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Southwest District

June 16, 2006

Susan J. Pelz, P.E.
Solid Waste Manager
Southwest District
13051 North Telecom Parkway
Temple Terrace, Florida 33637-0926

Re: Lena Road Landfill, Manatee County
Pending Permit No.: 39884-011-SF/01, Closure,
Stage I, Partial Closure #2
Response 3 to FDEP Letter Dated May 5, 2006

Dear Ms Pelz:

This letter is in response to your request for additional information regarding the above referenced permit application. Your requests are typed in italics followed by our responses in normal bold type. Four copies of this response with each revision, replacement, or additional new document are included.

2. ***Part P, Rule 62-701.600, F.A.C.***

b. *Closure design (Rule 62-701.600(5), F.A.C.).*

1) See Comment 8 below. Please provide slope stability calculations for the proposed final cover design and configuration. Please provide all inputs, printouts for models, etc. to support the conclusions. Please include slope stability with equipment loading, horizontal and parallel seepage. The calculations do not appear to include the combination of these forces.
(Response: See Response 8 below.)

4) See Comment #8 below. Please provide calculations (transmissivity, long-term creep, clogging), HELP models etc., for the geocomposite design/use.
(Response: See Response 8 below.)

5) See Comment #8 below. Please provide pipe calculations for crushing, buckling and deflection for all pipes proposed to be used in the project.
(Response: See Response 8 below.)

3. ***Part P, Appendix A, CQA Plan. (Rules 62-701.600(5)(f)1., 62-701.400(7) and 62-701.400(8), F.A.C.)*** *Please be advised that the CQA Plan and Technical Specifications will be reviewed again in their entirety after the responses to this request for information are submitted.*

FILE

a. *Technical Specifications.*

1) Section 01005. Please revise this section to include requirements for spill prevention, control and reporting. **(Response: Section 01005 was revised to require spill prevention, control and reporting.)**

3) Section 01015. Please explain how the slurry wall material will be salvaged and how it will be determined that the salvaged material is suitable for use as the landfill barrier layer (§1.03.A.). **(Response: The section was revised to require the contractor to provide all new material.)** *Please clarify where pipes will penetrate the slurry wall in this project (§1.03.B.).* **(Response: There are no planned penetrations of the slurry wall below the geomembrane cap.)** *Please specify the ASTM method that will be used for permeability testing of the repaired areas of the slurry wall (§1.03.C.).* **(Response: The ASTM standard was specified.)** *Please clarify if groundwater monitoring wells and piezometers will be protected during construction (§1.06).* **(Response: The landfill is a construction site, and the piezometers and groundwater monitoring wells are protected by concrete filled bollards. No additional protection is planned.)** *Please clarify where "floors" and "structures" are located in this project (§1.11.B.).* **(Response: The reference to floors was removed. There are energy dissipater structures, pipes, inlets, wellheads, etc. that the contractor will install, and should take care to protect. The section was rewritten to better describe the constructed work for this project.)**

5) Section 01045. Please explain why "cutting and patching" is not relevant to this project. **(Response: Cutting and patching is already addressed in Section 01005 General Requirement in subpart 1.09 Cutting and Patching. Section 01045 was also added back into these specifications.)**

6) Section 01150. Please clarify where "rock" will be excavated in the project (§1.07, Bid Item 3). **(Response: We could not find the word rock in Bid Item 3. We ran a word search on the section for the word "rock," and eliminated it in every other section where it was found.)** *Please clarify which underdrains are referenced in Bid Item 14.* **(Response: We revised Bid Item 14 to call out the specific details for the referenced underdrains.)**

7) Section 01200. Please provide Specifications that correlate with the CQA plan (see §1.3.3.). Please specify the expected duration of this construction project. **(Response: The section was revised to require weekly progress meeting.)**

9) Section 02064. Please explain why "modifications to existing structures, piping and equipment" is not relevant to this project since the stormwater let downs will be connected to existing pipes/structures and the geosynthetics will

be attached to existing Partial Closure #1 geosynthetics. **(Response: The section was revised and resubmitted with this response.)** *Please resubmit this section, revised as appropriate, to address the following comments from the February 24, 2006 letter: Please specify the disposal location for all wastes resulting from this project (§3.01.A.).* **(Response: The section was revised per your comments, and resubmitted with this response. The location for disposal of all waste for this project was specified.)** *Please clarify where valves for existing piping are shown on the drawings (§3.01.C.).* **(Response: Section 3.01.C was revised to clarify the work required. No valve is needed at the connection.)** *Please clarify where pumps will be installed in this project (§3.01.K) and provide a specification for pumps.* **(Response: There are no pumps, and the reference was deleted.)** *Please clarify where asbestos cement pipe is located in this project (§3.03, §3.04) and show the locations on the drawings.* **(Response: There are no asbestos cement pipes for this project. The section was deleted.)** *Please specify where water and wastewater utility pipes will be abandoned in place in this project (§3.05).* **(Response: There are no water and waste water utility pipes to abandon for this project. The section was deleted.)**

10) Section 02220. Please provide specifications that correlate (see §2.01.B and §1.01.B.5.). ***(Response: The sections were revised to correlate.)*** *Please explain the term "protective soil bedding" (§3.01).* **(Response: The protective soil bedding is the soil directly under the geomembrane to protect the geomembrane from puncture. The word protective was deleted, and a definition was added for bedding soil.)** *Please specify the permeability of the protective cover soil.* **(Response: Soil permeability was added to the specification along with testing requirements.)** *Please provide a specification for the bedding soil.* **(Response: Specifications were added for the bedding soils.)** *Please specify that the soil layer thickness "indicators" shall not damage the liner (§3.02.A.).* **(Response: This was added to the section.)** *Please specify who will conduct the tests listed in §3.03.A.* **(Response: The responsible party for this testing was added to the section.)** *Please include permeability of the protective cover soil in the table in §3.03.A.* **(Response: The permeability of the protective cover soil was added to the table.)** *It has been the Department's experience that most grading tolerances are ±0.1 ft. Please revise the construction tolerance accordingly or explain why a 1 foot tolerance is acceptable (§3.04.A.).* **(Response: Requiring that the grading tolerances for record drawings be within +/- 0.1 foot of the design elevations specified on the drawings is possible for a landfill liner system constructed on a firm compacted foundation. For a landfill cap constructed on a decaying and settling mound of solid waste, this is impractical. The drawings are based on a topographic map developed from an aerial photograph. The aerial photographer gives a tolerance of +/- 0.5 feet for the contours. A copy of his survey accuracy is enclosed with this letter. To require that the contractor's**

final elevations be within +/- 0.1 foot of the elevations called for on the drawings is not within the degree of accuracy for a topographic map that is +/- 0.5 feet. In addition, the landfill is settling. The elevations on the topographic map are accurate at the time of the photograph. But a year later landfill elevations tend to settle between a few inches or a few feet making design elevations obsolete. It is critical to maintain the differential elevations, and minimum slopes are specified. The section was revised to clarify the meaning. The final survey will be reported with spot elevations to the nearest +/- 0.1 feet. A note was added to the drawings to require the contractor installing the landfill gas system to submit record elevations for the landfill gas pipe prior to covering the pipe. This will allow the inspector to confirm that the pipe has the minimum cover and slope prior to covering the pipe with soil.) *Please explain how "graders or other power equipment" will not damage the liner (§3.04.C.).* **(Response: The reference to using a grader was deleted. The equipment for placing the protective cover soil is defined in Section 02776.)**

11) Section 02221. Please clarify where #57 stone is used (§2.01.C.2.). **(Response: #57 stone is used in locations as shown on the drawings. The intent is to use the #57 stone for bedding pipe in areas below the geomembrane where the bedding could have to be placed on top of solid waste.)** *Please explain the difference between "coarse aggregate" and "crushed stone" (§2.01.C.), and explain where each is used in the project.* **(Response: The term crushed stone was changed to coarse aggregate. Coarse aggregate can be naturally occurring or produced by crushing rock.)**

12) Section 02276. Please provide a copy of the SWFWMD or ERP permit for the project. **(Response: This specific project does not require a SWFWMD or ERP permit. This project is part of the landfill construction, and is covered by MSSW Permit #403143.01, which is on file with FDEP. All closure work is within the limits of the permitted landfill.)**

14) Section 02610. Please specify that the gas wells are "perforated" and not "slotted" pipe (§3.04.A.1.). **(Response: Slotted was changed to perforated in this section.)**

15) Section 02712. Please provide calculations that support a compressive load of 1000 psf. **(Response: The 1000 psf is the standard for testing and comparing geocomposites. The minimum two foot protective soil cover at 120 pounds per cubic foot is a compressive load of 240 pounds per square foot. Testing at 1,000 psf is conservative. Since FDEP requires that the geocomposite be tested at the actual compressive load, we revised the specifications to Test at a compressive load of 240 psf.)** *Please provide specifications that include the actual layers that will be used in the project for*

the transmissivity testing. **(Response: The specifications were revised to require all transmissivity testing to use the actual layers.)** *Please specify conformance testing for all geosynthetic components. Table 3 does not specify the required values.* **(Response: The required values are given in Table1 and Table 2. Table 3 was revised to add the values given in Table 1 and Table 2 to Table 3.)** *Please include testing in the transverse direction as well as machine direction.* **(Response: There is no basis to test in the transverse direction as well as the machine direction. The double-sided capping geocomposite drainage layer is designed to have greater strength and transmissivity in the machine direction. The geocomposite is rolled out down the slope in the machine direction to take advantage of the greater strength and transmissivity. This is because water that seeps through the protective cover soil will flow down the slope through the geocomposite. The stress on the geocomposite to resist sliding is also in the direction down the slope. The manufacturer reports the transmissivity and strength in the machine direction only. We see no reason to test the geocomposite in the transverse direction, and require the same properties.)**

16) Section 02776. Please revise the specifications to clearly identify that the Contractor's activities are not CQA (§1.02.D). **(Response: The reference to QA was deleted.)** *Please include interface friction angle testing for the actual materials that will be used at the site.* **(Response: The interface friction angle testing will be for the actual materials that will be used at the site.)** *Although the Specifications and CQA Plan indicate that the seams shall meet GRI-GM19, the values listed do not correlate GRI-GM19. Please provide revised Specifications and CQA Plan that correlate the seam strengths to GRI-GM19 at a minimum (Table 02776-A).* **(Response: The Table was revised.)** *Please include the thickness required for the smooth geomembrane.* **(Response: Table 02776-A gives the minimum average as 40 mil and lowest Individual Reading as 36. A note was added to clarify that this applies to both textured and smooth geomembranes.)** *Please include interface friction angle testing by the CQA consultant for the actual materials used in the project.* **(Response: This requirement was added.)** *Please include interface friction angle testing requirements for smooth and textured geomembrane, with and without geocomposite, as the design requires.* **(Response: The interface friction angle testing is for the side slope design, which consists of: protective cover soil/geocomposite/textured geomembrane/bedding soil. There is no smooth geomembrane covered by geocomposite, so we included friction angle testing for the smooth geomembrane to the soil only.)** *Please provide specifications for pipes that penetrate the geomembrane (e.g., booting details, etc.).* **(Response: A section was added to specify pipe penetrations.)** *Although the response indicated that references to concrete on the geomembrane were deleted, these changes do not appear to have been made. Please specify where concrete is used in this project (§6.01.C.).* **(Response: The reference to**

concrete in Section 6.01.C. was deleted, and the section on pipe penetration inserted.)

17) Section 15051. Please revise this section to correlate with the drawings and specification Section 02720 that indicate that some pipes are corrugated and some pipes (e.g., stormwater) are slotted. **(Response: There are no slotted or corrugated storm water pipes in Section 15051. Section 02720 specifies the terrace under drain pipe which is corrugated and slotted.)** *Please provide specifications for the gas header pipe installation.* **(Response: Installation for the gas header pipe is described in Section 3.02 Installation.)** *Please specify the survey frequency and invert elevation tolerances for the gas header piping.* **(Response: The survey frequency was added.)**

b. Department permits are issued for specific activities pursuant to Rule 62-4.160(2), F.A.C. Rule 62-701.320(5)(b), F.A.C., requires that all applications shall be of sufficient detail to show how the facility will be constructed in accordance with Department rules. Please provide technical specifications ("contract specifications") for all portions of the proposed final cover system (including liner, subgrade, stormwater piping and inlets, dewatering, spill prevention and control, submittals, construction certification/contract closeout, etc.). It appears that several relevant specification sections (01580, 01620, 02064, 02575) were deleted from the application. Please resubmit these sections with the response to this request for information. **(Response: Specification sections 01580, 01620, 02064 and 02575 were revised per your previous comments, and are included with this response.)**

c. §1.0. Please revise §1.2.6.3. or Table 1-1 to correlate regarding the geocomposite manufacturer's qualifications. **(Response: Section 1.2.6.3 was revised.)** *Please include conformance testing as a responsibility of the CQA Monitor (§1.2.7.).* **(Response: This was added to Section 1.2.7.)** *Please provide CQA requirements for soils testing.* **(Response: The CQA requirements for soil testing are in Section 4. A statement was added that the CQA Monitor is responsible for directing the CQA requirements for soil testing.)** *It has been the Department's experience that construction projects of this magnitude typically hold weekly progress meetings between the contractor, CQA team, design engineer and owner. Please clarify if weekly progress meetings are anticipated, and provide a revised CQA Plan accordingly (§1.3.1., §1.3.3.)* **(Response: The requirement for weekly progress meetings were added to the sections.).**

d. §2.0. Please provide revised CQA Plan that references the appropriate GRI specification for LLDPE geomembranes (§2.1.1). **(Response: The reference was revised.)** *Although the Specifications and CQA Plan indicate that the seams shall meet GRI-GM19, the values listed do not correlate with GRI-GM19. Please provide revised Specifications and CQA Plan that correlate the seam strengths to GRI-GM19 at a minimum.* **(Response: The reference in the table was revised.)** *Please provide revised*

CQA Plan and Specifications that include interface friction angle testing for each of the interfaces and the actual materials that will be present in the final cover system. **(Response: The requirements were added to the tables.)** *Please include CQA sections regarding the protective cover soil.* **(Response: Section 2 is entitled "Geosynthetics Manufacturing and Delivery." CQA testing for the protective cover soil is addressed in Section 4 Construction Sampling and Testing.)** *Please clarify who performs the testing listed on page 2-3.* **(Response: The responsibility was clarified.)** *Please provide required values for Table 2-2.* **(Response: The required values were also added to this table.)** *Please revise Table 2-2, page 3 of 3 to correlate with page 1 of 3.* **(Response: The tables were revised.)**

e. §3.0. Please provide CQA requirements and technical specifications for the soil above the geomembrane. **(Response: Section 3 is entitled Geosynthetics Installation." The technical specifications for the soil above the geomembrane are included in the technical specifications in Section 02220. The CQA requirements are included in Section 4.0 Construction Sampling and Testing.)** *Please specify if the contractor is responsible for correcting the "supporting soil" or soils above the geomembrane if damage is caused by erosion (§3.1.1.).* **(Response: The word erosion was added.)** *Please specify the activities that the CQA monitor will observe "for compliance with the specifications" (Table 3-2).* **(Response: Table 3-2 lists the observations that the CQA Monitor will make to determine that the geomembrane and geosynthetics delivered to the site are not damaged in transport, and are stored properly so as not to be damaged while stored at the site. The section was revised to clarify the activities.)** *Please clarify where concrete pads will be in contact with the geomembrane (Table 3-3).* **(Response: The reference was deleted.)** *Please revise §3.3.3 to correlate with Table 4-1.* **(Response: Section 3.3.3 is correlated to Table 4-1 by specifically referencing Table 4-1.)** *Please specify the "test results for compliance with the specifications" (Table 3-5).* **(Response: Table 3-5 calls for compliance with the test results with the specifications given in the specifications and Table 4-1. The tests were also listed in Table 3-5.)** *Please provide drawings that show the limits of the geomembrane and the locations of all monitoring wells, piezometers and gas probes.* **(Response: The limits of the geomembrane and the locations of all monitoring wells, piezometers and gas probes within the limits of this project are shown on Construction Drawing C-8. The construction drawings are part of the CQA Plan.)** *Please provide a revised CQA Plan that includes Section 3.5.7., Certification of Completion, and Section 3.5.8., Engineer's full-time resident inspector. It appears that these sections were deleted from the previous submittal. Although Response #3.e. indicates that this information is included in §5.2 and §1.2.7., it does not appear that this information is included.* **(Response: These sections were added back into this section, and revised as needed to be specific to this project.)**

f. §4.0. Please provide CQA conformance testing for all soil components of the final cover system. **(Response: The table was revised to require conformance testing for all soil components of the final cover system.)** *Please include permeability in the*

conformance testing of the protective cover soil. **(Response: Permeability testing was added to the table.)** *Please clarify if wrinkles in the geocomposite will be removed prior to placement of the protective soil layer.* **(Response: A statement was added to remove wrinkles from the geocomposite.)**

5. *Permit Drawings for Manatee County Lena Road Landfill Final Closure, January 2005 (Rules 62-701.320(5)(b), 62-701.320(7)(f), F.A.C.) The following comments correlate with the comments in the Department's February 24, 2006 letter.*

b. *Sheets C-3 and C-4. Please clarify the connections of all gas header and condensate piping. It does not appear that condensate will drain appropriately in some areas. For example, the lateral from GW-118 to GW-135 terminates at elevation +35.7 which appears to be a low point for header GW-193 to the main condensate knockout but is not located at the main knockout.* **(Response: The elevation was corrected, and the revised drawing included with this response.)** *Please provide invert elevations for all gas header and lateral piping and connections.* **(Response: We have added the elevations. A note was also added to the drawing requiring the contractor to submit survey notes with the elevation of the gas header and lateral pipes prior to covering the pipes to verify all existing landfill elevations and adjust pipe elevations based on the existing elevations found at the time of construction so that the pie has the minimum grade and cover.)**

c. *Sheet C-5. Please provide specifications for "pea gravel."* **(Response: The reference to pea gravel was replaced with the term FDOT #7 coarse aggregate.**

d. *Sheet C-6. Please specify the material under the header pipe in Detail E.* **(Response: Section E was revised to clarify the material under the header pipe.)** *Please specify the pipe size and type in Detail C.* **(Response: The pipe size was added to this section.)** *Please provide dimensions for the pipe trench/bedding in Sections A, B and E.* **(Response: The dimensions were repeated on each section.)** *Please clarify if the pipe gravel is wrapped with geotextile.* **(Response: There is no geotextile wrap.)**

e. *Sheets C-9 and C-10. Please provide a cross-section or detail and specify the high points for the stormwater conveyances.* **(Response: Sheets C-9 and C-10 are plan drawings. The high point and low points are designated by the contours and spot elevations. Sections L, M and N on Sheet C-12 are sections from the high point to low point of the storm water conveyances. The storm water run-off sheet flows to the swales, and flows in the swales to the storm water inlets. The storm water then flows through the pipes to exit at the energy dissipators.)**

f. *Sheet C-11. Although Detail G shows an anchor trench for the geocomposite, this detail is in a portion of the closure that is less than 5H:1V and would therefore not include a geocomposite.* **(Response: Section G was revised to eliminate the geocomposite for this section. Section GG was added to show the termination on**

the side slopes where there is a geocomposite. The limits for the sections were added to Sheet C-8.) *Please provide a detail that shows the limits of the Partial Closure #2 in the flat areas.* **(Response: The limits of Partial Closure #2 are shown on Sheet C-8.)** *Please provide a plan view that shows the limits of the geocomposite and textured geomembrane.* **(Response: Sheet C-8 was revised to clarify the limits of the geocomposite and the textured geomembrane.)** *Please explain how the existing geocomposite will be anchored after the anchor trench in Detail H is removed.* **(Response: The detail was changed to connect the existing geocomposite to the new geocomposite in Partial Closure #2.)** *Since the geocomposite will only be located on the slopes and not the top, please revise detail H to clearly distinguish between the slope and top of landfill.* **(Response: Section H is a specific section taken at the terrace to show the tie-in of the existing geocomposite to the geocomposite in Partial Closure #2.)** *Please provide calculations that demonstrate that the geocomposite will be adequately anchored.* **(Response: The drawings were revised to tie the geocomposite in Partial Closure #2 to the existing geocomposite.)** *Please show how the geocomposite is installed relative to the stormwater piping shown in Detail I.* **(Response: Detail I was revised to show the same detail as on the terraces.)**

g. <u>*Sheet C-13*</u>. *Please clarify the piping shown in Section N1 and Section N. It does not appear that the piping shown correlates between these details.* **(Response: Section N and section N1 were revised to clarify the piping.)** *Please specify the material below the stormwater inlet that will prevent the stormwater inlet from damaging the liner (Section N).* **(Response: Section N was revised to add a dimension to the protective soil layer placed under the inlet.)** *Please provide specifications for the geotextile shown in Detail N3.* **(Response: The geotextile is the geotextile that comes with the geocomposite. This geotextile is specified in Section 02712 Double-sided Capping Geocomposite Drainage Layer. The top geotextile on the geocomposite is pulled back to expose the geonet core. The pipe and coarse aggregate are placed on the geonet core directly, and the geotextile is placed over the gravel. This allows the water flowing in the geocomposite core to flow directly into the gravel without having to flow through a geotextile.)**

h. *Please provide a scale and north arrow on all sheets.* **(Response: The sheets were reviewed and Sheet C-8 was missing a north arrow. This sheet was revised to add a north arrow.)**

Signed/Sealed doc

8. ***Calculations, Rules 62-701.320(7)(e), 62-701.320(6), F.A.C.*** *Please be advised that the calculations will be reviewed in their entirety after receipt of the response to this request for information.*

a. *Please provide calculations that are signed and sealed by the registered professional engineer who prepared them.* **(Response: All calculations are signed and sealed by the professional engineer who prepared them.)**

b. Please provide the references and/or basis for all calculations provided. Some parameters were not clearly defined, sources of equations were not provided, and assumptions were not clearly stated or supported. **(Response: The references and/or basis for all calculations are provided.)**

c. *Section 1. The specifications provided do not correlate with the calculations. Please provide specifications that required the protective sand to have a permeability of 1 x 10^{-3} cm/sec and be classified as silty sand with an internal friction angle of at least 26 degrees.* **(Response: The calculations and specifications were revised to specify the protective cover soil that meets the acceptable factor of safety of 1.5, which is silty sand with a maximum permeability of $2x10^{-4}$ cm/sec. Only a minimum friction angle of 17 degrees is required, but an angle of 23 degrees for the soil was specified to be more conservative.)** *Please include testing requirements that conform to these properties.* **(Response: Testing requirements were added to the specifications.)** *Please provide the reference for the runoff coefficient of 0.7.* **(Response: The theoretical maximum infiltration rate is equal to the coefficient of permeability of the cover soil specifications. If the coefficient of permeability is 1x10-3 cm/sec, or 1.4 inches per hour, then at the peak of the 25-year 24-hour storm event when the rainfall intensity is 3.8 inches per hour, a maximum of 37% of the rainfall could infiltrate the soil. So the runoff coefficient would be 1-0.37 or 0.63. The calculations were not sensitive to the runoff coefficient so we ran the calculations with a zero runoff coefficient.)** *Please provide the basis for using a 1-hour, 25-year storm for the design instead of a 24-hour, 25-year storm.* **(Response: The calculations use rainfall intensity or the rate at which the rain falls per hour. The maximum rate occurs during the peak hour of the storm event. Four scenarios were run as summarized below to determine the sensitivity to the rainfall intensity and run0ff coefficient.)**

Scenario	Rainfall Intensity Per Hour	Specified Minimum Permeability of cover soil	Travel Time Through 2' Cover Soil	Run-off Coeff. (See Note Below)	Minimum Friction Angle for Factor of Safety of 1.5	Drainage Layer Capacity (needs to be greater than 1.0 to avoid saturation)	Calculated Stability Factor of Safety (Must be greater than 1.5)
1	0.44 in/hr 11.2 mm/hr	$1.0x10^{-3}$ cm/sec 14.2 mm/hr	16.9 hrs	0	16.7	1.157	1.558
2	2.0 in/hr 50.8 mm/hr	$0.35x10^{-3}$ cm/sec 12.6 mm/hr	48 hrs	0	16.7	1.029	1.557
3	3.8 in/hr 96.5 mm/hr	$0.35x10^{-3}$ cm/sec 12.6 mm/hr	48 hrs	0	16.7	1.029	1.557
4	3.8 in/hr 96.5 mm/hr	$0.35x10^{-3}$ cm/sec 12.6 mm/hr	48 hrs	0.87	16.7	1.033	1.557

Note: Run-off coefficient is calculated as:
(Rainfall Intensity per Hr. – Permeability of Cover Soil) / Rainfall Intensity per Hr.

So for Scenario 1 where the permeability is greater than the rainfall intensity, the run-off coefficient is zero. To be conservative, we used zero for Scenarios 2 and 3. Scenario 4 is the same as scenario 3, but used run-off coefficient of 0.87. There is no difference in the Factor of safety, and only a slight increase in the Drainage Layer Capacity calculation, which must be greater than 1. We specified the cover soil permeability at a maximum of 2 x 10^{-4} cm/sec. The average should be lower for the silty cover soils available in the area.)

d. Section 2. *It appears that the "Run #2 with transmissivity reduced for factors of safety" calculation (5 pages) was deleted from the Calculations.* **(Response: The calculation is at the end of Section 1 with all the stability calculations.)** *Please provide this calculation as revised by θ_{ult} calculation.* **(Response: The revised calculation is included with this letter in Section 1 of the revised Calculations Book.)** *It appears that the Manning's coefficient used is for clean ADS pipe. Please provide an operation plan that includes frequent cleaning of the stormwater pipes, or provide revised calculations that include n values adjusted for "debris collection and sedimentation."* **(Response: The calculation is for the terrace underdrain pipe. The purpose of this drain pipe is to intercept the flow of water from the geocomposite on the landfill side slope. Debris and sediment in the storm water runoff will be filtered out by infiltration passing through 2-feet of protective cover soil, the geotextile, the FDOT #7 coarse aggregate and the slotted pipe. The pipe is on a 2% slope. Any fine soil that passes through the cover soil and geotextile would be carried along with the water flow in the pipe. The pipe size was increased from 8-inch diameter to 12-inch diameter to increase the pipe capacity.)** *Please provide the formula used to calculate Q.* **(Response: Q is the quantity of water drained by the geocomposite on the side slope. The calculations were revised and are included in Section 2 of the revised Calculation Book included with this response.)** *Please explain how 3.6 mm/hr is a volumetric flow rate.* **(Response: The calculation is based on rainfall intensity. The volume of flow is based on the permeability of the cover soil and geocomposite. This was meant as rainfall intensity to use as a basis of design. The calculations were revised to clarify the assumptions and methods used.)** *Please provide calculations for all drainage areas. It does not appear that all of the contributing areas are accurately represented by an area of approximately 200 ft. x 131 ft.* **(Response: The terrace under drain pipe is designed to remove the water that is coming from the geocomposite. The geocomposite has a design permeability of 8.5 cm/sec. The pipe has to take the flow from the geocomposite at each terrace. The inlets are spaced 300-feet on center. So on average each pipe has to take the flow from 150-feet of geocomposite. The calculations were revised to clarify this issue.)**

e. Section 3. *Please provide calculations that include loading from equipment (such as mowers) that may be used after closure.* **(Response: The calculations were revised and included loading from a typical mower. The revised calculations are included with this response.)** *Please provide calculations in English units.* **(Response: The revised calculations use English units.)** *Please provide equipment cut sheets*

*supporting the loading used. (***Response: A cut sheet was included with the calculations for a typical mower.)** *Please include slope stability that considers horizontal and parallel seepage.* **(Response: The calculation included horizontal and parallel seepage.)** *Please specify the reference for the friction angles used.* **(Response: The references are for the friction angles used for the calculations are included in the revised calculations.)**

f. Section 4. Although the calculations assume that the pipe bedding constant, k=0.1, the drawings do not show the pipe bedding, but show the pipes placed directly on geocomposite (k >0.1). **(Response: The drawing was revised to clearly show that there is a 6-inch bedding layer under the pipe.)** *Please revise the drawings, specifications or calculations as appropriate.* **(Response: The drawing was revised to clearly show that there is a 6-inch bedding layer under the pipe.)** *Please provide calculations that include loading from equipment (e.g., mowers) that may be used after closure.* **(Response: The calculations were revised and include a cut sheet from a typical mower.)** *Please specify the reference for each of the values used.* **(Response: The reference for each of the values used is included with the revised calculations.)** *Please clarify how W=1200 lbs/cf is converted to 67 lbs/lf.* **(Response: The calculations are for 1200 lbs/square foot and not 1200 pounds per cubic foot. The conversion is to 67 lbs/linear inch and not 67 pounds per linear foot. The calculation is as follows: 1200 pounds per square foot divided by 144 square inches per square foot is 8.33 pounds per square inch. The pipe is 8 inches wide. Eight inches multiplied by 8.33 pounds per square inch is equal to 66.64 pounds per linear inch. In the calculation, we rounded 66.64 pounds per linear inch to 67 pounds per linear inch. See also the revised calculations for a mower.)** *Please specify the detail in the drawings that supports this calculation.* **(Response: This calculation is for the landfill terrace underdrain shown in Detail N3 on Sheet C-13. The calculations were revised to include and clarify this detail.)** *The calculation provided does not correlate with the reference provided for modulus of elasticity.* **(Response: The initial modulus of elasticity is 110,000 psi, the 50-year modulus of elasticity is 22,000 psi. We further reduced the modulus of elasticity to 20,000 psi to be conservative. The calculations were revised and used a modulus of elasticity of 20,000 psi.)** *Please explain why the AASHTO formula for pipe buckling was used instead of Moser's equation which is reportedly more conservative.* **(Response: We revised the calculations and used Moser's equation.)** *Please provide a diagram (or reference the detail in the drawings) that shows how "B" is derived.* **(Response: The calculations were revised using the Moser's equation, which does not use "B.")** *It does not seem that the design intent is for 3 feet of water to have accumulated above the pipe in the terrace drains.* **(Response: If an inlet is blocked water could pond in the terrace up to 3-feet deep in the area around the inlet. At 2-feet, water flow in the terrace would change direction, and spill over the high point in the terrace and flow to the next inlet. So water could pond to 2-feet with a blocked inlet, or 3-feet if the terrace ditch is blocked preventing flow to the other two adjacent inlets on the terrace. The calculations were revised and included 3-feet of water loading on the**

terrace along with the mower tire.) *Please explain why box trucks or semi-tractor trailers are expected to be on the landfill after closure (see page 20/24).* **(Response: Box trucks or semi-tractor trailers are not expected to be on the landfill after closure. The H-20 loading was selected as a basis of design which the pipe could meet. The calculations were revised for a typical mower.)**

g. *Section 6. The revised calculation states, "For P_L see 30 attached." However, information on the live loading could not be located in this section. Please provide the basis, reference or calculation for the live loading.* **(Response: The page was revised to correct the referenced page in the calculations. The revised page is included with this response.)**

h. *Section 7. Please provide the reference for the broad-crested weir formula and coefficient, k_w.* **(Response: The reference for the broad crested weir formula is included with this response with the revised calculations for storm water run-off. These inlet structures are the same as those inlets used for Partial Closure #1.)** *Please provide the basis for assuming an 8 minute, 25-year rainfall event (See also comment #8.c.).* **(Response: The 8-minute intensity of 8.8-inches per hour was selected based on the travel time for the size of the basins and the steepness of the slopes. The storm water calculations were revised to calculate the travel time for the inlets on the crest of the landfill and on the terraces. The calculations explain the basis for selecting the design storm water intensity from the rainfall intensity duration frequency curves.)** *Please provide the reference for using 0.70 for the runoff coefficient.* **(Response: The stormwater calculations were revised and are included with this response with the references for the runoff coefficient.)**

i. *Section 8. Please provide calculations that correlate with Detail G/C-11.* **(Response: DetailG/C-11 is for the anchor trench parallel to the slope. There should be no tension on the geomembrane and/or geocomposite. The purpose for this anchorage is to prevent wind and water from moving under the geomembrane and/or the geocomposite. Anchor trenches are not designed to allow the geomembrane and/or geocomposite to be tensioned such that the geomembrane and/or geocomposite hold up the protective cover soil on the slope to prevent a sliding failure. The friction angle between the materials and drainage has to do that task. The anchor trench calculation is to determine the anchorage ratio. If the anchorage ratio > 1, then the geomembrane and/or geocomposite pull-out mode controls. If the anchorage ratio = 1, then the design is balanced. If the anchorage ratio < 1, then the geomembrane and/or geocomposite tension rupture mode controls. If the cover soil slides, it may not be important if the geomembrane and/or geocomposite ruptures or pulls out during the slide. The anchor trench calculations were revised for the following four surface sliding conditions: #1 Section G/C-11 Top of Landfill – Soil/Smooth Geomembrane/soil; Condition #2 Section GG/C-11 Side Slope of Landfill Parallel to Slope – Soil/Geocomposite/Textured Geomembrane; #3 Section GG/C-11 Side Slope of**

Landfill Parallel to Slope – Soil/Geocomposite and textured geomembrane/Soil; and, #4 Section I/C-11 On top of Landfill Perpendicular to the Slope – Soil/Geocomposite/Textured Geomembrane. The anchorage ratio was > 1 for each of these conditions for minimum anchorage. But if the contractor puts more geomembrane and/or geocomposite in the anchor trench than the minimum for pull out mode failure, and the actual anchorage ratio is < 1, in our opinion that is not important. It only means that if a cover soil slide occurs, the geomembrane and/or geotextile will rupture before it pulls out.) *Since the same soils are proposed to be used for the bedding layer and protective soil layer, please explain why different values for δ_L and δ_U provided are different.* **(Response: The calculations are for the anchoring of the geocomposite on top of the textured geomembrane. The calculation for the anchor trench assumed that the geocomposite slid between the protective cover soil on top of the geocomposite, and the textured geomembrane below. This is the reason for two separate friction angles. One is between the soil and the geotextile, and the other between the geotextile and the textured geomembrane. The calculations were revised to clarify this fact and expanded.)** *Since specifications for geotextiles were not provided, please explain why geotextile properties (instead of geocomposite properties) were used in these calculations.* **(Response: A geocomposite is a composite made up of a geonet core and two geotextiles. The geonet core is covered by a geotextiles on the top and the other on the bottom. The specifications for the geocomposite are in Section 02712 Double-sided Capping Geocomposite Drainage Layer. The section has specifications for the geonet core and the geotextiles. Since the protective cover soil is placed on the geotextile, the calculations used the friction angle between the geotextile and the protective cover soils.)**

j. *Section 9. Please provide specifications for "pea gravel."* **(Response: The term pea gravel was deleted from the calculations, specifications and drawings, and replaced with FDOT #7 coarse aggregate.)** *Please provide calculations for the static, live and internal (vacuum) loading of the gas piping.* **(Response: The calculations in Section 9 included the static load for the soil, the live load for equipment and internal vacuum loading of the gas piping.)** *Please provide the basis for assuming 48 inches of water for the internal pressure of the pipe.* **(Response The vacuum at each well head must be kept negative, and is usually less than 10 inches of water. The blower with vacuum at 48-inches of water has been adequate to keep the wells at a negative pressure. The calculations assumed a maximum vacuum on the pipe of 96-inches. Included with this response is information on the blower for the landfill gas collection system. The blower is New York Blower Model #30012A 75 Hp. The A stands for aluminum and the 12 stands for the size of the inlet. According to the rating curve, this blower can pull a maximum of 76 inches at 3000 CFM. So using 96 inches in the calculation is reasonable.)**

Sincerely,

Joseph L. Miller, P.E. #39177
Project Engineer

Cc: Gus DiFonzo, Manatee County w/ 2 copies

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List of Attachments

1. Revised Specification: PageTOC-i, Page 01005-9, Section 01015 Control of Work, Section 01045 Cutting and Patching, Section 01150 Measurement and Payment, Page 01200-2, Section 01580 Project Identification and Signs, Section 01620 Storage and Protection, Section 02064 Modifications to Existing Structures, Piping and Equipment, Section 0220 Filling and Compacting for Earthwork, Page 02221-2, Section 02575 Pavement Repair and Restoration, Page 02712-4 and Page 02712-6, Page 02776-3, Page 02776-28, and Page 15051-6.
2. Revised CQA Plan: Pages iii, 1-9, 1-10, 1-15, 2-1, 2-2, 2-3, 2-5, 2-6, 2-7, 3-1, 3-2, 3-5, 3-13, 3-15, 4-1 4-8
3. Letter Dated May 26, 2005 from I.F. Rooks Associates, Inc.
4. Calculation Book with revisions dated June 16, 2006
5. Revised Drawings C-3, C-4, C-5, C-6, C-8, C-9, C-10, C-11, C-12 and C-13.

I.F. ROOKS & ASSOCIATES, INC.

PHOTOGRAMMETRY

May 26, 2005

Mr. Joe Miller
PBS&J, Inc.
482 South Keller Road
Orlando, Florida 32810

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
JUN 19 2006
SOUTHWEST DISTRICT TAMPA

Re: Lena Road Landfill:

Dear Mr. Miller:

We are pleased to submit our proposal for topographic mapping and photographic services for the referenced project.

Aerial Photography

We will photograph the area with B&W film at scales compatible with the production of photographic and photogrammetric products as outlined herein. The aerial photography will be flown with a low distortion 6" precision aerial mapping camera. The photography will be adequate for the production of the required maps and photographs.

Field Control

Prior to the flight we will prepare a control diagram detailing the size and location of targets to be placed in the project area. The placement of these targets is not included in this proposal. A total of six (6) targets will be required.

Topographic Mapping

Utilizing the aerial photography and field survey data as outlined above, we will compile a 1" = 100' scale topographic map with one foot contours covering the subject area. Mapping will be on stable base mylar material, and will contain all cultural, planimetric, and topographic detail normally shown on maps of this scale.

The horizontal accuracy of the mapping will be such that at least 90% of all well defined features will be shown within 1/40" of their true position at map scale when compared to the nearest control station and none will be in error more than 1/20" using the same comparisons. The vertical accuracy of the mapping will be such that at least 90% of all elevations interpolated from solid line contours will be within one half the contour interval when compared to the nearest benchmark, and none will be in error more than the contour interval.

106 N.W. DRANE STREET
PLANT CITY, FLORIDA 33563

PHONE (813) 752-2113
FAX (813) 752-3102

Project: Lena Road Landfill

In areas where dense underbrush, unharvested crops, or evergreen coverage prevents seeing the ground in the aerial photography, the contours will be dashed to indicate that they may be to the standard accuracy indicated above. In such ground hidden areas we will make use of stereo photogrammetric elevations read where we can see the ground, and we will compile the contours as accurately as possible.

Delivery Items

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
JUN 19 2006
SOUTHWEST DISTRICT TAMPA

1.) (2) 1" - 100' Manuscripts W/1" Contours (Stage I & Stage III)

2.) (2) AutoCad Files

3.) (2) Volume Reports

4.) (1) 1" - 200' Digital Mosaic (Tif)

Fee & Payments

Our fee for the services listed above shall be four thousand five hundred sixty dollars, ($ 4,560.00), payable upon delivery of all materials and services. This proposal is valid for a period of ninety days.

Thank you for the opportunity to furnish this proposal. For your convenience, we are making this form a contract agreement for your file. When you wish to proceed with this project, an executed copy of this document will serve as your acceptance of this proposal.

All terms and conditions of this Contract Agreement accepted this

_____Day of_____2005

by_____

Sincerely,

I.F. Rooks & Associates, Inc.

I.F. Rooks, Jr. PSM

FILE

PBS&J

An employee-owned company

March 22, 2006

Susan J. Pelz, P.E.
Solid Waste Manager
Southwest District
3804 Coconut Palm Drive
Tampa, Florida 33619

Dept. of Environmental Protection

APR 07 2006

Southwest District

Re: Lena Road Landfill, Manatee County
Pending Permit No.: 39884-011-SF/01, Closure
Response 2 to FDEP Letter Dated February 24, 2006

Dear Ms Pelz:

This letter is in response to your request for additional information regarding the above referenced permit application. Your requests are typed in italics followed by our responses in normal bold type. Four copies of this response with each revision, replacement, or additional new document are included.

2. ***Part P, Rule 62-701.600, F.A.C.***

a. Gas migration report and report on effectiveness of the landfill design. (Rules 62-701.600(4)(d) and (e), F.A.C.)

1) Please provide a revised Figure L-8 (currently attached to the Operation permit) that shows the locations of the property boundaries. Please clarify if "Gary Seely office" (gas well location 18) is in an enclosed structure. In the event that this location is in an enclosed structure, it appears that the 25% LEL threshold for landfill gas has been exceeded in several sampling events. Please clarify the corrective actions taken to prevent the accumulation of landfill gas (LFG) in this structure.

Response: Included with this response is Figure L-8A which shows the property boundaries, limits of the landfill and the location of the landfill gas monitoring wells and points.

"Gary Seely office" is Gas Monitoring Point 1 (GMP-1), and not Gas Monitoring Well 18 (GMW-18). GMW-18 was located in that portion of the Stage III Landfill with old solid waste and GMW-18 was removed with the filling of Stage III Landfill.

b. Closure design (Rule 62-701.600(5), F.A.C.).

1) See Comment 8 below. Please provide slope stability calculations for the proposed final cover design and configuration. Please provide all inputs, printouts for models, etc. to support the conclusions. Please include slope stability with equipment loading, horizontal and parallel seepage. The calculations do not appear to include the combination of these forces.

Response: See response 8 below.

4) See Comment #8 below. Please provide calculations (transmissivity, long-term creep, clogging), HELP models etc., for the geocomposite design/use.

Response: See response 8 below.

5) See Comment #8 below. Please provide pipe calculations for crushing, buckling and deflection for all pipe proposed to be used in the project.

Response: See response 8 below.

c. *Closure Operation Plan (Rule 62-701.600(6), F.A.C.)*

2) Long-term care plan .(Section P.8) Although pages P-8 and P-9 were revised, the revisions only restated the requirements of the current permit and did not address each of the items listed in Section P.8.1 (e.g., settlement, dead vegetation, need to cut vegetation, illegal dumping, trespassing, etc.). Please specify the timeframe for implementing repairs for damage that is observed during the monthly inspections. Please describe the procedures for repairing the gas management system, and timeframe for implementing the repairs, if deficiencies are found (See Section P.8.12.)

Response: Section P.8 was revised to respond to your request for additional descriptions and time frames for repair.

3. ***Part P, Appendix A, CQA Plan. (Rules 62-701.600(5)(f)1., 62-701.400(7) and 62-701.400(8), F.A.C.)*** *Please be advised that the CQA Plan and Technical Specifications will be reviewed again in their entirety after the responses to this request for information are submitted.*

a. *Technical Specifications.*

1) Section 01005. Please clarify the reference to a "railroad permit" (§1.01.A). Please specify a tolerance for all grades, thicknesses of soil components and piping in the project (§1.07.A.)

Response: The reference to the railroad permit was deleted. Tolerances were added to Section 1.07.A. Section was revised to delete information not pertinent to this project.

2) Section 01010. Please clarify if the contractor will water sod until it is established (§1.01.A.).

Response: The section was revised to add "water sod until it is established," and delete all information not pertinent to this project.

3) Section 01015. Please provide procedures for identifying and protecting the slurry wall.

Response: A section was added on procedures for identifying, protecting and repairing the slurry wall.

PBSJ

4) Section 01030. Please specify that water located inside the slurry wall is leachate and shall be managed accordingly (§1.09.A.). Please specify how leachate will be managed during construction (§1.09.B.).

Response: Section 01030 was revised to specify that water located inside the slurry wall is leachate, and must be pumped to the leachate collection manhole.

5) Section 01045. Please clarify where electrical conduit is included in the project (§1.01.A.5.).

Response: The section was not needed, and was deleted from the revised set of specifications.

6) Section 01150. Please clarify where "rock" will be excavated in the project (§1.07, Bid Item 3). Please clarify which underdrains are referenced in Bid Item 14.

Response: The reference to "rock" was deleted. The reference to the underdrains was also clarified.

7) Section 01200. Please clarify if weekly progress meetings will be held (1.03).

Response: Monthly progress meeting are held to review the contractor's monthly request for payment, schedule and problems that may delay the project or increase the costs. The section was revised to include daily progress meetings between the Resident Project Representative and the Contractor's Site Superintendent.

8) Section 01710. Please specify the disposal location for all wastes resulting from this project (§3.01.C.).

Response: Section 3.01.C was revised to call for all solid waste to be disposed of in the on-site Class I Lena Road Landfill.

9) Section 02064. Please specify the disposal location for all wastes resulting from this project (§3.01.A.). Please clarify where valves for existing piping are shown on the drawings (§3.01.C.). Please clarify where pumps will be installed in this project (§3.01.K) and provide a specification for pumps. Please clarify where asbestos cement pipe is located in this project (§3.03, §3.04) and show the locations on the drawings. Please specify where water and wastewater utility pipes will be abandoned in place in this project (§3.05).

Response: After reviewing Section 02064 Modifications to Existing Structures, Piping and Equipment, the section is not needed. The section was deleted from the revised set of specifications.

10) Section 02220. Please specify where "foundations for structures" are located in this project and show the locations on the drawings (§1.01.A). Please define the term

"structural excavation" (§1.01.C). Please specify where trees are located in this project (§1.01.D). Please specify where dewatering water (leachate) will be discharged (§1.03.A.). Please clarify where "slush" is expected to be encountered in this project (§1.03.C.). Please specify where "controlled fill" is used in this project and show it on the drawings (§2.01.). Please specify where concrete or masonry, footings, base slabs and exterior walls are located in this project and show the locations on the drawings (§3.03, §3.05, §02221-2.01.B.).

Response: After reviewing Section 02220 Excavation, Backfill, Fill and Grading for Structures, the section is not needed. The section was deleted from the set of revised specifications.

11) Section 02221. Please specify where trees are located in this project (§1.01.C). **(Response: Reference was deleted.)** *Please specify that water located inside the slurry wall is leachate and shall be managed accordingly (§1.02.B.5 through B.8.).* **(Response: Revision made.)** *Please provide specifications for the subgrade soils and cover soils (§2.01).* **(Response: Specifications were added.)** *Please specify where each of the soil types listed are used in the project.* **(Response: Soil types not used in the project were deleted.)** *Please clarify where manhole bases will be installed as part of this project (§2.01.D.2).* **(Response: There are no new manholes required for this project. The reference was deleted.)** *Please specify the maximum size of objects, sticks, etc. in the subgrade to correlate with the CQA Plan (§2.01.D.1).* **(Response: The reference was revised.)** *Please explain where peat will be excavated in this project (§3.02.B.).* **(Response: Reference was deleted.)** *Please clarify where "rock" will be excavated in the project (§3.03.B).* **(Response: Reference was deleted.)** *Please clarify which lines will be abandoned (§3.04.G.)* **(Response: Reference was deleted.)**

12) Section 02276. Please provide a copy of the SWFWMD permit for erosion and sedimentation control (§1.02). **(Response: Reference was deleted.)** *Please clarify if soils above the liner will be scarified to a depth of 6 inches (§3.01.A.1.).* **(Response: In areas where there is vegetation, the vegetation will be stripped, but not scarified.)** *Please provide the "approved descriptions and working drawings" (§3.02.A.).* **(Response: No drawings are needed. The reference was deleted.)**

13) Section 02485. Please specify the source of water (§2.01.E.).

Response: The water will be reclaimed water and come from the adjacent Manatee County Wastewater Plant by way of the water reuse pipeline.

14) Section 02610. Please provide procedures for ensuring that the confining clay layer under the landfill will not be impacted by the installation of gas wells (§3.01.B.2.). **(Response: The section was rewritten to require the contractor to check the ground elevation at the location of the boring and verify the boring depth based on a landfill invert of El. 29. The boring as designed to penetrate the solid waste approximately 75% at the boring location.)** *Please provide specifications for the gas header pipe installation.* **(Response: This section applies only to the gas well and**

well head. The header pipe is addressed in Section 15051.) *Please specify the survey frequency and invert elevation tolerances for the gas header piping. Please specify surveying requirements for all gas management system piping.* **(Response: This section applies only to the gas well and well head. The header pipe is addressed in Section 15051.)**

15) Section 02712. Please define the "SIM" method. **(Response: "SIM" stands for "stepped isothermal method" as explained on Page GC8-6 of GRI Standard –GC8 Determination of the Allowable Flow Rate of a Drainage Geocomposite. A complete copy of GRI Standard –GC8 is enclosed for your information.** *Please provide calculations that support a compressive load of 1000 psf.* **(Response: The two foot soil cover over the double-sided capping geocomposite drainage layer at an average soil density of 120 pounds per cubic foot is a compressive load of 240 psf. The manufacturer tests the geocomposite at a standard compressive load of 1000 psi. This is approximately 4 times the actual compressive load, which is conservative, and represents a factor of safety of 4. Per 62-701.400 Landfill Construction Requirements, in (3) (d) 8, which discusses the requirements for determining the transmissivity of geonets, the last sentence reads: "For geonets used in final covers, only one test shall be conducted for a minimum period of one hour using the expected maximum design normal load from the cover soils and the actual boundary materials intended for the geonet." This requirement was added to Table 1.)** *Please provide specifications that include the actual layers that will be used in the project for the transmissivity testing.* **(Response: One test shall be conducted for a minimum period of one hour using the expected maximum design normal load from the cover soils, and the actual boundary materials intended for the geonet.)** *Please provide specifications for the "Ottawa sand" (Table 1).* **(Response: The specification for Ottawa sand is included with this response for your information.)** *Please specify conformance testing for all geosynthetic components.* **(Response: The Manufacturer's quality control test frequency is given in Table 4 of Section 02712.)** *Please specify if "the project contains long, steep slopes."* **(Response: The reference to long steep slopes was deleted. There are no long step slopes for this closure project.)** *Please specify how the geocomposite will be "properly anchored."* **(Response: The sentence was rewritten to clarify the meaning.)** *(§D.1) Please provide a MSDS for the "spray adhesive."* **(Response: MSDS for 3M Super Spray Adhesive is included with this response.)** *(§D.3.) Please specify the CQA tests referenced in §E.* **(Response: The CQA testing was added to Table 4.)**

16) Section 02776. Please provide a revised specification section that uses the term "performed" instead of "preformed." **(Response: The section was revised to correct the spelling.)** *Please clarify if the Installers quality control program is considered to be CQA* **(Response: The Installer is responsible for the construction quality control (CQC) program. The Owner is responsible for the construction quality assurance (CQA) program which is done by the Engineer or a separate company employed by the Owner.)** *(§1.02.C). Please clarify if the "site supervisor" or "foreman" is the "master seamer."* **(Response: The master seamer is a seamer with at least 1,000,000 linear feet of geomembrane seams. He is responsible for the seaming, and must be**

on-site while the seaming is in process. The site superintendent and/or foreman for the project may be master seamers, but do not have to be master seamers. The master seamer works under the direction of the superintendent and/or foreman. The specifications require that a superintendent and/or foreman must also be on site while seaming is in process. This allows the QA Monitor the means to communicate with a supervisor if there is a problem. The QA Monitor is not responsible for directing the activity of the seamers, and should communicate through the site superintendent and/or foreman.) *(§1.02.C.2 (d)) Please include interface friction angle testing for the actual materials that will be used at the site.* **(Response: This requirement was added to the specifications in Table 02776-A.)** *Please clarify how textured geomembrane will not exhibit "roughness" (§2.02.A.2.).* **(Response: Both textured and smooth geomembrane are included on this project. The sentence was revised. The word "roughness" was changed to "abrasions.")** *Although the Specifications and CQA Plan indicate that the seams shall meet at least 90% of the sheet strength, the values listed do not correlate with 90% of the sheet strength. As discussed with the County, the Department will accept seam strengths for LLDPE liner material equivalent to the values listed in GRI-GM19, or 90% of the sheet strength. Please provide revised Specifications and CQA Plan that correlate the seam strengths to GRI-GM19 at a minimum. (Table 02776-A)* **(Response: The specifications in Table 02776-A were revised to meet GRI-GM19.)** *Please provide revised specifications that reference EPA Method 9100 for leachate compatibility testing (§2.02.B.7.)* **(Response: The specifications were revised to reference EPA Method 9100.)** *Please specify where the neoprene sponge will be used (§2.03.B.).* **(Response: Reference was deleted.)** *Please specify that the CQA Monitor shall inspect the delivered materials for damage (§3.01.C.).* **(Response: We added the CQA Monitor.)** *Please specify that the CQA Monitor shall confirm that the proper procedures are followed (§4.01.A.).* **(Response: We added the term CQA Monitor.)** *Please specify the tests that §4.01.B. reference.* **(Response: The tests were added to Table 02776-A.)** *Please clarify if conformance test results must be received and approved by the Engineer prior to geomembrane installation (§4.02.A).* **(Response: The conformance test results must be received prior to acceptance of the geomembrane.)** *Please explain why access roads and berms would be shown on a panel layout drawing (§5.01.A.2(b)).* **(Response: Access roads and beams are shown on the panel layout drawings for reference, and to show the location of seams in critical areas for consideration of stress on the geomembrane.)** *Please define "excessive wrinkling" (§5.01.B.4(d)(7), §5.01.D.12(e)) and "seriously damaged" (§5.01.B.4(d)(9)).* **(Response: The definitions were added.)** *Please provide Table 2 (§5.01.D.10(e)).* **(Response: The table reference was corrected to Table 02776-A.)** *Please clarify where leachate collection pipes will penetrate the liner (§5.01.D.11.).* **(Response: No leachate pipes will penetrate the liner. The reference was deleted.)** *Please clarify which specification references the granular materials that will be used above the geomembrane (§6.01.B).* **(Response: A reference to the specification section was added.)** *Please specify where concrete is used in this project (§6.01.C.).* **(Response: The reference to concrete was deleted.)**

17) Section 15051. Please specify which piping this section is for (i.e., stormwater piping, gas header piping, gas extraction well piping). Please clarify if the piping in this section is corrugated or smooth wall, perforated or solid wall.

Response: This section applies to all HDPE pipe used for the stormwater pipe, landfill gas collection pipe and landfill gas wells.

b. Department permits are issued for specific activities pursuant to Rule 62-4.160(2), F.A.C. Rule 62-701.320(5)(b), F.A.C., requires that all applications shall be of sufficient detail to show how the facility will be constructed in accordance with Department rules. Please provide technical specifications ("contract specifications") for all portions of the proposed final cover system (including liner, subgrade, stormwater piping and inlets, dewatering, spill prevention and control, submittals, construction certification/contract closeout, etc.).

Response: Revised specification pages or sections as applicable are included with this response.

c. §1.0. It does not appear that all parties are included in Table 1-1 (e.g., soils CQA). Please include all of the parties and their qualifications in Table 1-1. **(Response: The Geotechnical Engineer reference in the table was changed to Soils CQA Engineer.)** *Please specify when each of the submittals are required to be submitted.* **(Response:** *Please provide specifications for the bedding layer that correlate with the CQA plan (§1.1).* **(Response: A specification section was added for the bedding sand.)** *Please include the CQA for the soils component of the final cover on Table 1-1 and the Organizational Chart (Table 1-2).* **(Response: The reference to the Geotechnical Engineer was changed to CQA Soils Monitor.)** *It has been the Department's experience that general contractors generally subcontract out portions of the project (i.e., liner installation). Please explain under what circumstance the general contractor would directly employ earthwork and geosynthetic crews (Table 1-2, §1.2.5.)* **(Response: The general contractor would directly employ earthwork and geosynthetic crews if the general contractor is qualified to do both. For example, Comanco Environmental Corporation, which started as a subcontractor for geosynthetics installation, now is a general contractor with the capacity and capabilities to do both.)** *Please clarify when the information listed in Section 1.2.6.2. will be submitted.* **(Response: A time for submittal was added to the section.)** *Please specify the "pre-installation information" required to be submitted (page 1-8).* **(Response: The reference was deleted.)** *Please include the earthwork contractor on Table 1-1 (see §1.2.6.4.).* **(Response: Reference was added.)** *Please provide specifications that correlate with the CQA Plan for the earthwork contractors responsibilities (§1.2.6.4.).* **(Response: The specifications were revised as necessary to correlate the CQA Plan for the earthwork subcontractor's responsibilities.)** *Please clarify which sections of the CQA Plan and/or Specifications include CQA conformance testing for each of the geosynthetics (§1.2.7.).* **(Response: Section 1.2.7 describes the responsibility of the CQA monitors. A reference was added that the CQA conformance testing for the geomembrane can be found in Section 2.)** *Please provide CQA requirements for soils testing.* **(Response: The requirements are in Section 4.3.2)** *Please explain the role of the geotechnical engineer (§1.2.10.).* **(Response: The geotechnical engineer is the professional in charge of the soils testing. The term geotechnical engineer was deleted and**

replace with CQA Monitor. The CQA Monitor for soils testing may be a geotechnical engineer, or works for a geotechnical engineer.) *It has been the Department's experience that construction projects of this magnitude typically hold weekly progress meetings between the contractor, CQA team, design engineer and owner. Please clarify if weekly progress meetings are anticipated, and provide a revised CQA Plan accordingly (§1.3.1.).* **(Response: Monthly progress meetings are held with the Owner to review the progress, schedule, contractor's monthly pay request, change orders, and problems that may delay the work. The Resident Project Representative meets daily with the Contractor's Superintendent to review the project progress. The CQA monitor meets daily with the Supervisor in charge of installation of the geosynthetics to review project progress.)**

d. §2.0. Please specify the value and testing parameters (i.e., loading conditions, time) for transmissivity of the CDN (Table 2-2). **(Response: Table was revised per previous comment. Per 62-701.400 Landfill Construction Requirements, in (3) (d) 8, which discusses the requirements for determining the transmissivity of geonets, the last sentence reads: "For geonets used in final covers, only one test shall be conducted for a minimum period of one hour using the expected maximum design normal load from the cover soils and the actual boundary materials intended for the geonet." This requirement was added.)** *Please clarify if the final cover includes the geocomposite on slopes flatter than 5H:1V.* **(Response: The geocomposite is used only on the side slopes.)** *Please explain how textured geomembrane will not have "roughness," or provide revised Specifications and CQA Plan that delete this requirement (e.g., §2.1.1.).* **(Response: Both textured and smooth geomembrane are included on this project. The sentence was revised. The word "roughness" was changed to "abrasions.")** *(Response: Please provide revised CQA Plan that references the appropriate GRI specification for LLDPE geomembranes (§2.1.1).* **(Response: The change was made.)** *Please provide a revised CQA Plan that includes Oxidative Induction Time CQA conformance testing (§2.1.1.).* **(Response: Testing was added to the CQA conformance testing.)** *Please specify the asperity height for the textured geomembrane on Table 2-1.* **(Response: The asperity height for textured geomembrane was added.)** *Although the Specifications and CQA Plan indicate that the seams shall meet at least 90% of the sheet strength, the values listed do not correlate with 90% of the sheet strength. As discussed with the County, the Department will accept seam strengths for LLDPE liner material equivalent to the values listed in GRI-GM19, or 90% of the sheet strength. Please provide revised Specifications and CQA Plan that correlate the seam strengths to GRI-GM19 at a minimum.* **(Response: The change was made.)** *Please clarify which CQA section or Specifications section includes the CQA conformance testing for each of the geosynthetics.* **(Response: The CQA conformance testing was added to both the specification and the CQA Manual by adding another column to the tables.)** *Please specify in the CQA plan the type of geotextile (woven, non-woven) and geonet (bi-planar, tri-planar) used in the geocomposite (§2.1.2.).* **(Response: The description was expanded to include the words non-woven and tri-planer.)** *Please provide revised CQA Plan and Specifications that include interface friction angle testing for each of the interfaces and the actual materials that will be present in the final cover system.* **(Response: This requirement was added to the specifications and the CQA Manual in the tables.)** *Please verify that the testing frequencies on Table 2-2 correlates with page 2-4.* **(Response: Table 2-2 was revised to give both the manufacturer's quality control testing, and the CQA testing. The description on page 2-4 was deleted.)** *Please include CQA sections regarding the*

protective cover soil. It appears that §2.1.1.2. and §2.2.2 were deleted from the previous submittal. **(Response: Section 2.0 describes the geosynthetics manufacturing and delivery. The protective cover soils are describes in Section 3.0 Geosynthetics Installation.)**

e. §3.0. Please specify the tolerances for the grades and thicknesses each of the soil layers (§3.1.1.). (Response: The tolerances for grades and thicknesses were specified.) Please provide a specification for the "supporting soil" (§3.1.1.). **(Response: The reference to supporting soil was deleted, and replaced with bedding soil, and minimum tolerances were added.)** *Please specify how the thickness of the "supporting soil" will be verified (§3.1.1, Table 3-1).* **(Response: The thickness will be verified by probing the bedding soil.)** *Please provide CQA requirements and technical specifications for the soil above the geomembrane. (***Response: A section was added to the CQA Manual. See Specification Section 02220, and CQA Manual Section 4.1.)** *Please specify if the contractor is responsible for correcting the "supporting soil" or soils above the geomembrane if damage is caused by erosion (§3.1.1.).* **(Response: The section was rewritten to clarify the contractor's responsibilities.)** *Please specify the activities that the CQA monitor will observe "for compliance with the specifications" (Table 3-2).* **(Response: The term CQA Monitor was added to observe.)** *Please explain and provide details for how the geocomposite will be anchored (§3.3.2.).* **(Response: The section was rewritten to clarify the details.)** *Please clarify where concrete pads will be in contact with the geomembrane (Table 3-3).* **(Response: The reference was deleted.)** *Please provide a specification for the "protective soil cover material" (§3.3.3).* **(Response: The specifications were added to the CQA Manual.)** *Please specify how the CQA Monitor will "check" the cover soil (§3.3.3).* **(Response: The method of checking was added to the CQA Manual.)** *Please provide specifications for the repair of erosion of the protective soil layer (§3.3.3).* **(Response: Specification requiring repair of erosion by replacing the soil eroded were added.)** *Please explain the reference to "curing time" for the geomembrane welds (Table 3-4).* **(Response: The reference was deleted, and no curing time is required.)** *Please specify the "test results for compliance with the specifications" (Table 3-5).* **(Response: The location for the test results referenced was added to the table.)** *Please specify how the thickness will be measured (Table 3-5).* **(Response: The method for measuring the thickness was added to the table.)** *Please clarify where monitoring wells and piezometers will be secured to the geomembrane (§3.5.3.).* **(Response: The reference was clarified, and the locations added to the drawings.)** *Please provide drawings that show the limits of the geomembrane and the locations of all monitoring wells, piezometers and gas probes.* **(Response: The monitoring wells, piezometers and gas probes locations were added on the drawings.)** *Please provide a revised CQA Plan that includes Section 3.5.7., Certification of Completion, and Section 3.5.8., Engineer's full-time resident inspector. It appears that these sections were deleted from the previous submittal.* **(Response: Section 3.5.7 Certification of Completion was a duplication of the information in Section 5.2 Construction Certification. Section 3.5.8 Engineer's Full-Time Resident Inspector was a duplication of the information in Section 1.2.7 Construction Quality Assurance Monitors.)**

f. §4.0. Please provide CQA conformance testing for all geosynthetic components of the final cover system. **(Response: The conformance testing for the Geosynthetic materials is included in Section 2.0. This section was retiled to clarify that this testing and sampling is during construction.)** *Please provide a revised CQA Plan that requires at least one*

destructive test every 500 ft. of constructed seam (§4.2.3.1.). **(Response: The interval for seam testing was changed to 500-ft.)** *Please provide a revised CQA Plan that requires a minimum of 5 replicate specimens for each destructive test.* **(Response: The testing was revised to require all five to pass.)** *Please provide Table 4-1 (§4.2.3.2.).* **(Response: The table reference was corrected to Table 2-1.)** *Please specify how "long seam lengths greater than 5 feet" will be repaired (§4.2.4.3.).* **(Response: The sentence was rewritten to clarify the meaning.)** *Please explain how "all seaming equipment used in repairing procedures" will "be satisfied" (§4.2.4.3.).* **(Response: The sentence was rewritten to clarify the meaning.)** *Please define "excessive wrinkles" (§4.2.4.5). (Response: Excessive wrinkles are wrinkles that will crease when covered by soil.) Please specify how the cover soil thickness will be checked (§4.3.1.).* **(Response: The method for verifying the cover soil thickness was added. See Table 4-1.)**

g. §5.0. Please provide Attachment A (§5.1.). **(Response: Attachment A was included with the revised CQA Plan.)** *Please clarify who will submit the Certification of Construction Completion to the Department (§5.2, §1.2.8.).* **(Response: The Professional Engineer in charge of construction quality assurance will be responsible for submitting the Certification of Construction Completion.)** *Please include a list of deviations from the permitted plans, geomembrane repair logs, surveys, monthly and weekly progress meeting minutes, and limits of the slurry wall and anchor trench in the Certification documents (§5.2.).* **(Response: The requirement to submit a list of deviations was added.)**

4. ***Appendix B.*** *Please provide the information that was intended to be in this section. Although Response #4 indicates that the Table of Contents identified Appendix B, the CQA Plan Table of Contents does not reference Appendix B and the permit application submittal does not appear to have a Table of Contents.*

Response: The permit application uses page 3 of 40 of FDEP Form 62-701.900(1) as a table of contents. This is the form required by FDEP for submitting the permit application. Page 3 of 40 is the table of contents for the permit application form, and is the table of contents we use to submit the permit application. We use this table of contents so we follow the application exactly. On the page 3 of 40 at the bottom of the page are indicated Appendix A and B to the application. Appendix B is entitled "Location for Filling FDEP Requests for Additional Information and Responses As Required." There was nothing in Appendix B at the time we filled the application. Included with this response is a revised page 3 of 40 with the reference to Appendix B deleted.

5. ***Permit Drawings for Manatee County Lena Road Landfill Final Closure, January 2005*** *(Rules 62-701.320(5) (b), 62-701.320(7)(f), F.A.C.) Since additional drawings have been added, and the previous drawings have been renumbered, the following comments do not correlate with the comments in the Department's June 23, 2005 letter.*

a. Please provide a current topographic survey of the site and the proposed final closure contours for the Stage I-Partial Closure #2.

Response: The drawings were revised to add the most recent aerial photograph and topographic map, which are based on a July 26, 2005 aerial photograph.

b. Sheets C-3 and C-4. Please provide invert elevations for all gas header piping and connections.

Response: Elevations were added to the gas header piping and connections on the drawings as requested. Due to landfill settlement, the contractor will adjust all elevations as needed based on the actual topographic elevations found at the time of construction.

c. Sheet C-5. Please reference the location of the gas wellhead on the gas extraction well detail on this sheet. Please provide a specification for the granite.

Response: A note was added that the gas well head detail is located on Sheet C-5. The specification for granite was expanded in Section 02610 – Landfill Gas Well and Wellhead.

d. Sheet C-6. Please provide details for how the geocomposite will be anchored. Please provide calculations that demonstrate that the geocomposite will be adequately anchored. Please specify the material under the header pipe in Detail E. Please specify the pipe bedding material in Detail C.

Response: Sheet 6 is entitled "Landfill Gas Collection System – Typical Sections and Details." The geocomposite is shown for reference only. The details for how the geocomposite is anchored are shown on the drawings pertaining to the landfill cap.

