repairs:

1. Inspect the geomembrane before and after seaming for evidence of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection. Sweep or wash the geomembrane surface if surface contamination inhibits inspection.
2. Test each suspect location, both in seam and non-seam areas, using the methods described in the "Nondestructive Seam Continuity Testing" Article of this Part. Repair each location that fails nondestructive testing.
3. Cut and reseam wrinkles not conforming with Part 2 of this Section. Test the seams thus produced like any other seam.
4. Repair Procedures:
   a. Repair any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test. Use the most appropriate of the available procedures:
      i. patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter;

ii. abrading and reseaming, used to repair small sections of extruded seams;
iii. spot seaming, used to repair minor, localized flaws;
iv. capping, used to repair long lengths of failed seams;
v. topping, used to repair areas of inadequate seams, which have an exposed edge less than 4 inches in length; and
vi. removing bad seam and replacing with a strip of new material seamed into place (used with long lengths of fusion seams).

b. When making repairs, satisfy the following:
   i. abrade surfaces of the geomembrane that are to be repaired no more than 60 minutes prior to the repair;
   ii. clean and dry all geomembrane surfaces immediately prior to repair;
   iii. only use approved seaming equipment;
   iv. extend patches or caps at least 6 inches beyond the edge of the defect, and round corners of patches to a radius of at least 3 inches; and
   v. cut the geomembrane below large caps to avoid potential for water or gas collection between the two sheets.

5. Repair Verification:
   a. Test each repair using the methods described in the "Nondestructive Seam Continuity Testing" Article of this Part. Repairs that pass the nondestructive test are adequate unless the CQA Consultant elects to also perform destructive tests. Re-repair and retest failed tests.

3.05 ANCHORAGE SYSTEM

A. The anchor trench shall be excavated prior to geomembrane placement to the lines, grades, and configuration indicated on the Construction Drawings.

B. Slightly rounded corners shall be provided in the trench where the geomembrane adjoins the trench to avoid sharp bends in the geomembrane.

C. Temporarily anchor each geomembrane panel in the anchor trench at the crest of the slope as soon as the panel is deployed or positioned.

D. Do not entrap loose soil, sand bags, or other materials between or beneath the geosynthetic layers.

E. Do not backfill the anchor trench until all geosynthetic layers are installed in the anchor trench. Backfill in accordance with the Construction Drawings and Section 02215.

F. Do not damage any geosynthetic layer when backfilling the anchor trench.

3.06 MATERIALS IN CONTACT WITH THE GEOMEMBRANE

A. Take all necessary precautions to prevent damage to the geomembrane during the installation of other components of the liner and final cover system.

B. Do not drive equipment directly on the geomembrane. Only use equipment above the geomembrane that meets the following ground pressure requirements.

Maximum Allowable Equipment Ground Pressure (pounds per square inches)	Minimum Thickness of Overlying Material (inches)
<5	12
<10	18
<20	24
>20	36

3.07 SURVEY CONTROL

A. Survey the installed geomembrane liner and final cover in accordance with Section 02100.

3.08 GEOMEMBRANE ACCEPTANCE

A. The Contractor shall retain all ownership and responsibility for the geomembrane until accepted by the Owner.

B. The geomembrane shall be accepted by the Owner when:
   1. the installation is finished;
   2. all documentation of installation is completed including the CQA Consultant's final report; and
   3. verification of the adequacy of all field seams and repairs, including associated testing, is complete.

3.09 PROTECTION OF WORK

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

B. In the event of damage, the Contractor shall make all repairs and replacements necessary at no additional cost to Owner.

TABLE 02770-1
REQUIRED HDPE GEOMEMBRANE PROPERTIES

Properties	Qualifiers	Units[1]	Specified Values Textured	Test Method
Physical Properties				
Thickness	Nominal Minimum	mils	54	ASTM D 5994 (T)
Specific Gravity	Minimum	N/A	0.94	ASTM D 792 Method A or ASTM D 1505
Carbon Black Content	Range	%	2-3	ASTM D 1603
Carbon Black Dispersion	N/A	none	8 of 10 in Category 1 or 2 and all in Category 1, 2, or 3	ASTM D 5596
Mechanical Properties				
Tensile Properties				
1. Force Per Unit Width at Yield	Minimum	lb/in	130	ASTM D 6693
2. Tensile Strength (force per unit width at break)	Minimum	lb/in	72	ASTM D 6693
3. Elongation at Yield	Minimum	%	12	ASTM D 6693
4. Elongation at Break	Minimum	%	100	ASTM D 6693
Tear Resistance	Minimum	lb	40	ASTM D 1004 Die C Puncture
Puncture Resistance	Minimum	lb	80	ASTM D 4833

TABLE 02770-1 (continued)

Properties	Qualifiers	Units(1)	Specified Values Textured	Test Method
Environmental Properties				
SP-NCTL	Minimum	hrs	200(2)	ASTM D 5397

Notes: 1. % = percent
g = grams
min = minutes
lb/in = pounds per inch
lb = pound
°C = degrees Celsius
hrs = hours

2. Time-to-failure at a tensile stress of 30 percent of the tensile yield strength. For textured geomembrane, test is conducted on smooth geomembrane from the same resin lot (batch) as the textured geomembrane furnished.

TABLE 02770-2

REQUIRED HDPE GEOMEMBRANE SEAM PROPERTIES

Properties	Qualifiers	Units(3)	Specified Values		Test Method
			Smooth	Textured	
Shear Strength(1)					
fusion	Minimum	lb/in	120	120	ASTM D 6392
extrusion	Minimum	lb/in	108	108	ASTM D 6392
Peel Adhesion					
			FTB(2)	FTB(2)	
fusion	Minimum	lb/in	78	78	ASTM D 6392
extrusion	Minimum	lb/in	70	70	ASTM D 6392

Notes:
1. Also called "Bonded Seam Strength". Value is at material yield point and failure shall occur in material outside of seam area.
2. FTB = Film Tear Bond. (Maximum 10 percent seam separation)
3. lb/in = pounds per inch

[END OF SECTION]

SECTION 02780

GEOSYNTHETIC CLAY LINER

PART 1 GENERAL

1.01 SCOPE

A. This section includes the requirements for geosynthetic clay liner (GCL) products and placement.

1.02 RELATED SECTIONS AND PLANS

A. Section 02200 - Earthwork

B. Section 02740 - Geocomposites

C. Section 02770 - Geomembranes

D. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

A. Latest Version American Society of Testing and Materials (ASTM) Standards:

1. ASTM D 638. Standard Test Method for Tensile Properties of Plastics.
2. ASTM D 792. Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
3. ASTM D 1004. Standard Test Method of Initial Tear Resistance of Plastic Film and Sheeting.
4. ASTM D 1238. Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
5. ASTM D 1505. Standard Test Method for Density of Plastics by the Density Gradient Technique.
6. ASTM D 1603. Standard Test Method for Carbon Black in Olefin Plastics.
7. ASTM D 4595. Standard Test Method for Tensile Properties of Geotextiles by Wide-Width Strip Method.
8. ASTM D 4632. Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
9. ASTM D 4643. Determination of Water (Moisture) Content of Soil by Microwave Oven Method

10. ASTM D 4833. Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
11. ASTM D 5596. Standard Test Method for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
12. ASTM D 5887. Standard Test Method for Measurement of Index Flux through Saturated GCL Specimens Using a Flexible Wall Permeameter
13. ASTM D 5890. Standard Test Method for Swell Index of Clay Mineral Component of GCLs.

1.04 SUBMITTALS

A. Submit to the Engineer for review not less than 21 calendar days prior to use the following information regarding the GCL proposed for use.
   1. manufacturer and product name;
   2. evidence that the manufacturer has more than two years of experience in the manufacturing of GCL;
   3. manufacturer's quality control procedures;
   4. manufacturer's requirements for any geotextile component of the GCL to include a minimum, mass per unit area, grab strength, and grab elongation are to be required;
   5. certification that manufacturer's requirements for geotextile component of GCL are met;
   6. certification of minimum average roll values (95 percent lower confidence limit) and the corresponding test procedures for all GCL properties listed in Table 02780-1; and
   7. manufacturer's recommended procedures for overlapping adjacent GCL panels.

B. Submit to the Engineer for review at least 14 days prior to GCL placement manufacturing quality control certificates for each roll of GCL as specified in this section. Submit certificates signed by the manufacturer quality control manager. The quality control certificates shall include:
   1. lot, batch, or roll numbers and identification;
   2. sampling procedures; and
   3. results of Manufacturer quality control tests.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the GCLs will be monitored by the CQA Consultant as required by the CQA Plan.

B. The CQA Consultant will perform material conformance testing of the GCLs.

C. The Contractor shall be aware of the activities required of the CQA Consultant by the CQA Plan and shall account for these activities in the installation schedule.

D. The Contractor shall correct all deficiencies and nonconformances identified by the CQA Consultant and shall do so at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 GCL

A. Furnish GCL with bentonite core and nonwoven geotextile and/or woven geotextile backings.

B. Furnish GCL having properties that comply with the required values shown in Table 02780-1.

C. GCL consisting of a bentonite core with woven and/or nonwoven geotextile backings shall meet the following requirements:

1. Hydraulic conductivity is equal to or less than 5×10^{-9} centimeters per second, when measured in a flexible wall permeameter in accordance with ASTM D 5887 under an effective confining stress of 5 pounds per square inch.
2. Minimum roll width is 15 feet.
3. Minimum roll length is 100 feet.
4. Bentonite component is at least 90 percent sodium montmorillonite.
5. Bentonite component is applied at a minimum rate of 0.75 pounds per square foot, when measured at a water content of less than or equal to 25 percent.
6. Geotextile backings are woven and nonwoven materials, respectively, manufactured with polypropylene or polyester material, and conforming to the minimum property values shown in Table 02780-1.
7. Needlepunching is used to bind geotextile backings and bentonite core.
8. Bentonite is contained by the geotextiles in a manner that prevents more than nominal dislodgment of bentonite during GCL transportation, handling, and installation.

2.02 MANUFACTURING QUALITY CONTROL

A. Sample and test the GCL to demonstrate that the material complies with the requirements of this section.

B. Perform manufacturing quality control tests to demonstrate that GCL properties conform to the stated requirements. Perform the following tests at a minimum frequency of once per 50,000 square feet.

Test	Procedure
bentonite content	ASTM D 5261
bentonite moisture content	ASTM D 4643
bentonite free swell	ASTM D 5890
hydraulic conductivity	ASTM D 5887
peel	ASTM D 4632

C. Comply with the certification and submittal requirements of this section.

D. If a GCL sample fails to meet the quality control requirements of this section, sample and test rolls fabricated at the same time and in the same lot as the failing roll. Continue to sample and test the rolls until the extent of the failing rolls are bracketed by passing rolls. Do not supply any failing rolls.

2.03 PACKING AND SHIPPING

A. Supply GCL in rolls wrapped in impermeable and opaque protective covers.

B. Mark or tag GCL rolls with the following information:
   1. manufacturer's name;
   2. product identification;
   3. lot number;
   4. roll number;
   5. roll weight; and
   6. roll dimensions.

C. GCL rolls not labeled in accordance with this section or on which labels are illegible upon delivery to the project site will be rejected and replaced at no additional expense to the Owner.

D. Deliver the GCL to the site at least 14 calendar days prior to the scheduled installation date to allow the CQA Consultant to obtain conformance samples and complete conformance testing as described in the CQA Plan.

2.04 HANDLING AND STORAGE

A. Handle, store, and care for the GCL in a manner that does not cause hydration or damage.

B. Protect the GCL from moisture, excessive heat or cold, puncture, or other damaging or deleterious conditions. Store the GCL rolls on pallets or other elevated structures. Do not store GCL rolls directly on the ground surface. Cover the GCL entirely with a tarp. Store GCL rolls out of direct sunlight. Follow any additional storage procedures required by the Manufacturer.

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. Provide certification in writing that the surface on which the GCL will be installed is acceptable as described below. Give this certification of acceptance to the CQA Consultant prior to commencement of GCL installation in the area under consideration.

B. Maintain the prepared soil surface until the GCL is placed. The subgrade should be rolled with a smooth-drum compactor to remove any wheel ruts, footprints, or other abrupt grade changes before placement of the GCL.

C. Do not place the GCL onto an area that has been softened by precipitation or that has cracked due to desiccation. Repair such areas in accordance with Section 02200 or Section 02225.

3.02 PLACEMENT

A. Do not commence GCL placement until the CQA Consultant completes conformance evaluation of this material and performance evaluation of previous work, including Contractor's survey results for previous work.

B. Weight GCL with sandbags or other means to prevent uplift or movement in wind. Immediately remove and replace any damaged or leaking sandbags.

C. Cut the GCL using a utility blade. Do not damage underlying material during cutting and fully repair any such damage.

D. Do not entrap stones or other foreign objects under the GCL. Do not drag equipment across the exposed GCL.

E. Replace any GCL that is damaged by any means including foreign objects, or installation activities.

F. Install GCLs in accordance with Manufacturer's recommendation (i.e., typically geotextile on the outside of the roll facing down).

G. Do not install the GCL on a wet subgrade or in standing water. Prevent hydration of the bentonite core prior to completion of construction of the liner system.

H. Do not install the GCL during precipitation or other conditions that may cause hydration of the GCL.

I. Install the overlying geomembrane as soon as possible following GCL installation. Cover all GCL that is placed during a workday with overlying geomembrane. Cover and protect the edges of GCL from hydration due to storm water run-on.

J. Remove and replace GCL that becomes hydrated. Hydration is defined by a moisture content of 40 percent or greater when measured in accordance with ASTM D 4643.

K. Place earthen and other geosynthetics material components of the liner system over the GCL as soon after installation of the GCL as possible, but in no case longer than 7 days after the first GCL is placed.

3.03 OVERLAPS

A. On slopes steeper than 5 horizontal to 1 vertical, install GCLs continuously down the slope; that is, allow no horizontal seams on the slope.

B. Allow no horizontal seams on the base of the landfill within 5 feet of the toe of a slope.

C. Overlap GCL in strict accordance with the Manufacturer's recommended procedures. As a minimum, overlap adjacent panels at least 6 inches along the sides and 12 inches along the ends.

3.04 MATERIALS IN CONTACT WITH THE GCL

A. Perform installation of other components in a manner that prevents damage to the GCL.

B. Do not drive equipment directly on the GCL.

C. Install the GCL in appurtenant areas, and connect the GCL to appurtenances as indicated on the Construction Drawings. Do not damage the GCL while working around the appurtenances.

3.05 REPAIR

A. Repair any holes or tears in the GCL by placing a GCL patch over or under the hole. On slopes greater than 5 percent, the patch shall overlap the edges of the hole or tear by a minimum of 2 feet in all directions. On slopes 5 percent or flatter, the patch shall overlap the edges of the hole or tear by a minimum of 1 foot in all directions. Secure the patch with a water-based adhesive approved by the Manufacturer.

B. Remove any soil or other material that may have penetrated the torn GCL.

C. Do not nail or staple the patch.

TABLE 02780-1

REQUIRED GCL PROPERTY VALUES

PROPERTIES	QUALIFIERS	UNITS(6)	SPECIFIED(1) VALUES	TEST METHOD
GCL Properties				
Bentonite Content(2) (GCL)	Minimum	lb/ft^2	0.75	ASTM D 5261 or ASTM D 5993
Bentonite Moisture Content	Maximum	%	25	ASTM D 4643
Bentonite Free Swell	Minimum	ml/2g	24	ASTM D 5890
Hydraulic Conductivity(5)	Minimum	cm/s	5×10^{-9}	ASTM D 5887 or ASTM D 5084
Grab Strength(3)	Minimum	lb	150	ASTM D 4632
Peel Strength(3)	Minimum	lb	15	ASTM D 4632
Geotextile Properties				
Polymer Composition	Minimum	%	95 polyester or polypropylene	

Notes:
1. All values represent minimum average roll values.
2. Measured at a moisture content not exceeding 25 percent.
3. For geotextile backed GCLs.
4. lb/ft^2 = pounds per square foot
   cm/s = centimeter per second
   % = percent
   lb = pound
   lb/in = pounds per inch
   ml/2g = milliliters per two grams
5. The GCL test specimen shall be hydrated with the fluid which is expected to cause hydration in the field, or similar fluid, for a minimum of 48 hours using sufficient backpressure to achieve a minimum B coefficient of 0.9 and using a confined effective consolidation stress not exceeding five pounds per square inch. Then, the hydraulic conductivity test on the GCL specimen shall be conducted, using the appropriate permeant fluid, at a confined effective consolidation stress not exceeding five pounds per square inch. The hydraulic conductivity test shall continue until steady state conditions are reached or a minimum of two pore volumes of permeant fluid have passed through the test specimen. The permeant fluid shall be tap water.

[END OF SECTION]

SECTION 02930

VEGETATION

PART 1 GENERAL

1.01 SCOPE

A. This section includes the requirements for sodding, seeding, liming, fertilizing, and maintaining vegetation until established and accepted. Areas to be sodded include: i) 3:1 perimeter berm slopes; ii) slopes at entrance to the flexible leachate storage containers; and iii) any other disturbed area as directed by the Engineer.

1.02 RELATED SECTIONS AND PLANS

A. Section 02100 - Surveying

B. Section 02200 - Earthwork

C. Construction Quality Assurance (CQA) Plan

1.03 REFERENCES

A. Standard Specifications for Road and Bridge Construction (SSRBC), Florida Department of Transportation, 2001 Edition (FDOT Specifications).

1.04 SUBMITTALS

A. Submit the following to the Engineer not less than 30 calendar days prior to use for review:
1. proposed type and source of sod and seed; and
2. manufacturer's product data for commercial fertilizer and lime and the recommended methods of application.

B. Submit a plan for handling and storage of materials to prevent damage by moisture, heat, or exposure. Include all recommendations of manufacturers and suppliers.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sod shall be live, thriving, and meet the requirements of Florida Department of Agriculture and Consumer Services.

B. Seeds shall be live seed and meet the requirements of Florida Department of Agriculture and Consumer Services.

C. The seed shall be have been harvested from the previous years crop.

D. All seed bags shall have a label attached stating the date of harvest, LOT number, percent purity, percent germination, noxious weed certification, and date of test

E. Use fertilizer that is dry or liquid commercial grade fertilizer uniform in composition that meets the requirements of all State and Federal regulations and standards of the Association of Agricultural Chemists. Deliver fertilizer to the site in original, properly labeled, unopened, clean, containers each showing the manufacturer's guaranteed analysis conforming to applicable fertilizer regulations and standards. Use fertilizer that is 16-4-8 or as modified by the Engineer based on testing of the topsoil by the CQA Consultant. Apply fertilizer to all sodded areas.

F. Use lime that is agricultural ground limestone with a minimum total neutralizing power of 90 percent. The lime shall have a gradation of at least 40 percent passing the U.S. Standard Number 100 sieve, and at 95 percent passing the U.S. Standard Number 8 sieve.

PART 3 EXECUTION

3.01 PLANTING AND APPLICATION OF FERTILIZER

A. Do not commence vegetation until the Engineer reviews the results of soil analyses.

B. Notify the Engineer 24 hours prior to laying sod, seeding, or fertilizing.

C. The seed and fertilizer shall be placed by hydro seeding, or other method approved by the Engineer.

D. The underlying soil layer should be graded to the lines and limits as indicated on the Construction Drawings. The soil layer surface shall be scarified and damp immediately prior to the seed or sod placement.

E. Repair all gullies, washes, or disturbed areas that develop subsequent to final dressing of the prepared surface.

F. Seeded areas shall be watered after germination as necessary until the vegetation is well established.

G. Apply fertilizer and lime to all areas where sod is placed unless otherwise indicated by the Engineer.

H. Apply fertilizer and lime at the specified rates. If not applied hydraulically, thoroughly rake the fertilizer and lime into the prepared surface to a minimum depth of 2 inches.

I. Application rates:
   1. Application rates for seeding shall be according to manufacture/supplier recommendations or as directed by the Engineer.
   2. Application rates for fertilizer and lime in this section may be adjusted after the results of the site soil test results performed by the CQA Consultant are available.
   3. Base contract price on application rates for fertilizer and lime specified in this section. Contract price will be adjusted for any variations either decreasing or increasing the application rates

J. For areas to be covered with seed or sod:
   1. Apply fertilizer at a uniform rate of 1,200 pounds per acre or as otherwise directed by the Engineer.
   2. Apply agricultural lime at a rate of two tons per acre or as otherwise directed by the Engineer.

3.03 MAINTENANCE

A. Maintain seeded and sodded areas immediately after placement until vegetation is well established and exhibits a vigorous growing condition.

B. The Contractor shall supply and apply supplemental irrigation for the maintenance period following the placement of the seed or sod. All seeded and sodded areas should receive a minimum of 1½ in. of water per week either by precipitation or supplemental irrigation.

C. Maintain the seeded and sodded areas in satisfactory condition. Maintenance of the seeded and sodded areas includes repairing eroded areas, revegetating, watering, and mowing (if applicable). A satisfactory condition of a seeded or sodded area is defined as a 10,000 square feet section of turf that has no bare spots larger than three square feet.

D. The inspection will be performed by the Engineer, who will determine whether repair of sodded areas or revegetation is required.

3.04 ACCEPTANCE

A. The vegetated areas shall be accepted at the end of the warranty period if a satisfactory condition as defined in this Section exists.

3.05 WARRANTY PERIOD

A. Vegetated areas shall be subject to a warranty period of not less than 60 days from the issuance of the Engineer's final completion notice to the Contractor for the Contract over 100 percent of the areas seeded and sodded.

B. At the end of the warranty period, the Engineer will perform an inspection upon written request by the Contractor. Vegetated areas not demonstrating satisfactory condition of vegetation as outlined above, shall be repaired, resodded, and maintained to meet all requirements as specified herein at the Contractor's expense. All unaccepted areas requiring repair, replacement of sod and/or reseeding shall be subject to a 60 day warranty period commencing at the completion of the reworking.

C. After all necessary corrective work has been completed, the Engineer will certify in writing the final acceptance of the vegetated areas.

[END OF SECTION]

SECTION 15100

VALVES

PART 1 GENERAL

1.01 SCOPE

This specification identifies the minimum requirements for ball, gate, butterfly, check, and globe valves (valves) to be provided and installed.

1.02 REFERENCES

The publications listed below, latest revision, form a part of this specification to the extent referenced. The publications are referenced within the text by the designation only.