A calculation was added to the calculation book that demonstrates that the geocomposite will be adequately anchored.

The pipe bedding material in Detail C and E was clarified.

e. Sheets C-9 and C-10. Please specify the invert elevations and ditch elevations for all of the stormwater ditches, inlets and discharge points.

Response: Elevations were added to the drawings as requested. Due to landfill settlement, the contractor will adjust all elevations as needed based on the actual topographic elevations found at the time of construction.

f. Sheet C-11. Since the anchor trench shown in Detail G does not include a containment berm, please clarify how leachate from the active portions of Phase I will not discharge above the partial closure cap. Please provide details for how the geocomposite will be anchored. Since the geocomposite will only be located on the slopes and not the top, please revise detail H to clearly distinguish between the slope and top of landfill.

Response: Since the Stage I Landfill is closed, there is no active portion of the Stage I Landfill to generate leachate that could discharge above the partial closure cap. Also, a review of the limits of the geomembrane cap for Partial Closure 2, which is shown on

Sheets C-9 and C-10, indicate that the cap is extended over the highest portion of the landfill. There are no active portions above the partial closure cap.

The geocomposite is placed on top of the textured geomembrane. The geotextile locks onto the textured geomembrane and is anchored in place. The textured geomembrane and geocomposite are anchored on the terraces and top of the landfill. The textured geomembrane and geocomposite extended over the top of the berms located along the top of the landfill and the terraces, down the back slope of the berms.

The geocomposite will only be located on the slopes. The geocomposite ends at the toe of each slope at each terrace. The geocomposite is discontinued in the terrace. The purpose of doing this is to collect the water on each terrace, and prevent the potential for pressure to build up in the geocomposite that could extend from the toe of the landfill to the top of the landfill. The tie-in of Partial Closure 2 to Partial Closure 1 is being made on a terrace. The geocomposite for Partial Closure 2 ends at the toe of the slope and does not continue across the terrace to connect with the geocomposite installed for Partial Closure 1. We extended the limits of Detail H to make this concept clearer.

g. Sheet C-13. Please clarify the piping shown in Section N1 and Section N. It does not appear that the piping shown correlates between these details. Please provide a specification for 8-inch slotted ADS pipe. Please specify the depth of material over this pipe in Detail N3.

Response: Section N is taken through the stormwater inlet structure and parallel to the terrace. The section shows the hole for the connection of the stormwater drain pipe. The stormwater drain pipe runs up and down the slope. Perpendicular to the stormwater drain pipe is the terrace under drain pipes. The terrace under drain pipes enter the stormwater inlet structure 90 degrees from the stormwater drain pipes.

A specification for ADS pipe is included with this response.

Detail N3 indicates that the depth of gravel over the pipe is 4". We added another dimension to indicate that the minimum soil cover over the geomembrane must be 2-feet.

*8. **Calculations, Rules 62-701.320(7)(e), 62-701.320(6), F.A.C.** Please be advised that the calculations will be reviewed in their entirety after receipt of the response to this request for information.*

a. Please provide calculations that are signed and sealed by the registered professional engineer who prepared them. The "calculation book" submitted was not signed and sealed.

Response: Four copies of the "Calculation Book" are included with this response. The cover page for each of the four copies was signed and sealed.

b. Please provide the references and/or basis for all calculations provided. Some parameters were not clearly defined, sources of equations were not provided, and assumptions were not clearly stated or supported.

Response: The calculations were reviewed and additional references and/or basis for all calculations were provided as necessary to clearly define the parameters, sources of calculations and assumptions.

c. Section 1. *These calculations (and those in Section 2) appear to include soil properties of "silty sand with sod" for the cover soil. However, the specifications indicate that the "Ottawa sand" (§02712, Table 1) will be used.* **(Response: Section 02712 is a specification for "Double-sided Capping Geocomposite Drainage Layer." The Ottawa sand in Table 1 is the designated testing sand required by GRI Standard – GC8 Determination of the Allowable Flow Rate of a Drainage Geocomposite. This standard test is used to evaluate, compare and index geocomposite drainage layers. The procedure determines the drainage composite's flow rate, and then this value is modified by means of creep reduction and clogging reduction factors.)** *Please provide revised calculations that are based on the materials required by the specifications.* **(Response: The calculations are based on the materials required by the specifications. The calculations use allowable flow rates determined by a standardized test, and creep reduction and clogging reduction factors. The calculation uses the permeability of the proposed cover soils which are silty sands.)** *Please provide calculations for the range of values for the transmissivity.* **(Response: Additional calculations were included in the revised calculation book for the range of Transmissivity.)** *Please provide a copy of the appropriate portions of the Giroud, Zhao & Richardson (2000) reference. (***Response: Four complete copies of *Giroud, Zhao & Richardson (2000) were included with this response.)***

d. Section 2. *Please provide calculations that include Rf_{in} values between 1.3-1.5 (Koerner, 4th ed, 1998).* **(Response: The calculations were revised and the Rf_{in} *value was increased from 1.2 to 1.5.)*** *Please provide the basis for the RF_{cr} values.* **(Response: The RF_{cr} value of 1.4 is as recommended by Koerner, 1998, and repeated in Table 3.1 of Giroud, Zhao & Richardson (2000)).** *The interface friction angle in the calculations in Section 2 does not appear to correlate with the calculations in Section 1. Please clarify.* **(Response: Section 1 uses the actual interface friction angle in the calculations to calculate the factor of safety. In Section 2, the reduction factors (RF) are used to calculate the required minimum interface friction angle.)** *Please provide the reference for the value 3.31×10^{-3} in the θ_{req} calculation.* **(Response: The 3.31×10^{-3} is θult from the previous calculation for θult. Since the reduction factors were increase in the revised calculations, θult changed.)** *It appears that the pipe calculations in Section 2 are for 8 inch pipe. However, the detail provided in this section indicates that the pipe is 6-inch. Please provide the basis for n=0.012.* **(Response: The detail attached was from a design example of a typical lateral drain with a 6-inch pipe. We used this example for the calculations, but a 6 inch pipe was marginal so we increased the pipe size to 8 inch pipe. We deleted the detail from the calculations. We attached a reference for HDPE as the basis for *n=0.012.)***

e. Section 3. *Please provide calculations that include loading from equipment that may be used after closure.*

Response: The calculation in Section 3 does include loading from equipment that may be used after closure. The calculation is for equipment with a total load of 55 metric tons,

which is 61short tons or 122,000 pounds. The legal road limit is 80,000 pounds. After closure, no equipment over 80,000 pounds maximum is anticipated.

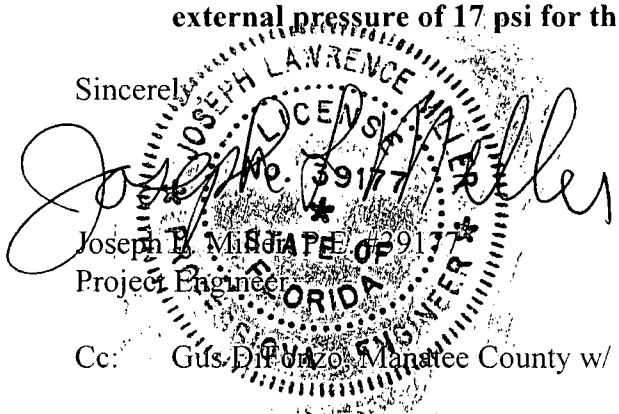
f. *Section 4. Although the calculations assume that the pipe bedding will be crushed gravel, it does not appear that a specification for gravel was provided and the drawings do not show the pipes bedded in gravel. Please revise the drawings, specifications or calculations as appropriate.* **(Response: The drawings, specifications and calculations were revised as appropriate.)** *Please provide calculations that include loading from equipment that may be used after closure.* **(Response: The calculation in Section 3 does include loading from equipment that may be used after closure. The calculation is for equipment with a total load of 55 metric tons, which is 61short tons or 122,000 pounds. The legal road limit is 80,000 pounds. After closure, no equipment over 80,000 pounds maximum is anticipated.)** *Please provide the reference for the P_{cr} formula.* **(Response: The reference for Pcr formula is ADS Technical Report 4.103" which is included with the calculations. The formula is on page 17/24 of the calculations.)**

g. *Section 6. Please provide calculations for all piping that will be used in this project. Please discuss the appropriateness of using Chart 24 since the pie "assumes no external loads" but the pipes may be subject to external loading.*

Response: The stormwater pipe strength calculations are in Section 6. The terrace under drain pipe strength calculations are in Section 4. Section 8 was added entitled "Pipe Strength Calculations for the Landfill Gas Collection System Pipe."

In Section 6, on page 2 of 18, calculation item 1 is a calculation of the safety factor for the maximum burial depth using Chart 24. Calculation item 2 is a check of the safety factor for maximum external pressure on the pipe. The maximum external pressure is calculated on page 1 where $P_t = P_s + P_L + P_i$. P_t is the total pressure on the pipe. P_s is the external soil pressure on the pipe. P_L is the live load pressure on the pipe. P_i is the internal pressure on the pipe due to vacuum. In calculation item 2, the maximum allowable external pressure in psi for an SDR 32.5 pipe with a soil modulus of 1000 psi, which is given in Table 24 as 17 psi, is divided by the maximum external pressure of 6.7 psi to give a factor of safety of 4.8. This is in addition to the factor of safety already built into the maximum allowable external pressure of 17 psi for the pipe.

Sincerely,



Joseph P. Miller, PE 39177
Project Engineer

Cc: Gus DiFranzo, Manatee County w/ 2 copies

PBSJ

List of Attachments

1. Revised Page 3 of 40 of the application with Reference to Appendix B deleted.
2. New Figure L-8A Landfill Gas Migration Monitoring Locations
3. Section P.8, pages P-8, P-9, P-10 and P-11.
4. Material Safety Data Sheet for 3M Super 77 Spray Adhesive
5. Specifications for Ottawa Sand
6. Geosynthetic Research Institute (GRI) Standard – GC8
7. Revised Specifications (Complete Set)
8. Revised "Calculation Book" dated March 22, 2006 (Complete Book)
9. Revised CQA Plan with Appendix
10. Revised Drawings (Complete Set)

DESIGN OF LATERAL DRAINAGE SYSTEMS FOR LANDFILLS

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2000

Design of Lateral Drainage Systems for Landfills
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Chapter 1 Review of Lateral Drainage System Functions

Lateral drainage systems within modern landfills must be designed to provide one or more of the following functions:

- **To Limit The Head Acting On The Liner Systems,** at a minimum this is required for demonstration of regulatory compliance that requires the maximum head on the primary liner in a municipal solid waste (MSW) landfill to be maintained at less than 30 cm. (e.g., 40 CFR 258.40(2) for MSW landfills and 40CFR 264.302 for Hazardous Waste landfills). Many double geomembrane liner systems are dependent on the lower lateral drainage system to reduce the head on the lower geomembrane to limit leakage.

- **To Detect Leakage Through and Overlying Barrier System,** double liner systems collect leakage of the upper liner to monitor the performance of the upper liner and to limit the head acting on the lower liner.

- **To Ensure Stability of Slopes,** in particular this refers to drainage of surface infiltration water that percolates down through the soil veneer above a barrier layer in either the liner or final cover systems. *This need to limit the hydraulic pressure within the lateral drain is the reason that this manual focuses on design methods that limit the depth of flow within the lateral drain to less than the thickness of the drain itself. This is referred to as unconfined flow. Solutions based on confined flow are not discussed in this manual. For such solutions, the reader is referred to Giroud et.al. (2000).*

Additional considerations are given to relief of gas generated pressures on the barrier layer. The application of the design methodology to gas is based on principles of intrinsic permeability. These same principles would allow the reader to apply the solutions in this manual to any fluid or gas.

1.1 Lateral Drains in Liner Systems

The primary function provided by a lateral drainage system and its service life must be clearly understood by the designer and regulatory reviewer. Functional and service requirements of all lateral drainage systems will be reviewed in this manual. Additionally, this design manual presents material selection guidance, recommended service reduction factors, and design considerations for all lateral drainage systems found within modern landfills. Design examples are used to develop recommended minimum physical properties for geosynthetic drainage composites or geonets for these applications.

Figure 1.1 shows the two independent lateral drainage systems that may be used as part of some modern liner systems. The upper lateral drainage system is called the leachate collection and removal system (LCRS) and the lower lateral drainage system is called the leakage detection system (LDS). The roles and service lives of these two systems may be dramatically different depending on the designer's intent.

The LCRS is the workhorse of the landfill that must remove a significant volume of leachate while resisting clogging and not generating excess hydrostatic pressures. Excess hydrostatic pressure must be avoided to limit potential slope stability related problems in the landfill. This service requirement means that the lateral drainage systems within the landfill must be designed such that the do not reach saturation. To ensure this, the maximum height of the leachate must remain within the height of the

lateral drain such that the flow is unconfined. The reader will find that this point is reinforced throughout this manual.

The LDS does indeed measure the leakage through the primary liner system but actually serves the environment by limiting the head acting on the lower secondary liner system. While the monitoring of leakage through the primary liner is of interest, the limiting of leakage through the secondary liner system is of greater environmental importance. The LDS will handle significantly less volume than the LCRS during its service life but must limit the head acting on the secondary liner to a fraction of that allowed on the primary liner.

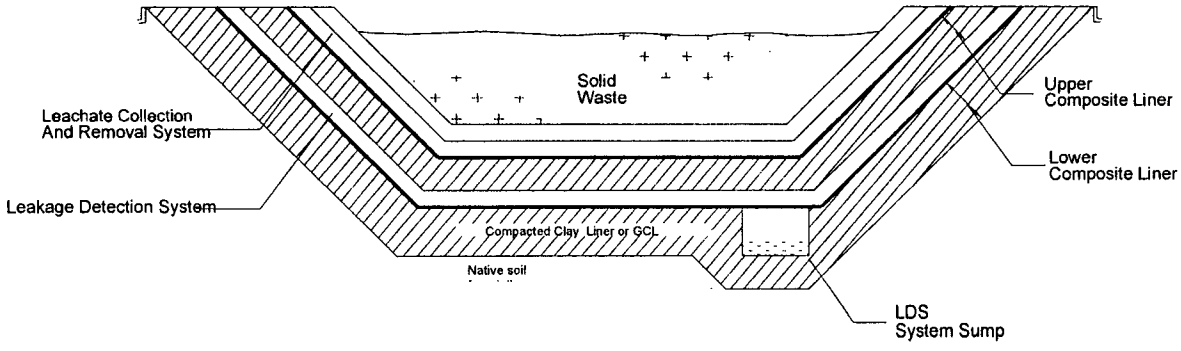


Figure 1.1 LCRS and LDS Drainage Collection Systems

1.1.1 Leachate Collection and Removal Systems (LCRS)

The LCRS is commonly the only lateral drainage system provided in a MSW landfill and serves as the primary means for leachate collection and removal. The LCRS will typically experience a significant reduction in the volume of leachate that the drain must handle with time, but may concurrently experience a reduction in its capacity due to compressive creep, biological and chemical clogging caused by the leachate. Knowing the rate that liquid vertically enters the lateral drainage layer over the liner system requires estimating the rate that leachate is draining from the waste. Two methods exist for making this estimate: 1 -use EPA's HELP model, or 2- use empirical rates based on historic leachate generation rates. The HELP model is limited in that it does not readily allow the operational/post-closure transition life of a landfill to be modeled, e.g., the geometry of the landfill model remains the same through the entire evaluation analysis. However, recent evaluation of actual leachate generation rates have shown that the HELP model can be a very good approximations to actual conditions, see M.A. Othman et al. (1998).

Empirical leachate generation rates are also commonly used to evaluate the three key phases in the life of the lateral drainage layer. Typical rates for non-arid climates are as follows: 1. leachate generation rates of 1200-2000 gallon/acre/day (gad) (11000 - 19000 l/hectare/day) during active placement of waste, 2. 200-600 gad (1870 - 3650 l/hectare/day) once 12-inch of interim cover is placed, and 3. 50-150 gad (470 - 920 l/hectare/day) after placement of the final cover. The authors confirmed the reasonableness of these values through discussions with state solid waste regulators in Florida, New York, North Carolina, and Virginia. Empirical values can be estimated from regional landfill service records, if available, and

published values of typical leachate generation values.

Leachate generation rates will be dramatically impacted by the degree of leachate/stormwater separation that is inherent in the facilities design and operational practices. The leachate generation rates referenced above reflect typical design and operational leachate/stormwater significant separation strategies may have less leachate, while those poorly designed and operated will have significantly more. Figures 1.2 to 1.4, show three different common landfill liner geometry and stormwater/leachate separation systems:

- Figure 1.2a - **'Sawtooth'** bottom commonly used on very flat sites. The sawtooth allows a minimum 2% liner slope to be maintained without the need for excessive fill. Each valley requires a sump and liquids collected in valleys having no waste can easily be discharged to the stormwater system. Figure 1.2b - is a Hawaiian landfill using a sawtooth bottom separation efforts. Facilities that employ

- Figure 1.3a - **'Low Permeability Operational Cover'** shows a stormwater separation system that relies on available low permeability soils or 'plastic rain sheets' to form surface collection pans that allow separation of rain from actual leachate. Stone drains penetrate the collection pans. In the absence of waste, the stone drains are sealed to prevent rain from draining to the underlying LCRS. Prior to placement of waste in the collection pan, the stone drains are exposed and from then on convey the leachate to a common sump via the LCRS. Figure 1.3b - is a North Carolina landfill using a low permeability operational cover

- Figure 1.4a - **'Canyon Swales'** allow the liner system to be incrementally raised on the canyon side walls and limits stormwater run on. This separation system concentrates on the side slopes and not the bottom of the landfill liner system. Figure 1.4b - is a California canyon landfill project using canyon wall swalesSuch stormwater separation systems can dramatically reduce the volume of leachate that the LCRS must handle though frequently the resulting leachate is stronger since it is not diluted by stormwater. Geonets can play an important role in typical LCRS systems.

Present high performance geonets/geocomposites can withstand large normal loads and are increasingly used as the LCRS on the bottom slopes landfills. In this application they are commonly used in conjunction with a low-quality sand drainage layer. The presence of the geocomposite drain allows the specifications for the sand to be relaxed and avoids costly processing of the sand. Careful considerations, however, must be given to evaluate the structural stability of the geonet product under sustained large normal loads. To address long-term compressive stress on the geonet core of a geocomposite, Holtz et al. (1997) suggest that the design pressure on a geocomposite core be limited to either:

(a) the maximum pressure sustained on the core in a test of 10,000 hour minimum duration, or
(b) the crushing pressure of a core as defined with a quick loading test, divided by a safety factor of 5.

1.1.2 Leakage Detection Systems (LDS)

Of all the varied drainage applications that geonets serve, their use in leakage detection systems (LDS) within waste containment systems is probably their most natural application. Leakage detection systems must provide two important functions in liner systems:

1) allow the leakage from an overlying primary liner system to be monitored (hence the term LDS), and

2) minimize the head acting on an underlying secondary liner system.

- Geonets provide a perfect balance of low water storage capacity and high flow transmissivity for the design of LDS systems. A majority of LDS systems are constructed exclusively with them. The role of

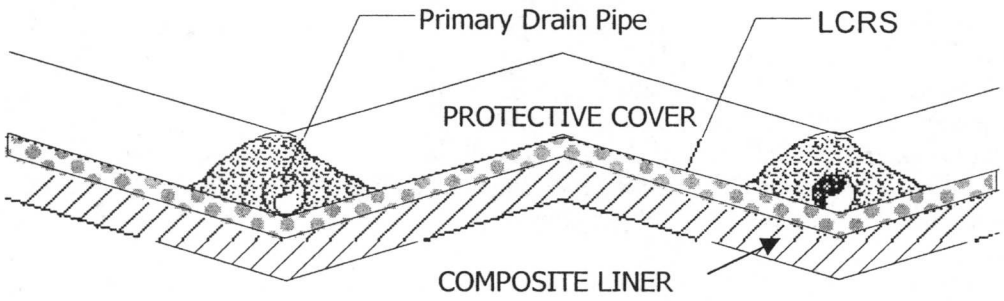


Figure 1.2a Sawtooth Design

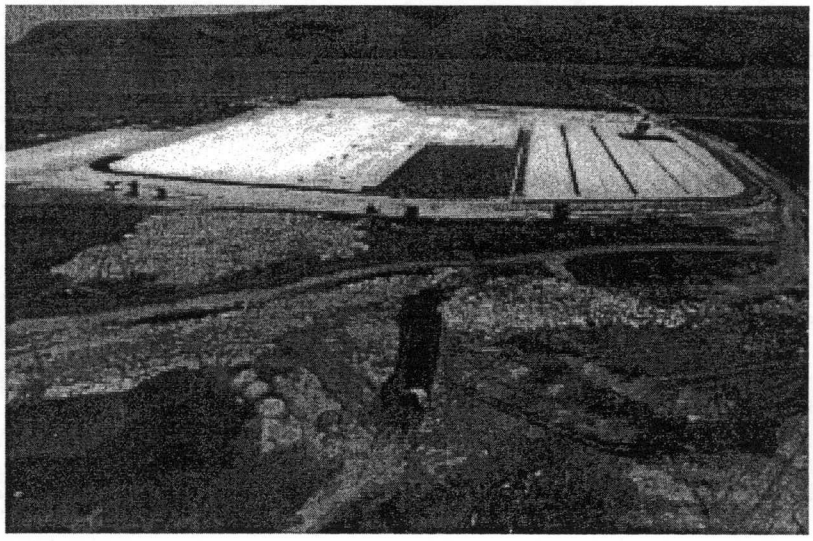


Figure 1.2b Hawaiian Landfill Using a Sawtooth Bottom

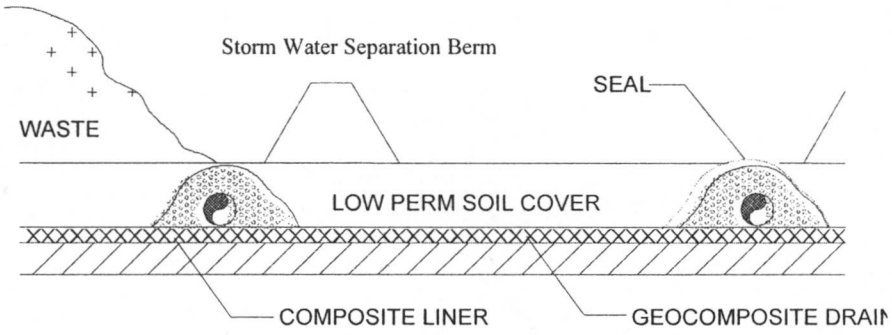


Figure 1.3a Low Permeability Operational Cover

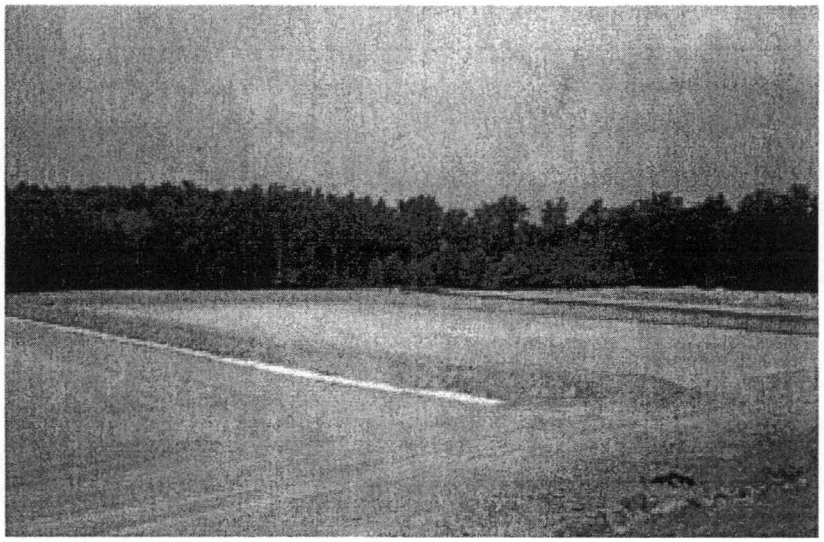


Figure 1.3b North Carolina Landfill Using a Low Permeability Operational Cover

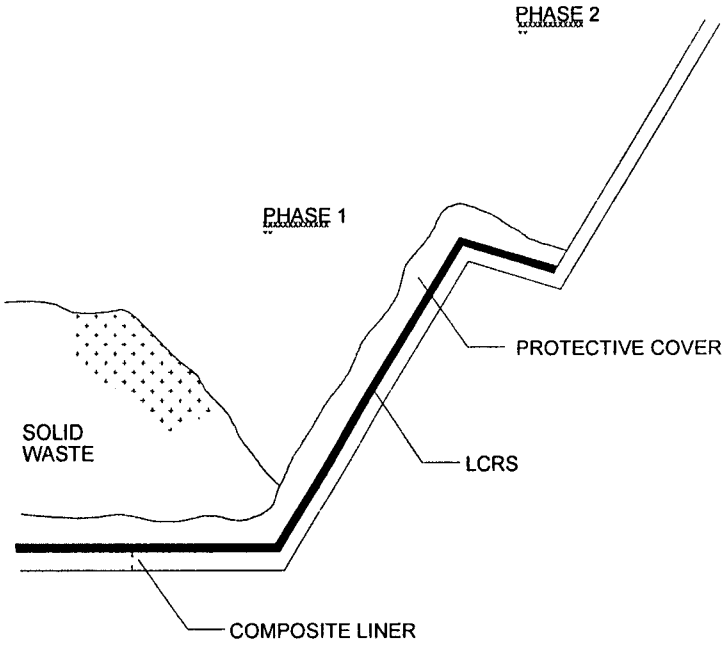
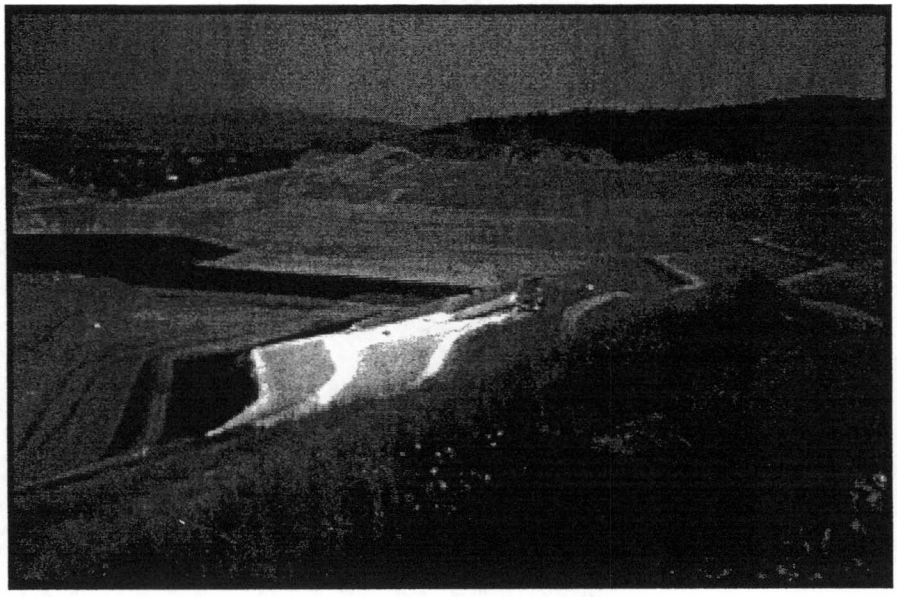


Figure 1.4a Canyon Swales Design



1.4b Californian Canyon Landfill Using Canyon Wall Swales

the LDS system in reducing the head acting on the secondary liner system, and thereby lowering the leakage rate, may be considered its most important role. Its ability to provide this head reduction even when subjected to significant leakage from the primary liner system must be demonstrated.

Fortunately, the potential volume of leachate that must be handled by the LDS decreases with time. A reduction in leachate volume with time is clearly shown in the EPA data presented in Table 1 that identifies three stages in the life of a LDS system: 1) construction and pre-operational, 2) operational, and 3) post closure. This means that the required transmissivity for the LCRS declines with time. This may not be true in landfills that recirculate leachate, e.g. bioreactors.

Table 1 Leakage of Alternative Liner Systems, gal/acre/day
(Othman et al., 1998)

Liner Type	GM/GCL Barrier			GM/CCL Barrier			GM Only		
Life Cycle Stage[1]	1	2	3	1	2	3	1	2	3
Average Flow	14	2.28	0.03	23	15	6.8	41	18	6.8
Minimum Flow	0.0	0.00	0.00	0.13	2.4	0.00	0.81	0.0	0.02
Maximum Flow	104	30	0.10	126	71	29	229	158	26
# of cells	19	19	4	31	41	15	30	32	8
# of landfills	3	3	1	11	11	4	11	11	4

(1) 1 - as initially constructed, 2 - during active waste placement, and 3 - with final cover in place

1.2 Lateral Drains in Final Cover Systems

Figure 1.5 shows the two independent lateral drainage systems commonly associated with a typical final cover system: side slope drain, and the top drain. While both drainage layers act to reduce the head acting on the underlying barrier system, the impact of failure of these two systems is dramatically different. Failure of a lateral drainage system will increase the head acting on the barrier. On the flatter slopes associated with the top of typical cover systems, the higher head will result in an increase in the infiltration rate through the barrier. A similar failure of the lateral drainage layer on the side slope will result in a catastrophic slope failure of all layers above the barrier system. Thus it would seem reasonable to require a larger factor of safety for lateral drainage systems on the side slopes of final covers compared to the top lateral drainage systems on gentle slopes. Surprisingly, we will show in Chapter 3.3 that a single factor of safety is adequate.

1.3 Functional Role vs. Regulatory Role

The conservatism taken in the design of a lateral drainage system must reflect the actual service conditions that the drain will experience. Many lateral drainage systems, including all LDS and many LCRS area collectors in 'Low Permeability Operational Cover' systems, do not actually convey significant quantities of leachate during their service life. Such systems are required, however, to provide a demonstrated control of the head acting on the liner that they overlie.

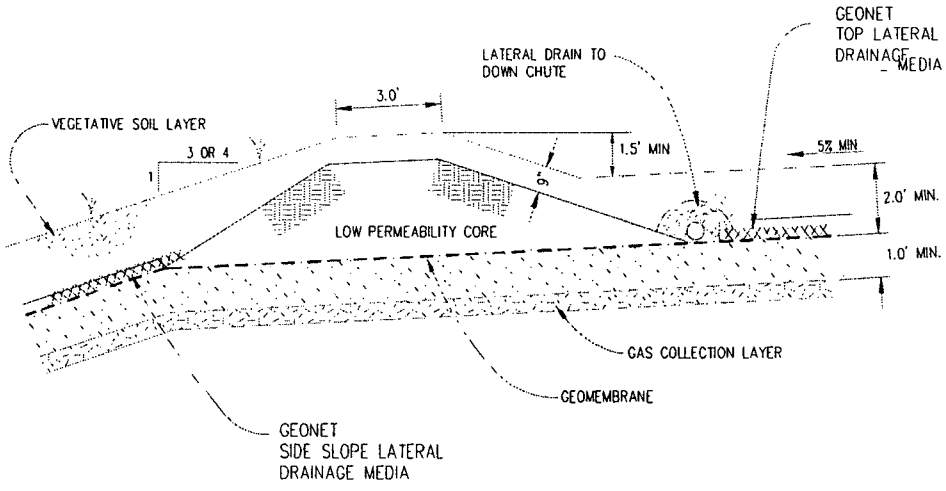


Figure 1.5 Final Cover Drainage Systems

Designers must use extreme caution when using regulatory "minimum" design values for lateral drainage systems. Such values may be codified minimums or simply guidance provided by the permitting agency. Codified minimums include 40 CFR 264.301 (3) that requires a minimum $3x10^{-5}$ m^3/sec-m transmissivity for a geocomposite drain. Such codified minimums may actually underestimate the required transmissivity by several orders of magnitude. A similar problem was observed by Koerner, et. al, 1997, with non-conservative predicted flows to lateral drainage systems obtained from the HELP model. A combination of 'El Nino" rain events that are dramatically larger than the synthetic weather predictions of the HELP model and the need for HELP to conservatively predict leakage through the liner system frequently result in order of magnitude errors in HELP predicted lateral drainage values. Such models are a valuable aid in the design of containment systems, but required transmissivity should be compared to that resulting from the methodology presented in the following chapters – with the larger value assumed in design.

Chapter 2 Site Specific Requirements for Drainage Composites

Two types of drainage geonets are shown in Figure 2.1, with the triplanar geonet shown on the right and the biplanar geonet on the left. Biplanar geonets consist of two layers of ribs superimposed over each other; while triplanar geonets are comprised of two layers of inclined ribs separated by thick vertical ribs, creating a wide flow channel. Geocomposite drainage systems are composed of a drainage net core with a geotextile laminated on one or both faces. An upper geotextile is used to filter out particles from overlying soils. A lower geotextile is used to increase the interface friction with an underlying textured geomembrane. A geocomposite drain is designed for in-plane flow over a large surface area.

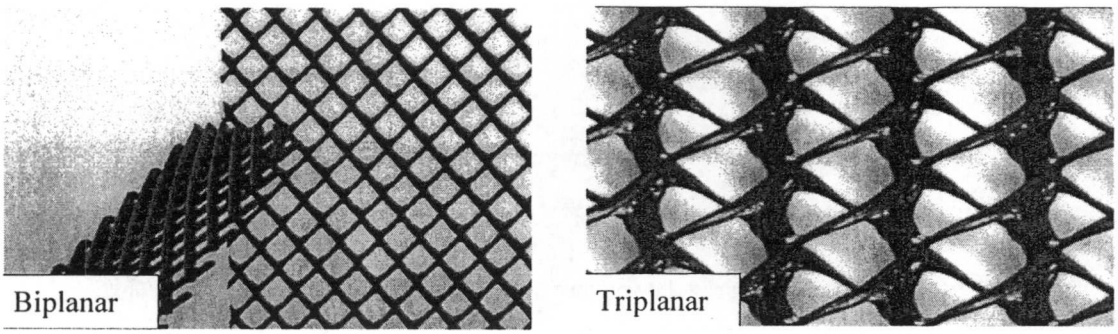


Figure 2.1 Photos of two types of geonet drainage products.

The critical engineering properties of a geocomposite drain include:

- In-plane flow capacity (or transmissivity) of the geonet/geocomposite under design loads and boundary conditions,
- Filtration characteristics of the upper geotextile relative to the soil retained or the liquid in question,
- Internal shear strength, and
- Interface friction with adjacent soil and/or 'geo' layers.

The in-plane flow capacity of a geocomposite is evaluated using a laboratory transmissivity test (ASTM D-4716). This test is performed using the transmissivity box setup shown on Figure 2.2. This apparatus allows a range of normal loads and boundary conditions, i.e., soil or geomembrane, to be applied to the face of the geocomposite. The head acting across the 12-inch square sample can be varied to create a range of gradients that simulate field slope conditions. The flow gradient, i, is defined as the head divided by the flow length (12 inches in the case of ASTM D4716). Typical data produced by this test are shown on Figures 2.3 and 2.4. In general, transmissivity decreases with increasing normal loads and increases with decreasing flow gradients. The transmissivity of a geocomposite is discussed in greater detail in Chapter 3 and the use of transmissivity charts is discussed in Chapters 4 and 5.

Geotextile filter designs are performed on the basis of the characteristics of the soil immediately up gradient of the geotextile. These soil properties include Atterberg limits and grain-size distribution. These criteria are common to all drainage applications of geotextiles. As such, the generalized filter criteria provided by AASHTO M-288 is reviewed in this manual. It is important to remember that such

filter criteria have been established for clean water and does not account for potential clogging of the geotextile due to chemical or biological actions. However, research has shown that a geotextile clogging potential due to such conditions is very similar to that of sand. Therefore, the overlying soils placed against the geotextile also face a high potential of clogging when exposed to leachates with high biological activity or precipitants.

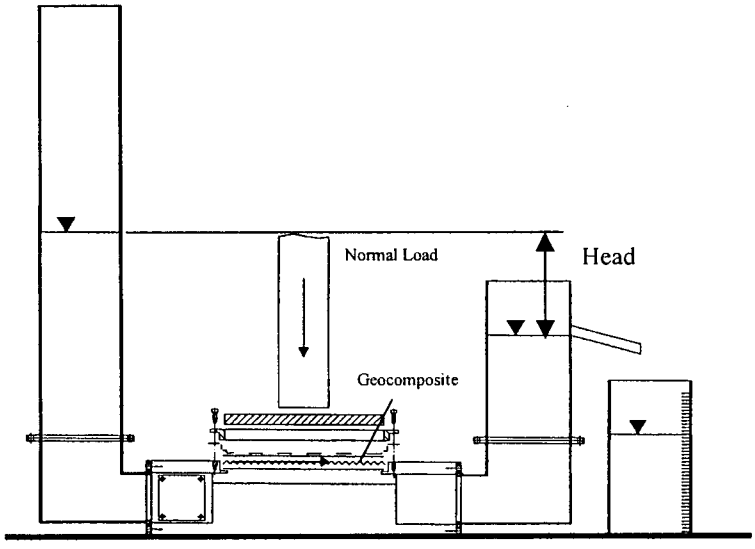


Figure 2.2 Typical cross section of a constant gradient transmissivity apparatus.

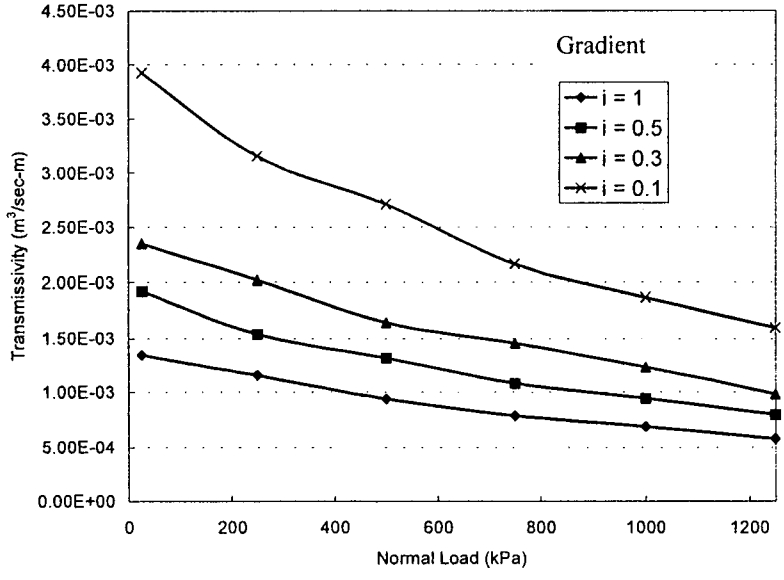


Figure 2.3 Transmissivity data vs. normal loads for a triplanar geonet laminated with a 270g/m^2 nonwoven on each side with soil as a top boundary and aluminum plate lower boundary (ASTM D4716).

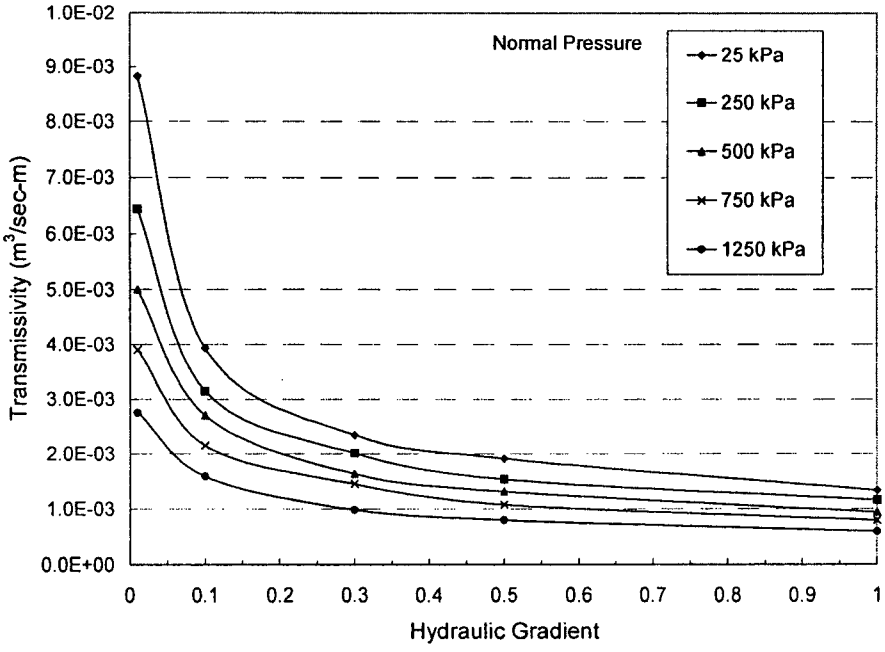


Figure 2.4 Transmissivity vs. gradients for a triplanar geonet laminated with a 270g/m^2 nonwoven geotextile on each side with soil as a top boundary and aluminum plate as lower boundary (ASTM D4716).

The internal shear strength of the geocomposite is controlled by the lamination strength of the geotextiles to the core drainage net. Lamination of the polypropylene geotextile to the polyethylene geonet is typically done using a thermal process. The shear strength of the lamination can be verified using the direct shear test (ASTM D-5321). It is, however, commonly empirically verified using a specified minimum ply peel adhesion strength (ASTM D-413) with a minimum ply adhesion of 1 lb/in commonly specified.

Interface friction tests are critical for geocomposites that will be used in short or long-term applications that involve significant slopes. The interface shear strength between the geocomposite and an adjacent surface is evaluated using either the direct shear test (ASTM D-5321) or tilt-table tests not currently standardized. As with the transmissivity test, sample size is commonly 12-inch square and the test equipment allows a range of normal loads and boundary conditions to be applied to the face of the geocomposite.

2.1 Geotextile Selection

The geotextile covering on a geocomposite drain must provide the following: sufficient strength to resist installation damage, adequate permittivity to allow water to enter the drainage composite, adequate filtration characteristics to prevent clogging while at the same time preventing excessive loss of the soil retained, sufficient bonding strength to the drainage geonet. The bottom geotextile provides only

friction and cushion protection for the underlying geomembrane. Fortunately, minimum strength and filter properties can be quickly evaluated using AASHTO M-288 requirements for similar transportation related drainage applications. In addition, there are many soil retention criteria, such as Luettich et al. (1992), Holtz et al. (1997), available for further examinations.

2.1.1 Geotextile Minimum Strength for "Survivability"

The term "geotextile survivability" refers to the fabric's ability to withstand installation stresses associated with a particular application, and to perform as intended in the project design. In 1996, AASHTO published a set of survivability criteria for geotextiles, designated as AASHTO M 288-96. The guidelines prescribe four tests to assess the strength of a geotextile and its ability to survive installation stress. These guidelines address both woven and nonwoven geotextiles. In drainage composites, nonwovens are used exclusively so that only a portion of M288 is presented in Table 2-1. Class1 geotextiles meet the most stringent survivability criteria and Class 3 geotextiles meet the minimum survivability criteria.

The class of geotextile required on a geocomposite is dependent on the specific application. AASHTO M 288-96 provides guidelines for five general applications: subsurface drainage, separation, stabilization, permanent erosion control, and paving. The default geotextile class for subsurface drainage applications is Class 2. However, for each application, the engineer may specify geotextile class based on past field experience or laboratory test data. The "survivability" strength for the geotextile in a drainage composite commonly does not control the selection of the geotextile but "bonding" requirements to physically connect the geotextile to the drainage core will control.

Table 2.1 Nonwoven Geotextile Survivability Requirements
(After AASHTO M 288-96)

Property	Test Method	Class 1	Class 2	Class 3
Grab Strength	ASTM D 4632	900 N (203 lb)	700 N (158 lb)	500 N (113 lb)
Sewn Seam Strength	ASTM D 4632	810 N (182 lb)	630 N (142 lb)	450 N (10l lb)
Tear Strength	ASTM D 4533	350 N (79 lb)	250 N (57 lb)	180 N (41 lb)
Puncture Strength	ASTM D 4833	350 N (79 lb)	250 N (57 lb)	180 N (41 lb)
Burst Strength	ASTM D 3786	1700 kPa (247 psi)	1300 kPa (189 psi)	950 kPa (138 psi)

2.1.2 Geotextile Filter Criteria

Geotextile filtration properties must be selected based on the up-gradient soil gradation and plasticity, and site specific hydraulic conditions. The following filter criteria assume that the soil being retained is "set" in intimate contact with the geotextile, i.e., no voids exist between the fabric

and the soil. For non-vertical drains this is accomplished by gravity, for vertical drains this must be accomplished by compaction of the soils adjacent to the geocomposite.

Most geotextile filter designs are based on the retained soil Atterberg limits and grain size distribution. Atterberg limits (ASTM D-4318) include the liquid limit (LL), plastic limit (PL), and plasticity index (PI) of the soil. Such information is helpful in assessing the flow capacity and clogging potential of a geotextile. The PI value provides a measure of soil cohesiveness, a high PI value indicates high clay content of a highly cohesive soil. For filter design criteria presented in this manual, it is important to determine if the PI is greater or less than 15 percent. Generally, particles do not move within soils having a PI greater than 15 percent so there is no clogging potential.

For the purposes of filtration design, soils can be characterized as stable or unstable. Stable soils perform an internal filtration process that limits migration of fines within the soil. Typically, these soil types include well-graded soils. Unstable soils are those which cannot perform self-filtration (i.e. they have the potential to pipe internally). They may include gap-graded, and broad-graded soils, and other highly erodable soils. In gap-graded soils, there exists a coarse and fine fraction, but very little medium fraction. If there is an insufficient quantity of soil particles in the medium fraction, fine soil particles pipe through the coarse fraction. In broad-graded soils, the gradation is distributed over a very wide range of particle sizes such that fine soil tends to pipe through coarser particles.

For a soil to be classified as both well-graded and stable , it must meet the following criteria:

$$C_U = \frac{D_{60}}{D_{10}} > 4 \quad \text{and} \quad 1 < C_c = \frac{D_{30}^2}{D_{10} \, x \, D_{60}} < 3 \qquad \text{Eq. 2.1}$$

where: D_{10} = the diameter at which 10 percent of the soil is finer.
D_{30} = the diameter at which 30 percent of the soil is finer.
D_{60} = the diameter at which 60 percent of the soil is finer.
C_u = the coefficient of uniformity, it quantifies distribution of particle sizes
C_c = the coefficient of curvature, it identifies internal soil stability

Sample gradation curves of well-graded and uniformly graded soil are shown in Figure 2.5 and gap-graded and broad-graded soils are shown in Figure 2.6. The value of D_{60}/D_{10} distinguishes unstable broad-graded soil from a well-graded soil. For broad graded-soils, this value exceeds 20. Another characteristic of unstable broad-graded soils is that the gradation curve is concave upward.

The geotextile hydraulic requirements are based on its through-the-plane flow capacity, permittivity, and its apparent opening size, AOS. The AOS is defined as the diameter of glass beads that 5% or less will pass through the geotextile during the ASTM D4751 dry sieve test. This is also commonly referred to as the O_{95} of the geotextile. Minimum hydraulic requirements shown in Table 2-2 are from AASHTO M 288-96 and should be considered in the selection of a geotextile.

Table 2-2 Geotextile criteria for subsurface drainage
(after AASHTO M 288-96)

Filter Criteria	Percent Soil Passing No. 200 (0.075mm) Sieve		
	< 15	15 to 50	>50
Minimum Permittivity, ASTM D-4491	0.5 sec^{-1}	0.2 sec^{-1}	0.1 sec^{-1}
Maximum AOS, ASTM D-4751	0.43 mm	0.25 mm	0.22 mm

An additional check on the ability of the geotextile to retain the up gradient soil can also be verified using the retention criteria, such as proposed by Holtz et al. (1997). Use of this criterion requires performing a grain size analysis on the retained soil to determine the D_{85}, and C_u of the soil, where D_{85} is the particle size at which 85% of the retained soil particles are finer than, and C_u is the coefficient of uniformity.

$$O_{95}/D_{85} < B \qquad \text{Eq. 2.2}$$

For sands, gravely sands, silty sands, and clayey sands (with less than 50% passing the 0.075 mm sieve), B is a function of coefficient of uniformity

$B=1$	$C_u < 2$ or > 8
$B=0.5*C_u$	$2 < C_u < 4$
$B=8/C_u$	$4 < C_u < 8$

For silts and clays (with more than 50% passing the 0.075 mm sieve) B =1.8.

Thus, the critical physical properties of a retained soil that impact the selection of a geotextile include the "stability" of its particle size distribution, the percent fines, and the D_{85}. These factors can be economically evaluated in a simple grain size analysis (ASTM D-421 & 422).

An evaluation of clogging potential (including particulate clogging and biological clogging potential) for the geotextile should also be conducted. To minimize particulate clogging:

$$O_{95} > 3\ D_{15} \qquad \text{for } C_u > 3$$

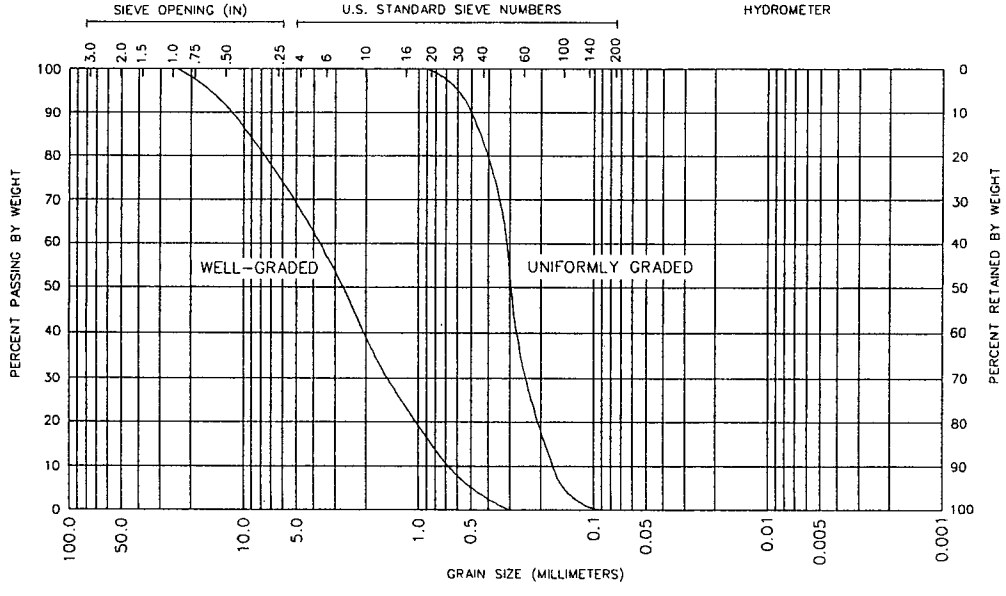


Figure 2.5 Well-graded and uniformly-graded soils.

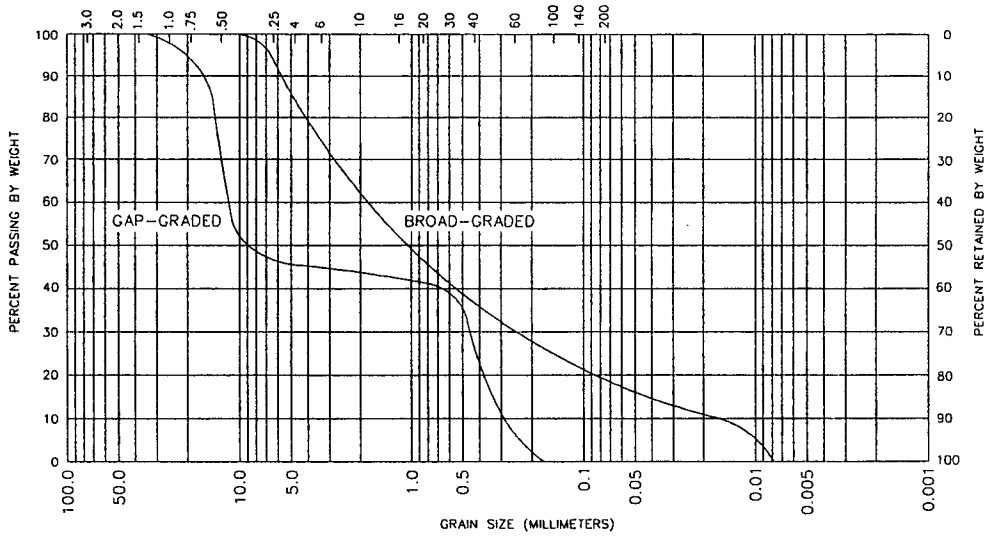


Figure 2.6 Gap-graded and broad-graded soils

In addition to the above empirical equation, there are two laboratory test methods available specifically for this evaluation:

- ASTM D5101, Gradient Ratio test (Standard test method for measuring the soil-geotextile system clogging potential at low normal loads)
- ASTM D5567, Hydraulic Conductivity Ratio test (Standard test method for measuring the soil-geotextile system clogging potential at higher normal loads)

The potential for biological clogging is influenced by the relative biological activity of the pore water liquid. Typical ground waters have a low biological, e.g. inactive, potential while leachates collected in most landfills is 'active' and has a high clogging potential. The actual biological clogging potential can be evaluated by using the actual leachate in the two tests described above. Lacking this data, the minimum permeability of the geotextile in a geocomposite lateral drainage layer should satisfy the following criteria (based on data from Koerner et al. 1993):

$$K_{geotextile} > 100\ K_{soil} \qquad \text{'Active' Liquid}$$

$$K_{geotextile} > 10\ K_{soil} \qquad \text{'Inactive' Liquid}$$

The permeability of the geotextile must be significantly larger than the permeability of the soil to address biological clogging concerns. This does not mean, however, that the soil itself will not clog. The above relationship must not be used for sock covers over perforated pipes. Test data indicated reductions of permeability in sock drain applications that reached 5 order-of-magnitude reduction.

2.2 Interface Friction

Geocomposite drains have proven to be very stable in slope applications due to the high interface friction of a nonwoven geotextile with both textured geomembranes and soils. Similar to the soil shear behavior, the

geotextile/soil interface behavior is affected by the soil particle size, particle shape, moisture content, normal stress level, and degree of compaction or relative density, in addition to the geotextile type. In the drainage application where a soil layer is placed over a nonwoven needle-punched geotextile, with a wet interface and medium compaction effort, the efficiency of the interface could be related to the soil gradation and internal friction angle. The efficiency of the geosynthetic interface E as presented in Table 2.3, is defined as: $E = \tan(\delta)/\tan(\phi)$ where δ is the interface friction angle and, ϕ is the soil internal friction angle, assuming zero adhesion between the two materials. These data can be used to estimate the interface friction angle between nonwoven geotextiles and soils for preliminary design. Confirmation laboratory interface friction tests should be performed with site-specific materials during construction.

Table 2.3 Nonwoven Needle-Punched Geotextile / Soil Interface Efficiency

Soil	Efficiency (E)
Silt	0.85
Uniform fine to medium sand	0.80
Well-graded sand	0.70
Sand or gravel	0.60

Figure 2.7 presents the direct shear test data between a geocomposite and a sandy cover soil; the calculated friction angle is 34.1° peak, and 21.7° residual.

Against a textured geomembrane, the interface friction of a nonwoven needle-punched geotextile can be taken as 28° for peak and 14° for residual. Figure 2.8 presents the direct shear test data between a geocomposite and 60 mil textured geomembrane; the calculated friction angle is 36.6° peak, and 14.6° residual.

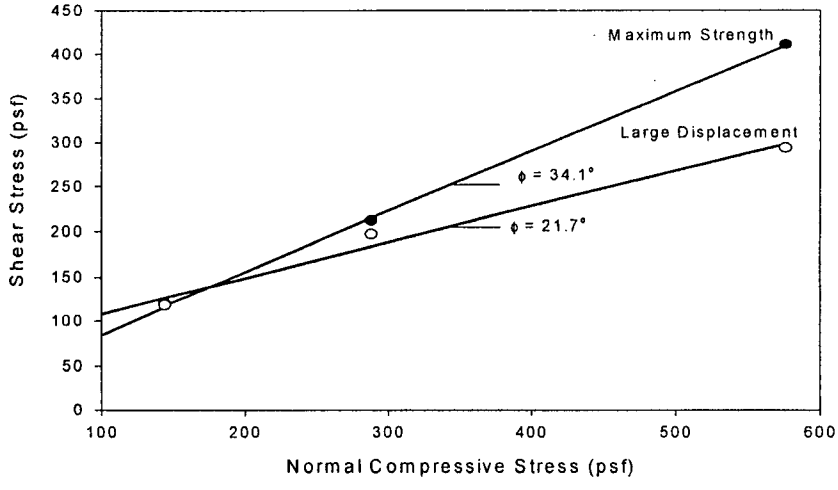


Figure 2.7 A direct shear test on geocomposite vs. cover soil

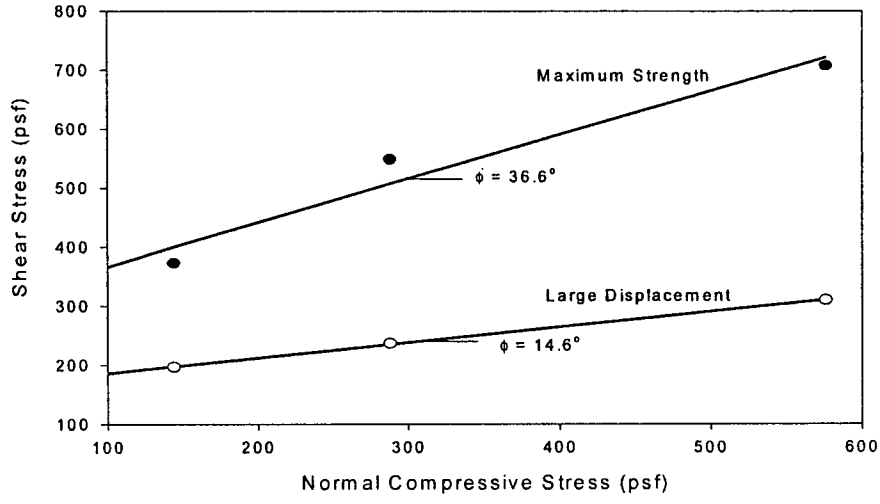


Figure 2.8 A direct shear test on geocomposite vs textured geomembrane

Frequently the geonet core is placed immediately adjacent to a smooth or textured geomembrane. This is very common for Leakage Detection Systems, see Chapter 5.2. The peak interface friction between these two 'geo' components can be estimated conservatively as 8 degrees for smooth geomembrane, and 13 degrees for textured geomembrane. The residual friction angle between a geonet and a geomembrane is typically less than 8 degrees. These values are for low normal load (<1000 psf) applications.

Double geonet systems create an additional interface of geonet to geonet. A large scale direct shear test was conducted to evaluate this interface. The normal loads applied are 20, 40 and 60 kPa. The displacement vs. shear force is presented in Figure 2.9, and normal stress vs. shear stress is shown in Figure 2.10. The peak friction angle of the tested interface is 12°, and the residual friction angle is 11°. This result is consistent with the peak geonet to geonet interface friction angle reported to be 14° by Koerner and Hwu (1989). Such a low value of interface friction angle may cause a veneer instability problem when double geonet systems are placed on typical landfill side slopes. Laboratory direct shear tests performed for normal loads that exceed this range indicate increased interface friction.

It is always recommended to perform the direct shear test (ASTM D5321) on the interfaces of concern under the project specific conditions to evaluate their interface friction behavior.

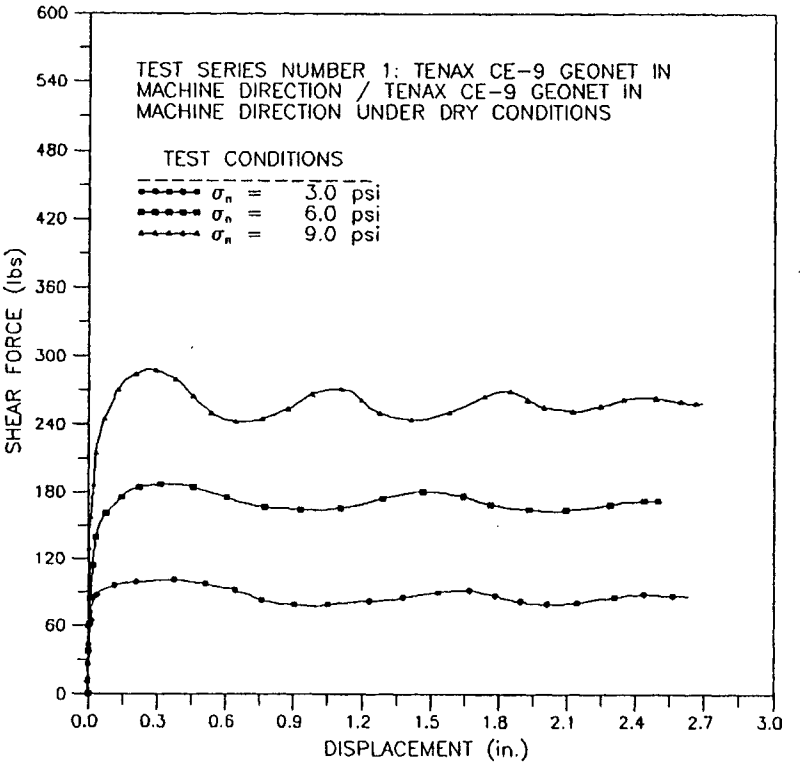


Figure 2.9 Displacement vs. shear force between two geonets.

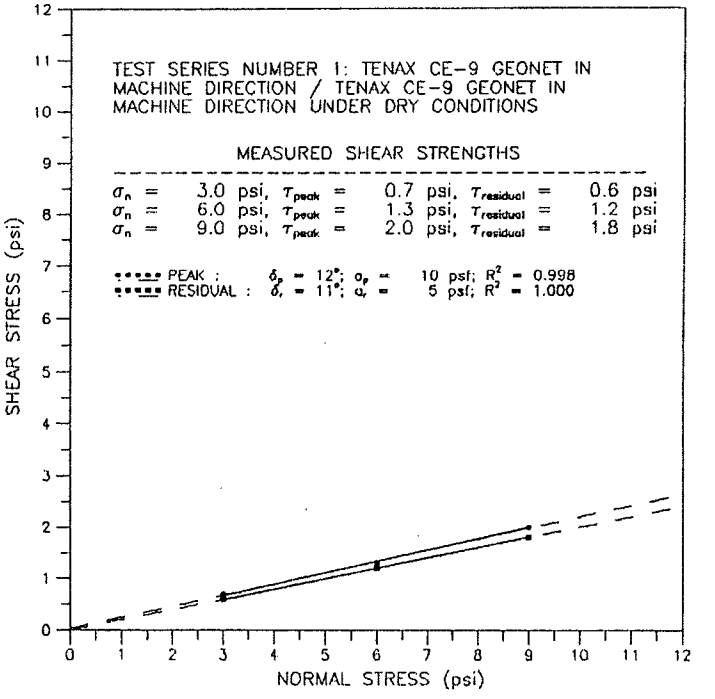


Figure 2.10 Normal stress vs. shear stress between two geonets

Chapter 3 Transmissivity Requirements for Drainage Composites

Presently, regulatory guidance exists for *minimum* values of transmissivity for lateral drains in landfill liner and final cover systems. Typically these are presented as part of a one-dimensional section of a liner or cover system. Such guidance cannot address the specifics of all sites and therefore are not a substitute for the rational design of a lateral drainage system. This chapter reviews both regulatory minimum transmissivity requirements and additional service factors that can reduce the long-term effectiveness of a lateral drainage system.

3.1 Minimum Regulatory Transmissivity

3.1.1 Sand or Gravel Drainage Layers

For hazardous waste landfills, USEPA Minimum Technology Guideline (MTG) requires a drainage layer with minimum thickness of 30 cm and permeability of 0.01 cm/sec. This minimum drainage requirement applies to both the surface water removal layer in the final cover, the leachate collection, and the leakage detection layers in the liner systems. For non-hazardous waste landfills, the above minimum drainage requirement commonly applies to the leachate collection layer. The lateral drainage capacity of the above minimum requirement can be quantified by the flow rate per unit width and per unit gradient or hydraulic transmissivity. Transmissivity is defined as

$$\theta = k \cdot t = \frac{q}{i} \qquad \text{Eq. 3.1}$$

Where

- θ = hydraulic transmissivity (m^3/sec-m)
- q = flow rate per unit width (m^3/sec-m)
- k = coefficient of permeability, also called hydraulic conductivity (m/sec)
- i = hydraulic gradient
- t = drainage layer thickness (m)

Based on Equation 3.1, 30 cm of sand with a permeability of $1 * 10^{-2}$ cm/sec produces a transmissivity value of

$$\theta = 1*10^{-2}*30 \text{ cm}^3\text{/sec-cm} = 3*10^{-5} \text{ m}^3\text{/sec-m}$$

This value represents the minimum EPA MTG transmissivity for soil drainage materials. Therefore, if a drainage safety factor of 2 for MTG design is required for a sand or gravel drain, the allowable transmissivity, θ_{allow}, will be as follows:

$$\theta_{allow} = 2*3*10^{-5} \text{ m}^3\text{/sec-m} = 6*10^{-5} \text{ m}^3\text{/sec-m}$$

3.1.2 Geocomposite Drains

Hazardous waste landfill regulation 40 CFR 264.301(3) requires a minimum $3x10^{-5}$ m^3/sec-m transmissivity for a composite drainage media. This transmissivity is equal to that of a drainage layer with minimum thickness of 30 cm and permeability of 0.01 cm/sec. Thus, regulatory equivalence between natural and geocomposite lateral drainage systems is currently based on equivalent transmissivity. This concept is invalid as shown in Section 3.1.3.

Composite drainage media are composed of a geonet drainage core with a geotextile laminated to one or both faces. A geocomposite drain is designed to replace or augment soil drainage over a large surface area. There are obvious advantages for geocomposites to be used as landfill lateral drainage, such as, a significant saving in landfill volume, ease of installation, consistency in material properties inherent with manufacturing quality control (MQC) plans, and lower cost in general. However, geocomposites are made of polymeric materials, which exhibit different characteristics from natural drainage soils. Additionally, since geocomposite are very thin and we are designing for unconfined flow, the allowable head is much less than the regulatory requirements.

When a geocomposite is used to construct a liquid collection layer, the thickness of the liquid collection layer is the thickness of the transmissive component of the geocomposite (i.e. the core of the geocomposite). The thickness of the liquid collection layer is not the total thickness of the geocomposite including the geotextile.

3.1.3 Equivalency of Geosynthetic and Natural Drains

It is common design practice today to replace a natural drainage layer with a geosynthetic drainage layer having the same transmissivity. Giroud, Zhao, and Bonaparte (2000) have shown that this practice is incorrect and non-conservative. A equivalency based solely on transmissivity will lead to selection of a geosynthetic drainage layer that may not provide adequate flow capacity and may result in the development of significant hydraulic pressures. Such hydraulic pressures can significantly impact the slope stability of landfill systems.

Equivalency between two lateral drainage systems must take into consideration the service flow gradients and maximum flow depth. A 30 cm thick natural drainage layer can support larger flow gradients and maximum flow depth than a 6 mm thick drainage geocomposite. Thus, the drainage geocomposite must provide a larger transmissivity to overcome these limitations. Giroud, Zhao, and Bonaparte (2000) have shown that, to be equivalent to a natural drainage layer, the minimum transmissivity of the geocomposite must be greater than the transmissivity of the natural layer multiplied by an equivalence factor, E. For natural drainage systems having maximum flow depths of 30 cm (1 ft), E is can be approximated as follows:

$$E \approx \frac{1}{0.88}\left[1 + \left(\frac{1}{0.88\,L}\right)\left(\frac{\cos\beta}{\tan\beta}\right)\right] \qquad \text{Eq. 3.5}$$

efficiency values for common slope lengths and grades are presented on Table 3.2 Note that E increases with decreasing length of drainage and grade.

The equivalency defined by Eq. 3.5 is based on equal unconfined flow volumes in the natural and geocomposite lateral drainage systems. However, the designer should also realize that the very low heads associated with unconfined flow in a geocomposite lateral drain will result in a significant reduced head acting

on the underlying liner system and therefore a reduced potential leakage. Thus equivalence here is based on equal flow properties and not equal leakage of the lateral drain and liner systems.

Table 3.2. Values of the equivalency factor, *E*, between a geosynthetic liquid collection layer and a granular liquid collection layer when the prescribed maximum liquid thickness is 0.3 m (1 ft), as a function of the slope, β, and the length, *L*, of the liquid collection layer.

	Slope of the liquid collection layer, tanβ								
m (ft)	0.02	0.03	0.04	0.05	0.1	1/4	1/3	1/2	1
15 (50)	2.43	2.00	1.78	1.65	1.39	1.24	1.21	1.18	1.15
30 (100)	1.78	1.57	1.46	1.39	1.26	1.19	1.17	1.16	1.15
45 (150)	1.57	1.42	1.35	1.31	1.22	1.17	1.16	1.15	1.14
60 (200)	1.46	1.35	1.30	1.27	1.20	1.16	1.15	1.15	1.14

3.1.4 Adequacy of HELP Model

Research by Thiel and Stewart (1993), Soong and Koerner (1997) indicate that the HELP model significantly underestimates percolation into a lateral drainage layer. Eight seepage-induced landfill slope failures have been recorded and analyzed to confirm this by Soong and Koerner (1997). The federal and state minimum permeability value of $1*10^{-2}$ cm/sec or $1*10^{-3}$ cm/sec for drainage soils was found too low by a factor of 10, and in some cases 100. Higher permeability drainage media or high performance drainage geocomposites are recommended. When the permeability of drainage media is increased to $1*10^{-1}$ cm/sec (increased by a factor of 10 over $1*10^{-2}$ cm/sec), the minimum 'prescriptive' transmissivity of a geosynthetic product is increased to $(2.4 - 6.0)*10^{-3}$ m^3/sec-m.

3.2 Long-Term-In-Soil Performance of Geocomposite Drains

Lateral drainage systems degrade with time due to the very liquids they carry and the normal loads they are subjected to. A geocomposite liquid collection layer must have sufficient flow capacity to ensure that there is no pressure buildup within the liquid collection layer. Therefore, to ensure long-term performance, the hydraulic design of a geocomposite liquid collection layer must ensure that the liquid collection layer has sufficient flow capacity under the conditions that exist in the field during the entire design life of the liquid collection layer. The flow capacity under those conditions is referred to as "long-term-in-soil flow capacity".

Thus, the designer must provide surplus initial hydraulic capacity in the lateral drain to ensure that flow within the lateral drain remains unconfined. The discussion in this section is intended to provide the reader with a comprehensive background in the various factors that can degrade the performance of a lateral drain. Many of these factors can be quantified during laboratory testing of the geocomposite. However, many factors are not readily quantified. This requires significant judgement on the part of the designer. Such judgement must be tempered by the criticality of the application and the impact of potential failure.

The long term performance of a lateral drain requires a larger initial transmissivity, θ_{LTIS}, than that obtained from the design equations, $\theta_{req'd}$. This process was initially quantified by Koerner (1998) as follows:

$$FS = \frac{\theta_{LTIS}}{\theta_{req'd}} \qquad \text{Eq. 3.2}$$

$$\theta_{LTIS} = \frac{\theta_{measured}}{RF_{in} \cdot RF_{cr} \cdot RF_{cc} \cdot RF_{bc}} \qquad \text{Eq. 3.3}$$

where FS is the overall safety factor for drainage, θ_{LTIS} is the long-term-in-soil hydraulic transmissivity of the drainage geocomposite, $\theta_{req'd}$ is the required transmissivity (e.g., for MTG= $3*10^{-5}$ m^3/sec-m), $\theta_{measured}$ is the transmissivity measured in accordance with ASTM D4716, and RF are service reduction factors described as follows:

RF_{in} = reduction factor for elastic deformation, or intrusion of the adjacent geotextiles into the drainage channel.
RF_{cr} = reduction factor for creep deformation of the drainage core and/or adjacent geotextile into the drainage channel.
RF_{cc} = reduction factor for chemical clogging and/or precipitation of chemicals in the drainage core space.
RF_{bc} = reduction factor for biological clogging in the drainage core space.

Suggested empirical default values of the reduction factors are listed in Table 3.1 (Koerner, 1998). Currently, laboratory testing can be performed to evaluate RF_{in} and RF_{cr} on a site and drainage composite specific basis. Such testing is discussed in this chapter.

Table 3.1 Recommended preliminary reduction factor values for determining allowable flow rate or transmissivity of geonets (Koerner, 1998)

Application area	RF_{in}	RF_{cr}	RF_{cc}	RF_{bc}
Surface water drains for covers	1.3 - 1.5	1.1 - 1.4	1.0 - 1.2	1.2 – 1.5
Leachate Collection and Removal Systems (LCRS)	1.5 - 2.0	1.4 - 2.0	1.5 - 2.0	1.5 - 2.0
Leachate Detection Systems (LDS)	1.5 - 2.0	1.4 - 2.0	1.5 - 2.0	1.5 - 2.0

While the above total safety factors may appear to be very conservative there may be long-term service reduction factors not accounted for. For instance, Figure 3.1 shows extensive root penetration into a geonet that was recovered from a failed landfill cover. The root penetration was so dense that the transmissivity of the geonet drainage core was essentially reduced to zero. The authors feel that root penetration in cover lateral drains can be minimized only by using high capacity drainage composites that quickly remove water from the drain so that roots are not attracted within the core.

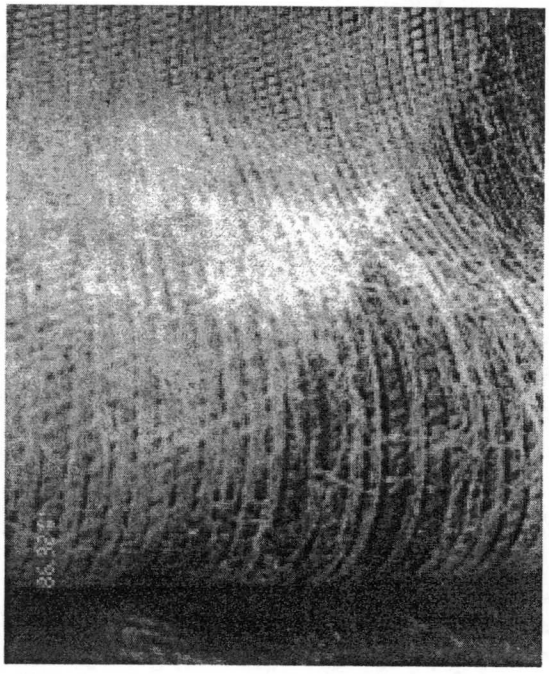


Figure 3.1 Root penetration into the geonet

More recent work by Giroud et al. (2000) has defined additional long-term service factors that influence the performance of a geocomposite lateral drainage system. This work builds on the previous work by Koerner (1998) and follows the basic equation form presented as Eq. 3.3. Giroud observed that the flow capacity of a geocomposite in the field can be reduced by a variety of mechanisms that depend on the following parameters: the applied stress, time, contact with the adjacent materials, and environmental conditions (e.g. presence of chemicals, biological activity, temperature).

More specifically, the thickness and/or the hydraulic conductivity of the transmissive core of a geocomposite may be reduced by instantaneous compression of the core, intrusion of the geotextile filter into the core, time-dependent compression (i.e. creep) of the core, and additional intrusion of the geotextile into the core due to time-dependent deformation of the geosynthetic. These four mechanisms are caused by the applied stresses.

In addition, chemical degradation of the polymeric compound(s) used to make the transmissive core may reduce its effective thickness and/or its hydraulic conductivity. Finally, clogging of the transmissive core may reduce its effective thickness and/or its hydraulic conductivity. Clogging results from physical, chemical and biological mechanisms; biological clogging is typically caused by the growth of micoorganisms (Giroud 1996), but an extreme case is that of clogging due to root penetration in the drainage medium, see Figure 3.1.

A given mechanism (e.g. compression or clogging) may result in (or may be interpreted as) a reduction in effective thickness and/or a reduction in hydraulic conductivity. Therefore, to evaluate the decrease in flow capacity of a geocomposite, it is simpler to use the hydraulic transmissivity, which is the product of thickness

and hydraulic conductivity (see Equation 3.1). Accordingly, from a practical standpoint, the decrease in flow capacity due to the mechanisms described above is expressed by using reduction factors on the hydraulic transmissivity as follows:

$$\theta_{LTIS} = \frac{\theta_{measured}}{\prod(RF)} = \frac{\theta_{measured}}{RF_{IMCO} \times RF_{IMIN} \times RF_{CR} \times RF_{IN} \times RF_{CD} \times RF_{PC} \times RF_{CC} \times RF_{BC}} \quad \text{Eq. 3.6}$$

where θ_{LTIS} = long-term-in-soil hydraulic transmissivity of the considered geosynthetic., $\theta_{measured}$ = value of hydraulic transmissivity measured in a laboratory test, and $\Pi(RF)$ = product of all reduction factors.

The mechanism-specific reduction factors include the following:

RF_{IMCO} = reduction factor for immediate compression, i.e. decrease of hydraulic transmissivity due to compression of the transmissive core following immediately the application of stress;
RF_{IMIN} = reduction factor for immediate intrusion, i.e. decrease of hydraulic transmissivity due to geotextile intrusion into the transmissive core following immediately the application of stress;
RF_{CR} = reduction factor for creep, i.e. time-dependent hydraulic transmissivity reduction due to creep of the transmissive core under the applied stress;
RF_{IN} = reduction factor for delayed intrusion, i.e. decrease of hydraulic transmissivity over time due to geotextile intrusion into the transmissive core resulting from time-dependent deformation of the geotextile;
RF_{CD} = reduction factor for chemical degradation, i.e. decrease of hydraulic transmissivity due to chemical degradation of the polymeric compound(s) used to make the geocomposite;
RF_{PC} = reduction factor for particulate clogging, i.e. decrease of hydraulic transmissivity due to clogging by particles migrating into the transmissive core;
RF_{CC} = reduction factor for chemical clogging, i.e. decrease of hydraulic transmissivity due to chemical clogging of the transmissive core; and
RF_{BC} = reduction factor for biological clogging, i.e. decrease of hydraulic transmissivity due to biological clogging of the transmissive core.

Note that RF_{IN}, RF_{CR}, RF_{CC}, and RF_{BC} were previously discussed by Koerner (1998).

Each reduction factor corresponds to a mechanism that reduces the hydraulic transmissivity of the geocomposite in the field. If one of these mechanisms occurs during the hydraulic transmissivity test in the laboratory to the same extent as in the field, then the corresponding reduction factor is equal to 1.0. It is important to understand that a reduction factor equal to one does not necessarily mean that the related mechanism affecting the hydraulic transmissivity of a virgin material does not exist. It simply means that the effect of this mechanism is already included into $\theta_{measured}$. An ideal hydraulic transmissivity test would perfectly simulate in the laboratory all the mechanisms that reduce the hydraulic transmissivity in the field such that all reduction factors would be equal to 1.0. However, such a test is not achievable from a practical standpoint, because it would be extremely complex and would require a very long time.

Examination of Eq. 3.8 indicates the following:

- RF_{IMCO} and RF_{IMIN} correspond to instantaneous mechanisms (i.e. mechanisms that take place as soon as the stress is applied), whereas the other reduction factors correspond to time-dependent mechanisms.

- RF_{IMCO}, RF_{IMIN}, RF_{CR}, and RF_{IN}, result from mechanical mechanisms, i.e. they are directly related to the applied stress. In contrast, RF_{CD}, RF_{PC}, RF_{CC}, and RF_{BC} result from physico-chemical mechanisms and, as such, they are not directly related to the applied stress.
- The physico-chemical mechanisms do not occur during typical hydraulic transmissivity tests that are performed with pure water. In contrast, the mechanical mechanisms may occur during the hydraulic transmissivity test, which affects the magnitude of RF_{IMCO}, RF_{IMIN}, RF_{CR}, and RF_{IN}, as discussed below.

It is important to note that the four reduction factors that result from mechanical mechanisms depend on the conditions under which the hydraulic transmissivity is measured. These conditions include: the stress applied during the hydraulic transmissivity test, the time during which the stress is applied before the flow rate (from which the hydraulic transmissivity is derived) is measured (the "seating time"), and the nature and behavior of the boundary materials in contact with the drainage composite during the transmissivity test. From this viewpoint, the following comments can be made:

- RF_{IMCO} can be eliminated (i.e. $RF_{IMCO} = 1.0$) if the hydraulic transmissivity is measured after a stress equal to, or greater than, the stress in the soil is applied to the specimen of transmissive material subjected to the hydraulic transmissivity test.
- RF_{IMIN} can be eliminated (i.e. $RF_{IMIN} = 1.0$) if the hydraulic transmissivity test simulates the boundary conditions created by the presence of materials adjacent to the transmissive material.
- RF_{CR} and RF_{IN} can be decreased if the hydraulic transmissivity is measured after the stress has been applied for a certain period of time (seating time), because part of the creep of the transmissive core and part of the delayed intrusion would have occurred before the hydraulic transmissivity is measured.

An extreme case would occur if the hydraulic transmissivity is measured on the transmissive core placed between two smooth plates, under no load, with pure water (so none of the physico-bio-chemical mechanisms can take place), and during a period of time that is so short that none of the time–dependent mechanisms can develop. In this extreme case, all of the eight reduction factors defined above would have their maximum value. A typical hydraulic transmissivity test is between: (i) the ideal case where all mechanisms are perfectly simulated and, consequently, all reduction factors would be equal to 1.0; and (ii) the extreme case where all of the eight reduction factors would have their maximum value. Two more typical laboratory test conditions are described below.

In the first typical case of test conditions, the transmissive core is placed between two rigid plates and a load is equal to or greater than the design load is sustained for a certain period of time (the seating time). In this case, the instantaneous compression takes place before the hydraulic transmissivity is measured. Therefore, $RF_{IMCO} = 1$. Also, some creep occurs during the seating time. As a result, the value of RF_{CR} is less than in the theoretical case where the hydraulic transmissivity would be measured at time zero. Equation 3.6 then becomes:

$$\theta_{allow} = \frac{\theta_{measured}}{\prod(RF)} = \frac{\theta_{measured}}{RF_{IMIN} \times RF_{CR} \times RF_{IN} \times RF_{CD} \times RF_{PC} \times RF_{CC} \times RF_{BC}} \qquad \text{Eq. 3.7}$$

[change allow to LTIS in equation]

Seating times of 100 or 300 hours are often recommended in the United States (Holtz et al. 1997). During such seating times, a significant amount of creep takes place. As a result, RF_{CR} is significantly less than it would be if the seating time were short. Also, it is likely that RF_{IN} is significantly less than it would be if the seating time were short.

In the second typical case of test conditions, the boundary conditions created by the presence of adjacent materials are simulated. To that end, the geocomposite is placed between two materials (soil or geosynthetic) that are identical to, or that simulate, the materials that are adjacent to the considered geocomposite in the field, and the sustained load is equal to or greater than the design load. Therefore, $RF_{IMCO} = 1$ and $RF_{IMIN} = 1$. Also, some creep and some time-dependent intrusion of geotextile into the transmissive core channels occur during the seating time. As a result, the values of RF_{CR} and RF_{IN} are less than in the theoretical case where the hydraulic transmissivity would be measured at time zero. Equation 3.6 then becomes:

$$\theta_{LTIS} = \frac{\theta_{measured}}{\prod(RF)} = \frac{\theta_{measured}}{RF_{CR} \times RF_{IN} \times RF_{CD} \times RF_{PC} \times RF_{CC} \times RF_{BC}} \qquad \text{Eq. 3.8}$$

The determination of RF_{CR}, RF_{IN}, RF_{CD}, RF_{PC}, RF_{CC} and RF_{BC} requires long-duration tests. Due to lack of time, such tests cannot be performed for the design of a specific project. Therefore, values obtained from Tables 3.1 or 3.3, from the literature, or from the geosynthetic manufacturer should be used. Table 3.3 provides guidance regarding the values of the reduction factors for geonets and geocomposites having geonets as the transmissive core (which are the most frequently used geosynthetic liquid collection layers). However, the design engineer is cautioned that the values of the reduction factors may significantly vary depending on the type of geocomposite and the exposure conditions (stress, chemical composition of the soil and liquid). Also, as pointed out above, the values of some of the time-dependent reduction factors (e.g. RF_{CR} and RF_{IN}) may significantly vary depending on the conditions under which the hydraulic transmissivity is measured. The values given in Table 3.3 correspond to the case where the seating time is of the order of 100 hours or more and the boundary conditions due to adjacent materials are simulated in the hydraulic transmissivity test.

Table 3.3. Guidance for the selection of some of the reduction factors on the flow capacity of geonets and geocomposites having a geonet transmissive core.

Examples of application	Normal stress	Liquid	RF_{IN}	RF_{CR}	RF_{CC}	RF_{BC}
Landfill cover drainage layer, Low retaining wall drainage	Low	Water	1.0 – 1.2	1.1 – 1.4	1.0 – 1.2	1.2 – 1.5
Embankment, Dams, Landslide repair, High retaining wall drainage	High	Water	1.0 – 1.2	1.4 – 2.0	1.0 – 1.2	1.2 – 1.5
Landfill leachate collection layer, Landfill leakage collection and detection layer, Leachate pond leakage collection and detection layer	High	Leachate	1.0 – 1.2	1.4 – 2.0	1.5 – 2.0	1.5 – 2.0

Notes: Table 3.3 was developed using reduction factor values from Koerner (1998). Design engineers are cautioned that the values of the reduction factors may significantly vary depending on the type of geocomposite and the exposure conditions (stress, chemical composition of the soil and liquid). Also, RF_{IN} and RF_{CR} depend on the testing conditions under which the hydraulic transmissivity is measured. The reduction factor values given in Table 3.3 correspond to the case where the seating time is of the order of 100 hours or more and the boundary conditions due to adjacent materials are simulated in the hydraulic transmissivity test. Finally, due to lack of relevant data, no guidance is provided for RF_{CD} and RF_{PC}.

Also, it should be noted that RF_{CR}, RF_{CD}, RF_{CC} and RF_{BC} (and, to a lesser degree, RF_{IN} and RF_{PC}) correspond to time-dependent mechanisms. Therefore, the values of RF_{CR}, RF_{CD}, RF_{CC} and RF_{BC} (and, to a lesser degree, RF_{IN} and RF_{PC}) selected by the design engineer depend on the design life of the liquid collection layer. In cases where the liquid supply rate varies with time, the design engineer may consider several time periods. For example, in the case of landfills with no leachate recirculation, three phases may be considered: (i) construction and pre-operational phase; (ii) operational phase; and (iii) post-closure phase. As time elapses, the

leachate collection system will typically experience a reduction in the rate of leachate that needs to be collected, but may concurrently experience a reduction of its flow capacity due to time-dependent mechanism such as creep and clogging.

The above discussion is for geocomposites, in particular, for geocomposites whose transmissive core is a geonet (which are the most frequently used geosynthetic liquid collection layers). In the case where the geosynthetic liquid collection layer is a thick needle-punched nonwoven geotextile, the mechanisms described above exist with the exception of geotextile intrusion into the transmissive core since, in this case, the geotextile itself is the transmissive medium. In this case, the reduction factors presented above exist, but no guidance is proposed herein regarding their values.

Finally, it should be noted that the various reduction factors may not be completely independent. For example, chemical degradation may affect creep resistance (i.e. may increase RF_{CR}), and, as shown by Palmeira and Gardoni (2000), the presence of soil particles in a needle-punched nonwoven geotextile (i.e. particulate clogging) may reduce the geotextile's compressibility (i.e. it may reduce RF_{IMCO} and RF_{CR} while increasing RF_{PC}).

In the absence of site specific testing data, the authors recommend the upper limits of the above default values for landfill covers, average default values for leachate collection systems, and lower limits for leakage detection systems. This reflects the service life of the final cover, the potential for significant compressive creep or intrusion of the leachate collection systems, the large quantity of leachate to be handled by the leachate collection system, and the expected lower level of intrusion and leachate volume to be conveyed by the leakage detection system. When a design drainage safety factor of 2 is used, the total default long-term service reduction factor (including the reduction factors) suggested (Richardson and Zhao, 1998) is as follows:

- **6 for landfill closures** (design drainage safety factor (2), intrusion (1.2), creep (1.4), biological clogging (1.2), chemical clogging (1.5), i.e., 2*1.2*1.4*1.2*1.5 = 6.0);
- **20 for leachate collection systems** (2*1.2*2.0*2.0*2.0 = 19.6);
- **20 for leakage detection systems** (2*1.2*2.0*2.0*2.0 = 19.6).

Thus

$\theta_{ultimate}$ =6*3*10^{-5} m^3/sec-m =1.8*10^{-4} m^3/sec-m for cover drains
$\theta_{ultimate}$ =20*3*10^{-5} m^3/sec-m = 6 *10^{-4} m^3/sec-m for leachate collection drains.
$\theta_{ultimate}$ =10*3*10^{-5} m^3/sec-m = 6 *10^{-4} m^3/sec-m for leakage collection drains.

3.3 Laboratory Long-Term Transmissivity Evaluation Base On Site Conditions

As discussed above, an ideal transmissivity test would perfectly simulate all the field mechanisms that reduce the transmissivity during the service life such that all of the reduction factors would be equal to 1.0. Unfortunately, this is not possible. This means that the designer must clearly understand to what degree each of the reduction factors has been simulated in the laboratory transmissivity test. Information of such considerations is currently not incorporated in ASTM D-4716. This section discusses what information is currently known regarding such considerations.

3.3.1 Geotextile Intrusion, RF_{IN}

The transmissivity value must be obtained under normal loads exceeding the field-anticipated long-term

maximum pressure and site-representative hydraulic gradient. The test boundary conditions must replicate actual field service conditions. For the surface water removal layer in landfill covers and the leachate collection layer in landfill liners, the upper boundary is either a vegetative supporting soil layer or drainage/protection layer. The appropriate overlying material must be included in the transmissivity test to properly simulate the intrusion of the geotextile into the geonet and the resulting loss of transmissivity. For leakage detection system testing, the upper boundary of the geonet is either another geomembrane or a filter geotextile/soil barrier layer forming part of a composite primary liner system. In the case of a composite primary liner, the upper boundary in the transmissivity test must include both the filter geotextile and a soil layer. Holtz et al. (1997) suggests that the sustained normal load in transmissivity tests needs to be at least 300 hours or until equilibrium is reached, whichever is greater. Figure 3.2 presents the long-term transmissivity test data for a triplanar geonet composite tested under in-soil condition and normal load of 720 kPa (15,000psf).

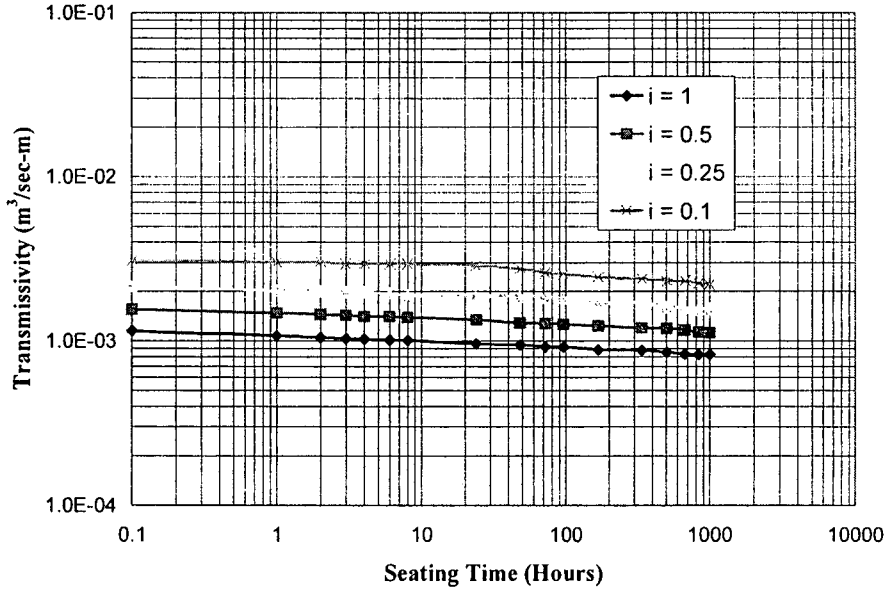


Figure 3.2 Long-term transmissivity for a triplanar Geocomposite (with soil boundary, 270 g/m^2 nonwoven each face, normal load =720 kPa)

Transmissivity test data indicate that the default reduction value for geotextile intrusion might be greatly underestimated, especially under high normal loads. Even if a soil layer is simulated in the transmissivity test, an increased reduction factor for intrusion should still be considered in design to account for variance of soil types, moisture content, compaction effort, and scale effect.

The service reduction factors due to intrusion of the typical needle-punched nonwoven geotextile used for a biplanar geocomposite are presented in Table 3.2. Note that under normal load of 720 kPa., the intrusion reduction factors with typical overlying material are significantly larger than suggested default reduction values (1.5 – 2). This is especially true for clayey soils where the reduction factor is as high as 20. This is 10 times larger than the previously suggested default reduction factors. The presence of a soft adjacent material layer causes significant geotextile intrusion into the geonet flow channel. The intrusion reduction factors are also found to be dependent upon hydraulic gradient. At a low gradient, intrusion reduction factors are

significantly larger than those at a higher gradient. Thus, a geocomposite used on flatter bottom slopes will require a larger service reduction factor than that used on steeper side slopes.

Table 3.2 Intrusion reduction factors for the biplanar geocomposite under normal load of 720 kPa.

Test boundaries	i = 1	i = 0.5	i = 0.1
Steel plate	1	1	1
Neoprene	3.42	6.17	13.74
Sand 95% compaction	4.19	7.62	13.74
Clay	4.67	7.98	20.59

The intrusion reduction factors for a triplanar geocomposite are listed in Table 3.3. Under all the testing conditions, the triplanar geocomposite exhibits much less needle-punched nonwoven geotextile intrusion into the geonet's core space than the biplanar geocomposite. This is mainly due to the triplanar structure. The middle flow plane contributes to the large flow rate of the triplanar geonet; the top and bottom auxiliary planes accommodate the intrusion of geotextiles. The reduction factors of the triplanar geocomposite with sand are in agreement with the suggested values. The effect of soil compaction seems to be insignificant under high compressive loads and clayey soil continues to cause greater intrusion than sand.

Table 3.3 Intrusion reduction factors for the triplanar geocomposite under normal load of 720 kPa.

Test boundaries	i = 1	i = 0.5	i = 0.1
Steel plate	1	1	1
Neoprene	1.57	1.66	1.79
Sand 95% compaction	1.27	1.25	1.3
Sand 75% compaction	1.3	1.3	1.32
Clay	2.58	2.78	3.6

3.3.2 Creep Reduction Factor, RF_{CR}

The reduction factor for creep is dependent upon the normal load applied has typically required 10,000-hour compressive creep test to rigorously determine it. Figure 3.3 shows 10,000 hour compressive creep data under normal load of 98 kPa (2,000 psf) and 25,000 psf (1220 kPa) respectively. More recent work by Giroud, Zhao, and Richardson (2000) has shown that the reduction in transmissivity due to creep, RF_{CR}, can be related to the reduction in thickness. This relationship is for a geocomposite drainage layer expressed as follows:

$$RF_{CR} = \left[\frac{\left(t_{CO}/t_{virgin}\right)-\left(1-n_{virgin}\right)}{\left(t_{CR}/t_{virgin}\right)-\left(1-n_{virgin}\right)}\right]^3 \qquad \text{Eq. 3.9}$$

Here t_{virgin} is the initial unloaded thickness, n_{virgin} is the initial unloaded porosity, t_{CO} is the thickness measured shortly after application of the normal load, and t_{CR} is the thickness after creep deformation has occurred. This equation allows the long term performance of a drainage geocomposite to be predicted based on long term thickness measurements alone. This greatly simplifies long term testing requirements for drainage composites.

This relationship is presented on Figure 3.4 for a typical range of thickness ratios, t_{CR}/t_{virgin}, for a geonet porosity of 0.75.

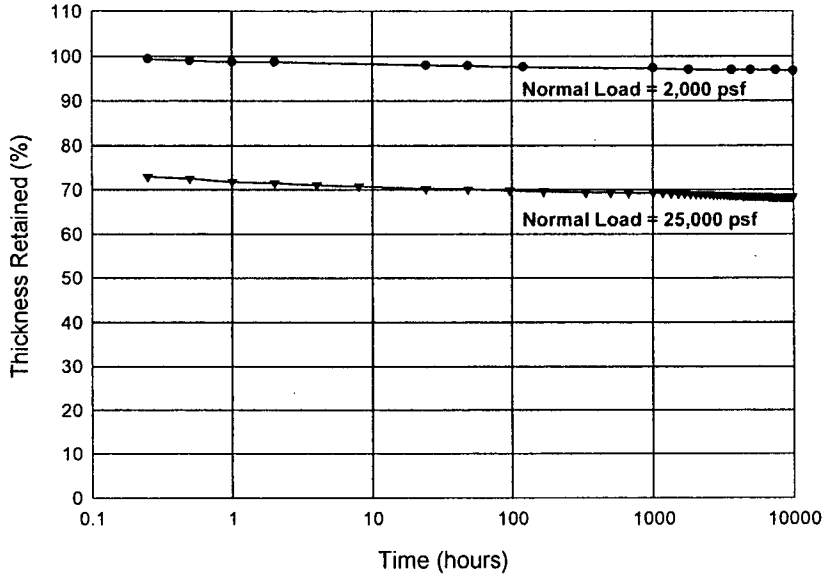


Figure 3.3 Thickness Reduction with Time For Tri-Planar Geonet

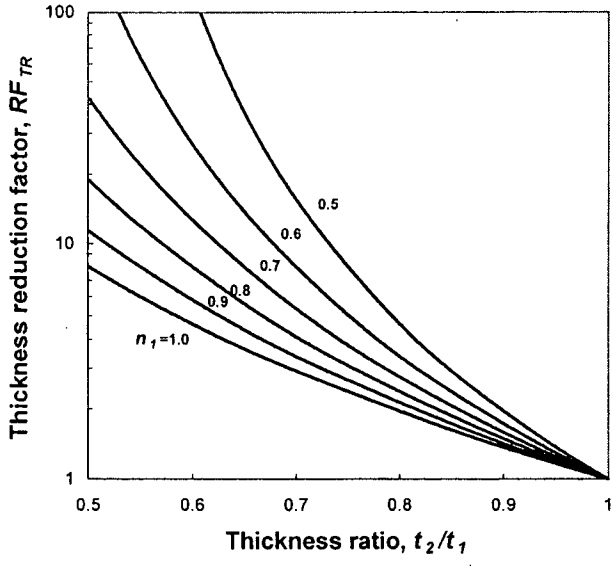


Figure 3.4 Long-Term Creep Reduction Factor, RF_{CR}, Based on Thickness

3.4 Multiple Geonet Capacity

Double geonet systems have been traditionally used to achieve high transmissivities that could not be achieved with a single geonet. However, there are some technical concerns about the double geonet systems with respect to transmissivity, compressive strength, and interface stability.

Transmissivity ---- Due to the additional interface and interlocking of top and bottom geonets, the normal flow channel is interfered with, i.e., the hydraulic transmissivity of double geonet systems will not necessarily be doubled from a single geonet. Figure 3.5 shows the efficiency of double geonet systems between two geomembranes under different normal loads (Koerner and Hwu, 1989), where efficiency is defined as the actual flow rate of the double geonets compared to the flow rate of a single geonet. The efficiency of double of biplanar geonet systems between two geomembranes under 720 *kPa* is only 112% , or 12% increase in flow rate by using a two-layer system. The main reason for this non-additive flow rate is that when the two biplanar geonets are placed on top of each other, each layer of geonet interferes with the other's flow capacity, particularly under heavy loads.

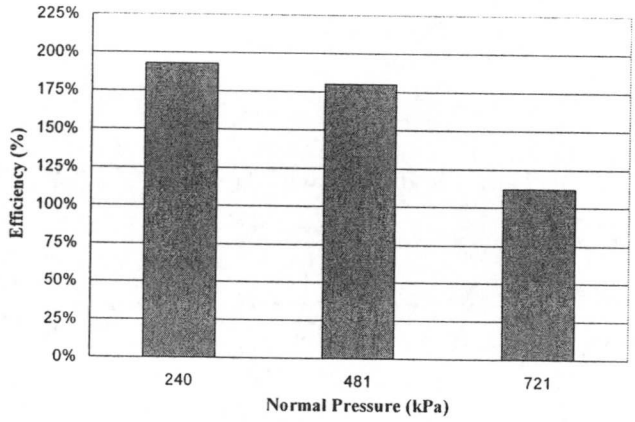


Figure 3.5 Efficiency of double geonet systems between geomembranes (from Koerner and Hwu, 1989)

Compressive Behavior ---- The compressive strength of a double-geonet system is significantly less than that of a single geonet; this may be of a great concern for lateral drainage layers over liner systems. The compressive strength of a single geonet tested by Koerner and Hwu, (1993) was between 960 to 1100 kPa; while stacking two biplanar geonets together, the compressive strength dropped to only 335 to 575 kPa. If the field normal loads exceed the compressive strength of the double geonet system, the geonet structure will collapse and the flow capacity is minimal. The compressive load and strain curves for a double biplanar geonet system vs. a single layer geonet of the same type are presented in Figure 3.6. The double biplanar geonet system has a much lower yield stress than a single geonet.

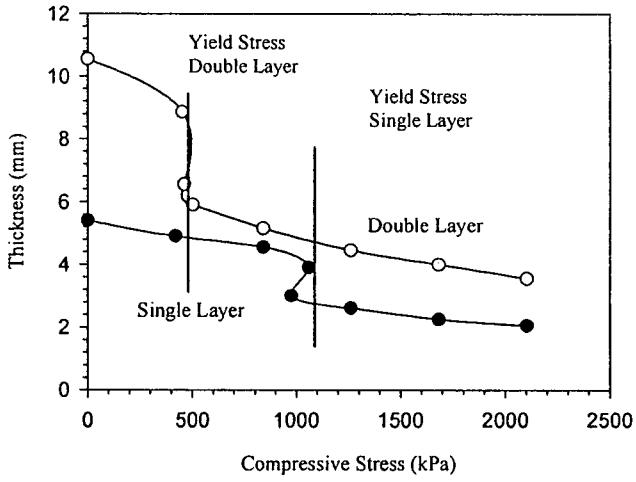


Figure 3.6 Compression curves of single and double geonet systems

Chapter 4 Designing Lateral Drains in Final Cover System Side Slopes

The final covers on RCRA Subtitle C (Hazardous) and D (Municipal) landfills must limit the infiltration through the cover to a rate less than the leakage rate of the liner system (40 CFR 264.310 and 40 CFR 258.60 respectively). For the double lined RCRA C landfill, EPA has required the use of both a composite barrier and a lateral drainage layer to limit the head acting on the barrier.

For municipal landfills, EPA interpreted this requirement (Federal Register June 26, 1992) by requiring that final covers include a composite barrier. The composite barrier consists of an 18 inch compacted soil barrier having a permeability less than $1x10^{-5}$ cm/sec overlain by a geomembrane. A nominal 6-inch erosion control layer placed over the geomembrane completed the minimum regulatory profile. In reality this 6 inch erosion control layer is ill suited for vegetative survival and is never incorporated alone. A typical erosion control layer must provide sufficient water storage capacity to allow the cover vegetation to survive periods of drought. Except for arid and semi-arid regions, which require an even greater thickness, this typically requires a minimum of 18 inches layer of vegetative support soil beneath a 6-inch topsoil layer.

The design of final covers for lined landfills presents the designer with challenges related to soil erosion and slope stability. This section will focus on the design of geosynthetic drainage composites to ensure slope stability of the 3H to 4H:1V (25-33%) side slopes common to landfill final covers. This topic has been the subject of recent academic studies at GRI and was the topic of keynote presentation at the 6th International Conference on Geosynthetics in Atlanta (Koerner and Soong, 1998). Here limiting infiltration is not the primary concern, but stability is.

The presence of a barrier layer within the final cover invites sliding failure of the cover due a build up of pore water above the barrier, or landfill gas (LFG) pressures beneath the barrier. Both pore water and LFG pressures reduce the contact or effective stress acting on veneer interfaces and thus reduce the sliding stability of the final cover. For this reason, all designs in this manual are based on maintaining the fluid flow in the lateral drain in an unconfined condition. Under this condition, the maximum flow height is less that the effective height of the transmissive core of the geocomposite.

Additionally, the infiltrating water produces a zone of saturation that increases the unit weight of the soil and can generate significant seepage forces in the overlying soil. Infiltrating water moves vertically downward as long as the underlying lateral drain is able to accept the infiltration. If the underlying lateral drain saturates and is unable to accept the infiltration, then the infiltrating water flows parallel to the slope and the seepage forces can detrimentally impact the stability of the layers above the barrier layer.

To ensure the stability of the cover slope, the designer must confirm that the cover system is adequate to prevent the following from developing:

1. seepage forces,
2. the reduction in contact stresses between the geomembrane and the geocomposite drain due to excess pore water pressures cause by the infiltrating water, and
3. the reduction in contact stresses between the geomembrane and the underlying soil resulting from LFG pressures.

Note that the first and second conditions are both eliminated if the lateral drainage system has adequate transmissivity to accommodate the maximum rate of infiltration with flow remaining unconfined. This section

will focus on a review of the design of geocomposite drainage layers to satisfy critical combinations of these three design considerations.

4.1 Water Infiltration Forces

The final cover will at some times in its life approach saturation due to weather conditions. The greatest uncertainty in the design of the pore water drain is accurately predicting the maximum rate of water infiltration. The extreme weather generated by 'El Nino' has made this prediction easier since the high precipitation and mild weather that accompanied El Nino produced saturated conditions in the vegetative layer in many regions of the United States that we previously would not have anticipated. In fact, the authors feel that, with the exception of arid and semi-arid regions, the designer should assume that the vegetative layer becomes saturated during its service life.

The maximum seepage force in the cover soil layers using the infinite slope model shown on Figure 4.1 is given as follows:

$$F_{seep} = \gamma_w \, d \sin \beta \qquad \text{Eq. 4.1}$$

where β is the slope angle and d is the vertical thickness of the soil cover and γ_w is the unit weight of water.

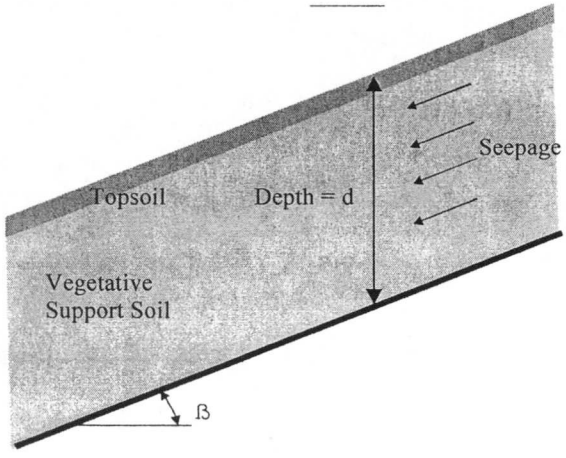


Figure 4.1 Infinite slope model

If the transmissivity of the underlying lateral drainage system is inadequate, then the infiltrating water will begin to flow parallel to the slope and the seepage forces will reduce the stability. If the cover soil fully saturates and the drain layer is inadequate, the slope stability factor of safety is given as

$$FS = \frac{Resisting\ Forces}{Driving\ Forces} = \frac{\gamma_b d \cos\beta \tan\delta}{\gamma_b d \sin\beta + \gamma_W d \sin\beta} = \frac{\gamma_b \tan\delta}{\gamma_{sat} \tan\beta} \approx 0.5 \frac{\tan\delta}{\tan\beta} \qquad \text{Eq.4.2}$$

where γ_{sat} is the saturated unit weight of the soil and γ_b is the buoyant unit weight of the soil and * is the interface friction angle.

When such seepage forces are eliminated by using high flow capacity geocomposite, the slope safety factor, FS, becomes:

$$FS = \frac{\tan\delta}{\tan\beta} \qquad \text{Eq. 4.3}$$

For common 4H:1V side slopes and FS = 1.5, this requires a minimum interface friction angle of 20.5° when the cover soil is not saturated and 36.8° when it is saturated. The 20.5° interface friction angle is easily achieved due to the "velcro" stick between nonwoven geotextiles and most textured geomembranes. The 36.8° interface friction angle actually exceeds the shear strength of common soils used in landfill cover systems and demonstrates that seepage forces must be prevented by the use of an adequately designed lateral drainage system. The design of this system is covered in section 4.2.

4.2 Pore Pressure Reduction

Surface water infiltrating through the vegetative layer will accumulate above the barrier layer and generate detrimental pore water pressures if it is not drained off. The greatest uncertainty in the design of the lateral drainage system is accurately predicting the maximum rate of water infiltration. The extreme weather generated by 'El Nino' type phenomena allows us to assume that the vegetative layer will saturated at least once during the service life of the final cover. If the overlying soil layers are saturated, the gradient, i, is equal to one (unit gradient) and the infiltration velocity is equal to the permeability of the soil.

The design of the pore water pressure drain underlying a saturated cover soil layer was first presented by Thiel and Stewart at the Geosynthetics '93 conference in Vancouver, B.C. The rate of water infiltration into the geocomposite drain can be readily calculated under a unit gradient since the infiltration velocity is equal to the permeability of the vegetative layer. Typical permeability values for vegetative systems range from 1×10^{-3} to 1×10^{-5} cm/sec. Tighter soils do not allow root penetration and soils looser do not provide adequate water storage. The basic lateral drainage model developed by Thiel is shown on Figure 4.2.

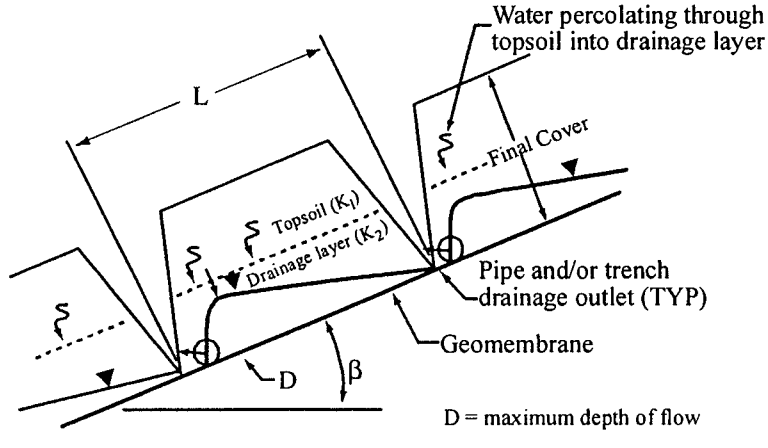


Figure 4.2 Schematic of head buildup in the drainage layer (Thiel and Stewart, 1993)

The quantity of water, Q_{in}, infiltrating into a unit width of drainage composite having a length L is given by

$$Q_{in} = k_{veg} L\ 1 \cos\beta \qquad \text{Eq. 4.4}$$

The flow capacity of a drainage layer is solved for using Darcy's Law as follows:

$$Q_{out} = kiA = ki\,(tx1) = [kt]\,i = 2\,i \qquad \text{Eq. 4.5}$$

where t is the thickness of the drainage layer, i is the flow gradient, and $[kt]$ is transmissivity, *2*. For slopes, the gradient i is equal to sin∃, where ∃ is the slope angle. The transmissivity of a geocomposite drainage layer is obtained from laboratory testing as described in Section 2. It is important that 2 be obtained at normal stress levels, boundary conditions, and gradients that reflect actual field conditions. Additional reduction factors for creep deformation of the drainage core, biological clogging of the geotextile, etc. may also be considered. Thiel and Stewart's model is limited to slopes steeper than 20%. For flatter slopes, the model developed by McEnroe (1993) and discussed in Section 5 should be used. It should be noted, however, that the simple model developed by Thiel and Stewart is conservative at the flatter slopes and therefore could be used in design of such slopes.

A factor of safety for the drainage capacity, FS_{dc}, of the geocomposite drainage layer can be defined as follows

$$FS_{dc} = \frac{Q_{out}}{Q_{in}} = \frac{\theta i}{k_{veg} L \cos\beta} = \frac{\theta \tan\beta}{k_{veg} L} \qquad \text{Eq. 4.6}$$

The authors recommend a minimum factor of safety of 6 (overall drainage safety factor plus reduction factors) for lateral drainage systems in final covers, see Section 3.2. It is important to understand the impact of both *2* and L on the hydraulic factor of safety. Conveniently, the effective drainage length of the drain can be limited by draining it at each side slope swale commonly used to limit surface erosion L, see Thiesen and Richardson, 1998. Such swales are commonly 100 to 150 feet apart down the slope. The geocomposite drainage layer can be designed to drain into each swale as shown on Figure 4.3.

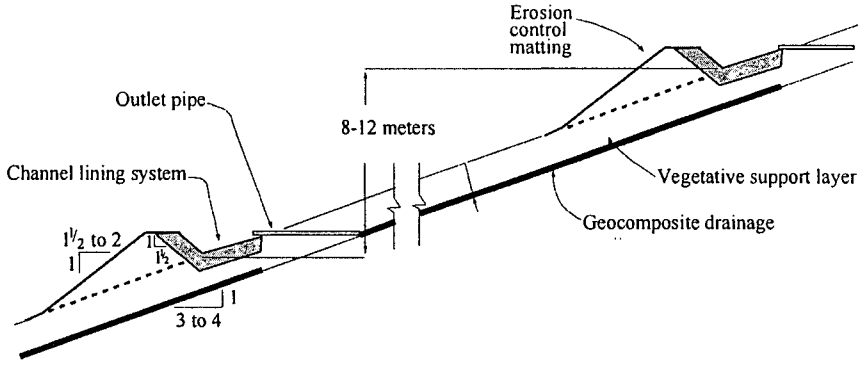


Figure 4.3. A schematic diagram of a side slope swale in a landfill final cover

The typical range of required transmissivity is easy to estimate based on typical slopes of 4H:1V to 3H:1V, a vegetative soil permeability of 1 x 10^{-4} cm/sec, and a vertical spacing of swales from 8 to 12 meters (25 to 40-ft.), and an assumed long-term service reduction factor of 6.0 (FS = 2 and **A**RF = 3). Using these assumptions, the required transmissivity ranges from 4.5 x 10^{-4} to 1.2 x 10^{-3} m^3/sec-m. This is a surprisingly

small range of transmissivity, and serves as a good rule-of-thumb for designers to use to check their values. Note that the required transmissivity is directly proportional to the permeability of the vegetative cover soil. When a geocomposite drain is designed based on this maximum inflow criteria, the maximum potential head over the underlying liner is less than the thickness of the geocomposite and we satisfy our requirement for unconfined flow.

The need for such a high overall drainage safety factor can be shown by examining the conditions that exist between full saturation of the cover soils and effective drainage of the geonet. If a lesser value of transmissivity is used or develops with time, a zone of saturation in the overlying soils will develop. Soong and Koerner (1997) define the depth of saturation as compared to the overall thickness of the soil cover as the "Submergence Ratio". As the zone of saturation rises, the submergence ratio approaches 1 and the cover soils experience increased seepage forces and pore water pressure. Figure 4.4 demonstrates the relations of cover soil stability, submergence ratio, and drainage safety factor as a function of transmissivity of the geocomposite. These stability analyses are based on the research report by Soong

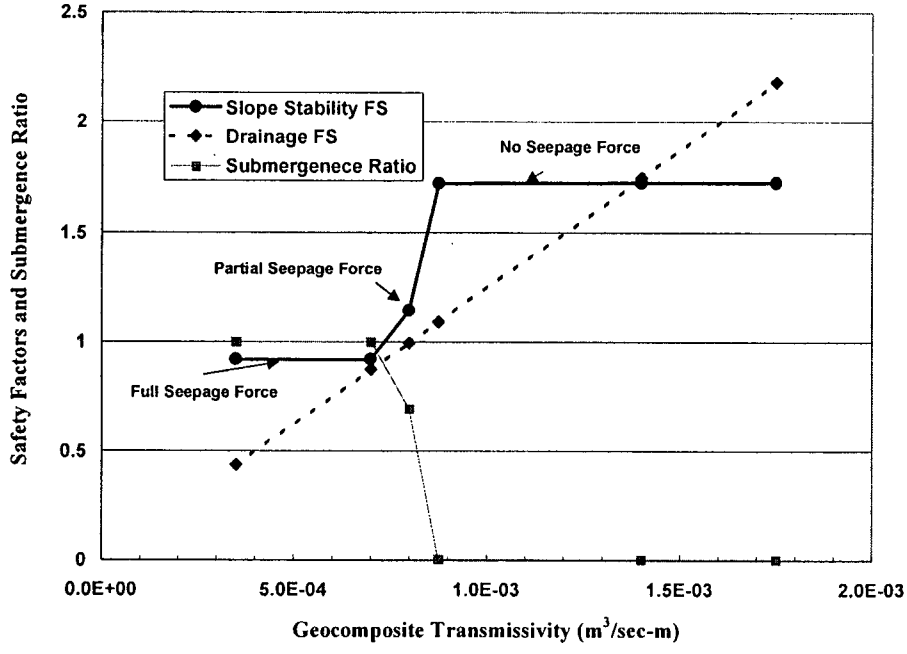


Figure 4.4. Safety factor for slope drainage, stability and geocomposite transmissivity

and Koerner (1997) for the following field conditions: slope length = 40m long, slope inclination angle =14° (4H:1V), minimum interface friction angle (δ) = 22°, permeability of the vegetative cover soil = $5x10^{-4}$ cm/sec, precipitation = 60 mm/hr, and the run off coefficient = 0.4. For these field conditions, the cover soil is subjected to infiltration induced pore pressures in the lateral drain when the *drainage* safety factor is less than 1. The pore pressures greatly reduce the safety factor for slope stability. The slope stability factor of safety under full saturation can also be calculated by equation 4.2 (infinite slope assumption) to equal 0.8. Note that Soong and Koerner include a toe buttressing restraint that provides an additional 0.1 increase in the safety factor.

As the transmissivity of the geocomposite increases, the depth of saturation and pore pressures are both reduced and the slope stability safety factor increases. When the transmissivity is sufficiently large such that

no pore pressures develop, the slope stability factor of safety calculated by equation 4.3 to equal 1.6. Note from Figure 4.4 that the transition from excess pore pressure (FS=0.8) to no pore pressures (FS=1.6) occurs over a change in transmissivity from 7×10^{-4} to 8.8×10^{-4} m^3/sec-m. This is a minor change in transmissivity (25% reduction) considering the fact that transmissivity tests have significant variability (Koerner and Soong, 1998). This example clearly demonstrates why the authors recommend that a high factor of safety for lateral drainage systems in landfill covers.

The actual specified transmissivity, $2_{ultimate}$, must also account for long-term service reduction factors as discussed in Chapter 3. For lateral drains in final covers, the authors recommend that $2_{ultimate}$ should be 8 times larger than the transmissivity calculated from Eq. 4.6 with $FS_{dc} = 1.0$. For the general conditions discusses in this section, Eq. 4.6 yields $2 = k_{veg} L \cos\beta / i$ or $5.8*10^{-4}$ m^3/sec-m. Applying the recommended long-term service reduction factor of 8 results in $2_{ultimate} = 4*10^{-3}$ m^3/sec-m. This high value of transmissivity will ensure that the minimum required transmissivity is available through the full service life of the cover.

Note that the required transmissivities are directly proportional to the permeability of the vegetative cover soil, as shown in Figure 4.5. The transmissivity in this example is $2 = 1*10^{-3}$ m^3/sec-m. An increase in the permeability of the cover soil from $6*10^{-4}$ cm/sec to $7.5*10^{-4}$ cm/sec resulted in 87% drop in the safety factor of the slope. A safe slope turns to a predictable failing of the cover soil. While the estimation of the cover soil permeability is typically based upon limited test data, the variations in permeability with the same soil type can be 2 to 4 orders of magnitude, see Freeze and Cherry (1979). The variation in the cover soil permeability and its consequences on cover soil stability further justify a higher safety factor for geocomposite drainage design since geocomposites are manufactured products with much higher consistence in their properties. A comprehensive discussion of factors influencing the magnitude of required factor of safety for slope stability considerations is presented by Lin et al. (1997).

Figures 4.4 and 4.5 show very clearly that the head acting on the barrier can change dramatically with only a minor change in either the transmissivity of the lateral drainage layer or permeability of the vegetative support soils. While Figures 4.4 and 4.5 are academically interesting, a designer realizes that uncertainties in soil permeability for the vegetative layer preclude such precision. Therefore, the designer must provide a high factor of safety in the transmissivity of the lateral drainage system, to ensure that the system will not be subjected to full seepage forces, i.e., that the head remains in the thickness of the geocomposite for a wide range of soil permeability. For this reason, the authors recommend using a minimum long-term service reduction factor of 8 for lateral drains in final cover systems.

Figure 4.6 presents the influence of slope length on safety factors for drainage and slope stability. The drainage safety factor is inversely proportional to the slope length, i.e., and the longer the drainage length, the greater flow demand is on the geocomposite transmissivity remains the same. When the slope length is too long, water head starts to build up over the liner and the cover soil slope experiences quickly experiences the full seepage force. Again, a sudden drop in the safety factor of slope stability can be predicted at the bottom of long slopes.

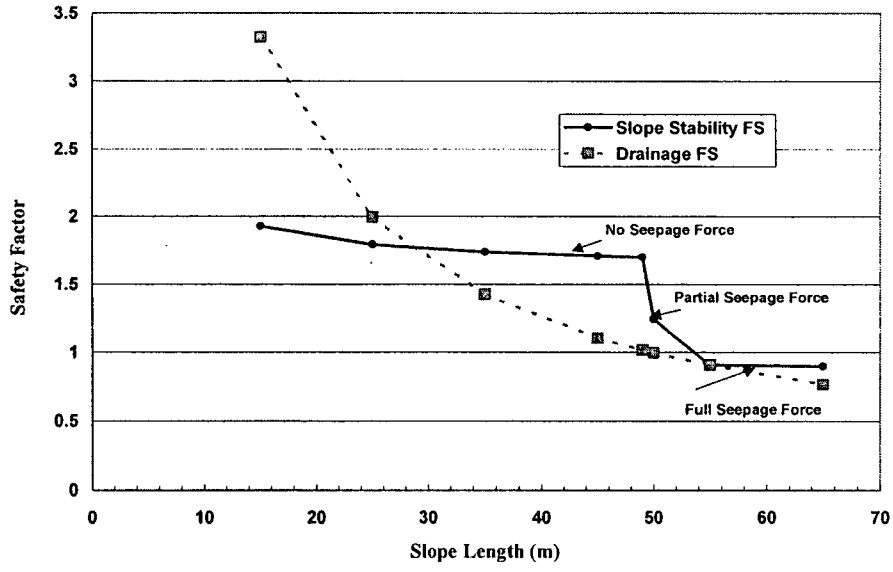


Figure 4.5. Safety factors for drainage, slope stability, and cover soil permeability

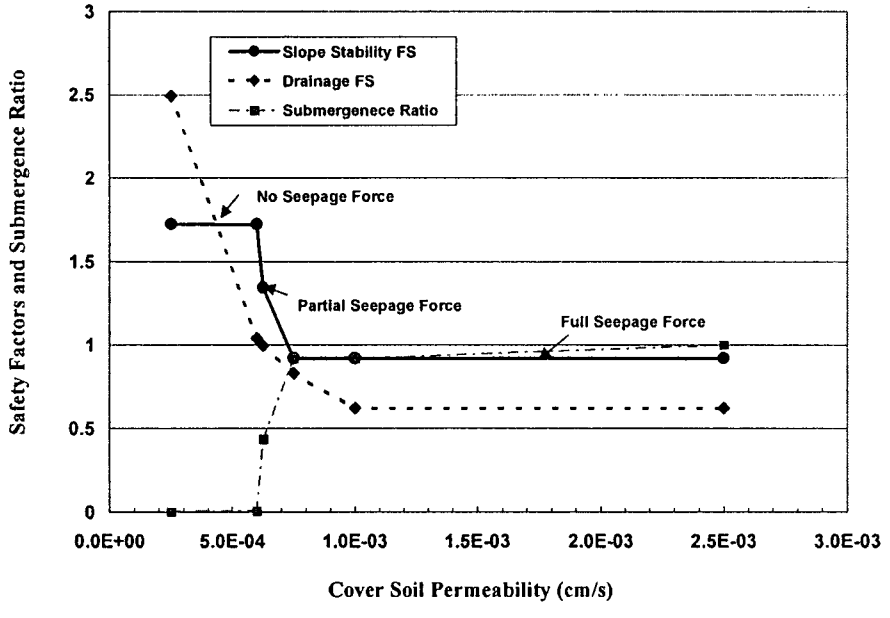


Figure 4.6. Safety factor for slope drainage, stability, and length

4.3 LFG Pressure Dissipation

Engineers have traditionally modeled the movement of both gas and fluids through porous media using Darcy's Law as follows:

$$Q = kiA \qquad \text{Eq. 4.7}$$

Where Q is the flow rate (L^3/T), k is permeability (L/T), i is the dimensionless flow gradient defined as the head loss (L) divided by the flow length (L), and A is the area of flow (L^2). This Law assumes that the permeability is independent of the gradient, which requires that the flow be laminar. The requirement for laminar flow means that we should be conscious of the concepts of laminar, transitional, and turbulent flows of fluids and their respective properties. The classical definitions of these flow regimes are as follows:

> **Laminar flow** occurs when the fluid particles move parallel to each other such that their respective flow lines do not cross. Under these flow conditions, the relative velocity between the flow lines is controlled by the viscosity of the fluid.
>
> **Turbulent flow** occurs when the particle flow lines cross such that a mixing occurs and energy is lost due to both viscosity and the mixing. Since additional mechanisms exist to remove energy from the fluid, turbulent flow is inherently less efficient than laminar flow.

Studies performed by men such as Terzaghi (1923) and Fancher et al. (1933) determined that the applicability of Darcy's Law to soils was limited by the Reynold's number, R_e, of the flow (Reynolds, 1883). R_e is defined as

$$R_e = \frac{dv\rho}{\mu} = \frac{dv}{\upsilon} \qquad \text{Eq.4.8}$$

where d is the diameter of flow path (L), **<** is the average velocity of flow, ***D*** is the fluid density (M/L^3), **:** is the dynamic viscosity ($M\text{-}T/L^2$) and Λ is the kinematic viscosity (L^2/T). Values of ***D*** and **:** for common liquids and gases of concern are presented in Table 1. Note that these values are temperature dependent.

Table 1 Intrinsic Permeability Variables for Common Fluids and Gases (70↓↑F)

	Density, ***D***		Unit Weight, (		Dynamic Viscosity, **:**			Kinematic Viscosity, Λ	
	$slug/ft^3$	kg/m^3	pcf	N/m^3	Centi-poise	lb-s/ft^2	N-s/m2	ft^2/s	m^2/s
Water	**1.94**	**1000**	**62.4**	**9800**	**1.01**	**2.12E-5**	**1.01E-3**	**1.09E-5**	**1.01E-6**
Air	**.00234**	**1.2**	**.0753**	**11.8**	**.018**	**3.78E-7**	**1.79E-5**	**1.63E-4**	**1.48E-5**
CO2	**3.55E-3**	**1.83**	**.114**	**17.9**	**.015**	**3.15E-7**	**1.50E-5**	**8.88E-5**	**8.21E-6**
Methane	**1.29E-3**	**.666**	**.0416**	**6.54**	**.011**	**2.31E-7**	**1.1E-5**	**1.79E-4**	**1.65E-5**
LFG(1)	**2.53E-3**	**1.31**	**.0815**	**12.8**	**.0132**	**2.77E-7**	**1.32E-5**	**1.09E-4**	**1.01E-5**

(1) 55% CO_2, 45% CH_4

What complicates our use of Reynold's number is the discovery that value of R_e at the transition from laminar to turbulent flow is dependent on the flow diameter d. For flow of fluids in pipes, the transition from laminar

flow, to transitional flow, to turbulent flow occurs at R_e values of 2000 and 4000 respectively. However, for porous media such as soils, having thousands on interconnecting flow tubes, the transition for laminar flow occurs at values of R_e from approximately 1 to 10! This means that fluid flows in gravel and rip-rap will be turbulent and not obey Darcy's Law *since the apparent permeability, k, is not independent of the gradient, i.* Most engineers, however, commonly apply Darcy's Law to such coarse materials.

For laminar flow, Darcy's Law can be expressed in terms of intrinsic permeability as

$$Q = K\frac{\gamma_f}{\mu_f} i_f A \qquad \text{Eq. 4.9}$$

where γ_f is the density of the fluid, μ_f is the dynamic viscosity of the fluid, and i_f is the fluid gradient. The permeability, k, commonly used by engineers is related to the intrinsic permeability, K, as follows

$$k_f = K\frac{\gamma_f}{\mu_f} \qquad \text{Eq. 4.10}$$

Thus if the permeability is known for a given fluid (or gas), it can be determined for any second fluid using the following expression

$$\frac{k_1}{k_2} = \frac{\mu_2}{\mu_1}\frac{\gamma_1}{\gamma_2} \qquad \text{Eq. 4.11}$$

This is true only for laminar flow, e.g. permeability, *k*, is independent of gradient, *i*. Thus, knowing the permeability of the porous media to water, k_{h2o}, the permeability for air, methane, and landfill gas can be obtained by dividing k_{h2o} by 14.8, 16.3, and 10.0 respectively. Application of this theory to geosynthetic Lateral drainage systems was first proposed by Giroud and Bonaparte (1984).

4.3.1 Application of Intrinsic Permeability to Gas Flow in Geonets

Geonets are the "gravel" of geosynthetic drainage media and therefore would reasonably be expected to have turbulent flow. This means the permeability, and therefore the transmissivity, are influenced by the gradient. This is clearly shown by the typical water transmissivity data obtained from a geonet presented on Figure 4.7. The approximate diameter of the flow path is approximately 6.1 mm (0.02 ft). Interpretation of this data is aided by solving for the flow velocity such that the Reynold's number for the flow is known. At a gradient of 0.02 and normal load of 512 psf (25 kPa), the flow rate is $Q_{h2o}i$ or 17.8×10^{-5} m3/sec-m ($8.9 \times 10^{-3} \times 0.02$ m^3/sec-m). For a typical geonet thickness of 6 mm, this indicates an average flow velocity of 3.0×10^{-2} m/s (9.2×10^{-2} ft/sec). The Reynold's number for this flow is then equal to

$$R_e = \frac{dv}{\upsilon} = \frac{0.02 \bullet 9.2x10^{-2}}{1.09x10^{-5}} = 168 \qquad \text{Eq. 4.12}$$

Similarly, the Reynold's numbers at gradients of 0.1 and 1.0 are equal to 394 and 1345 respectively. The actual flow rates for this test are plotted as a function of gradient on Figure 4.8. Since laminar flow is defined in sands at $R_e < \sim 10$ and pipes at $R_e < 2000$, it is reasonable to assume that the transition for geonets will be between these two limits. The data from Figure 4.8 strongly suggests that the transition from laminar flow for geonets occurs approximately at $R_e < 500$ for geonets. This will occur in most geonets at a flow gradient less than 0.1.

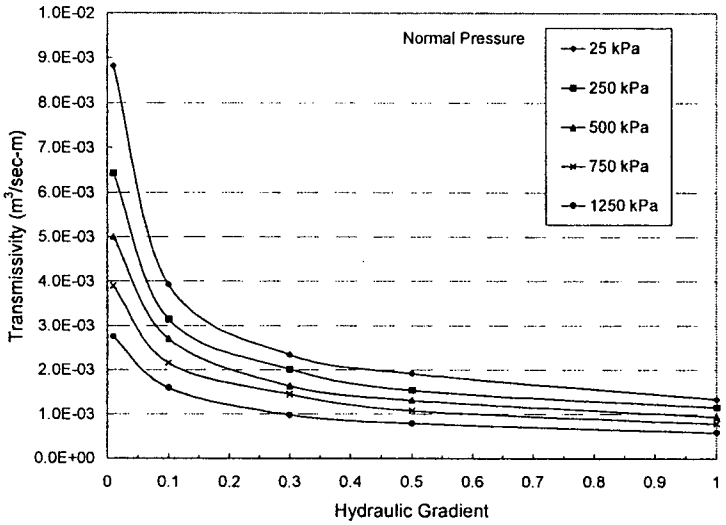


Figure 4.7 Transmissivity vs. Hydraulic Gradient for Geonet

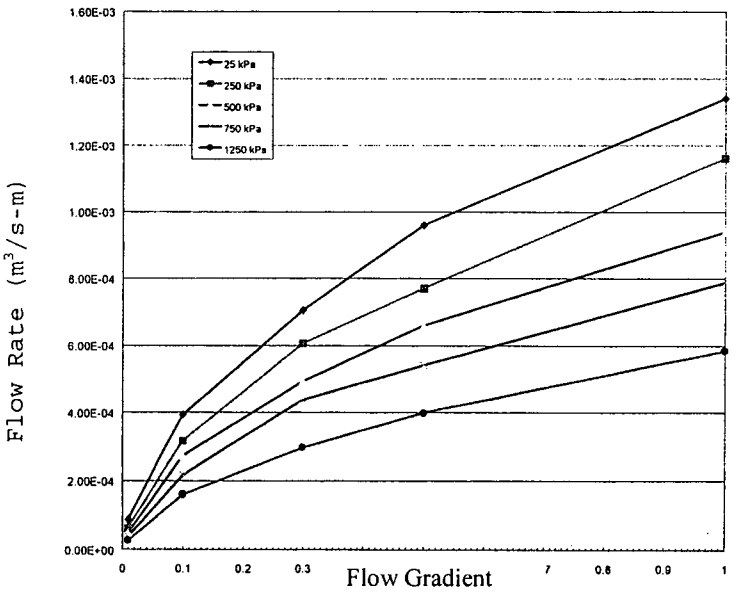


Figure 4.8 Flow Rate vs. Hydraulic Gradient for Geonet

It is very important to note the following: the intrinsic permeability conversion between fluids is conservative if the flow experienced in the field is laminar whether the measured flow, in the laboratory transmissivity test, is turbulent or laminar. Figure 4.8 clearly shows that, under turbulent flow, the measured transmissivity decreases dramatically. Projections based on turbulent measurements in the laboratory will be conservative in field applications as long as laminar flow conditions exist in the field. This is irrespective of the actual field gradient. Thus, it is very important that the actual flow conditions in the field application be verified. The

assumption of laminar flow allows the use of Darcy's Law and is valid for low flow gradients common to landfill gas collection systems, see Emcon 1980.