A. ANSI/ASME B31.3	Code for Chemical Plant Refinery Piping
B. ASME/ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys

PART 2 PRODUCTS

2.01 VALVES

A. Check and Ball valves shall be constructed of plastic or HDPE and shall contain Viton or Teflon seats and seals.

B. Butterfly valves shall have coated or painted cast iron or stainless steel bodies with Viton seats and seals. The seats and seals shall wrap around the interior of the valve body to prevent leachate contact with the valve body.

C. Flanges shall be HDPE or PVC. Stainless steel backing flanges shall be provided where necessary to prevent flange distortion or leakage at the flange joints.

D. Flange spacers shall be provided between flanges and butterfly valves to prevent the valve disc from contacting the flange face.

2.02 PRODUCT STORAGE

A. All flange faces shall be covered by plastic or other suitable covers.

B. All threaded connections shall be covered with plastic caps or plugs to protect against damage during shipment.

C. Each shipping crate or box shall be marked to clearly identify the contents. Like valves shall be crated or boxed together.

D. Bare metal surfaces prone to rusting prior to installation shall be coated with a suitable rust preventative.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

Installation of valves shall comply with the requirements of this specification and ANSI/ASME B31.3.

3.02 EXAMINATION

Prior to installation the Contractor shall verify that the valves have been handled properly, including verification that the valves are not damaged and the interior is free of dirt and debris.

3.03 INSTALLATION

A. Valves shall be installed in accordance with the requirements of the applicable design drawings.

B. If not otherwise specified on the applicable design drawings, valves shall be oriented to allow operator access to hand wheels or levers.

C. Valves shall be installed preceding all gauges.

D. All valves shall be accessible and located to provide easy replacement, repair or service.

E. No valve shall be installed with the stem pointing down below the horizontal.

(END OF SECTION 15100)

SECTION 16010

GENERAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE

A. This specification identifies the minimum requirements for the selection and installation of conduit, conduit fittings, conductor and other general electrical materials not specifically identified in other specifications.

B. Selection and installation of conduit, conductor, and other general electrical materials shall be in accordance with the requirements of this specification, manufacturer's instructions, the National Electric Code (NEC), local code, and as specified on applicable design drawings.

1.02 RELATED SPECIFICATIONS

A. Section 16170 - Grounding and Bonding

1.05 REFERENCES

A.	NEMA 250-1985	Enclosures for Electrical Equipment (1,000 Volts Maximum)
B.	ANSI/NFPA 70-1993	National Electrical Code
C.	ANSI/NFPA 70E-1988	Electrical Safety Requirements for Employee Workplaces
D.	ISA RP60.8-1990	Recommended Practice Electrical Guide for Control Centers.

1.04 ALTERNATES

A. Alternate selection and installation requirements will be considered, provided they meet the intent of this specification and result in construction and performance that is equivalent to and otherwise in accordance with this specification. All proposed alternates and deviations from this specification shall be described by the Contractor and may not be substituted until mutually agreed upon in writing by the Contractor and the Engineer.

1.05 SUBMITTALS

A. CONTRACTOR shall be responsible for preparing all submittals required for permitting. Drawings and specifications required by the permitting agency and not provided in this package shall be the CONTRACTORS responsibility. CONTRACTOR shall be responsible for identifying and supplying the appropriate size conductor and conduit to connect all equipment and control devices.

PART 2 PRODUCTS

2.01 GENERAL

A. All electrical equipment and material shall be new, unless otherwise noted or specified on the applicable design drawings; all new equipment and material shall be labeled or listed by Underwriters' Laboratories, Inc. (UL).

B. All material furnished under this specification shall be the standard products of manufacturers regularly engaged in the production of such equipment, and shall be that manufacturer's latest standard design. All similar items for similar uses shall be identical insofar as practical, and shall be the product of one manufacturer.

2.02 CONDUIT AND CONDUIT FITTINGS

A. Rigid steel conduit shall be UL listed, hot dipped galvanized.

B. All polyvinyl chloride (PVC) conduit shall be UL listed, schedule 40.

C. High density polyethylene (HDPE) pipe may be substituted for PVC for runs between the individual control panels and the control panels and the main power drop.

D. Primer and adhesive shall be a type approved for electrical-grade PVC conduit.

E. Electrical metallic tubing (EMT) shall be UL listed, hot dipped galvanized. The maximum EMT conduit size shall be 2 inches; its use shall be strictly limited to applications specified in this specification.

F. The minimum conduit size shall be 3/4 inch.

G. Couplings, connectors, and fittings shall be an approved type specifically designed and manufactured for the purpose. Conduit fittings shall be threaded-type steel for rigid steel conduit; EMT fittings shall be threadless-type steel. Conduit fittings shall be PVC for PVC conduit.

H. All conduit between the sump area and the control panel as well as any conduit that passes over the top of the FLSC liner prior to entering the control panel shall be isolated with an approved conduit seal off to prevent the migration of landfill gasses into the cabinet.

I. Control wiring and power supply conductors shall not be installed in common conduit or breakout boxes.

J. Control and power conduit shall be separated by at least 12 inches for runs exceeding 5 feet. Smaller conduit spacing may be used at cabinet penetrations as necessary.

K. Liquid Tite®, or equivalent, flexible conduit may be used where appropriate. All Liquid Tite® conduit shall be connected at each end to an appropriate conduit coupler or conduit grip. Open ended conduits shall not be installed.

2.03 CONDUCTORS

A. All conductors shall be soft drawn copper with AWG sizes as specified by the electrician or electrical designer and shall be insulated for 600 volts. Conductors shall be insulated with THHW or THWN insulation or as indicated on the applicable design drawings. The electrical Contractor or the electrical engineer shall identify appropriate wire sizes.

B. Conductor size, insulation type, and the manufacturer's name shall be permanently marked on the conductor jacket at regular intervals.

C. All conductors shall be delivered to the job site in coils containing the manufacturer's name with an approval tag indicating conductor size and type of insulation.

D. Leachate pumps shall use only those power cables provided by the manufacturer. Power cables shall be continuous from the pump to the breakout box. No splices will be allowed in the cable between the pump and the breakout box.

2.04 SIGNAL AND COMMUNICATIONS CIRCUIT CONDUCTORS

A. Special cables shall be as specified on the applicable design drawings.

B. Instrument and control cables shall be individually shielded, twisted pairs in multi-pair cables. The number of pairs in each cable is specified on the applicable design drawings.

2.05 BREAKOUT JUNCTION BOXES

A. Breakout boxes shall be shall be purchased from Sligo Systems, Inc. Ormond Beach, Florida and shall be equipped with terminal strips, and internal desiccant.

2.06 WIRING DEVICES

A. All wiring devices shall be commercial-grade Hubbell, Bryant, or Arrow-Hart.

B. Weatherproof covers shall be cast aluminum and hinged.

2.07 SUPPORTS AND FASTENING

A. Conduit hangers, brackets, beam clamps, and other support and fastening devices shall be products manufactured by Unistrut, Superstrut, or a Engineer-approved equal that are designed for the proposed use. Wire and perforated strap iron shall not be used.

B. Fasteners and supports shall be a type approved by the Engineer.

2.08 MISCELLANEOUS EQUIPMENT

A. Copper clamps, connectors, and lugs in contact with dissimilar metals shall be tin-plated and a type approved by the Engineer.

B. All connections shall be made on terminal strips. Wire nuts shall not be used.

C. All wire shall be full length from termination to termination. Splices shall not be used.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical systems shall be installed in accordance with the requirements of this specification, manufacturer's instructions, federal, state, and local regulations, and as specified on the applicable design drawings.

B. Materials, workmanship, and installation shall conform to all requirements of the legally constituted authorities having jurisdiction.

C. Where more stringent requirements than required by the NEC or local codes are specified herein, this specification shall take precedence.

D. The electrical systems specified on the design drawings are generally diagrammatic, and shall be followed as closely as actual construction and work of other trades will permit.

The exact routing of conduit and location of secondary electrical devices, shall be determined in the field by the Contractor.

E. The Contractor shall coordinate all electrical work with the work of other trades or disciplines, verify all scales, and report any dimensional discrepancies or other conflicts to the Engineer before performing work.

F. The Contractor shall furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, clamps, expendables, and other miscellaneous items required to complete the electrical systems specified in this specification and on the applicable design drawings.

3.02 ELECTRICAL CLASSIFICATION

A. The electrical classification for all areas of construction shall be nonhazardous. All sump areas shall be considered wet and damp.

B. All work performed by the Contractor and all materials selected or provided by the Contractor shall be in accordance with the requirements of the classifications in Paragraph 3.02A, at a minimum, and the specific requirements of this specification, and as specified on the applicable design drawings.

3.03 CONDUIT INSTALLATION

A. Rigid steel conduit shall be used in the following applications:

1. In all cases where circuits are exposed to physical damage
2. For stub-ups through concrete slabs, except PVC conduit shall be used to encase individual ground leads
3. In potentially wet locations, except as specified on the applicable design drawings
4. Where transitioning from below-grade PVC to above-grade rigid, rigid shall be used within 18 inches of grade or stub-up

B. Rigid PVC conduit shall be used in the following applications:

1. In all cases where circuits are below-grade and not subject to physical damage
2. To ensure compliance with the requirements of Paragraph 3.03A related to transition from below-grade to above-grade conduit runs.

C. Liquidtight shall be used in the following applications and in accordance with the requirements of Paragraph 3.07:

1. At motor connections
2. At expansion joints
3. At equipment that produces vibration
4. At connections to instruments
5. As required by the NEC or local code.

D. General Requirements

1. All conduit shall be installed in accordance with the requirements of this specification and as specified on the applicable design drawings.

2. Distribution of power, and control circuits shall be by a conduit and conductor system installed below grade where practicable. Below grade conduit shall be PVC or HDPE.

3. After cutting conduit, all ends shall be properly reamed to remove burrs that may damage to conductor insulation.

4. A minimum spacing of 12 inches shall be maintained between power and control conduits.

5. Rigid steel conduit, when run in earth or in sand or gravel fill, shall be protected by 3M Scotchrap™ No. 50, and applied to clean, degreased conduit pipe in a helical wrap, half-lap. Individual joint wrap shall overlap conduit wrap by a 3-inch minimum.

6. Conduit backfilling and encasement shall be as specified on the applicable design drawings.

7. Underground conduits from the main power drop, rising above-grade or entering concrete pull vaults shall be rigid steel conduit.

8. All necessary sleeves required where conduits pass through floors, footings, or walls shall be coordinated by and shall be the responsibility of the Contractor. All holes in concrete floors, vaults, or boxes shall be core drilled. Chipping of concrete is not permitted.

9. All conduit stub-ups for future use shall have couplings and plugs installed.

10. Running threads shall not be used for connecting conduits.

11. Bushings shall be installed where a rigid metal conduit enters a box, fitting, or other enclosure to provide protection to the wire from abrasion.

12. All underground coupling threads shall be painted with red lead or 3M Scotchrap™ pipe primer.

13. Above-grade conduit shall be supported in accordance with NEC support-spacing requirements. Groups of conduits clamped together in mid-span will not be acceptable as meeting the support requirements. Conduits shall be secured at 8-foot maximum intervals and within 3 feet of every outlet or termination, unless otherwise specified on the applicable design drawings.

14. Conduit shall not be supported from adjacent piping.

15. A No. 12 AWG, TW insulation copper pull conductor or a 3/16-inch diameter nylon pull rope shall be left in each empty conduit run installed under this specification.

16. No conduit in the final installation shall be crushed or otherwise deformed.

17. PVC conduit shall be installed using solvent joints.

18. Identification of need, selection, supply, and installation of conduit seals, vents, drains, and unions shall be the responsibility of the Contractor.

19. All conduit between the sump area and the control panel as well as any conduit that passes over the top of the landfill liner prior to entering the control panel shall be isolated with an approved conduit seal off to prevent the migration of landfill gasses into the cabinet.

20. The ends of all conduit shall be located above the seasonal high water line and shall be sealed against moisture and insect/rodent intrusion.

3.04 INSTALLATION OF CONDUCTORS

A. All conductors shall be installed in accordance with the requirements of this specification and as specified on the applicable design drawings.

B. All conductors shall be continuous from outlet to outlet and/or terminal to terminal, and shall be identified in accordance with the requirements of Paragraph 3.10.

C. Conductors shall not be pulled into any portion of the conduit until all construction work that might cause damage to the conductors has been completed. Mechanical means used to pull conductors shall be approved by the Contractor.

D. Conductors shall not be spliced in conduits under any circumstances.

E. Where required, splices in conductors and cables shall be in suitable enclosures and made using properly sized solderless connectors. All splices shall be provided with insulation equal to or greater than the insulation of the conductor. A minimum of 12 inches of free length shall be provided for each conductor to be spliced. The number of taps and splices shall be held to a minimum.

F. All ground, neutral, and line connections to receptacle and wiring device terminals shall be made as recommended by the manufacturer. Ground jumper from outlet box to ground terminal or devices shall be provided when the device is not approved for grounding through the mounting screws.

G. All conductors and cables shall be installed in accordance with the manufacturer's instructions. Methods of gripping cables and tension limitations shall be coordinated before pulling all cables. In no case shall the pulling force in pounds exceed values set forth by the manufacturer.

H. Only commercially prepared conductor pulling compounds that are noninjurious to the cable jacket or insulation and approved by the cable manufacturer shall be used. Using soaps, soap flakes, detergents, or similar preparations shall not be permitted.

I. An indication of phasing shall be maintained for all power circuits using color-traced conductors or by applying permanent labels to the conductors (Table 1).

J. Shield and/or shield drain conductors for electric instrument and transducer cables shall have continuity from the sensing element to the control panel. The shield shall be grounded only to the designated ground at a single point.

K. For connections to devices with screw terminals, no more than two conductors shall be installed to one screw. All such connections shall be made using lugs.

L. Wire nuts shall not be used.

M. Continuity and identification of all circuits shall be checked by the Contractor.

N. All conductors shall be terminated in terminal strips. Terminal strip connections shall be checked prior to approval.

O. All terminal strip connections shall be made inside either the control panel or an approved Breakout Junction Box.

P. All conductor splices shall be waterproof and located above the seasonal high water line.

Q. All conductors shall be installed in conduits. No direct burial cable shall be installed at the site. Control cable shall be installed in conduits between the breakout boxes and the sumps. Flow meter leads shall have the shortest exposed wiring length practicable.

3.05 INSTALLATION OF OUTLET, AND BREAKOUT JUNCTION BOXES

A. Breakout junction boxes shall be installed as specified on the applicable design drawings and at other locations where necessary or convenient for installation of conductors. Junction and pull boxes shall be the sizes recommended by the manufacturer and shall be appropriate for the sizes of conduit and conductors served. In no case shall junction boxes be less than 4-inches square by 1 1/2-inches deep.

B. Breakout junction boxes shall contain integral terminal strips for all connections and a replaceable desiccant.

C. All Breakout boxes shall be NEMA-4X rated.

D. Junction boxes shall be independently supported. Conduit fittings and junction boxes shall be accessible for maintenance.

E. All conduits in pull boxes shall be neatly supported using Unistrut.

F. Conduit bodies used as pull points for conductor, cable, and fiber optic cable installed in the collection and disposal system shall be installed in pull vaults. The conduit bodies shall be grouped and installed in the pull vaults and be accessible. Conduit ends shall be sealed to prevent the migration of water into the conduit.

G. All breakout boxes and other pull boxes shall be located such that all portions of the box and all entries into the box will be above the seasonal high water line.

3.06 MISCELLANEOUS INSTALLATION REQUIREMENTS

A. All control systems, conduits and conductors shall be terminated in junction boxes or at instruments as specified on the applicable design drawings.

B. Structures shall not be cut without authorization from the Engineer. Any required openings or spaces shall be arranged for in time to prevent any unnecessary cutting. All cutting shall be done by the appropriate trade involved.

C. Copper clamps, connectors, and lugs coming into contact with dissimilar metals shall be tin-plated and a Engineer-approved type. Where insulation is required, such fitting shall be protected by not less than two layers of 3M Scotchfill™ electrical insulation putty. Voids shall be filled and sharp edges shall be padded. The 3M Scotchfill™ electrical insulation putty shall be tightly wrapped with two half-lapped layers of 3M Scotch 33™ plastic-backed electrical tape.

3.07 CONNECTIONS AND TERMINATIONS TO EQUIPMENT

A. General

1. Interconnecting conduit and conductor shall be installed in accordance with the requirements of this specification, and as specified on the applicable design drawings.

2. Connections and terminations include those required for electric pump motors, instrumentation, control and circuit breaker panels, and breakout junction boxes.

3. Where possible, conduits shall enter the bottom of control and circuit breaker panels, junction and pull boxes, and miscellaneous enclosures. Entry shall be made using conduit fittings and bushings selected and provided by the Contractor or panel manufacturer. Top or side entry must be specifically approved by the Engineer.

4. Terminations to terminal strips shall be secured to the torque values specified by the manufacturer.

5. All conductors connecting to equipment shall be identified in accordance with the requirements of Paragraph 3.10.

3.08 ANCHORING

A. All panels shall be securely fastened to concrete posts or mounted on Unistrut connected to concrete posts. Posts shall be embedded a minimum of 3 feet into the surrounding ground and shall be outside the landfill liner system wherever possible. Mounting posts inside the liner system shall be placed so they do not penetrate the liner. Sizing of the concrete posts and associated bolts shall be determined by the Contractor.

3.09 IDENTIFICATION

A. General Requirements

1. All electrical enclosures, conduit, conductors, electric motors, and other electrical components shall be labeled by the Contractor in accordance with applicable federal, state, and local regulations.

2. In addition to the requirements above, all enclosures, conduit, conductors, and other electrical components shall be labeled by the Contractor with wire and conduit tag numbers as specified on the applicable design drawings.

3. All instrumentation conductors shall be labeled by the Contractor with wire tag numbers specified in the control system vendor design drawings.

4. All conduits shall be identified with the wiring and instrumentation numbers of conductors contained within the conduit.

7. Additional identification requirements shall be as described below.

B. Enclosures

1. Enclosures include control and circuit breaker panels and junction and pull boxes.

2. Labels printed "Danger High Voltage" shall be provided and affixed to all 480-volt panels.

3. All control and circuit breaker panels will be provided by the Contractor with appropriately engraved nameplates. The Contractor shall only provide and affix labeling in accordance with the requirements of Paragraph 3.10.

4. All junction or pull boxes shall be labeled with a description of the enclosed wiring.

C. Miscellaneous

1. Labels shall be provided on all switches and receptacles indicating the panel and circuit number to which the device is connected.

2. All grouped switches shall be labeled with an engraved device plate.

3.10 INSPECTION AND TESTING

A. General

1. Inspections and tests identified in this specification represent minimum or special requirements identified by the Engineer. The Contractor shall be responsible for identifying and implementing all inspections and tests to meet the requirements of this specification and to ensure that proper operation can be expected when the remediation system is put into service.

2. Any additional tests recommended by the equipment manufacturer shall be completed and documented prior to startup. A copy of all such testing must be provided to the Engineer for approval prior to startup.

3. All test data obtained shall be compiled by the Contractor and submitted to the Engineer.

4. All testing will be witnessed by the Engineer unless specifically waived by the Engineer. The Contractor shall notify the Engineer a minimum of 24 hours before conducting any testing.

5. The Engineer's witnessing of inspections or tests shall in no way relieve the Contractor of responsibility for carrying out the requirements of this specification.

B. Miscellaneous Inspections and Tests

1. A continuity test shall be performed on all conductors subsequent to installation, but prior to final termination. A report documenting the results of the continuity test shall be prepared by the Contractor and submitted to the Engineer.

2. Operational tests shall be performed on all motor control circuits.

3. Circuit breakers, motor starters, switches, relays, and other equipment shall be inspected for loose connections to ensure that contacts and working parts are correctly aligned and free from dust and foreign matter.

4. Motors shall be checked for proper rotation. A report documenting the results of the rotational check shall be prepared by the Contractor and submitted to the Engineer.

5. Circuit breakers with adjustable trips shall be checked for proper thermal and magnetic settings for proper protection. A report documenting all trip points and settings shall be prepared by the Contractor and submitted to the Engineer.

C. Insulation Resistance Testing

1. Insulation resistance testing shall be performed on all 480-volt loads to ensure insulation integrity.

2. All cables and conductors shall be visually inspected when received, or before installation. This inspection shall include investigating for concealed damage to cables on reels that are damaged or broken, and in boxes that have been punctured by sharp objects or severely crushed and dented from improper handling. Any cable showing signs of damage shall not be installed.

3. All cables and conductors shall be meggered phase-to-phase and phase-to-ground after installation, but before termination, to determine if insulation was damaged during installation. Insulation resistance during testing shall be 1 megohm.

4. Insulation resistance testing for final acceptance shall be made with all equipment connected and terminated, but with circuit protective devices open. Phase-to-ground tests shall be performed for each phase.

5. The Contractor shall submit the insulation resistance testing procedure for approval by the Engineer before insulation resistance testing.

6. A report documenting the results of the insulation resistance testing shall be prepared by the Contractor and submitted to the Engineer.

D. Grounding System Inspection and Testing

Grounding system inspection and testing shall be performed in accordance with the requirements of Section 16170.

ATTACHMENTS

TABLES

TABLE 1

CONDUCTOR COLOR-CODE CHART

CONDUCTOR	120/208	277/480
Phase A (1)	Black	Brown
Phase B (2)	Red	Orange
Phase C (3)	Blue	Yellow
Neutral	White	White or Light Grey
Equipment Ground	Green	Green

[END OF SECTION]

SECTION 16170

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SCOPE

A. This specification identifies the minimum requirements for electrical grounding and bonding.

B. Grounding and bonding shall be in accordance with the requirements of this specification, the National Electric Code (NEC), local code, and as specified on the applicable design drawings.

1.02 ALTERNATES

Alternate selection and installation requirements will be considered, provided they meet the intent of this specification and result in construction and performance that is equivalent to and otherwise in accordance with this specification. All proposed alternates and deviations from this specification shall be described by the Contractor and may not be substituted until mutually agreed upon in writing by the Engineer.

1.03 RELATED SPECIFICATIONS

A.	Section 16010	General Electrical Requirements
B.	Section 16651	Control Panel Fabrication

1.04 REFERENCES

The publication listed below, latest revision applicable, form a part of this specification to the extent referenced. The publications are referred to within the text by the designation only.

A.	ANSI/NFPA 70	National Electrical Code (Latest Edition)
B.	ANSI/NFPA 70E	Electrical Safety Requirements for Employee Workplaces (Latest Edition)
C.	ANSI/UL-467	Standard for Safety Grounding and Bonding Equipment

PART 2 PRODUCTS

2.01 GENERAL

A. All electrical equipment and material shall be new, unless otherwise noted or specified on the applicable design drawings; all new equipment and material shall be labeled or listed by Underwriters' Laboratories, Inc. (UL).

B. All ground connectors shall be copper of the clamp type, or cadweld. All clamp accessories such as bolts, nuts, and washers shall also be bronze to assure a permanent corrosion resistant assembly. Ground lugs, ground rod clamps, and connectors shall be NEC-grade copper and tin-plated when in contact with dissimilar metals.

D. Ground rods shall be copper-clad steel conforming to ANSI/UL 467. Ground rods shall be ¾-inch diameter and driven a minimum of 5 feet into the groundwater.

E. Grounding resistance shall be checked and documented. The maximum allowable grounding resistance is 5 ohms. If a value greater than 5 ohms is measured then additional grounding will be required until a value of less than 5 ohms is achieved.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical systems shall be installed in accordance with the requirements of this specification, manufacturer's instructions, federal, state, and local regulations, and as specified on the applicable design drawings.

B. The grounding system shall include but is not limited to ground cable fittings, connectors, and all other devices and material as required to render the system complete and meet the requirements of NEC Article 250. Except where specifically indicated otherwise, all exposed noncurrent carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in nonmetallic raceways and neutral conductor of the wiring system shall be grounded. The ground connection shall be made at the main service equipment and shall be extended to the grounding grid system.

C. The location of ground rods shall be the Contractor's responsibility. However, grounding rods shall be installed outside of the landfill liner system. The lengths of rods forming an individual ground array shall be equal and shall be of the quantity required to obtain a ground resistance of less than 5 ohms. The grounding system shall be in strict accordance with Article 250 of the N.E.C.

D. Grounding clamps shall be used to bond each separately derived system to the grounding electrode conductors.

E. All ground wire shall be bare.

F. Neutrals shall be solidly grounded at the transformer secondary only where it shall be bonded with the primary ground.

G. Each grounding type bushing shall have the maximum ground wire accommodation available in standard manufacture for the particular conduit size. Connection to the bushing shall be with wire of this maximum size. This type bushing shall be used at all panelboards disconnect switches, and at all distribution equipment.

H. All branch circuits and feeders shall include a ground conductor sized in accordance with the requirements of the applicable design drawings.

I. An additional copper ground conductor, sized in accordance with the requirements of the NEC, shall be provided in all raceways to ground all intermediate metal boxes, conduit, and equipment.

3.02 EQUIPMENT GROUND

A. Ground continuity throughout the sump area shall be maintained by means of a ground conductor run in all conduits. Grounding conductors run in conduit shall be insulated copper conductors, sized in accordance with the design drawings.

B. Metal supports for any electrical equipment, etc, shall be bonded to the nearest ground bus. If not indicated otherwise, provide #6 AWG conductor in 3/4-inch conduit.

C. Copper bonding jumpers shall be used to obtain a continuous metallic ground for all electrical equipment.

3.03 SHIELD GROUNDING

A. Shields on power cable shall be grounded at each termination in a manner recommended by the cable manufacturer.

B. Shielded instrumentation cable shall be grounded at one end only; this shall typically be at the "receiving" end of the signal carried by the cable. Instrumentation shall only be grounded at the location specified by the instrument manufacturer.

C. Termination of each shield drain wire shall be on its own terminal screw. All of these terminal screws in one rack shall be jumpered with No. 16 solid tinned bare copper wire; connection to ground shall be accomplished with a No. 12 green insulated conductor to the main ground bus.

3.04 LIGHTNING GROUNDS

A. Lightning protection devices shall be grounded to a separate grounding rod as specified by a licensed lighting protection specialist. Lightning protection devices shall also be bonded to the system ground unless otherwise directed by the lightning protection specialist.

[END OF SECTION]

SECTION 16651

CONTROL PANEL FABRICATION

PART 1 GENERAL

1.01 SCOPE

A. This specification identifies the minimum requirements for the design, fabrication and testing of the Pump Control Panels located at the impacted stormwater and leachate flexible leachate storage containers and at the impacted stormwater pumping location as indicated on the Construction Drawings. The Contractor is responsible for the functional operation of panel wiring from the main power drop to the panel and from the panel to the leachate/impacted stormwater sump pumps and various instrumentation. Panel general arrangement and construction shall be as shown on the contract drawings and indicated in the specifications. Follow the panel manufacturers written requirements and recommendations for mounting and space allocation, wiring and grounding of all equipment contained in the pump control panel. It is the intent of this specification to provide a fully operational and ready-to-use system.

B. The control panel shall be designed in accordance with the requirements of this specification, and the design drawings. No change orders will be accepted unless a specific change of scope is requested in writing by the Engineer, fully approved and executed.

C. This specification describes the functional requirements of the control panel and all internal components necessary to provide a complete and operating system.

D. The Contractor shall provide overall system integration of existing pumping equipment with the Pump Control Panel. The Contractor shall be responsible for coordination of control wiring and communications between the Pump Control Panel, pumps, level transducers, flow meters, and any other instrumentation, equipment or control panels that require communication or input/output capabilities.

1.02 RELATED SPECIFICATIONS

A. Section 16010	General Electrical Requirements.
B. Section 16170	Grounding and Bonding
C. Section 16652	Instrumentation

1.03 REFERENCES

The enclosures, wiring, and component parts of this system shall conform to the latest revision of the following codes and regulations:

A. National Electric Code (NEC), ANSI/NFPA 70

B. National Electric Safety Code (NESC), ANSI C2

C. American National Standards Institute (ANSI)

D. National Electrical Manufacturing Association (NEMA)

E. Electronics Industry Association / Telecommunications Industry Association (EIA/TIA)

F. All applicable federal, state, and local codes.

1.04 SUBMITTALS

A. The control panel manufacturer shall provide a copy of the panel design to the Engineer prior to beginning assembly of the panel. The Engineer shall review and provide written approval or required modifications prior to assembly.

B. The control panel manufacturer shall provide written documentation of functionality testing of the control panel and all instrumentation interfacing with the control panel.

PART 2 PRODUCTS

2.01 GENERAL

A. All wiring for control panel shall be provided by the contractor. Requirements shall comply with Section 16010.
B. The control panel shall be assembled by Sligo Systems, Inc. of Ormond Beach, Florida. All control panel components shall be provided by Sligo Systems, Inc.

2.02 PANEL COMPONENTS

The leachate Control Panel is intended to remotely operate the two sump pumps located in the two flexible leachate storage containers. The impacted stormwater Control Panel is intended to remotely operate the two sump pumps located in the two flexible leachate storage containers, which are to be used for impacted stormwater. The pumps will consist of 2-HP submersible pumps. The Control Panels will also monitor leachate levels in the sumps and flow rates in the piping during sump pump operation.

A. All pump controls will be housed in a painted NEMA Type 4 Cabinet. Cabinet Size will be be determined by the panel manufacturer.

B. Controls will be protected from weather by placing them behind the outer door of the cabinet.

C. The Cabinet will be equipped with an appropriately sized service disconnect switch capable of de-energizing all equipment in the cabinet and all external equipment serviced by the cabinet. The service disconnect shall be accessible from the outside of the cabinet when the outer door is closed.

D. The primary sump pumps (PS-1104-01 and PS-1104-02) will be controlled by a level transducer located inside the sump. The level transducer will monitor the depth of leachate in the primary sump and will start and stop the primary leachate pumps at specific set points.

E. The two primary pumps will alternate as lead and lag with each pump activation. Set points will be such that the lead pump will start when the first high level set point (SPH-1104-01) is reached. If leachate levels in the sump continue to rise then the lag pump will start when the second high level set point (SPH-1104-02) is reached. Both primary sump pumps will be set to turn off at the same set point (SPL-1104-01).

F. The secondary sump pump will be turned on by high level set point, SPH-1104-03 and turned off by low level set point, SPH-1104-03.

G. A high-high level alarm (LAHH-1104-01) will be activated if either of the high-high level set points (SPHH-1104-01 or SPHH-1104-02) are activated. This alarm will activate a flashing strobe light on top of the control panel to notify the operator that leachate levels in the sump risers are too high.

H. A separate fused disconnect will be provided to house an external power receptacle. This separate fused disconnect shall be referred to as the booster pump disconnect. The fused disconnect and receptacle shall meet the following requirements:

   a) The booster pump disconnect and receptacle shall be housed in a NEMA 4 cabinet;

   b) The booster pump disconnect shall have an auxiliary pole to provide a control signal to the sump pump control panel. This control signal shall disable the sump pumps when the booster pump disconnect is activated.

   c) The receptacle shall be capable of handling the power loads from the following 20 hp motor:

      i) 3-phase 460 power;

      ii) Minimum efficiency 40 percent;

      iii) Power factor 0.89

iv) Service factor 1.15.

d) The receptacle shall be a watertight pin and sleeve style connector.

e) The receptacle shall be accessible without opening the booster pump disconnect panel.

I. The Leachate Sump Control Panel shall be capable of communicating with the Leachate Storage Area Control Panel such that:

a) All pumps will be shut down in the event a signal is received indicating that all four leachate pump-in valves in the leachate storage area are closed.

b) All sump pumps will be shut down in the event any one of the high-high level switches in the leachate storage area has been activated.

c) A separate control panel, to be added in the future, will be able to monitor sump pump operation and limit the number of pumps operating to 4.

J. Operation of the sump pumps and the control panel shall conform to the operational notes set forth on the Process and Instrumentation Diagram.

K. Communication between the Sump Pump Control Panel and the Leachate Storage Area Control Panel shall use a 2 wire signal processing system.

a) The panel manufacturer shall be responsible for determining the appropriate number of nodes required for operation.

b) The 2 wire system installed shall be such that it can be modified in the future for radio telemetry.

L. All pumps will operate on 460VAC 3 phase power.

M. A 110VAC, 20 amp convenience outlet shall be provided at the control cabinet location.

N. A convenience light fixture shall also be provided at the control cabinet. The light shall be sufficient to illuminate the sump area and the control cabinet area. An externally mounted light switch rated for exterior installation shall be installed at the control cabinet location.

O. The control cabinets shall be shielded from direct sunlight to the extent possible by installing a fiberglass or plastic backing and roof to the control panel mounting posts.

P. Three-position switches capable of overriding the level switch operation will be provided for each pump. The each switch will be equipped with a legend plate identifying the switch position. The switch positions shall be labeled as Hand, Off and Auto corresponding to the operation of the pump at that position. The Hand position will allow an operator to turn on the pump motor independent of the water level in the sump. The hand position will be spring loaded to prevent the switch from being left in the hand position. The Off position will allow an operator to turn off the pump motor independent of the water level in the sump. The Auto position will return the pump to control by the level switches.

Q. Each pump shall be protected by a Type E-1 current/voltage monitor. The monitor shall be set by the contractor to detect stuck impeller and no flow conditions.

R. Each pump shall have a pilot light mounted on the front of the panel. The pump control panel will be configured such that the pilot light will light when the associated pump is operating.

S. The pump control panel will be equipped with three beacon lights mounted on top of the panel box.

   a) A steady lit amber colored light shall be configured to indicate power is available to the panel. The amber light shall be lit when the main disconnect switch on the pump control panel is in the on position.

   b) A flashing red light shall be configured to indicate operational problems associated with:

      i) High or low voltage

      ii) High or low current

      iii) Water level has activated the High High Level switch (HHL-01).

   c) A flashing blue light shall be configured to indicate operational problems associated with the active level transducer.

   d) Flashing lights shall be strobe activated types. Mechanical rotating lights shall not be used.

T. Panel Wiring

   a) Wire PLC inputs and outputs to terminal blocks for field wiring connection.

U. Wireway

   a) Provide ventilated plastic wireways inside the panels for separating and organizing the wiring.

   b) Electric signals carried in one Wireway will be of similar types and voltage levels. Provide separate wireways for AC and DC wiring. Route internal wiring in separate wireway from space allowed for external field wiring. Provide each signal type with its own terminal strip.

V. Terminal Blocks

a) All fabricator wiring shall be limited to one side of the terminal strips. The other side of the terminal is reserved for field wiring connections.

W. Wire Marking

a) Permanently identify each wire at both ends with a permanent identification tag. Identify wiring according to wire identifiers on the control panel design plans provided. Wire from terminal block to terminal block without splicing.

2.03 LIGHTNING PROTECTION

A. The control cabinet location shall be protected from incoming voltage surges by an appropriately sized service entrance Transient Voltage Surge Supression (TVSS) unit. The TVSS shall be manufactured by Erico, Inc.

B. An additional TVSS unit shall be installed on the incoming communication conductors.

C. Two Lightning protection devices (lightning rods) shall be installed above the control panel to protect the system from lightning strikes.

D. Lightning protection and TVSS units shall be designed and installed by a qualified lighting protection specialist.

E. Grounding and bonding shall be accomplished in accordance with Section 16170, Grounding and Bonding.

PART 3 EXECUTION

3.01 GENERAL

A. The Control Panel shall provide system control for the proposed system as discussed in Part 2 of this specification and as depicted on the design drawings.

3.02 TESTING

A. The Control Panel will be given a complete visual inspection and fully powered point-to-point by the Contractor before notifying the Engineer that the system is ready for testing.

B. Testing will be conducted in accordance with the manufacturer's requirements. Written documentation of the field-testing shall be provided before the system is accepted by the Engineer.

C. The Contractor shall have the control cabinet installation inspected and verified by Sligo Systems, Inc. Sligo Systems shall prepare an inspection report on the cabinet installation. The inspection report shall be provided to the Engineer prior to acceptance of the panel.

D. Electrical power shall be checked by the Contractor and written documentation shall be provided indicating that the incoming power is within the limits required by the control panel, pump, and instrumentation manufacturers

3.03 FINAL INSPECTION AND COMMISSIONING

The Engineer shall inspect the panels after installation to ensure that each has been installed in accordance with this section and the contract drawings. The Contractor shall demonstrate the operation of the completed panel system to the Engineer to show that it operates as intended by the design. If system components fail or are inoperative during the testing and/or operational demonstration, they shall be repaired or replaced by the Contractor.

(END OF SECTION 16651)

SECTION 16652

INSTRUMENTATION

PART 1 GENERAL

1.01 SCOPE

A. This specification identifies the minimum requirements for the purchase and installation of instrumentation including:
   a) Level transducers;
   b) Flow meters; and
   c) Pressure Gauges.

B. The Contractor shall provide overall system integration of existing pumping equipment with the Pump Control Panel. The Contractor shall be responsible for coordination of control wiring and communications between the Pump Control Panel, pumps, level transducers, flow meters, and any other instrumentation, equipment or control panels that require communication or input/output capabilities.

1.02 RELATED SPECIFICATIONS

A. Section 16010 General Electrical Requirements.

B. Section 16651 Control Panel Fabrication

1.03 REFERENCES

The enclosures, wiring, and component parts pertaining to the installation of the electrical portions of the instrumentation shall conform to the latest revision of the following codes and regulations:

A. National Electric Code (NEC), ANSI/NFPA 70

B. National Electric Safety Code (NESC), ANSI C2

C. American National Standards Institute (ANSI)

D. National Electrical Manufacturing Association (NEMA)

E. Electronics Industry Association / Telecommunications Industry Association (EIA/TIA)

F. All applicable federal, state, and local codes.

1.04 SUBMITTALS

A. The contractor shall provide a cut sheet of all instrumentation proposed for the site. The Engineer shall review and provide written approval or required modifications prior to assembly.

B. Instrumentation shall be tested by the manufacturer and shall be accompanied by documentation of a passing test. All documentation shall be provided to the engineer prior to acceptance of the equipment.

PART 2 PRODUCTS

2.01 GENERAL

A. All wiring shall be provided by the Contractor or Manufacturer. Requirements shall comply with Section 16010.

2.02 INSTRUMENTATION

A. Level transducers shall be Sligo Systems Series PT009-50 Submersible Level Sensors with built in surge suppression.
B. Flow meters shall be Tiger Mag Model SSFM565 Flow Sensors. Flow meters shall be purchased with integral PVC or Stainless Steel spool sections, with flange connections.
C. Pressure gauges shall: have a 0 to 50 psi range; 4 inch face; and be glycerin filled.

2.03 FINAL INSPECTION AND COMMISSIONING

The Engineer shall inspect all instrumentation after installation to ensure that each has been installed in accordance with this section and the contract drawings. The Contractor shall demonstrate the operation of the instrumentation to the Engineer to show that it operates as intended by the design. If system components fail or are inoperative during the testing and/or operational demonstration, they shall be repaired or replaced by the Contractor.

[END OF SECTION]

APPENDIX I

Construction Quality Assurance Plan

AGupta
9 NOV 2006

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1. INTRODUCTION

1.1 Overview

This Construction Quality Assurance (CQA) Plan describes the quality assurance and construction quality control (CQC) activities that will be undertaken during construction of the flexible leachate storage containers (FLSCs) at the Central County Solid Waste Disposal Complex (CCSWDC) located in Sarasota, Florida. The CCSWDC facility is owned and operated by Sarasota County Solid Waste Operations (Sarasota County). The purpose of this document is to define the scope, formal organization, and procedures necessary to achieve a high level of quality and assure that the construction of the CCSWDC FLSC facility is constructed in compliance with the approved design as shown or indicated in the Construction Drawings and Technical Specifications. This plan addresses the CQA and CQC activities to be performed during construction.

1.2 Project Description

The design and construction of FLSC facility is presented in the Construction Drawings and Technical Specifications. The project includes the following:

- construction of a double-composite liner system;
- construction of the leachate collection, removal, transmission and storage systems;
- construction of a gas management system;
- construction of the final cover system components above the FLSC surfaces;
- construction of surface water management system; and
- general site work including FLSC grading and general earthwork.

1.3 CQA Plan Scope

The CQA Plan establishes the quality assurance and quality control monitoring and testing activities to be implemented during construction of the FLSC facility. The CQA Plan was developed in consideration of the current Florida Department of Environmental Protection (FDEP) guidelines and regulations. The scope of the CQA Plan includes:

- defining the responsibilities of parties involved with the construction of the FLSC facility;
- providing guidance in the proper construction of FLSC facility components;
- establishing testing protocols for the evaluation of FLSC facility components;
- establishing procedures for construction documentation; and
- providing the means for assuring that the overall construction conforms to the Construction Drawings and Technical Specifications.

The CQA Plan is intended to establish procedures for the CQA Consultant and to inform the Contractor of CQA activities during the construction of the FLSC facility. The CQA Plan is considered a supplement to the Technical Specifications and a part of the construction contract. In the case of any conflict between the CQA procedures described in this plan and the requirements of the Technical Specifications, the Technical Specifications will govern.

1.4 CQA Plan Organization

The remainder of this CQA Plan is organized as follows:

- definitions of key terms are presented in Section 2;
- project organization and descriptions, responsibilities, and qualifications of key parties involved with the construction of the FLSC facility are presented in Section 3;
- requirements for CQA documentation are described in Section 4;
- CQA activities for the soil components of the FLSC facility, to include fill placement, liner system, final cover system, and general earthwork, are presented in Section 5;
- CQA activities for geomembranes, geosynthetic clay liner, geotextiles, and geocomposites are presented in Sections 6 through 9, respectively;
- CQA activities for piping and fittings are covered in Section 10;
- CQA activities for mechanical and electrical components are described in Section 11;
- CQA activities for concrete associated work are outlined in Section 12; and

- CQA activities for road construction and general civil site work are presented in Sections 13 and 14, respectively.

2. CQA PLAN DEFINITIONS

2.1 Construction Quality Assurance and Construction Quality Control

In the context of this document, construction quality assurance and construction quality control are defined as follows:

- Construction Quality Assurance (CQA) - The planned and systematic means and actions designed to assure adequate confidence that materials and/or services meet contractual and regulatory requirements and will perform satisfactorily in service.

- Construction Quality Control (CQC) - Those actions which provide a means to measure and regulate the characteristics of an item or service in relation to contractual and regulatory requirements.

- In the context of this document:

- CQA refers to means and actions employed by the CQA Consultant, Engineer, or Sarasota County to assure conformity of the various components of the FLSC facility construction project with the requirements of the Construction Drawings and Technical Specifications.

- CQC refers to those actions taken by the CQA Consultant, Contractor, Manufacturers, or Installers to ensure that the materials and the workmanship of the various components of the FLSC facility construction project meet the requirements of the Construction Drawings and Technical Specifications. In the case of the geosynthetic components of these systems, CQC is provided by the CQA Consultant and/or Manufacturers and Installers of the various geosynthetics.

2.2 Plans and Specifications

In this CQA Plan, reference to Construction Drawings and Technical Specifications is understood to mean those plans and specifications issued as a part of a specific contract for construction of a component or phase at the FLSC facility. In all cases, it is expected that this CQA Plan will conform to the Construction Drawings and Technical Specifications. In case of conflict, the approved Construction Drawings and Technical Specifications will govern.

2.3 Geosynthetics

Geosynthetics is the generic term for all synthetic materials used in geotechnical engineering applications; the term includes geotextiles, geogrids, geonets, geomembranes, geosynthetic clay liners (GCL), and geocomposites. There are four types of geosynthetic products referenced in this CQA Plan that are included in the FLSC facility construction. These geosynthetics include: (i) high density polyethylene (HDPE) and polyethylene (PE) geomembranes used in the liner and final cover systems, respectively; (ii) GCL used in the double-composite liner system; (iii) geotextiles used as filters or separators; and (iv) geocomposite drainage layers used in the liner and the final cover systems.

2.4 Construction Activities

In the context of this CQA Plan, the FLSC facility construction is understood to include:

- geosynthetic and soil components of the liner system;
- leachate collection, removal, transmission, and storage systems;
- geosynthetic and soil components of the final cover system above the FLSC surfaces;
- gas management system;
- surface-water management system components;
- other site work including grading and general earthwork;
- road work; and
- other construction activities as assigned by Sarasota County.