LFG Generation Rate ---- LFG are generated during the biodegradation of fractions of the MSW. The actual rate of gas generation for a given landfill is dependent on the waste composition, waste moisture content, etc. such that a design engineer will have to make a assumption for the gas generation rate. For lined landfills that do not recirculate leachate, the gas generation rate, q_{gas}, can be typically assumed to equal 0.1 scf/year/lb. of MSW. The rate of gas flux, Q_{gas} (scf/ft^2/yr), immediately beneath the final cover can be conservatively estimated as follows:

$$Q_{gas} = \frac{\text{Weight of Waste x } q_{gas}}{\text{Area of Final Cover}} \qquad \text{Eq. 4.13}$$

The design of the geocomposite drain for gas removal can then be calculated using Equation 4.6 previously used for surface water infiltration.

The gas flow, Q_{in}, into a unit width of the geocomposite having a length, L, is given as follows:

$$Q_{in} = M_{gas}(Lx1)\cos\beta \qquad \text{Eq. 4.14}$$

The gas flow capacity of the geocomposite could be evaluated in the laboratory using gas flows. However such tests are exceptionally rare. An estimate for the air transmissivity of the drainage geocomposite can be calculated by *dividing* the water transmissivity by 14; for landfill gas divide by 10. This conversion is based on an assumption of laminar flow and the ratio of the intrinsic viscosity of the gas to water.

LFG Collection Blanket Capacity ---- The assumption of laminar flow allows the use of Darcy's Law and is valid for low flow gradients common to landfill collection systems. This assumption allows the maximum pressure generated by the gas collected by a blanket drain, u_{max}, be defined as follows, Thiel (1999):

$$u_{max} = \frac{Q_{gas}\gamma_{gas}}{\theta_{req}}\left[\frac{L^2}{8}\right] \qquad \text{Eq. 4.15}$$

where γ_{gas} is the density of LFG or 0.0815 pcf and L is the length of the gas collection blanket. Calculation of the required transmissivity requires an assumption for the maximum gas pressure that can be allowed beneath the barrier layer in the final cover. For example, typical landfill side slopes generally require the gas pressure remain below 3" H_2O or 15.6 psf relative pressure beneath the barrier for stability considerations. The required transmissivity, θ_{req}, is then calculated as follows:

$$\theta_{req} = \frac{Q_{gas}\gamma_{gas}}{u_{max}}\left[\frac{L^2}{8}\right] \qquad \text{Eq. 4.16}$$

While the density of the LFG is greater than that of air (γ_{air} = 0.75 pcf), the movement of LFG is essentially governed by gas pressure gradients and not gravity. Thus the "L" dimension can be either vertical up the slope or horizontal to the slope.

It is more difficult to establish a 'typical' range of required gas transmissivity since the volume of waste impacts the calculation and will vary from site-to-site. However, assuming a waste depth of approximately 100-ft (30.8 m), M_{gas} can be calculated to equal approximately 670 scf/year/ft^2 (6.5 x 10^{-6} m^3/sec/m^2). For a typical gas collector length, *L*, of 100-ft. (30.6m), the required gas transmissivity is approximately 5.0 x 10^{-5}

$m^3/s - m$. The equivalent water transmissivity would equal 5.0×10^{-5} $m^3/s - m$. The assumed 0.1 scf/year/lb gas generation rate was obtained from unlined landfills that exposed the waste to significantly more water than Subtitle D landfills do. Actual gas generation rates can be obtained by performing a NSPS (40 CFR Part 60) Tier 2 gas emissions survey.

4.3.2 Impact of Gas Pressures on Slope Stability

Landfill gas can exert a pressure beneath the final cover geomembrane that may lead to a decrease in the stability of final cover side slopes. Such gas pressures are a certainty in passive gas venting systems and may occur if active gas recovery systems are shut down by accident or for service. The slope stability for the case where seepage forces are not present is given as follows:

$$FS = \frac{Resisting\ Forces}{Driving\ Forces} = \frac{(\gamma_t d \cos\beta - u_g)\tan\delta}{\gamma_t d \sin\beta} \qquad \text{Eq.4.17}$$

where β is the slope angle, d is the vertical thickness of the soil cover (see Figure 4.1), $(_t$ is the total unit weight of the cover soil, and u_g is the effective gas pressure beneath the barrier layer. The effective gas pressure can be conservatively assumed to equal u_{max}, see Eq. 4.15.

An extreme condition can develop if an active gas system is shut down due to a major storm. If the storm conditions lead to saturation of the vegetative soil layer then seepage forces may develop and the slope stability factor of safety reduces to the following:

$$FS = \frac{Resisting\ Forces}{Driving\ Forces} = \frac{(\gamma_b d \cos\beta - u_g)\tan\delta}{\gamma_{sat} d \sin\beta} \qquad \text{Eq.4.18}$$

where $(_b$ is the bouyant weight and $(_{sat}$ is the saturated weight of the soil. Note that this conditions occurs only if the lateral drainage system is hydraulically insufficient to handle the infiltration through the vegetative soil layer.

4.4 Design Examples

Example 1: Determine the required water transmissivity for a geocomposite drainage layer for a final cover having the following properties:

- 6% slopes
- pipe spacing of 35 meters
- long-term service reduction factor = 6
- 2-foot vegetative cover with $K = 1 \times 10^{-4}$ cm/sec
- Assume both HELP model infiltration rates and the saturated case

Typical "east coast" locations yield HELP peak design rate of fluid supply, r or $k_h = 9 \times 10^{-6}$ cm/sec. From Figure 5.5 (see the following chapter), the minimum required drainage layer permeability for the HELP case is 0.016 cm/sec. For the saturated or unit gradient case, r or $k_h = 1 \times 10^{-4}$ cm/sec and the required permeability is 0.16 cm/sec. The required ultimate transmissivity, $\mathbf{2}_{ultimate}$, are calculated assuming an equivalent 30 cm thick drainage layer such that $\mathbf{2}$ = k * thickness * long-term service reduction factor. The required transmissivities

are 3.8 x 10^{-4} m^3/sec-m and 3.8 x 10^{-3} m^3/sec-m respectively. Note that the HELP model significantly underestimates the transmissivity required if the cover saturates.

The normal load acting on the geocomposite drainage blanket in this application is typically less than 25 kPa (500 psf). The geocomposite drain is then selected using laboratory transmissivity test data such as shown on Figure 2.3 for a flow gradient *equal to or greater than* the 0.06 field condition, e.g. use a 0.1 laboratory gradient.

Example 2: Determine the required gas transmissivity for a geocomposite drainage layer for a final cover having the following properties:

- gas collector pipe spacing, L, of 35 meters (115 ft)
- average waste thickness of 40 meters (131 ft)
- allowable gas pressure of 1" H_2O
- long-term service reduction factor = 6

The rate that landfill gas enters the blanket collector can be estimated using Eq. 4.13 as follows:

$$Q_{gas} = \frac{\text{Weight of Waste x 0.1 scf/lb/yr}}{\text{Area of Final Cover}} = \frac{131' x 70 pcf x 0.1}{1 ft^2} = 917 scf/ft^2/yr = 1.75 x 10^{-3} scf/ft^2/\text{min}$$

The minimum required transmissivity can then be calculated using Eq. 4.16.

$$\theta_{req} = \frac{Q_{gas}\gamma_{gas}}{u_{\max}}\left[\frac{L^2}{8}\right] = \frac{1.75 x 10^{-3} x 0.0815 pcf}{5.2 psf}\left[\frac{115^2}{8}\right]$$

This reduces to a minimum transmissivity of 0.045 ft^3/min-ft (6.8 x 10^{-4} m^3/sec-m). Applying the long-term service reduction factor of 6 results in a minimum required LFG transmissivity of 3.8 x 10^{-4} m^3/sec-m. The required geonet would therefore be required to have a minimum <u>water</u> transmissivity of 3.8 x 10^{-5} m^3/sec-m.

Example 3: Evaluate influence of LFG pressures on the slope stability of final cover side slopes having the following properties:

- 3H:1V slopes ($ = 18.4↓↑)
- vertical thickness of soil cover, d = 2 ft.
- total unit weight of soil cover, ($_t$ = 100 lb/ft^3
- saturated unit weight of soil cover, ($_{sat}$ = 115 lb/ft^3
- effective LFG pressure = 3" H_2O (15.6 lb/ft^2)
- interface friction angle between lateral drain and barrier = 25↓↑

Under normal service conditions, the sliding factor of safety of the slope is given by Eq. 4.17

$$FS = \frac{(\gamma_t d\cos\beta - u_g)\tan\delta}{\gamma_t d\sin\beta} = \frac{(100\ 2\cos 18.4° - 15.6)\tan 25°}{100\ 2\sin 18.4°} = 1.28$$

Under saturated conditions with an undersized lateral drainage system, seepage forces develop and reduce the factor of safety as given by Eq. 4.18

$$FS = \frac{(\gamma_b d \cos\beta - u_g)\tan\delta}{\gamma_{sat} d \sin\beta} = \frac{((115 - 62.4)2\cos 18.4° - 15.6)\tan 25°}{115\ 2 \sin 18.4°} = 0.54$$

The combination of seepage forces and LFG pressures will cause a significant decrease in final cover stability.

Chapter 5 Designing Lateral Drains in Liner Systems

Lateral drainage systems must provide a reliable means of removing leachate collected on the liner system to both limit leakage through the liner and ensure stability of the waste. The leakage through a penetration in a geomembrane can be estimated using the following equation (Giroud, et al. 1992):

for good contact $$Q = 0.21\, h^{0.9}\, a^{0.1}\, k^{0.74}$$ Eq. 5.4

for poor contact $$Q = 1.15\, h^{0.9}\, a^{0.1}\, k^{0.74}$$ Eq. 5.5

where a is the area of the penetration (m^2) in the geomembrane component of the barrier, k is the permeability of the low permeability soil component of the barrier system (m/s), and h (m) is the head acting on the barrier. Be aware that these equations are valid only with the above SI units and for heads less than the thickness of the soil component of the barrier system. The area of penetration, a, is assumed to be limited by a comprehensive construction quality assurance program during construction. In RCRA liner systems, the permeability of the CCL is typically less than 1×10^{-7} cm/sec. *The designer's role is therefore limited to ensuring that the head, h, acting on the barrier system is minimal.* For the barrier system in MSW landfills, RCRA Subtitle D limits the head acting on the liner to less than 30 cm except immediately following a design storm event. If the drainage is maintained in unconfined flow within the geocomposite, the maximum head may be less than approximately 6 mm. This reduction in head will significantly limit potential leakage through the liner system. Obviously, a leakage detection system (LDS) will not only provide an indicator of the performance of the overlying liner system, but will also provide for a very minimal head acting on the underlying liner.

A LCRS must handle all of the leachate that is generated by the waste. During the initial operation of the landfill, the rate of leachate generation can be several thousands of gallons per acre per day. Once interim cover is placed over the waste, leachate generation will drop significantly and runoff water is collected. The eventual construction of a final cover over the landfill will further decrease leachate generation and the volume of leachate reaching the LCRS. Thus the flow through the LCRS decreases with time, and therefore demand on the geocomposite, decreases with time. This is fortunate since most landfill leachate is rich in both biological activity and suspended solids that tend to clog the LCRS. Landfills designed to recirculate leachate must use greater factors of safety in designing lateral drainage systems than recommended herein.

In general, geocomposite drainage systems are used to provide improved stability to side slopes in LCRS applications and for their fast detection time in LDS applications. This chapter reviews the basic design considerations for LCRS and LDS design.

5.1 LCRS Design – Side Slopes

Geocomposite drains dominate in the coverage of side slopes in the LCRS. Combined with a textured geomembrane, a drainage geocomposite often provide the most practical and appropriate means of extending the LCRS up slopes without creating slope stability problems. For typical side slope LCRS systems, we limit hydrostatic forces over the geomembrane by verifying that the drainage capacity of the geocomposite drainage layer is not exceeded by the inflow to the drain. This limits the head acting on the geomembrane to less than the small height of the drainage geocomposite and ensures that the flow is unconfined. Landfill side slopes are typically stable once waste is placed against them so the time interval of potential instability may be small.

Key design considerations for the side slope LCRS and the associated protective cover are as follows:

1. Select a geocomposite drain to handle the maximum potential inflow prior to placement of the waste over the slopes. Fortunately, the normal loads are small during this phase so a large transmissivity is easily obtained.

2. Verify slope stability of the LCRS and protective cover layers assuming full saturation exists in the soil layers above the LCRS. A nominal factor of safety of 1.2 is adequate since exposure time is minimal for this condition.

The design of the side slope LCRS is based on a modification of a cover design procedure first presented by Thiel and Stewart at the Geosynthetics '93 conference in Vancover, B.C. The rate of water infiltration into the geocomposite drain is determined by assuming the protective soil layer becomes saturated. Then the water is moving down under a unit gradient such that the infiltration velocity is equal to the permeability of the vegetative layer. Typical permeabilities for protective cover soils range from $5x10^{-4}$ to $5x10^{-6}$ cm/sec. The basic model developed by Thiel and Stewart (1993) is shown on Figure 5.1.

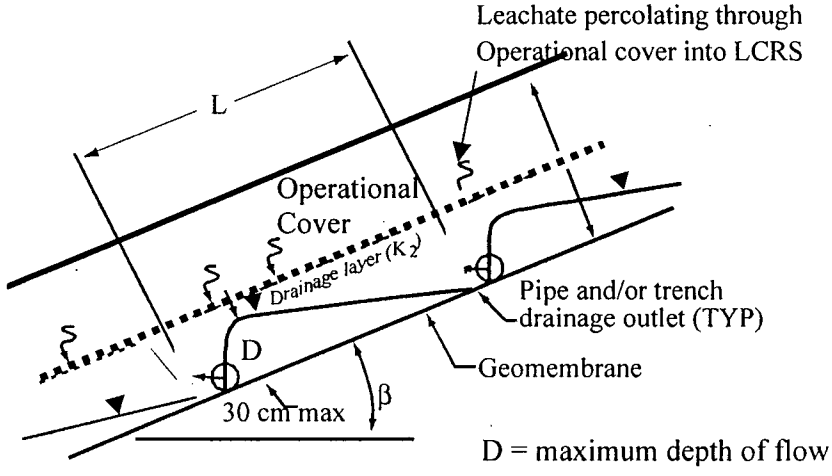


Figure 5.1 Schematic of head buildup in the drainage layer (adapted from Thiel and Stewart, 1993)

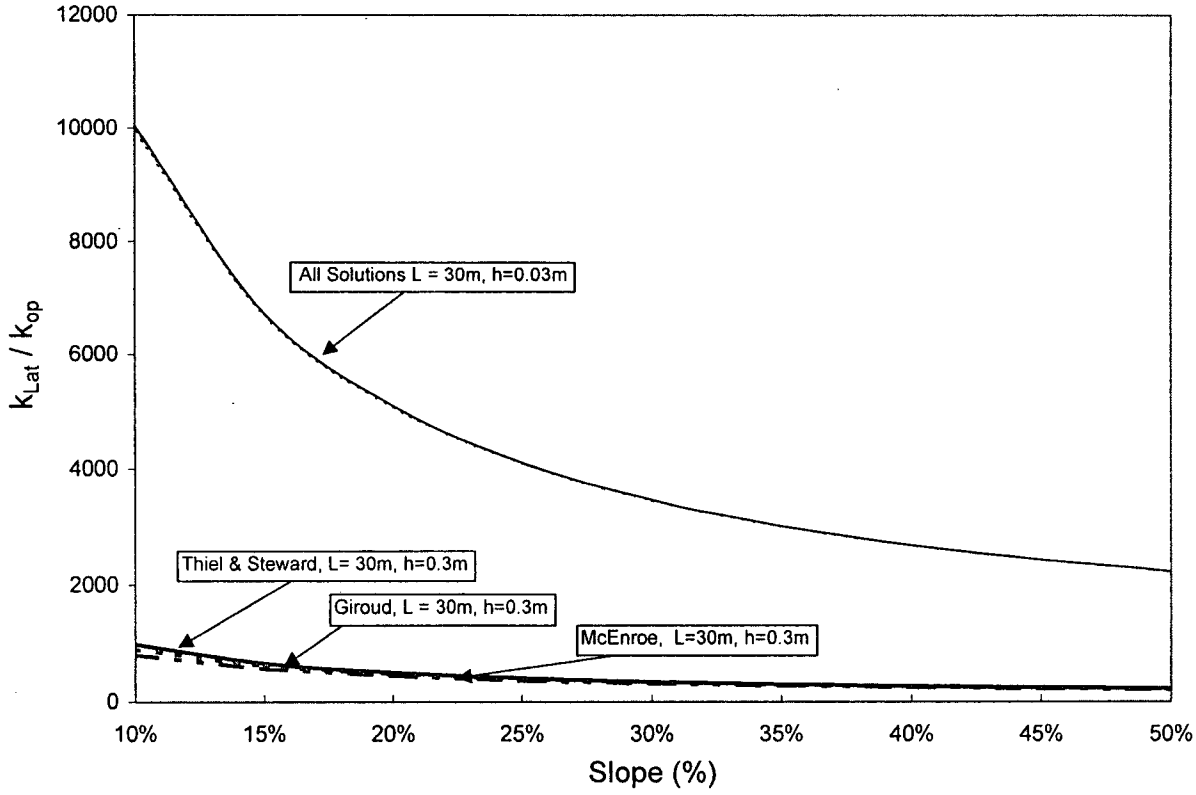
The quantity of water, Q_{in}, infiltrating through the operational cover into a unit width of drainage composite having a length L is given by

$$Q_{in} = k_{OpCover} L * \cos \beta \qquad \text{Eq. 5.1}$$

The flow capacity of a drainage layer, Q_{out}, is solved for using Darcy's Law as follows

$$Q_{out} = kiA = ki\,(t^*1) = [kt]\,i = \theta\, i \qquad \text{Eq. 5.2}$$

where t is the thickness of the drainage layer, i is the flow gradient, and $[kt]$ is defined as transmissivity, θ. The transmissivity of a geocomposite drainage layer is obtained from laboratory testing as described in Chapter 3. It is important that $\theta_{ultimate}$ (see Eq. 3.3) be obtained at normal stress levels, boundary conditions,



and hydraulic gradients that reflect actual field conditions. Additional reduction factors for creep deformation of the drainage core, biological clogging of the geotextile, etc. can be neglected for this analysis.

Figure 5.2 Comparison of Thiel and Stewart vs. Giroud vs. McEnroe Solutions for Varying Slopes

Figure 5.2 compares the simplified Thiel and Stewart model to the exact solution developed by McEnroe (see section 5.2.1) and the Giroud's approximate numerical solution (see section 5.2.2). The Thiel and Steward solution is more than 12% in error for slopes less than 25% while the Giroud numerical approximation is less than 1% in error for all slopes. Note that both the approximate solutions are more conservative than McEnroe's solution. The authors strongly recommend that designers use Giroud's numerical approximation for design and the Thiel and Steward solution as a quick and simple check. Numerical problems with McEnroe's "exact solution are discussed in section 5.2.2 and the complexity of the solution itself preclude the use of this solution for general design applications. For geocomposite drains only, Giroud's numerical solution can be reduced to a very simple solution as presented in section 5.2.2

Having ensured that the flow in the geocomposite will remain unconfined, the remaining step is to verify the slope stability of the LCRS and protective cover layer. This can be conservatively done using an infinite slope model. See Koerner and Soong (1998), for more rigorous analyses that include toe buttressing and tapered cover soil thickness. Using the infinite slope model, the factor of safety against slope failure is given by the following:

$$FS = \frac{Resisting\ Forces}{Driving\ Forces} = \frac{\gamma a \cos\beta \tan\delta}{\gamma a \sin\beta} = \frac{\tan\delta}{\tan\beta} \qquad \text{Eq. 5.3}$$

where β is the slope angle, δ is the interface friction angle, and a is the vertical thickness of the overlying protective cover.

5.2 LCRS - Bottom Slopes

A protective buffer is required between the waste and the geomembrane liner system. Typically, a minimum 2-foot thick earthen buffer is used. For this reason, geocomposite LCRS drains are commonly used in conjunction with a 2-ft sandy soil layer over the bottom of a landfill. The use of a geocomposite allows the permeability criteria for the sand to be reduced since the total drainage capacity is related to the sand layer transmissivity +geocomposite layer transmissivity. This allows the use of sands with fines and saves the expense of soil screening and washing. The transmissivity of the combined sand + geocomposite system is simply the sum of the individual transmissivity. The maximum head in the sand/geocomposite lateral drain that can be tolerated without generating excess hydrostatic pressures must be evaluated based on slope stability considerations.

In the design of a drainage layer within the 2% to 8% slopes common to landfill liner bottoms and portions of the final cover, slope stability may not be a major concern and limiting infiltration becomes the primary design objective. Evaluation of the stability of waste materials placed within the landfill is not covered in this book. However, Soong and Koerner (1997) have described the stability failure of waste masses due to inadequate transmissivity of the LCRS. Such global failures are beyond the scope of this manual.

For liner bottom slopes, we must calculate the actual head acting on the barrier to demonstrate regulatory compliance, ensure unconfined flow, and evaluate barrier leakage. This section reviews three methods for evaluating the head in a lateral drainage system: 1- McEnroe's exact solution, 2-Giroud's numerical approximation, and 3-published EPA equation.

5.2.1 McEnroe's Equations for Head

The head acting on the barrier system are commonly calculated using relationships developed by McEnroe (1993) for lateral drainage layers. The maximum head acting on the liner system is a function of the transmissivity of the lateral drainage layer, θ, the horizontal spacing of perforated drainage pipes within the lateral drainage layer, L, the slope of the barrier system, β, and the design rate of fluid supply, r, of liquid vertically entering the lateral drainage layer.

McEnroe's equations were developed for natural drainage layers having a thickness that greatly exceeds that of a geocomposite drainage layer. The application of McEnroe's equations to drainage geocomposites assumes that Darcy's law is applicable. Note that McEnroe's equations are based on 'free drainage condition', i.e., the collection system has to be designed adequately so that there is no backwater effect over the barrier layer. McEnroe's equations are as follows:

$$h_{max} = LS(R - RS + R^2S^2)^{1/2} \exp\left[\frac{1}{B}\tan^{-1}\left(\frac{2RS-1}{B}\right) - \frac{1}{B}\tan^{-1}\left(\frac{2R-1}{B}\right)\right] \qquad \text{For R>1/4} \qquad \text{Eq. 5.6}$$

$$h_{max} = LS(R - RS + R^2S^2)^{1/2}\left[\frac{(1-A-2R)(1+A-2RS)}{(1+A-2R)(1-A-2RS)}\right]^{1/2A} \qquad \text{For R} < 1/4$$

$$h_{max} = LS\frac{R(1-2RS)}{1-2R}\exp\left[\frac{2R(S-1)}{(1-2RS)(1-2R)}\right] \qquad \text{For R} = 1/4$$

where h_{max} is the maximum head over the liner, $R = r/(k\sin^2\beta)$, S = slope of liner = $\tan\alpha$, $A = (1\text{-}4R)^{1/2}$, $B = (4R\text{-}1)^{1/2}$, r = design rate of fluid supply, k = coefficient of permeability of the drainage layer. The sawtooth liner geometry assumed in McEnroe's solution is shown in Figure 5.3. McEnroe evaluated three impingement conditions:

Case I - $r/k\sin^2\beta > 0.25$ - the slope/transmissivity capacity of the drainage layer controls the mounding height as is appropriate for flatter slopes,

Case II - $r/k\sin^2\beta = 0.25$ - a balance conditions exists between the design rate of fluid supply and the slope/transmissivity capacity of the drainage layer , and

Case III - $r/k\sin^2\beta < 0.25$ - the design rate of fluid supply controls the mounding height as is appropriate for typical side slopes.

The three cases are shown in Figure 5.3. Note that Cases II and III can also be used to model the condition of a liner on an infinite slope with collector pipes uniformly spaced down the slope. Case I conditions for the infinite slope condition require the slope length to be taken as the actual distance between the pipes, 2L. A more thorough discussion of McEnroe's analysis is given by McBean et al. (1995).

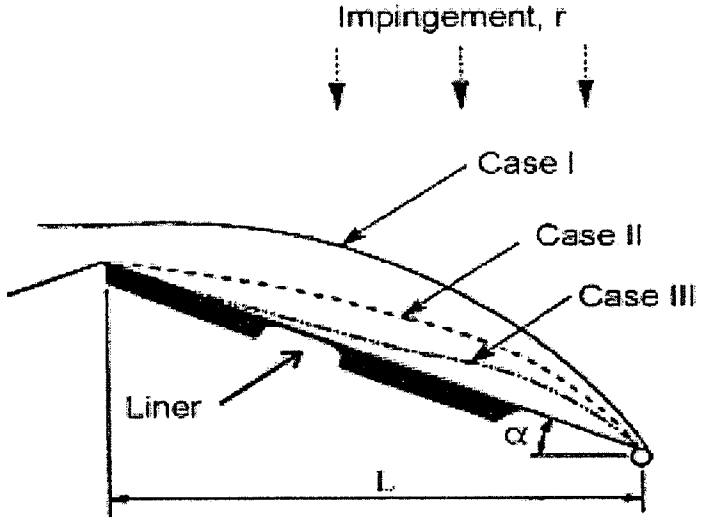


Figure 5.3 Sawtooth-liner geometry for McEnroe's solutions

5.2.2 Giroud's Approximate Numerical Solution

While McEnroe's solution is "exact", it is difficult to use and may be very sensitive to the number of significant digits used. An alternative solution based on simplifying assumptions and numerical methods was first presented by Giroud et al. (1992) and is discussed in Giroud et al. (2000). The maximum head on the liner, termed t_{max} by Giroud, is given by the following equation:

$$t_{max} = j \frac{\sqrt{\tan^2\beta + 4\,q_h/k} - \tan\beta}{2\cos\beta} L \qquad \text{Eq.5.7}$$

where q_h is the design rate rate of liquid supply over a horizontal surface in terms of an equivalent velocity, $ is the slope angle, L is the drainage length of the lateral drain, and k is the permeability of the lateral drain. The j term is a numerical modifying factor given by the following:

$$j = 1 - 0.12\exp\left\{-\left[\log\left(\frac{8(q_h/k)}{5\tan^2\beta}\right)^{5/8}\right]^2\right\} \qquad \text{Eq. 5.8}$$

Table 5.1 shows that values of the maximum liquid thickness calculated using Giroud's equation are within 1% of the McEnroe results for q_h/k less than 1×10^{-1}, which is the case in virtually all practical applications. Note also that the asterisked McEnroe values in Table 5.x could not be calculated using a Hewlett Packard HP 15 C calculator, although it uses 10 digits (see the discussion near the end of Example 1). The calculation had to be done using Microsoft Excel, which uses 15 digits. The double asterisked values could not be calculated with Microsoft Excel, although it uses 15 digits. For example, the value 3.16×10^{-9} was obtained using Equation 5.x as follows: $(q_h/k)/\sin\beta = 1\times10^{-9} / \sin[\tan^{-1}(1/3)] = 3.16\times10^{-9}$. Ironically, in this particular case, the "approximate" Giroud equation gives an accurate value whereas McEnroe's equation, even when used with Microsoft Excel, does not.

Table 5.1 Comparison between values of t_{max}/L obtained numerically using Giroud's equations and McEnroe's equations.

q_h/k	tanβ	Giroud's equation Eq. 5.xx	McEnroe's equations for $i_{toe} = \cos\beta$	tanβ	Giroud's equation Eq. 5.xx	McEnroe's equations for $i_{toe} = \cos\beta$
1×10^{-9}	0.02	5.00×10^{-8}	5.00×10^{-8}*	0.5	2.24×10^{-9}	2.24×10^{-9} **
1×10^{-8}		5.00×10^{-7}	5.00×10^{-7}*		2.24×10^{-8}	2.24×10^{-8} *
1×10^{-7}		4.99×10^{-6}	4.99×10^{-6}		2.24×10^{-7}	2.24×10^{-7}*
1×10^{-6}		4.93×10^{-5}	4.94×10^{-5}		2.24×10^{-6}	2.24×10^{-6}*
1×10^{-5}		4.61×10^{-4}	4.65×10^{-4}		2.24×10^{-5}	2.23×10^{-5}
1×10^{-4}		3.68×10^{-3}	3.68×10^{-3}		2.23×10^{-4}	2.23×10^{-4}
1×10^{-3}		2.08×10^{-2}	2.09×10^{-2}		2.19×10^{-3}	2.19×10^{-3}
1×10^{-2}		8.65×10^{-2}	8.67×10^{-2}		2.01×10^{-2}	2.01×10^{-2}
1×10^{-1}		3.04×10^{-1}	3.16×10^{-1}		1.51×10^{-1}	1.52×10^{-1}
1×10^{-9}	0.3333	3.16×10^{-9}	3.16×10^{-9}**	1.0	1.41×10^{-9}	1.41×10^{-9}**
1×10^{-8}		3.16×10^{-8}	3.16×10^{-8}*		1.41×10^{-8}	1.41×10^{-8}*
1×10^{-7}		3.16×10^{-7}	3.16×10^{-7}*		1.41×10^{-7}	1.41×10^{-7}*
1×10^{-6}		3.16×10^{-6}	3.16×10^{-6}		1.41×10^{-6}	1.41×10^{-6}*
1×10^{-5}		3.16×10^{-5}	3.16×10^{-5}		1.41×10^{-5}	1.41×10^{-5}
1×10^{-4}		3.14×10^{-4}	3.14×10^{-4}		1.41×10^{-4}	1.41×10^{-4}

1×10^{-3} 1×10^{-2} 1×10^{-1}		3.03×10^{-3} 2.65×10^{-2} 1.77×10^{-1}	3.05×10^{-3} 2.66×10^{-2} 1.85×10^{-1}		1.40×10^{-3} 1.35×10^{-2} 1.17×10^{-1}	1.41×10^{-3} 1.41×10^{-2} 1.41×10^{-1}

The total flow rate through the collecter, Q, is equal to q_hL per unit width of the drainage layer. For geocomposite lateral drains, Giroud (2000) has shown that Eq. 5.7 can be simplified due to the small flow thickness to the following:

$$t_{max} = \frac{q_h L}{k \sin\beta} \qquad \text{Eq. 5.9}$$

This greatly simplified equation is appropriate when the thickness of the geocomposite is less than 20 mm over the range of slopes common to most landfills. This equation should not be used with thicker natural drainage layers. This allows the required transmissivity for a geocomposite drain to be directly solved for as follows

$$\theta_{required} = \frac{r}{(\sin\alpha)/L} \qquad \text{Eq.5.10}$$

Solutions based on Giroud's numerical solution will be conservative and less than 5% in error. Again, the simplified solution is applicable to geocomposite drainage systems only.

5.2.3 EPA's Published Equation

USEPA (1989) also published the following equation, commonly referred to as Moore's equation, to calculate the maximum head over the liner:

$$h_{max} = Lr^{1/2}\sin\alpha\left[\frac{S^2}{r\sin^2\alpha} + 1 - \frac{S}{r\sin^2\alpha}(S^2 + r\sin^2\alpha)^{1/2}\right] \qquad \text{Eq.5.11}$$

The derivation of this equation has never been presented and its validity is questioned, Giroud (2000). For a 25% slope, the EPA equation over-estimates the head over the liner at low r, while at r greater than 0.1, the EPA equation under-estimates the head. ***The authors strongly recommend the use of Giroud's equations for the computation of the head in lateral drainage systems.*** **Prior equations presented by USEPA should be used with caution since their derivation has never been presented and the equations are suspect.**

5.2.4 Design Rate of Liquid Supply, q_h

The most significant unknown for the designer to evaluate is the rate of liquid supply vertically entering the lateral drainage layer. For the design rate of fluid supply of liquid vertically entering the lateral drainage layer over the liner system, we must estimate the rate that leachate is draining from the waste. Two methods exist for making this estimate: 1) use EPA's HELP model, or 2) use empirical rates based on historic leachate generation rates. The HELP model is limited in that it does not readily allow the operational/post-closure transition life of a landfill to be modeled, e.g., the geometry of the landfill model remains the same through the entire evaluation analysis. Because of this limitation, empirical rates are commonly used to evaluate the three key phases in the life of the lateral drainage layer. These phases are 1) during active placement of the waste, 2)

after placement of interim cover, and 3) after placement of the final cover. Values for these phases can be estimated from regional landfill service records, if available, and published values of typical leachate generation values. It should be noted, however, that recent evaluation of actual leachate generation rates have shown that the HELP model can be a very good approximation to actual conditions (see M.A. Othman et al., 1998).

Published values of typical leachate generation values for non-arid regions show typical leachate generation rates of 1200-2000 gallon/acre/day (gad) or a design rate of liquid supply of 1.3-2.2 x 10^{-6} cm/sec during active placement of waste. This reduces to 200-600 gad once a 12-inch interim cover is placed, and 50-150 gad after placement of the final cover. The accuracy of these values was confirmed through discussions with state solid waste regulators in Florida, New York, North Carolina, and Virginia. Leachate generation rates will be dramatically impacted by the degree of leachate/storm water separation that is inherent in the facilities design and operational practices. The leachate generation rates referenced above reflect typical design and operational efforts. The 10^{-6} cm/sec design rate of liquid supply approximately represents the infiltration into a leachate collection system through a silty/clayey protective soil layer during initial waste placement. Facilities that employ supplemental 'rain sheets' may have less leachate, while those using porous operational covers will have significantly more. The design is obviously conservative for long-term flows if it is designed properly for the short-term operational flows.

For a design rate of liquid supply rate, *r*, of $1*10^{-4}$ cm/sec on a 2% slope, the required range of permeability is 0.1 to 0.8 cm/sec. Assuming a default long-term service reduction factor of 20 as recommended in Chapter 3.2 and a 30 cm thickness, the resulting range of transmissivity required for the leachate collection systems on a 2% slope are 6 to 48 x 10^{-3} m^2/sec. Decreasing the design rate of liquid supply to $1*10^{-6}$ cm/sec, the range of required transmissivity is 6 to 48 x 10^{-5} m^2/sec. Based on the actual design rate of liquid supply, leachate collection systems may require a very high capacity flow under high normal loads - a tough application. High flow drainage composites or a combination of geocomposite with natural soil drains will be necessary to accomplish this goal.

5.2 LDS Design

The LDS system must be generally designed to satisfy the following objectives:

- provide rapid detection of a major breach in the primary liner system, common requirements are for 24 hour maximum detection time; and

- limit the head acting on the secondary liner to less than the thickness of the LDS or 0.3m, whichever is less.

Unfortunately, regulators commonly focus on the quantity of leachate drained by the LDS system. It is important to remember that meeting the second objective is more important than arbitrarily limiting the allowable flow rate. The second objective is ensured by defining an Action Leakage Rate (ALR) that is *less* than the saturated flow rate of the LDS. If the ALR is exceeded, then the facility must implement supplemental efforts to limit the generation of leachate in the refuse and/or increase the rate of leachate removal from the primary collector system. The generation of leachate can be reduced by minimizing the size of the active working face and by increasing run-off from interim covers using tarps. The rate of removal can be increased by increased or continual operation of leachate recovery pumps.

Liquids collected by the LDS can include water generated by exposure during construction, water from the consolidation of the soil component of an upper composite liner, and from leakage through the upper liner system. Gross, et. al (1990) have presented a means of evaluating the relative contribution of each source.

Construction water can mimic a liner leak even prior to placement of waste in the landfill. Fortunately, the use of a geocomposite drain limits the quantity of such water and speeds its drainage. Consolidation waters from the clay liner result from the high water content of typical clay liners and the consolidation normal loads generated by the waste. The quantity of consolidation water can be estimated using standard consolidation analysis of the clay liner.

Geonets provide the most efficient material for rapid detection of leakage in an overlying liner system. Having very limited field capacity and a very high transmissivity, the geonet minimizes the time lag between leakage occurrence and detection time. A LDS constructed of sand or gravel has significant liquid storage potential that can delay the detection of leakage in the primary liner.

5.2.1 24 Hour Detection

Many regulations require that the LDS detect a major break of the primary liner system within 24 hours. The travel time of liquids draining through the LDS system is estimated by assuming that the LDS is saturated. Given the assumption of saturation, the apparent velocity of flow in the drainage net, v, can be estimated from Darcy's Law as follows:

$$Q = kiA = (kt)\, i\, w = \theta\, i\, w = vA = v\, w\, t \qquad \text{Eq. 5.12}$$

or

$$v = \theta\, i/t \qquad \text{Eq. 5.13}$$

where θ is the transmissivity of the geonet, A is the cross sectional area of the net ($A = wt$, where w is the width, and t is the thickness of the geonet or geocomposite), and i is the flow gradient. The thickness of the geonet or geocomposite is determined under the design load (at least twice the anticipated service load). Figure 5.5 presents a typical curve of geocomposite thickness under a range of normal loads. This should be confirmed for the specific geocomposite under consideration.

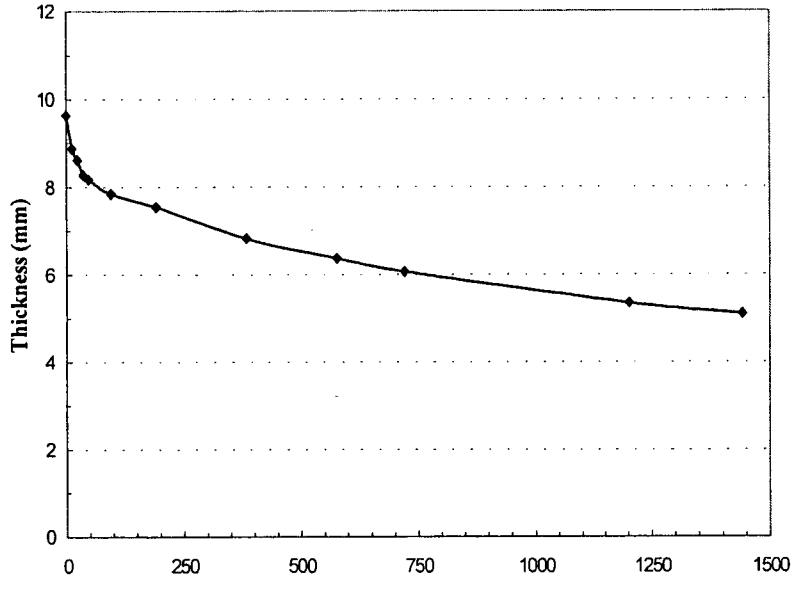


Figure 5.5 Geocomposite thickness under a range of normal loads

The design transmissivity of the drainage geonet must be obtained from laboratory transmissivity test data (ASTM D-4716), typically provided by the manufacturer divided by a long-term service reduction factor. For the LDS, a default long-term service reduction factor of 10 is recommended, as described in Section 3.2. The transmissivity test must be performed with normal loads and boundary conditions that replicate field service conditions. For LDS testing, the lower boundary of the geonet is typically the lower geomembrane. The upper boundary of the geonet is either the upper geomembrane or a filter fabric/soil barrier layer forming part of a composite primary liner system. In the case of a composite primary, the upper boundary in the transmissivity test must include both the filter geotextile and a soil layer. This properly simulates the intrusion into the upper boundary and the resulting loss of transmissivity.

The true velocity, v_{true}, is actually greater than the apparent velocity calculated above due to the volume of flow space occupied by the drainage geonet ribs. The true velocity of flow, V_{true}, is calculated by dividing the apparent velocity by the porosity, n, of the geonet.

$$V_{true} = V/n \qquad \text{Eq. 5.14}$$

Here porosity is defined as the volume of the voids divided by the total volume of the geonet. Typical values of porosity for geonets range from 0.4 to 0.8.

Figure 5.6 shows a common landfill cell geometry or profile. The maximum travel time, T, for this system can be calculated using equation 5.13 as follows:

$$T = T_1 + T_2 = L_1/v_1 + L_2/v_2 \qquad \text{Eq. 5.15}$$

or $$T = L_1 / \{\theta_1 i_1/t_1 n_1\} + L_2 / \{\theta_2 i_2/t_2 n_2\} \qquad \text{Eq. 5.16}$$

where the transmissivities, θ, are obtained from a manufacturer's chart such as Figure 2.3, the thickness of the geonet is obtained from a manufacturer's chart such as Figure 5.7, the geonet porosity n is provided by the manufacturer and i is the flow gradient in the field. All geonet properties should be at normal loads that reflect field service loading.

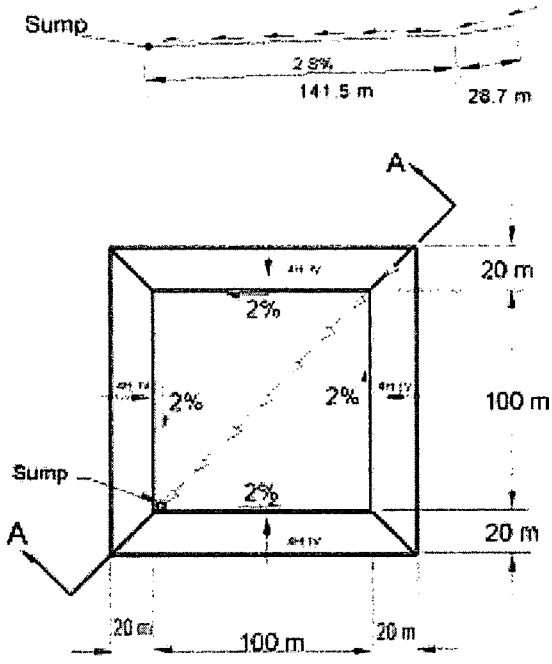


Figure 5.6 Common landfill–cell profile

For the conditions on Figure 5.6, we can assume that the following properties reflect field service conditions:

- Rate of liquid supply, $q_h = 1 \times 10^{-6}$ cm/sec
- $\theta_1 = 3.2 \times 10^{-4}$ m^3/sec-m @ i = 0.028 and $\theta_2 = 1.8 \times 10^{-4}$ m^3/sec-m @ i = 0.017, considering FS=10, see Figure 2.4
- $t_1 = t_2 = .006$m, see Figure 5.6
- Flow lengths $L_1 = 28.7$m and $L_2 = 141$m
- $n_1 = n_2 = 0.6$, manufacturer's data sheet

Using these values, the travel time for the example cell shown is approximately 16.7 hours.

5.2.2 Action Leakage Rate

The ALR is defined in 40 CFR 265.302 as the maximum design flow rate that the leakage detection system can remove without the fluid head on the bottom liner *exceeding 30 cm*. This limit was based on a lateral drainage system using sand or gravel and was intended to define the flow rate at which a portion of the system became saturated. This is consistent with our fundamental premise that lateral drainage systems in landfills must be designed such that the flow within the layer is unconfined. For the geometry of the example used above, two alternative LDS designs will be evaluated: the first is simply a layer of sand or gravel that combined with the liner contours results in a radial flow of liquids to the sump, the second incorporates toe drains to allow the water draining over the bottom to flow perpendicular to the floor elevation contour lines, e.g. directly down slope. These two cases are shown on Figure 5.9.

The saturated flow rate in the case of radial flow is limited by the reduced flow area as the liquid approaches the sump. The design of lateral drainage layers with radial flow has been determined by Giroud and Zhao

(2000) for square and round sumps for both confined and unconfined flow. Their approach to the unconfined flow condition is presented here. For a corner sump serving a quadrant having a radius R, the maximum flow rate into the sump is equal to

$$Q_{max} = 0.25\ \pi\ R^2\ q_h \qquad \text{Eq. 5.17}$$

where q_h is the rate of liquid supply to the LDS.

The minimum transmissivity required to maintain an unconfined flow condition is given as

$$\theta_{min} = \frac{q_n\left(R^2 - r^2\right)}{2ri} \qquad \text{Eq. 5.18}$$

where r is the radius of the sump and i is the hydraulic gradient.. The maximum head in the LDS occurs at the edge of the sump an is given by

$$t_{max} = \left[\frac{q_h}{2ki}\right]\left[\frac{R^2 - r^2}{r}\right] \qquad \text{Eq. 5.19}$$

where r is the radius of the sump, and k is the permeability of the LDS. Giroud (2000) has shown that if the liquid thickness is less than one tenth the height of the slope serviced by the collection system, then the hydraulic gradient i can be approximated by sin∃ where ∃ is the slope angle.

For the example problem, the flow into the LDS, Q_{min}, is obtained from Eq. 5.17 to equal 8.85 x 10^{-5} m^3/sec or 1790 gallons per day. The gradient ranges from 0.02 at the toe of the slopes to 0.028 flowing directly across the contour lines. A conservative estimate of i_{avg} is therefore 0.02. Assuming r = 1m , the minimum required transmissivity is obtained from Eq. 5.18 to equal 2.5 x 10^{-3} m^3/sec-m. This slightly exceeds the transmissivity assumed in the travel time analysis.

Alternative two improves the performance of the LDS system by the addition of drains at the toe of all slopes. This can be accomplished using either a stone-encapsulated perforated pipe or a triplanar geocomposite drain. The supplemental toe drain must be sized such that the flow of liquids over the bottom of the LDS is perpendicular to contour lines. If this is done, then the restrictions of radial flow are lost and the maximum flow into the sump, Q, is defined as follows:

$$Q = \theta\, i\, W = \quad \theta\, W \sin \exists \qquad \text{Eq. 5.20}$$

where W is the maximum width of the LDS along a contour line. For the example problem, W equals 141m and Q is calculated to equal 1.26 x 10-3 m3/sec or 28,800 gallons per day. This may be limited by the capacity of the toe drains to accept this quantity of flow from the floor blanket drain but clearly exceeds the Q_{max} flowing into the LDS.

Giroud and Zhao (2000) recommend treating rectangular sumps as equivalent circular sumps using the following equivalent radius:

$$r = 2\sqrt{\frac{ab}{\pi}} \qquad \text{Eq 5.21}$$

Giroud and Zhao (2000) also showed that the ratio of required transmissivities between a radial and conventional flow LDS for a system similar to the example is give by the following:

$$\frac{Q_{conv}}{Q_{rad}} = \frac{2B}{\pi r} = \frac{B}{\sqrt{\pi ab}} \qquad \text{Eq. 5.22}$$

For the previous example this ratio equals (2*141)/(3.1415*1) = 89. Thus , the use of toe drains improved the performance of the LDS by nearly two orders of magnitude. For this reason, radial flow systems should be avoided.

The capacity of a triplanar toe drain can be calculated as follows:

$$Q_{toe} = \theta_{toe}\, i_{toe}\, w_{toe} \qquad \text{Eq. 5.23}$$

where w_{toe} is the width of the toe drain. Thus for the design example, $i_{toe} = 0.02$, the addition of only 7m of a triplanar geonet having a transmissivity of 3×10^{-3} m^3/s-m would provide a toe drain capacity of 6850 gallons per day. The two toe drains serving the sump would therefore have a maximum flow capacity of 13700 gallons per day or 2854 gad. This is less than the 28,800 gallons per day capacity of the floor LDS and therefore controls.

The use of a geonet for the LDS system has the advantage of dramatically reducing the head acting on the lower liner under these saturated flow conditions. A sand or gravel LDS will have a 30 cm head compared to a 6 mm head for the geonet alternative. Recalling from Eqs. 5.7 and 5.8 that the leakage through a composite liner is proportional to $h^{0.9}$, the use of a geonet in the example will reduce potential leakage by a factor of $30^{0.9}/.6^{0.9} \searrow 34$. This is significant!

The actual value selected for the ALR must be less than this estimated maximum saturated flow into the LDS sump. Picking too low of a value will risk having the facility forced into a heightened monitoring/operational mode with each excedence, or even facing closure. Picking too high of a value will nominally increase the cost of the LDS recovery pump system since it must be sized to handle the ALR flow rate. Typical ALR values range from a low of 20 gad for liner systems using a composite primary liner to as much a 200 gad for those using only a single primary liner.

Recent studies sponsored by US-EPA (Othman et al.,1998) have shown that actual peak flows measured in LDS systems range from 0.1-126 gad initially and drops to 2.4-71 gad during operation of the cells for systems having a composite primary liner that includes a compacted clay liner and a geomembrane. For systems using a composite primary liner that includes a GCL, the flows measured in LDS systems range from 0-104 gad initially and to 0-30 gad during operation. These flows can include construction waters draining from the LDS, pore water from the consolidating primary clay liner in addition to leakage through the primary liner. They indicate that most LDS systems currently installed are not saturated and are limiting the head acting on the secondary liner system. This same study clearly showed the value of a composite primary liner in lowering flow rates to the LDS. Cells having only a geomembrane primary liner had a range of peak initial flow rates to the LDS of 0.8-229 gad and operational peak flow rates of 0-158 gad. Limited post-closure data indicates a significant drop in the long-term flow rate to the LDS after placement of the final cover. This study also demonstrates the need to actually calculate the ALR and not use rules of thumb to set it.

5.2.3 Head Reduction Design

The most important environmental role of the LDS is to limit the head acting on the secondary barrier liner system. As discussed in Chapter 5.1.2, the leakage through a defect in a geomembrane is influenced by the head acting on the barrier. The designer must therefore ensure that the head acting on the secondary barrier system is minimal.

For municipal solid waste landfill, RCRA Subtitle D limits the allowable head to less than 30 cm. With typical CQA and a 1 x 10^{-7} cm/sec hydraulic conductivity for the soil component of the liner system, this implies that typical liner leakage will be less than approximately 0.84 gallon/acre/day (assumes good contact and 6 penetrations @ 1 cm^2 each per acre). The data presented by Othman et al. (1998) indicates that many primary liners are performing below this level of service which is no doubt due to poor liner clay contact and the impact of geomembrane wrinkles. The addition of a LDS system allows the designer to limit the design head to something less than the thickness of the geonet forming the LDS. For a typical geonet, this means that the maximum head acting on the geomembrane is less than the thickness of the geonet or approximately 7 mm. Substituting this into equation 5.7 for the same typical field conditions reduces the predicted total leakage to less than 0.03 gallon/acre/day.

The elimination of wrinkles in the liner system is obviously of great importance in LDS construction. What may be an acceptable wrinkle in a single composite liner system having an allowable 30 cm head is clearly not acceptable beneath a LDS system that is trying to achieve a 6 mm maximum head. The CQA program for LDS systems must therefore provide decisive measures to minimize wrinkling of the geomembrane. Typically such measures include limiting the amount of liner that is placed before placement of the geonet and primary liner system. This may force the simultaneous construction of the various layers of the liner system as compared to the current practice of constructing the layers consecutively.

5.3 Design Examples

Example One: Determine the required transmissivity of a geocomposite LCRS given the following service conditions:

- 4% slope
- pipe spacing 55m
- normal load is 750 kPa (15,000 psf)
- permeability of protective soil cover is 10^{-4} cm/sec
- long-term service reduction factor = 20

From Figure 5.6, the minimum permeability is 0.36 cm/sec for a design rate of fluid supply of $1*10^{-4}$ cm/sec, a 4% slope, and a 55m pipe collection spacing. The required transmissivity is calculated assuming an equivalent 30 cm thick drainage layer to be 1.08×10^{-3} m^2/sec. Applying the factor of safety, the minimum transmissivity is equal to 2.16×10^{-2} m^2/sec. Care must be taken to ensure that the laboratory transmissivity tests utilize the correct range of normal loads (and seating time if creep is a concern), and the correct testing boundary conditions simulating the field installation.

Giroud's simplified solution, Eq. 5.8, predicts a required permeability of 0.40 cm/sec and a resulting required geonet transmissivity of 2.75×10^{-2} m^2/s.

Example Two: Design a side slope LCRS given the following service conditions:

- 4H:1V slope, $\beta = 14^\circ$, i=0.242
- slope length = 125 feet (38.2m)
- 24-inch protective cover soil; (γ_{sat} = 110 pcf, permeability = 10^{-4} cm/sec)
- long-term service reduction factor = 20

Determine Minimum Transmissivity, Eqs. 5.1 and 5.2

$$FS = \frac{Q_{out}}{Q_{in}} = \frac{[kt]i}{k_{ProtCover}L} = \frac{\theta i}{k_{ProtCover}L}$$

Setting the long-term service reduction factor to 20 and solving for θ

$$\theta_{ultimate} = 20\ k_{ProtCover}L/i = 20 * 10^{-4}\ \text{cm/sec} * 125\ \text{ft}/\ 0.242 = 3.1 \times 10^{-3}\ m^3/\text{sec-m}$$

This value of transmissivity will ensure that the geocomposite does not become saturated. This can also be solved for using Giroud's simplified equations. For a natural drainage layer, h_{max} = 30cm, Giroud's Eq.5.08 predicts a required transmissivity of 3.05×10^{-3} m^2/sec. For a geonet, Giroud's Eq.5.10 predicts a required transmissivity of 3.14×10^{-3} m^2/sec.

Verify Slope Stability, Eq. 5.5

$$FS = \frac{Resisting\ Forces}{Driving\ Forces} = \frac{\tan\delta}{\tan\beta}$$

For FS = 1.5, $\delta_{min} = 20.5^{\circ}$

Therefore, the geocomposite drain must provide a minimum interface friction with the adjacent geomembrane and soil layers of 20.5° and a minimum transmissivity under service conditions of 3.1×10^{-3} m^3/sec-m.

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Appendix: A Sample Specification for Geocomposite Drainage Layer

Property	Test Method	Unit	Value
GEONET			
Tensile Strength – Machine Direction	ASTM D4595	(lb/ft)/ (kN/m)	[_____]
Compressive Behavior, Retained Thickness			
under [_____](psf)/(kPa)	ASTM D1621	(%)	[_____]
under [_____](psf)/(kPa) after 10,000 hours	GRI-GN1	(%)	[_____]
Resin Density	ASTM D1505	(g/cm^3)	[_____]
Maximum Resin Melt Index	ASTM D1238	(g/10 min)	[_____]
Carbon Black Content	ASTM D4218	(%)	[_____]
Thickness	ASTM D5199	(mils)/ (mm)	[_____]
GEOTEXTILE			
Apparent Opening Size (AOS)	ASTM D4751	(US Sieve)/(mm)	[_____]
Weight	ASTM D3776	(oz/yd^2)/(g/m^2)	[_____]
Water Flow Rate	ASTM D4491	($gal/min/ft^2$)/ (lpm/m^2)	[_____]
Permeability	ASTM D4491	(cm/sec)	[_____]
Puncture Strength	ASTM D4833	(lbs)/ (N)	[_____]
Trapezoid Tear	ASTM D4533	(lbs)/ (N)	[_____]
Grab Tensile Strength	ASTM D4632	(lbs)/ (N)	[_____]
Grab Elongation	ASTM D4632	(%)	[_____]
Mullen Burst	ASTM D3786	(psi)/ (kPa)	[_____]
UV Resistance @500 Hours	ASTM D4355	(%)	[_____]
GEOCOMPOSITE			
Ply Adhesion	ASTM D413	(lb/in)/ (N/m)	[_____]
Friction Angle	ASTM D5321	(Degrees)	[_____]
Transmissivity ASTM D 4716-95	ASTM D4716-95	($gal/min/ft$)/(m^3/sec-m)	[_____]

NOTES:

1. Geonet and Geotextile properties listed are prior to lamination.

2. The contractor shall perform laboratory interface friction tests on Geocomposite/[_____], and Geocomposite/[_____] interfaces in accordance with ASTM D5321. Normal stresses of [___], [____], and [____] (psf)/(kPa) along with a displacement rate of [____] (inches/min)/ (mm/min) shall be used. Geotextile shall be attached to the geonet in the same configuration as will be used in the field. All tested interfaces shall exhibit the listed minimum required interface friction angle. A minimum of [___] tests shall be performed and the results are submitted and approved prior to delivery of any geocomposite material.

3. Geocomposite transmissivity shall be measured using water at 68 degrees F with a gradient of [___] under a normal pressure of [_____] (psf)/(kPa). Geotextiles shall be attached to the geonet in the same configuration as will be used in the field for transmissivity testing. The drainage geonet shall sandwiched between [_____] on the bottom and [_____] on the top. A minimum seating period of [_____] hours shall be used. Geocomposite transmissivity is measured every [_____] (square feet)/(square meter) of product.

OHIO STATE UNIVERSITY COLLEGE OF BIOLOGICAL SCIENCES MSDS FILE

3M -- 3M SUPER 77 SPRAY ADHESIVE - ADHESIVE, AEROSOL MATERIAL SAFETY DATA SHEET FSC: 8040 NIIN: 009386860 Manufacturer's CAGE: 76381 Part No. Indicator: A Part Number/Trade Name: 3M SUPER 77 SPRAY ADHESIVE

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General Information

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Item Name: ADHESIVE, AEROSOL Company's Name: 3M COMPANY Company's Street: 3M CTR Company's City: ST. PAUL Company's State: MN Company's Country: US Company's Zip Code: 55144-1000 Company's Emerg Ph #: 612-733-1110 Company's Info Ph #: 612-733-1110 Distributor/Vendor # 1: STEVEN INDUSTRIES Distributor/Vendor # 1 Cage: 33150 Record No. For Safety Entry: 012 Tot Safety Entries This Stk#: 013 Status: SH Date MSDS Prepared: 01JAN87 Safety Data Review Date: 11AUG93 Supply Item Manager: GSA MSDS Serial Number: BRNQQ Specification Number: MMM-A-1058 Hazard Characteristic Code: N/ Unit Of Issue: CN Unit Of Issue Container Qty: 24 OZ CN Type Of Container: METAL

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Ingredients/Identity Information

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Proprietary: NO Ingredient: HEXANE (N-HEXANE) Ingredient Sequence Number: 01 Percent: 10-20 NIOSH (RTECS) Number: MN9275000 CAS Number: 110-54-3 OSHA PEL: 500 PPM ACGIH TLV: 50 PPM; 9293 Other Recommended Limit: NONE SPECIFIED ---------- Proprietary: NO Ingredient: HEXANE (OTHER ISOMERS) Ingredient Sequence Number: 02 Percent: 10-20 NIOSH (RTECS) Number: 1002929HI OSHA PEL: NOT ESTABLISHED ACGIH TLV: NOT ESTABLISHED Other Recommended Limit: NONE SPECIFIED ---------- Proprietary: NO Ingredient: CYCLOHEXANE (SARA III) Ingredient Sequence Number: 03 Percent: 10-20 NIOSH (RTECS) Number: GU6300000 CAS Number: 110-82-7 OSHA PEL: NOT ESTABLISHED ACGIH TLV: 300 PPM Other Recommended Limit: NONE SPECIFIED ---------- Proprietary: NO Ingredient: PROPANE Ingredient Sequence Number: 04 Percent: 10-20 NIOSH (RTECS) Number: TX2275000 CAS Number: 74-98-6 OSHA PEL: 1000 PPM ACGIH TLV: NOT ESTABLISHED Other Recommended Limit: NONE SPECIFIED ---------- Proprietary: NO Ingredient: ISOBUTANE Ingredient Sequence Number: 05 Percent: 10-20 NIOSH (RTECS) Number: TZ4300000 CAS Number: 75-28-5 OSHA PEL: NOT ESTABLISHED ACGIH TLV: NOT ESTABLISHED Other Recommended Limit: NONE SPECIFIED ---------- Proprietary: NO Ingredient: DIMETHYL ETHER Ingredient Sequence Number: 06 Percent: 10-20 NIOSH (RTECS) Number: PM4780000 CAS Number: 115-10-6 OSHA PEL: NOT ESTABLISHED ACGIH TLV: NOT ESTABLISHED Other Recommended Limit: CMRG: 1000 PPM ---------- Proprietary: NO Ingredient: NON-VOLATILE COMPONENTS - N.J. TRADE SECRET REGISTRY #04499600-5452P (RESIN, SYNTHETIC POLYMER, RESIN, ANTIOXIDANT) Ingredient Sequence Number: 07 Percent: 1-30 NIOSH (RTECS) Number: 1004255PI OSHA PEL: NOT ESTABLISHED ACGIH TLV: NOT ESTABLISHED Other Recommended Limit: NONE SPECIFIED ---------- Proprietary: NO Ingredient: MAXIMUM VOC: 525.00 GRAMS/LITER. MAXIMUM VOC MINUS WATER MINUS EXEMPT SOLVENTS: 525 GRAMS/LITER. Ingredient Sequence Number: 08 NIOSH (RTECS) Number: 9999999VO Other Recommended Limit: NONE SPECIFIED

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Physical/Chemical Characteristics

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Appearance And Odor: LIGHT CREAM COLORED, LIQUID IN AEROSOL, SWEET/FRUITY ODOR. Boiling Point: CMPRSSD GAS Vapor Pressure (MM Hg/70 F): CMPRSD GAS Vapor

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FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT TAMPA

Density (Air=1): 2.97 Specific Gravity: 0.702 (WATER=1) Evaporation Rate And Ref: 1.90 (ETHER=1) Solubility In Water: NIL Percent Volatiles By Volume: 75.00 Viscosity: N/A pH: N/A

Fire and Explosion Hazard Data

Flash Point: NR Extinguishing Media: COW, FOAM, DRY CHEMICAL Special Fire Fighting Proc: FIRE FIGHTERS SHOULD BE EQUIPPED WITH SELF- CONTAINED BREATHING APPARATUS WHEN FIGHTING FIRES INVOLVING THIS MATERIAL. Unusual Fire And Expl Hazrds: EXTREMELY FLAMMABLE. (TREAT AS FLAMMABLE PRESSURIZED CONTAINER). OVERHEATED, CLOSED CONTAINER ADJACENT TO FIRE COULD EXPLODE DUE TO PRESSURE BUILDUP.

Reactivity Data

Stability: YES Cond To Avoid (Stability): DO NOT STORE AT TEMPERATURES ABOVE 120F. DO NOT PUNCTURE OR INCINERATE CONTAINER. Materials To Avoid: N/A Hazardous Decomp Products: CO, CO2, AND SMOKE PARTICLES WHEN SUBJECTED TO EXCESSIVE HEAT OR FLAME. Hazardous Poly Occur: NO Conditions To Avoid (Poly): DO NOT STORE AT TEMPERATURES ABOVE 120F. DO NOT PUNCTURE OR INCINERATE CONTAINER.

Health Hazard Data

Route Of Entry - Inhalation: YES Route Of Entry - Skin: YES Health Haz Acute And Chronic: ACUTE:EYE:IRRIT.SKIN:ABSORBED THRU SKIN IN HARMFUL AMOUNTS.INHAL:RESP SYSTEM IRRIT,TEMP NERVOUS SYSTEM IMPAIRMENT (LIGHT-HEADED,WEAKNESS,DIZZINESS,HEADACHE,NAUSEA,FACIAL NUMNESS).PERIPHERAL NERVE DAMAGE.ASPHYXIATION & DEATH.INGEST:UNLIKELY FROM AEROSOL CONTAINER. DIGESTIVE SYS IRRIT(NAUSEA,DIARRHEA,VOMIT).ASPIRATN HZD. Signs/Symptoms Of Overexp: CHRONIC: SKIN: PROLONGED AND REPEATED SKIN CONTACT MAY DEFAT SKIN LEADING TO IRRITATION AND DERMATITIS. Emergency/First Aid Proc: EYE: IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT LEAST 10 MINUTES. CALL A PHYSICIAN. SKIN: WASH AFFECTED AREA WITH SOAP AND WATER. INHALATION: MOVE TO UNCONTAMINATED AIR. CALL A PHYSICIAN. IF SWALLOWED: DO NOT INDUCE VOMITING. CALL A PHYSICIAN IMMEDIATELY.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: IF CANS RUPTURE. EXTINGUISH ALL IGNITION SOURCES. VENT AREA. OBSERVE PRECAUTIONS FROM OTHER SECTIONS. CONTAIN SPILL. COVER WITH ABSORBENT MATERIALS AS NEEDED. COLLECT SPILLED MATERIAL. PLACE IN DOT APPROVED METAL CONTAINER, AND SEAL Waste Disposal Method: INCINERATE ABSORBED & PARTIALLY FULL CANS AFTER MIX W/FLAMMABLE MATERIAL IN PERMITTED HAZRDOUS WASTE FACILITY. DO NOT PUNCTURE/BURN CANS IN HOUSEHOLD INCINERATOR. DISPOSE OF EMPTY CANS IN SANITARY LANDFILL. DISPOSE IN ACCORD W/REGS. D001 (IGNITABLE). Precautions-Handling/Storing: FOR INDUSTRIAL USE ONLY. KEEP AWAY FROM HEAT/IGNITION SOURCES. AVOID PROLONGED BREATHING VAPORS. KEEP OUT OF REACH OF CHILDREN. DON'T TAKE INTERNALLY. Other Precautions: USE VENT TO KEEP CONC BELOW PEL/TLV.DON'T USE IN CONFINED AREAS/AREA W/LITTLE AIR MOVEMENT.USE LOCAL EXHAUST VENT IF LRG QTY SPRAYED IN SHORT TIME. PREVENT EYE & SKIN CONTACT.DONT STORE >120F.DON'T PUNCTURE/BURN CNTNR IN HOUSEHOLD INCINRTR.