2.5 CQA Lines of Communications

Successful execution of this CQA Plan is dependent on open and continuous communication between all parties having a role in the project. The lines of communication between Sarasota County, Engineer of Record, Design Engineer, Construction Manager, Contractor, and CQA Consultant are defined in the organization charts included in Section 3 of this CQA Plan.

3. PROJECT ORGANIZATION AND PERSONNEL

3.1 Overview

The FLSC facility construction organization chart is shown in Figure 3-1. It is understood that the Project Manager will act on behalf of the Sarasota County in all matters relating to the construction of the FLSC facility. Day-to-day construction activities at the FLSC facility will be managed through the direct interaction of several parties below Project Manager level including but not limited to the Construction Manager, Design Engineer, Contractor, and CQA Consultant. The organization chart for the FLSC facility CQA Consultant is presented in Figure 3-2. The description, qualifications, and responsibilities of the parties responsible for construction and CQA at the FLSC facility project are described below.

3.2 Construction Manager

The Construction Manager shall be an individual employed by the Project Manager and who is responsible for overall management of the construction project at the site. In this CQA plan the term "Construction Manager" shall refer specifically to an authorized representative of the Project Manager at the FLSC facility. The Construction Manager will hold a baccalaureate degree in construction management, engineering, or related field or have 10 years of construction management experience. The Construction Manager will also have 3 years of FLSC construction experience. The Construction Manager shall be responsible for coordination and oversight of all construction activities including: (i) contract administration; (ii) construction management; (iii) review of any modifications or changes to the construction contract documents; and (iv) final approval authority for contract or shop drawings and submittals.

3.3 Design Engineer

The Design Engineer is the individual representing the firm having responsibility for FLSC facility design. The Design Engineer will hold a minimum of a baccalaureate degree in engineering, be a Professional Engineer registered in the state of Florida, and have 10 years experience in construction management, engineering, or related fields.

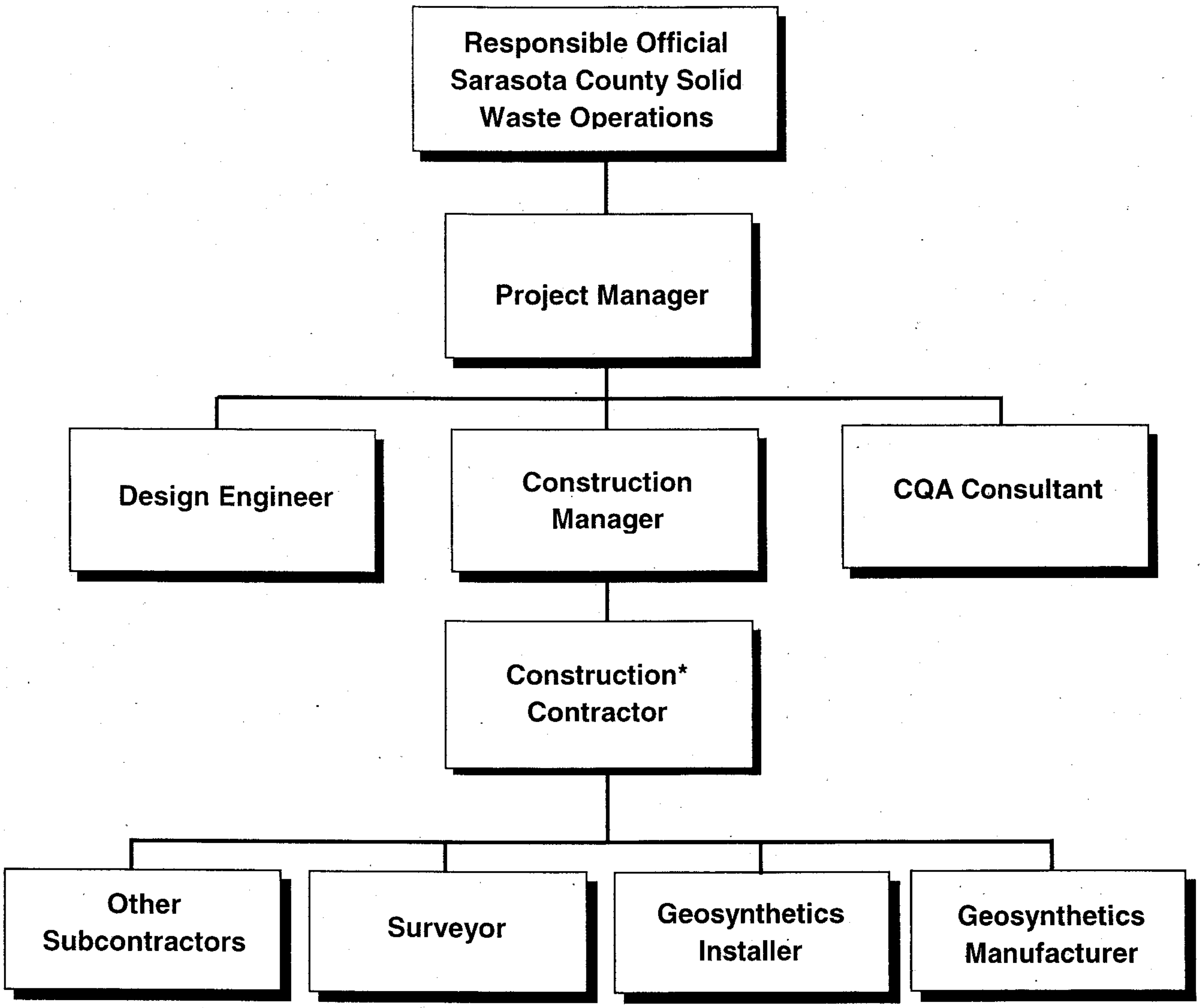
The Design Engineer shall have expertise which demonstrates significant familiarity with geosynthetics and soils, as appropriate, including design and construction experience related to FLSC liner system, and final cover system. The Design Engineer is responsible for approving all design and specification changes and making design clarifications that may be required during construction at the FLSC facility. The Design Engineer shall assist the Construction Manager in reviewing and approving the Contractor's shop drawings and submittals as necessary. The Design Engineer will not be present on-site but will visit the project during construction and attend the project coordination meetings as required to assure conformance with plans and specifications. The Design Engineer will be capable of discussing and interpreting all elements of the FLSC facility design. The Design Engineer shall have the authority to recommend changes or modifications to the Construction Drawings and Technical Specifications for approval by Sarasota County and FDEP, as required.

3.4 <u>Contractor</u>

The Contractor is the firm or corporation having a legally binding agreement to construct components of the FLSC facility construction, or shall be qualified construction personnel hired directly by Sarasota County and working under the direct supervision of a construction foreman and superintendent. The Contractor is represented on-site by a qualified individual who is authorized to act on behalf of the Contractor in all matters pertaining to the construction at the FLSC facility. The Contractor shall be qualified as required by the contract to perform all aspects of work required to successfully construct the project. The Contractor shall be registered in accordance with applicable local, state, and federal requirements and shall demonstrate significant prior related experience. The Contractor's field representative shall be a qualified individual who is able to perform all tasks associated with FLSC facility construction activities. The Contractor's field representative shall demonstrate experience similar to the Construction Manager. The Contractor's field representative shall have the authority to direct and instruct the Contractor's crews and its subcontractors.

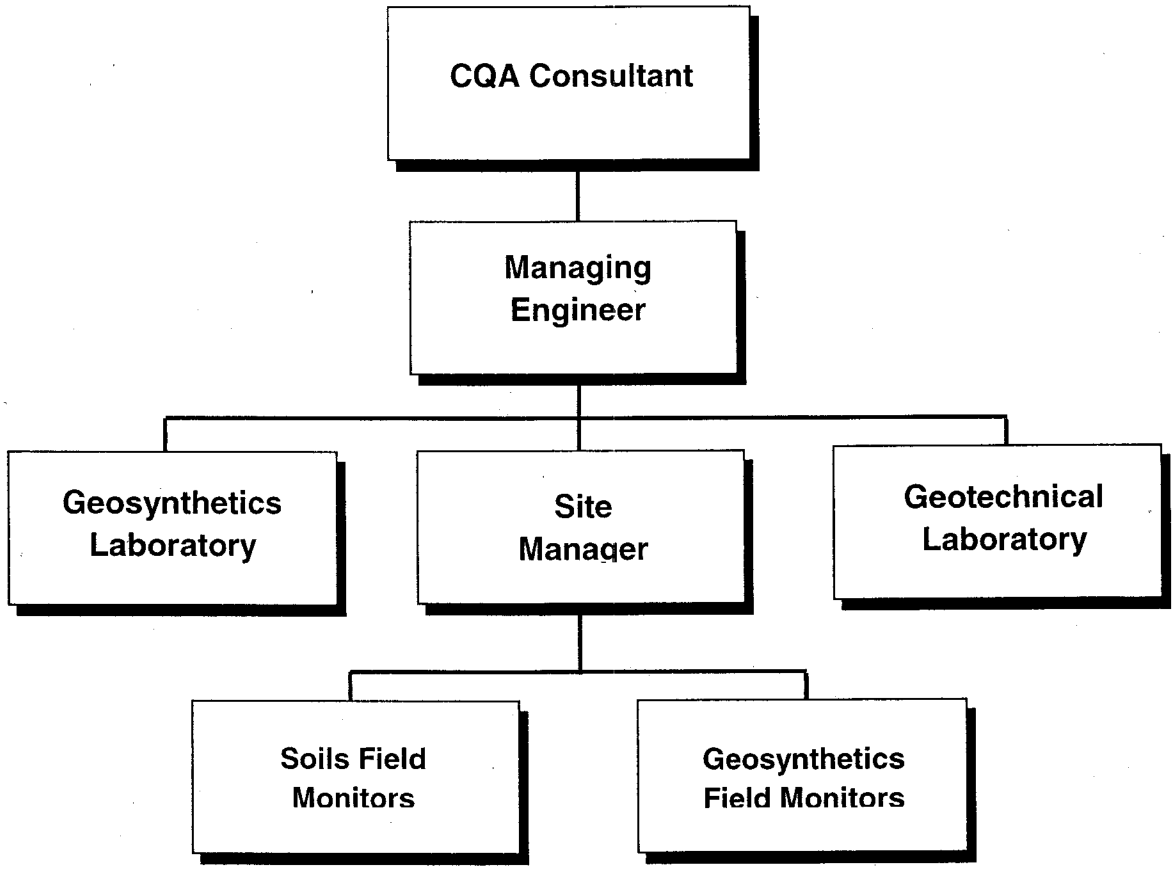
The Contractor is responsible for all construction materials and activities. The Contractor is also responsible for scheduling and coordination of the required work with its subcontractors to complete the project within the construction schedule approved by the Construction Manager. The Contractor shall provide an experienced supervisory representative at all times during any construction activity on-site. The Contractor is responsible for furnishing as-built record drawings and a copy of all documentation required during the construction at the FLSC facility. The Contractor is also responsible for updating all construction drawings for any deviations from the original plans and specifications on a regular basis.

Figure 3-1
FLSC Facility Construction Organization Chart



*The Construction Contractor is assumed to have earthwork capabilities as an integral part of the firm. Otherwise, the earthwork subcontractor is a major entity in this chart under the prime contractor.

Figure 3-2
FLSC Facility CQA Organization Chart



The Contractor's field representative is responsible for coordinating and supervising the work of all subcontractors on site. At a minimum, the Contractor's field representative will be responsible for the following:

- informing the Construction Manager of any discrepancies between the plans and specifications and the field conditions;
- submitting all documentation required by the Construction Drawings and Technical Specifications in a timely manner;
- attending all project coordination meetings held on site;
- scheduling all phases of the construction;
- maintaining a daily log of all construction activities on site;
- implementing and verifying all QC procedures required of the Contractor and/or subcontractors; and
- submitting proposed alternative materials or construction methods to the Construction Manager for approval prior to acquisition and use.

3.5 CQA Consultant

3.5.1 Definition

The CQA Consultant is the party, independent from Sarasota County and the Contractor, responsible for observing, testing, and documenting activities related to the CQA and CQC of the soil and geosynthetic components and other activities related to the construction at the FLSC facility as described in this CQA Plan.

3.5.2 Qualifications

The CQA Consultant shall be a well-established firm specializing in geotechnical engineering, liner and final cover system design, construction management, and CQA. The CQA Consultant shall possess the equipment, personnel, and licenses necessary to conduct the monitoring and testing activities required by this CQA Plan and the FLSC facility Construction Drawings and Technical Specifications. The CQA Consultant shall also be experienced in the installation and CQA of soil and geosynthetic materials similar to those materials to be used for the FLSC facility construction. The CQA Consultant will be experienced in the preparation of CQA documentation including CQA plans, field documentation, field testing procedures, laboratory testing procedures, construction specifications for construction, construction plans, and CQA certification reports. The CQA Consultant shall provide qualified staff for the project.

In addition, the CQA Consultant shall provide the following, in writing, to Sarasota County as required:

- corporate background and information;
- a detailed summary of the firm's CQA capabilities;
- a detailed summary of the firm's CQA experience; and
- a representative list of at least 10 completed facilities for which the CQA Consultant has provided CQA monitoring services for the installation of the corresponding geosynthetic material; for each facility, the following information will be provided:
    - name and purpose of facility, its location, and date of installation;
    - name of owner;
    - surface area of each geosynthetic material installed; and
    - telephone number of person familiar with the project.

The CQA Consultant shall provide resumes of personnel to be involved in the project including:

- the CQA Managing Engineer, who operates from the office of the CQA Consultant and who conducts periodic visits to the site as required;
- the CQA Site Manager, who is located at the site; and
- the CQA Field Monitors, who will be located at the site.

The CQA Consultant organization will be led by the CQA Managing Engineer, who will hold a baccalaureate degree in engineering and be a Professional Engineer registered to practice in the state of Florida. The CQA Site Manager will be the representative of the CQA Consultant on site and will have experience in similar construction and be specifically familiar with the construction of soil and geosynthetic components of the FLSC.

3.5.3 Responsibilities

The CQA Consultant shall be responsible for monitoring and documenting the activities of the Contractor relative to the installation of the liner and final cover system components as well as various appurtenances related to the construction at the FLSC facility. The CQA Consultant will be responsible for monitoring the compliance of construction materials delivered to the site with the submittals and/or shop drawings previously reviewed and approved by the Construction Manager. The CQA Consultant shall assure that the Contractor's construction methods and workmanship are performed in accordance with the Construction Drawings and Technical Specifications. The CQA Consultant shall be responsible for obtaining and testing samples of the various construction materials in accordance with the testing frequencies identified in this plan. The CQA Consultant shall also be responsible for obtaining, labeling, and shipping samples for off-site laboratory testing in accordance with the requirements of this plan and appropriate specifications.

The CQA Consultant shall be responsible for soils quality control testing to be performed by both the on-site and off-site testing laboratories. The CQA Consultant shall be responsible for staffing and operating the on-site soils laboratory, if required. Test results from the on-site and off-site laboratories shall be submitted to the Construction Manager within a time frame that will not impede or delay construction activities.

The on-site soils laboratory, if required, shall be equipped to perform routine index testing including, but not limited to:

- standard Proctor (ASTM D 698);
- particle-size analysis (ASTM D 422 and ASTM C 136);
- Atterberg limits (ASTM D 4318);

- moisture content (ASTM D 2216 and ASTM D 4643);
- soils classification (ASTM D 2487); and
- percent passing No. 200 sieve (ASTM D 1140).

The CQA Consultant shall also be responsible for conducting routine field tests during construction of the FLSC facility, which shall include:

- moisture content by nuclear methods (ASTM D 3017);
- in-place density by nuclear methods (ASTM D 2922);
- lift thickness by direct measurement;
- sand cone (ASTM D 1556); and
- drive cylinder (ASTM D 2937).

The CQA Consultant will be responsible for the quality control of its on-site laboratory testing program and for documenting the calibration of the soils laboratory testing equipment. Equipment calibration certificates shall be maintained in the CQA Consultant's on-site project file. All tests will be conducted in accordance with ASTM or other applicable state or federal standards. Test results shall be submitted to the Construction Manager within a time frame that will not impede or delay construction of activities.

The duties of the CQA Personnel are discussed in the following subsections.

3.5.3.1 CQA Managing Engineer

The CQA Managing Engineer:

- reviews the FLSC Construction Drawings and Technical Specifications;
- reviews soils and geosynthetics-related documents (such reviews are for familiarization and for evaluation of constructibility only);
- attends project meetings related to construction quality activities;
- administers the CQA program (i.e., assigns and manages all on-site CQA

personnel, reviews all field reports, and provides engineering review of all CQA-related activities);

- provides quality control of CQA documentation;
- reviews changes to the construction design, and assures any major changes are submitted to FDEP for approval prior to incorporation into the Construction Drawing and Technical Specifications; and
- with the CQA Site Manager, prepares the final certification report.

3.5.3.2 CQA Site Manager

The CQA Site Manager:

- acts as the on-site representative of the CQA Consultant;
- familiarizes all CQA Field Monitors with the site, project documents, and the CQA requirements;
- manages the daily activities of the CQA Field Monitors;
- attends regularly scheduled CQA-related meetings on-site;
- reviews the ongoing preparation of the construction record drawings;
- reviews test results provided by the Contractor;
- verifies the calibration and condition of on-site testing equipment;
- reviews the CQA Field Monitors' daily reports and logs;
- provides reports to the Construction Manager, and documents in a daily report any reported relevant observations by the CQA Field Monitors;
- prepares a daily report for the project;
- oversees the collection and shipping of all laboratory test samples;
- reviews results of laboratory testing and makes appropriate recommendations;

- reports any unresolved deviations from the CQA Plan and Construction Drawings and Technical Specifications to the Construction Manager;

- assists with the preparation of the final certification report;

- reviews appropriate certifications and documentation from the Contractor and the Geosynthetics Manufacturer and Installer, and makes appropriate recommendations;

- reviews the Geosynthetics Manufacturer's QC documentation;

- reviews the geosynthetics Installer's personnel qualifications for conformance with those required by the Technical Specifications; and

- performs duties of CQA Field Monitor as needed.

3.5.3.3 CQA Field Monitors

The duties of the CQA Field Monitors are monitoring and documenting construction of all soils and geosynthetics components of the FLSCs and other CCSWDC facility activities, as assigned by the CQA Site Manager.

The duties of the CQA Field Monitors will include:

- monitoring material stockpiles for any deterioration of materials;

- monitoring surface-water drainage in the areas of soil and geosynthetic material stockpiles;

- preparing daily field reports;

- recording CQA and CQC activities on field logs;

- reporting problems to the CQA Site Manager;

- assisting with collection of samples from the constructed soil components in accordance with the CQA Plan;

- monitoring soil placement and compaction operations;

- monitoring the unloading and on-site handling and storage of the geosynthetics;
- monitoring geosynthetic repair operations;
- monitoring geosynthetic material deployment and installation operations; and
- collecting conformance samples for testing by CQA laboratories.

In addition to these specific duties, all CQA Field Monitors will document any on-site activities that could result in damage to the soils or geosynthetic components of the FLSC. This is particularly true during the placement and compaction of the initial lift of soil on top of the underlying geosynthetic material. Any observations so noted by the CQA Field Monitors shall be reported immediately to the CQA Site Manager.

3.6 Soils CQA Laboratory

3.6.1 Definition

The Soils CQA Laboratory is the party, independent from Sarasota County and Contractor, responsible for conducting geotechnical laboratory tests in accordance with standards referenced in the Construction Drawings and Technical Specifications and this CQA Plan. The testing results generated by the Soils CQA Laboratory shall be used by the CQA Consultant to verify compliance of the soils construction materials with the plans and specifications and submittals previously approved by the Construction Manager.

It is anticipated that the on-site Soils CQA Laboratory will be utilized to perform the conformance evaluation testing of the various soils components at the FLSC facility. The off-site soils CQA Laboratory will be for more sensitive performance testing required during construction such as hydraulic conductivity testing which require tightly controlled laboratory conditions.

3.6.2 Qualifications

The Soils CQA Laboratory will be experienced in testing of soils similar to those proposed for use in the construction at the FLSC facility in accordance with ASTM and other applicable soil test standards. The Soils CQA Laboratory will be capable of providing test results within a maximum of 7 working days of receipt of samples and will maintain that capability throughout the duration of the earthwork construction.

Prior to construction, the Soils CQA Laboratory, if different from the CQA Consultant, shall submit their qualifications and QA/QC procedures to the Construction Manager for review and approval. The qualifications presented by the Soils CQA Laboratory shall, as a minimum, include:

- corporate background and statement of qualifications;
- list of testing capabilities including reference to ASTM test methods;
- a laboratory QA/QC plan;
- information on staff size and experience; and
- information regarding test result turnaround time.

3.6.3 Responsibilities

The Soils CQA Laboratory will be responsible for testing various soils components at the FLSC facility. These tests shall include, but not be limited to, material qualification (conformance) tests and material construction quality control (performance) tests as described in Construction Drawings and Technical Specifications. The CQA Consultant will be responsible for coordinating the Soils CQA Laboratory testing.

3.7 Geosynthetics CQA Laboratory

3.7.1 Definition

The Geosynthetics CQA Laboratory is the party, independent from Sarasota County, Contractor, and geosynthetics Manufacturer and Installer, responsible for conducting tests on samples of geosynthetic materials used in construction of the FLSC in accordance with standards referenced in the Construction Drawings and Technical Specifications and this CQA Plan. The testing results generated by the Geosynthetics CQA Laboratory shall be used by the CQA Consultant to verify compliance of the geosynthetic materials with plans and specifications and submittals previously approved by the Construction Manager.

3.7.2 Qualifications

The Geosynthetics CQA Laboratory shall hold current accreditation by Geosynthetic Research Institute (GRI) or be approved by the Design Engineer and have experience in testing geosynthetics similar to those proposed for use during construction at the FLSC facility. The Geosynthetics CQA Laboratory shall be familiar with ASTM and other applicable geosynthetic test standards. The Geosynthetics CQA Laboratory will be capable of providing destructive test results for geomembrane field seams within 24 hours of receipt of samples and will maintain that capability throughout the duration of geosynthetic material installation.

Prior to construction, the Geosynthetics CQA Laboratory, if different from the CQA Consultant, shall submit their qualifications to the Construction Manager for review and approval. The qualifications presented by the Geosynthetics CQA Laboratory shall, as a minimum, include:

- corporate background and statement of qualifications;
- listing of testing capabilities including reference to ASTM or other applicable test methods;
- a laboratory QA/QC plan;
- information on staff size and experience; and
- information regarding test result turnaround time.

3.7.3 Responsibilities

The Geosynthetics CQA Laboratory will be responsible for testing various geosynthetic components of the FLSC. These tests shall include, but not be limited to, geosynthetic conformance and performance tests and destructive testing of the geomembrane field seams as described in the Construction Drawings and Technical Specifications. The CQA Consultant will be responsible for coordinating the Geosynthetics CQA Laboratory testing.

3.8 Geosynthetics Manufacturers

The geosynthetics Manufacturers are the firms or corporations responsible for production of the geosynthetic materials to be used in construction at the FLSC facility. The geosynthetics Manufacturers shall be able to provide sufficient production capacity and qualified personnel to meet the demands of the project schedule. Prior to shipment of any material to the site, each geosynthetics Manufacturer shall be pre-qualified and approved by the Construction Manager. The geotextile, geomembrane, geocomposite and GCL Manufacturers shall meet the qualifications outlined in the Technical Specifications, respectively.

Each geosynthetics Manufacturer is responsible for the production and quality control of its respective geosynthetic product. In addition, each geosynthetics Manufacturer is responsible for the condition of the geosynthetic until the material is accepted by the Contractor. Each geosynthetics Manufacturer shall produce a consistent high quality product that shall meet all the requirements of the Technical Specifications. Each geosynthetics Manufacturer shall submit quality control documentation to the Construction Manager for its respective products as required by the Technical Specifications.

3.9 Geosynthetics Installers

The geosynthetics Installers will be experienced and qualified to install the geosynthetic materials of the type specified for this project. The geosynthetics Installers will be approved and/or licensed by the geosynthetics Manufacturers. A copy of the approval letter or license will be submitted by the Contractor to the Construction Manager as required by the Technical Specifications. The geosynthetics Installers shall meet the qualifications outlined in the Technical Specifications. The geosynthetics Installers will designate one representative as its supervisor, who will be responsible for acting as the geosynthetics Installer's spokesman on site. The geosynthetics Installers will provide the Construction Manager with a list of proposed seaming personnel and their qualifications. This document will be reviewed by the CQA Consultant. Final approval of the geosynthetic Installer's geomembrane seaming personnel will be the responsibility of the Construction Manager. Any proposed seaming personnel deemed insufficiently experienced will not be accepted. The most experienced seamer, the "master seamer", shall provide direct supervision, as required, over less experienced seamers. No field seaming shall take place without the master seamer being present.

The geosynthetics Installer's supervisor will be responsible for installation of the geosynthetics used in construction at the FLSC facility and for providing supervision and guidance to the installation crew. The geosynthetics Installer's supervisor is also responsible for the following: (i) obtaining samples, as required by the CQA Plan and the specifications; (ii) field testing; (iii) documenting quality control testing activities; and (iv) coordinating the geosynthetics installation activities with the Construction Manager. The geosynthetics Installer's supervisor will be responsible for documenting the geosynthetics installation activities, including, but not limited to, on-site personnel, material inventories, production figures, test results, installation deficiencies, and resolution of construction problems.

3.10 Surveyor

The Surveyor is responsible for lines and grades required for control of the work on an ongoing basis during all phases of the FLSC facility construction. Close interaction between the Surveyor, Contractor, and the CQA Consultant is essential to ensure that construction at the FLSC facility is completed in accordance with the Construction Drawings and Technical Specifications. The project Surveyor shall be a state of Florida licensed Professional Land Surveyor or registered Professional Engineer who shall sign and seal all construction survey record drawings. All surveying personnel shall be experienced in the provision of surveying services, including detailed accurate documentation as required in the Technical Specifications. The Surveyor is responsible for all surveying activities and products in accordance with the Technical Specifications.

4. DOCUMENTATION

4.1 Overview

An effective CQA Plan depends largely on recognition of all construction activities that should be monitored and the assignment of responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance and quality control activities. The CQA Consultant shall be responsible for assuring that the Contractor's quality control requirements have been addressed and satisfied.

The CQA Site Manager shall provide the Construction Manager descriptive daily field reports, data sheets, and logs, as requested, which document that monitoring activities have been accomplished. Examples of some of the forms that will be used to document CQA activities are included in Attachment A. The CQA Site Manager shall also maintain at the job site a complete file of Construction Drawings and Technical Specifications, this CQA Plan, the Contractor's Quality Control Plan(s), checklists, test procedures, daily logs, and other pertinent construction and CQA documents.

4.2 Daily Record Keeping

The CQA Consultant's daily reporting procedures shall include: (i) daily summary report; (ii) monitoring logs; (iii) testing data sheets; and (iv) when appropriate, problem identification and corrective measures reports.

4.2.1 Daily Summary Reports

The CQA Consultant's daily summary reports shall include the following information as applicable:

- an identifying sheet number for cross referencing and document control;
- date, project name, location, and other pertinent project identification;
- data on weather conditions;
- summary on meetings held and their results;

- process description(s) and location(s) of construction activities underway during the time frame of report;

- descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;

- description of locations where tests and samples were taken;

- a narrative summary of field test results;

- off-site materials received, including quality control documentation;

- decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard testing results;

- identifying sheet numbers of data sheets and/or problem reporting and corrective measures reports used to substantiate the decisions described above; and

- signature of the respective CQA Site Manager and/or the CQA Field Monitor.

4.2.2 CQA Monitoring Logs and Test Data Sheets

Monitoring observations, sampling information, and test results shall be recorded on the appropriate monitoring logs and test data sheets. The CQA Consultant shall use the monitoring logs and test data sheets to ensure completeness of the required CQA activities. Any corrections to the monitoring logs and test data sheets shall be single line crossed out, initialed by the CQA personnel responsible for the correction and dated. Examples of relevant monitoring logs are presented in Attachment A.

The CQA Consultant's monitoring logs and test data sheets shall include the following information as applicable:

- project specific information such as project name, location;

- the date the CQA activity was performed;

- a unique identifying sheet number for cross-referencing and document control;

- description or title of the CQA activity or test procedure;
- location of the CQA activity or location from which the sample was obtained;
- type of CQA activity or procedure used (reference to standard method when appropriate);
- recorded observation or test data, with all necessary calculations;
- results of the CQA activity and comparison with specification requirements (pass/fail); and
- the initials or signature of personnel involved in CQA inspection activity.

4.2.3 Nonconformance Identification and Reporting

A nonconformance is defined herein as material or workmanship that does not meet the specified requirement(s). Nonconformance identification and corrective measures reports should be cross-referenced to specific summary reports, logs, or test data sheets where the nonconformance was identified. The reports should include the following information as applicable:

- a unique identifying sheet number for cross-referencing and document control;
- detailed description of the problem;
- location of the problem;
- probable cause;
- how and when the problem was located;
- estimation of how long problem has existed;
- suggested corrective measures;
- documentation of corrections (reference to inspection data sheets);
- suggested methods to prevent similar problems; and

- signature of the appropriate CQA Field Monitor and concurrence by the CQA Site Manager.

In some cases, not all of the above information will be available or obtainable. However, when available, such efforts to document nonconformances could help to avoid similar nonconformances in the future. The CQA Site Manager shall distribute copies of the report to the Construction Manager for further actions.

4.3 Photographic Documentation

The CQA Site Manager will be responsible for obtaining photographic documentation of the Contractor's activities, materials installation methods, and testing procedures. Photographs will serve as a pictorial record of work progress, problems, and corrective measures. Photographic reporting data sheets should be utilized to organize and document photographs taken during construction at the FLSC facility. Such data sheets could be cross-referenced or appended to summary reports, CQA monitoring logs, or test data sheets and/or problem identification and corrective measures reports. At a minimum, photographic reporting data sheets should include the following information:

- a unique identifying number on data sheets and photographs for cross-referencing and document control;
- person responsible for photograph;
- the date and location where the photograph was taken; and
- location and description of the work;

These photographs will serve as a pictorial record of work progress, problems, and corrective measures. Color prints shall be organized chronologically and kept in a permanent protective file. Negatives and/or digital files shall be stored in a separate protective file.

4.4 Design and/or Specifications Changes

Design and/or specifications changes may be required during construction. In cases of Contractor initiated changes, the Contractor must submit written requests for such changes to the Construction Manager. The Design Engineer shall review and respond to these requests in a timely manner. All design and/or specifications changes will be made only with the approval of the Engineer of Record and Design Engineer and approval by FDEP if required. Such changes will take the form of a change order to the contract if required.

4.5 Nonconformances

The Construction Manager will be informed in writing of any significant recurring nonconformance with the Construction Drawings, Technical Specifications, or CQA Plan by the CQA Consultant. The cause of the nonconformance will be determined by the CQA Consultant. The Contractor will be directed by the Construction Manager to make appropriate changes in materials or procedures in order to correct the nonconformance. When this type of evaluation is made, the results will be documented, and any revision to procedures or specifications must be approved by the Design Engineer.

4.6 CQA Certification Report

At the completion of construction phases, the CQA Consultant will provide Sarasota County with a construction phase final certification report for submittal to FDEP. This report will acknowledge: (i) that the work has been performed in compliance with the approved Construction Drawings, Technical Specifications, and approved modifications; (ii) physical sampling and testing has been conducted at the appropriate frequencies; and (iii) that the summary documentation provides the necessary supporting information.

At a minimum, this report will include:

- summary of CQA activities;
- CQA monitoring logs and testing data sheets including sample location plans;
- laboratory test results;
- problem identification and reports of corrective measures reports;
- a descriptive summary of any changes to the Construction Drawings or Technical Specifications; and
- a summary statement indicating compliance with the Construction Drawings or

Technical Specifications and any approved changes that are signed and sealed by the CQA Managing Engineer.

The record drawings, which 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.), and a geomembrane panel drawing prepared by the CQA Consultant will also be included as part of the final certification report.

4.7 Storage of Records

The CQA Site Manager will be responsible for all CQA document storage during the construction at the FLSC facility. This includes the CQA Consultant's copy of the Construction Drawings and Technical Specifications, the CQA Plan, and the originals of all the data sheets and reports. When the FLSC facility construction is complete and upon issuance of the final certification report, the CQA document originals will be organized and retained by the CQA Consultant until requested by Sarasota County. Required records shall include, but not be limited to, field logbooks, other data collections forms, equipment calibration records, costs data, drawings, maintenance records, and all associated reports.

5. SOILS CONSTRUCTION

5.1 Introduction

CQA monitoring and testing shall be performed during installation of the liner system, the final cover system, and other earthwork components. Criteria to be used for determination of acceptability of the various soil components are identified in the Construction Drawings and Technical Specifications and this CQA Plan.

5.2 Soil Components

General fill is the principal soil component used in the FLSC facility construction. A varying thickness of compacted general fill will be constructed below the FLSC facility liner system. In addition, general fill material is also used for earthwork related to perimeter berm construction. All general fill placement, grading, and compaction will be monitored and tested in accordance with the Construction Drawings, Technical Specifications, and this CQA Plan.

5.3 Record Drawings and As-Built Surveys

During construction of the soil components at the FLSC facility, the CQA Consultant shall routinely review record drawings submitted by the Contractor. The drawings are used to verify location of work, percent of work completed, layer thickness, or final grades. Prior to the placement of successive soil or geosynthetic layers the CQA Consultant shall review as-built surveys that indicate compliance of the preceding layer thickness, lines, and grades. Once an as-built survey has been received, it will be the responsibility of the CQA Consultant to review the information in a timely manner and notify the Contractor of any noncompliance.

5.4 Related Construction Drawings and Technical Specifications

Several sections of the Technical Specifications should be referenced by the CQA Consultant for pertinent soil materials physical properties and construction requirements. Related specifications include the following:

- Section 02100 - Surveying;
- Section 02110 - Clearing, Grubbing & Stripping;

- Section 02200 - Earthwork;
- Section 02215 - Trenching and Backfilling;
- Section 02235 - Drainage Gravel;
- Section 02245 - Riprap;
- Section 02290 - Erosion & Sediment Control; and
- Section 02920 - Vegetative Layer.

Prior to the start of soils construction, the CQA Consultant shall review the information required by the Technical Specifications listed above. Compliance of the submittals with the Technical Specifications shall be determined by the Construction Manager.

5.5 Subgrades

During construction, monitoring of the subgrade preparation shall be performed by the CQA Consultant. The CQA Consultant shall monitor to assure a firm and smooth surface that is free of vegetation and other deleterious materials is achieved. Material placed to achieve grades indicated on the Construction Drawings shall be monitored by the CQA Consultant to verify that the subgrade material and fill placement, grading, and compaction complies with the Technical Specifications. Areas that do not meet the Technical Specifications will be delineated, and nonconforming areas will be reworked by the Contractor. This process will be repeated until acceptable results are achieved.

The CQA Consultant shall monitor the repair and rework of fill material that is damaged by excess moisture (causing softening). If such conditions are found to exist, the CQA Consultant shall evaluate the suitability of the subgrade by the following methods as applicable:

- moisture/density testing; and/or
- continuous visual inspection during proof-rolling.

5.6 Conformance Testing

It will be necessary for the CQA Consultant to observe and test the soil components to ensure they are uniform and conform to the requirements of the Technical Specifications. For soil materials obtained from on-site sources, visual inspections and conformance tests shall be performed by the CQA Consultant prior to the materials being used. If soil materials are obtained from off site borrow sources, visual inspection and conformance tests shall be performed at the source location or as the materials arrive at the FLSC site. Borrow area inspections may also be utilized by the CQA Consultant to ensure that only suitable soil materials are transported to the FLSC site. For off-site borrow areas containing non-uniform materials, it shall be necessary for the Contractor and the CQA personnel to coordinate excavation and monitoring of the segregation of substandard materials. All materials failing to comply with conformance standards shall be rejected for use at the FLSC facility.

Initial evaluation of various soil types by CQA personnel during construction shall be largely visual; therefore, the CQA personnel must be experienced with visual-manual soil classification procedures. CQA personnel shall be aware that changes in color or texture can be indicative of a change in soil type. CQA personnel shall observe soils for deleterious materials (e.g., roots, stumps, and large objects). When necessary, the visual-manual procedure for the description and identification of soils shall be conducted by the CQA Consultant in accordance with test method ASTM D 2488.

5.6.1 Test Methods

Conformance tests used to evaluate the suitability of soil materials during construction shall be performed in accordance with the current ASTM or other applicable test procedures indicated in Table 5-1. Documentation and reporting of the test results shall be the responsibility of the CQA Consultant.

The standard Proctor test (ASTM D 698) shall be used for the evaluation of moisture/density relationships unless otherwise indicated. Any conflict regarding acceptance of test results shall be resolved by the Design Engineer.

5.6.2 Test Frequency

The frequency of conformance tests shall conform to the minimum frequencies presented in Table 5-1. The frequency of testing may be increased at the discretion of the CQA Consultant or if variability of the materials is observed. The testing frequencies described herein for general fill shall also apply to materials used by the Contractor in areas outside the limits of the liner and final cover systems at the FLSC facility.

5.7 Construction Monitoring

During installation of the various soil components, the CQA Consultant shall visually observe and document the Contractor's earthwork activities for the following:

- changes in the soil consistency;
- the thickness of lifts as loosely placed and as compacted;
- soil conditioning prior to placement including general observations regarding moisture distribution, clod size, etc.;
- placement method which may damage or cause displacement or wrinkling of geosynthetics;
- the action of the compaction and heavy hauling equipment on the construction surface (sheepsfoot penetration, pumping, cracking, etc.);
- the number of passes used to compact each lift;
- desiccation cracks or the presence of ponded water; and
- final lift or layer thickness.

5.8 Performance Testing

During construction, the CQA Consultant shall observe and test all soil components to ensure they are installed in accordance with the requirements of the Construction Drawings and Technical Specifications. The CQA Consultant shall also evaluate the procedures, methods, and equipment used by the Contractor to install the various soil components.

5.8.1 Test Methods

All performance testing shall be conducted in accordance with the Technical Specifications or as directed by the Design Engineer. The field testing methods, used to evaluate the suitability of soils during their installation, shall be performed by the CQA Consultant in accordance with current ASTM test procedures indicated in Table 5-2. Documentation and reporting of the test results shall be the responsibility of the CQA Consultant.

The standard Proctor test (ASTM D 698) shall be used for the evaluation of moisture/density relationships unless otherwise indicated. In-place surface moisture/density by nuclear test methods (ASTM D 3017 and D 2922) shall be used for in-situ field testing. The sand cone test method (ASTM D 1556) or drive cylinder test method (ASTM D 2937) shall be used to establish correlations of moisture and density in cases of uncertainty, and as a check of the nuclear surface moisture/density gauge calibration. Any conflict regarding acceptance of test results shall be resolved by the Design Engineer.

5.8.2 Test Frequency

Performance testing shall be conducted during the course of the work. The minimum construction performance testing frequencies are presented in Table 5-2. The frequency may be increased at the discretion of the CQA Consultant or if variability of the materials is observed by the CQA Consultant. Sampling locations shall be selected by the CQA Consultant. If necessary, the location of routine in-place density tests shall be selected using a non-biased sampling approach.

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

- rollers slip during rolling operations;
- lift thickness is greater than specified;
- material is at improper and/or variable moisture content;
- it is suspected that less than the specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- rollers may not have used optimum ballast;
- there is change to subgrade condition since subgrade approval;
- fill materials differ substantially from those specified;
- the degree of compaction is doubtful; and
- as directed by the Design Engineer or the Construction Manager.

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

- adverse weather conditions;
- breakdown of equipment;
- at the start and finish of grading;
- material fails to meet specifications; and
- the work area is reduced.

5.9 Deficiencies

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

As soon as possible, after determining the extent and nature of substandard materials, noncompliant construction practice, or other such deficiency in materials or workmanship which cannot be immediately resolved on-the-spot, the CQA Consultant shall notify the Construction Manager and Contractor and schedule appropriate retests when the work deficiency is to be corrected.

The CQA Consultant shall verify that the Contractor has corrected all noted deficiencies. If a specified criterion cannot be met, or unusual weather conditions hinder work, the Contractor shall submit suggested solutions or alternatives to the Construction Manager for review.

At locations where the field testing indicates in-situ conditions which do not comply with the requirements of the Technical Specifications, the failing area shall be reworked to the satisfaction of the CQA Consultant. Alternatively, at the CQA Consultant's option, undisturbed samples of in-place material shall be obtained for appropriate testing. All retests performed by the CQA Consultant must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

5.10 Documentation

The documentation of soils CQA testing activities is an important factor in assuring the successful construction, performance, and approval of the soil components of the FLSC facility. The CQA monitoring observations, sample location descriptions, field test results, and on-site laboratory test results shall be documented by the CQA Consultant on forms specifically designed for their purpose. Reports and forms shall be submitted to the Construction Manager as requested.

TABLE 5-1

MINIMUM CONFORMANCE TESTING FREQUENCIES FOR FLSC SOIL COMPONENTS

TEST NAME/ TEST METHOD	GENERAL FILL
SPECIFICATION SECTION	02200
Particle Size Analysis/ASTM D 422	1 test per 5,000 yd^3
Particle Size Analysis/ASTM C 136	N/A
Soil Classification/ASTM D 2487	1 test per 5,000 yd^3
Standard Proctor/ASTM D 698	1 test per 5,000 yd^3

N/A = Not Applicable

TABLE 5-2

MINIMUM PERFORMANCE TESTING FREQUENCIES FOR FLSC SOIL COMPONENTS

TEST NAME/ TEST METHOD	SOIL TYPE: GENERAL FILL/ MISC. SOILS
SPECIFICATION SECTION	02200
In-Situ Moisture/ASTM D 3017	5 tests per acre per lift[1] or 1 test per 200 lf per lift
In-Situ Density/ASTM D 2922	5 tests per acre per lift[1] or 1 test per 200 lf per lift and 1 test per 500 lf of pipeline trench
Sand Cone/ASTM D 1556 or Drive Cylinder/ASTM D 2937	1 test per 25 nuclear tests or 1 test per 200 lf per lift

N/A = Not Applicable

NOTE: 1. A minimum of two nuclear moisture and density tests each day of active soils construction

6. GEOMEMBRANE

6.1 Introduction

The CQA Consultant shall perform conformance and destructive seam testing and shall monitor the installation of geomembranes as required by Section 02770 of the Technical Specifications and this CQA Plan. The testing used to evaluate the conformance of the geomembrane sheet and seams with the requirements of the Technical Specifications shall be carried out by the CQA Consultant in accordance with the current versions of the ASTM or other applicable test procedure indicated in Tables 6-1 and 6-2.

6.2 Manufacturing Plant Visit

At the request of Sarasota County, the CQA Consultant, or authorized representative, shall visit the plant of the geomembrane Manufacturer for the purpose of collecting conformance samples and verifying that manufacturing quality control procedures are in conformance with Section 02770 of the Technical Specifications. If possible, such a visit shall be performed prior to or during the manufacturing of the geomembrane rolls for the FLSC facility project. The CQA Consultant shall review the manufacturing process, quality control procedures, laboratory facilities, and testing procedures.

During the project specific plant visit, the CQA Consultant shall:

- verify that properties guaranteed by the geomembrane Manufacturer meet all specifications;
- verify that the measurements of properties by the geomembrane Manufacturer are properly documented and test methods used are acceptable;
- spot inspect the rolls and verify that they are free of holes, blisters, or any sign of contamination by foreign matter;
- review packaging and transportation procedures to verify that these procedures are not damaging the geomembrane;
- verify that all rolls are properly labeled; and

- verify that extrusion rods and/or beads manufactured for the field seaming of the geomembrane are derived from the same base resin type as the geomembrane.

Upon completion of the manufacturing plant visit, a report describing the findings and observations shall be completed by the CQA Consultant and shall be included as an attachment to the final certification report.

6.3 Transportation, Handling and Storage

The CQA Consultant shall monitor the transportation, handling, and storage of the geomembrane on-site. The Construction Manager shall designate a geomembrane storage location. It will be the responsibility of the Contractor to protect the geomembrane stored on site from theft, vandalism, and damage.

Upon delivery at the site, the Contractor, Installer, and CQA Consultant shall conduct an inspection of the rolls for defects and damage. This inspection shall be conducted without unrolling the materials unless defects or damages are found or suspected. The CQA Consultant shall indicate to the Construction Manager:

- rolls, or portions thereof, which should be rejected and removed from the site because they have severe or nonrepairable flaws which may compromise geomembrane quality; and

- rolls that include minor and repairable flaws that do not compromise geomembrane quality.