Control Measures

Ventilation: LOCAL EXHAUST VENTILATION SHOULD BE USED IF LARGE QUANTITIES ARE SPRAYED IN A SHORT PERIOD OF TIME. Protective Gloves: WEAR IMPERVIOUS GLOVES. Eye Protection: WEAR SAFETY GLASSES.

ansportation Data

Trans Data Review Date: 93223 DOT PSN Code: DTJ DOT Symbol: D DOT Proper Shipping Name: CONSUMER COMMODITY DOT Class: ORM-D DOT Label: NONE IMO PSN Code: AKH IMO Proper Shipping Name: AEROSOLS/AEROSOL PRODUCT * IMO Regulations Page Number: SEE 9022 IMO UN Number: 1950 IMO UN Class: 9 * IMO Subsidiary Risk Label: - * IATA PSN Code: ALS IATA UN ID Number: 1950 IATA Proper Shipping Name: AEROSOLS, FLAMMABLE, N.O.S. IATA UN Class: 2.1 IATA Label: FLAMMABLE GAS AFI PSN Code: ALS AFI Class: FORB * AFI Basic Pac Ref: FORBIDDEN MMAC Code: NK

Disposal Data

Label Data

Label Required: YES Label Status: G Common Name: 3M SUPER 77 SPRAY ADHESIVE Special Hazard Precautions: ACUTE:EYE:IRRIT.SKIN:ABSORBED THRU SKIN IN HARMFUL AMOUNTS.INHAL:RESP SYSTEM IRRIT,TEMP NERVOUS SYSTEM IMPAIRMENT (LIGHT-HEADED,WEAKNESS,DIZZINESS,HEADACHE,NAUSEA,FACIAL NUMNESS).PERIPHERAL NERVE DAMAGE.ASPHYXIATION & DEATH.INGEST:UNLIKELY FROM AEROSOL CONTAINER. PROLONGED AND REPEATED SKIN CONTACT MAY DEFAT SKIN LEADING TO IRRITATION AND DERMATITIS. Label Name: 3M COMPANY Label Street: 3M CTR Label City: ST. PAUL Label State: MN Label Zip Code: 55144-1000 Label Country: US Label Emergency Number: 2-733-1110

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Dept. of Environmental Protection

U.S. SILICA
Sands of Time

APR 07 2006
Southwest District

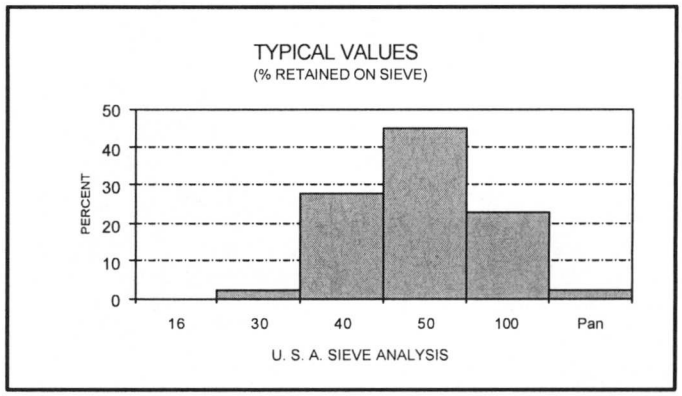
PRODUCT DATA

ASTM (1) GRADED SAND

UNGROUND SILICA

PLANT: OTTAWA, ILLINOIS

(1) AMERICAN FOUNDRYMEN'S SOCIETY



USA STD SIEVE SIZE		TYPICAL VALUES		
		% RETAINED		% PASSING
MESH	MILLIMETERS	INDIVIDUAL	CUMULATIVE	CUMULATIVE
16	1.180	0.0	0.0	100.0
30	0.600	2.0	2.0	98.0
40	0.425	28.0	30.0	70.0
50	0.300	45.0	75.0	25.0
100	0.150	23.0	98.0	2.0
PAN		2.0	100.0	0.0

TYPICAL PROPERTIES

COLOR ..... WHITE
GRAIN SHAPE ..... ROUND
HARDNESS (Mohs) 7
MELTING POINT (Degrees F) 3100
MINERAL ..... QUARTZ
pH 7
SPECIFIC GRAVITY 2.65

TYPICAL CHEMICAL ANALYSIS, %

SiO_2 (Silicon Dioxide) 99.7
Fe_2O_3 (Iron Oxide) 0.020
Al_2O_3 (Aluminum Oxide) 0.06
TiO_2 (Titanium Dioxide) 0.01
CaO (Calcium Oxide) ..... <0.01
MgO (Magnesium Oxide) ..... <0.01
Na_2O (Sodium Oxide) ..... <0.01
K_2O (Potassium Oxide) ..... <0.01
LOI (Loss On Ignition) 0.1

CONFORMS TO ASTM C778

December 15, 1997

<u>DISCLAIMER</u>: The information set forth in this Product Data Sheet represents typical properties of the product described; the information and the typical values are not specifications. U.S. Silica Company makes no representation or warranty concerning the Products, expressed or implied, by this Product Data Sheet.

<u>WARNING</u>: The product contains crystalline silica - quartz, which can cause silicosis (an occupational lung disease) and lung cancer. **For detailed information on the potential health effect of crystalline silica - quartz, see the U.S. Silica Company Material Safety Data Sheet.**

U.S. Silica Company **P.O. Box 187, Berkeley Springs, WV 25411-0187** **(304) 258-2500**

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT
TAMPA

Geosynthetic Research Institute
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Dept. of Environmental Protection
APR 17 2006
Southwest District

Original: April 17, 2001

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT TAMPA

GRI Standard – GC8

Standard Guide for

Determination of the Allowable Flow Rate of a Drainage Geocomposite

1. Scope

1.1 This guide presents a methodology for determining the allowable flow rate of a candidate drainage geocomposite. The resulting value can be used directly in a hydraulics-related design to arrive at a site-specific factor of safety.

1.2 The procedure is to first determine the candidate drainage composite's flow rate for 100-hours under site-specific conditions, and then modify this value by means of creep reduction and clogging reduction factors.

1.3 For aggressive liquids, a "go-no go" chemical resistance procedure is suggested. This is a product-specific verification test for both drainage core and geotextile covering.

1.4 The type of drainage geocomposites under consideration necessarily consists of a drainage core whose purpose it is to convey liquid within its manufactured plane. The drainage core can be a geonet, 3-D mesh, built-up columns, single or double cuspations, etc.

1.5 The drainage core usually consists of a geotextile on its upper and/or lower surface. In some cases, the drainage core is used by itself. The guide addresses all of these variations.

1.6 The guide is also applicable to thick nonwoven geotextiles when they are utilized for their drainage capability.

1.7 All types of polymers are under consideration in this guide.

1.8 The guide does not address the required (or design) flow rate to which a comparison is made for the final factor of safety value. This is clearly a site-specific issue.

2. Referenced Documents

2.1 ASTM Standards
D1987 – "Test Method for Biological Clogging of Geotextile or Soil/Geotextile Filters"
D2240 – "The Method for Rubber Property – Durometer Hardness"
D4716 – "Test Method for Constant Head Hydraulic Transmissivity (In Plane Flow) of Geotextiles and Geotextile Related Products"

D5322 – "Standard Practice for Immersion Procedures for Evaluating the Chemical Resistance of Geosynthetics to Liquids"
D6364 – "Test Method for Determining the Short-Term Compression Behavior of Geosynthetics"
D6388 – "Standard Practice for Tests to Evaluate the Chemical Resistance of Geonets to Liquids"
D6389 – "Standard Practice for Tests to Evaluate the Chemical Resistance of Geotextiles to Liquids"

2.2 GRI Standards
GS 4 Test Method for Time Dependent (Creep) Deformation Under Normal Pressure

2.3 Literature
Giroud, J.-P., Zhao, A. and Richardson, G. N. (2000), "Effect of Thickness Reduction on Geosynthetic Hydraulic Transmissivity," Geosynthetics International, Vol. 7, Nos. 4-6, pp. 433-452.
Koerner, R. M. (1998), Designing with Geosynthetics, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 761 pgs.

3. Summary of Guide

3.1 This guide presents the necessary procedure to be used in obtaining an allowable flow rate of a candidate drainage geocomposite. The resulting value is then compared to a required (or design) flow rate for a product-specific and site-specific factor of safety. The guide does not address the required (or design) flow rate value, nor the subsequent factor of safety value.
3.2 The procedures recommended in this guide use either ASTM or GRI test methods.
3.3 The guide is applicable to all types of drainage geocomposites regardless of their core configuration or geotextile type. It can also be used to evaluate thick nonwoven geotextiles.

4. Significance and Use

4.1 The guide is meant to establish uniform test methods and procedures in order for a designer to determine the allowable flow rate of a candidate drainage geocomposite for site-specific conditions.
4.2 The guide requires communication between the designer, testing organization and manufacturer in setting site-specific control variables such as product orientation, stress level, stress duration, type of permeating liquid and materials below/above the geocomposite test specimen.
4.3 The guide is useful to testing laboratories in that a prescribed guide is at hand to provide appropriate data for both designer and manufacturer clients.

5. Structure of the Guide

5.1 Basic Formulation – This guide is focused on determination of a "q_{allow}" value using the following formula:

$$q_{allow} = q_{100}\left[\frac{1}{RF_{CR} \times RF_{CC} \times RF_{BC}}\right] \quad (1)$$

where

q_{allow} = allowable flow rate
q_{100} = initial flow rate determined under simulated conditions for 100-hour duration
RF_{CR} = reduction factor for creep to account for long-term behavior
RF_{CC} = reduction factor for chemical clogging
RF_{BC} = reduction factor for biological clogging

Note 1: By simulating site-specific conditions (except for load duration beyond 100 hours and chemical/biological clogging), additional reduction factors such as intrusion need not be explicitly accounted for.

Note 2: The value of q_{allow} is typically used to determine the product-specific and site-specific flow rate factor of safety as follows:

$$FS = \frac{q_{allow}}{q_{reqd}} \quad (2)$$

The value of "q_{reqd}" is a design issue and is not addressed in this guide. Likewise, the numeric value of the factor-of-safety is not addressed in this guide. Suffice it to say that, depending on the duration and criticality of the situation, FS-values should be conservative unless experience allows otherwise.

5.2 Upon selecting the candidate drainage geocomposite product, one must obtain the 100-hour duration flow rate according to the ASTM D4716 transmissivity test. This establishes the base value to which drainage core creep beyond 100-hours and clogging from chemicals and biological matter must be accounted for.

Note 3: It is recognized that the default duration listed in ASTM D4716 is 15-minutes. This guide purposely requires that the test conditions be maintained for 100-hours.

5.3 Reduction Factor for Creep – This is a long-term (typically 10,000 hours) compressive load test focused on the stability and/or deformation of the drainage core without the covering geotextiles. Stress orientation can be perpendicular or at an angle to the test specimen depending upon site-specific conditions.

5.4 Chemical and/or Biological Clogging – The issue of long term reduction factors to account for clogging within the core space is a site-specific issue. The issue is essentially impractical to simulate in the laboratory, hence a table is provided for consideration by the designer.

5.5 Chemical Resistance/Durability – This procedure results in a "go-no go" decision as to potential chemical reactions between the permeating liquid and the polymers comprising the drainage core and geotextiles. The issue will be addressed in this guide but is not a reduction factor, per se.

6. Determination of the Base Line Flow Rate (q_{100})

6.1 Using the ASTM D4716 transmissivity test with the conditions stated below (unless otherwise agreed upon by the parties involved), determine the 100-hour flow rate of the drainage geocomposite under consideration.

6.1.1 The test specimen shall be the entire geocomposite. If geotextiles are bonded to the drainage core, they shall not be removed and the entire geocomposite shall be tested as a unit. A minimum of three replicate samples in the site-specific orientation shall be tested and the results averaged for the reported value.

6.1.2 Specimen size shall be 300 × 300 mm (12 × 12 in.) within the stressed area.

6.1.3 The specimen orientation is to be agreed upon by the designer, testing laboratory and manufacturer. In this regard, it should be recognized that the specimen orientation during testing has to match the proposed installation orientation. Thus the site-specific design governs both the testing orientation and subsequent field installation orientation.

6.1.4 Specimen substratum shall be one of the following four options. The decision of which is made by the project designer, testing organization and manufacturer. The options are (i) rigid platen, (ii) foam, (iii) sand or (iv) site-specific soil or other material.

6.1.4.1 If a rigid platen is used the choices are usually wood, plastic or metal. The testing laboratory must identify the specifics of the material used.

6.1.4.2 If closed cell foam is used, it shall be 12 mm (0.5 in.) thick and a maximum durometer of 2.0 as measured in ASTM D2240, Type D.

6.1.4.3 If sand is used it shall be Ottawa test sand at a relative density of 85%, water content of 10% and compacted thickness of 25 mm (1.0 in.).

6.1.4.4 If site-specific soil or other material is used it must be carefully considered and agreed upon between the parties involved. Size, gradation, moisture content, density, etc., are all important considerations.

6.1.5 Specimen superstratum shall also be one of the four same options as mentioned in § 6.1.3 above. It need not be the same as the substratum.

6.1.6 The applied stress level is at the discretion of the designer, testing organization and manufacturer. Unless stated otherwise, the orientation shall be normal to the test specimen.

6.1.7 The duration of the loading shall be for 100 hours. A single site-specific data point is obtained at that time, i.e., it is not necessary to perform intermediate flow rate testing, unless otherwise specified by the various parties involved.

6.1.8 The hydraulic gradient at which the above data point is taken (or a range of hydraulic gradients) is at the discretion of the designer, testing organization and manufacturer.

6.1.9 The permeating liquid is to be tap water, unless agreed upon otherwise by the designer, testing organization, and manufacturer.

6.1.10 Calculations

$$Q = kiA \tag{3}$$

$$Q = ki(Wt)$$

$$Q/W = \theta i \tag{4}$$

$$q = \theta i \tag{5}$$

where

Q = flow rate per unit time (m^3/sec)
k = permeability (m/sec)
i = hydraulic gradient (= H/L)
H = head loss across specimen (m)
L = length of specimen (m)
A = cross sectional area of specimen (m^2)
W = width of specimen (m)
t = thickness of specimen (m)
θ = transmissivity (m^3/sec-m or m^2/sec)
q = flow rate per unit width (m^2/sec)

The results can be presented as flow rate per unit width (Q/W), or as transmissivity (θ), as agreed upon by the parties involved.

7. Reduction Factor for Creep

7.1 Using the GRI GS4 test method or ASTM D6364 (mod.) for time dependent (creep) deformation, the candidate drainage core is placed under compressive stress and its decrease in thickness (deformation) is monitored over time.

> Note 4: This is not a flow rate test, although the test specimen can be immersed in a liquid to be agreed upon by the designer, testing organization, and manufacturer. However, it is usually a test conducted without liquid.

7.1.1 The test specimen shall be the drainage core only. If geotextiles are bonded to the drainage core they should be carefully removed. Alternatively, a sample of the drainage core can be obtained from the manufacturer before the geotextiles are attached. A minimum of three replicate tests shall be performed and the results averaged for the reported value.

7.1.2 Specimen size should be 150 × 150 mm (6.0 × 6.0 in.) and placed in a rigid box made from a steel base and sides. The steel load plate above the test specimen shall be used to transmit a constant stress over time. Deformation of the upper plate is measured by at least two dial gauges and the results averaged accordingly.

Note 5: For high stress conditions requiring a large size and number of weights with respect to laboratory testing and safety, the specimen size can be reduced to 100 × 100 mm (4.0 × 4.0 in.).

7.1.3 Specimen substratum and superstratum shall be rigid platens. Alternatively, a 1.5 mm (60 mil) thick HDPE geomembrane can be placed against the drainage core with the steel plates as back-ups.

7.1.4 The test specimen shall be dry unless water or a simulated or site-specific leachate is agreed upon by the parties involved.

7.1.5 The normal stress magnitude(s) shall be the same as applied in the transmissivity test described in Section 6.0. Alternatively, it can be as agreed upon by the designer, testing organization, and manufacturer.

7.1.6 The load inclination shall be normal to the test specimen. If there exists a tendency for the core structure to deform laterally, separate tests at the agreed upon load inclinations shall also be performed at the discretion of the parties involved.

7.1.7 The dwell time shall be 10,000 hours. If, however, this is a confirmation test (or if a substantial data base exists on similar products of the same type), the dwell time can be reduced to 1000 hours. This decision must be made with agreement between the designer, testing organization, and manufacturer.

Note 6: Alternative procedures to arrive at an acceptable value for the creep reduction factor based on shorter test times (e.g., the use of time-temperature superposition or stepped isothermal method) may be acceptable if agreed upon by the various parties involved.

7.1.8 The above process results in a set of creep curves similar to Figure 1(a). The curves are to be interpreted as shown in Figure 1(b). The reduction factor for creep of the core is interpreted according to the following formulas, after Giroud, Zhao and Richardson (2000).

$$RF_{CR} = \left[\frac{\left(t_{CO} / t_{original}\right) - \left(1 - n_{original}\right)}{\left(t_{CR} / t_{original}\right) - \left(1 - n_{original}\right)} \right]^3 \qquad (6)$$

where

RF_{CR} = reduction factor for creep
$t_{original}$ = original thickness (m)
t_{CO} = thickness at 100-hours (m)
t_{CR} = thickness at >>100-hours, e.g., at 10,000 hours (m)
$n_{original}$ = original porosity (see Equation 7)

$$n_{original} = 1 - \frac{\mu}{\rho t_{original}} \tag{7}$$

where

μ = mass per unit area (kg/m^2)
ρ = density of the formulation (kg/m^3)

7.1.9 The above illustrated numeric procedure is not applicable to drainage geocomposites which include geotextiles. It is for the drainage core only.

Example: A HDPE geonet has the following properties: mass per unit area μ = 1216 g/m^2 (or 1.216 kg/m^2); density ρ = 950 kg/m^2 and original thickness of 8.55 mm.

Test specimens were evaluated according to ASTM D4716 for 100 hours and the average thickness decreased to 7.14 mm. A 10,000 hour creep test was then performed on a representative specimen according to GRI-GS4 and the resulting thickness further decreased to 6.30 mm. Thus Δy in Figure 1(b) is 7.14 – 6.30 = 0.84 mm. Determine the creep reduction factor "RF_{CR}".

Solution: The porosity n, is calculated according to Eq. (7) as follows

$$n_{original} = 1 - \frac{\mu}{\rho t_{original}}$$
$$= 1 - \frac{1.216}{(950)(0.00855)}$$
$$= 1 - 0.150$$
$$n_{original} = 0.850$$

The reduction factor for creep is calculated according to Eq. (6) as follows:

$$RF_{CR} = \left[\frac{(t_{CO} / t_{original}) - (1 - n_{original})}{(t_{CR} / t_{original}) - (1 - n_{original})}\right]^3$$

$$= \left[\frac{(7.14 / 8.55) - (1 - 0.850)}{(6.30 / 8.55) - (1 - 0.850)}\right]^3$$

$$= \left[\frac{0.835 - 0.150}{0.737 - 0.150}\right]^3$$

$$= \left[\frac{0.685}{0.587}\right]^3$$

$$RF_{CR} = 1.59$$

Note 7: Other calculation methods to arrive at the above numeric value of creep reduction factor may be considered if agreed upon by the various parties involved.

8. Reduction Factors for Core Clogging

There are two general types of core clogging that might occur over a long time period. They are chemical clogging and biological clogging. Both are site-specific and both are essentially impractical to simulate in the laboratory.

8.1 Chemical clogging within the drainage core space can occur with precipitates deposited from high alkalinity soils, typically calcium and magnesium. Other precipitates can also be envisioned such as fines from turbid liquids although this is less likely since the turbid liquid must typically pass through a geotextile filter. It is obviously a site-specific situation.

8.2 Biological clogging within the drainage core space can occur by the growth of biological organisms or by roots growing through the overlying soil and extending downward, through the geotextile filter, and into the drainage core. It is a site-specific situation and depends on the local, or anticipated, vegetation, cover soil, hydrology, etc.

8.3 Default tables for the above two potential clogging mechanisms (chemical and biological) are very subjective and by necessity broad in their upper and lower limits. The following table is offered as a guide.

Range of Clogging Reduction Factors (modified from Koerner, 1998)

Application	Chemical Clogging (RF_{CC})	Biological Clogging (RF_{BC})
Sport fields	1.0 to 1.2	1.1 to 1.3
Capillary breaks	1.0 to 1.2	1.1 to 1.3
Roof and plaza decks	1.0 to 1.2	1.1 to 1.3
Retaining walls, seeping rock and soil slopes	1.1 to 1.5	1.0 to 1.2
Drainage blankets	1.0 to 1.2	1.0 to 1.2
Landfill caps	1.0 to 1.2	1.2 to 3.5
Landfill leak detection	1.1 to 1.5	1.1 to 1.3
Landfill leachate collection	1.5 to 2.0	1.1 to 1.3

9. Polymer Degradation

9.1 Degradation of the materials from which the drainage geocomposite are made, with respect to the site-specific liquid being transmitted, is a polymer issue. Most geocomposite drainage cores are made from polyethylene, polypropylene, polyamide or polystyrene. Most geotextile filter/separators covering the drainage cores are made from polypropylene, polyester or polyethylene.

> Note 8: It is completely inappropriate to strip the factory bonded geotextile off of the drainage core and then test one or the other component. The properties of both the geotextile and drainage core will be altered in the lamination process from their original values.

9.2 If polymer degradation testing is recommended, the drainage core and the geotextile should be tested separately in their as-received condition before lamination and bonding.

9.3 The incubation of the drainage cores and/or geotextile coupons is to be done according to the ASTM D5322 immersion procedure.

9.4 The testing of the incubated drainage cores is to be done according to ASTM D6388 which stipulates various test methods for evaluation of incubated geonets.

> Note 9: For drainage cores other than geonets, e.g., columnar, cuspated, meshes, etc., it may be necessary to conduct additional tests than appear in ASTM D6388. These tests, and their procedures, should be discussed and agreed upon by the project designer, testing organization, and manufacturer.

9.5 The testing of the incubated geotextiles is to be done according to ASTM D6389 which stipulates various test methods for evaluation of incubated geotextiles.

> Note 10: The information obtained in testing the drainage core (Section 9.4) and the geotextile (Section 9.5) result in a "go-no go" situation and not in a reduction factor, per se. If an adverse chemical reaction is indicated, one must select a different type of geocomposite material (drainage core and/or geotextile).

10. Summary

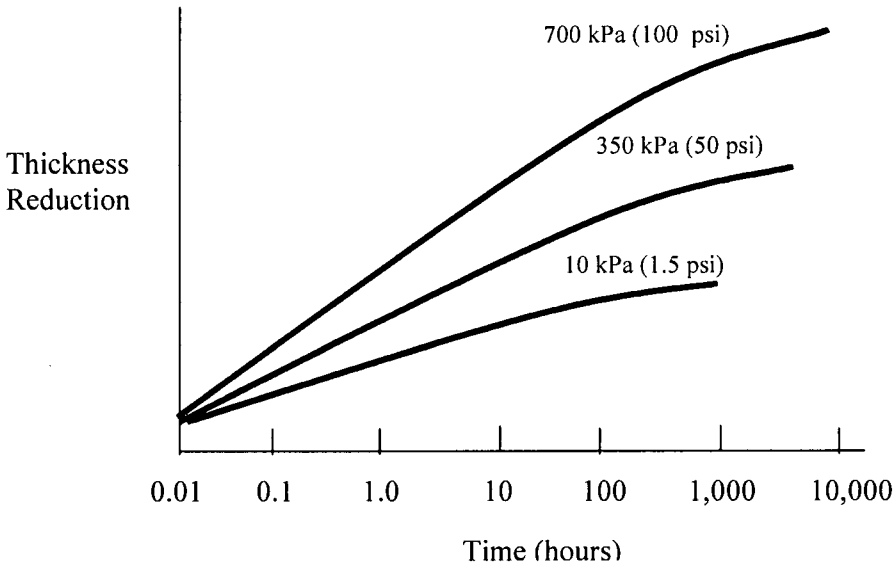
10.1 For a candidate drainage geocomposite, the 100-hour flow rate behavior under the site-specific set of variables, e.g., specimen orientation, stress level, hydraulic gradient, and permeating liquid is to be obtained per ASTM D4716 following procedures of Section 6.0.

10.2 A reduction factor for long term creep of the drainage core following Section 7.0 per GRI GS4 or ASTM D6364 (mod.) is then obtained. The result is usually a unique value for a given set of conditions.

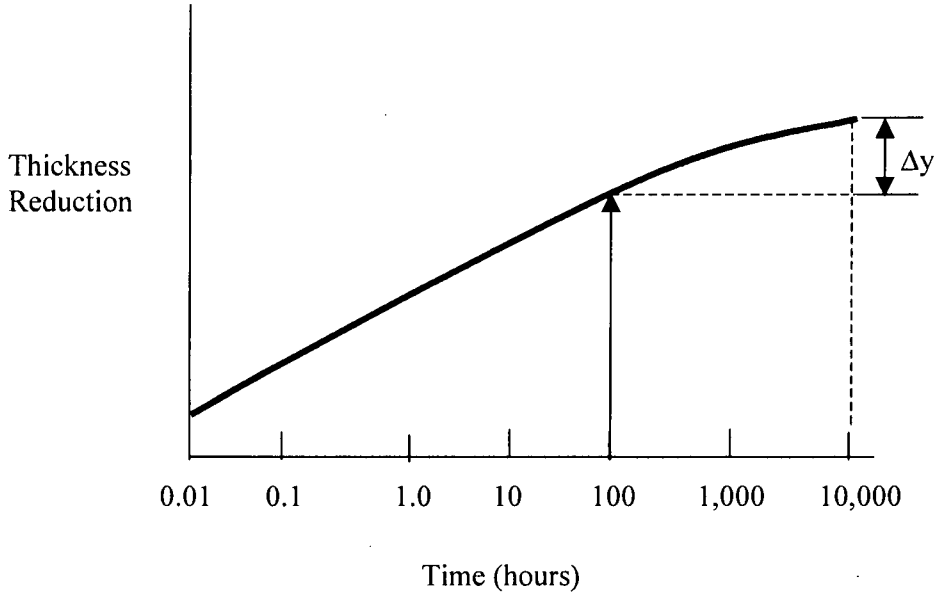
10.3 A reduction factor for chemical and/or biological clogging, as discussed in Section 8.0 can be included. It is very much a site-specific situation at the discretion of the parties involved.

10.4 Polymer degradation to aggressive liquids is covered in separate immersion and test protocols, e.g., ASTM D5322 (immersion), ASTM D6388 (geonets) and ASTM D6389 (geotextiles) as discussed in Section 9.0. The procedure does not result in a reduction factor, rather in a "go-no go" decision with the product under consideration.

10.5 Other possible flow rate reductions and/or concerns such as flow in overlap regions, effect of high or low temperatures, etc., are site-specific and cannot readily be generalized in a guide such as this.



(a) Hypothetical data from creep testing illustrating effect of normal load magnitude



(b) Interpretation of project specific normal load curve to obtain creep reduction factor

Figure 1 – Hypothetical example of creep test data and data interpretation to obtain creep reduction factor

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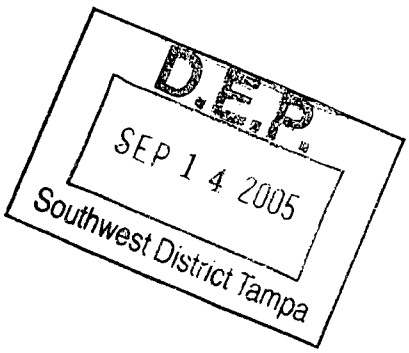

Susan J. Pelz, P.E.
Solid Waste Manager
Southwest District
3804 Coconut Palm Drive
Tampa, Florida 33619

Re: Lena Road Landfill, Manatee County
Pending Permit No.: 39884-011-SF/01, Closure
Response 1 to FDEP Letter Dated June 23, 2005

Dear Ms Pelz:

This letter is in response to your request for additional information regarding the above referenced permit application. Your requests are typed in italics followed by our responses in normal type. Four copies of this response with each revision, replacement, or additional new information are included.

Comment: 1. ***Application form****. [Rule 62-701.320(7)(b), F.A.C.]*
a. Item #A.5. Please provide a revised application form that references DEP Id# SWD-41-44795.

Response: Form was revised to reference DEP ID# SWD-41-44795.

Comment: 1. b. Item B.18. Please provide a revised application form that references 18 monitoring wells as indicated in the current Operation permit.

Response: Item B.18 was revised to indicate 18 monitoring wells.

Comment: 2. ***Part P, Rule 62-701.600, F.A.C.***
a. Gas migration report and report on effectiveness of the landfill design. (Rules 62-701.600(4) (d) and (e), F.A.C.)

Comment: 2. a. 1. Please provide a summary of exceedances in the gas migration monitoring system (including subsurface monitoring probes and onsite structures) and a report evaluating the effectiveness of the landfill design to prevent gas migration.

Response: Included with this response is a table entitled: "Manatee County Lena Road Landfill – Summary of Readings for Subsurface Monitoring Probes and Onsite Structures – From December 2001 through June 2005." The table summarizes the gas readings in percent of lower explosive limit (LEL)

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recorded at each probe or on-site structure. The only exceedances are at Probe 11A, which was a replacement for Probe 11 removed during the construction of the new landfill entrance road and scale house. Probe 11A exceeded 100% LEL right after installation. This was surprising since Probe 11 had no exceedances. Also, Probe 11A is north of the Stage III landfill, which was inactive when Probe 11A was installed. Probes 11B and 11C were installed to check the path of methane gas migration toward the property line. These probes have no exceedances. It is believed that Probe 11A was installed in an area where Manatee County placed shredded yard waste to stabilize a haul road, and it is this decaying yard waste that is generating the methane. Between the Stage III Landfill and Probe 11A is the slurry wall and a storm water retention area usually filled with water. These two natural barriers make the Stage III Landfill an unlikely source of methane detected in Probe 11A. Since there are no other exceedences in the probes or points measured in on-site structures, and we are unaware of any odor complaints, the landfill design and operation is effective in preventing gas migration offsite beyond the landfill property boundaries. The expansion of the Stage I Landfill gas recovery system, anticipated as part of this closure permit, will increase the effectiveness of the landfill gas collection system.

Comment: 2. a. 2. Please provide a discussion of the effectiveness of the active gas extraction system. Please include the date it was installed, a description of any problems encountered and corrective actions taken, and any other information that demonstrates that the system is working as designed.

Response: The Stage I Lena Road Landfill Gas Collection System was completed in March 2000 according to the record drawings, which are dated March 2000. A problem encountered during construction resulted in completing the system late, and the FDEP Air Program took enforcement action which is describes in "In-kind Project Consent Agreement OGC File No. 00-1305." Manatee County completed the requirements of the enforcement action, and described this in a letter dated November 27, 2002. We believe the system is working as designed. The active gas extraction system is installed in the Stage I Landfill. There are no exceedances in the probes or on-site structures near the Stage I Landfill. Probe 11A, which is north of the Stage III Landfill has detected methane, but Probes 11B and 11C, which are between 11A and the property line show no exceedances. There is no landfill gas migrating off-site past the property line through the soil, and we are unaware of any odor complaints. The Stage I Landfill gas collection system design and operation is effective in preventing methane gas migration offsite. The landfill gas collection and flare system is also regulated by a Title V Air Permit. The surface emissions are checked quarterly by measuring methane just above the landfill surface on a 100-foot grid. If surface emissions are detected, the opening is increased at the nearest landfill gas wells to increase landfill gas extraction in the area of the exceedance. Quarterly reports are submitted to the FDEP Air Section.

Comment: 2. a. 3. Please specifically discuss the basis for determining that "the landfill design and operation has proved effective in protecting the environment... ." (page P-3)

Response: The landfill design and operation has proven effective in protecting the environment since no landfill gas is migrating off-site through the soil, the groundwater monitoring wells have not detected leachate migrating through the slurry wall, and we are unaware of any odor complaints which would be an indication of landfill gas migrating off-site through the atmosphere. In addition, FDEP has just reviewed the landfill operations, and renewed the landfill operation permit for another five years. If the landfill design and operation had not proven effective in protecting the environment, FDEP would not have renewed the landfill operation permit.

Comment: 2. b. Closure design (Rule 62-701.600(5), F.A.C.)
1. Please provide slope stability calculations for the proposed final cover design and configuration. Please provide all inputs, printouts for models, etc. to support the conclusions. Figure J-1 in the Operation Renewal Application does not appear to pertain to the final cover system and calculations (including all assumptions and references) do not appear to have been provided in Part J of the Operation Renewal Application. Please include slope stability with equipment loading, horizontal and parallel seepage.

Response: The Calculations are in the Calculation Book included with this response.

Comment: 2. b. 2. Please provide stormwater calculations that demonstrate that the ditches, swales, downcomers, etc. are sized appropriately to manage the expected quantity of stormwater from the closed areas.

Response: The calculations are in the Calculation Book included with this response.

Comment: 2. b. 3. Please provide calculations that demonstrate that the composite drainage net (CDN) geotextile will not clog.

Response: The calculations are in the Calculation Book included with this response.

Comment: 2. b. 4. Please provide calculations (transmissivity, long-term creep, clogging), HELP models etc., for the CDN design/use.

Response: The calculations are in the Calculation Book included with this response.

Comment: 2. b. 5. Please provide pipe calculations for crushing, buckling and deflection of the 18" corrugated Detail (2/C-4) and 6-inch SDR-17 (Detail 9/C-5) HDPE pipe. Please provide calculations that demonstrate that the FDOT #7 stone will not clog the terrace underdrain (Detail 9/C-5).

Response: The pipe strength calculations for the stormwater pipe and terrace underdrain are in the Calculation Book included with this response. The 18" corrugated pipe was replaced with SDR-32.5 HDPE pipe. The calculation book also include the calculations to demonstrate that the FDOT #7 stone is properly sized for the slotted pipe.

Comment: 2. c. Closure Operation Plan (Rule 62-701.600(6), F.A.C.)
1. Please clarify the schedule for the Stage I, Partial Closure 2. In Item 'm' (page P-6) the submittal states, "...the final closure work will take two years. The closure should be completed by January 2041, and the 30-year long-term care and monitoring will continue until 2071."

Response: Schedule was revised to address only the Stage I, Partial Closure 2.

Comment: 2. c. 2. Long-term care plan. Please specify the timeframe for implementing repairs for damage that is observed during the monthly inspections. Please describe the procedures for repairing the gas management system, and timeframe for implementing the repairs, if deficiencies are found.

Response: Pages P-8 and P-9 were revised to specify the time frame for implementing repairs for damage that is observed during the monthly inspections. Also included are procedures for repairing the gas management system and timeframe for implementing the repairs if deficiencies are found.

Comment: 2. c. 3. Please explain how monitoring wells and piezometers will be protected during construction.

Response: Monitoring wells and piezometers are protected by bollards. If the wells are damaged during construction, or have to be removed to facilitate construction, a permit modification will be submitted for well and piezometer replacements as necessary.

Comment: ***3. Part P, Appendix A, CQA Plan. (Rules 62-701.600(5)(f)1., 62-701.400(7) and 62-701.400(8), F.A.C.)***

a. Please provide technical specifications ("contract specifications") for all portions of the proposed final cover system (including liner, subgrade, CDN, stormwater piping and inlets, sod, dewatering, submittals, contract closeout, etc.). Please be advised that the CQA Plan will be reviewed again in its entirety after the technical specifications are submitted.

Response: Technical specifications are included with this response.

Comment: 3. b. Department permits are issued for specific activities pursuant to Rule 62-4.160(2), F.A.C. Rule 62-701.320(5)(b), F.A.C., requires that all applications shall be of sufficient detail to show how the facility will be constructed in

accordance with Department rules. The CQA Plan states, "following completion of the design, plans, specifications and the selection of the General Contractor, a preconstruction meeting will be held." (§1.3.1.) Please clarify if the information submitted is the complete design, plans, and specifications for the project. If not, please provide this information.

Response: The CQA Plan was revised to state: "A preconstruction meeting will be held prior to the start of construction." The information submitted is the complete design, plans and specifications for this project.

Comment: 3. c. §1.0. Please provide an organizational chart that shows the relationship of all the parties to the project. It does not appear that all parties are included in Table 1-1 (e.g., general contractor). Please include all of the parties and their qualifications in Table 1-1. Please specify when each of the submittals (e.g., §1.2.6.5.) are required to be submitted. Please clarify where "granular drainage layers" are included in this project (§1.2.6.7.; §3.3.3.). Please clarify where the "resume of the CQA Program manager for this project is included as part of this package" (§1.2.8.).

Response:

- Table 1-2 was added that provides an organizational chart that shows the relationship of all the parties to the project.
- Table 1-1 was revised to include the general contractor and other parties specific to this project.
- Section 1.2.6.5 was revised to specify when each submittal is required.
- Sections 1.2.6.7 and 3.3.3 were rewritten to delete the reference to granular drainage layers.
- Section 1.2.8 was deleted.

Comment: 3. d. §2.0. Please clarify if the composite drainage net (CDN) includes non-woven geotextile on both sides. Please clarify if the CDN is bi-planar or triplanar (§2.1.1.3.). Please specify the value and testing parameters (i.e., loading conditions, time) for transmissivity of the CDN (Table 2-2). Please provide seam strength requirements that meet the requirements of Rule 62-701.400(3)(d)1., F.A.C. (Table 2-3). Please provide conformance testing requirements for each geosynthetic material. Please provide storage and handling requirements for the geomembrane & CDN (§2.2.1.).

Response:

- Section 2.0 was revised to clarify that the CDN includes non-woven geotextile on both sides. The proposed CDN is TENAX TENFLOW double-sided capping geocomposite comprised of a tri-axial geonet structure with thermally bonded, nonwoven, AASHTO Class 2 geotextile on both sides.
- The value and testing parameters for transmissivity of the CDN were added to Table 2-2.

- Tables 2-1 and 2-3 were modified to clearly indicate that the geomembrane shall have factory and field seams whose shear strengths during testing are at least 90% of the specified minimum yield strength for that lining material, and that failure shall occur in the lining material outside the seam area.
- Conformance testing requirements were added for the geomembrane and the double-sided capping geocomposite.
- Section 2.2 Transportation, Handling and Storage was expanded to add requirements for the geomembrane and CDN.

Comment: 3. *e. §3.0. Please specify the compaction required for the subgrade (§3.1.1.). Please clarify where geomembrane liner will be placed over the CDN (§3.3.2.). Please clarify if overlaps must be sufficient for shear testing of the seams (§3.4.3.). Please verify the maximum size for roots, sticks or sharp-edges stones (§3.5.2.; §3.1.1., §2.1.1.2.). Please clarify where sumps will be constructed in this project (§3.5.4.).*

Response:

- Compaction requirements were added to Section 3.0 for the subgrade.
- No geomembrane will be placed over the CDN. This reference was deleted.
- The reference to overlaps sufficient for shear testing of seams was added.
- The maximum size for roots, sticks or sharp-edge stones was added.
- The reference to leachate sumps was deleted as there will be no leachate sumps constructed for this project.

Comment: 3. *f. §4.0. Please include thickness testing for the subgrade. Please specify the compaction required (§4.1.). Please clarify the length of the geomembrane rolls (§4.3.1.).*

Response:

- Section 4 was revised to add thickness testing to the subgrade, and specify the compaction requirements.
- Section 4.3.1 referred to factory seams, which are no longer used. The section with reference to factory seams was deleted.

Comment: 3. *g. §5.0. Please clarify who will submit the Certification of Construction Completion to the Department (§5.2; §1.2.8; §1.2.9.). Please include surveys and stormwater system as-built information in the Certification documents (§5.2.).*

Response: Section 5.0 was revised to clarify that the Design Engineer is also the CQA Certifying Engineer, and will submit the certification of construction completion. Section 1.2.8 CQA Program Manager was deleted. Section 5.2 was revised to add the survey information for the storm water system as-built information in the certification documents.

Comment: 4. ***Appendix B.*** *Please provide the information that was intended to be in this section.*

Response: The Table of Contents identifies Appendix B as the "Location for Filing FDEP Requests for Additional Information and Responses."

Comment: 5. ***Permit Drawings for Manatee County Lena Road landfill Final Closure, January 2005*** *(Rules 62-701.320(5)(b), 62-701.320(7)(f), F.A.C.)*
a. Please provide a current topographic survey of the site and the proposed final closure contours for the Stage I-Partial Closure #2.

Response: The closure plan drawings submitted for the renewal of the landfill operation permit were replaced with the closure plan construction drawings specific to the Stage I Landfill Partial Closure #2. The replaced closure plan drawings specific to the Stage I Landfill Partial Closure #2 have a recent aerial photograph dated July 26, 2004 on Drawing C-2. The topographic survey for the landfill developed from this aerial photograph is included on each of the plan drawings. The final contours are shown on Drawings C-8, C-9 and C-10. An aerial photograph is taken in July each year, and used to prepare a topographic map. The Stage I Landfill Partial Closure #2 drawings submitted with this response have the aerial photograph taken last year on July 26, 2004. This year the aerial photograph was also taken on July 26, 2005. A copy of the aerial photograph and topographic map will be submitted to FDEP as soon as it is available. Since no solid waste was placed between July 26, 2004 and July 26, 2005 in the Stage I Landfill area proposed for closure, there are only minor changes in the contours due to landfill settlement.

Comment: 5. *b. <u>Sheet C-2.</u> Please provide additional cross-sections of the proposed final closure (e.g., north-south, northeast-southwest). Please provide a cross-section showing the tie-in between the cap liner and the slurry wall. Since Stage III is not part of the proposed Stage I-Partial Closure #2 (S1-PC#2) project, please explain the purpose of cross-section A-A on this sheet. Please provide cross-sections of the northern and western tie-in between the Stage I-Partial Closure #1 (S1-PC#1) and S1-PC#2 and the northern bench of S1-PC#1. Please provide a detail of the connection of the stormwater letdown pipes in the SI-PC#2 with the existing pipes in the S1-PC#2 and the northern bench of S1-PC#1. Please clarify the location of the landfill gas flare on this sheet and reference the appropriate detail on other sheets. Please provide a detail of the anchor trench for the northern extent of the S1-PC#2. Please clarify which layer of the final cover system the contours on this sheet represent.*

Response:

- A north-south cross section and an east-west cross section is included on Sheet C-14 of the replace drawings.
- The tie-in detail for the geomembrane cap and the slurry wall is shown on Sheet C-11.
- The cross section showing the Stage III Landfill was deleted from the replaced drawings.
- The northern tie-in is shown on Sheet C-11.

- The tie-in between Stage I Partial Closure #1 and Partial Closure #2 in included on Sheet C-11.
- The tie-in detail for extension of the storm water pipes is shown on Sheet C-12.
- The location of the landfill gas flare is shown on Sheets C-2 and Sheets C-3.
- The anchor trench for the northern extent of the geomembrane is shown on Sheet C-11.
- The proposed final contours, which are the top of the cover soil, are shown on Sheets C-8, C-9, and C-10.

Comment: 5. *c. Sheet C-3. It appears that Section A-A is not included in this project. Please clarify why gas vents are not shown in Phase I in Section B-B.*

Response: Section A-A was deleted from the replaced drawings. No gas vents were shown on Section B-B since the intent was not to show every landfill gas well in section, but only illustrate the depth of a typical gas well.

Comment: 5. *d. Sheet C-4. Please show the tie-in for the cap liner and the slurry wall on Detail 1. It appears that Details 2 and 5 on this sheet are in areas that are not included in this project.*

Response: Details for areas outside of the limits for this partial closure were deleted.

Comment: 5. *e. Sheet C-5. Please clarify the reference to "double composite" drainage net in Detail 6. Please clarify the reference to stormwater "inlet" in Section A. Please provide additional details for the "Stormwater inlet structure" in Detail 7A. Please specify the stormwater downcomer pipe size and type in Detail 7A. It appears that Detail 10 is in a location that is not in this project. Please specify the pipe slope for the 6-inch perforated pipe in Detail 10.*

Response:

- The reference to double composite drainage net was clarified.
- The inlet and pipe sizes are included on Sheets C-9, C-10, C-12, and C-13.
- Details for locations outside the Partial Closure #2 were removed from the replace drawings.
- The minimum pipe slopes were added to the details.

Comment: 5. *f. Sheet C-6. Please clarify where the "existing" 8-inch lateral, "proposed" 8-inch lateral, "proposed 18-inch header" pipes and horizontal gas collection trench are shown on this drawing.*

Response: This was a typical legend used on all sheets so not every symbol appeared on every sheet.

Comment: 5. g. Sheet C-8. Please provide specifications for all piping and gravel. Please verify the boot detail in the typical wellhead detail. On the "typical wellhead detail" it appears that a strap is used to secure the boot, but the close-up detail shows the boot welded to the pipe. Please clarify where Section A, "Typical Pipe Section" is referenced. There appear to be two different Sections A/C-8 on this sheet.

Response:

- Specifications for piping and gravel are included with this response.
- The typical wellhead boot detail was clarified and is shown on Sheet C-6.
- Locations of typical pipe section are shown on the plan drawings.

Comment: 6. ***Rule 62-701.320(8), F.A.C.*** *Please provide proof of publication of the attached Notice of Application to the Department.*

Response: The proof of publication is included with this response.

Manatee County Solid Waste Management Facility, Lena Road Landfill, Application and Engineering Report for Renewal of Landfill Operation Permit, dated April 2004 (received May 14, 2004) including pages subsequently revised, amended or replaced (see Operation Permit 39884-010-SO-01 for full reference). *Several portions of the pending closure permit application reference this document.*

Comment: 7. ***Part O, Gas Management System Requirements.*** *[Rule 62-701.530, F.A.C.] a. Section 3.3. Please clarify how the "routine odor monitoring program to determine the timing and extend of any offsite odors" is different than the daily inspections by the landfill manager.*

Response: The daily inspection by the landfill manager occurs on-site by driving around the perimeter landfill access road. This is the road that runs along the top of the perimeter slurry wall within 20 feet of the solid waste in the landfill. If no odors are smelled, it is assumed the landfill is not causing odors. If an adjacent neighbor makes an odor complaint, then a "routine odor monitoring program to determine the timing and extent of any offsite odors" would be implemented. The monitoring would be at the site of the off-site odor complaint to determine the timing and extent of the odor at the location of the odor complaint. The off-site odor could be coming from the landfill, or may not be related to the landfill at all.

Comment: 7. b. PBSJ Memorandum dated April 26, 2004.
1) Please clarify the basis for using 840 scfm for the model. It appears that the model "methane.txt" indicates that in 2005 the expected gas flow rate is 3.585 x 10^7 cm/yr (2409 cfm).

Response: The 840 scfm is the actual amount as measured by the flow meter at the flare for the existing Stage I landfill gas collection system. This is the actual amount collected which is less than the theoretical amount generated. The 2,409 scfm is

the theoretical amount generated in 2005 as estimated by the U.S. EPA LANDGEM model. The landfill gas collection system model was first run for the existing flow condition, and repeated for the theoretical amount anticipated.

Comment: 7. b. 2) Please complete the statement, "The results showed..." on page 2 in the last paragraph.

Response: Delete the statement "The results showed." The statement is completed in the next sentence: "The results indicate that the system would perform properly with the proposed additions, and the current blower system will be adequate to meet future system demands."

Sincerely,

Joseph L. Miller, P.E. #39177
Project Engineer

cc: Gus DiFonzo, Manatee County w/ 2 copies

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List of Attachments

1. Revised Application Form Page 4 of 40.
2. Revised Application Form Page 7 of 40.
3. New Table entitled "Manatee County Lena Road Landfill – Summary of Readings for Subsurface Monitoring Probes and Onsite Structures – From December 2001 through June 2005."
4. New "Calculation Book"
5. Revised Pages P-4 through P-9, and new Page P-10.
6. Replaced CQA Plan (No change in Forms)
7. Technical Specifications
8. Replace drawings entitled "Lena Road Landfill Stage I Landfill Partial Closure #2 dated July 2005."
9. Proof of Publication

THE HERALD

WWW.HERALDTODAY.COM
P.O. Box 921
Bradenton, FL 34206-0921
102 Manatee Avenue West
Bradenton, FL 34205-8894
941/748-0411 ext. 7065

The Herald
Published Daily
Bradenton, Manatee, Florida

STATE OF FLORIDA
COUNTY OF MANATEE;

Before the undersigned authority personally appeared Sandy Riley, who on oath says that she is a Legal Advertising Representative of The Herald, a daily newspaper published at Bradenton in Manatee County, Florida; that the attached copy of the advertisement, being a Legal Advertisement in the matter of **NOTICE OF APPLICATION** in the Court, was published in said newspaper in the issues of, **8/5/05**
Affiant further says that the said publication is a newspaper published at Bradenton, in said Manatee County, Florida, and that the said newspaper has heretofore been continuously published in said Manatee County, Florida, each day and has been entered as second-class mail matter at the post office in Bradenton, in said Manatee County, Florida for a period of 1 year next preceding the first publication of the attached copy of advertisement; and affiant further says that she has neither paid nor promised any person, firm or corporation any discount, rebate, commission or refund for the purpose of securing this advertisement for publication in the said newspaper.

Sandy Riley
(Signature of Affiant)

Sworn to and subscribed before me this
8th Day of August, 2005

DIANE S. BACRO
Notary Public
State of Florida
My comm. exp. 08-15-2007
Comm. No. DD 206531

Diane S. Bacro
SEAL & Notary Public
Personally Known X OR Produced Identification_____
Type of Identification Produced_____

State of Florida Department of Environmental Protection
Notice of Application

The Department announces the receipt of an application for permit from **Manatee County Utilities Operations Department, Mr. Daniel Gray, Director** for construction of a partial closure of the existing solid waste class 1 landfill, referred to as the **Manatee County Lena Road Class 1 Landfill, located at 3333 Lena Road, Bradenton, Manatee County, Florida.**

This application is being processed and is available for public inspection during normal business hours, 8a.m. to 5p.m. Monday through Friday, except legal holidays, at the Department of Environmental Protection, Southwest District Office, 3804 Coconut Palm Drive, Tampa, Florida 33619-8318
8/5/05

DEP
SEP 14 2005
Southwest District Tampa

PBS&J

An employee-owned company

May 24, 2005

Susan J. Pelz, P.E.
Solid Waste Manager
Southwest District
3804 Coconut Palm Drive
Tampa, Florida 33619

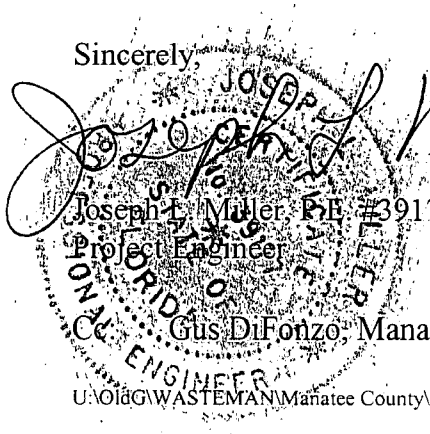
RE: Lena Road Landfill, Manatee County
GMS ID No: 4041C02025
Renewal of Lena Road Landfill Closure Permit

Dear Ms Pelz:

Enclosed are four copies of the application, engineering report and attachments for renewal of the Lena Road Landfill Closure Permit. Also enclosed is a check for $7,500 as the permit renewal application fee.

If you have any questions, please call me at 407-647-7275 Ext. 4153

Sincerely,



Joseph L. Miller, P.E. #39177
Project Engineer

Cc: Gus DiFonzo, Manatee County w/ 2 copies

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PBS&J

employee-owned company

482 South Keller Road
Orlando, Florida 32810

0727828

Bank of America, N.A.
Atlanta, Georgia
64-1278/611

CHECK DATE
May 23, 2005

PAY Seven Thousand Five Hundred and 00/100 Dollars

AMOUNT $7,500.00

TO FLORIDA DEPT. OF ENVIRONMENTAL PROTECTION

PBS&J OPERATIONAL ACCOUNT

AUTHORIZED SIGNATURE

Security Check features included. Details on back.

⑈0727828⑈ ⑆061112788⑆ 0032998315888⑈

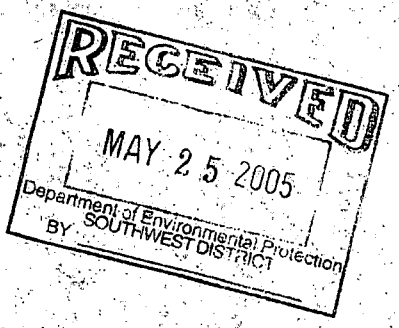
PBS&J

482 South Keller Road Orlando, Florida 32810

EMILY BUSINESS FORMS 800.392.6018 ADVANTAGE

0727828

Invoice Number	Date	Voucher	Amount	Discounts	Previous Pay	Net Amount
APPLICATION FEE	5/20/05	0629032	7,500.00			7,500.00
FLORIDA DEPT. OF ENVIR. PR 099 1		Totals	7,500.00			7,500.00



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

DEP Form # 62-701.900(1)
Form Title Solid Waste Management Facility Permit
Effective Date 05-27-01

DEP Application No.
(Filled by DEP)

RECEIVED
MAY 25 2005
Department of Environmental Protection
BY SOUTHWEST DISTRICT

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

Manatee County Solid Waste Management Facility
Lena Road Landfill

Renewal of
Closure Permit
For
Class I Landfill

May 24, 2005

U:\OldG\WASTEMAN\Manatee County\WA-46 Renew Closure Permit for Lena Ldf\Application\62-701.900.1.DOC

Northwest District
160 Governmental Center
Pensacola, FL 32501-5794
850-595-8360

Northeast District
7825 Baymeadows Way, Ste. B200
Jacksonville, FL 32256-7590
904-448-4300

Central District
3319 Maguire Blvd., Ste. 232
Orlando, FL 32803-3767
407-894-7555

Southwest District
3804 Coconut Palm Dr.
Tampa, FL 33619
813-744-6100

South District
2295 Victoria Ave., Ste. 364
Fort Myers, FL 33901-3881
941-332-6975

Southeast District
400 North Congress Ave.
West Palm Beach, FL 33401
561-681-6600

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.

Dept. of Environmental Protection

APR 07 2006

Southwest District

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 - **Submitted**

PART B: DISPOSAL FACILITY GENERAL INFORMATION - **Submitted**

PART C: NON-DISPOSAL FACILITY GENERAL INFORMATION - **Not Applicable**

PART D: PROHIBITIONS - **Not Applicable**

PART E: SOLID WASTE MANAGEMENT FACILITY PERMIT REQUIREMENTS, GENERAL - **Not Applicable**

PART F: LANDFILL PERMIT REQUIREMENTS - **Not Applicable**

PART G: GENERAL CRITERIA FOR LANDFILLS - **Not Applicable**

PART H: LANDFILL CONSTRUCTION REQUIREMENTS - **Not Applicable**

PART I: HYDROGEOLOGICAL INVESTIGATION REQUIREMENTS - **Not Applicable**

PART J: GEOTECHNICAL INVESTIGATION REQUIREMENTS - **Not Applicable**

PART K: VERTICAL EXPANSION OF LANDFILLS - **Not Applicable**

PART L: LANDFILL OPERATION REQUIREMENTS - **Not Applicable**

PART M: WATER QUALITY AND LEACHATE MONITORING REQUIREMENTS - **Submitted**

PART N: SPECIAL WASTE HANDLING REQUIREMENTS - **Not Applicable**

PART O: GAS MANAGEMENT SYSTEM REQUIREMENTS - **Submitted**

PART P: LANDFILL CLOSURE REQUIREMENTS - **Submitted**

PART Q: CLOSURE PROCEDURES - **Submitted**

PART R: LONG TERM CARE REQUIREMENTS - **Submitted**

PART S: FINANCIAL RESPONSIBILITY REQUIREMENTS - **Submitted**

PART T: CERTIFICATION BY APPLICANT AND ENGINEER OR PUBLIC OFFICER - **Submitted**

Appendix A Lena Road Landfill Stage I Closure Permit Expiration date 07/27/2005 (Replaced this permit with new permit after it is issued.)

~~**Appendix B Location for Filing FDEP Requests for Additional Information and Responses As Required ***~~

*** Revise March 22, 2006 to delete reference to Appendix B.**

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):

[X] Disposal
- [X] Class I Landfill
- [ ] Class II Landfill
- [ ] Class III Landfill
- [ ] Other Describe: _____
- [ ] 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
- [X] Closure

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

4. Facility name: Manatee County Solid Waste Management Facility - Lena Road Landfill

5. DEP ID number: **SWD-41-44795 *** County: Manatee

6. Facility location (main entrance): 3333 Lena Road, Bradenton, FL 34202

7. Location coordinates:

Section: 1 Township: 35S Range: 18E and Section: 31 Township: 34S Range: 19E
Section: 6 & 7 Township: 35S Range: 19E

Latitude: 27 ° 28' 9.74" Longitude: 82 ° 26' 34.60"

*** Revised August 30, 2005**

D.E.P.
SEP 14 2005
Southwest District Tampa

8. Applicant name (operating authority): Manatee County Government

Mailing address: 4410 66th Street West | Bradenton, | FL | 34210
Street or P.O. Box | City | State | Zip

Contact person: Daniel T. Gray Telephone: (941) 792-8811

Title: Utility Operations Director

dan.gray@co.manatee.fl.us
E-Mail address (if available)

9. Authorized agent/Consultant: PBS&J

Mailing address: 482 South Keller Road | Orlando, Florida | 32810-6101
Street or P.O. Box | City | State | Zip

Contact person: Joseph L. Miller, P.E. Telephone: (407) 647-7275

Title: Project Manager

jlmiller@pbsj.com
E-Mail address (if available)

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

Mailing address: _____
Street or P.O. Box | City | State | Zip

Contact person: _____ Telephone: (___) _____

_____
E-Mail address (if available)

11. Cities, towns and areas to be served: All of Manatee County, both incorporated and unincorporated, Long Boat Key and small portions of neighboring counties.

12. Population to be served:

Current: 292,000 Five-Year Projection: 328,000

13. Date site will be ready to be inspected for completion: N/A

14. Expected life of the facility: Landfill Stages I, II and III - 65 years

15. Estimated costs:

Total Construction: $ N/A Closing Costs: $33,880,710.90

16. Anticipated construction starting and completion dates:

From: N/A To: N/A

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

N/A yds^3/day Received 1280 tons/day N/A gallons/day
Landfilled 1100 tons/day

B. DISPOSAL FACILITY GENERAL INFORMATION

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

This application is for renewal of the Closure Permit for the Class I Landfill.

2. Facility site supervisor: Mike Gore

Title: Superintendent - Landfill Division Telephone: (941) 708-8562

mike.gore@co.manatee.fl.us
E-Mail address (if available)

3. Disposal area: Total 316 acres; Used 206 acres; Available 110 acres.

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

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

6. Charge for waste received: N/A $/yds^3 25 $/ton
(See also Material Rate Table in Part B)

7. Surrounding land use, zoning:

[X] Residential	[ ] Industrial
[X] Agricultural	[ ] None
[ ] Commercial	[X] Other Describe: Transportation & Utilities

8. Types of waste received:

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

9. Salvaging permitted: [ ] Yes [X] No

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

11. Spotters: Yes [X] No [ ] Number of spotters used: 16

12. Site located in: [ ] Floodplain [ ] Wetlands [X] Other Uplands

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

14. Days of operation: Monday through Saturday

15. Hours of operation: 8:00 a.m. to 5:00 p.m.

16. Days Working Face covered: Monday through Saturday

17. Elevation of water table: 29 Ft. (NGVD 1929)

18. Number of monitoring wells: **18***

19. Number of surface monitoring points: 2

20. Gas controls used: [X] Yes [ ] No Type controls: [X] Active [ ] Passive

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

21. Landfill unit liner type:

[X] Natural soils
[ ] Single clay liner
[ ] Single geomembrane
[ ] Single composite
[X] Slurry wall
[ ] Other Describe:

[ ] Double geomembrane
[ ] Geomembrane & composite
[ ] Double composite
[ ] None

22. Leachate collection method:

[X] Collection pipes
[ ] Geonets
[ ] Well points
[ ] Perimeter ditch
[ ] Other Describe:

[ ] Sand layer
[ ] Gravel layer
[ ] Interceptor trench
[ ] None

23. Leachate storage method:

[ ] Tanks
[ ] Surface impoundments
[X] Other Describe: None

24. Leachate treatment method:

[ ] Oxidation
[ ] Secondary
[ ] Advanced
[X] None
[ ] Other

[ ] Chemical treatment
[ ] Settling

D.E.P.
SEP 14 2005
Southwest District Tampa

*** Revised August 30, 2005**

25. Leachate disposal method:

[ ] Recirculated
[ ] Transported to WWTP
[ ] Injection well
[ ] Evaporation
[ ] Other _____
[X] 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: [X] Yes [ ] No

Type of treatment: Sand filter

Name and Class of receiving water: Cypress Strand, Gates Creek via on-site wetlands Class III.

28. Environmental Resources Permit (ERP) number or status: MSSW Permit #403143.01

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

* No Change means no change from "Application and Engineering Report for Renewal of Landfill Operation Permit for Lena Road Landfill", (3-hole punched bound documents) dated April 30, 2004 (received by FDEP on May 14, 2004), as revised, replaced or amended (information inserted into original) dated September 9, 2004, October 6, 2004, December 14, 2004, February 7, 2005 and March 17, 2005.

** See "Biennial Water Quality Monitoring Plan Evaluation - First Half 2002 through Second Half 2003 - Manatee County Solid Waste Division - Lena Road Landfill" prepared by PBS&J and Dated December 11, 2003.

RECEIVED
MAY 25 2005
Department of Environmental Protection
BY SOUTHWEST DISTRICT

M. WATER QUALITY AND LEACHATE MONITORING REQUIREMENTS (62-701.510, FAC)

S	LOCATION	N/A	N/C		
				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;
___	Cover page M 1 a.	___	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)
___	M 1 b.	___	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)
___	M 1 c.	___	X*	(1)	Detection wells located downgradient from and within 50 feet of disposal units;
___	M 1 c.	___	X*	(2)	Downgradient compliance wells as required;
___	M 1 c.	___	X*	(3)	Background wells screened in all aquifers below the landfill that may be affected by the landfill;
___	M 1 c	___	X*	(4)	Location information for each monitoring well;
___	M 1 c	___	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;
___	M 1 c	___	X*	(6)	Well screen locations properly selected;
___	M 1 c	___	X*	(7)	Procedures for properly abandoning monitoring wells;
___		X	___	(8)	Detailed description of detection sensors if proposed.

* No Change means no change from "Application and Engineering Report for Renewal of Landfill Operation Permit for Lena Road Landfill", (3-hole punched bound documents) dated April 30, 2004 (received by FDEP on May 14, 2004), as revised, replaced or amended (information inserted into original) dated September 9, 2004, October 6, 2004, December 14, 2004, February 7, 2005 and March 17, 2005.

LENA ROAD LANDFILL
LANDFILL CLOSURE
PERMIT RENEWAL

Part O

May 24, 2005

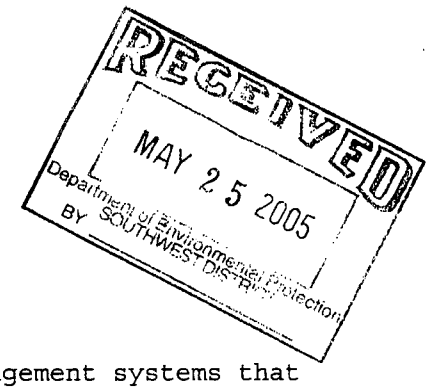
Prepared for

Manatee County Government
Utility Operations Department
Solid Waste Division
3333 Lena Road
Bradenton, Florida 34202

Prepared by

PBS&J

482 S. Keller Rd.
Orlando, Florida 32810-6101



O. GAS MANAGEMENT SYSTEM REQUIREMENTS (62-701.530,FAC)

1. Provide the design for a gas management systems that will (62-701.530(1), FAC):

X	O 1.			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	O 1.			b. Be designed for site-specific conditions;
X	O 1.			c. Be designed to reduce gas pressure in the interior of the landfill;
X	O 1.			d. Be designed to not interfere with the liner, leachate control system or final cover.
X	O 2.			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	O 3.			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	O 4.a			a. Information required in Rules 62-701.320(7) and 62-701.330(3), FAC supplied;
X	O 4.b			b. Information required in Rule 62-701.600(4), FAC supplied where relevant and practical;
X	O 4.c			c. Estimate of current and expected gas generation rates and description of condensate disposal methods provided;
X	O 4.d			d. Description of procedures for condensate sampling, analyzing and data reporting provided;
X	O 4.e			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	O 4.f			f. Performance bond provided to cover closure costs if not already included in other landfill closure costs.

Part O Gas Management System Requirements

1. Design of the Gas Management System

The landfill gas management system was designed to:

a. Prevent concentrations of combustible gases from exceeding 25% of the LEL in structures and 100% of the LEL at the property boundary

b. For site-specific conditions. The landfill gas collection drawings for the existing system and the expansion for the Stage I Phase II Landfill Closure are included in Part O of "Application and Engineering Report for Renewal of Landfill Operation Permit for Lena Road Landfill", (3-hole punched bound documents) dated April 30, 2004 (received by FDEP on May 14, 2004), as revised, replaced or amended (information inserted into original) dated September 9, 2004, October 6, 2004, December 14, 2004, February 7, 2005 and March 17, 2005 along with the calculations.

c. Reduce gas pressure in the interior of the landfill

d. Not to interfere with the liner, leachate control system or final cover

2. Landfill Gas Migration Monitoring

The landfill gas migration monitoring plan was submitted in Part L of "Application and Engineering Report for Renewal of Landfill Operation Permit for Lena Road Landfill", (3-hole punched bound documents) dated April 30, 2004 (received by FDEP on May 14, 2004), as revised, replaced or amended (information inserted into original) dated September 9, 2004, October 6, 2004, December 14, 2004, February 7, 2005 and March 17, 2005. The Landfill Closure does not require a separate landfill gas migration-monitoring plan. The landfill gas control system shall be operated, monitored and maintained in accordance with the 1999 "Manatee County, Lena Road Landfill Operation and Maintenance Manual for Landfill Gas & Environmental Products, Inc. Triton CF – 3000 Candle Flare (300-3000 SCFM)" or subsequent revisions or replacement manuals necessary for continued compliance.

3. Gas Remediation Plan and Odor Remediation Plan

a. Gas Remediation Plan

If combustible gas concentrations exceed 25% of the Lower Explosive Limits (LEL) inside structures both on and off the landfill site, or are greater than 100% at the property limit, the owner or operator shall:

- Immediately take all necessary steps to ensure protection of human health and notify the Department; and,
- Within seven days of detection, submit to the Department for approval a gas remediation plan for gas releases. The plan shall describe the nature and extent of the problem and the proposed remedy. The remedy may include some or all of the

gas management system design contained in 62-701.530 (1). The remedy shall be completed within 60 days of the detection unless otherwise approved by the Department.

b. Odor Remediation Plan

The facility shall be operated to control objectionable odors in accordance with Rule 62-296.320(2), F.A.C. If gas concentrations cause objectionable odors beyond the landfill property, the owner of operator shall:

- On days when the landfill is receiving solid waste, the landfill manager, or his designated representative, shall drive around the perimeter of the landfill and smell for odors;
- Keep a log of the date, time and location of any odor complaints reported by landfill staff or from residents;
- Visit the location of the odor complaint and confirm the odor;
- Check to see that the flare is in operation;
- Check the flare operation record to see if the flare has been out of operation and when and for how long;
- Check the landfill surface emissions and penetrations to see if there is a gas leak from the landfill;
- Check to see if any wells are closed;
- Adjust the well heads to increase vacuum to well heads in the location of any suspected gas leaks;
- Implement a routine odor monitoring program to determine the timing and extent of any off-site odors; and,
- If the monitoring program confirms the existence of objectionable odors, submit to the Department for approval an odor remediation plan for the gas releases. The plan shall describe the nature and extent of the problem and the proposed remedy. The remedy shall be initiated within 30 days of approval.

4. Landfill Gas Recovery Facility

a. The information required in Rules 62-701.320(7) and 62-701.330(3) F.A.C. is included in Part A, B and O of this application. Parts E, F and L and are not required for a Closure Permit application.

b. The information required in Rule 62-701.600(4), F.A.C., Closure Report is included in Part P of this application.

c. The estimate of current and expected gas generation rates is given in Table O-1. Condensate is drained back into the landfill and collected by the leachate collection system.

d. Condensate is not sampled and analyzed separately from the leachate.

e. It is anticipated that the landfill gas collection and flaring system will operate for 30 years after landfill closure during the long-term care period.

f. The landfill gas collection system and long-term care costs are included in the cost estimate in Part S of "Application and Engineering Report for Renewal of Landfill Operation Permit for Lena Road Landfill", (3-hole punched bound documents) dated April 30, 2004 (received by FDEP on May 14, 2004), as revised, replaced or amended (information inserted into original) dated September 9, 2004, October 6, 2004, December 14, 2004, February 7, 2005 and March 17, 2005.