The CQA Consultant shall also monitor that equipment used to handle the geomembrane on-site is adequate and does not pose any risk of damage to the geomembrane when used properly.

6.4 Conformance Testing

6.4.1 Sampling Procedures

Upon delivery of the geomembrane rolls to the FLSC facility, the CQA Consultant shall ensure that representative geomembrane conformance samples are obtained at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing.

Geomembrane conformance samples shall be taken across the entire width of the roll and shall not include the first 3 ft of material. Unless otherwise directed by the Design Engineer, samples shall be 3 ft long by the roll width. The required minimum geomembrane conformance sampling frequencies are provided in Table 6-1. The CQA Consultant shall mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA personnel identification.

6.4.2 Testing Procedures

Conformance testing of the geomembrane materials delivered to the site will be conducted to ensure compliance with both the Technical Specifications and the Manufacturer's list of minimum average roll values. As a minimum, the geomembrane conformance test procedures listed in Table 6-1 shall be performed by the Geosynthetics CQA Laboratory.

6.4.3 Test Results

All conformance test results shall be reviewed, accepted, and reported by the CQA Consultant before deployment of the geomembrane. Any non-conformance of the material's properties with the requirements of the Technical Specifications shall be reported to the Construction Manager. In all cases, the test results shall meet, or exceed, the property values listed in Attachment B.

6.4.4 Conformance Test Failure

In the case of failing test results, the Contractor may request that another sample from the failing roll be retested by the Geosynthetics CQA Laboratory with the

Manufacturer's technical representative present during the test procedure. If the retest fails or if the option to retest is not exercised, then two isolation conformance samples shall be obtained by the CQA Consultant. These isolation samples shall be taken from rolls, which have been determined by correlation with the manufacturer's roll number, to have been manufactured prior to and after the failing roll. This method for choosing isolation rolls for testing should continue until passing tests are achieved. All rolls that fall numerically between the passing roll numbers shall be rejected. The CQA Consultant will verify that the Contractor has replaced all rejected rolls. The CQA Consultant shall document all actions taken in conjunction with geomembrane conformance failures.

6.5 Anchor Trench

The CQA Consultant shall verify and document that the anchor trench has been constructed as indicated in the Construction Drawings. The amount of anchor trench open at any time shall be limited to one day of geomembrane installation capacity. The anchor trench shall be constructed with proper drainage to prevent ponding.

Geosynthetic materials in the anchor trench shall be temporarily anchored with sand bags or other suitable methods approved by the CQA Consultant. The anchor trench shall be backfilled with suitable material as indicated in the Construction Drawings and Technical Specifications as soon as possible after all geosynthetics are installed. In-place moisture/density by nuclear methods testing of the compacted anchor trench backfill shall be performed at a frequency of one per 100 lineal feet of anchor trench.

The anchor trench shall be constructed with a slightly rounded corner where the geosynthetics enter the trench. No loose soil shall be allowed to underlie the geosynthetics in the anchor trench. The CQA Consultant shall verify that all temporary ballast (i.e., sandbags) and deleterious materials are removed from the anchor trench prior to backfilling. Backfilling of the anchor trench shall be performed when the geomembrane is in its most contracted state to prevent stress inducement and using extreme care to prevent any damage to the geosynthetic materials.

6.6 Geomembrane Placement

6.6.1 Field Panel Identification

A field panel is a piece of geomembrane larger than approximately 10 ft^2, which is to be seamed in the field, i.e., a field panel is a roll or a portion of roll cut in the field. The CQA Consultant shall assure that each field panel is given an "identification code" (number or letter-number) consistent with the as-built layout plan. This identification code shall be agreed upon by the Installer and CQA Consultant. This field panel identification code shall be as simple and logical as possible. The geosynthetic Manufacturer's roll numbers shall be traceable to the field panel identification code.

The CQA Consultant shall document the correspondence between roll numbers, factory panels, and field panel identification codes. The field panel identification code shall be used for all quality assurance/quality control records.

6.6.2 Field Panel Placement

The CQA Consultant shall monitor that field panels are installed substantially at the location indicated in the Installer's layout plan, as approved or modified. The CQA Consultant shall record the field panel identification code, Manufacturer's roll number, location, date of installation, time of installation, and dimensions of each field panel.

Geomembrane placement shall not proceed at an ambient temperature below 40°F or above 104°F unless authorized by the Design Engineer. Geomembrane placement shall not proceed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds. The CQA Consultant shall monitor that the above conditions are fulfilled and that the supporting soil has not been damaged by adverse weather conditions.

The CQA Consultant shall monitor geomembrane deployment for the following:

- any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means;
- the prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement;

- any geosynthetic elements immediately underlying the geomembrane are clean and free of foreign objects or debris;

- all personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane;

- the method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;

- the method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);

- adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, continuous loading, e.g., by adjacent sand bags, is recommended along edges of panels to minimize risk of wind flow under the panels); and

- direct contact with the geomembrane is minimized; i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

The CQA Consultant shall observe the geomembrane panels, after placement and prior to seaming, for damage. The CQA Site Manager shall advise the Construction Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected shall be marked and their removal from the work area recorded by the CQA Consultant. Repairs shall be made according to procedures described in this Section.

6.7 Field Panel Seaming

6.7.1 Panel Layout

The CQA Consultant shall review the panel layout drawing previously submitted to the Construction Manager by the Installer and verify that it is consistent with accepted state of practice. In general, seams should be oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 ft beyond the toe or shoulder of the slope, or areas of potential stress concentrations, unless otherwise authorized by the Design Engineer. A seam numbering system compatible with the field panel identification numbering system shall be agreed upon prior to any seaming.

6.7.2 Seaming Equipment and Products

Approved processes for field seaming are extrusion welding and fusion welding. Proposed alternate processes shall be documented and submitted to the Construction Manager for approval. Only equipment which have been specifically recommended by the geosynthetics Manufacturer by make and model shall be used. All seaming equipment shall be permanently marked with an identification number.

6.7.2.1 Fusion Process

The fusion-welding apparatus must be automated, self-propelled devices. The fusion-welding apparatus shall be equipped with gauges giving the applicable temperatures and welding speed. The CQA Consultant shall monitor ambient temperatures, geomembrane surface temperatures, apparatus speed, and apparatus temperatures at appropriate intervals.

The CQA Consultant shall also monitor that:

- the number of spare operable seaming apparatus agreed by the Construction Manager are maintained on site;
- equipment used for seaming will not damage the geomembrane;
- the seaming zone is dry and clean;
- there is sufficient overlap between panels;
- the electric generator is placed on a smooth base such that no damage occurs to the geomembrane;
- for cross seams, the edge of the cross seam is ground to a smooth incline (top and bottom) prior to welding;
- an insulating material is placed beneath the hot welding apparatus after usage;

and

- a movable protective layer is used, as necessary, directly below each overlap of geomembrane that is to be seamed to prevent build-up of moisture between the sheets.

6.7.2.2 Extrusion Process

The extrusion-welding apparatus shall be equipped with gauges giving the temperature in the apparatus and at the nozzle. The CQA Consultant shall verify that the extrudate is comprised of the same resin as the geomembrane sheeting. The CQA Consultant shall monitor extrudate temperatures, ambient temperatures, and geomembrane surface temperatures at appropriate intervals.

The CQA Consultant shall also monitor that:

- the number of spare operable seaming apparatus agreed by the Construction Manager are maintained on site;
- equipment used for seaming is not likely to damage the geomembrane;
- the seaming zone is dry and clean;
- the extruder is purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel;
- the electric generator is placed on a smooth base such that no damage occurs to the geomembrane; and
- an insulating material is placed beneath the hot welding apparatus after usage.

6.7.3 Seam Preparation

The CQA Consultant shall monitor that:

- prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;

- seams are overlapped a minimum of 4 inches;
- if seam overlap grinding is required, the process is completed according to the geosynthetics Manufacturer's instructions or Section 02770 of the Technical Specifications, whichever is the more stringent, prior to the seaming operation, and in a way that does not damage the geomembrane;
- the grind depth shall not exceed 10 percent of the geomembrane thickness;
- grinding marks shall not appear beyond the extrudate after it is placed; and
- seams are aligned with the fewest possible number of wrinkles and "fishmouths".

6.7.4 Weather Conditions for Seaming

The normally required weather conditions for seaming are as follows:

- Unless authorized by the Design Engineer, no seaming shall be attempted at an ambient temperature below 40°F or above 104°F.
- Between ambient temperatures of 40°F and 50°F, seaming is possible if the geomembrane is preheated by either sun or hot air device, and if there is no cooling of the geomembrane to below 50°F resulting from wind.
- In all cases, the geomembrane seam areas shall be dry and protected from rain and wind.

The CQA Consultant shall verify that methods used by the Installer for seaming at ambient temperatures below 40°F or above 104°F will produce seams that are entirely equivalent to seams produced at ambient temperatures between 40°F and 104°F and protect the overall quality of the geomembrane. The CQA Consultant shall monitor that seaming conducted during abnormal weather conditions is performed in accordance with the methods approved by the Design Engineer.

6.7.5 Overlapping and Temporary Bonding

The CQA Consultant shall monitor that:

- the panels of geomembrane have a finished overlap of a minimum of 4 in. for both extrusion and fusion welding, but in any event sufficient overlap shall be provided to allow peel tests to be performed on the seam;

- no solvent or adhesive is used; and
- the procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any spot welding apparatus is controlled such that the geomembrane is not damaged.

6.7.6 Trial Seams

The CQA Consultant shall verify that the Installer performs trial seam tests in accordance with Section 02770 of the Technical Specifications. The CQA Consultant shall observe and document the Installer's trial seam testing procedures. The trial seam samples shall be assigned an identification number and marked accordingly by the CQA Consultant. Each sample shall be marked with the date, time, machine temperature(s) and setting(s), number of seaming unit, and name of seaming technician. Trial seam samples shall be maintained until destructive seam testing of the applicable seams are tested and pass.

6.7.7 General Seaming Procedures

No geomembrane seaming shall be performed unless the CQA Consultant is on-site. The CQA Consultant shall monitor the general seaming procedure used by the installer as follows:

- If required for fusion welding, a movable protective layer of plastic will be placed directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture build-up between the sheets to be welded.
- If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.
- Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be

patched with an oval or round patch of the same geomembrane extending a minimum of 6 in. beyond the cut in all directions.

- If seaming operations are carried out at night, adequate illumination shall be provided by the Contractor/Installer to the satisfaction of the CQA Consultant.

- Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

6.7.8 Nondestructive Seam Continuity Testing

The CQA Consultant shall monitor that the Installer shall nondestructively test all field seams over their full length using a vacuum test unit or air pressure test (for double fusion seams only). Spark testing will be performed if the seam cannot be tested using the vacuum or air pressure test methods. The purpose of nondestructive tests is to check the continuity of seams. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. The CQA Consultant shall:

- monitor nondestructive testing;

- document the results of the nondestructive testing; and

- inform the Contractor and Construction Manager of any noncompliance.

Any required seam repairs shall be made in accordance with the Technical Specifications. The CQA Consultant shall:

- observe the repair procedures;

- observe the retesting procedures; and

- document the results.

The seam number, date of observation, dimensions and/or descriptive location of the seam length tested, name of person performing the test, and outcome of the test shall be recorded by the CQA Consultant.

6.7.9 Destructive Testing

Destructive seam testing shall be performed during the geomembrane installation. The purpose of this testing is to evaluate seam strength. Destructive seam testing shall be done as the seaming work progresses, not at the completion of all field seaming.

6.7.9.1 Location and Frequency

The CQA Consultant shall select all destructive seam test sample locations. Sample locations shall be established as follows.

- A minimum frequency of one test location per 200 ft of seam length. This minimum frequency is to be determined as an average taken throughout the entire facility. This minimum frequency will be decreased for seams made outside the normal ambient temperature range of 40°F to 104°F.

- Test locations shall be determined during seaming at the CQA Consultant's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding.

The Installer shall not be informed in advance of the locations where the seam samples will be taken.

6.7.9.2 Sampling Procedures

Destructive seam testing shall be performed as the seaming progresses in order to obtain the Geosynthetic CQA Laboratory test results before the geomembrane is covered by overlying materials. The CQA Consultant shall:

- observe sample cutting;

- assign a number to each sample, and mark it accordingly; and

- record sample location on geomembrane panel layout drawing.

All holes in the geomembrane resulting from destructive seam test sampling shall be immediately repaired in accordance with repair procedures described in

Section 02770 of the Technical Specifications. The continuity of the new seams in the repaired area shall be nondestructively tested as described in this Section.

6.7.9.3 Size of Samples

At a given sampling location, two types of samples (field test samples and laboratory test samples) shall be taken. First, a minimum of two field samples or test strips should be taken for field testing. Each of these test strips shall be 1 in. wide by 12 in. long, with the seam centered parallel to the width. The distance between these two specimens shall be 42 in. If both specimens pass the field test described in this Section, a second full laboratory destructive sample shall be taken for testing by the Geosynthetics CQA Laboratory.

The full destructive sample shall be located between the two field test strips. The sample shall be 12 in. wide by 42 in. long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

- one 12 in. by 12 in. portion to the Installer;
- one 12 in. by 12 in. portion to the Construction Manager for archive storage; and
- one 12 in. by 18 in. portion for Geosynthetics CQA Laboratory testing.

6.7.9.4 Field Testing

The test strips shall be tested in the field, for peel adhesion, using a gauged tensiometer. In addition to meeting the strength requirements outlined in Attachment B, all specimens shall exhibit a Film Tear Bond and shall not fail in the weld. If any field test sample fails to meet these requirements, the destructive sample has failed.

The CQA Consultant shall witness all field tests and mark all samples and portions with their number. The CQA Consultant shall also log the date, number of seaming unit, seaming technician identification, destructive sampling, and pass or fail description.

6.7.9.5 Geosynthetics CQA Laboratory Testing

Destructive test samples shall be tested by the Geosynthetics CQA Laboratory. Testing shall include "Bonded Seam Strength" and "Peel Adhesion" (ASTM D 6932). The minimum acceptable values to be obtained in these tests are presented in Attachment B. At least five specimens shall be tested for each test method. Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear...). Both the inside and outside tracks of the double track fusion seams shall be tested for peel adhesion. A passing test shall meet the minimum required values in at least four out of five specimens.

The Geosynthetics CQA Laboratory shall provide test results no more than 24 hours after they receive the samples. The CQA Site Manager shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Construction Manager.

6.7.9.6 Procedures for Destructive Test Failure

The following procedures shall apply whenever a sample fails a destructive test, whether that test was conducted in the field or by the Geosynthetics CQA Laboratory. The CQA Consultant will monitor that the Installer follows one of the two options below:

- The Installer can reconstruct the seam (e.g., remove the old seam and reseam) between any two passed destructive test locations or between points judged by the CQA Consultant to represent conditions of the failed seam (e.g., a tie-in seam or a seam made by the apparatus and/or operator used in the failing seam);or

- The Installer can trace the welding path to an intermediate location a minimum of 10 ft from the point of the failed test in each direction and take a small sample for additional field testing in accordance with the destructive test procedure at each location. If these additional isolation samples pass the field test, then full laboratory samples are taken at both locations. If these laboratory samples meet the specified strength criteria, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed or repaired.

All failed seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken or the entire seam is reconstructed and retested. In cases exceeding 150 ft of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing. Repairs shall be made in accordance with this section. The CQA Consultant shall document all actions taken in conjunction with destructive test failures.

6.8 Defects and Repairs

6.8.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the CQA Consultant for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The Construction Manager shall require the geomembrane surface to be broomed or washed by the Contractor if the amount of dust or mud inhibits examination.

6.9 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the geosynthetics Installer in accordance with Section 02770 of the Technical Specifications. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Installer and CQA Consultant.

In addition, the following conditions shall be monitored by the CQA Consultant:

- surfaces of the geomembrane which are to be repaired shall be abraded no more than one hour prior to the repair;
- all surfaces must be clean and dry at the time of the repair;
- all seaming equipment used in repairing procedures must be approved;
- the repair procedures, materials, and techniques shall be approved by the CQA Consultant in advance of the specific repair;

- patches or caps shall extend at least 6 in. beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 in.; and

- the geomembrane below large caps should be appropriately cut to avoid water or gas collection between the two sheets.

6.9.1 Verification of Repairs

Each repair shall be numbered and logged. Each repair shall be non-destructively tested using approved methods. Repairs which pass the non-destructive test shall be taken as an indication of an adequate repair. Large caps may be of sufficient extent to require destructive test sampling, at the discretion of the CQA Consultant or as specified in Table 6-2. The CQA Consultant shall observe all non-destructive testing of repairs and shall record the number of each repair, date, and test outcome.

6.10 Liner System Acceptance

The Contractor shall retain all responsibility for the geosynthetics until acceptance by the Construction Manager. The terms for the liner system acceptance are described in Section 02770 of the Technical Specifications.

6.11 Materials in Contact with the Geomembrane

The procedures outlined in this section are intended to assure that the installation of materials in contact with the geomembrane do not cause damage. Additional quality assurance and quality control procedures are necessary to assure that systems built with these materials will be constructed in such a way to ensure proper performance.

6.11.1 Soils

The CQA Consultant shall monitor that the Contractor takes all necessary precautions to ensure that the geomembrane is not damaged during its installation, during the installation of other components of the liner system, or by other construction activities. The CQA Consultant shall monitor the following:

- placement of protective soil materials above the geomembrane which shall not proceed at an ambient temperature below 40°F or above 104°F unless otherwise approved by the Construction Manager;

- soil placement operations above the geomembrane shall be performed by the Contractor to minimize wrinkles in the geomembrane;
- equipment used for placing soil shall not be driven directly on the geomembrane;
- a minimum soil thickness of 1 ft is maintained between a light, track-mounted dozer (e.g., having a maximum ground pressure of 5 psi) and the geomembrane;
- a minimum soil thickness of 3 ft is maintained between rubber-tired vehicles and the geomembrane; and
- soil thickness shall be greater than 3 ft in heavily trafficked areas such as access ramps.

6.11.2 Appurtenances

The CQA Consultant shall monitor that:

- installation of the geomembrane in appurtenant areas, and connection of geomembrane to appurtenances have been made in accordance with the Construction Drawings and Technical Specifications;
- extreme care is taken by the Installer when seaming around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas; and
- the geomembrane has not been visibly damaged when making connections to appurtenances.

TABLE 6-1

GEOMEMBRANE CONFORMANCE TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM TESTING FREQUENCY[1]
Specific Gravity	ASTM D 792 Method A or ASTM D 1505	1 test per 100,000 ft^2
Thickness	ASTM D 5199 or ASTM D 5994 GRI GM13	1 test per 100,000 ft^2
Tensile Strength at Yield	ASTM D 638	1 test per 100,000 ft^2
Tensile Strength at Break	ASTM D 638	1 test per 100,000 ft^2
Elongation at Yield	ASTM D 638	1 test per 100,000 ft^2
Elongation at Break	ASTM D 638	1 test per 100,000 ft^2
Carbon Black Content	ASTM D 1603	1 test per 100,000 ft^2
Carbon Dispersion	ASTM D 5596	1 test per 100,000 ft^2

TABLE 6-2

GEOMEMBRANE SEAM
TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM TESTING FREQUENCY
Peel Adhesion of Seam	ASTM D 6392$^{(1,3)}$	1 test every 200 ft
Bonded Seam Strength	ASTM D 6392$^{(2,3)}$	1 test every 200 ft
Vacuum Testing Welded Seams	—	100 percent of extrusion welds
Air Pressure Testing Welded Seams	—	100 percent of fusion welds

Notes:

1. For peel adhesion, seam separation shall not extend more than 10 percent into the seam interface. Testing shall be discontinued when the sample has visually yielded.
2. For shear tests, the sheet shall yield before failure of the seam.
3. For either test, sample failure shall be a Film Tear Bond (FTB) as outlined in NSF 54, Attachment A.

7. GEOSYNTHETIC CLAY LINER

7.1 Introduction

The CQA Consultant shall perform conformance testing and shall monitor the installation of the geosynthetic clay liner (GCL) as required by Section 02780 of the Technical Specifications and this CQA Plan. The testing used to evaluate the conformance of the GCL with the requirements of the Technical Specifications shall be performed by the CQA Consultant in accordance with the current versions of the ASTM or other applicable test procedure indicated in Table 7-1.

7.2 Transportation, Handling, and Storage

The CQA Consultant shall monitor the transportation, handling, and storage of the GCL on-site. The Construction Manager shall designate a GCL storage location. Handling of the rolls shall be performed in a competent manner such that damage does not occur to the GCL or its protective wrapping. Any protective wrapping that is damaged or stripped off the rolls shall be repaired immediately to the satisfaction of the CQA Consultant. During transportation, handling, and storage the GCL rolls will be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

Upon delivery of the GCL at the site, the Contractor, Installer, and CQA Consultant shall conduct an inspection of the rolls for defects and damage. This inspection shall be conducted without unrolling the materials unless defects or damages are found or suspected. The CQA Consultant shall indicate to the Construction Manager:

- rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- rolls which include minor repairable flaws.

The CQA Consultant shall also monitor that equipment used to handle the GCL on-site is adequate and does not pose any risk of damage to the GCL when used properly.

7.3 Conformance Testing

7.3.1 Sampling Procedures

Upon delivery of the rolls of GCL, the CQA Consultant will assure that samples are removed and forwarded to the Geosynthetic CQA Laboratory for testing of conformance to both the Technical Specifications and the list of guaranteed properties provided by the Manufacturer. Conformance samples will be 3 ft long by the roll width. The CQA Consultant will mark the machine direction on the samples with a waterproof marker, and tape or otherwise secure the cut edges of the sample to eliminate the loss of the granular bentonite. The required minimum sampling frequencies are provided in Table 7-1. The rolls shall be immediately re-wrapped and replaced in their shipping trailers or in the temporary field storage area. The CQA Consultant shall mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA personnel identification.

7.3.2 Testing Procedure

Conformance testing of the GCL materials delivered to the site will be conducted to ensure compliance with both the Technical Specifications and the Manufacturer's list of minimum average roll values. As a minimum, the GCL conformance test procedures listed in Table 7-1 shall be performed by the Geosynthetics CQA Laboratory.