TABLE 0-1 LENA ROAD LANDFILL EXPECTED LANDFILL GAS GENERATION RATES

Source: C:\MANATE~1\MANATEE.PRM

Model Parameters

Lo : 170.00 m^3 / Mg
k : 0.0500 1/yr
NMOC : 4000.00 ppmv
Methane : 50.0000 % volume
Carbon Dioxide : 50.0000 % volume

Landfill Parameters

Landfill type : No Co-Disposal
Year Opened : 1978 Current Year : 2002 Closure Year: 2034
Capacity : 16070000 Mg
Average Acceptance Rate Required from
Current Year to Closure Year : 324912.00 Mg/year

Model Results

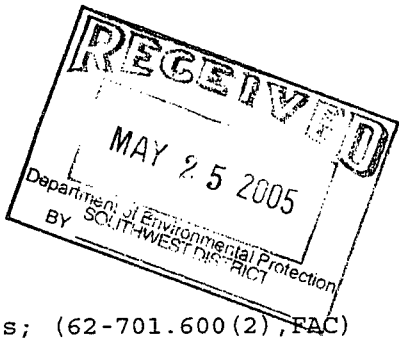
Year	Refuse In Place (Mg)	Methane Emission Rate (Mg/yr)	Methane Emission Rate (Cubic m/yr)
1979	8.811E+04	4.997E+02	7.489E+05
1980	1.882E+05	1.043E+03	1.563E+06
1981	3.004E+05	1.628E+03	2.441E+06
1982	4.299E+05	2.283E+03	3.422E+06
1983	5.770E+05	3.006E+03	4.506E+06
1984	7.914E+05	4.075E+03	6.108E+06
1985	1.008E+06	5.105E+03	7.652E+06
1986	1.205E+06	5.973E+03	8.953E+06
1987	1.428E+06	6.946E+03	1.041E+07
1988	1.674E+06	8.002E+03	1.200E+07
1989	1.940E+06	9.121E+03	1.367E+07
1990	2.210E+06	1.021E+04	1.530E+07
1991	2.479E+06	1.123E+04	1.684E+07
1992	2.765E+06	1.231E+04	1.845E+07
1993	3.058E+06	1.337E+04	2.004E+07
1994	3.342E+06	1.433E+04	2.148E+07
1995	3.668E+06	1.548E+04	2.320E+07
1996	3.994E+06	1.657E+04	2.484E+07
1997	4.322E+06	1.762E+04	2.642E+07
1998	4.648E+06	1.861E+04	2.790E+07
1999	4.982E+06	1.960E+04	2.938E+07
2000	5.288E+06	2.038E+04	3.055E+07
2001	5.546E+06	2.085E+04	3.125E+07
2002	5.871E+06	2.167E+04	3.249E+07
2003	6.196E+06	2.246E+04	3.366E+07
2004	6.521E+06	2.321E+04	3.478E+07
2005	6.846E+06	2.392E+04	3.585E+07
2006	7.171E+06	2.459E+04	3.686E+07
2007	7.495E+06	2.524E+04	3.783E+07
2008	7.820E+06	2.585E+04	3.874E+07
2009	8.145E+06	2.643E+04	3.962E+07
2010	8.470E+06	2.698E+04	4.045E+07
2011	8.795E+06	2.751E+04	4.123E+07
2012	9.120E+06	2.801E+04	4.199E+07

2013	9.445E+06	2.849E+04	4.270E+07
2014	9.770E+06	2.894E+04	4.338E+07
2015	1.009E+07	2.937E+04	4.402E+07
2016	1.042E+07	2.978E+04	4.464E+07
2017	1.074E+07	3.017E+04	4.522E+07
2018	1.107E+07	3.054E+04	4.578E+07
2019	1.139E+07	3.090E+04	4.631E+07
2020	1.172E+07	3.123E+04	4.681E+07
2021	1.204E+07	3.155E+04	4.729E+07
2022	1.237E+07	3.185E+04	4.775E+07
2023	1.269E+07	3.214E+04	4.818E+07
2024	1.302E+07	3.242E+04	4.859E+07
2025	1.334E+07	3.268E+04	4.898E+07
2026	1.367E+07	3.293E+04	4.936E+07
2027	1.399E+07	3.316E+04	4.971E+07
2028	1.432E+07	3.339E+04	5.005E+07
2029	1.464E+07	3.360E+04	5.037E+07
2030	1.497E+07	3.381E+04	5.067E+07
2031	1.529E+07	3.400E+04	5.096E+07
2032	1.562E+07	3.419E+04	5.124E+07
2033	1.594E+07	3.436E+04	5.150E+07
2034	1.607E+07	3.340E+04	5.007E+07
2035	1.607E+07	3.177E+04	4.763E+07
2036	1.607E+07	3.023E+04	4.530E+07
2037	1.607E+07	2.875E+04	4.310E+07
2038	1.607E+07	2.735E+04	4.099E+07
2039	1.607E+07	2.601E+04	3.899E+07
2040	1.607E+07	2.475E+04	3.709E+07
2041	1.607E+07	2.354E+04	3.528E+07
2042	1.607E+07	2.239E+04	3.356E+07
2043	1.607E+07	2.130E+04	3.193E+07
2044	1.607E+07	2.026E+04	3.037E+07
2045	1.607E+07	1.927E+04	2.889E+07
2046	1.607E+07	1.833E+04	2.748E+07
2047	1.607E+07	1.744E+04	2.614E+07
2048	1.607E+07	1.659E+04	2.486E+07
2049	1.607E+07	1.578E+04	2.365E+07
2050	1.607E+07	1.501E+04	2.250E+07
2051	1.607E+07	1.428E+04	2.140E+07
2052	1.607E+07	1.358E+04	2.036E+07
2053	1.607E+07	1.292E+04	1.936E+07
2054	1.607E+07	1.229E+04	1.842E+07
2055	1.607E+07	1.169E+04	1.752E+07
2056	1.607E+07	1.112E+04	1.667E+07
2057	1.607E+07	1.058E+04	1.585E+07
2058	1.607E+07	1.006E+04	1.508E+07
2059	1.607E+07	9.570E+03	1.435E+07
2060	1.607E+07	9.104E+03	1.365E+07
2061	1.607E+07	8.660E+03	1.298E+07
2062	1.607E+07	8.237E+03	1.235E+07
2063	1.607E+07	7.836E+03	1.174E+07
2064	1.607E+07	7.453E+03	1.117E+07
2065	1.607E+07	7.090E+03	1.063E+07
2066	1.607E+07	6.744E+03	1.011E+07
2067	1.607E+07	6.415E+03	9.616E+06
2068	1.607E+07	6.102E+03	9.147E+06
2069	1.607E+07	5.805E+03	8.701E+06
2070	1.607E+07	5.522E+03	8.276E+06
2071	1.607E+07	5.252E+03	7.873E+06
2072	1.607E+07	4.996E+03	7.489E+06
2073	1.607E+07	4.753E+03	7.124E+06
2074	1.607E+07	4.521E+03	6.776E+06
2075	1.607E+07	4.300E+03	6.446E+06

2076	1.607E+07	4.091E+03	6.131E+06
2077	1.607E+07	3.891E+03	5.832E+06
2078	1.607E+07	3.701E+03	5.548E+06
2079	1.607E+07	3.521E+03	5.277E+06
2080	1.607E+07	3.349E+03	5.020E+06
2081	1.607E+07	3.186E+03	4.775E+06
2082	1.607E+07	3.030E+03	4.542E+06
2083	1.607E+07	2.883E+03	4.321E+06
2084	1.607E+07	2.742E+03	4.110E+06
2085	1.607E+07	2.608E+03	3.910E+06
2086	1.607E+07	2.481E+03	3.719E+06
2087	1.607E+07	2.360E+03	3.537E+06
2088	1.607E+07	2.245E+03	3.365E+06
2089	1.607E+07	2.135E+03	3.201E+06
2090	1.607E+07	2.031E+03	3.045E+06
2091	1.607E+07	1.932E+03	2.896E+06
2092	1.607E+07	1.838E+03	2.755E+06
2093	1.607E+07	1.748E+03	2.621E+06
2094	1.607E+07	1.663E+03	2.493E+06
2095	1.607E+07	1.582E+03	2.371E+06
2096	1.607E+07	1.505E+03	2.256E+06
2097	1.607E+07	1.431E+03	2.146E+06
2098	1.607E+07	1.362E+03	2.041E+06
2099	1.607E+07	1.295E+03	1.941E+06
2100	1.607E+07	1.232E+03	1.847E+06
2101	1.607E+07	1.172E+03	1.757E+06
2102	1.607E+07	1.115E+03	1.671E+06
2103	1.607E+07	1.060E+03	1.589E+06
2104	1.607E+07	1.009E+03	1.512E+06
2105	1.607E+07	9.595E+02	1.438E+06
2106	1.607E+07	9.127E+02	1.368E+06
2107	1.607E+07	8.682E+02	1.301E+06
2108	1.607E+07	8.259E+02	1.238E+06
2109	1.607E+07	7.856E+02	1.178E+06
2110	1.607E+07	7.473E+02	1.120E+06
2111	1.607E+07	7.108E+02	1.065E+06
2112	1.607E+07	6.762E+02	1.014E+06
2113	1.607E+07	6.432E+02	9.641E+05
2114	1.607E+07	6.118E+02	9.171E+05
2115	1.607E+07	5.820E+02	8.723E+05
2116	1.607E+07	5.536E+02	8.298E+05
2117	1.607E+07	5.266E+02	7.893E+05
2118	1.607E+07	5.009E+02	7.508E+05
2119	1.607E+07	4.765E+02	7.142E+05
2120	1.607E+07	4.532E+02	6.794E+05
2121	1.607E+07	4.311E+02	6.462E+05
2122	1.607E+07	4.101E+02	6.147E+05
2123	1.607E+07	3.901E+02	5.847E+05
2124	1.607E+07	3.711E+02	5.562E+05
2125	1.607E+07	3.530E+02	5.291E+05
2126	1.607E+07	3.358E+02	5.033E+05
2127	1.607E+07	3.194E+02	4.787E+05
2128	1.607E+07	3.038E+02	4.554E+05
2129	1.607E+07	2.890E+02	4.332E+05
2130	1.607E+07	2.749E+02	4.121E+05
2131	1.607E+07	2.615E+02	3.920E+05
2132	1.607E+07	2.487E+02	3.728E+05
2133	1.607E+07	2.366E+02	3.547E+05
2134	1.607E+07	2.251E+02	3.374E+05
2135	1.607E+07	2.141E+02	3.209E+05
2136	1.607E+07	2.037E+02	3.053E+05
2137	1.607E+07	1.937E+02	2.904E+05
2138	1.607E+07	1.843E+02	2.762E+05

2139	1.607E+07	1.753E+02	2.627E+05
2140	1.607E+07	1.667E+02	2.499E+05
2141	1.607E+07	1.586E+02	2.377E+05
2142	1.607E+07	1.509E+02	2.261E+05
2143	1.607E+07	1.435E+02	2.151E+05
2144	1.607E+07	1.365E+02	2.046E+05
2145	1.607E+07	1.299E+02	1.946E+05
2146	1.607E+07	1.235E+02	1.852E+05
2147	1.607E+07	1.175E+02	1.761E+05
2148	1.607E+07	1.118E+02	1.675E+05
2149	1.607E+07	1.063E+02	1.594E+05
2150	1.607E+07	1.011E+02	1.516E+05
2151	1.607E+07	9.620E+01	1.442E+05
2152	1.607E+07	9.151E+01	1.372E+05
2153	1.607E+07	8.705E+01	1.305E+05
2154	1.607E+07	8.280E+01	1.241E+05
2155	1.607E+07	7.876E+01	1.181E+05
2156	1.607E+07	7.492E+01	1.123E+05
2157	1.607E+07	7.127E+01	1.068E+05
2158	1.607E+07	6.779E+01	1.016E+05
2159	1.607E+07	6.448E+01	9.666E+04
2160	1.607E+07	6.134E+01	9.194E+04
2161	1.607E+07	5.835E+01	8.746E+04
2162	1.607E+07	5.550E+01	8.319E+04
2163	1.607E+07	5.280E+01	7.914E+04
2164	1.607E+07	5.022E+01	7.528E+04
2165	1.607E+07	4.777E+01	7.161E+04
2166	1.607E+07	4.544E+01	6.811E+04
2167	1.607E+07	4.323E+01	6.479E+04
2168	1.607E+07	4.112E+01	6.163E+04
2169	1.607E+07	3.911E+01	5.863E+04
2170	1.607E+07	3.720E+01	5.577E+04
2171	1.607E+07	3.539E+01	5.305E+04
2172	1.607E+07	3.366E+01	5.046E+04
2173	1.607E+07	3.202E+01	4.800E+04
2174	1.607E+07	3.046E+01	4.566E+04
2175	1.607E+07	2.897E+01	4.343E+04
2176	1.607E+07	2.756E+01	4.131E+04
2177	1.607E+07	2.622E+01	3.930E+04
2178	1.607E+07	2.494E+01	3.738E+04
2179	1.607E+07	2.372E+01	3.556E+04
2180	1.607E+07	2.257E+01	3.382E+04
2181	1.607E+07	2.147E+01	3.217E+04
2182	1.607E+07	2.042E+01	3.061E+04
2183	1.607E+07	1.942E+01	2.911E+04
2184	1.607E+07	1.848E+01	2.769E+04
2185	1.607E+07	1.757E+01	2.634E+04
2186	1.607E+07	1.672E+01	2.506E+04
2187	1.607E+07	1.590E+01	2.384E+04
2188	1.607E+07	1.513E+01	2.267E+04
2189	1.607E+07	1.439E+01	2.157E+04
2190	1.607E+07	1.369E+01	2.052E+04
2191	1.607E+07	1.302E+01	1.951E+04
2192	1.607E+07	1.238E+01	1.856E+04
2193	1.607E+07	1.178E+01	1.766E+04
2194	1.607E+07	1.121E+01	1.680E+04
2195	1.607E+07	1.066E+01	1.598E+04
2196	1.607E+07	1.014E+01	1.520E+04
2197	1.607E+07	9.645E+00	1.446E+04
2198	1.607E+07	9.174E+00	1.375E+04
2199	1.607E+07	8.727E+00	1.308E+04
2200	1.607E+07	8.301E+00	1.244E+04
2201	1.607E+07	7.897E+00	1.184E+04

2202	1.607E+07	7.511E+00	1.126E+04
2203	1.607E+07	7.145E+00	1.071E+04
2204	1.607E+07	6.797E+00	1.019E+04
2205	1.607E+07	6.465E+00	9.691E+03
2206	1.607E+07	6.150E+00	9.218E+03
2207	1.607E+07	5.850E+00	8.769E+03
2208	1.607E+07	5.565E+00	8.341E+03
2209	1.607E+07	5.293E+00	7.934E+03
2210	1.607E+07	5.035E+00	7.547E+03
2211	1.607E+07	4.790E+00	7.179E+03
2212	1.607E+07	4.556E+00	6.829E+03
2213	1.607E+07	4.334E+00	6.496E+03
2214	1.607E+07	4.122E+00	6.179E+03
2215	1.607E+07	3.921E+00	5.878E+03
2216	1.607E+07	3.730E+00	5.591E+03
2217	1.607E+07	3.548E+00	5.318E+03
2218	1.607E+07	3.375E+00	5.059E+03
2219	1.607E+07	3.211E+00	4.812E+03
2220	1.607E+07	3.054E+00	4.578E+03
2221	1.607E+07	2.905E+00	4.354E+03
2222	1.607E+07	2.763E+00	4.142E+03
2223	1.607E+07	2.629E+00	3.940E+03
2224	1.607E+07	2.500E+00	3.748E+03
2225	1.607E+07	2.378E+00	3.565E+03
2226	1.607E+07	2.262E+00	3.391E+03
2227	1.607E+07	2.152E+00	3.226E+03
2228	1.607E+07	2.047E+00	3.068E+03
2229	1.607E+07	1.947E+00	2.919E+03
2230	1.607E+07	1.852E+00	2.776E+03
2231	1.607E+07	1.762E+00	2.641E+03
2232	1.607E+07	1.676E+00	2.512E+03
2233	1.607E+07	1.594E+00	2.390E+03



	LOCATION	N/A	N/C

P. LANDFILL FINAL CLOSURE REQUIREMENTS (62-701.600,FAC)

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

X	P 1			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	P 1			b. Notice to user requirements within 120 days of final receipt of wastes;
X	P 1			c. Notice to public requirements within 10 days of final receipt of wastes.

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

x	P 2a			a. Application submitted to Department at least 90 days prior to final receipt of wastes;
				b. Closure plan shall include the following:
X	P 2b			(1) Closure report;
X	P 2b			(2) Closure design plan;
X	P 2b			(3) Closure operation plan;
X	P 2b			(4) Closure procedures;
X	P 2b			(5) Plan for long-term care;
X	P 2b			(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	P 3a			(1) Identification of landfill;

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

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

	LOCATION	N/A	N/C		PART P CONTINUED
X	P 5e			e.	Development and implementation of the water quality monitoring plan required in Rule 62-701.510, FAC.
X	P 5f			f.	Development and implementation of gas management system required in Rule 62-701.530, FAC.
X	P 6			6.	Justification for and detailed description of procedures to be followed for temporary closure of the landfill, if desired; (62-701.600(7),FAC)

CQA PLAN

LENA ROAD LANDFILL
LANDFILL CLOSURE
PERMIT RENEWAL

Part P

May 24, 2005

Prepared for

Manatee County Government
Utility Operations Department
Solid Waste Division
3333 Lena Road
Bradenton, Florida 34202

Prepared by

PBS&J

482 S. Keller Rd.
Orlando, Florida 32810-6101

Part P Landfill Closure Requirements

P 1. Closure Schedule Requirements

a. Notice to The Department

One year prior to the projected date of final receipt of wastes, Manatee County will submit to the FDEP a written notice with a schedule for cessation of waste acceptance and closure of the landfill. If unforeseen circumstances do not allow a one-year notification, the County will provide written notice to the Department as soon as the need to close the landfill becomes apparent.

b. Notice to Users

At least 120 days prior to the date of final receipt of wastes, Manatee County will advise users of the intent to close the Lena Road Landfill by posting signs at the entrance of the facility. The signs will give the closing date, the person responsible for the closing, and the location of alternative disposal facilities. These signs will be maintained throughout the closure period. If unforeseen circumstances do not allow the 120-day notice, Manatee County will provide notification to users as soon as the need to close the landfill becomes apparent.

c. Notice to Public

Within ten days prior to the date of final receipt of waste, Manatee County will publish a notice of the landfill closing in the legal advertising section of a newspaper of general circulation in the County. Manatee County will also provide proof of publication to the FDEP within seven days of publication.

P 2. Closure Permit General Requirements

a. Submittal of Application for Closure

An application for final closure with the Closure Plan will be submitted to the Department at least 90 days prior to final receipt of wastes.

b. Closure Plan

The Closure Plan includes:

(1) Closure report – See Part P 3.
(2) Closure design – See Part P 4.
(3) Closure operation plan – See Part P 5.
(4) Closure procedures – See Part P 7 and Part Q.
(5) Long-term care Plan – See Part P 8.
(6) A demonstration that proof of financial responsibility for long-term care will be provided – See Part S of this application

This Closure Plan is in accordance with Section 62-701.600, F.A.C.

Part P Landfill Closure Requirements

P 3. Closure Report Requirements

a. General Information Requirements:

(1) The identification of the landfill is given on the application in Part A 4 and 5.

(2) The location of the landfill is given in Part A 6 and 7. The description of the facility is given in the application in Part A. The location of the facility is shown on Figure E-1. The information for facility vicinity map is shown on Figures E-2, E-3 and E-4. Figures E-1, E-2, E-3 and E-4 are not changed from those submitted in "Application and Engineering Report for Renewal of Landfill Operation Permit for Lena Road Landfill", (3-hole punched bound documents) dated April 30, 2004 (received by FDEP on May 14, 2004), as revised, replaced or amended (information inserted into original) dated September 9, 2004, October 6, 2004, December 14, 2004, February 7, 2005 and March 17, 2005.

(3) The total disposal area is 316 acres. The landfill property is 740.2 acres.

(4) The legal property description is included on Drawing #3 Property Boundary in Appendix B submitted by HDR in the landfill operation permit application dated December 31, 1997. This application led to FDEP issuing Operation Permit No. 39884-001-SO with July 28, 1999 as the date of issue.

(5) History of the Landfill – This is a Class I landfill operated by Manatee County. The site was originally a dump that was converted to a trench landfill. With the change in regulations, a slurry wall and leachate collection system was built around the solid waste and area proposed for future solid waste disposal. Interior slurry walls divided the landfill into three stages called Stage I, Stage II and Stage III. The western area of the Stage III Landfill contains the original dump and trench landfill. High-rise landfill construction started in the Stage I Landfill, and moved to the Stage III Landfill in February 2004. When the Stage III Landfill reaches capacity, which is projected as year 2013, solid waste disposal will move into the Stage II Landfill and continue until approximately 2034 to 2038. Final landfill closure will take an estimated two years. Long-term care should start in 2041 and continue until at least 2071. The Stage I Landfill Partial Closure #1 closed 30-acres on the east and south slope of the landfill. Stage I Landfill Partial Closure #2, which is scheduled for 2005 and 2006, will close approximately 58-acres on the south, west and top of the Stage I Landfill.

(6) Identification of types of waste disposed of at the landfill is given in Part B 8.

b. Information on the geotechnical report was submitted in Part J of "Application and Engineering Report for Renewal of Landfill Operation Permit for Lena Road Landfill", (3-hole punched bound documents) dated April 30, 2004 (received by FDEP on May 14, 2004), as revised, replaced or amended (information inserted into original) dated

September 9, 2004, October 6, 2004, December 14, 2004, February 7, 2005 and March 17, 2005. Information on the hydrogeological investigation was included in Part I of that same application. The water quality monitoring plan required by Rule 62-701.330(3), FAC was included in Part M of that application. No changes are proposed to the water quality monitoring for the partial closure of the Stage I Landfill.

c. Land use and zoning information was submitted in "Application and Engineering Report for Renewal of Landfill Operation Permit for Lena Road Landfill", (3-hole punched bound documents) dated April 30, 2004 (received by FDEP on May 14, 2004), as revised, replaced or amended (information inserted into original) dated September 9, 2004, October 6, 2004, December 14, 2004, February 7, 2005 and March 17, 2005. Land use information was included on the Vicinity Map Figure E-2 Sheet 2 of 2. The zoning information was included on the Vicinity Map Figure E-2 Sheet 1 of 2. The roads, highways right-of-ways or easements were shown on the Vicinity Map Figure E-2.

d. Report on actual or potential gas migration at landfills containing degradable wastes, which would allow migration of gas off the landfill property. This landfill contains degradable wastes and has the potential for gas migration off the property. The landfill has a perimeter network of landfill gas migration monitoring probes to detect the actual movement of landfill gas in the direction of the property line. The location of the probes and the monitoring plan is included in Part L of this application. After closure, the monitoring plan will continue during the long-term care period. The perimeter slurry wall reduces the potential for landfill gas migration off-site. The slurry wall contains a low permeability bentonite soil, and was primarily constructed to retain leachate on-site but is also a barrier to landfill gas migration. The high groundwater table also acts as a barrier to landfill gas migration off-site through the ground. The elevation for the top of ground in the vicinity of the landfill is varies between El. 34 and 38. The ground water elevation in the vicinity of the landfill varies between top of ground and El. 27. The invert for the solid waste is at approximately El. 29. Also, the landfill gas collection system keeps the landfill under vacuum and the flow of landfill gas is away from the perimeter and towards the landfill gas extraction system. The perimeter slurry wall, high groundwater table and landfill gas extraction system prevents landfill gas from migrating off-site through the soil.

e. Report assess the effectiveness of the landfill design and operation including results of geotechnical investigations, surface water and stormwater management, gas migration and concentrations, condition of existing cover and nature of waste disposed of at the landfill. - Based on the results of the geotechnical investigation, surface water and stormwater management and water quality testing, gas migration and concentration monitoring, leachate collection, treatment and monitoring of leachate quality, landfill gas collection and flaring system, condition of the existing cover in the 30-acres already closed, condition of the cover soil in the landfill with intermediate cover and nature of the solid waste disposed of the landfill through elimination of hazardous waste by use of trained spotters, the landfill design and operation has proved effective in protecting the environment and keeping the landfill from spreading pollution off site.

P 4. Closure Design Requirements to be Included in the Closure Design Plan

The Stage I Landfill Partial Closure #2 Drawings dated July 2005 are included with Response 1 for this permit application. A complete list of drawings is given on the cover page. (Rev. Aug. 25, 2005)

a. Plan Sheet showing Phases of site closing - ~~The closure phasing plan is shown on Final Closure Drawing C-2.~~ The Stage I Landfill Partial Closure #2 limits are shown on Drawing C-2. (Rev. Aug. 25, 2005)

b. Drawing showing existing topography and proposed final grades - The existing topography and proposed final grades are shown on ~~Final Closure Drawing C-2.~~ Drawings C-8, C-9 and C-10. (Rev. Aug. 25, 2005)

c. Provisions to close units when they reach approved design dimensions - ~~The landfill closure phasing schedule is shown on Final Closure Drawing C-2.~~ The Stage I Landfill Partial Closure #2 limits are shown on Drawing C-2. (Rev. Aug. 25, 2005)

d. Final elevations before settlement - The final design elevations before settlement for the Stage I Landfill Partial Closure #2 are shown on ~~Final Closure Drawing C-2~~ Drawings C-8, C-9 and C-10. (Revised August 25, 2005)

e. Side slope design - The landfill side slope between terraces is 5H:1V. Including terraces, the overall side slope from the toe of the solid waste to the crest of the landfill is 6H:1V. This is much flatter than the 3H:1V maximum side slopes permitted by the FDEP regulations. The side slope and foundation analysis for the overall stability of the landfill was submitted with Part J, and showed that the landfill was stable. The closure design calls for a textured geomembrane on the side slopes covered by Tenax Tenflow a double-sided capping geocomposite comprised of a tri-axial geonet structure with thermally bonded, nonwoven, AASHTO Class 2 geotextiles on both sides. ~~a bonded composite geonet with at least an 8 ounce geotextile.~~ (Rev. Aug. 25, 2005) The angle of friction between the protective cover soil of sand and the geotextile is at least 26°. By the infinite slope method of analysis, the factor of safety for the cover soil sliding on a 5H:1V (11.31°) plane between the soil and the geotextile is 2.45 (F.S. = tan 26°/tan 11.31°).

f. Final Cover Installation Plans

(1) The CQA plan for installing and testing final cover is included in Appendix A of Part P.

(2) Schedule for Installing Final Cover After Final Receipt of Waste - ~~The schedule for installing final cover after final receipt of waste is shown on Final Closure~~

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~~Drawing C-2 of the Final Closure Drawings~~. The Stage I Landfill Partial Closure #2 is scheduled to start 120 days after the closure permit is renewed, and be completed within 365 days. (Revised Aug. 25, 2005)

(3) Description of drought-resistant species to be used in the vegetation cover - Bahia Sod is the drought-resistant species to be used in the vegetation cover.

(4) Top gradient design to maximize runoff and minimize erosion - The top gradient is 4.2% to maximize runoff and minimize erosion.

(5) Provisions for cover material to be used for final cover maintenance – This is an active landfill that will continue in operation until the projected year of 2038. Stockpile of initial cover soil will be available for final cover maintenance. After final closure is completed in about 2041, a 100 cubic yard cover soil stockpile to provide cover soil material for final cover maintenance will be kept at the location shown on Final Closure Drawing C-2 submitted for renewal of the landfill operation permit. (Revised Aug. 25, 2005)

g. Final Cover Design Requirements

A typical section of the final cover is shown on ~~Final Closure~~ Drawing C-~~5~~ C-11in the Typical Final Cap Detail. The final cover will consist of:

- A 6-inch thick bedding for the geomembrane barrier layer. The bedding will consist of soil, which is primarily sand with at least 100% passing a ½ inch sieve. The intermediate cover may be used as bedding if it meets this gradation and is free of all vegetation, roots, and other debris that may puncture the geomembrane.
- A geomembrane barrier layer, which will be a 40-mil LLDPE geomembrane liner. The geomembrane will be textured on the side slopes, and smooth on slopes flatter than 5H:1V. The LLDPE geomembrane used in the barrier layer will be a semi-crystalline thermoplastic with at least 40 mils average thickness as defined by method GRI GM13, with a maximum water vapor transmission rate of 2.4 g/(m^2xday), have a chemical and physical resistance to materials it may come in contact with and withstand exposure to the natural environmental stresses and forces throughout the installation, seaming process and settlement of the waste during the closure and long-term care period.
- ~~A double composite geonet with an 8-oz non-woven geotextile for protection of the barrier geomembrane and drainage of the protective soil layer.~~ Tenax Tenflow a double-sided capping geocomposite comprised of a tri-axial geonet structure with thermally bonded, nonwoven, AASHTO Class 2 geotextiles on both sides. (Rev. Aug. 25, 2005)
- A 24-inch protective soil layer, which will consist primarily of sand with 100% passing the ½ inch sieve.
- Bahia sod will be placed over the protective soil as a drought-resistant species for the vegetative cover.

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h. Proposed Method of Stormwater Control - Collecting runoff in terraces at approximately El. 55, El. 75, El. 95, and El. 110 will control stormwater. The terrace will be sloped to stormwater inlets approximately 300 feet apart. The stormwater inlets will transfer the runoff to polyethylene stormwater pipes that will safely carry the stormwater to the toe of the landfill without erosion. At the end of the stormwater pipe there will be an energy dissipator to transfer the runoff to the perimeter stormwater swale without erosion. The location for the stormwater inlets and pipes are shown on Drawings C-9 and 10. ~~Final Closure Drawing C-2 Final Grading and Drainage Plan.~~ Typical sections and details for the storm water control system are shown on Drawings C-11, C-12 and C-13 ~~C-3, C-4, and C-5.~~ (Rev. Aug. 25, 2005)

i. Proposed method of Access Control - The landfill property is fenced as a method of access control. After final closure is complete, the fence will be maintained and the gate locked as a method of access control.

j. Description of Proposed Final Use of the Closed Landfill, if any - At this time, no final use of the closed landfill is proposed, if any. So no description can be submitted. Prior to any final use of the closed landfill, the landfill owner will consult the Florida Department of Environmental Protection, and submit a plan and construction details for any proposed structures.

k. Description of the Proposed or Existing Gas Management System, which Complies with Rule 62-701.530, FAC - There is a landfill gas collection system and flare for the Stage I Landfill. This system will be expanded as the landfill is filled. The landfill gas collection system is shown on Drawings C-3, C-4, C-5, and C-6 ~~Final Closure Drawings C-6, C-7, and C-8.~~ (Rev. Aug. 25, 2005)

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P 5. Closure Operation Plan shall include:

l. Detailed description of actions, which will be taken to close the landfill - The detailed description of actions to be taken to close the landfill are given in Part P 7 Closure Procedures

m. Time schedule for completion of closing and long-term care - The time schedule for closure of each stage of the landfill is included on the Landfill Closure Phasing Plan on Final Closure Drawing C-2 submitted for renewal of the Operation Permit. Stage II, the final landfill stage, is projected to be full in 2038. Due to the size and complexity of the closure, the final closure work will take two years. The final closure should be completed by January 2041, and the 30-year long-term care and monitoring will continue until 2071. The Stage I Landfill Partial Closure #2 is scheduled to start 120 days after the closure permit is renewed, and be completed within 365 days. (Revised August 25, 2005)

n. Describe proposed method for demonstrating financial responsibility - The proposed method for demonstrating financial responsibility is given in Part S of this application.

o. Indicate any additional equipment and personnel needed to complete closure - The landfill owner will contract with a contractor to complete the closure. So the landfill owner does not require any additional equipment and personnel to complete the closure.

a. Development and Implementation of the Water Quality Monitoring Plan Required in Rule 62-701.510 FAC - The Water Quality Monitoring Plan is included in Part M of this application.

P. 6. Justification for and Detailed Description of Procedures to be followed for Temporary Closure of the Landfill - The landfill owner has no intentions to temporarily close the landfill.

P.7. Closure Procedures

The owner or operator is responsible for the closure procedures as follows:

1. Send out the notices as required in Part P 1.
2. Apply for final closure of the landfill at least 90 days before the date when wastes will no longer be accepted. The application shall be on Form 62-701.900(1). If the landfill is in operation under a Department permit, the owner or operator shall request a modification of the permit in lieu of submitting a closure permit application. The application or request shall include a closure plan, which is made up of the information listed in Part P 2 of this application. The required information is included in Part P of this application.
3. Prepare a request for proposals from contractors to construct the landfill closure as permitted by FDEP.
4. Award a contract to construct the closure.
5. The contractor will:

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- Clear vegetation from the landfill surface where the cap will be installed
- Regrade and fill depression on the landfill surface to get the slopes as shown on the final closure drawing and eliminate any depressions that may pond water
- Proof roll the landfill surface and correct grades as needed
- Install any remaining landfill gas extraction wells required by the closure
- Place the 6-inch bedding for the geomembrane
- Place the geomembrane
- Place the bonded composite geonet
- Install the landfill gas laterals and connect the landfill gas extraction wells to the header.
- Place the stormwater inlets, downcommer pipes and energy dissipators

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- Place the 24-ich layer of protective soil cover
- Place the sod
- Prepare the record construction drawings with the final landfill topography

6. The closure procedures required by 62-701.610 FAC, shall be as follows:

- The Department shall specify in the closure permit which particular closing steps or operations must be inspected and approved by the Department before proceeding with subsequent closure actions
- After closure is completed, the owner or operator shall prepare a final survey or aerial mapping of the closed landfill.
- A certification of closure construction completion, signed, dated and sealed by a professional engineer independent of the contractor, shall be provided to the Department upon completion of closure. All substantial deviations from the permitted closure plan shall be noted.
- After closure operations are inspected and approved by the Department, the landfill owner or operator shall file a declaration to the public in the deed records in the office of the county clerk in the county in which the landfill is located. The declaration shall include a legal description of the property on which the landfill is located and a site plan specifying the area actually filled with solid waste. The declaration shall also include a notice that any future owner or user of the site should consult with the Department prior to planning or initiating any activity involving the disturbance of the landfill cover, monitoring systems or other control structures. A certified copy of the documentation shall be filed with the Department.
- Upon receipt of the documents required, which are the survey, closure certification and declaration to the public, the Department shall within 30 days acknowledge by letter to the facility operator that notice of termination of operation and closing of the facility has been received. If the entire landfill has been closed, the date of this letter shall be the official date of landfill closing for the purpose of determining the long-term care period. If only a portion of the landfill has been closed, the long-term care period will begin upon the closing of the entire landfill, unless the portion, which has been closed, can be monitored and maintained separately from the rest of the landfill. The date of this letter shall be the official date of landfill closing for the purpose of determining the long-term care period.

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P.8. Long-term Care Plan (Revised March 22, 2006)

The long-term care plan consists of the following:

Monthly Site Inspections. The County inspector shall look for and take the following action:

EROSION Covered disposal areas, or other disposal areas which exhibit significant erosion, shall be repaired according to the following schedule:

1. If the cover materials have eroded such that greater than 50% of the cover in that location has been eroded, then initiate repair of the affected area within three (3) days of discovery (or after the event that caused the erosion such as a hurricane); and
2. If waste is exposed, then repair the affected area by the end of the next working day (or after the event that caused the erosion such as a hurricane).

DAMAGE In the event of damage to any portion of the landfill site facilities, unauthorized stormwater/leachate discharge outside the slurry wall, failure of any portion of the landfill systems (including damaged or dry groundwater monitoring wells), fire, explosion, the development of sinkhole (s) or other subsurface instability at the site, the permittee shall immediately (within 24 hours) notify the Department explaining such occurrence and remedial measures to be taken, method to prevent reoccurrence, and time frame needed for repairs. Written, detailed notification shall be submitted to the Department within (7) days following the occurrence. Routine maintenance does not require notification, but shall be noted on daily reports.

ILLEGAL DUMPING If illegal dumping is found, the waste shall be collected within 48-hours and disposed of at a Class I solid waste landfill, a no dumping sign shall be posted and the police notified. The inspector should also look through the solid waste illegally dumped for names, addresses and phone numbers that could be used by the police to prosecute illegal dumpers.

TRESSPASSERS If trespassers are spotted, the inspector shall immediately call the police. If signs of trespassers are found, the inspector shall look for any signs of the method of entry to the site, such as a broken fence of broken lock. If a lock is broken, it should be immediately replaced. If a fence is broken such as to allow entry to the site, the fence shall be replaced with in 7-days, and a no trespassing sign posted at the location of the illegal entry.

NEED TO CUT VEGETATION The inspector shall check the height of the vegetation. The vegetation must be maintained at less than 18-inches in height, which requires cutting the vegetation every 4 to 8 weeks, or between 8 and 10 times per year depending on annual rainfall and vegetation growth. If the vegetation is greater than 18-inches in height, the inspector shall call the mowing crew.

STOMWATER INLETS AND OUTFALLS Monthly and after major storm events the inspector shall check the stormwater culverts and remove debris from the inlets immediately.

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DEAD VEGETATION Dead vegetation on the cover in areas greater than one square yard shall be replaced as needed with Bahia sod to prevent erosion, but no less than once a year all dead vegetation in areas greater than one square yard shall be replaced.

SETTLEMENT Settled areas or areas with standing water shall be marked, and fill placed in depressions. Areas which exhibit settlement (low spots and improperly graded areas) that may cause ponding of water shall be repaired (additional soil placed, regarded, seeded and/or sodded) within seven (7) days.

MONITORING SYSTEMS The inspector shall check the monitoring system. If a monitoring well is destroyed or can't be sampled, the County shall immediately (within 24-hours) notify the Department of Environmental Protection explaining such occurrence and remedial measures to be taken and time needed for repairs. Written detailed notification shall be submitted to the Department within seven (7) days following the occurrence. A minor permit modification application must be submitted to the Department to abandon and replace monitoring wells. Per 62-701.620 (10): "All inoperative monitoring devices shall be replaced with functioning devices within 60-days of the discovery of the malfunctioning unit unless the landfill owner or operator is notified otherwise in writing by the Department."

LEACHATE MANAGEMENT SYSTEM The inspector shall check the leachate management system, and monthly measure the hydraulic gradient across the slurry wall at the monitoring well / piezometer pairs, and report the results quarterly. In the event that the leachate management systems are damaged or are not operating effectively, the FDEP shall be notified within 24-hours. Written detailed notification shall be submitted to the Department within seven (7) days following the occurrence. Corrective actions shall be initiated within thirty (30) days of the written notification, unless otherwise approved by the Department.

LANDFILL GAS MANAGEMENT SYSTEM The inspector shall check the landfill gas management system, and monthly adjust the landfill gas collection system wellheads and flare. In the event that the landfill gas management system is damaged or is not operating effectively, the FDEP shall be notified within 24-hours. Written detailed notification shall be submitted to the Department within seven (7) days following the occurrence. Corrective actions shall be initiated within thirty (30) days of the written notification, unless otherwise approved by the Department. In addition, the landfill gas collection system and flare shall be operated in compliance with the Startup/Shutdown/Malfunction Plan on file with FDEP.

GAS REMEDIATION If the results of gas monitoring show that combustible gas concentrations exceed 25% of the LEL calibrated to methane in structures or 100% of the LEL calibrated to methane at the property boundary, the permittee shall immediately take all necessary steps to ensure protection of human health and notify the Department. Within 7 days of detection, a gas remediation plan detailing the nature and extent of the problem and the proposed remedy shall be submitted to the Department for approval. The remedy shall be completed within 60 days of detection unless otherwise approved by the Department."

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In addition, the following is required:

- Semiannually sampling and testing of groundwater from the groundwater monitoring wells and surface water monitoring points. Prepare and submit the semi-annual water quality monitoring reports.
- Annual sampling and testing of leachate. One leachate sample will be taken from each leachate pump station. The leachate will be tested as specified in the permit.
- Prepare and submit the monthly leachate generation reports, and quarterly landfill gas-monitoring reports.
- Prepare and submit the Title V Air Permit Reports.
- Conduct an annual surface emissions monitoring survey, and submit a report per the Title V Air Permit.
- Annually by September 1, prepare an update of the financial assurance cost estimate form.
- Renew the permit per the permit condition (Every five to ten years as required.)

Revised March 22, 2006

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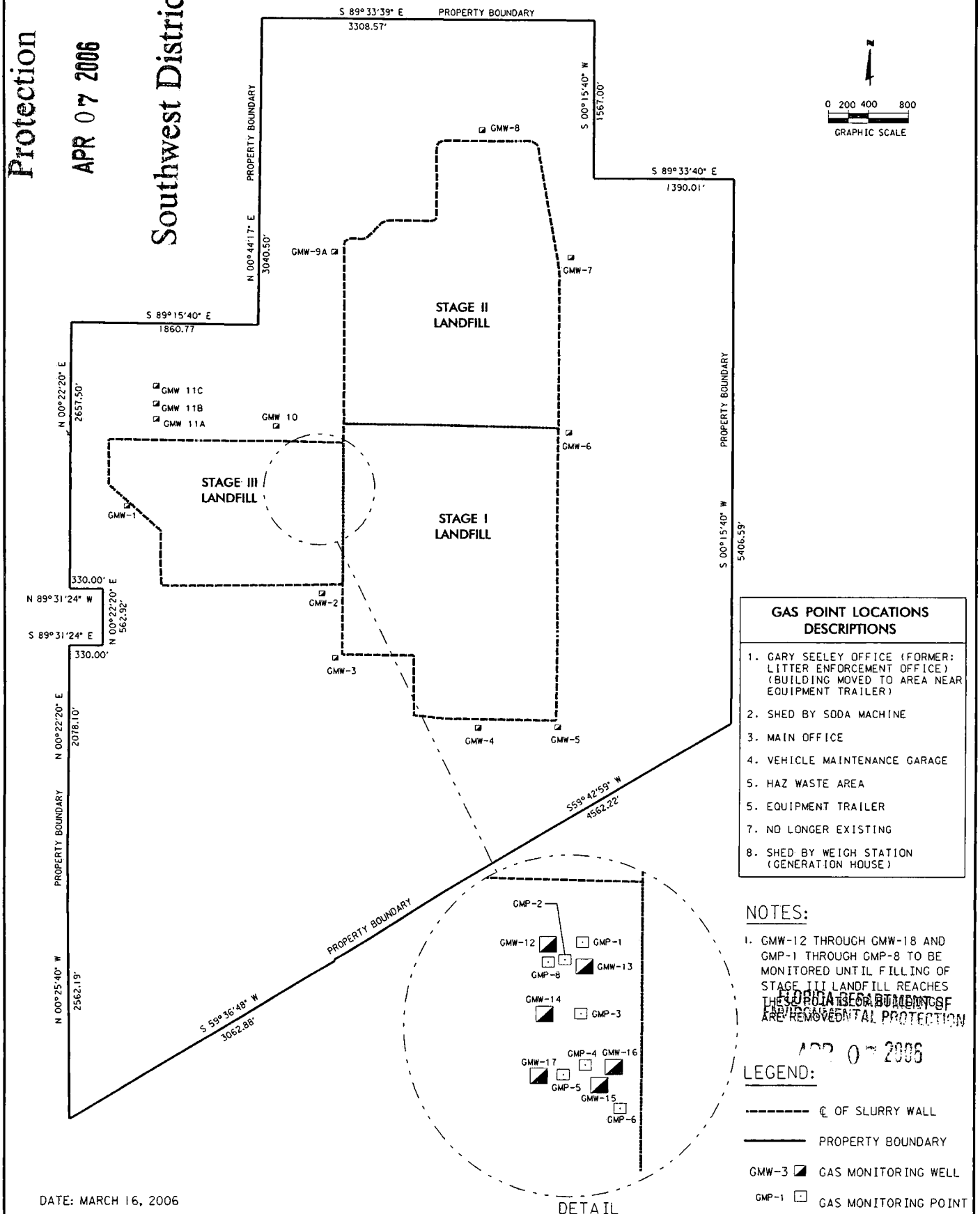
Dept. of Environmental Protection
Southwest District
APR 07 2006



GAS POINT LOCATIONS DESCRIPTIONS

1. GARY SEELEY OFFICE (FORMER: LITTER ENFORCEMENT OFFICE) (BUILDING MOVED TO AREA NEAR EQUIPMENT TRAILER)
2. SHED BY SODA MACHINE
3. MAIN OFFICE
4. VEHICLE MAINTENANCE GARAGE
5. HAZ WASTE AREA
5. EQUIPMENT TRAILER
7. NO LONGER EXISTING
8. SHED BY WEIGH STATION (GENERATION HOUSE)

NOTES:

1. GMW-12 THROUGH GMW-18 AND GMP-1 THROUGH GMP-8 TO BE MONITORED UNTIL FILLING OF STAGE III LANDFILL REACHES THE SOUTHEASTERN BOUNDARY OF THE LANDFILL AND GAS PIPES ARE REMOVED.

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LEGEND:

- ℄ OF SLURRY WALL
- PROPERTY BOUNDARY
- GMW-3 GAS MONITORING WELL
- GMP-1 GAS MONITORING POINT

DATE: MARCH 16, 2006

PBS&J

LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

LANDFILL GAS MIGRATION MONITORING LOCATIONS

FIG. L-8A

\\ORLFS1\ECS\OLDH_S\ENVCADD\WASTEMAN\MANATEE\LENARD\PERMIT-RENEWAL-2004\MLR_FIG-L-8A.DGN

16-MAR-2006 13:50 --- EMP. NO: 9327

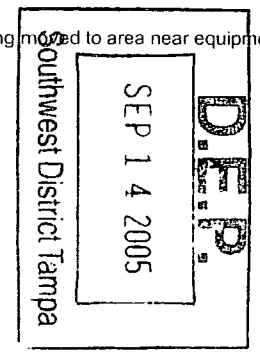
MANATEE COUNTY LENA ROAD LANDFILL
SUMMARY OF READINGS FOR SUBSURFACE MONITORING PROBES AND ONSITE STRUCTURES
FROM DECEMBER 2001 THROUGH JUNE 2005

Well	YEAR/MONTH OF READING IN % LEL																
	2001	2002				2003				2004				2005			
	Dec.	Mar	Jun	Sept	Dec	Mar	Jun	Sept	Dec	Mar	Jun	Sept	Dec	Mar	Jun	Sept	Dec
1	0%	0%	2%	1%	0%	0%	0%	0%	0%	0%	0%	2%	0%	1%	1%		
2	0%	0%	0%	2%	2%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%		
3	0%	0%	0%	1%	0%	0%	1%	1%	0%	0%	0%	2%	0%	0%	0%		
4	0%	0%	0%	1%	2%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%		
5	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	2%	0%	1%	0%		
6	0%	0%	0%	0%	0%	0%	1%	1%	0%	1%	0%	2%	0%	1%	0%		
7	0%	0%	0%	0%	2%	0%	0%	0%	0%	1%	0%	2%	0%	2%	0%		
8	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	2%	0%	1%	0%		
9	0%	0%	na	na	2%	0%											
9A							0%	0%	0%	0%	0%	1%	0%	3%	0%		
10	0%	na	0%	0%	2%	0%	0%	0%	0%	0%	0%	2%	0%	1%	0%		
11	0%	0%	na	na	2%	na											
11A								100%	57%	124%	280%	>100%	>100%	>100%	>100%		
11B											2%	4%	0%	2%	0%		
11C											0%	0%	0%	2%	0%		
12	0%	0%	0%	2%	2%	0%	1%	1%	0%	0%	0%	2%	0%	4%	0%		
13	0%	0%	0%	1%	2%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%		
14	0%	0%	0%	2%	2%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%		
15	na	0%	0%	2%	0%	2%	10%	0%	0%	0%	0%	4%	0%	2%	0%		
16	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%		
17	0%	0%	0%	2%	0%	0%	4%	2%	0%	0%	0%	1%	0%	1%	0%		
18	11%	28%	>100%	1%	18%	18%	22%	5%	42%	1%	70%	Note 1					

Notes:
1. Well 18 is located in the Stage III Landfill in an area previous filled with solid waste. Well 18 was removed in Sept. 2004 during filling of the Stage III Landfill.

POINT																	
1	0%	0%	0%	1%	0%	2%	0%	0%	0%	0%	0%	2%	0%	2%	0%		
2	0%	0%	0%	1%	0%	2%	0%	0%	0%	0%	0%	2%	0%	0%	0%		
3	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	2%	0%	2%	0%		
4	0%	2%	0%	2%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%		
5	0%	0%	0%	1%	0%	2%	8%	0%	0%	0%	0%	2%	0%	0%	0%		
6	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%		
8	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%		

Gas Point Location Descriptions
1. Gary Seely Office (to become secure storage. Building moved to area near equipment trailer.)
2. Pre-fab shed on north side of Office
3. Main office.
4. Vehicle Maintenance Garage
5. Haz Waste Area (All Storage Sheds)
6. Equipment Trailer
7. Deleted
8. Generator House



PART P

APPENDIX A

Construction Quality Assurance Plan for Installing and Testing Final Cover for Lena Road Stage I Landfill

Partial Closure #2

March 22, 2006

Prepared for

Manatee County
Utilities Operations Department
Solid Waste Division

Dept. of Environmental Protection

APR 07 2006

Southwest District

Prepared by

PBS&J

482 South Keller Road
Orlando, Florida 32810
Phone (800) 284-5182
Supervising Professional Engineer
Joseph L. Miller, P.E. (#39177)

PROJECT # 120498.46

JOSEPH LAWRENCE MILLER LICENSE No. 39177 STATE OF FLORIDA PROFESSIONAL ENGINEER

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Attachment A - Forms

Daily Field Report
Certificate of Subgrade Acceptance
Panel Placement Log
Trial Weld Testing Report
Seaming Log
Seam Non-Destructive Testing Log
Seam Destructive Sample and Testing Log
Geomembrane Cover Acceptance Form

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1.0 Introduction

1.1 Purpose and Scope

This Construction Quality Assurance (CQA) Plan is for the landfill cap to be constructed as part of the Lena Road Stage I Landfill Partial Closure #2.The Design Engineer prepared this CQA plan for Manatee County and the Florida Department of Environmental Protection (FDEP) to assure that the landfill final cover meets the FDEP regulations, contract construction drawings, and specifications. This plan describes the quality assurance for manufacturing, transportation, storage, handling, and installation of the geomembrane, double-sided capping geocomposite, soil bedding under the geomembrane and protective soil layer over the geomembrane.

A typical section of the final cover landfill cap is shown on Closure Drawing C-11 in the Typical Final Cap Detail. The final cover will consist, from bottom to top, of:

- A 6-inch thick protective soil bedding for the geomembrane barrier layer. The protective soil bedding will consist of sandy soil with at least 100% passing a ½-inch sieve. The intermediate cover may be used as protective soil bedding if it meets this gradation and is free of all vegetation, roots, stones, etc. smaller in size than ½ inch, and other debris that may puncture the geomembrane.

- A geomembrane barrier layer, which will be a 40-mil LLDPE geomembrane. The geomembrane will be textured on the side slopes, and smooth on all slopes flatter than 5H:1V. The LLDPE geomembrane used in the barrier layer will be a semi-crystalline thermoplastic with at least 40 mils average thickness as defined by method GRI GM13, with a maximum water vapor transmission rate of 2.4 g/ (m^2xday), have a chemical and physical resistance to materials it may come in contact with and withstand exposure to the natural environmental stresses and forces throughout the installation, seaming process and settlement of the waste during the closure and long-term care period.

- A double-sided capping geocomposite for drainage over the textured geomembrane on the side slopes.

- A 24-inch protective soil layer, which will be a sandy soil with 100% passing the ½-inch sieve.

- Bahia sod will be placed over the protective soil as a drought-resistant species for the vegetative cover.

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1.2 Project Party Definitions and Responsibilities

The project will involve the interaction of the Owner, the Design Engineer, the General Contractor, the Manufacturer, Geosynthetic Installer, Construction Quality Assurance Monitors (CQAM), and the FDEP. The following provides the description, the qualifications required, and the responsibilities of these individual parties, and others who will be involved in the project. The minimum personnel qualifications for individuals comprising the project party are shown in Table 1-1, and an organizational chart is presented in Table 1-2.

1.2.1 Permitting Agency

The permitting agency reviews the Owner's permit application including the site-specific CQA plan for compliance with the regulations and issues the permit for the work. FDEP may also visit the construction site to observe the work in progress, and upon completion, review the Certificate of Construction Completion.

1.2.2 Owner/Operator

The Owner/Operator, Manatee County, is responsible for design, construction, and operation of the facility and this project. The Owner/Operator has the authority to select and dismiss organizations charged with the design and construction, and CQA Plan. The Owner/Operator is responsible for complying with the requirements of the permitting agency, the submission of CQA data, and assuring the permitting agency that the facility was constructed as specified in the construction plans and specifications, and as approved by the permitting agency. The Owner/Operator is responsible for final acceptance of the closure construction with consideration of recommendations from the Design Engineer and the Owner's Representative.

1.2.3 Owner's Representative

The Owner's Representative is responsible for coordinating schedules, meetings, and field activities. This responsibility includes communications to other members in the owner's organization, permitting agency, material suppliers, general contractor, specialty subcontractors or installers, and CQA Monitor.

Table 1-1
PERSONNEL QUALIFICATIONS

Individual	Qualification
Permitting Agency	Florida Department of Environmental Protection
Owner/Operator	Entity permitted to own/operate facility.
Design Engineer	Registered Professional Engineer employed by Owner
Owner's Representative	Registered Professional Engineer, Engineer in Training, Certified CQA Monitor or Construction Manager
General Contractor	State licensed contractor to whom the Owner awards construction of the project.
Earthwork Subcontractor	Subcontractor responsible for the earthwork.
Subcontractors	Contractors employed by the general contractor for special skills, such as surveyor, piping, geosynthetics installer, etc.
Geosynthetic Manufacturer	Experience in manufacturing at least 1,000,000 m^2 (10,000,000 ft^2) of similar geosynthetic materials.
MQC Personnel	Manufacturer's trained personnel in charge of quality control of the geosynthetic materials manufactured.
MQC Officer	The manufacturer's designated individual in charge of the geosynthetic material quality control program.
Geosynthetics Installer	Experience installing at least 1,000,000 m^2 (10,000,000 ft^2) of similar geosynthetic materials. This may be the general contractor or a subcontractor.
CQC Personnel	Employed by the geosynthetics installer; certified by NICET.
CQA Monitor	Employed by the Design Engineer. A Florida Register Professional Engineer or Level III NICET Certified. Assistant Monitors must be Level II NICET Certified. Maximum of 2 crews per monitor.
CQA Certifying Engineer	Design Engineer Florida Registered Professional Engineer
Geosynthetic Testing Laboratory	Certified by NICET
CQA Soils Engineer	State certified to sample and test soil for engineering.

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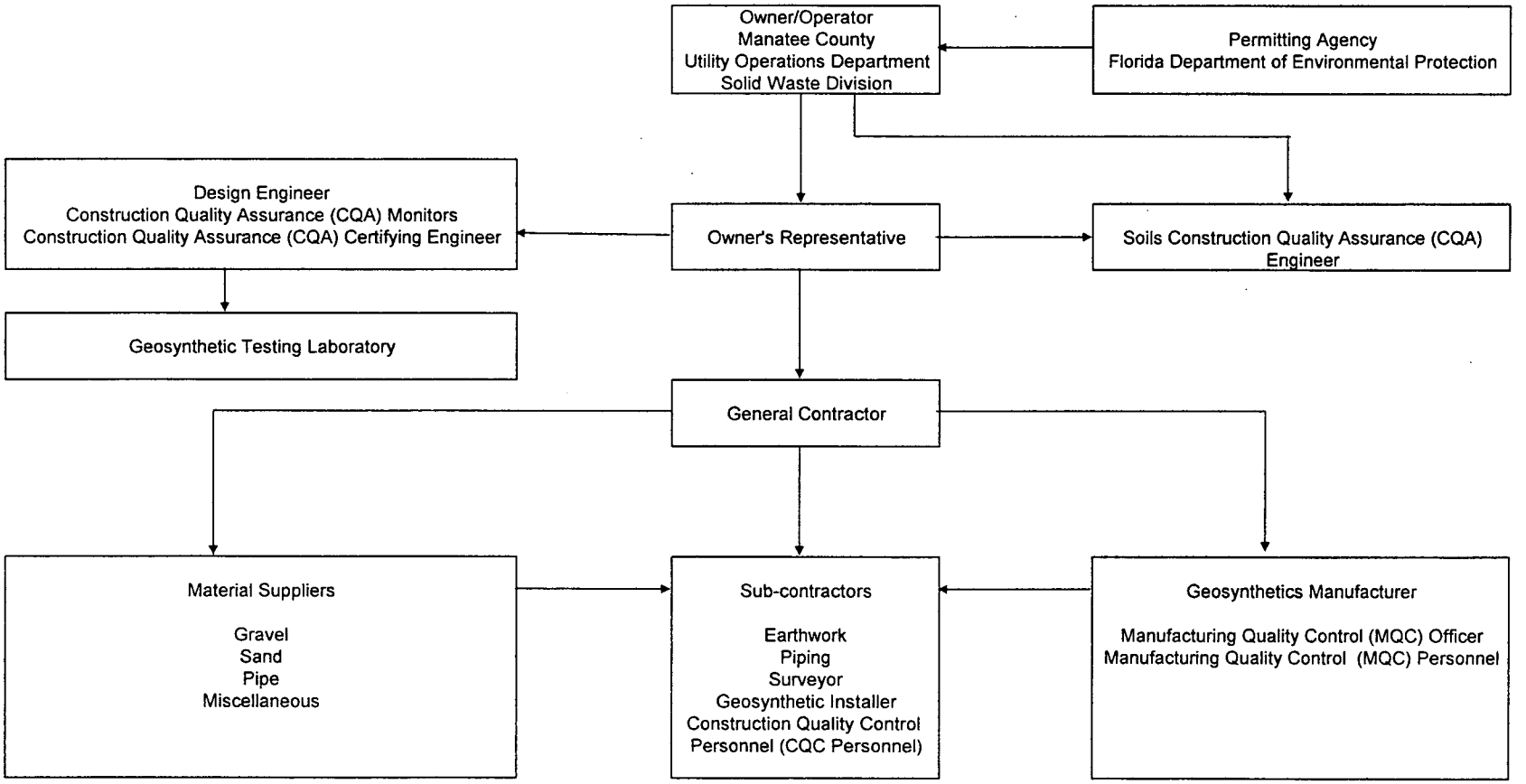
Table 1-2

Organization Chart For

Manatee County Lena Road Landfill - Stage I Landfill Partial Closure #2
Quality Assurance Plan



1.2.4 Design Engineer

The Design Engineer, PBS&J, has the responsibilities assigned to the Engineer in the Contract Documents and in this CQA Plan. The Design Engineer's primary responsibility is to design a facility that meets the operational requirements of the Owner/Operator, complies with accepted design practices, and meets the requirements of the permitting agency. The Design Engineer may need to change some aspects of the design if unexpected conditions are encountered during construction (e.g., a change in site conditions, unanticipated logistical problems during construction, or lack of availability of certain materials). The Design Engineer's responsibilities with respect to the CQA Plan are:

- Attendance at a preconstruction meeting to clarify objectives and goals to be achieved for the closure.
- Review of shop drawings submitted by the General Contractor, and make recommendations to the Owner for acceptance or rejection.
- Make periodic site visits to review the construction quality.
- Review the work of the CQAM
- Consult with the Owner's Representative as needed

1.2.5 General Contractor

The General Contractor has overall responsibility for construction of the project, ensuring that it is constructed in accordance with the contract plans and specifications that have been developed by the Design Engineer and approved by the Permitting Agency, and for construction quality control during construction. The General Contractor is also responsible for informing the Owner and the CQA Engineer of the scheduling and occurrence of all construction activities.

The General Contractor shall provide the services of manufacturers, geosynthetic installer and other subcontractors needed to construct the landfill closure. The General Contractor arranges for purchase of materials that meet specifications and contracts with an installer (if the General Contractor is not qualified). The General Contractor shall accept and retain full responsibility for the quality control of all materials and installation and shall be held responsible for ensuring that the materials and the workmanship meet the requirements of the contract plans and specifications.

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The General Contractor shall be responsible for the submittal to the Design Engineer, for approval, of all information related to the qualifications of any subcontractors providing services for the closure. Any subcontractors to the General Contractor on this installation shall coordinate their activities through and interface with the General Contractor only. Information to be

contained in the qualifications submittal for the geomembrane manufacturer and installer is detailed in the following text.

Transportation, handling, storage, and care of the geomembrane system materials and its components prior to and following installation at the site, is the responsibility of the General Contractor. The General Contractor shall be liable for all damages to the materials incurred prior to final acceptance of the closure by the Owner.

1.2.6 Support Personnel

1.2.6.1 Geomembrane Manufacturer

The Geomembrane Manufacturer is responsible for the manufacture of its materials and for quality control during manufacture, and formulates the compounding ingredients (or resins), mixes the compound, and forms the roll of geomembrane. The Geomembrane Manufacturer is responsible for certifying that its materials conform to those specifications and any more stringent requirements or specifications included in the contract of sale to the Owner or its agent. The quality control steps taken by a manufacturer are critical to overall quality management. Such activities often take the form of process quality control, computer-aided quality control and the like.

Qualification Submittals to be submitted by the Contractor within 30 days after Notice to Proceed:

- Corporate background and information, including corporate annual report.
- Manufacturing capabilities including:

  Information on plant size, equipment, qualified personnel, number of shifts per day, and capacity per shift.

  Daily production quantity with sufficient production capacity available to meet the demands of the project schedule for this contract.

  Quality control procedures (manual) for manufacturing.

  List of material properties including certified test results, to which geomembrane samples are attached.

- A list of at least six (6) successfully completed facilities during the past five (5) years of similar scope and size totaling a minimum of 10,000,000 square feet, for which the manufacturer has manufactured a geomembrane geomembrane. For each facility, the following information shall be provided:

Name and purpose of facility, its location, and date of installation.

Name of owner, project manager, designer, installer, and contact person at the facility.

Geomembrane thickness and surface area of geomembrane manufactured.

Available information on the performance of the lining system and the facility.

- Origin (resin supplier's name, resin production plant) and identification (brand name, number) of the polyethylene resin.

1.2.6.2 Geomembrane Installer

The Geomembrane Installer is responsible for the handling, storage, placement, installation, seaming, and restraint of the geomembrane against wind, and attending all site meetings. At the discretion of the General Contractor, the geomembrane installer may also be responsible for transportation to the site, and storing the material on site. The Geomembrane Installer must have a construction quality control plan to detail the proper manner in which materials are handled, placed, and installed.

Qualification Submittals to be submitted by the Contractor within 30 days after the Notice to Proceed:

The Geomembrane Installer engaged by the General Contractor for transportation, field handling, storage, placement, seaming, temporary restraining (against wind), anchoring and other site aspects of the geomembrane geomembrane shall be trained and qualified to install geomembrane, and shall be approved by the geomembrane manufacturer. The Geomembrane Installer's qualifications will require the Design Engineer's acceptance. Written information required includes:

- Copy of geomembrane installer's letter of approval by the Geomembrane Manufacturer.
- Corporate background and information, including corporate annual report.
- Description of installation capabilities, including:

  Information on equipment and personnel.

  Average daily production anticipated.

  Quality control procedures (manual).

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- A list of at least six (6) successfully completed facilities during the past five (5) years of similar size and scope, totaling a minimum of 10,000,000 square feet, for which the installer has installed a geomembrane. Projects shall be considered similar only if the manufacturer and/or installer had total responsibility for system manufacture and/or installation and the installed system has successfully fulfilled its primary function for a minimum of two (2) years. For each installation, the following information shall be provided:

  Name and purpose of facility, its location, and date of installation.

  Name of owner, project manager, designer, manufacturer, and name of contact at the facility who can discuss the project.

  Name and qualifications of the supervisor(s) of the installer's crew(s).

  Geomembrane thickness, surface area of the installed geomembrane.

  Type of seaming and type of seaming apparatus used.

  Duration of installation.

  Available information on the performance of the geomembrane and the facility.

- Resume of the installer's "master seamer" to be assigned to this project, including dates and duration of employment. Resume of the field engineer or installation supervisor to be assigned to this project, including dates and duration of employment. All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. At least one seamer shall have experience seaming a minimum of 1,000,000 linear feet of geomembrane seams using the same type of seaming apparatus in use at the site. 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. Prior to commencement of the installation, the General Contractor shall submit:

- A drawing showing the installation layout identifying field seams, as well as any variance or additional details, which deviate from the engineering drawings. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.

- Installation schedule.

- A quality control plan for the production and installation of the geosynthetics.

- A list of personnel performing field-seaming operations along with pertinent experience information.

- Initial subgrade acceptance certificates, signed by the Geomembrane Installer.

During the installation, the General Contractor shall be responsible for submission of:

- The Geomembrane Installer's quality control plan prior to starting work.
- The Geomembrane Installer's subgrade acceptance certificates for each area to be covered by the geomembrane, signed by the installer, prior to placing the geomembrane.

Upon completion of the installation, the installer shall submit:

- Geomembrane installation certification.
- The installation and product warranties.
- Record drawings showing seam locations, repair locations, and geomembrane test sample locations.

1.2.6.3 Double-sided Capping Geocomposite

The qualified manufacturer shall be a company, corporation, or firm regularly engaged in the development and manufacture double-sided capping geocomposite with a history of successful production for a minimum period of three (3) years. The manufacturer shall have supplied a minimum of ten (10) projects during the past five (5) years of similar size and scope totaling a minimum of 10 million (10,000,000) square feet. Projects shall be considered similar only if the manufacturer had total responsibility for manufacture and the installed system has successfully fulfilled its primary function for a minimum of two (2) years. The Contractor must submit the qualification submittals to the Engineer within 30 days after the Notice to Proceed.

1.2.6.4 Earthwork Subcontractor

The Earthwork subcontractor is responsible for grading the site to elevations and grades shown on the plans and for constructing earthen components of the closure. The Earthwork subcontractor is hired by the General Contractor. The Earthwork subcontractor is responsible not only for grading the site to proper elevations, but also for obtaining suitable earthen materials, transport, and storage of those materials, preprocessing of materials if necessary, placement and compaction of materials, and protection of materials during and after placement

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1.2.7 Construction Quality Assurance Monitors (CQAM)

The CQAM, as Design Engineer's agent at the site, will work under the supervision of the Design Engineer, and will confer with the Design Engineer regarding CQAM's actions. The CQAM's

dealings in matters pertaining to the on-site work shall, in general, be with Design Engineer and General Contractor, and keeping the Owner advised as necessary. The CQAM's dealings with subcontractors shall only be through, or with the full knowledge and approval of, General Contractor. The CQAM shall generally communicate with Owner with the knowledge of, and under the direction of, Design Engineer. The CQAM shall also supervise all assistant CQA Monitors (if needed) for the project.

The CQA Monitor is responsible for the conformance testing as follows:

- CQA conformance testing for the geomembrane is as listed in Table 02776-A of Specification Section 02776 Geomembrane on page 02776-8, and are repeated in Table 2-1 of Section 2.0 of this CQA Plan.
- CQA conformance testing for the double-sided capping geocomposite is as listed in Table 3 of Specification Section 02712 Double-sided Capping Geocomposite Drainage Layer on page 02712-6, and repeated in Table 2-2 of Section 2.0 of this CQA Plan.
- CQA conformance testing for the soils as listed in Specifications Section 02220 3.03 Tests and repeated in Section 4 of the CQA Plan Section 4.1

Quality assurance and construction quality assurance monitors are responsible for making observations and performing field tests to ensure that a facility is constructed in accordance with the plans and specifications accepted by the Permitting Agency.

Duties and Responsibilities of CQA Monitor:

1. Schedules: Review the progress schedule, schedule of Shop Drawing submittals, and schedule of values prepared by General Contractor, and consult with Design Engineer concerning acceptability.

2. Conferences and Meetings: Attend meetings with General Contractor, such as preconstruction conferences, progress meetings, job conferences, and other project-related meetings and prepare and circulate copies of minutes.

3. Liaison:

   a. Serve as Design Engineer's liaison with General Contractor, working principally through General Contractor's Superintendent, and assist in understanding the intent of the Contract Documents; and assist Design Engineer in serving as Owner's liaison with General Contractor when General Contractor's operations affect Owner's on-site operations.

   b. Assist in obtaining from Owner additional details or information, when required, for proper execution of the Work.

4. Shop Drawings and Samples:

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b. Advise Design Engineer of the commencement of any work requiring a Shop Drawing or sample if Design Engineer has not accepted the submittal.

c. Receive samples, which are furnished at the site by General Contractor, and notify Design Engineer that the samples are available for inspection.

5. Review of Work, Rejection of Defective Work, Inspections, and Tests:

a. Observe the work in progress on site to assist Design Engineer in determining if the work is proceeding in accordance with the Contract Documents.

b. Report to the Design Engineer any work, which appears unsatisfactory, defective, or does not conform to the Contract Documents, or does not meet the requirements of any inspection, test, or approval. Advise Design Engineer of work that CQAM believes should be corrected, rejected, uncovered for observation, tested, inspected, or accepted.

c. Verify that tests are conducted in presence of appropriate personnel, that all seam weld tests are witnessed under his supervision, and that the General Contractor maintains adequate records thereof; observe, record, and report to Design Engineer appropriate details relative to the test procedures and start-ups.

d. Accompany visiting inspectors representing public or other agencies having jurisdiction over the project, record the results of these inspections, and report to Design Engineer.

6. Interpretation of Contract Documents: Report to Design Engineer when clarifications and interpretations of the Contract Documents are needed and transmit to General Contractor clarifications and interpretations as issued by Design Engineer.

7. Modifications: Evaluate General Contractor's suggestions for modifications in drawings or specifications and report recommendations to Design Engineer. Transmit decisions to General Contractor as issued by Design Engineer.

8. Records:

a. Maintain orderly files at the job site for correspondence, reports of job conferences, Shop Drawings and samples, copies of original Contract Documents including all Work Directive Changes, Addenda, Change Orders, Field Orders, additional Drawings issued subsequent to the execution of the Contract, Design Engineer's clarifications and interpretations of the Contract Documents, progress reports, and other project-related documents.

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b. Prepare Daily Construction Reports, recording General Contractor hours on the job site, weather conditions, data relative to questions of Work Directive Changes, Change Orders, or changed conditions, list of job site visitors, daily activities, decisions, observations in general, and specific observations in more detail as in the case of observing test procedures; and send copies to Design Engineer.

c. Record names, addresses, and telephone numbers of all General Contractors, subcontractors, and major suppliers of materials and equipment.

d. Ensure that General Contractor maintains record drawings of panel seams, penetrations, and repairs.

9. Reports:

a. Furnish Daily Construction Reports to Design Engineer, noting work progress and the General Contractor's compliance with the progress schedule, and schedule of Shop Drawings and sample submittals.

b. Draft proposed Change Orders and Work Directive Changes, obtaining backup material from General Contractor and recommend to Design Engineer Change Orders, Work Directive Changes, and Field Orders.

c. Immediately report any accidents to Design Engineer and Owner.

d. Report scheduled major tests, inspections, or start of important phases of the work to the Design Engineer in advance.

e. Immediately notify the Design Engineer, who will notify the Owner, of all test failures.

10. Payment Requisitions: Review applications for payment with General Contractor for compliance with the established procedure for their submission and forward with recommendations to Design Engineer, noting particularly the relationship of the payment requested to the schedule of values, work completed and materials and equipment delivered at the site but not incorporated in the work.

11. Certificates: Verify that certificates and other data required to be assembled and furnished by General Contractor are applicable to the items actually installed and in accordance with the Contract Documents, and have this material delivered to Design Engineer for review and forwarding to Owner prior to final payment for the Work.

12. Completion:

a. Before Design Engineer issues a Certificate of Substantial Completion, submit to General Contractor a list of items observed to require completion or correction.

b. Conduct final inspection in the company of Design Engineer, Owner, and General Contractor and prepare a final list of items to be completed or corrected.

c. Observe that all items on final list have been completed or corrected and make recommendations to Design Engineer concerning acceptance.

13. Limitations of Authority:

The CQAM:

a. Shall not authorize any deviations from the Contract Documents or substitution of materials or equipment, unless authorized by Design Engineer.

b. Shall not exceed limitations of Design Engineer's authority as set forth in the Contract Documents.

c. Shall not undertake any of the responsibilities of General Contractor, subcontractors or General Contractor's superintendent, or expedite the work.

d. Shall not advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences, or procedures of construction unless such advice or directions are specifically required by the Contract Documents.

e. Shall not advise on, issue directions regarding, or assume control over safety precautions and programs in connection with the work.

f. Shall not accept Shop Drawings or sample submittals from anyone other than General Contractor.

g. Shall not authorize Owner to occupy the project in whole or in part.

h. Shall not participate in specialized field or laboratory tests or inspections conducted by others except as specifically authorized by Design Engineer.

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1.2.8 CQA Certifying Engineer

The CQA Certifying Engineer is responsible for certifying to the Owner and permitting agency that, in his or her professional opinion, the facility has been constructed in accordance with plans

and specifications and CQA documentation approved by the permitting agency. The certification statement is accompanied by a final CQA report that contains all the appropriate documentation including daily observation reports, sampling locations, test results, as-built drawings, or sketches, and other relevant data. The CQA Certifying Engineer must be a registered professional engineer in the state that the facility is constructed with experience and competency in certifying like installations, and approved by the permitting agency.

1.2.9 Geosynthetic Testing Laboratory

The Design Engineer will retain a Geosynthetic Testing Laboratory. The testing laboratory shall have its own internal QA plan to ensure that laboratory procedures conform to the appropriate ASTM standards or other applicable testing standards. The testing laboratory is responsible for ensuring that tests are performed in accordance with the applicable methods and standards, for following internal QC procedures, for maintaining sample chain-of-custody records and for reporting data.

The laboratory must be willing to allow the owner, design engineer, permitting agency, or installer to observe sample preparation and testing procedures, or record-keeping procedures, either announced or unannounced. The laboratory shall issue two copies of all results, certified by an officer of the testing laboratory, directly to the CQAM. Results provided shall include raw measurements and any intermediate calculations required to determine the final test results. The laboratory is also responsible for keeping accurate records of all tests conducted and retains collected samples for six months after acceptance of construction by the Design Engineer.

1.2.10 Soils Construction Quality Assurance (CQA) Engineer

The soils construction quality assurance (CQA) engineer must be state certified to sample and test soils for engineering properties. The Soils CQA engineer will be hired by the owner. The Owner's Representative will coordinate the activities of the Soils CQA engineer with the CQA Monitor.

1.3 Sites and Project Control

To promote a high degree of quality control during the closure, meetings shall be held prior to and during the cap construction. Site visits shall also be conducted to ascertain the progress of the project.

1.3.1 Project Coordination Meetings

The purpose of meetings is to coordinate tasks among the parties of the project, to relate the lines of authority and to provide a method of communication among the parties of the project, and to discuss in detail specifics related to the quality assurance/quality control aspects of the project with parties involved in the project. A preconstruction meeting will be held prior to the start of construction. General progress meetings will be held weekly during installation of the cap. The weekly progress meetings will include the Contractor, Geosynthetic Installer, CQA Monitor, Design Engineer, Owner and Owner's Resident Project Representative. The CQA Monitor shall meet daily with the Contractor's superintendent and geosythetic installer to review the work scheduled for the day, progress completed and any other items that may affect the quality or progress of the work.

1.3.2 Site Visits

The Design Engineer shall visit the site during construction as needed to assure the work is conducted according to the drawings and specifications. State and local regulatory officials may visit the site at any time.

1.3.3 Problem Identification and Corrective Measure Reports

A problem is defined as material workmanship that does not meet the requirements of the plans, specifications, or CQA plan for a project or any obvious defect in material or workmanship, even if there is conformance with plans, specifications, and the CQA plan. Special meetings shall be held when and if problems or deficiencies are present or are likely to occur which cannot be resolved during weekly progress meetings. At a minimum, representatives of the Contractor, the Owner, and the Engineer shall attend the meetings. Problem identification and corrective measures reports should contain the information listed below.

- Unique identifying sheet number for cross-referencing and document control.
- Note location of the problem.
- Description of the problem in as much detail as possible and with supporting sketches and photographic information where appropriate.
- Probable cause.
- How and when the problem was located with reference to inspection data sheet or data summary report by CQAM.
- Where relevant, estimation of how long the problem has existed.

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- Any disagreement noted by the inspector between the inspector and contractor about whether or not a problem exists or the cause of the problem.
- Suggested corrective measure(s).
- Documentation of correction if corrective action was taken and completed prior to finalization of the problem and corrective measures report (reference to inspection data sheet, where applicable).
- Where applicable, suggested methods to prevent similar problems.
- Signature of the CQA Monitor and review signature of Design Engineer.

The CQA Monitor shall document problem or work deficiency meetings.

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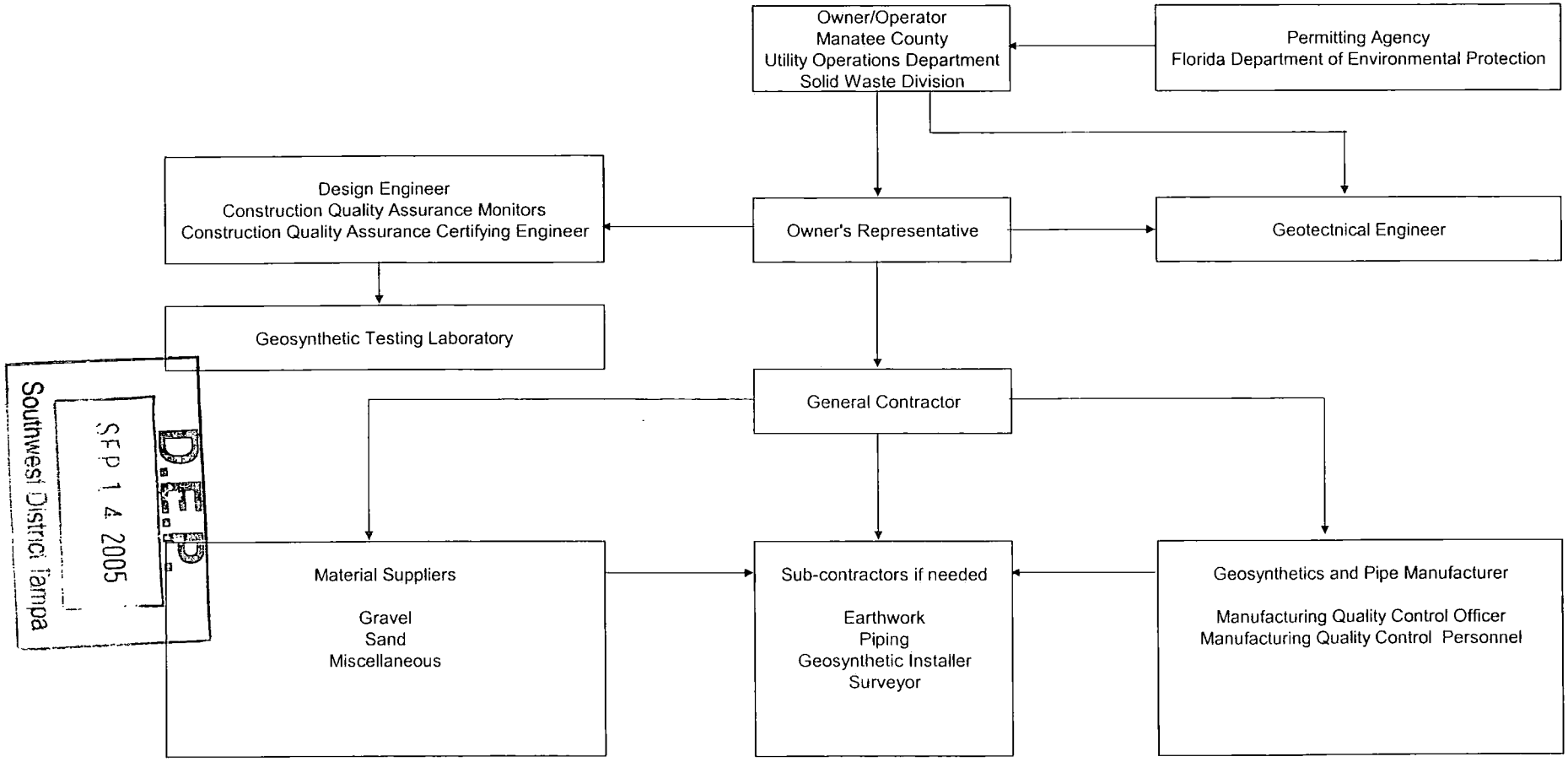
Table 1-2

Organization Chart For

Manatee County Lena Road Landfill - Stage I Landfill Partial Closure #2
Quality Assurance Plan



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2.0 Geosynthetics Manufacturing and Delivery

The Manatee County Lena Road Landfill Closure includes geosynthetics with a geomembrane barrier meeting the requirements of FDEP Rule Chapter 62-701, F.A.C, and a double-sided capping geocomposite over the textured geomembrane on the 5H:1V side slopes. The 2-foot (24-thich protective soil cover shall be placed over the geomembrane, or the geomembrane covered by the geocomposite on the side slopes. In either case, the 24-inch thick protective soil cover is a minimum cover thickness and shall me measured from the top of the geomembrane or the geocomposite if the geocomposite is placed over the geomembrane.

2.1 Manufacturing

2.1.1 Geomembrane

The geomembrane shall be manufactured from virgin, first-quality polyethylene resin specifically for use in geomembranes. Reclaimed polymer shall not be used or added to the resin. The polyethylene resin shall have the following properties:

Density	ASTM D1505	0.939 g/cm^3 (max)
Melt Index	ASTM D1238 - Condition E	$\leq$1.0 g/10 min.

The geomembrane shall be a linear low-density polyethylene (LLDPE) sheet, and shall have the properties given in Table 2-1. In addition, the geomembrane shall:

- Consist of a nominal 40-mil thickness.
- Contain no more than 1 percent by weight of additives, fillers, or extenders (carbon black not included).
- Not have striations fold crimps, abrasions, pinholes, or bubbles on the surface.
- Be produced so as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.
- The geomembrane shall be supplied in rolls.
- Geomembranes shall pass a continuous spark test by the manufacturer.
- Geomembranes shall meet the specifications in GRI GM17 and the seams per GRI GM19.

The manufacturer shall be required to perform quality control testing to verify compliance with the specifications. The test frequencies are given in Table 2-1. The CQA Monitor shall sample the delivered geomembrane at the rate of one sample per 100,000 sf, and send the samples to the Geosynthetic Testing Laboratory for testing per the CQA tests listed in Table 2-1.

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Table 2-1 from Specification Section 02776

Table 02776-A - Material Properties for
White-Surfaced Linear Low Density Polyethylene (LLDPE) Geomembrane
PER GEOSYNTHETIC RESEARCH INSTITUTE (GRI) TEST METHOD GM17 (SEE NOTE 1)

Property	Test Method	Units	Value	Manufacturer Test Frequency	CQA Test Frequency
Thickness – Smooth Minimum Average Lowest Individual Reading	ASTM D 5199	 mil mil	 40 36	Per roll	100,000 ft.^{2}
Thickness – Textured Minimum Average Lowest Individual Reading	ASTM D 5994	 mil mil	 40 36	Per roll	100,000 ft.^{2}
Density (max)	ASTM D 1505	g/cm3	0.939	Per 200,000 lbs	500,000 ft.^{2}
Carbon Black Content Range	ASTM D 1603, modified	%	2 - 3	Per 45,000 lbs	500,000 ft.^{2}
Carbon Black Dispersion	ASTM D 5596	Note 2		Per 45,000 lbs	500,000 ft.^{2}
2% Modulus – (max)	ASTM D 5323	Lb/in	2400	Per formulation	
Tensile Properties (Each Direction)	ASTM D 6693 Type IV			Per 20,000 lbs	100,000 ft.^{2}
Smooth Strength at Break Elongation at Break	"	 lb/in %	 152 800	"	"
Textured Strength at Break Elongation at Break	"	 lb/in %	 60 250	"	"
Tear Resistance	ASTM D 1004	lb	22	Per 45,000 lbs	100,000 ft.^{2}
Smooth Puncture Resistance	ASTM D 4833	lb	56	Per 45,000 lbs	100,000 ft.^{2}
Textured Puncture Resistance	ASTM D 4833	lb	44	Per 45,000 lbs	100,000 ft.^{2}
Oxidative Induction Time	ASTM D 3895	Min.	100	Per 200,000 lbs	500,000 ft.^{2}
Textured - Asperity Height (min. Ave.)	GRI GM-12	Mil	10	Every 2nd roll Both sides	500,000 ft.^{2}
Interface Friction Angles (See Note 3)	ASTM D-5321 Saturated Conditions	Degrees Minimum All surfaces	22	One test	One test
Hot Wedge Seams Shear Strength Peel Strength	ASTM D-6392 (See Note 4)	 lb/in lb/in	 60 50	N/A	Every 500 feet of seam
Extrusion Fillet Seam Shear Strength Peel Strength	ASTM D-6392 (See Note 4)	 lb/in lb/in	 60 44	N/A	Every 500 feet of seam

Note 1 40 mil Smooth LLDPE shall be per Table 1(a), and Textured LLDPE shall be per Table 2(a) of GRI Test Method GM17.

Note 2 Only near spherical agglomerates are considered. Nine of ten views shall be Category 1 or 2. No more than one view shall be Category 3.

Note 3 Interface friction angle test shall be conducted for the actual materials that will be used at the site. The test shall include the interface friction angle for the following interfaces: protective cover soil/double sided capping geocomposite/textured /bedding soil, and soil/smooth geomembrane/soil with a reduction in the friction angle to 17 degrees minimum.

Note 4 All seam strengths shall be those values as listed in GRI-GM19.

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A field panel is the unit area of geomembrane, which is to be welded in the field. All welds shall have the minimum strengths given in Table 2-1.

The manufacturer shall perform quality control testing to verify that the geomembrane complies with the specifications. Prior to shipping any material, geomembrane roll production documentation shall be submitted to the CQA Monitor by the Contractor. Testing shall be carried out by the manufacturer to demonstrate that the resin meets the contract specification, and the Contractor shall submit the manufacturer's written certification that it does. Any geomembrane manufactured from non-complying resin shall be rejected. At the Engineer's discretion, the Engineer may carry out additional conformance testing. If the results of the Contractor's and the Engineer's testing differ, the testing shall be repeated by the Engineer, and the Contractor shall be allowed to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods have been followed.

The Manufacturer through the Contractor shall submit documentation that includes the following:

- Test information and documentation to ensure the geomembrane has the physical, chemical, and mechanical properties specified.
- Origin (resin supplier's name, resin production plant) identification, (brand name, number) and production date(s) of the resin.
- Three (3) copies of quality control certificates issued by the resin supplier.
- Reports on the tests conducted to verify the quality of the resin used to manufacturer the geomembrane rolls assigned to the project.
- The documentation shall state that no reclaimed polymer is added to the resin during the geomembrane manufacturing process.
- Samples shall be taken across the entire width of the roll. The machine direction shall be marked on the samples with an arrow. The geomembrane test sample shall meet or exceed the specified values. Certification of the test values obtained shall be provided to the Engineer.
- In addition, the manufacturer/installer shall provide to the Engineer, the manufacturer's certification on the quality of the rolls. At a minimum, the certifications shall include quality control certificates for each batch of resin and each shift's production of geomembrane and shall be signed by responsible parties employed by the manufacturer (such as the production manager) and shall be notarized. The quality control certificates shall also include:

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1) Roll numbers and identification.
2) Sampling procedures.
3) Results of quality control tests, including description of test methods used.

Each roll of product shall be labeled with:

- Manufacturer
- Product Identification
- Unique roll identification number
- Dimensions

2.1.2 Double-Sided Capping Geocomposite

The double-sided capping geocomposite is Tenflow as manufactured by Tenax and uses a tri-planar (tri-axial) geonet structure with thermally bonded non-woven geotextile, and shall meet or exceed the property values listed in Table 2-2. The Contractor shall provide to the Engineer the manufacturer's quality certifications. At a minimum, the certifications shall include quality control certificates for each shift's production and shall be signed by responsible parties employed by the manufacturer shall be notarized and supplied to the Engineer.

The quality control certificate shall include:

(1) Roll numbers and identification
(2) Sampling procedures
(3) Results of quality control tests, including a description of test methods used.

The CQA Monitor shall sample the delivered geocomposite, and send the samples to the Geosynthetic Testing Laboratory for quality assurance testing. The sampling and testing frequency are given on Table 2-2.

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TABLE 2-2 Page 1of 3 from Specification Section 02712

TABLE 1: REQUIRED GEOCOMPOSITE DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	UNITS	VALUE
Geonet			
Structure	Triaxial		
Thickness (min.)	ASTM D 5199	mil	325
Tensile Strength (min.)	ASTM D 4595	lb/ ft	450
Density (min.)	ASTM D 1505	g/cm^3	0.94
Melt Flow Index (max.)	ASTM D 1238	g/10 min	1.0
Carbon Black Content (min.)	ASTM D 4218	%	2
Creep Reduction Factor[1]	GRI- GC8	-	1.1
Geocomposite			
Ply Adhesion (min.)	ASTM F 904	lb/inch	0.5
Transmissivity[2] –Machine Direction (min.) @240 psf load	ASTM D 4716 GRI –GC8	(m^2/sec)	7.0E-03 @ gradient 0.1 4.0E-03 @ gradient 0.33

Notes:

1. The creep reduction factor is determined from 10,000 hour test duration, extrapolated to 30 years and using a compressive load of 2,000 psf. SIM (Stepped isothermal method) method is acceptable for confirmation only, but is not acceptable for baseline data to determine the creep reduction factor.

2. Transmissivity tests shall use the normal compressive load for the two foot thick protective cover soil of 240 psf at hydraulic gradients of 0.1 and 0.33. Testing boundary conditions from the top to bottom are: upper steel load plate/ local silty sand form the borrow area proposed as the source for the protective cover soil / Geocomposite / Geomembrane / lower load plate with a minimum seating period of 1 hour.

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TABLE 2-2 Page 2 of 3 from Specification Section 02712

TABLE 2: REQUIRED GEOTEXTILE PROPERTIES

PROPERTY	TEST METHOD	UNITS	VALUE
Serviceability Class	Class 2		
AOS (MaxARV)	ASTM D4751	US Sieve (mm)	70 (0.21)
Permittivity (MARV)	ASTM D4491 Falling head	sec^{-1}	0.5
Grab Tensile Strength (MARV)	ASTM D4632	lbs	157
Trapezoid Tear (MARV)	ASTM D4533	lbs	56
Puncture Strength (MARV)	ASTM D4833	lbs	56
CBR Puncture Strength (MARV)	ASTM D6241	lbs	346
UV Resistance @500 Hours (MIN)	ASTM G154	%	70

Note: The geotextile is a non –woven geotextile.

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TABLE 2-2 - Page 3 of 3 from Specification Section 02712
TABLE 3:REQUIRED MANUFACTURER'S QUALITY CONTROL TEST DATA AND CONSTRUCTION QUALITY CONTROL (CQA) TESTING

PROPERTY	TEST METHOD	VALUE	FREQUENCY	CQA Testing Frequency (See Note 1)
Resin Tests				
DENSITY (min.)	ASTM D1505	0.94 g/cm^3	Per Lot	No Test
MELT FLOW INDEX (max.)	ASTM D1238	1.0 g/10 min	Per Lot	No Test
Geonet Tests				
THICKNESS (min.)	ASTM D5199	325 mil (8.26 mm)	50,000 ft^2	250,000 ft^2
CARBON BLACK CONTENT (min.)	ASTM D4218	2 % min 2-3% range	50,000 ft^2	250,000 ft^2
TENSILE STRENGTH-MD (min.)	ASTM D4595	450 lbs/ft	50,000 ft^2	250,000 ft^2
Geotextile Tests				
WEIGHT	ASTM D3776	6Oz/sy	100,000 ft^2	250,000 ft^2
AOS (Max ARV)	ASTM D4751	70 US Sieve (021mm)	500,000 ft^2	1,000,000 ft^2
PERMITTVITY (MARV)	ASTM D4491 Falling head	0.5 sec^{-1}	500,000 ft^2	1,000,000 ft^2
GRAB TENSILE STRENGTH (MARV)	ASTM D4632	157 lbs	100,000 ft^2	250,000 ft^2
TRAPEZOID TEAR (MARV)	ASTM D4533	56 lbs	100,000 ft^2	250,000 ft^2
PUNCTURE STRENGTH (MARV)	ASTM D4833	56 lbs	100,000 ft^2	250,000 ft^2
CBR PUNCTURE STRENGTH (MARV)	ASTM D6241	346 lbs	500,000 ft^2	1,000,000 ft^2
Geocomposite Tests				
PLY ADHESION (min.)	ASTM D904	0.5 lbs/in	100,000 ft^2	250,000 ft^2
TRANSMISSIVITY-MD (See Note 2)	ASTM D4716 GRI-GC8	7.0E-03m^2/sec @ gradient 0.1 4.03E-03 m^2/sec @ gradient 0.33	200,000 ft^2	500,000 ft^2

1. CQA Testing is the responsibility of the Owner.
2. Transmissivity tests shall use the normal compressive load for the two foot thick protective cover soil of 240 psf at hydraulic gradients of 0.1 and 0.33. Testing boundary conditions from the top to bottom are: upper steel load plate/ local silty sand form the borrow area proposed as the source for the protective cover soil / Geocomposite / Geomembrane / lower load plate with a minimum seating period of 1 hour.
3. MARV – Minimum Average Roll Value; MaxARV – Maximum Average Roll Value.

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2.2 Delivery - Transportation, Handling, and Storage

Care shall be taken to ensure that no damage occurs during transportation, handling, and storage of the geomembrane and geocomposite. The rolls shall be protected from excessive heat and cold, puncture, cutting, ultraviolet radiation, precipitation, dirt or other damaging or deleterious conditions. Labels for each roll panel identifying:

1) The manufacturer.
2) Product identification.
3) Lot number.
4) The thickness of the material.
5) The length and width of the roll
6) Roll or field number.
7) Directions for unrolling the material.

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Transportation, handling, storage, and care of the geosynthetics prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to final acceptance by the Owner.

1. Protective Wrapping – All rolls of geocomposite shall be enclosed in a protective wrapping that is opaque and water proof. The protective wrapping must be wrapped around or placed around the geocomposite in the manufacturing facility as the final step in the manufacturing process. The packaging should not interferer with the handling of the rolls either by slings or by utilization of the central core upon which the geotextile is wound. The protective wrapping should prevent exposure of the geotextile to ultraviolet light, prevent it from moisture uptake, and limit damage to the roll. Every roll must be labeled with the manufacturers name, style and type, lot and roll numbers, and roll dimensions including length, width, and gross weight. Details must conform to ASTM D-4873.

2. Storage at Manufacturing Facility – Rolls shall be stored at the manufacturing facility indoors. Rolls should not be stacked one on top of the other to the extent that deformation of the core occurs or to the point where accessibility can cause damage in handling.

3. Transportation – Rolls may be shipped from the manufacturer to the site or storage facility by ship, truck, or railroad. Rolls may be loaded with a crane or fork lift. The method of loading the rolls, transporting them, and off-loading them should not cause damage to the material, its core, nor its protective wrapping. Any protective wrapping that is accidentally damaged or stripped off should be repaired immediately or the roll moved to an enclosed facility until repairs can be made.

4. Storage at the Field Site – Rolls should be handled in a competent manner such that damage does not occur to the material or its protective wrapping. All geosynthetics should be stored and handled per ASTM D-4873. Rolls must be stored in an area where water can not accumulate. The rolls should be elevated off the ground so as not to form a dam creating the ponding of water. The rolls must be stacked in such a way that cores are not crushed nor is the material damaged. Rolls must not be stored outdoors for longer than 6-months.

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3.0 Geosynthetics Installation

3.1 Earthwork

3.1.1 Geomembrane Subgrade

The Earthwork shall be incompliance with Specifications Section 02220 Filling and Compaction for Earthwork. The Contractor shall be responsible for grading the surface of the existing 18-inch thick intermediate soil cover. A bedding layer for the geomembrane shall be minimum 6-inches thick (The thickness can be greater, but not less than 6-inches), and a minimum grade of 2% (The overall top of the landfill has a grade of 4%. The minimum grade in all places shall be 2% or greater. No grade less than 2% will be accepted.) Foreign objects such as rocks, sticks, glass, sharp objects, stones larger than ½-inch in any dimension, and any other harmful materials that may puncture the geomembrane shall be removed from the surface of the subgrade. Soil at the surface of the subgrade shall be graded to drain to the stormwater inlets at slopes no less than those shown on the drawings. The surface shall be graded such that there is no ponding of water. The subgrade shall be compacted, and the surface shall be firm and smooth to allow movement of vehicles and equipment without causing rutting or other harmful effects on the subgrade area. No abrupt changes in grade, standing water, or excessive moisture will be permitted. The surface to be covered with the geomembrane shall be rolled with a smooth steel drum or pneumatic roller to ensure that the area is free of irregularities, loose earth and abrupt changes in grade. All visible vegetation shall be removed. The geomembrane installer shall be responsible for inspection of the subgrade surface integrity, and shall certify his acceptability and responsibility for the geomembrane subgrade's integrity and suitability in writing to the Contractor prior to beginning geomembrane installation. The Contractor shall give this certification of acceptance to the CQA Monitor, who will then check the proposed subgrade for installation, and approve the surface prior to installation. Special care should be taken to maintain the prepared soil surface. No geomembrane shall be placed onto an area, which has become softened by precipitation. Any damage to the subgrade supporting soils or protective cover soils caused by installation activities, erosion, etc. shall be repaired by the contractor until substantial completion and the project is accepted by the Owner. Table 3-1 describes quality assurance observation activities to ensure that the subgrade meets the contract specifications.

3.1.2 Anchor Trench

The anchor trench shall be excavated as shown on the drawings. No loose soil shall be allowed beneath the geomembrane. The anchor trench shall be backfilled and compacted. Care shall be taken to prevent any damage to the geomembrane system when back filling the trenches. Trench corners shall be rounded where the geomembrane enters the trench so as to avoid sharp bends in the geomembrane.

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3.2 Quality Assurance

Upon delivery to the project site, the geomembrane and geocomposite shall be inspected to confirm that proper labeling and transportation procedures described in Section 2 have been followed. The CQA Monitor shall be responsible for the sampling of geomembrane and geocomposite delivered to the site to see that it conforms to the contract specifications as specified Section 02776 Geomembrane Table 02776-A and Section 02712 Double-sided Capping Geocomposite Drainage Layer Table 3 (See also Section 2 of the CQA Plan where these tables are repeated), and to the quality control testing results provided by the Contractor as described in Section 2. The observations to be conducted by the CQA Monitor are outlined in Table 3-2.

Table 3-1
Earthwork Preparation Observation

The CQA Monitor will:

- Observe placement of recessed areas for pipes and stormwater inlets and outlets.
- Observe compacted fill such that it is smooth, uniform, no abrupt changes in grade, no standing water.
- Test thickness and density of bedding soil compaction of the bedding soils per Table 4-1.
- Observe stripping and excavating operations to remove undesirable material, vegetation and debris of any kind (organics, roots, rocks).
- Review survey, checking dimensions, (boundaries), side slopes, bottom slope with respect to design.
- Photograph the earthwork process for records.

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Table 3-2
Geomembrane and Geocomposite Transportation/Storage Observation

The CQA Monitor shall observe all of the following:

- The condition of the packaging on the geomembrane and/or geosynthetics delivered to the site. If the packaging is damaged, the CQA Monitor shall take special care to observe the condition of the materials in the area of the damaged packaging.
- Markings on the package to see that the packaging label includes: name of manufacturer; product type/thickness; manufacturer's batch code; date of manufacture; dimensions (length and width); panel number corresponding to layout; and directions for unrolling/unfolding.
- The condition of the geomembrane and geosynthetics upon delivery. Punctures from nails, tears, crumpling due to inadequate packaging shall be noted.
- The condition of the storage area so that the materials are secure from vandalism, with minimized exposure to wind or traffic, materials elevated off the ground and any other sources of potential damage to the stored materials.
- Observe the sampling of geosynthetic received. The samples are for CQA testing to determine compliance with the specifications. Samples shall be properly labeled. Thickness should be checked during sampling using calipers or a micrometer.

Any field panels which become seriously damaged (torn, twisted, or crimped), or that do not conform to the contract specifications, shall be replaced. Less serious damage may be repaired if accepted by the Engineer and the Owner. Damaged panels, or portions of damaged panels, which have been rejected shall be removed from the work area. The CQA Monitor shall fully document the receipt of the geomembrane rolls at the construction site, the inspection procedure, and results in the Daily Field Report.

3.3 Placement

3.3.1 Geomembrane Placement

3.3.1.1 Layout Drawings

The Contractor shall provide layout drawings to the CQA Monitor prior to geomembrane placement. These drawings shall indicate the panel configuration and location of seams. The Design Engineer, prior to the installation of geomembrane, must accept the layout drawings.

3.3.1.2 Panel Identification

Each field panel must be given an "identification code" (number or letter-number) consistent with the layout drawings. The CQA Monitor and Contractor shall agree upon this identification code. The field panel identification code shall be related, through a table or chart, to the original resin, and the constituent rolls and factory panels.

3.3.1.3 Field Panel Placement

- Location: Field panels shall be installed (as accepted or modified) at the location and positions indicated in the layout drawings.
- Installation Schedule: The schedule of field panel installation and seaming shall be accepted by the Engineer and shall be indicated in the layout drawings.
- Weather Conditions: Geomembrane shall not be placed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in standing water, or when excessive winds prevail.
- Method of Placement: The Contractor shall ensure that:

    1) No equipment shall damage the geomembrane through handling, traffic, leakage of hydrocarbons, or other means.

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2) No personnel working on the geomembrane shall engage in any activities, which could damage the geomembrane (e.g., smoking, wearing improper shoes, disposing of harmful waste material).

3) The panels shall be unrolled in a manner, which precludes scratches or crimps in the geomembrane.

4) The method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels).

5) Adequate temporary loading and/or anchoring devices which are not likely to damage the geomembrane (e.g., sand bags, tires), shall be placed in a manner which prevents the geomembrane from being lifted by the wind (in case of high winds, continuous loading is recommended along the panels' edges to minimize risk of wind flow under the panels).

6) Direct contact with the geomembrane shall be minimized; i.e., geotextiles, extra geomembrane, or other suitable materials shall protect geomembrane in excessively high traffic areas. At no time during the geomembrane placement shall any vehicle, except those specifically approved for material deployment, be allowed directly on the exposed material.

Table 3-3 outlines the type of observations to be conducted by the CQA Monitor during the placement of the geomembrane. The Panel Placement Log shall be completed.

Table 3-3
Geomembrane Placement Observation

The CQA Monitor shall:

Checklist geomembrane delivery tickets (retain with Project Records) and manufacturer's quality control certificate to observe compliance with specifications.

Observe geomembrane placement/compliance with layout drawing(s).

Observe proper temporary anchorage of geomembrane, and placement of geomembrane in non-stressed state.

Observe weather conditions for acceptability; suspend activities if weather is deemed unacceptable.

Observe lines and width of anchor trench, backfill, compaction, and no voids.

Observe geomembrane penetrations and connections;

Observe overlays for compliance with specifications.

When placement is complete, traverse entire geomembrane surface, observing for tears, punctures, thin spots, and adequacy of seams; mark and document defects.

Observe sampling/destructive testing of and field seams as required in specifications; observe non-destructive testing of 100 percent of seams. Rejected seams should be fully documented, then repaired.

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3.3.2 Double-sided Capping Geocomposite Placement

The Contractor shall handle all composites in such a manner as to ensure no damaged in any way, and the following shall be complied with:

1) On slopes, the geocomposite shall be secured at the top of the slope using the placement bar which is used to deploy the rolls of geocomposite, then rolled down the slope in such a manner as to continually keep the sheet in tension. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.

2) 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 covered.

3) Geocomposite shall only be cut using scissors.

4) The Contractor shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.

5) During placement of geocomposite, care shall be taken not to entrap dirt or excessive dust that could cause clogging, and/or stones that could damage the adjacent geomembrane.

6) Care should be taken not to leave tools in or under the geocomposite.

7) Adjacent rolls shall be overlapped per Specification Section 02712. These overlaps of the geonet shall be secured by tying. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed. Tying shall be per Specification Section 02712.

Soil cover material placed over the geocomposite shall be placed in such a manner as to assure that the geocomposite is not damaged. Care shall be taken to minimize any slippage of the geocomposite and to assure that no tensile stress is induced in the materials.

3.3.3 Protective Cover Soil Placement

The protective cover soil material shall be spread and fine graded over the geomembrane, or the geocomposite placed over the geomembrane on the side slopes. The CQA Monitor shall check the cover soil during placement by using a ruler and by observing the cover depth markers placed by the Contractor to confirm that the protective soil cover is a minimum of 2-feet thick in all places. Upon completion of the final grading, the CQA Monitor and the Contractor shall visually inspect the cover soil. Areas, which appear to be inadequately prepared, will be reworked as

necessary to achieve the thickness and grade required. The CQA Monitor and Contractor shall inspect the condition of the cover soil on a daily basis. Any area not meeting the requirements of the contract specifications shall be reworked by the Contractor. Testing for the protective soil cover is given in Table 4-1. The protective soil cover is specified in Section 02220 Filling and Compaction for Earthwork. The Soil CQA Monitor shall check the protective soil cover thickness per Table 4-1. If protective cover soil is damaged by erosion, the protective soil cover shall be replaced per Specification Section 02220 Filling and Compaction for Earthwork. Eroded soil shall not be used if it is saturated and not within 2% of the optimum moisture content.

3.4 Field Seaming for Geomembrane

3.4.1 Seam Layout

In general, seams shall be placed parallel to the line of maximum slope, i.e., along, not across, the slope. The number of field seams shall be minimized in corners and odd-shaped geometric locations.

3.4.2 Personnel Requirements

All personnel performing seaming operations shall be qualified as indicated in Section 1.2.

3.4.3 Overlapping and Temporary Bonding

- Panels of geomembrane shall overlap by a minimum of 3 inches for extrusion welding, 5 inches for fusion welding and 5 inches for double wedge fusion welding. In any case, overlap shall be sufficient to allow peel tests to be performed on the seam.

- The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane; specifically, the air temperature at the nozzle of any spot-welding apparatus shall be controlled so that the geomembrane is not damaged.

- No solvent or adhesive shall be used unless the product is accepted in writing by the Engineer (samples shall be submitted to the Engineer for testing and evaluation).

3.4.4 Seam Area Preparation

- Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.

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- If seam overlap grinding is required, the process shall be completed according to the manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane.

- Seams shall be aligned with the fewest possible number of wrinkles and no "fish mouths."

3.4.5 Seaming Equipment and Products

Extrusion welding and fusion welding are the processes approved for field seaming. Only apparatus which have been specifically accepted (by make and model) shall be used. Proposed alternate processes shall be documented by the Contractor and submitted to the Engineer for approval.

- Extrusion Process: The extrusion welding apparatus shall be equipped with gauges, which register the temperatures both in the apparatus and at the nozzle. The Contractor shall provide documentation regarding the extrudate to the Engineer, and shall certify that the extrudate meets the contract specifications, and comprises the same resins as the geomembrane. The Contractor shall maintain at least one spare, operational seaming apparatus on site. Equipment used for seaming shall not damage the geomembrane, and the geomembrane shall particularly be protected from damage in heavy traffic areas. The extruder shall be cleaned until all heat-degraded extrudate has been removed from the barrel prior to beginning a seam. Whenever the extruder is stopped, the barrel shall be cleaned of all head-degraded extrudate. All degraded extrudate must be removed from the geomembrane area. The electric generator shall be placed on a smooth base so that the geomembrane is not damaged. Also, a smooth insulation plate or fabric shall be placed beneath the hot welding apparatus after each use.

- Fusion Process: The fusion-welding apparatus shall be a self-propelled hot wedge-welding device and shall be equipped with gauges, which register applicable temperatures and pressures. The Contractor shall maintain at least one spare operational seaming apparatus on site. Seaming equipment shall not damage the geomembrane, and the geomembrane shall be protected from damage in heavy traffic areas. For cross seams associated with fusion welding, the edge of the cross seams shall be ground to a smooth incline (top and bottom) prior to welding. The electric generator shall be placed on a smooth base so that the geomembrane is not damaged. Similarly, a smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after each use. A movable, protective layer may be used directly beneath where the geomembrane overlaps and is to be seamed to prevent moisture buildup between the sheets.

3.4.6 Weather Conditions for Seaming

- Unless authorized in writing by the Engineer, no seaming shall be attempted at ambient temperatures below 40°F (5°C) or above 104°F (40°C). Seaming shall be allowed at ambient temperatures between 40°F (5°C) and 50°F (10°C), if the geomembrane is preheated (by either the sun or a hot air device), and if no excessive cooling results from the wind. At ambient temperatures above 50°F (10°C), no preheating shall be required. The geomembrane shall always be kept dry and protected from wind damage.

- If the Contractor wishes to use methods, which may allow seaming at ambient temperatures below 40°F (5°C) or above 104°F (40°C), the Contractor shall demonstrate to the Engineer that the seam produced equals those produced under normally accepted conditions, and that overall geomembrane quality is not adversely affected.

- All seaming operations shall cease upon the presence of any precipitation (drizzle, sprinkle, etc.).

3.4.7 Trial Seams

- Trial seams shall be made on geomembrane fragments to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period, and at least once every four hours, for each seaming apparatus used that day. Also, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams. The trial seam sample shall be at least 3 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as previously indicated.

- Two adjoining specimens each 1-inch wide shall be cut from the trial seam by the Contractor. The specimens shall be tested, in shear and peel respectively, using a field tensiometer. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial welds are achieved.

- When tests described above are completed, the remaining portion of the trial seam can be discarded. Alternatively, the remaining portion of the trial seam can be subjected to destructive testing. If a trial seam sample fails a test, then a destructive test seam sample taken from the seams completed by the seamer during the shift related to the considered trial seam shall be forwarded to the Engineer.

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3.4.8 General Seaming Procedures

The general seaming procedure used by the Contractor shall be as follows:

- For fusion welding, a movable protective layer of plastic may 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.

- Seaming shall extend to the outside edge of panels placed in the anchor trench (for a minimum distance of 6 inches in the anchor trench).

- If required, a firm substrate shall be provided directly under the seam overlap by using a flat board, a conveyor belt, or similar hard surface to achieve proper support.

- If seaming operations are carried out at night, adequate illumination shall be provided.

- 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 be patched with an oval or round patch of the same geomembrane and shall extend a minimum of 6 inches beyond the cut in all directions.

- A width of one (1) foot along the edge of the geomembrane shall be cleaned to remove all extraneous material (i.e., sand, silt, film, water, etc.) which could be detrimental to the seaming process. The extraneous material must be observed to be wiped, brushed, or blown free from each side of the soon-to-be-welded geomembrane.

- The observation activities that shall be carried out during field seaming of geomembrane panels are listed in Table 3-4. To aid in the documentation of these field activities, the CQA Monitor shall complete the Panel Seaming Checklist, Seam Testing Checklist, Seam Repair and Test Location Log, in addition to filing a Daily Construction Report.

Table 3-4
GEOMEMBRANE FIELD SEAMING OBSERVATION

The CQA Monitor shall observe:

- Observe geomembrane to ensure it is free from dirt, dust, and moisture.
- Observe seaming materials and equipment for conformance with specifications.
- Observe whether foundation is firm enough for seaming.
- Observe weather conditions.
- Measure temperature, pressures, and speed of seaming to see that they meet specifications.
- Observe destructive and non-destructive field-testing of trial seams.
- Observe all geomembrane system components for damage by personnel or equipment during seaming.
- Observe non-destructive testing for 100 percent of field seams. Mark and record locations of failed seams. Observe retesting after repair.
- Observe sampling for destructive testing of field seams once per every 500 feet of seams, at suspicious locations (dirt, moisture, non-destructive test failures). Document locations, time, crew, etc. Test one portion of the sample in field, remainder of sample sent out to laboratory.
- Document repairs including location, type, method used.

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3.5 Materials in Contact with the Geomembrane or Geocomposite

3.5.1 General

The Contractor shall take all necessary precautions so that the installation of these materials does not damage the geomembrane.

3.5.2 Cover Materials

Placement of cover soils on the geomembrane system shall not proceed at an ambient temperature below 40°F (5°C) or above 104°F (40°C), unless otherwise specified. Equipment used for placing cover material shall not be driven directly on the geomembrane system. A minimum thickness of 1 foot of cover soil is specified between a light dozer (such as a wide pad caterpillar D-3 or lighter) and the geomembrane. The soil cover shall be free of sharp-edged stones greater than 1/2 inches in size. In heavy traffic areas such as access ramps, cover material should be at least 3 feet thick. In any case, the following table shall be complied with:

Equipment Ground Pressure (psi)	Minimum Lift Thickness (in)
< 4	12
4-8	18
8-16	24
>16	36

When another is covering one component of the geomembrane system, precautions shall be taken to prevent damage by restricting heavy equipment traffic.

When covering the geomembrane system on sloped areas steeper than 8H:1V, the cover should be pushed up slope to minimize tension. The cover soil shall be placed over the geomembrane system as soon as possible after installation to protect the geomembrane from weather conditions, equipment, and vandalism.

Timely coverage of each component of the geomembrane system, while important and necessary, shall not proceed prior to acceptance of the installed system by the CQA Monitor. Observation activities associated with cover layer placement are listed in Table 3-5.

Table 3-5
Cover Layer Placement Observation

Immediately prior to covering the geomembrane, conduct thorough visual observation for damage, which may have occurred during installation. If damage is found, mark, document, repair, and then observe non-destructive testing (if applicable). Document (including photographs) in the Daily Construction Report.

Observe placement of the protective soil cover material installation and see that the Soils CQA Monitor/Engineer takes the samples and conducts the tests listed in Table 4-1 and that the results are in compliance with the organic content, gradation, thickness, moisture content, field density, final surface slope and interface friction angles as given in Specification Section 02220 Filling and Compaction for Earthwork.

Observe that cover material is free of objects (roots, sticks) that could damage geomembrane system.

Observe that equipment or procedures used to place cover do not damage the geomembrane system.

Verify Protective soil cover material thickness for compliance with specifications (The specifications require the protective cover soil to be greater than 24-inches) using a ruler to measure the thickness as it is placed, and observing that the Contractor has placed marking devices, such as 2 inch diameter PVC pipe, where the soil cover can be measured by sticking a ruler inside the PVC pipe and then measuring from the top of the outside of the PVC pipe to the top of the protective soil cover. If the difference is greater than 24-inches, the thickness of the protective soil cover is greater than 24-inches. The Soils CQA Monitor/Engineer shall confirm the protective cover soil thickness per Table 4-1.

3.5.3 Connection to Appurtenant Structures

The geomembrane will have to be secured to appurtenant structures such as landfill gas extraction wells, piezometers, leachate collection system HDPE manholes and HDPE pump station. All clamps, slips, bolts, nuts, or other fasteners used to secure the geomembrane to each appurtenance shall be stainless steel, or HDPE.

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3.5.4 Quality Assurance Observations

The CQA Monitor shall make quality assurance observations to prevent, detect, and correct the following: the use of unspecified materials; incomplete seams and seals; inadequate compaction of backfill; geomembrane damage due to contact with rough edges, sharp corners; and improper covering.

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Table 3-6
Joints to Structures Observation

Observe that materials are as specified.
Observe sealing systems, installation and placement in proper locations (no excessive stress).
Observe that all objects placed next to geomembrane system are smooth and free of features that could damage geomembrane.
Observe non-destructive testing of seams.

3.5.5 Acceptance

The Contractor shall retain all ownership and responsibility for the lining system until acceptance by the Owner. The lining system shall be accepted by the Owner when:

- The installation is finished.
- All documentation of installation is completed including the Engineer's final report.
- It is verified that all surrounding earth, which could come into contact with waste or leachate, has been covered by the geomembrane system.
- The adequacy of all field seams and repairs, including associated testing, has been verified.

The Owner has received written certification documents, including record drawings, sealed by a registered professional engineer.

3.5.6 CQA Monitor

The CQA Monitor shall observe a maximum of two (2) geomembrane seaming crews. If the Contractor and/or Subcontractors choose to use more than two (2) seaming crews simultaneously, then an assistant CQA Monitor is required. The Contractor and/or Subcontractors shall not install, seam or cover any geomembrane without the presence of the CQA Monitor.

3.5.7 Certification of Completion

Upon completion of the covering operation for each construction sequence, the Contractor shall certify the following to the Owner:

- The landfill closure cap has been constructed in accordance with the accepted project plans and specifications.
- The cover material meets all requirements of the accepted project plans and specifications. The geomembrane and other geosynthetics have not been damaged during the covering operation or construction.

3.5.8 Engineer's Full-Time CQA Monitor

The Engineer's full-time CQA Monitor shall observe a maximum of two (2) geomembrane seaming crews. If the Contractor and/or Subcontractors choose to use more than two (2) seaming crews simultaneously, then additional full-time CQA Monitors will be required. The Contractor and/or Subcontractors shall not install, seam or cover any geomembrane or geosynthics without the presence of the Engineer's full-time resident CQA Monitor.

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4.0 Construction Sampling and Testing

4.1 Subgrade Testing and Observation

The subgrade surface shall be inspected by the CQAM for surface preparation prior to installation of the geomembrane. The inspection shall be documented, including problems noted and corrective action taken. The subgrade shall be tested per table 4-1. A Geotechnical Testing Laboratory employed by the Owner shall make the tests.

TABLE 4-1 EARTHWORK TESTING

PROPERTY	UNITS	FREQUENCY	VALUE	TEST METHOD
Organic Content	%	Note 1	Not Detected, except in top 6-inches where 5% maximum by weight is acceptable.	ASTM D 2974-87
Gradation	N/A	1 per 5,000 tons	Per Specifications	ASTM D 2487
Thickness	Inches	2 per acre	Bedding soil 6 in. min. Cover soil – 24 in. min. All tests must pass.	ASTM D 1777 (See Note 3)
Moisture Content	%	1 per 5,000 tons	2 % +/- Optimum	ASTM D 1557
Field Density for Soil Bedding		1 per acre	93%	ASTM D 1557
Friction Angle of Protective Cover Soil and Bedding Soil	Degrees	3 tests	23 minimum	ASTM D3080-04 Direct Shear Test of Soils under Consolidated Drained Conditions
Final Elevation for Protective Cover Soil	+/- 0.1 Feet	100 ft. spacing	No depressions and 2 % minimum slope.	N/A
Permeability of Protective Cover Soil	Centimeters Per second	1 per 20,000 tons	Maximum permeability 2×10^{-4} cm/sec (Permeability shall range between 2×10^{-4} cm/sec And 1×10^{-6} cm/sec)	ASTM D5084-03 Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter – Method A

1. If needed based on visual observation of the soil to confirm organic content.
2. The test frequency is the minimum frequency. The Engineer shall increase the frequency as needed to confirm that the materials meet the specifications.
3. The testing firm shall use a rubber tipped digging tool to check the thickness of the final protective soil cover. All digging shall be by hand. Care shall be taken not to damage the geomembrane or geocomposite.

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4.2 Geomembrane Field Seams

4.2.1 Observation

Observation of geomembrane field seaming operations shall follow the procedures outlined in Table 3-4 (Geomembrane Field Seaming Observation). The Panel Seaming Log, the Seam Testing Log, and the Daily Field Report shall be used to document the observations.

4.2.2 Non-Destructive Seam Continuity Testing

- The Contractor shall non-destructively test all field seams over their full length using a vacuum test unit, air pressure (for double fusion seams only), or other accepted method. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. Any repairs required shall be completed in accordance with Section 4.2.4. The following procedures shall apply to locations where seams cannot be non-destructively tested:

  1) All such seams shall be cap-stripped with the same geomembrane material.

  2) If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation.

  3) If the seam cannot be tested prior to final installation, the seaming and cap-stripping operations shall be observed by the CQAM for uniformity and completeness.

  4) All fabricated boots shall be hydrostatically tested, or equivalent, prior to or after installation.

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4.2.2.1 Vacuum Testing

The equipment shall comprise the following:

1) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, and a soft neoprene gasket attached to the bottom of the box, a porthole or valve assembly, and a vacuum gauge. The viewing window must give an unobstructed view of the seam being tested at all times.

2) A steel or aluminum vacuum tank and pump assembly equipped with a pressure controller and pipe connections.

3) A rubber pressure/vacuum hose with fittings and connections.

4) A bucket and wide paintbrush.

5) A soapy solution, which allows for bubbles to linger under 5 psi.

The following procedures shall be followed:

1) Start the vacuum pump and reduce the tank pressure to approximately 10 inches of mercury (i.e., 5 psi gauge).

2) Wet a strip of geomembrane (approximately 4 in. by 24 in. in size) with the soapy solution.

3) Place the box over the wetted area.

4) Close the bleed valve and open the vacuum valve.

5) Ensure that a leak-tight seal is created.

6) For a period of not less than 15 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

7) If no bubbles appear after 15 seconds, close the vacuum valve and open the bleed valve, move the box to the next adjoining area with a minimum 3-inch overlap, and repeat the process.

8) All areas where soap bubbles appear shall be marked and repaired in accordance with Section 4.2.4.

4.2.2.2 Air Pressure Testing (for Double Fusion Seam Only)

The following procedures apply to those processes, which produce a double wedge seam with an enclosed space.

The equipment shall comprise the following:

1) An air pump (manual or motor driven) equipped with a pressure gauge which is capable of generating and sustaining a pressure of between 25 and 30 psi, and which is mounted on a cushion to protect the geomembrane.

2) A rubber hose with fittings and connections.

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3) A sharp, hollow needle, or other accepted pressure-feed device.

The following procedure shall be followed:

1) Seal both ends of the seam to be tested.

2) Insert needle or other accepted pressure-feed device into the tunnel created by the fusion weld.

3) Insert a protective cushion between the air pump and the geomembrane.

4) Start the air pump and increase to a pressure of between 25 and 30 psi, close the valve, and sustain pressure for approximately 5 minutes.

5) If pressure loss exceeds 2 psi or 10 cm mercury, or does not stabilize, locate faulty area and repair in accordance with Section 4.2.4.

6) Remove needle or other accepted pressure-feed device and repair in accordance with Section 4.2.4.

4.2.3 Destructive Seam Continuity Testing

Destructive seam tests shall be performed for field seams at locations designated by the CQAM. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

4.2.3.1 Sampling Procedure

1) Location and Frequency: Destructive test samples shall be collected at an average frequency of one test location per 500- feet of seam length. The Contractor as required by the CQAM shall take samples, in addition to the minimum average frequency. Test locations shall be determined during seaming, and may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding. The CQAM shall choose the locations. The Contractor will not be informed in advance of the locations where the seam samples will be taken. The Engineer reserves the right to increase sampling frequency in accordance with actual performance results of samples taken.

   The Contractor at locations designated by the CQAM as the seaming progresses to obtain laboratory test results before the geomembrane is covered by another material shall cut samples. Each sample shall be numbered, and the sample number and location shall be identified on the panel layout drawing. All holes in the geomembrane resulting from the destructive seam sampling shall be repaired immediately in accordance with the

procedures described in Section 4.2.4. The continuity of the new seams in the repaired area shall be tested according to Section 4.2.2.

2) Size of Samples: The samples shall be 12 inches wide by 44 inches long with the seam centered lengthwise. One 1-inch wide strip shall be cut from each end of the sample and these shall be tested in the field. The remaining portion of the sample shall be cut into three parts and distributed as follows:

- One portion to the Contractor for laboratory testing, 12 inches by 12 inches.
- One portion for the Engineer for testing, 12 inches by 18 inches.
- One portion to the Engineer for archive storage, 12 inches by 12 inches.

4.2.3.2 Geomembrane Testing Procedure

1) Field Testing: The two 1-inch wide strips shall be tested in the field, by hand or tensiometer, for peel and shear (respectively) and shall not fail in the seam. The field seam test methods employed shall ensure that all field seams comply with the values for peel and shear strength given in Table 2-1. When field samples fail to pass the tests, then the procedures outlined for destructive test failure shall be followed.

2) Laboratory Testing: Testing by the Engineer will include shear strength and peel adhesion. The testing procedures and the minimum acceptable values obtained in these tests are those indicated in Table 2-1. The tests shall per ASTM d 6392. A minimum of 5 replicated specimens must pass for each destructive test. The Engineer will send the samples to a geosynthetic testing laboratory and provide test results no more than 24 hours after the samples are received at the laboratory. The Engineer shall establish procedures for reporting test results with the selected laboratory.

3) Procedures for Destructive Test Failure: The following procedures shall apply whenever a sample fails the destructive test, whether the test is conducted by the Engineer's specified laboratory, the Contractor's laboratory, or by field tensiometer. The Contractor shall have two options, which shall be at his expense:

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- The Contractor can reconstruct the seam between any two passed test locations.
- The Contractor can trace the welding path to an intermediate location (at 10 feet minimum from the location of the failed test in each direction) and take a small sample at each location for an additional field test. If these additional samples pass the tests, then full laboratory samples shall be taken. If the laboratory samples pass the tests, then the seam shall be reconstructed between these locations. If either sample fails, then the process shall be repeated to establish the zone in which the seam should be reconstructed. In any case, all

acceptable seams must be bounded by two locations from which samples, which passed laboratory destructive tests, have been taken. In cases exceeding 150 feet of reconstructed seam, a sample taken from within the reconstructed zone must pass destructive testing. Whenever a sample fails, additional testing may be required for seams that were welded by the same welder and/or welding apparatus or welded during the same time shift. Such additional testing shall be at the Contractor's expense.

4.2.4 Defects and Repairs to Geomembrane

4.2.4.1 Identification

All seams and non-seam areas of the geomembrane will be observed by the CQAM for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The geomembrane surface shall be clean at the time of examination. If any amount of dust or mud inhibits examination, the geomembrane surface shall be broomed or washed by the Contractor. The Contractor shall ensure that this geomembrane examination precedes any seaming of that section.

4.2.4.2 Evaluation

Each suspect location both in the seam and non-seam areas shall be non-destructively tested using the methods described in Section 4.2.2, as appropriate. Each location, which fails the non-destructive testing, shall be marked by the Engineer and repaired by the Contractor. Work shall not proceed with any materials, which will cover locations, which have been repaired until laboratory test results are available with passing values.

4.2.4.3 Repair Procedure

The Contractor shall repair any portion of the geomembrane, which exhibits a flaw, or fails a destructive or non-destructive test. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Engineer and the Contractor. The available procedures include:

1) Patching: used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter. The patch shall be made of the same material as the geomembrane.

2) Grinding and rewelding: used to repair small sections of extruded seams.

3) Spot welding or seaming: used to repair small tears, pinholes, or other minor, localized flaws.

4) Topping: used to repair inadequate seam areas, which have an exposed edge.

5) Removing bad seam and replacing with a strip of new material welded into place, used with large lengths of fusion seams.

6) Capping will be allowed to repair defective seams

In addition, the following provisions shall be satisfied:

1) Geomembrane surfaces, which are to be repaired, shall be abraded no more than one hour prior to the repair.

2) All surfaces must be clean and dry at the time of repair.

3) All seaming equipment used in repairing procedures shall be approved by the Engineer, and trial seams made and tested prior to using the equipment.

4) The repair procedures, materials, and techniques shall be accepted in advance of the specific repair by the Engineer and Contractor.

5) Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.

6) The geomembrane material below large caps should be cut appropriately to avoid water or gas collections between the two sheets.

4.2.4.4 Verification of Repairs

Each repair shall be identified and logged. Each repair shall be non-destructively tested using the methods described in Section 4.2.2, as appropriate. Repairs, which pass the non-destructive test, shall indicate an adequate repair. Large caps may be of sufficient extent to require destructive test sampling, at the discretion of the Engineer. Failed tests indicate that the repair shall be redone and retested until a passing test results.

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4.2.4.5 Large Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the CQAM shall identify geomembrane wrinkles greater than 12-inches. The Contractor shall cut and reseam all wrinkles so identified. The seam thus produced shall be tested like any other seam.

The double-sided capping geocomposite drainage layer shall lay flat on top of the geomembrane such that wrinkles do not impede the flow of water in the geocomposite. After the double-sided capping geocomposite drainage layer is in place or when a large area is completed and ready for cover by placing the overlying protective cover soil, the CQAM shall identify wrinkles greater than 12-inches in the geocomposite drainage layer. The CQAM shall direct the Contractor's Installer to cut all wrinkles so identified and reconnect the geocomposite prior to placing the overlying protective cover soil.

4.3.1 Protective Soil Cover Testing Procedures

Protective soil cover testing is given in Table 4-1. The protective soil cover shall be visibly inspected to for soil particle sizes greater than ½ inch, and any other debris. Cover soil with gravel or cobbles greater than 1/2inch in size should be rejected. Cover soil contaminated with debris shall be rejected. The cover soil thickness shall be a minimum of 2-feet over the geomembrane or geocomposite. The CQA Monitor shall check the thickness of the soil cover as it is placed. Cover soil should be near the optimum moisture content while being placed. Excessively wet cover soil should be rejected. The soil surface shall be graded smooth, and compacted by the dozer spreading the cover soil such that the soil surface is not rutting under traffic. No compaction tests are required.

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5.0 Documentation

5.1 Daily Field Report and Other Reports, Logs and Forms

A Daily Field Report with a record of work progress, as shown in Attachment A, will be prepared each day by the CQA Monitor. This report will provide the chronological framework for identifying and referencing sampling events and all other attached checklists. A completed sample tag shall accompany all samples taken by the CQA Monitor. All sampling and tests will be noted in the Daily Field Report. The CQA Monitor will also take photographs to document the work, and problem areas as necessary.

The reports, logs and other forms which the CQA Monitor will complete in the course of construction activities include:

Daily Field Report
Certificate of Subgrade Acceptance
Panel Placement Log
Trial Weld Testing Report
Seaming Log
Seam Non-Destructive Testing Log
Seam Destructive Sample and Testing Log
Geomembrane Cover Acceptance Form

In the event that the CQA Monitor has identified material or workmanship that does not meet the design criteria, plans, or specifications, he shall notify the Design Engineer who shall notify the Owner. Based on the magnitude of the problem, the Design Engineer may choose to issue a Field Order. The CQA Monitor should give verbal direction to the Contractor for needed repairs to the geomembrane or seams, and if necessary, follow verbal directions with written directions if needed.

5.2 Construction Certification

The Professional Engineer in charge of construction quality assurance will be responsible for preparing and submitting the Final Construction Report which will include FDEP form number 62-701.900(2) for construction certification, reports, logs, forms, certifications, and other installation records, drawings, inspection reports, and geotechnical information. The report will include the following:

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- Certification of Construction Completion on FDER Form 62-701.900(2)
- Shop Drawing Submittals for geosynthetics, bedding soil and cover soil
- Quality Control Test Reports from Manufacturer

- Quality Assurance Test Reports from Geosynthetic Testing Laboratory
- Compaction and thickness of Geomembrane Bedding
- Thickness of Cover Soil
- Daily Field Reports
- Certificate of Subgrade Acceptances
- Panel Placement Logs
- Trial Weld Testing Reports
- Seaming Logs
- Seam Non-destructive Testing Logs
- Seam Destructive Sample & Testing Logs
- Geomembrane Cover Acceptance Forms
- Geotechnical Testing Results
- Installation Photographs
- Record drawings for the Geomembrane and Geocomposite
- Record drawings for the drainage and stormwater structures
- Record drawings for the landfill gas collection system expansion
- A list of deviations from the permitted plans
- Geomembrane repair logs
- Surveys
- Monthly Progress Meetings Minutes
- Special Progress Meeting Minutes
- Daily Progress Meeting Minutes in the form of the Daily Field Report
- Record drawing with the limits of the slurry wall and anchor trench

Items in the report shall be placed in chronological order.

The Professional Engineer in charge of construction quality assurance will be responsible to submit two copies of the Final Construction Report to FDEP with one copy for the Owner filed at the landfill. The originals will be filed with the Design/Certifying Engineer. The original and all copies submitted will have original signature and seal of the Design/Certifying Engineer on FDEP Form 62-701.900(2).

Attachment A - Forms

Daily Field Report
Certificate of Subgrade Acceptance
Panel Placement Log
Trial Weld Testing Report
Seaming Log
Seam Non-Destructive Testing Log
Seam Destructive Sample and Testing Log
Geomembrane Repair Logs
Geomembrane Cover Acceptance Form

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PAGE OF

DAILY FIELD REPORT

PROJECT: Lena Road Landfill Closure

LOCATION: Manatee County, Florida

OWNER: Manatee County

OWNER REP.:

CQA MANAGER:

PBSJ PROJ. NO.:

CONTRACTOR:

INSTALLER:

DATE:

DAY: S M T W TH F S

WEATHER: clear overcast rain

TEMP: 55-70 70-85 85-90 90-100

WIND: still moderate high

HUMIDITY: dry moderate humid

COMMENTS:

SUMMARY

PANEL PLACEMENT: _____ SQ. FT

SEAM WELDING: _____ FT.

SEAM TESTING: _____ FT.

DESTRUCTIVE TESTING: _____

LINER COVERED: _____ SQ. FT.

HOURS WORKED: _____

COMMENTS

COMMENTS:

PBS&J ON-SITE PERSONNEL:

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SIGNATURE: _____

PBS&J

PAGE OF

SEAM DESTRUCTIVE SAMPLE & TEST LOG

PROJECT: Lena Road Landfill Closure
LOCATION: Manatee County, Florida
INSTALLER:
CONTRACTOR:

OWNER: Manatee County
PROJECT NO.:
LINER TYPE:
SHEET SIZE:

SAMPLE #	SEAM #	SAMPLE LOCATION	MASTER SEAMER	WELD TYPE *	DATE CUT	DATE REPAIRED	CQA ID	PASS / FAIL
DS -								
DS -								
DS -								
DS -								
DS -								
DS -								
DS -								
DS -								
DS -								
DS -								
DS -								
DS -								
DS -								
DS -								
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* WELD TYPE: EW - EXTRUDED WELD; HWF - HOT WEDGE FUSION

COMMENTS:

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Approved:

CQA Manager

PBS&J PAGE_____ OF _____

CERTIFICATE OF SUBGRADE ACCEPTANCE

PROJECT:	Lena Road Landfill	OWNER:	Manatee County
LOCATION:	Manatee County, Florida	PROJECT NO.:	
INSTALLER:		LINER TYPE:	
CONTRACTOR:		SHEET SIZE:	

PANELS _____ NORTH ARROW

Draw map of approved subgrade or give panel numbers.