7.3.3 Test Results

The CQA Consultant will examine all results from laboratory conformance testing and will report any non-conformance to the Construction Manager. The GCL conformance test results shall meet or exceed the minimum property values presented in Attachment C.

7.3.4 Conformance Test Failure

In the case of failing test results, the Contractor may request that another sample from the failing roll be retested by the Geosynthetics CQA laboratory with the Manufacturer's technical representative present during the test procedure. If the retest fails or if the option to retest is not exercised, then two isolation conformance samples shall be obtained by the CQA Consultant. These isolation samples shall be taken from rolls, which have been determined by correlation with the manufacturer's roll number, to have been manufactured prior to and after the failing roll. This method for choosing isolation rolls for testing should continue until passing tests are achieved. All rolls that fall numerically between the passing roll numbers shall be rejected. The CQA Consultant will verify that the Contractor has replaced all rejected rolls. The CQA Consultant shall document all actions taken in conjunction with GCL conformance failures.

7.4 Surface Preparation

The GCL shall not be placed on surfaces which are softened due to high water content or cracked due to desiccation. The CQA Consultant and the Installer will jointly verify that the surface on which the GCL will be installed is acceptable. The Contractor shall comply with the surface preparation and acceptance requirements identified in Section 02200 of the Technical Specifications. Additionally, the surface shall contain no loose stones and no ruts greater than 1-in. depth. The CQA Consultant shall notify the Contractor of any observed change in the supporting soil condition that may require repair work and verify that compacted soil repair work is completed in accordance with the requirements of the Technical Specifications of this CQA Plan.

7.5 Placement

The CQA Consultant shall verify that the Installer has taken all necessary precautions to protect the underlying subgrade during GCL deployment operations. The CQA Consultant shall verify that all GCL is handled in such a manner as to ensure they are not damaged in any way, and the following conditions are met:

- in the present of wind, all GCL are weighted with sandbags or the equivalent;

- GCL is kept continually under tension to minimize the presence of wrinkles;
- GCL is cut using a utility blade in a manner recommended by the Manufacturer;
- during placement, care is taken not to entrap fugitive stones or other debris under the GCL;
- the exposed GCL is protected from damage in heavily trafficked areas;
- a visual examination of the GCL is carried out over the entire surface, after installation, to assure that damaged areas, if any, are identified and repaired; and
- if a white colored GCL is used, precautions are taken against "snowblindness" of personnel.

7.6 Overlaps

The CQA Consultant shall monitor and verify the GCL overlapping procedures conform to the requirements of Section 02780 of the Technical Specifications. GCL panels shall be overlapped at a minimum of 6 inches along panel sides and a minimum of 12 inches along panel ends. Dry bentonite powder shall be applied, at a minimum rate of one pound per lineal foot, around pipe penetrations or other perforations of GCL which may be required.

7.7 Repair

The CQA Consultant shall monitor the repair of any holes or tears in the GCL or the geotextile backing. Repairs shall be made by placing a patch made from the same type GCL over the damaged area. On slopes greater than 5 percent, the patch shall overlap the edges of the hole or tear by a minimum of 2 ft in all directions. On slopes, 5 percent or flatter, the patch shall overlap the edges of the hole or tear by a minimum of 1 ft in all directions. The patch shall be secured to the satisfaction of the CQA Consultant to avoid shifting during soil placement or covering with another geosynthetic.

TABLE 7-1

GCL CONFORMANCE
TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM TESTING FREQUENCY
Hydraulic Conductivity	ASTM D 5887	1 test per 100,000 ft^2

8. GEOTEXTILES

8.1 Introduction

The CQA Consultant shall perform conformance testing and shall monitor the installation of geotextile filters, and separators as required by Section 02720 of the Technical Specifications and this CQA Plan. The testing used to evaluate the conformance of the geotextiles with the requirements of the Technical Specifications shall be performed by the CQA Consultant in accordance with the current versions of the ASTM or other applicable test procedure indicated in Table 8-1.

8.2 Transportation, Handling, and Storage

The CQA Consultant shall monitor the transportation, handling, and storage of the geotextile on-site. The Construction Manager shall designate a geotextile storage location. During transportation, handling, and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

Handling of the geotextile rolls shall be performed in a competent manner such that damage does not occur to the geotextile or to its protective wrapping. Rolls of geotextiles shall not be stacked upon one another to the extent that deformation of the core occurs or to the point where accessibility can cause damage in handling. Furthermore, geotextile rolls shall be stacked in such a way that access for conformance sampling is possible. Protective wrappings shall be removed less than one hour prior to unrolling the geotextile. After unrolling, a geotextile shall not be exposed to ultraviolet light for more than 30 calendar days.

Outdoor storage of geotextile rolls shall not exceed the Manufacturers recommendations or longer than 6 months whichever is less. For storage periods longer than 6 months a temporary enclosure shall be placed over the rolls, or they shall be moved to an enclosed facility. The location of temporary field storage shall not be in areas where water can accumulate. The rolls shall be elevated off the ground to prevent contact with ponded water.

Upon delivery at the site, the Contractor, Installer, and CQA Consultant shall conduct an inspection of the rolls for defects and damage. This inspection shall be conducted without unrolling the materials unless defects or damages are found or suspected. The CQA Consultant shall indicate to the Construction Manager:

- rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and

- rolls which include minor repairable flaws.

The CQA Consultant shall also monitor that equipment used to handle the geotextiles on-site is adequate and does not pose any risk of damage to the geotextiles when used properly.

8.3 Conformance Testing

8.3.1 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first 3 feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The required minimum geotextile conformance sampling frequencies are provided in Table 8-1. The CQA Consultant shall mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;

- project number;

- lot/batch number and roll number;

- conformance sample number; and

- CQA personnel identification.

The geotextile rolls which are sampled shall be immediately rewrapped in their protective coverings to the satisfaction of the CQA Consultant.

8.3.2 Testing Procedure

Conformance testing of the geotextile materials delivered to the site will be conducted to ensure compliance with both the Technical Specifications and the Manufacturer's list of minimum average roll values. As a minimum, the geotextile conformance test procedures listed in Table 8-1 shall be performed by the Geosynthetics CQA Laboratory.

8.3.3 Test Results

The CQA Consultant shall review all laboratory conformance test results and verify compliance of the test results with the specification shown in Attachment D prior to deployment of the geotextiles. Any non-conformance shall be reported to the Construction Manager.

8.3.4 Conformance Test Failure

In the case of failing test results, the Contractor may request that another sample from the failing roll be retested by the Geosynthetics CQA Laboratory with the Manufacturer's technical representative present during the test procedure. If the retest fails or if the option to retest is not exercised, then two isolation conformance samples shall be obtained by the CQA Consultant. These isolation samples shall be taken from rolls, which have been determined by correlation with the Manufacturer's roll number, to have been manufactured prior to and after the failing roll. This method for choosing isolation rolls for testing should continue until passing tests are achieved. All rolls that fall numerically between the passing roll numbers shall be rejected. The CQA Consultant will verify that the Contractor has replaced all rejected rolls. The CQA Consultant shall document all actions taken in conjunction with geotextile conformance failures.

8.3.5 Placement

The CQA Consultant shall monitor the placement of all geotextiles to assure they are not damaged in any way, and the following conditions are met.

- On slopes, the geotextiles shall be securely anchored in the anchor trench and then deployed down the slope in such a manner as to continually keep the geotextile in tension.

- In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with earth cover material.

- Trimming of the geotextiles shall be performed using only a upward cutting hook blade. Special care must be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.

- The CQA Consultant shall monitor that the Installer is taking necessary precautions to prevent damage to underlying layers during placement of the geotextile.

- During placement of geotextiles, care shall be taken not to entrap stones, excessive dust, or moisture that could generate clogging of drains or filters.

- A visual examination of the geotextile shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, (e.g., stones, sharp objects, small tools, sandbags, etc.) are present.

8.4 Seams and Overlaps

All geotextile filters shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped 6 in. prior to seaming. No horizontal seams shall be allowed on side slopes that are steeper than 10 horizontal to 1 vertical (i.e. seams shall be along, not across, the slope), except as part of a patch.

Sewing shall be done using polymeric thread with chemical and ultraviolet resistance properties equal to or exceeding those of the geotextile. The seams shall be sewn using a single row type "401" two-thread chainstitch. The CQA Consultant shall monitor the geotextile seaming procedures to verify that seams and overlaps are in accordance with Section 02720 of the Technical Specifications.

Geotextile separators may be overlapped a minimum of 2 feet in lieu of sewing.

8.5 Repair

The CQA Consultant shall monitor that any holes or tears in the geotextile are repaired as follows:

- On-slopes: A patch made from the same geotextile is double seamed into place (with each seam 1/4 in. to 3/4 in. apart and no closer than 1 in. from any edge) with a minimum 12-in. overlap. Should any tear exceed 50 percent of the width of the roll, that roll shall be removed from the slope and replaced.

- Non-slopes: A patch made from the same geotextile is sewn in place with a minimum of 12 in. overlap in all directions away from the repair area.

Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile. The CQA Consultant shall observe all repairs and assure that any non-compliance with the above requirements is corrected.

8.6 Placement of Soil Materials

The CQA Consultant shall monitor the Contractor's placement of all materials located on top of a geotextile, to verify:

- that no damage occurs to the geotextile;

- that no shifting of the geotextile from its intended position occurs and underlying materials are not exposed or damaged;

- that excess tensile stress does not occur in the geotextile; and

- that equipment ground pressure on geotextiles overlying geomembranes does not exceed those specified in Section 02720 of the Technical Specifications.

Soil backfilling or covering of the geotextile with another geosynthetic shall be completed within 30 days. On side slopes, soil layers shall be placed over the geotextile from the bottom of the slope upward.

TABLE 8-1

GEOTEXTILE CONFORMANCE TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM TESTING FREQUENCY
Mass per Unit Area	ASTM D 5261	1 test per 100,000 ft^2
Grab Strength	ASTM D 4632[(1)]	1 test per 100,000 ft^2
Trapezoidal Tear Strength	ASTM D 4533[(2)]	1 test per 100,000 ft^2
Puncture Resistance	ASTM D 4833[(3)]	1 test per 100,000 ft^2
Burst Strength	ASTM D 3786	1 test per 100,000 ft^2
Apparent Opening Size[(5)]	ASTM D 4751	1 test per 100,000 ft^2
Permittivity[(5)]	ASTM D 4491	1 test per 100,000 ft^2

Notes:

1. Minimum of values measured in machine and cross machine directions with 1 inch clamp on Constant Rate of Extension (CRE) machine.
2. Minimum value measured in machine and cross machine direction.
3. Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with 0.31-inch diameter solid steel cylinder with a flat tip centered within the ring clamp.
4. Apparent opening size and permittivity testing to be performed on filter geotextiles only.

9. GEOCOMPOSITES

9.1 Introduction

The CQA Consultant shall perform conformance testing and shall monitor the installation of the geocomposite drainage layers as required by Section 02740 of the Technical Specifications and this CQA Plan. The testing used to evaluate the conformance of the geocomposite drainage layers with the requirements of the Technical Specifications shall be performed by the CQA Consultant in accordance with the current versions of the ASTM or other applicable test procedure indicated in Table 9-1.

9.2 Transportation, Handling and Storage

The CQA Consultant shall monitor the transportation, handling, and storage of the geocomposite on-site. The Construction Manager shall designate a geocomposite storage location. During transportation, handling, and storage, the geocomposite shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

Handling of the geocomposite rolls shall be performed in a competent manner such that damage does not occur to the geocomposite or to its protective wrapping. Rolls of geocomposite shall not be stacked upon one another to the extent that deformation of the roll occurs or to the point where accessibility can cause damage in handling. Furthermore, geocomposite rolls shall be stacked in such a way that access for conformance sampling is possible. Protective wrappings shall be removed less than one hour prior to unrolling the geocomposite. After unrolling, a geocomposite shall not be exposed to ultraviolet light for more than 30 calendar days.

Outdoor storage of geocomposite rolls shall not exceed the Manufacturer's recommendations or longer than 6 months whichever is less. For storage periods longer than 6 months a temporary enclosure shall be placed over the rolls, or they shall be moved to an enclosed facility. The location of temporary field storage shall not be in areas where water can accumulate. The rolls shall be elevated off the ground to prevent contact with ponded water.

Upon delivery at the site, the Contractor, Installer, and CQA Consultant shall conduct an inspection of the rolls for defects and damage. This inspection shall be conducted without unrolling the materials unless defects or damages are found or suspected. The CQA Consultant shall indicate to the Construction Manager:

- rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- rolls which include minor repairable flaws.

The CQA Consultant shall also monitor that equipment used to handle the geocomposites on-site is adequate and does not pose any risk of damage to the geocomposites when used properly.

9.3 Conformance Testing

9.3.1 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first 3 feet. Unless otherwise specified, samples shall consist of one section 3 feet long by the roll width for geonet and geocomposite testing and one section 10 feet long cut 1 foot from the edge of the geonet for testing of the unbonded geotextiles. The required minimum geocomposite conformance sampling frequencies are provided in Table 9-1. The CQA Consultant shall mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA personnel identification.

The geocomposite rolls which are sampled shall be immediately rewrapped in their protective coverings to the satisfaction of the CQA Consultant.

9.3.2 Testing Procedure

Conformance testing of the geocomposite materials delivered to the site will be conducted to ensure compliance with both the Technical Specifications and the manufacturer's list of minimum average roll values. As a minimum, the geotextile, geonet, and geocomposite conformance test procedures listed in Table 9-1 shall be performed by the Geosynthetics CQA Laboratory.

9.3.3 Test Results

The CQA Consultant shall review all laboratory conformance test results and verify compliance of the test results with the specification shown in Attachment E prior to deployment of the geocomposites. Any non-conformance shall be reported to the Construction Manager.

9.3.4 Conformance Test Failure

In the case of failing test results, the Contractor may request that another sample from the failing roll be retested by the Geosynthetics CQA laboratory with the manufacturer's technical representative present during the test procedure. If the retest fails or if the option to retest is not exercised, then two isolation conformance samples shall be obtained by the CQA Consultant. These isolation samples shall be taken from rolls, which have been determined by correlation with the manufacturer's roll number, to have been manufactured prior to and after the failing roll. This method for choosing isolation rolls for testing should continue until passing tests are achieved. All rolls which fail numerically between the passing roll numbers shall be rejected. The CQA Consultant will verify that the Contractor has replaced all rejected rolls. The CQA Consultant shall document all actions taken in conjunction with geocomposite conformance failures.

9.4 <u>Placement</u>

The CQA Consultant shall monitor the placement of all geocomposites to assure they are not damaged in any way, and the following conditions are met.

- On slopes, the geocomposites shall be securely anchored in the anchor trench and then deployed down the slope in such a manner as to continually keep the geocomposites in tension.

- In the presence of wind, all geocomposites shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with earth cover material.

- Trimming of the geocomposites shall be performed using only a upward cutting hook blade. Special care must be taken to protect other materials from damage which could be caused by the cutting of the geocomposites.

- The CQA Consultant shall monitor that the Installer is taking necessary precautions to prevent damage to underlying layers during placement of the geocomposite.

- During placement of geocomposites, care shall be taken not to entrap stones, soil, excessive dust, or moisture that could damage the geomembrane, generate clogging of drains or filters, or hamper subsequent drainage operations.

- A visual examination of the geocomposite shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, (e.g., stones, sharp objects, small tools, sandbags, etc.) are present.

9.5 Joining, Seams, and Overlaps

The components of the geocomposite (e.g., geotextile, geotextile) shall be seamed, joined, and overlapped to like components in adjacent geocomposites. Lower geotextile components of the geocomposites shall be overlapped such that the component has a minimum overlap of four inches. Adjacent edges of geonet component along the length of the geocomposite should be overlapped a minimum 2-3 inches and joined by tying the geonet together with white or yellow plastic fasteners or polymeric thread. Geonet for adjoining geocomposite panels (end to end) along the roll width should be shingled down in direction of slope and overlapped a minimum of 12 inches. Upper geotextile components of the geocomposites shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped 6 in. prior to sewing. No horizontal seams shall be allowed on side slopes that are steeper than 10 horizontal to 1 vertical (i.e. seams shall be along, not across, the slope), except as part of a patch.

Sewing of geotextiles shall be done using polymeric thread with chemical and ultraviolet resistance properties equal to or exceeding those of the geotextile. The seams shall be sewn using a single row type "401" two-thread chainstitch. The CQA Consultant shall monitor the geotextile seaming and geonet tying procedures to verify that joining, seams, and overlaps are in accordance with Section 02740 of the Technical Specifications.

9.6 Repair

The CQA Consultant shall monitor that any holes or tears in the geocomposite are repaired as follows:

- A patch made from the same geocomposite will be secured into place by tying fasteners through the bottom geotextile and the geonet of the patch, and through the top geotextile and geonet.
- The patch will extend 2 feet beyond the edges of the hole or tear.
- The patch will be secured every 6 inches and heat sealed to the top geotextile of the geocomposite needing repair.
- If the hole or tear is more than 50 percent of the width of the roll, the damaged area should be cut out and the two portions of the geocomposite will be joined.

Care will be taken to remove any soil or other material which may have penetrated the torn geocomposite component. The CQA Consultant shall observe any repair and assure that any non-compliance with the above requirements is corrected.

9.7 Placement of Soil Materials

The CQA Consultant shall monitor the Contractor's placement of all soil materials located on top of a geocomposite, to verify:

- that no damage occurs to the geocomposite;
- that no shifting of the geocomposite from its intended position occurs and underlying materials are not exposed or damaged;

- that excess tensile stress does not occur in the geocomposite; and
- that equipment ground pressure on geocomposites overlying geomembranes does not exceed those specified in Section 02740 of the Technical Specifications.

Soil backfilling or covering of the geocomposite shall be completed within 30 days. On side slopes soil layers shall be placed over the geocomposite from the bottom of the slope upward.

TABLE 9-1

GEOCOMPOSITE CONFORMANCE TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM TESTING FREQUENCY[3]
<u>Geotextile Components</u>		
Mass per Unit Area	ASTM D 5261	1 test per 100,000 ft^2
Grab Strength	ASTM D 4632[1]	1 test per 100,000 ft^2
Trapezoidal Tear Strength	ASTM D 4533[2]	1 test per 100,000 ft^2
Apparent Opening Size	ASTM D 4751	1 test per 100,000 ft^2
Permittivity	ASTM D 4491	1 test per 100,000 ft^2
<u>Geocomposite</u>		
Transmissivity[3]	ASTM D 4716	1 test per 100,000 ft^2
Peel Strength	ASTM F 904	1 test per 100,000 ft^2

Notes:

1. Minimum of values measured in machine and cross machine directions with 1 inch clamp on Constant Rate of Extension (CRE) machine.
2. Minimum value measured in machine and cross machine direction.
3. The design transmissivity is the hydraulic transmissivity of the geocomposite measured using water at 68°F ± 3°F with a hydraulic gradient and compressive stress for geocomposites as described in the Technical Specifications. For the tests, the geocomposites shall be overlain by soil representative of the material that will be used on the project. The geocomposite shall be underlain by a textured geomembrane. The minimum test duration shall be 24 hours and the report for the test results shall include measurements at intervals over the entire test duration.

10. PIPES AND FITTINGS

10.1 Introduction

The CQA Consultant shall monitor the installation of ancillary materials such as pipes and fittings for the leachate collection and conveyance system and FLSC gas management system as required by Sections 02715 of the Technical Specifications, the Construction Drawings and this CQA Plan.

10.2 Butt-Fusion Welding Process

The CQA Consultant shall monitor the assembling of lengths of HDPE pipe into suitable installation lengths by the butt-fusion process. Butt-fusion means the butt-joining of the pipe by softening the aligned faces of the pipe ends in a suitable apparatus and pressing them together under controlled pressure. Butt-fusion welding of the HDPE pipes and fittings shall be performed by the Contractor in accordance with the pipe manufacturer's recommendations as to equipment and technique.

10.3 Transportation, Handling and Storage

The pipe is to be bundled together with plastic straps for bulk handling and shipment. The packing shall be such that either fork lifts or cranes equipped with slings can be used for safe handling. The pipe shall be segregated by wall thickness and diameter.

The CQA Consultant shall monitor the offloading of the pipe to assure that handling is done in a competent manner and that the pipes are not placed in areas where water can accumulate. The pipe shall not be stacked more then three high or in such a manner that could cause damage to the pipe. Furthermore, the pipe shall be stacked in such a manner that access for any conformance sampling is possible. Outdoor storage should be no longer than 12 months. For outdoor storage periods longer than 12 months a temporary covering shall be placed over the pipes, or they shall be moved to within an enclosed facility.

10.4 Installation

The CQA Consultant shall monitor that care is taken during installation of the pipes such that they will not be cut, kinked, or otherwise damaged. Ropes, fabric, or rubber-protected slings and straps shall be used by the Contractor when installing pipes. The use of chains, cables, or hooks inserted into the pipe ends shall not be allowed.

The Contractor shall install the pipe and fittings in such a manner that the materials are not damaged. Slings for handling the pipe shall not be positioned at butt-fused joints of HDPE pipes. Sections of the pipes with deep cuts and/or gouges shall be removed and the ends of the pipeline rejoined. Care shall be exercised when lowering pipe into the trench to prevent damage or twisting of the pipe.

10.5 Testing

The CQA Consultant shall monitor the testing of all pipes as required by the Technical Specifications and as necessary to assure workmanship conforming the state-of-practice.

11. MECHANICAL AND ELECTRICAL

11.1 Introduction

The CQA Consultant shall monitor the materials used in and installation of all mechanical and electrical systems to assure compliance with the Technical Specifications and approved submittals. The mechanical and electrical systems include, but are not limited to, the following:

- leachate sump pumps and associated connections and wiring;
- overhead/buried power distribution system, power wiring, including power circuit connections for pump motors, and equipment mounting boards; and
- temporary support facilities for electric, water, and sanitary sewer services.

11.2 Related Construction Drawings and Technical Specifications

The mechanical work performed by the Contractor shall comply with the Construction Drawings, Technical Specifications, and approved submittals. These specifications shall be referenced for specific details of the mechanical equipment requirements and installation. The electrical work performed by the Contractor shall comply with Construction Drawings, Technical Specifications, and approved submittals. These specifications shall be referenced for specific details of the electrical requirements and installation.

11.3 Codes, Rules, Inspections, and Workmanship

The CQA Consultant shall monitor the work of the Contractor in the installation of all mechanical and electrical appurtenances in accordance with national codes and other regulations or authorities having jurisdiction over the work. The CQA Consultant shall observe and document construction acceptance testing procedures performed by the Contractor.

11.4 Record Drawings

The CQA Consultant shall monitor the maintenance by the Contractor of a set of prints on which the actual installation of all mechanical and electrical work shall be accurately shown, indicating any variation from Construction Drawings or approved submittals. Changes in layout or circuitry shall be clearly and completely indicated as the work progresses. These progress prints shall be inspected by the Design Engineer and Construction Manager and used to determine the progress of mechanical and electrical work.

At the completion each phase of the work, the CQA consultant shall obtain from the Contractor a set of record drawings of the work to include marked-up prints showing the dimensioned location of all underground systems.

12. CONCRETE

12.1 Introduction

This CQA Consultant shall monitor the construction and perform conformance testing of all concrete materials and finished products to assure compliance with Construction Drawings and Technical Specifications.

12.2 Inspections

The CQA Consultant shall monitor concrete workmanship to assure that the Contractor does not place concrete until foundations, forms, reinforcing steel, pipes, conduits, sleeves, anchors, hangers, inserts, and other work required to be built into concrete has been inspected and approved by the Construction Manager. The Contractor is required to notify the Construction Manager and CQA Consultant at least 24 hours in advance of concrete placement activities for scheduling of the inspection activities described above.

12.3 Field Quality Control Testing

Conformance testing of placed concrete shall be the responsibility of the CQA Consultant. The concrete test program shall meet the following requirements:

- Concrete samples will be obtained by the CQA Consultant at a frequency of one set of standard cylindrical test specimens for the first 5 cubic yards and every 25 cubic yards of concrete or any portion of thereafter for each structure. For each work shift, when concrete is delivered, at least one set of specimens will be made. A set of test specimens will consist of at least three standard cylinders. Each set of test specimens will be tested for 2-day, 7-day, and 28-day compressive strength, and a fourth cylinder will be held in reserve.

- Compressive strengths shall be determined from the standard test specimens taken according to ASTM C 31 and ASTM C 172, and cured and tested in accordance with ASTM C 39. Core drilling, if required, and testing will be in accordance with ASTM C 94.

- If required by the Engineer, slump and air content shall be determined with no less frequency than that of casting strength specimen sets. Air content and slump shall be determined in accordance with ASTM C 231 and ASTM C 143, respectively.

The CQA Consultant shall be responsible for reporting all test results to the Contractor and the Construction Manager. Materials determined by the Construction Manager to fail the requirements of the Construction Drawings and Technical Specifications shall be rejected.

14. GENERAL SITE WORK

14.1 Introduction

The CQA Consultant shall monitor the activities that are to be performed for various general site work items including, but not limited to riprap, erosion and sediment control, culverts, fences and gates, and vegetation for compliance with Construction Drawings and Technical Specifications.

14.2 Conformance Testing

Conformance testing of materials to ensure compliance with the Construction Drawings and Technical Specifications shall be performed by the CQA Consultant at the discretion of the Construction Manager. If nonconformances or other deficiencies are found by the CQA Consultant in the Contractors materials or completed work, the Contractor will be required to repair or replace the deficiency at no cost. Any noncompliant items shall be reported to the Construction Manager.

ATTACHMENT A

CQA FORMS AND LOG

GeoSyntec Consultants

FIELD NUCLEAR MOISTURE/DENSITY TEST LOG (ASTM D 3017 AND ASTM D 2922)

PROJECT: ______

LOCATION: ______ PROJECT NO.: ______ TASK NO.: ______

DESCRIPTION: ______ DATE: ______ day ______ month ______ year

SPECIFICATION REQUIREMENTS

SOURCE: ______ MATERIAL TYPE: (CIRCLE ONE) FILL / SUBGRADE / SUBBASE / CLAY / OTHER: ______ LIFT THICKNESS (LOOSE/COMPACTED): ______

% COMPACTION: ______ MOISTURE RANGE: ______ ASTM D 698: / ASTM D 1557 (CIRCLE ONE)

NUCLEAR GAUGE TYPE: ______ NUCLEAR GAUGE SERIAL NO. ______ COR. FACTOR: ______ QA ID: ______

			LAB RESULTS			FIELD TEST RESULTS								
TEST NO.	TEST LOCATION	PROBE DEPTH/ LIFT NO.	SAMPLE NO.	OMC (%)	MAX DRY UNIT WT (PCF)	FMC (%)	WET UNIT WT (PCF)	DRY UNIT WT (PCF)	PERCENT COMPACT (%)	PASS	FAIL	RETEST NO.	RETEST PASS	RETEST FAIL

COMMENTS: ......

GeoSyntec Consultants

MATERIAL INVENTORY

PROJECT: ____________________

LOCATION: ____________________ PROJECT NO.: ________ TASK NO.: ________

DESCRIPTION: ____________________ YEAR: ________

PRODUCT TYPE: ____________________ MANUFACTURER: ____________________

INVENTORY			Q.A. CONFORMANCE				Q.C. DOCUMENTS			
DATE (day/mo)	BATCH / ROLL NO.	QA ID	DATE SAMPLED (day/mo)	SAMPLE NO.	PASS/ FAIL	QA ID	DATE RECEIVED (day/mo)	DATE CHECKED (day/mo)	PASS/ FAIL	QA ID

AVG. ROLL WIDTH: ____________________ AVG. ROLL LENGTH: ____________________

NUMBER OF ROLLS ABOVE: ____________________ ACCUMULATIVE NUMBER OF ROLLS: ________

CUMULATIVE AREA: ____________ NO. OF CONFORMANCE TESTS (page/total): ____/____

CERTIFICATE OF ACCEPTANCE
SUBGRADE SURFACE

INSTALLER	PROJECT
NAME: ______________________	NAME: ______________________
ADDRESS: ______________________	______________________
______________________	LOCATION: ______________________
______________________	______________________
INSTALLER AUTHORIZED REPRESENTATIVE: ______________________	______________________
	OWNER: ______________________

I, The undersigned, duly authorized representive of ______________________ do hereby accept the surface on which the geosynthetics will be installed and shall be responsible for maintaining the suitability of this surface, in accordance with the project specifications. (i.e., The contractor shall not install the geosynthetics until the subgrade surface is acceptable. Installation of the geosynthetics will be considered acceptance of the subgrade.)

PRIMARY: ☐ SECONDARY: ☐ OTHER: ☐ ______________________

DATE	PANEL NOS.	SIGNATURE

GEOSYNTEC CONSULTANTS

PANEL PLACEMENT LOG

PROJECT: ____________________

LOCATION: ____________________ PROJECT NO.: __________ TASK NO.: __________

DESCRIPTION: ____________________ YEAR: __________

PRIMARY: ☐ SECONDARY: ☐ OTHER: __________ PRODUCT TYPE: __________

PANEL NO.	BATCH / ROLL NO.	DATE (day/mo)	TIME	PLACEMENT LOCATION COMMENTS	APPROX WIDTH (ft)	APPROX LENGTH (ft)	QA ID
				TOTALS:(1)			

NOTE: (1) APPROXIMATE AREA: THIS PAGE: __________ (ft^2) ACCUMULATED: __________ (ft^2)

NOTES: ____________________

GeoSyntec Consultants

TRIAL SEAM LOG - EXTRUSION

PROJECT: ______

LOCATION: ______ PROJECT NO.: ______ TASK NO.: ______

DESCRIPTION: ______ YEAR: ______

SPECIFICATIONS: ______ TENSIOMETER DESCRIPTION: ______

TRIAL SEAM NO.	DATE (day/mo)	TIME	MACHINE NO.	OPER ID	(1) MATERIAL DESCRIPTION	EXTRUSION		TEST RESULTS				RE-TEST NO.	QA ID
						PREHEAT (SET/°C/°F)	BARREL (°C/°F)	PEEL (ppi/psi)	SHEAR (ppi/psi)	PASS	FAIL		

NOTE: (1) MATERIAL DESCRIPTION REFERS TO EITHER SMOOTH/SMOOTH (S/S); SMOOTH/TEXTURED (S/T); OR TEXTURED/TEXTURED (T/T).

GeoSyntec Consultants

TRIAL SEAM LOG - FUSION

PROJECT: ______

LOCATION: ______ PROJECT NO.: ______ TASK NO.: ______

DESCRIPTION: ______ YEAR: ______

SPECIFICATIONS: ______ TENSIOMETER DESCRIPTION: ______

TRIAL SEAM NO.	DATE (day/mo)	TIME	MACHINE NO.	OPER ID	(1) MATERIAL DESCRIPTION	FUSION		TEST RESULTS				QA ID
						WEDGE (SET/°C/°F)	MEASURED SPEED (°C/°F)	PEEL (ppi/psi)	SHEAR (ppi/psi)	PASS	FAIL	

NOTE: (1) MATERIAL DESCRIPTION REFERS TO EITHER SMOOTH/SMOOTH (S/S); SMOOTH/TEXTURED (S/T); OR TEXTURED/TEXTURED (T/T).

SYMBOLS

S11/P12 SECONDARY/PRIMARY GEOMEMBRANE PANEL NUMBER

NDT = NONDESTRUCTIVE TEST

VT = VACUUM TEST

AT = AIR TEST

X————X————X LEACHATE COLLECTION PIPE

TOE OF SLOPE

CREST OF SLOPE

xxxxxxxxxxxxxxxxxxxxxxxx ANCHOR TRENCH

ANCHOR TRENCH

GEOSYNTHETIC CLAY LINER (GCL)

GEOGRID

GEONET

GEOTEXTILE

GEONET COMPOSITE LAYER

CAPPED SEAM (FUSION)

NDT TESTED

DESTRUCTIVE SAMPLE (DS) LOCATION
P=PRIMARY
S=SECONDARY

(FAILED)

(PASSED)

NDT TESTED

EXTRUSION WELD REPAIR

NDT TESTED

COUPON SAMPLE LOCATION

NDT TESTED

PATCH REPAIR LOCATION (EXTRUSION)

NDT TESTED

PIPE PENETRATION

SUMP AREA

60 THICKNESS MEASUREMENT

ADJACENT PANEL REFERENCE

GeoSyntec Consultants

SEAM AND PANEL REPAIR LOCATION LOG

PROJECT: ______

LOCATION: ______ PROJECT NO.: ______ TASK NO.: ______

DESCRIPTION: ______ DATE: ______ day ______ month ______ year

CONTRACTOR: ______

PRIMARY: ☐ SECONDARY: ☐ OTHER: ☐ PRODUCT TYPE: ______

NORTH

NOTE:
SEE OTHER SIDE FOR SYMBOLS

QA ID: ______

GeoSyntec Consultants

PRODUCTION SEAM SUMMARY LOG

PROJECT: ____________________

LOCATION: ____________________ PROJECT NO.: ________ TASK NO.: ________

DESCRIPTION: ____________________ YEAR: ________

PRIMARY: ☐ SECONDARY: ☐ OTHER: ☐ ________ SPECIFICATIONS: AIR PRESSURE (__±__psi for 5 min.) ________ VACUUM BOX (______sec.) ________

PRODUCTION SEAM				LOCATION					NONDESTRUCTIVE TEST					
DATE (day/mo)	TIME	MACHINE NO.	OPERATOR ID	SEAM NO.	BEGIN	END	ACTUAL SEAM LENGTH (ft)	QA ID	LOCATION (ft)	TEST DETAILS	OPERATOR ID	PASS/ FAIL	ACTION	QA ID
				TOTAL (1)										

NOTE: (1) SEAM LENGTH: THIS PAGE ________ (ft) ACCUMULATED ________ (ft)

GeoSyntec Consultants

DESTRUCTIVE TEST LOG

PROJECT: ____________________

LOCATION: ____________________ PROJECT NO.: ________ TASK NO.: ________

DESCRIPTION: ____________________ YEAR: ________

CONTRACTOR: ____________ TEST REQUIREMENTS: ____________________

PRIMARY: ☐ SECONDARY: ☐ RE-TEST: ☐ OTHER: ☐ ____________

SAMPLE DISTRIBUTION: LABORATORY: ☐ ARCHIVE: ☐ INSTALLER: ☐ OTHER: ________

SAMPLE DATA							FIELD DATA						LABORATORY DATA							
D.S. NO.	TRACK (1)		LOCATION		MACH NO.	OPER ID	AVG PEEL (PPI/PSI)		AVG SHEAR (PPI/PSI)	PASS/FAIL	DATE SAMPLED/SHIPPED (day/mo)	QA ID	DATE OF RESULTS (day/mo)	AVG PEEL (PPI/PSI)		AVG SHEAR (PPI/PSI)	PASS/FAIL	RE-TEST	QA ID
	SINGLE	DOUBLE	SEAM	DISTANCE (ft)			INSIDE	OUTSIDE						INSIDE	OUTSIDE				

NOTES: (1) TRACK TYPES: E = EXTRUSION F = FUSION

 FILE NO. 3-10-DTL REVIEWED BY: ________ SHEET NO. ______ OF ______

GEOSYNTEC CONSULTANTS

REPAIR SUMMARY LOG

PROJECT: ____________________

LOCATION: ____________________ PROJECT NO.: ________ TASK NO.: ________

DESCRIPTION: ____________________ YEAR: ________

PRIMARY: ☐ SECONDARY: ☐ OTHER: ☐ ____________ CONTRACTOR: ____________

DATE (day/mo)	LOCATION				REPAIR NO. AND CODE (1)	REPAIR TYPE (2)	SIZE			WELDER ID		QA ID	NON-DESTRUCTIVE TESTING				
	SEAM	PANEL	DIST. (ft)	OFFSET (ft)			LENGTH (ft)	WIDTH (ft)	DIA (ft)	MACH NO.	OPER ID		DATE (day/mo)	OPER ID	PASS/ FAIL	ACTION	QA ID
(15)																	

NOTES: (1) REPAIR NO.: REPAIRS SHOULD BE NUMBERED SEQUENTIALLY.
(1) REPAIR CODES: P = PATCH, C = CAP, S= ANCHOR TRENCH EXTENSION (SKIRT), DS = DESTRUCTIVE SAMPLE, G = GRIND & WELD, T = TOPPING ALONG FUSION SEAM, R = RECONSTRUCTION
(2) REPAIR TYPES: E = EXTRUSION, F = FUSION

 FILE NO. 3-09-RSL

REVIEWED BY: ________ SHEET NO. ______ OF ______

ATTACHMENT B

TABLE 02770-1 and 02770-2
REQUIRED GEOMEMBRANE PROPERTIES

TABLE 02770-1
REQUIRED HDPE GEOMEMBRANE PROPERTIES

Properties	Qualifiers	Units[1]	Specified Values Textured	Test Method
Physical Properties				
Thickness	Nominal Minimum	mils	54	ASTM D 5994 (T)
Specific Gravity	Minimum	N/A	0.94	ASTM D 792 Method A or ASTM D 1505
Carbon Black Content	Range	%	2-3	ASTM D 1603
Carbon Black Dispersion	N/A	none	8 of 10 in Category 1 or 2 and all in Category 1, 2, or 3	ASTM D 5596
Mechanical Properties				
Tensile Properties				
1. Force Per Unit Width at Yield	Minimum	lb/in	130	ASTM D 6693
2. Tensile Strength (force per unit width at break)	Minimum	lb/in	72	ASTM D 6693
3. Elongation at Yield	Minimum	%	12	ASTM D 6693
4. Elongation at Break	Minimum	%	100	ASTM D 6693
Tear Resistance	Minimum	lb	40	ASTM D 1004 Die C Puncture
Puncture Resistance	Minimum	lb	80	ASTM D 4833

TABLE 02770-1 (continued)

Properties	Qualifiers	Units(1)	Specified Values Textured	Test Method
Environmental Properties				
SP-NCTL	Minimum	hrs	200(2)	ASTM D 5397

Notes: 1.
% = percent
g = grams
min = minutes
lb/in = pounds per inch
lb = pound
°C = degrees Celsius
hrs = hours

2. Time-to-failure at a tensile stress of 30 percent of the tensile yield strength. For textured geomembrane, test is conducted on smooth geomembrane from the same resin lot (batch) as the textured geomembrane furnished.

TABLE 02770-2

REQUIRED HDPE GEOMEMBRANE SEAM PROPERTIES

Properties	Qualifiers	Units[3]	Specified Values		Test Method
			Smooth	Textured	
Shear Strength[1]					
fusion	Minimum	lb/in	120	120	ASTM D 6392
extrusion	Minimum	lb/in	108	108	ASTM D 6392
Peel Adhesion					
			FTB[2]	FTB[2]	
fusion	Minimum	lb/in	78	78	ASTM D 6392
extrusion	Minimum	lb/in	70	70	ASTM D 6392

Notes: 1. Also called "Bonded Seam Strength". Value is at material yield point and failure shall occur in material outside of seam area.
2. FTB = Film Tear Bond. (Maximum 10 percent seam separation)
3. lb/in = pounds per inch

[END OF SECTION]

ATTACHMENT C

TABLE 02780-1
REQUIRED GEOSYNTHETIC CLAY LINER PROPERTY VALUES

TABLE 02780-1

REQUIRED GCL PROPERTY VALUES

PROPERTIES	QUALIFIERS	UNITS(6)	SPECIFIED(1) VALUES	TEST METHOD
GCL Properties				
Bentonite Content(2) (GCL)	Minimum	lb/ft^2	0.75	ASTM D 5261 or ASTM D 5993
Bentonite Moisture Content	Maximum	%	25	ASTM D 4643
Bentonite Free Swell	Minimum	ml/2g	24	ASTM D 5890
Hydraulic Conductivity(5)	Minimum	cm/s	5×10^{-9}	ASTM D 5887 or ASTM D 5084
Grab Strength(3)	Minimum	lb	150	ASTM D 4632
Peel Strength(3)	Minimum	lb	15	ASTM D 4632
Geotextile Properties				
Polymer Composition	Minimum	%	95 polyester or polypropylene	

Notes:
1. All values represent minimum average roll values.
2. Measured at a moisture content not exceeding 25 percent.
3. For geotextile backed GCLs.
4. lb/ft^2 = pounds per square foot
   cm/s = centimeter per second
   % = percent
   lb = pound
   lb/in = pounds per inch
   ml/2g = milliliters per two grams
5. The GCL test specimen shall be hydrated with the fluid which is expected to cause hydration in the field, or similar fluid, for a minimum of 48 hours using sufficient backpressure to achieve a minimum B coefficient of 0.9 and using a confined effective consolidation stress not exceeding five pounds per square inch. Then, the hydraulic conductivity test on the GCL specimen shall be conducted, using the appropriate permeant fluid, at a confined effective consolidation stress not exceeding five pounds per square inch. The hydraulic conductivity test shall continue until steady state conditions are reached or a minimum of two pore volumes of permeant fluid have passed through the test specimen. The permeant fluid shall be tap water.

[END OF SECTION]

ATTACHMENT D

TABLE 02720-1
REQUIRED PROPERTY VALUES FOR GEOTEXTILE FILTER AND SEPARATOR

TABLE 02720-1

REQUIRED PROPERTY VALUES FOR GEOTEXTILE

PROPERTIES	QUALIFIER	UNITS	SPECIFIED[1] VALUES	TEST METHOD
Type				
nonwoven needlepunched				(-)
Polymer composition	minimum	%	95 polypropylene or polyester by weight	(-)
Mass per unit area	minimum	oz/yd^2	8	ASTM D 5261
Filter Requirements				
Apparent opening size (O_{95})	maximum	mm	0.21	ASTM D 4751
Permittivity	minimum	sec^{-1}	0.5	ASTM D 4491
Mechanical Requirements				
Grab strength	minimum	lb	180	ASTM D 4632[2]
Tear strength	minimum	lb	75	ASTM D 4533[3]
Puncture strength	minimum	lb	75	ASTM D 4833[4]
Burst strength	minimum	psi	350	ASTM D 3786
Durability				
Ultraviolet Resistance	minimum	%	70	ASTM D 4355

Notes:

(1) All values represent minimum average roll values.
(2) Minimum of values measured in machine and cross machine directions with 1 inch clamp on Constant Rate of Extension (CRE) machine.
(3) Minimum value measured in machine and cross machine direction.
(4) Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.
(5) mm = millimeter
% = percent
oz/yd^2 = ounce per square yard
sec = second
lb = pound
psi = pound per square inch

[END OF SECTION]

ATTACHMENT E

TABLE 02740-1
REQUIRED PROPERTIES VALUES FOR GEOCOMPOSITE

TABLE 02740-1
GEOCOMPOSITE PROPERTY VALUES

PROPERTIES	QUALIFIER	UNITS	SPECIFIED VALUES (1)	TEST METHOD
Geonet Component:				
Polymer composition	Minimum	%	95 polyethylene by weight	--
Polymer density	Minimum	g/cm^3	0.93	ASTM D 1505
Carbon black content	Range	%	2 - 3	ASTM D 1603
Nominal thickness	Minimum	mil	200	ASTM D 1777 or ASTM D 5199
Geotextile Component:				
Type	None	none	needlepunched nonwoven	--
Polymer composition	Minimum	%	95 polyester or polypropylene	
Mass per unit area	Minimum	oz/yd^2	8	ASTM D 5261
Apparent opening size	Maximum	mm	$O_{95} \leq 0.21$ mm	ASTM D 4751
Permittivity	Minimum	sec^{-1}	0.5	ASTM D 4491
Grab strength	Minimum	lb	180	ASTM D 4632 (2)
Tear strength	Minimum	lb	75	ASTM D 4533 (2)
Puncture strength	Minimum	lb	75	ASTM D 4833 (3)
Burst Strength	Minimum	psi	350	ASTM D 3786
Geocomposite:				
Transmissivity	Minimum	m^2/s	5×10^{-4}	ASTM D 4716
Peel strength	Minimum	lb/in.	1.0	ASTM F 904 or GRI GC-7

Notes:
1. All values represent minimum average roll values.
2. Minimum value measured in machine and cross-machine direction.
3. Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.
4. Transmissivity of geocomposite shall be tested with geocomposite sandwiched between geomembranes using water at 68°F with a gradient of 0.1 under compressive stress of 500 psf for 24 hours.