I the Undersigned, duly authorized representative of _____ have reviewed the above referenced subgrade with PBS&J's CQA Monitor, and finds it acceptable for installation of the proposed geomembrane liner for this project. I also shall be responsible for the soil subgrade's acceptability, integrity and suitability, in accordance with the contract documents from this date to completion acceptance by owner of the installation. This acceptability integrity and suitability considers at the time of placement that the structure of the subgrade meets or exceeds the requirements of the contract documents.

Name Title

Signature Date

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S&J'S CQA MONITOR:

Signature Date

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Approved: _____

13-May-99 file:Cert Subgrade.WK4 CQA Manager

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PANEL PLACEMENT LOG

PROJECT: Lena Road Landfill
LOCATION: Manatee County, Florida
INSTALLER:
CONTRACTOR:

OWNER: Manatee County
PROJECT NO.:
LINER TYPE:
SHEET SIZE:

DATE: _____

TIME	PANEL NUMBER	ROLL NUMBER	SUBGRADE APPROVED	THICKNESS MILS	LENGTH FEET	WIDTH FEET	AREA SQ. FT.	CQA ID

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TOTAL LINER AREA PLACED FOR DAY: _____ **SF**

* THICKNESS - A MINIMUM OF FIVE READINGS.

COMMENTS: _____

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Approved: _____
CQA Manager

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PAGE OF

TRIAL WELD TESTING REPORT

PROJECT: Lena Road Landfill
LOCATION: Manatee County, Florida
INSTALLER:
CONTRACTOR:

OWNER: Manatee County
PROJECT NO.:
LINER TYPE:
SHEET SIZE:

DATE: _____

MACHINE #	TIME	PEEL	SHEAR	PASS / FAIL *	CQA

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* FIELD SEAM PROPERTIES: Shear strength - Minimum of 44 ib/in; and, Peel strength - 40 lb/in.

COMMENTS: _____

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Approved: _____
CQA Manager

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SEAMING LOG

PROJECT: Lena Road Landfill
LOCATION: Manatee County, Florida
INSTALLER: _____
CONTRACTOR: _____

OWNER: Manatee County
PROJECT NO.: _____
LINER TYPE: _____
SHEET SIZE: _____

DATE: _____

SEAM #	MASTER SEAMER	SEAM TYPE *	EQUIPMENT			TEMPERATURE		SEAMING TIME		SEAM LENGTH	CQA ID
			#	SPEED	TEMP.	SHEET	AMB.	START	END		

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* Seam Type - HWF - Hot wedge fusion welder; EW - Extrusion welder.

TOTAL SEAMS FOR DAY: _____ **FEET**

COMMENTS: _____

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Approved: _____

CQA Manager: Joe Miller

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SEAM NONDESTRUCTIVE TESTING LOG

PROJECT: Lena Road Landfill
LOCATION: Manatee County, Florida
INSTALLER:
CONTRACTOR:

OWNER: Manatee County
PROJECT NO.:
LINER TYPE:
SHEET SIZE:

SEAM NUMBER	TEST TYPE *	PRESSURE		TIME		PASS / FAIL	DATE	CQA ID
		START	END	START	END			

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* SEAM TEST TYPE: V - VACUUM; AP - AIR PRESSURE; VI - VISUAL; ADD "R" FOR RETEST OF FAILED SEAM.

COMMENTS:

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Approved: ____________________
CQA Manager

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PAGE _____ OF _____

LINER COVER ACCEPTANCE FORM

PROJECT:	Lena Road Landfill	OWNER:	Manatee County
LOCATION:	Manatee County, Florida	PROJECT NO.:	
INSTALLER:		LINER TYPE:	
CONTRACTOR:		SHEET SIZE:	

The Installer and Contractor certify that the liner is complete and ready for soil cover in the following location:

_____

_____

_____

_____

_____

_____

_____

_____

This acceptance by PBS&J allows the Contractor to proceed in covering the liner with soil in the designated area. This approval does not relieve the Contractor of his responsibilities to meet any of the synthetic liner performance requirements of the Contract Specifications.

FINAL COVER CHECK LIST

_____ Synthetic liner seams tested, repaired, and passed.
_____ Large wrinkles and bridges removed.
_____ Liner panels visually inspected and defects repaired.
_____ All penetrations and seam destructive test patches photographed
_____ As-built survey completed and checked.
_____ All equipment removed from liner surface.
Comments:

_____ INSTALLER _____ DATE

_____ CONTRACTOR _____ DATE

_____ PBS&J _____ DATE

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NOTE! If PBS&J observes any deviations of the requirements listed above or the Contractor damages the liner system during the installation of the landfill gas collection system, work in contact with the liner will be halted in the designated area, and the damage repaired, tested and approved by the QA Monitor.

PBS&J, INC.

SEAM REPAIR AND TEST LOCATION LOG

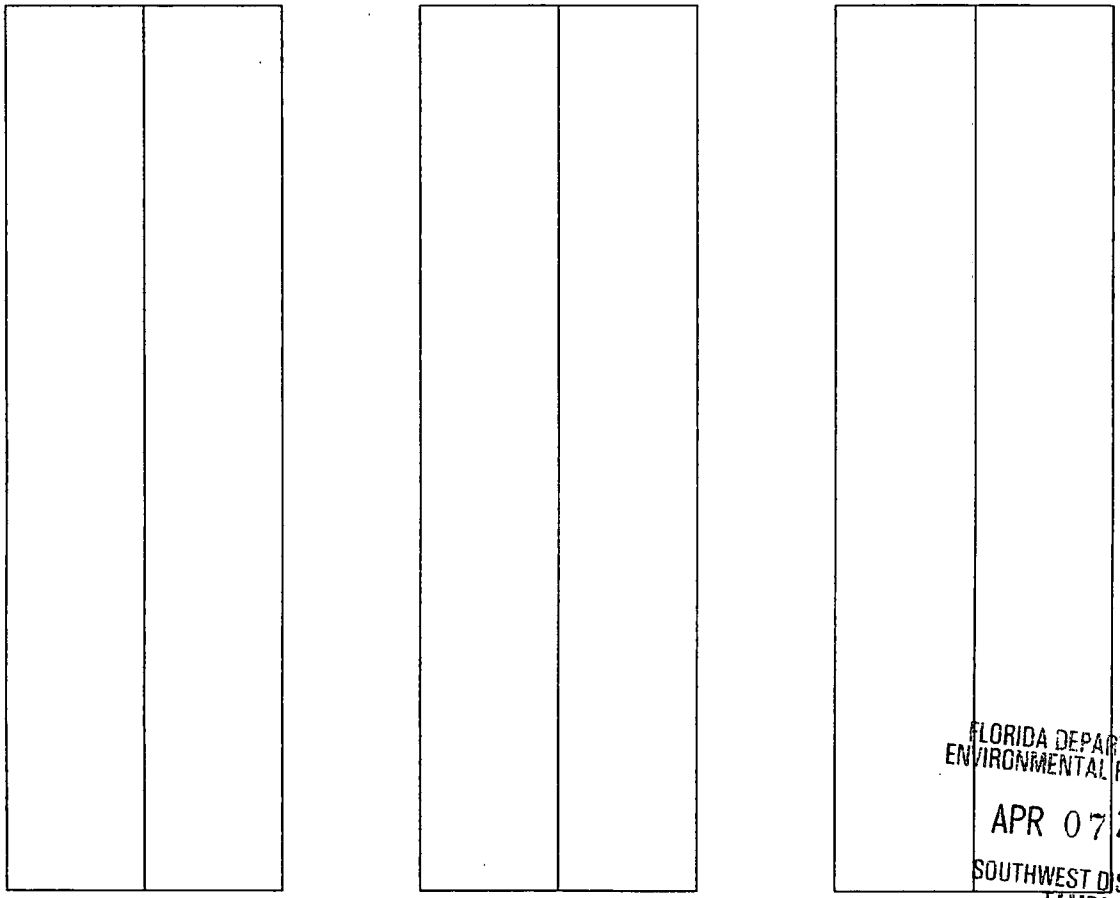
PROJECT: _____ CQA MANAGER: _____

LOCATION: _____ PROJECT NO.: _____

	PATCH	CAP	BEAD	SAMPLE	COMMENTS:
REPAIR					
REPAIRED					
TESTED	☐	▭	△	⊙	

North: North: North:

Seam #: _____ Seam #: _____ Seam #: _____



Completed: _____ Completed: _____ Completed: _____

Date: _____ Date: _____ Date: _____

Time: _____ Time: _____ Time: _____

CQA ID: CQA ID: CQA ID:

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PANEL REPAIR AND TEST LOG

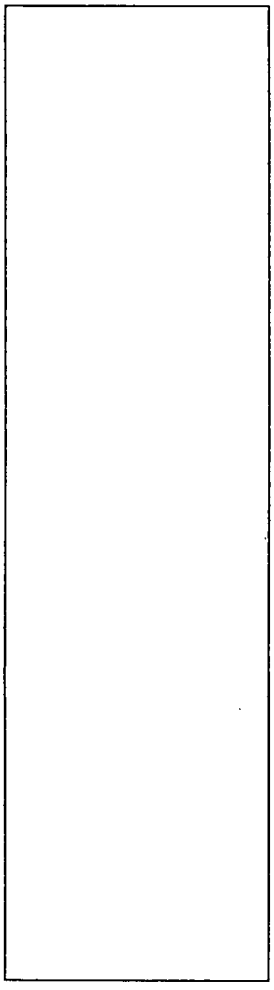
PROJECT: _____
LOCATION: _____

CQA MANAGER: _____
PROJECT NO.: _____

	PATCH	CAP	BEAD	SAMPLE	( ) THICKNESS (MIL)
REPAIR					COMMENTS:
REPAIRED					
TESTED	☐	▭	△	⊡	

North:

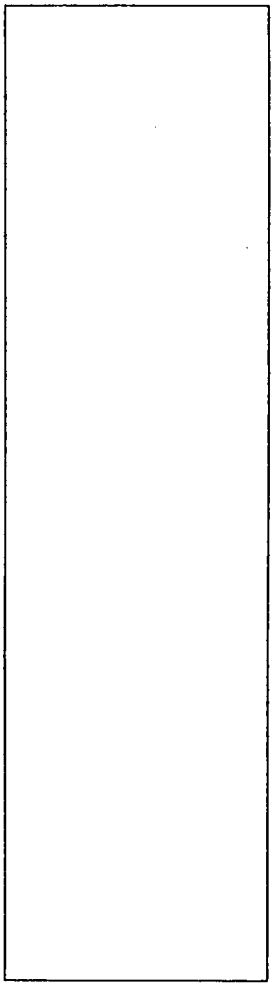
Panel #: _____



Completed: _____
Date: _____
Time: _____
CQA ID: _____

North:

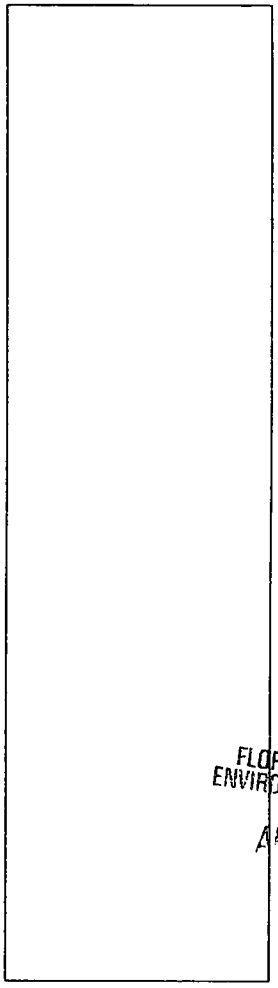
Panel #: _____



Completed: _____
Date: _____
Time: _____
CQA ID: _____

North:

Panel #: _____



Completed: _____
Date: _____
Time: _____
CQA ID: _____

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FILE: PRTSTLOG.XLS

LENA ROAD LANDFILL
STAGE I - PARTIAL CLOSURE #2
TECHNICAL SPECIFICATIONS

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SECTION 01005

GENERAL REQUIREMENTS

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PART 1 GENERAL

1.01 SCOPE AND INTENT

A. Description

The work to be done consists of the furnishing of all labor, materials, and equipment and the performance of all work included in this Contract.

B. Work Included

The Contractor shall furnish all labor, superintendence, materials, plant, power, light, heat, fuel, water, tools, appliances, equipment, supplies, shop drawings, working drawings and other means of construction necessary or proper for performing and completing the work. He shall obtain and pay for all required permits necessary for the work other than the Florida Department of Environmental Protection Landfill Closure Permit. He shall perform and complete the work in the manner best calculated to promote rapid construction consistent with safety of life and property and to the satisfaction of the Engineer and Owner, and in strict accordance with the Contract Documents. The Contractor shall clean up the work and maintain it during and after construction, until accepted, and shall do all work and pay all costs incidental thereto. He shall repair or restore all structures and property that may be damaged or disturbed during performance of the work.

The cost of incidental work described in these General Requirements, for which there are no specific Contract Items, shall be considered as part of the general cost of doing the work and shall be included in the prices for the various Contract Items. No additional payment will be made therefore.

The Contractor shall provide and maintain such modern plant, tools, and equipment as may be necessary, in the opinion of the Engineer, to perform in a satisfactory and acceptable manner all the work required by this Contract. Only equipment of established reputation and proven efficiency shall be used. The Contractor shall be solely responsible for the adequacy of his workmanship, materials, and equipment, prior approval of the Engineer notwithstanding.

1.02 PLANS AND SPECIFICATIONS

A. Plans

When obtaining data and information from the Plans, figures shall be used in preference to scaled dimensions, and large-scale drawings in preference to small scale drawings.

B. Copies Furnished to Contractor

The Contractor shall furnish each of the subcontractors, manufacturers, and material men such copies of the Contract Documents as may be required for their work. Additional copies of the Plans and Specifications, when requested, may be furnished to the Contractor at cost of reproduction.

C. Supplementary Drawings

When, in the opinion of the Engineer, it becomes necessary to explain more fully the work to be done or to illustrate the work further or to show any changes which may be required, drawings known as Supplementary Drawings, with specifications pertaining thereto, will be prepared by the Engineer and five paper prints thereof will be given to the Contractor.

D. Contractor to Check Plans and Data

The Contractor shall verify all dimensions, quantities, and details shown on the Plans, Supplementary Drawings, Schedules, Specifications, or other data received from the Engineer, and shall notify him of all errors, omissions, conflicts, and discrepancies found therein. Failure to discover or correct errors, conflicts, or discrepancies shall not relieve the Contractor of full responsibility for unsatisfactory work, faulty construction, or improper operation resulting there from nor from rectifying such conditions at his own expense. He will not be allowed to take advantage of any errors or omissions, as full instructions will be furnished by the Engineer, should such errors or omissions be discovered. All schedules are given for the convenience of the Engineer and the Contractor and are not guaranteed to be complete. The Contractor shall assume all responsibility for the making of estimates of the size, kind, and quality of materials and equipment included in work to be done under the Contract.

E. Specifications

The Technical Specifications consist of three parts: General, Products, and Execution. The General Section contains General Requirements which govern the work. Products and Execution modify and supplement these by detailed requirements for the work and shall always govern whenever there appears to be a conflict.

F. Intent

All work called for in the Specifications applicable to this Contract, but not shown on the Plans in their present form, or vice versa, shall be of like effect as if shown or mentioned in both. Work not specified in either the Plans or in the Specifications, but involved in carrying out their intent or in the complete and proper execution of the work, is required and shall be performed by the Contractor as though it were specifically delineated or described.

The apparent silence of the Specifications as to any detail, or the apparent omission from them of a detailed description concerning any work to be done and materials to be furnished, shall be regarded as meaning that only the best general practice is to prevail and that only material and workmanship of the best quality is to be used, and interpretation of these Specifications shall be made upon that basis.

The inclusion of the Related Requirements (or work specified elsewhere) in the General part of the specifications is only for the convenience of the Contractor, and shall not be interpreted as a complete list of related Specification Sections.

1.03 MATERIALS AND EQUIPMENT

A. Manufacturer

The names of proposed manufacturers, material men, suppliers and dealers who are to furnish materials, fixtures, equipment, appliances or other fittings shall be submitted to the Engineer for approval. Such approval must be obtained before shop drawings will be checked. No manufacturer will be approved for any materials to be furnished under this Contract unless he shall be of good reputation and have a plant of ample capacity. He shall, upon the request of the Engineer, be required to submit evidence that he has manufactured a similar product to the one specified and that it has been previously used for a like purpose for a sufficient length of time to demonstrate its satisfactory performance.

All transactions with the manufacturers or subcontractors shall be through the Contractor, unless the Contractor shall request, in writing to the Engineer, that the manufacturer or subcontractor deal directly with the Engineer. Any such transactions shall not in any way release the Contractor from his full responsibility under this Contract.

Any two or more pieces or material or equipment of the same kind, type or classification, and being used for identical types of services, shall be made by the same manufacturer.

B. Delivery

The Contractor shall deliver materials in ample quantities to ensure the most speedy and uninterrupted progress of the work so as to complete the work within the allotted time. The Contractor shall also coordinate deliveries in order to avoid delay in, or impediment of, the progress of the work of any related Contractor.

C. Tools and Accessories

The Contractor shall, unless otherwise stated in the Contract Documents, furnish with each type, kind or size of equipment, one complete set of suitably marked high grade special tools and appliances which may be needed to adjust, operate, maintain, or repair the equipment. Such tools and appliances shall be furnished in approved painted steel cases, properly labeled, and equipped with good grade cylinder locks and duplicate keys.

D. Installation of Equipment.

The Contractor shall have on hand sufficient proper equipment and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character.

Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Plans, unless directed otherwise by the Engineer during installation. All equipment shall be correctly aligned, leveled, and adjusted for satisfactory operation and shall be installed so that proper and necessary connections can be made readily between the various units.

E. Service of Manufacturer's Engineer

The Contract prices for equipment shall include the cost of furnishing (as required by equipment specifications sections) a competent and experienced engineer or superintendent who shall represent the manufacturer and shall assist the Contractor, when required, to install, adjust, test and place in operation the equipment in conformity with the Contract Documents. After the equipment is placed in permanent operation by the Owner, such engineer or superintendent shall make all adjustments and tests required by the Engineer to prove that such equipment is in proper and satisfactory operating condition, and shall instruct such personnel as may be designated by the Owner in the proper operation and maintenance of such equipment.

1.04 INSPECTION AND TESTING

A. General

Inspection and testing of materials will be performed by the Owner unless otherwise specified.

For tests specified to be made by the Contractor, the testing personnel shall make the necessary inspections and tests and the reports thereof shall be in such form as will facilitate checking to determine compliance with the Contract Documents. Three (3) copies of the reports shall be submitted and authoritative certification thereof must be furnished to the Engineer as a prerequisite for the acceptance of any material or equipment.

If, in the making of any test of any material or equipment, it is ascertained by the Engineer that the material or equipment does not comply with the Contract, the Contractor will be notified thereof and he will be directed to refrain from delivering said material or equipment, or to remove it promptly from the site or from the work and replace it with acceptable material, without cost to the Owner.

The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

B. Costs

All inspection and testing of materials furnished under this Contract will be performed by the Owner or duly authorized inspection engineers or inspections bureaus without cost to the Contractor, unless otherwise expressly specified.

The cost of shop and field tests of equipment and of certain other tests specifically called for in the Contract Documents shall be borne by the Contractor and such costs shall be deemed to be included in the Contract price.

Materials and equipment submitted by the Contractor as the equivalent to those specifically named in the Contract may be tested by the Owner for compliance. The Contractor shall reimburse the Owner for the expenditures incurred in making such tests on materials and equipment which are rejected for non-compliance.

C. Certificate of Manufacture

When inspection is waived or when the Engineer so requires, the Contractor shall furnish to him authoritative evidence in the form of Certificates of Manufacture that the materials to be used in the work have been manufactured and tested in conformity

with the Contract Documents. These certificates shall be notarized and shall include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer.

1.05 TEMPORARY STRUCTURES

A. Temporary Fences

If, during the course of the work, it is necessary to remove or disturb any fence or part thereof, the Contractor shall, at his own expense, if so ordered by the Engineer, provide a suitable temporary fence which shall be maintained until the permanent fence is replaced. The Engineer shall be solely responsible for the determination of the necessity for providing a temporary fence and the type of temporary fence to be used.

1.06 TEMPORARY SERVICES

A. First Aid

The Contractor shall keep upon the site, at each location where work is in progress, a completely equipped first aid kit and shall provide ready access thereto at all times when people are employed on the work.

1.07 LINES AND GRADES

A. Grade

All work under this Contract shall be constructed in accordance with the lines and grades shown on the Plans, or as given by the Owner/Engineer. The full responsibility for keeping alignment and grade shall rest upon the Contractor. The grades shown on the drawings for piping and ditches are minimum grades. The soil component thicknesses shown on the drawings are minimum thicknesses. The soil thicknesses for cover over pipes shown on the drawings are minimum thicknesses. The pipe dimensions shown on the drawings are nominal dimensions per ASTM Standards.

B. Safeguarding Marks

The Contractor shall safeguard all points, stakes, grade marks, monuments and bench marks made or established on the work, bear the cost of reestablishing them if disturbed, and bear the entire expense of rectifying work improperly installed due to not maintaining or protecting or to removing without authorization such established points, stakes and marks.

The Contractor shall safeguard all existing and known property corners, monuments and marks adjacent to but not related to the work and, if required, shall bear the cost of reestablishing them if disturbed or destroyed.

C. Datum Plane

All elevations indicated or specified refer to the Mean Sea Level Datum of the NGVD 1929 Datum and/or NAVD 1988.

1.08 PROTECTION OF WORK AND PUBLIC

A. Barriers and Lights

During the prosecution of the work, the Contractor shall put up and maintain at all times such barriers and lights as will effectually prevent accidents. The Contractor shall provide suitable barricades, red lights, "danger" or "caution" signs at all places where the work causes obstructions to the normal traffic or constitutes in any way a hazard to the public.

B. Smoke Prevention

A strict compliance with ordinances regulating the production and emission of smoke will be required. No open fires will be permitted.

C. Noise

The Contractor shall eliminate noise to as great an extent as practicable at all times. Air compressing plants shall be equipped with silencers and the exhaust of all gasoline motors or other power equipment shall be provided with mufflers. In the vicinity of hospitals and schools, special care shall be used to avoid noise or other nuisances. The Contractor shall strictly observe all local regulations and ordinances covering noise control.

Except in the event of an emergency, no work shall be done between the hours of 7:00 P.M. and 7:00 A.M. If the proper and efficient prosecution of the work requires operations during the night, the written permission of the Owner shall be obtained before starting such items of the work.

D. Dust prevention

The Contractor shall prevent dust nuisance from his operations or from traffic by keeping the roads and/or construction areas sprinkled with water at all times.

1.09 CUTTING AND PATCHING

The Contractor shall do all cutting, fitting or patching of his portion of the work that may be required to make the several parts thereof join and coordinate in a manner satisfactory to the Engineer and in accordance with the Plans and Specifications. The work must be done by competent workmen skilled in the trade required by the restoration.

1.10 CLEANING

A. During Construction

During construction of the work, the Contractor shall, at all times, keep the site of the work and adjacent premises as free from material, debris and rubbish as is practicable and shall remove the same from any portion of the site if, in the opinion of the Engineer, such material, debris, or rubbish constitutes a nuisance or is objectionable.

The Contractor shall remove from the site all of his surplus materials and temporary structures when no further need therefore develops.

B. Final Cleaning

At the conclusion of the work, all equipment, tools, temporary structures, and materials belonging to the Contractor shall be promptly taken away, and he shall remove and promptly dispose of all water, dirt, rubbish or any other foreign substances.

The Contractor shall thoroughly clean all equipment and materials installed by him and shall deliver such materials and equipment undamaged in a bright, clean, polished, and new operating condition.

1.11 MISCELLANEOUS

A. Protection Against Siltation and Bank Erosion

1. The Contractor shall arrange his operations to minimize siltation and bank erosion on construction sites and on existing or proposed water courses and drainage ditches.
2. The Contractor, at his own expense, shall remove any siltation deposits and correct any erosion problems as directed by the Engineer which results from his construction operations.

B. Existing Facilities

The work shall be so conducted to maintain existing facilities in operation insofar as is possible. The flare shall be kept in operation at all times.

C. Use of Chemicals

All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, must show approval of either EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with instructions.

D. Spill Prevention, Control and Reporting

The contractor shall take care to prevent fuel spills, and shall have a training program and plan for the prevention and control of spills. Fuel spills shall be reported, and cleaned up per F.A.C. Chapter 62-770 Petroleum Contamination Site Cleanup Criteria. Temporary storage tanks for the project shall meet F.A.C. Chapter 62-762 Above Ground Storage Tank System as applicable.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS/REQUIREMENTS INCLUDED

A. The work included in this contract consists of the construction the Lena Road Landfill Stage I Partial Closure #2, which includes expanding the landfill gas collection system, the landfill cap and the stormwater collection system. The landfill gas collection system expansion consists of installing the landfill gas extraction wells in the landfill, the well heads, collection pipes and connecting the new wells to the existing header pipe. Work includes start-up and testing of each well, balancing the new gas extraction wells with the existing system so the final system is in complete operation at the end of the project. The Contractor shall operate the landfill gas collection system for a minimum of thirty days such that there is negative vacuum to each well. The landfill cap construction includes stripping vegetation and final grading the landfill area to be capped, adding bedding soil as needed, installing the geomembrane and double sided capping geocomposite, two feet of protective soil cover and a layer of sod. The Contractor shall be responsible for watering the sod until the sod is established. The Owner will provide the Contractor with reuse water from the adjacent wastewater plant for watering the sod. The storm water collection system includes extending the existing collection pipes to the top of the landfill, and installing new inlets and outlet structures at locations as shown on the drawings.

B. The Contractor shall furnish all shop drawings, working drawings, labor, materials, equipment, tools, services and incidentals necessary to complete all work required by these Specifications and as shown on the Contract Drawings.

C. The Contractor shall perform the work complete, in place and ready for continuous service and shall include any repairs, replacements, and/or restoration required as a result of damages caused prior to acceptance by the Owner.

D. The Contractor shall furnish and install all materials, equipment and labor which is reasonably and properly inferable and necessary for the proper completion of the work, whether specifically indicated in the Contract Documents or not.

1.02 WORK SEQUENCE

A. All work for this project will be done under this Contract, and shall be done with a minimum of inconvenience to the users of the landfill.

B. The Contractor shall, if necessary and feasible, construct the work in stages to accommodate the Owner's use of the premises during the construction period; coordinate the construction schedule and operations with the Owner's Representative.

1.03 CONSTRUCTION AREAS

A. The Contractor shall: Limit his use of the construction areas for work and for storage, to allow for:

1. Works by other Contractors.
2. Owner's Use.
3. Public Use.

B. Coordinate use of work site under direction of Engineer or Owner's Representative.

C. Assume full responsibility for the protection and safekeeping of products under this Contract, stored on the site.

D. Move any stored products under the Contractor's control, which interfere with operations of the Owner or separate contractor.

1.04 OWNER OCCUPANCY

A. It is assumed that portions of the Work will be completed prior to completion of the entire Work. Upon completion of construction of each individual section, including testing, the section may be connected to the landfill gas collection system and landfill gas sent to the flare. The Owner will accept the entire work as a whole when it is completed, tested and approved by the Engineer and Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01015

CONTROL OF WORK

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PART 1 GENERAL

1.01 WORK PROGRESS

The Contractor shall furnish personnel and equipment which will be efficient, appropriate and adequately sized to secure a satisfactory quality of work and a rate of progress which will ensure the completion of the work within the time stipulated in the Contract. If at any time such personnel appears to the Engineer to be inefficient, inappropriate, or insufficient for securing the quality of work required for producing the rate of progress aforesaid, he may order the Contractor to increase the efficiency, change the character, or increase the personnel and equipment and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

1.02 WORK LOCATIONS

Work shall be located substantially as indicated on the drawings, but the Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons.

1.03 PROCEDURES FOR IDENTIFYING, PROTECTING AND REPAIRING THE SLURRY WALL

A. The approximate location of the slurry wall is shown on the drawings. The contractor shall locate and identify the slurry wall, and flag or mark on the ground the location of the slurry wall when working in the area. The Contractor shall take care to protect the slurry wall by bracing the excavation when excavating near the slurry wall. If the slurry wall is damaged, the Contractor shall repair the slurry wall.

B. The slurry wall shall be repaired by mixing powered sodium bentonite with Protective Cover Soil (Silty Sand) at a ratio of 10% bentonite to 90% Protective Cover Soil by volume. This mixture shall be used for backfill in the area where the slurry wall must be repaired. The backfill shall be compacted to 98% Modified Proctor at plus or minus 2% of the optimum moisture content, and the repaired section shall be a minimum of 5-feet wide. The QA monitor shall observe and photograph the mixing, backfilling and compacting. A detailed report shall be submitted with the construction certification documentation for each slurry wall section damaged and repair.

C. One compaction test shall be taken at each repair location, or every 10 cubic yards. One sample of slurry wall repair material shall be taken at random from the in-place, compacted slurry wall repair using a Shelby tube, or other approved sampling

method. The sample shall be tested in the laboratory for permeability per ASTM D5084-03 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter – Method A. The sample shall have a minimum permeability of $1x10^{-7}$ cm/sec. Test results shall be submitted to FDEP with the certification of construction completion. The sample hole shall be backfilled will bentonite, or bentonite/slurry wall repair material.

1.04 OPEN EXCAVATIONS

A. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of open trench, prohibiting stacking excavated material and requiring that the trench shall not remain open overnight.

B. The Contractor shall take precautions to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles which could be dangerous to the public shall be barricaded and well lighted at all times when construction is not in progress.

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1.05 TEST PITS

Test pits for the purpose of locating underground pipeline or structures in advance of the construction shall be excavated and backfilled by the Contractor at the direction of the Engineer. Test pits shall be backfilled immediately after location and the surface shall be restored in a manner equal or better than the original condition. No separate payment will be made.

1.06 CARE AND PROTECTION OF PROPERTY

A. The Contractor shall be responsible for the preservation of all public and private property and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition equal or better to that existing before the damage was done, or he shall make good the damage in another manner acceptable to the Engineer.

C. Along the location of this work, all physical features shall be protected and restored in a thoroughly workmanlike manner unless otherwise shown on the drawings. All grass areas beyond the limits of construction which have been damaged by the Contractor shall be regraded and sodded to equal or exceed original conditions.

1.07 MAINTENANCE OF TRAFFIC

A. Open pits, trenches, unpaved streets, debris, or other obstructions due to construction that will prevent the normal flow of traffic during an extended construction stoppage, for any reason, shall be minimized. In the event an extended construction stoppage is found to be necessary, Contractor shall, at his own expense, provide normal traffic flow during extended construction stoppage. Extended stoppage will be defined by the Engineer.

B. All excavated material shall be placed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards, he shall repair the road surface, provide temporary roadways, erect wheel guards or fences, or take other safety measures which are satisfactory to the Engineer and Owner.

C. Detours around construction areas will be subject to the approval of the Owner and the Engineer. Where detours are permitted, the contractor shall provide all necessary barricades and signs as required to divert the flow of traffic. While traffic is detoured, the Contractor shall expedite construction operations and periods when traffic is being detoured, will be strictly controlled by the Owner.

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1.08 WATER FOR CONSTRUCTION PURPOSES

A. Reuse water is available for the Contractor from the adjacent wastewater treatment plant by way of an effluent waster water pipeline.

1.09 CLEANUP

During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as is possible. He shall dispose of all residues resulting from the construction work and at the conclusion of the work; he shall remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures and any other refuse remaining from the construction operations and shall leave the entire site of the work in a neat and orderly condition.

1.10 COOPERATION WITHIN THIS CONTRACT

A. All firms or person authorized to perform any work under this Contract shall cooperate with the General Contractor and his subcontractors or trades and shall assist in incorporating the work of other trades where necessary or required.

B. Cutting and patching, drilling and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

1.11 PROTECTION OF CONSTRUCTION AND EQUIPMENT

A. All newly constructed work shall be carefully protected from injury in any way. No wheeling or walking or placing of heavy loads on it shall be allowed and all portions injured shall be reconstructed by the Contractor at his own expense.

B. All newly constructed work such as landfill gas wells, well heads, pipes, storm water inlets, energy dissipaters, geomembrane, geocomposite, etc. shall be protected in a manner approved by the Engineer. Should any newly constructed work be damaged, all such damaged portions of the work shall be completely repaired and made good by the Contractor, at his own expense and to the satisfaction of the Engineer. If, in the final inspection of the work, any defects, faults, or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation for the materials and labor required. Further, the Contractor shall be fully responsible for the satisfactory maintenance and repair of the construction and other work undertaken herein, for at least the warranty period described in the Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01030

SPECIAL PROJECT PROCEDURES

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PART 1 GENERAL

1.01 PERMITS

Upon notice of award, the Contractor shall immediately apply for all applicable permits not previously obtained by the Owner to do the work from the appropriate governmental agency or agencies. No work shall commence until all applicable permits have been obtained and copies delivered to the Engineer. The costs for obtaining all permits shall be borne by the Contractor.

1.02 CONNECTIONS TO EXISTING SYSTEM

The Contractor shall perform all work necessary to locate, excavate and prepare for connections to the terminus of the existing systems all as shown on the Drawings or where directed by the Owner/Engineer. The cost for this work and for the actual connection to the existing systems shall be included in the price bid for the project and shall not result in any additional cost to the Owner. The termination point for each contract shall be as shown on the Contract Drawings.

1.03 RELOCATIONS

The Contractor shall be responsible for the coordination of the relocation of structures, including but not limited to light poles, power poles, signs, sign poles, fences, piping, conduits and drains that interfere with the positioning of the work as setout on the Drawings. No relocation of the items under this Contract shall be done without approval from the Engineer.

1.04 EXISTING UNDERGROUND PIPING

A. The attention of the Contractor is drawn to the fact that during excavation, the possibility exists of the Contractor encountering underground piping not shown on the Drawings.

B. The existing utility locations are shown without express or implied representation, assurance, or guarantee that they are complete or correct or that they represent a true picture of underground piping to be encountered. The Contractor shall be responsible for notifying the various utility companies to locate their respective utilities in advance of construction in conformance with all requirements provided for in the

Florida Underground Facilities Damage Prevention and Safety Act (Florida Statutes, Title XXXIII, Chapter 556).

C. The Contractor shall exercise care in any excavation to locate all existing piping and utilities. All utilities which do not interfere with complete work shall be carefully protected against damage. Any existing utilities damaged in any way by the Contractor shall be restored or replaced by the Contractor at his expense as directed by the Engineer and/or the owner of the utility.

F. It is intended that wherever existing piping must be crossed, no deflections will be allowed in landfill gas collection system piping or the stormwater system.

1.05 SUSPENSION OF WORK DUE TO WEATHER

Refer to FDOT Standards and Specifications Book, Section 8.

1.06 HURRICANE PREPAREDNESS PLAN

A. Within 30 days of the date of Notice to Proceed, the Contractor shall submit to the Engineer and Owner a Hurricane Preparedness Plan. The plan should outline the necessary measures which the Contractor proposes to perform at no additional cost to the Owner in case of a hurricane warning.

B. In the event of inclement weather, or whenever Engineer shall direct, Contractor shall ensure that he and his Subcontractors shall carefully protect work and materials against damage or injury from the weather. If, in the opinion of the Engineer, any portion of work or materials is damaged due to the failure on the part of the Contractor or Subcontractors to protect the work, such work and materials shall be removed and replaced at the expense of the Contractor.

1.07 POWER SUPPLY

Electricity as may be required for construction shall be secured and purchased by the Contractor.

1.08 SALVAGE

Any existing equipment or material, including, but not limited to, valves, pipes, fittings, couplings, etc., which is removed or replaced as a result of construction under this project may be designated as salvage by the Engineer or Owner and if so shall be protected for a reasonable time until picked up by the Owner. Any equipment or material not worthy of salvaging, as directed by the Engineer, shall be disposed of by the Contractor at no additional cost.

1.09 DEWATERING

A. The Contractor shall do all groundwater pumping necessary to prevent flotation of any part of the work during construction operations with his own equipment. All water that must be pumped from within the landfill slurry wall is landfill leachate, and must be pumped to the nearest landfill leachate collection manhole for disposal with the landfill leachate at the adjacent Manatee County Waste Water Treatment Plant.

B. The Contractor shall pump out any water which may seep or leak into the excavations and could come in contact with landfill leachate for the duration of the Contract with his own equipment. The Contractor shall dispose of this water by pumping it to the nearest landfill leachate collection manhole for disposal with the landfill leachate at the adjacent Manatee County Waste Water Treatment Plant.

1.10 ADDITIONAL PROVISIONS

A. Before commencing work on any of the existing pipelines, structures or equipment, the Contractor shall notify the Engineer, in writing, at least 10 calendar days in advance of the date he proposes to commence such work.

B. The Contractor shall provide, at his own expense, all necessary temporary facilities for access to and for protection of, all existing facilities. The Owner's personnel must have ready access at all times to the existing facilities. The Contractor is responsible for all damage to existing structures, equipment and facilities caused by his construction operations and must repair all such damage when and as ordered by the Engineer.

1.11 CONSTRUCTION CONDITIONS

The Contractor shall strictly adhere to the specific requirements of the governmental unit(s) and/or agency(ies) having jurisdiction over the work. Wherever there is a difference in the requirements of a jurisdictional body and these Specifications, the more stringent shall apply.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01045

CUTTING AND PATCHING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall be responsible for all cutting, fitting and patching, including excavation and backfill, required to complete the work or to:

1. Make its several parts fit together properly.

2. Uncover portions of the work to provide for installation of ill-timed work.

3. Remove and replace defective work.

4. Remove and replace work not conforming to requirements of Contract Documents.

5. Provide penetrations of non-structural surfaces for installation of piping and electrical conduit to the contractors field office and maintenance areas if electrical service is required.

PART 2 PRODUCTS

2.01 MATERIALS

Comply with specifications and standards for each specific product involved.

PART 3 EXECUTION

3.01 INSPECTION

A. Inspect existing conditions of project, including elements subject to damage or to movement during cutting and patching.

B. After uncovering work, inspect conditions affecting installation of products, or performance of work.

C. Report unsatisfactory or questionable conditions to Engineer. Do not proceed with work until Engineer has provided further instructions.

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3.02 PREPARATION

A. Provide adequate temporary support as necessary to assure structural value to integrity of affected portion of work.

B. Provide devices and methods to protect other portions of project from damage.

C. Provide protection from elements for that portion of the project which may be exposed by cutting and patching work and maintain excavations free from water.

3.03 PERFORMANCE

A. Execute cutting and demolition by methods which will prevent damage to other work and will provide proper surfaces to receive installation of repairs.

B. Execute excavating and backfilling by methods which will prevent settlement or damage to other work.

C. Fit and adjust products to provide a finished installation to comply with specified products, functions, tolerances and finishes.

D. Restore work which has been cut or removed; install new products to provide completed work in accordance with the requirements of the Contract Documents.

E. Replace surfaces airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

F. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes.

END OF SECTION

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SECTION 01050

FIELD ENGINEERING AND SURVEYING

FLORIDA DEPARTMENT OF
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PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

1. The Contractor shall provide and pay for field surveying service required for the project.

2. The Contractor shall furnish and set all necessary stakes to establish the lines and grades as shown on the Contract Drawings and layout each portion of the Work of the Contract.

    1. All survey work required in execution of Project.

    2. All costs of construction layout shall be included in the unit and lump sum prices contained in the respective divisions of the Contract Bid Form.

    3. Civil, structural or other professional engineering services specified or required to execute Contractor's construction methods.

1.02 QUALIFICATION OF SURVEYOR AND ENGINEER

All construction staking shall be conducted by or under the supervision of a Florida Registered Professional Surveyor and Mapper approved by the Owner. The Contractor shall be responsible for the layout of all such lines and grades, which will be subject to verification by the Engineer.

1.03 SURVEY REFERENCE POINTS

A. Existing basic horizontal and vertical control points for the Project are designated on the Contract Drawings.

2. Locate and protect all survey monumentation, property corners and project control points prior to starting work and preserve all permanent reference points during construction. All costs associated with the replacement of all survey monumentation, property corners and project control points shall be borne by the Contractor.

    1. Make no changes or relocations without prior written notice to Engineer.

    2. Report to Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

3. Require surveyor to replace project control points which may be lost or destroyed.

4. Establish replacements based on original survey control.

1.04 PROJECT SURVEY REQUIREMENTS

The Contractor shall establish temporary benchmarks as needed, referenced to data established by survey control points.

1.05 RECORDS

Maintain a complete, accurate log of all control and survey work as it progresses.

The Contractor shall employ a Professional Engineer or Surveyor registered in the State of Florida to verify survey data and properly prepare record drawings on Mylar and 3-1/2" diskettes. The Record Drawings, together with two copies, shall be certified by the licensed professional and shall be submitted to the Owner/Engineer.

1.06 SUBMITTALS

A. Submit name and address of Professional Surveyor and Mapper to Engineer for Owner's approval.

2. Submit certificate signed by the Professional Surveyor and Mapper certifying that elevations and locations of improvements are in conformance, or nonconformance, with Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01090

REFERENCE STANDARDS

D.E.P.
SEP 1 4 2005
Southwest District Tampa

PART 1 GENERAL

1.01 REQUIREMENTS

Abbreviations and acronyms used in Contract Documents to identify reference standards.

1.02

A. Application: When a standard is specified by reference, comply with requirements and recommendations stated in that standard, except when requirements are modified by the Contract Documents, or applicable codes established stricter standards.

B. Publication Date: The most recent publication in effect on the date of issue of Contract Documents, except when a specific publication date is specified.

1.03 ABBREVIATIONS, NAMES AND ADDRESSES OR ORGANIZATIONS

Obtain copies of reference standards direct from publication source, when needed for proper performance of work, or when required for submittal by Contract Documents.

AA — Aluminum Association
818 Connecticut Avenue, N.W.
Washington, DC 20006

AASHTO — American Association of State Highway and Transportation Officials
444 North Capital Street, N.W.
Washington, DC 20001

ACI — American Concrete Institute
Box 19150
Reford Station
Detroit, MI 48219

AI — Asphalt Institute
Asphalt Institute Building
College Park, MD 20740

AISC — American Institute of Steel Construction
1221 Avenue of the Americas

New York, NY 10020

AISI	American Iron and Steel Institute 1000 16th Street NW Washington, DC 20036
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
AWS	American Welding Society 2501 N.W. 7th Street Miami, FL 33125
CRSI	Concrete Reinforcing Steel Institute 180 North LaSalle Street, Suite 2110 Chicago, IL 60601
FDEP	Florida Department of Environmental Protection 3900 Commonwealth Blvd. Tallahassee, Florida 32399
FDOT	Florida Department of Transportation Standards Specifications for Road and Bridge Construction Maps & Publication Sales - Mail Station 12 605 Suwannee St. Tallahassee, FL 32399-0450

FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Bldg. 197 Washington, DC 20407
MCUOD	Manatee County Utility Operations Department 4410 66th St. W. Bradenton, FL 34210
MLSFA	Metal Lath/Steel Framing Association 221 North LaSalle Street Chicago, IL 60601
MMA	Monorail Manufacturer's Association 1326 Freeport Road Pittsburgh, PA 15238
NAAMM	National Association of Architectural Metal Manufacturers 221 North LaSalle Street Chicago, IL 60601
NEMA	National Electrical Manufacturer's Assoc. 2101 L Street N.W. Washington, DC 20037
OSHA	Occupational Safety and Health Assoc. 5807 Breckenridge Pkwy., Suite A Tampa, FL 33610-4249
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 20076
PCI	Prestressed Concrete Institute 20 North Wacker Drive Chicago, IL 60606

SDI	Steel Door Institute 712 Lakewood Center North Cleveland, OH 44107
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association 8224 Old Court House Road Vienna, VA 22180
SSPC	Steel Structures Painting Council 402 24th Street, Suite 600 Pittsburgh, PA 15213
SWFWMD	Southwest Florida Water Management District 2379 Broad Street Brooksville, FL 34604-6899
UL	Underwriter's Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01150

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SCOPE

A. The scope of this section of the Contract Documents is to further define the items included in each Bid Item in the Bid Form section of the Contract Documents. Payment will be made based on the specified items included in the description in this section for each bid item.

B. All contract prices included in the Bid Form section will be full compensation for all shop drawings, working drawings, labor, materials, tools, equipment and incidentals necessary to complete the construction as shown on the Drawings and/or as specified in the Contract Documents to be performed under this Contract. Actual quantities of each item bid on a unit price basis will be determined upon completion of the construction in the manner set up for each item in this section of the Specifications. Payment for all items listed in the Bid Form will constitute full compensation for all work shown and/or specified to be performed under this Contract.

1.02 ESTIMATED QUANTITIES

The quantities shown are approximate and are given only as a basis of calculation upon which the award of the Contract is to be made. The Owner/Engineer does not assume any responsibility for the final quantities, nor shall the Contractor claim misunderstanding because of such estimate of quantities. Final payment will be made only for satisfactorily completed quantity of each item.

1.03 WORK OUTSIDE AUTHORIZED LIMITS

No payment will be made for work constructed outside the authorized limits of work.

1.04 MEASUREMENT STANDARDS

Unless otherwise specified for the particular items involved, all measurements of distance shall be taken horizontally or vertically.

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1.05 AREA MEASUREMENTS

In the measurement of items to be paid for on the basis of area of finished work, the lengths and/or widths to be used in the calculations shall be the final dimensions

measured along the surface of the completed work within the neat lines shown or designated.

1.06 LUMP SUM ITEMS

Where payment for items is shown to be paid for on a lump sum basis, no separate payment will be made for any item of work required to complete the lump sum items. Lump sum contracts shall be complete, tested and fully operable prior to request for final payment.

1.07 UNIT PRICE ITEM

Separate payment will be made for the items of work described herein and listed on the Bid Form. Any related work not specifically listed, but required for satisfactory completion of the work shall be considered to be included in the scope of the appropriate listed work items.

No separate payment will be made for the following items and the cost of such work shall be included in the applicable pay items of work. Final payments shall not be requested by the Contractor or made by the Owner until as-built (record) drawings have been submitted and approved by the Engineer.

1. Shop Drawings, Working Drawings.
2. Clearing, grubbing and grading except as hereinafter specified.
3. Trench excavation.
4. Dewatering and disposal of surplus water.
5. Structural fill, backfill, and grading.
6. Replacement of unpaved roadways.
7. Cleanup and miscellaneous work.
8. Borrow materials.
9. Testing and placing system in operation.
10. Any material and equipment required to be installed and utilized for tests.
11. Pipe, structures, pavement replacement and/or appurtenances included within the limits of lump sum work, unless otherwise shown.
12. Maintaining the existing quality of service during construction.
13. Appurtenant work as required for a complete and operable system.
14. As-built Record Drawings.

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BID ITEM NO. 1 - MOBILIZATION

Measurement and payment for this Bid Item shall include full compensation for the required 100 percent (100%) Performance Bond, 100 Percent (100%) Payment Bond, all required insurance for the project and the Contractor's mobilization and demobilization costs as shown in the Bid Form.

Payment for mobilization shall not exceed 10 percent (10%) of the total Contract cost unless the Contractor can prove to the Owner that his actual mobilization cost exceeds 10 percent (10%).

BID ITEM NO. 2 - MISCELLANEOUS WORK AND CLEANUP

Payment for all work included under this Bid Item shall be made at the Contract lump sum price bid listed in the Bid Form and shall represent full compensation for all labor, materials and equipment required to perform all the work as shown on the Contract Drawings and specified herein and any other miscellaneous work not specifically included for payment under other Bid Items obviously necessary to complete the Contract. Partial payments will be based on the breakdown of the Bid Item in accordance with the Schedule of Values submitted by the Contractor and approved by the Engineer. Payment shall also include full compensation for project photographs, as-builts record drawings, project signs, traffic control, rubbish and spoil removal, repair, replacement or relocation of all signs, walls, private irrigation systems and related items and any and all other items required to complete the project in accordance with Contract Documents.

BID ITEM 3 – LANDFILL GAS COLLECTION WELLS

Payment for all work included under this Bid Item shall be made at the applicable Contract unit price bid per linear foot for furnishing and installing the landfill gas extraction well to the depths shown on the Contract Drawings and designated on the Bid Form for the actual length installed.

Measurement for the installed length shall be measured vertically from top of ground to bottom of extraction well. The extraction pipe shall be left a minimum of 4-feet above the top of ground as shown on the drawings, but not included in the measurement for the depth of the boring.

Payment shall represent full compensation for all labor, excavation, dewatering, casing, pipe, materials, backfill, compaction, testing, equipment and loading, hauling and dumping of the waste from the boring at the Stage III Landfill working face. No disposal fee will be charged. Also included shall be the recording of well location by coordinates and elevation, and all other appurtenances and incidentals required or specified to complete the well installation. No additional compensation will be made by the Owner for excavation performed below the bottom of the well.

BID ITEM 4 - LANDFILL GAS COLLECTION WELL HEADS

Payment for all work included in these Bid Items will be made at the applicable Contract unit price bid for furnishing and installing each landfill gas collection well head with fittings and connections as shown on the Contract Drawings and listed on the Bid Form. Payment shall represent full compensation for all labor, material, and

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equipment required to complete these Bid Items.

BID ITEM 5 – 8-inch HDPE PIPE

Payment for all work included in this Bid Item shall be made at the applicable Contract unit price bid per the schedule of prices for furnishing and installing the eight inch diameter HDPE pipe as shown on the Contract Drawings and listed in the Bid Form. Measurement and Payment shall be made for the actual length of the listed diameter pipe installed and will represent full compensation for all labor, materials, excavation, including dewatering, bedding, backfill, compaction, testing and equipment required to complete the Bid Item. No additional compensation will be made for excavation below the bottom of the pipe, for solid waste removal or bedding and backfill materials. No solid waste shall be used for backfill. All solid waste excavated will be loaded, hauled and dumped at the working face of the Stage III Landfill. No disposal fee will be charged.

BID ITEM 6 – 18-inch HDPE PIPE

Payment for all work included in this Bid Item shall be made at the applicable Contract unit price bid per the schedule of prices for furnishing and installing the eighteen inch diameter HDPE pipe as shown on the Contract Drawings and listed in the Bid Form. Measurement and Payment shall be made for the actual length of the listed diameter pipe installed and will represent full compensation for all labor, materials, excavation, including dewatering, bedding, backfill, compaction, testing and equipment required to complete the Bid Item. No additional compensation will be made for excavation below the bottom of the pipe, for solid waste removal or bedding and backfill materials. No solid waste shall be used for backfill. All solid waste excavated will be loaded, hauled and dumped at the working face of the Stage III Landfill. No disposal fee will be charged.

BID ITEM 7 – GEOMEMBRANE BEDDING (AS NEEDED)

Payment for all work included in this Bid Item shall be made at the applicable Contract unit price bid per the schedule of prices for furnishing and installing the sand as needed to properly prepare the bedding for the geomembrane as needed and as shown on the Contract Drawings and listed in the Bid Form. Measurement and Payment shall be made for the actual volume of sand installed and will represent full compensation for all labor, materials, compaction, testing and equipment required to complete the Bid Item.

BID ITEM 8 - GEOMEMBRANE

Payment for all work included in these Bid Items will be made at the applicable Contract unit price bid per square foot for furnishing and installing geomembrane as shown on the Contract Drawings and listed on the Bid Form. Payment shall

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represent full compensation for all labor, materials and testing, necessary equipment, and incidentals necessary to complete the work, ready for approval and acceptance by the Engineer/Owner. The geomembrane will be measured from the centerline of the anchor trench to the weld of the new geomembrane to the existing geomembrane. The unit price should include all overlaps.

BID ITEM 9 – DOUBLE SIDED CAPPING GEOCOMPOSITE

Payment for all work included in these Bid Items will be made at the applicable Contract unit price bid per square foot for furnishing and installing the bonded composite drainage net as shown on the Contract Drawings and listed on the Bid Form. Payment shall represent full compensation for all labor, materials and testing, necessary equipment, and incidentals necessary to complete the work, ready for approval and acceptance by the Engineer/Owner. The double sided capping geocomposite will be measured from the centerline of the anchor trench to the edge of the new drainage net where it overlaps the existing drainage net. The unit price should include all overlaps.

BID ITEM 10 – PROTECTIVE SOIL COVER

Payment for all work included in this Bid Item shall be made at the applicable Contract unit price bid per the schedule of prices for furnishing and installing the sand as needed for the minimum two foot protective soil cover over the geomembrane, and soil cover over the stormwater and landfill gas pipes as shown on the Contract Drawings and listed in the Bid Form. Measurement and Payment shall be made for the actual volume of sand installed and will represent full compensation for all labor, materials, compaction, testing and equipment required to complete the Bid Item.

BID ITEM 11 - STORMWATER INLETS

Payment for all work included in these Bid Items will be made at the applicable Contract unit price bid for furnishing and installing each stormwater inlet with fittings and connections as shown on the Contract Drawings and listed on the Bid Form. Payment shall represent full compensation for all labor, material, and equipment required to complete these Bid Items.

BID ITEM 12 – STORMWATER PIPE

Payment for all work included in this Bid Item shall be made at the applicable Contract unit price bid per the schedule of prices for furnishing and installing the HDPE stormwater pipe as shown on the Contract Drawings and listed in the Bid Form. Measurement and Payment shall be made for the actual length of the listed diameter pipe installed and will represent full compensation for all labor, materials, excavation, including dewatering, bedding, backfill, compaction, testing and

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equipment required to complete the Bid Item. No additional compensation will be made for excavation below the bottom of the pipe, for solid waste removal or bedding and backfill materials. No solid waste shall be used for backfill. All solid waste excavated will be loaded, hauled and dumped at the working face of the Stage III Landfill. No disposal fee will be charged.

BID ITEM 13 - ENERGY DISSIPATPRS AND CONCRETE

Payment for all work included in these Bid Items will be made at the applicable Contract unit price bid for furnishing and installing each energy dissipator and associated concrete with fittings and connections as shown on the Contract Drawings and listed on the Bid Form. Payment shall represent full compensation for all labor, material, and equipment required to complete these Bid Items.

BID ITEM 14 – LANDFILL TERRACE UNDERDRAINS

Payment for all work included in Bid Item 14 Landfill Terrace Underdrains shall be made at the applicable Contract unit price bid per the schedule of prices for furnishing and installing the drainpipe and coarse aggregate as shown on Detail N of Contract Drawing C-13 and listed in the Bid Form. Measurement and Payment shall be made for the actual length of the listed diameter pipe installed and will represent full compensation for all labor, materials, excavation, dewatering, bedding, backfill, compaction and equipment required to complete the Bid Item.

BID ITEM 15 - SODDING

Payment for all work included in this Bid Item will be made at the applicable Contract unit price bid per square yard for furnishing and installing sodding as shown on the Contract Drawings and listed on the Bid Form. Payment shall represent full compensation for all labor, materials, fertilizer, water, necessary equipment, and incidentals necessary to complete the work, ready for approval and acceptance by the Engineer/Owner.

BID ITEM 16 - DISCRETIONARY WORK

Payment for all work under this Bid Item and listed in the Bid Form shall be made only at the Owner's discretion in order to satisfactorily complete the project in accordance with the Plans and Specifications.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

FLORIDA DEPARTMENT OF
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SECTION 01152

REQUESTS FOR PAYMENT

FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT
TAMPA

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

Submit Applications for Payment to the Project Manager or as directed at the preconstruction meeting, in accordance with the schedule established by Conditions of the Contract and Agreement between Owner and Contractor.

1.02 FORMAT AND DATA REQUIRED

A. Submit payment requests in the form provided by the Owner with itemized data typed in accordance with the Bid Form.

B. Provide construction photographs in accordance with Contract Documents.

1.03 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

A. When the Owner or the Engineer requires substantiating data, Contractor shall submit suitable information with a cover letter.

B. Submit one copy of data and cover letter for each copy of application.

1.04 PREPARATION OF APPLICATION FOR FINAL PAYMENT

Fill in application form as specified for progress payments.

1.05 SUBMITTAL PROCEDURE

A. Submit applications for payment at the times stipulated in the Agreement.

B. Number: Three (3) copies of each application; all signed and certified by the Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01153

CHANGE ORDER PROCEDURES

FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT
TAMPA

PART 1 GENERAL

1.01 DEFINITION

A. Change Order: See General Conditions.

B. Field Directive Change: See General Conditions.

1.02 REQUIREMENTS INCLUDED

A. The Contractor shall promptly implement change order procedures:

1. Provide full written data required to evaluate changes.

2. Maintain detailed records of work done on a time-and-material/force account basis.

3. Provide full documentation to Engineer on request.

B. The Contractor shall designate a member of the Contractor's organization who:

1. Is authorized to accept changes to the Work.

2. Is responsible for informing others in the Contractor's employ of the authorized changes into the Work.

C. The Board of County Commissioners executes all Change Orders.

1.03 PRELIMINARY PROCEDURES

A. Project Manager may initiate changes by submitting a Request to Contractor. Request will include:

1. Detailed description of the change, products, costs and location of the change in the Project.

2. Supplementary or revised Drawings and Specifications.

3. The projected time extension for making the change.

4. A specified period of time during which the requested price will be considered valid.

5. Such request is for information only and is not an instruction to execute the changes, nor to stop work in progress.

B. Contractor may initiate changes by submitting a written notice to the Project Manager, containing:

1. Description of the proposed changes.

2. Statement of the reason for making the changes.

3. Statement of the effect on the Contract Sum and the Contract Time.

4. Statement of the effect on the work of separate contractors.

5. Documentation supporting any change in Contract Sum or Contract Time, as appropriate.

1.04 FIELD DIRECTIVE CHANGE

A. In lieu of a Change Order, the Project Manager may issue a Field Directive change for the Contractor to proceed with additional work within the original intent of the Project.

B. Field Directive change will describe changes in the work, with attachments of backup information to define details of the change.

C. Contractor must sign and date the Field Directive change to indicate agreement with the terms therein.

1.05 DOCUMENTATION OF PROPOSALS AND CLAIMS

A. Support each quotation for a lump sum proposal and for each unit price which has not previously been established, with sufficient substantiating data to allow the Engineer/Owner to evaluate the quotation.

B. On request, provide additional data to support time and cost computations:

1. Labor required.

2. Equipment required.

3. Products required.

a. Recommended source of purchase and unit cost.
b. Quantities required.

4. Taxes, insurance and bonds.

5. Credit for work deleted from Contract, similarly documented.

6. Overhead and profit.

7. Justification for any change in Contract Time.

C. Support each claim for additional costs and for work done on a time-and-material/force account basis, with documentation as required for a lump-sum proposal, plus additional information.

1. Name of the Owner's authorized agent who ordered the work and date of the order.

2. Date and time work was performed and by whom.

3. Time record, summary of hours work and hourly rates paid.

4. Receipts and invoices for:

a. Equipment used, listing dates and time of use.
b. Products used, listing of quantities.
c. Subcontracts.

1.06 PREPARATION OF CHANGE ORDERS

A. Project Manager will prepare each Change Order.

B. Form: see Section 00550 for sample form.

C. Change Order will describe changes in the Work, both additions and deletions, with attachments as necessary to define details of the change.

D. Change Order will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.

1.07 LUMP SUM/FIXED PRICE CHANGE ORDER

A. Project Manager initiates the form, including a description of the changes involved and attachments based upon documents and proposals submitted by the Contractor, or requests from the Owner, or both.

B. Once the form has been completed, all copies should be sent to Contractor for approval. After approval by Contractor, all copies should be sent to Owner for approval. The Owner will distribute executed copies after approval by the Board of County Commissioners.

1.08 UNIT PRICE CHANGE ORDER

A. Contents of Change Orders will be based on, either:

1. Owner's definition of the scope of the required changes.

2. Contractor's Proposal for a change, as approved by the Owner.

3. Survey of completed work.

B. The amounts of the unit prices to be:

1. Those stated in the Agreement.

2. Those mutually agreed upon between Owner and Contractor.

1.09 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/ CONSTRUCTION CHANGE AUTHORIZATION

A. At completion of the change, Contractor shall submit itemized accounting and supporting data as provided in the Article "Documentation of Proposals and Claims" of this Section.

B. Engineer will determine the allowable cost of such work, as provided in General Conditions and Supplementary Conditions.

C. Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time.

D. Owner and Contractor will sign and date the Change Order to indicate their agreement therewith.

1.10 CORRELATION WITH CONTRACTOR'S SUBMITTALS

A. Periodically revise Schedule of Values and Application for Payment forms to record each change as a separate item of work, and to record the adjusted Contract Sum.

B. Periodically revise the Construction Schedule to reflect each change in Contract Time.

1. Revise sub-schedules to show changes for other items of work affected by the changes.

C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01200

PROJECT MEETINGS

FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT
TAMPA

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Owner or Engineer shall schedule the pre-construction meeting, periodic progress meetings and special meetings, if required, throughout progress of work.

B. Representatives of contractors, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.

C. The Contractor shall attend meetings to ascertain that work is expedited consistent with Contract Documents and construction schedules.

1.02 PRE-CONSTRUCTION MEETING

A. Attendance:

1. Owner's Engineer.
2. Owner's Project Manager
3. Contractor.
4. Resident Project Representative.
5. Related Labor Contractor's Superintendent.
6. Major Subcontractors.
7. Major Suppliers.
8. Others as appropriate.

B. Suggested Agenda:

1. Distribution and discussion of:

    a. List of major subcontractors.
    b. Projected Construction Schedules.
    c. Coordination of Utilities

2. Critical work sequencing.

3. Project Coordination.

    a. Designation of responsible personnel.
    b. Emergency contact persons with phone numbers.

4. Procedures and processing of:
   a. Field decisions.
   b. Submittals.
   c. Change Orders.
   d. Applications for Payment.

5. Procedures for maintaining Record Documents.

6. Use of premises:
   a. Office, work and storage areas.
   b. Owner's REQUIREMENTS.

7. Temporary utilities.
8. Housekeeping procedures.
9. Liquidated damages.
10. Equal Opportunity Requirements.
11. Laboratory testing.
12. Job meetings.

1.03 PROGRESS MEETINGS

A. Schedule regular meetings. The progress meetings will be held weekly or less with the first meeting 30 days after the pre-construction meeting, or seven days after the notice to proceed, which ever is sooner. The Contractor, CQA Monitor, Design Engineer and Owner must be represented at the weekly progress meetings. Subcontractors as needed, such as the geosynthetics installer, shall also be represented. The expected duration of the construction project is 52-weeks.

B. Hold special meetings as required.

C. The Resident Project Representative shall meet daily with the Contractor's Superintendent to review the progress of the project.

D. The Construction Quality Assurance Monitor (CQA Monitor) shall meet daily with the Contractor's Supervisor responsible for the installation of the geosynthetics to review the progress of the project.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
JUN 19 2006
SOUTHWEST DISTRICT
TAMPA

SECTION 01310

CONSTRUCTION SCHEDULE & PROJECT RESTRAINTS

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT TAMPA

PART 1 GENERAL

1.01 GENERAL

A. Construction under this contract must be coordinated with the Owner and accomplished in a logical order to maintain utilization and flow through existing facilities and to allow construction to be completed within the time allowed by Contract Documents and in the manner set forth in the Contract.

1.02 CONSTRUCTION SCHEDULING GENERAL PROVISIONS

A. No work shall be done between 7:00 p.m. and 7:00 a.m. nor on Sunday or legal holidays without written permission of the Owner. However, emergency work may be done without prior permission.

B. Night work may be established by the Contractor as regular procedure with the written permission of the Owner. Such permission, however, may be revoked at any time by the Owner if the Contractor fails to maintain adequate equipment and supervision for the proper execution and control of the work at night.

C. Due to potential health hazards and requirements of the State of Florida and the U.S. Environmental Protection Agency, existing facilities must be maintained in operation.

D. The Contractor shall be fully responsible for providing all temporary piping, plumbing, electrical hook-ups, lighting, temporary structure, or other materials, equipment and systems required to maintain the existing facility's operations. All details of temporary piping and temporary construction are not necessarily shown on the Drawings or covered in the Specifications. However, this does not relieve the Contractor of the responsibility to insure that construction will not interrupt proper facility operations.

E. The Contractor shall designate an authorized representative of his firm who shall be responsible for development and maintenance of the schedule and of progress and payment reports. This representative of the Contractor shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the commitments of the Contractor's schedule.

1.03 PROGRESS OF THE WORK

The work shall be executed with such progress as may be required to prevent any delay to the general completion of the work. The work shall be executed at such

times and in or on such parts of the project and with such forces, materials and equipment to assure completion of the work in the time established by the Contract and in the manner set forth in the Contract.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The Contractor shall submit a critical path schedule as described herein.

B. The planning, scheduling, management and execution of the work are the sole responsibility of the Contractor. The progress schedule requirement is established to allow Engineer to review Contractor's planning, scheduling, management and execution of the work; to assist Engineer in evaluating work progress and make progress payments and to allow other contractors to cooperate and coordinate their activities with those of the Contractor.

2.02 FORM OF SCHEDULES

A. Prepare schedules in the form of a horizontal bar chart diagram. The diagram shall be time-scaled and sequenced by work areas. Horizontal time scale shall identify the first work day of each week.

B. Activities shall be at least as detailed as the Schedule of Values. Activity durations shall be in whole working days. In addition, man-days shall be shown for each activity or tabulated in an accompanying report.

C. Diagrams shall be neat and legible and submitted on sheets at least 8-1/2 inches by 11 inches suitable for reproduction. Scale and spacing shall allow space for notations and future revisions.

4. The schedules shall be prepared and submitted using the latest version of Microsoft Project, or other Owner approved software.

2.03 CONTENT OF SCHEDULES

A. Each monthly schedule shall be based on data as of the last day of the current pay period.

B. Description for each activity shall be brief, but convey the scope of work described.

C. Activities shall identify all items of work that must be accomplished to achieve substantial completion, such as items pertaining to Contractor's installation and testing activities; items pertaining to the approval of regulatory agencies; contractor's time required for submittals, fabrication and deliveries; the time required by Engineer to review all submittals as set forth in the Contract Documents; items of work

required of Owner to support pre-operational, startup and final testing; time required for the relocation of utilities. Activities shall also identify interface milestones with the work of other contractors performing work under separate contracts with Owner.

D. Schedules shall show the complete sequence of construction by activities. Dates for beginning and completion of each activity shall be indicated as well as projected percentage of completion for each activity as of the first day of each month.

E. Submittal schedule for shop drawing review, product data, and samples shall show the date of Contractor submittal and the date approved submittals will be required by the Engineer, consistent with the time frames established in the Specifications.

F. For Contract change orders granting time extensions, the impact on the Contract date(s) shall equal the calendar-day total time extension specified for the applicable work in the Contract change orders.

G. For actual delays, add activities prior to each delayed activity on the appropriate critical path(s). Data on the added activities of this type shall portray all steps leading to the delay and shall further include the following: separate activity identification, activity description indicating cause of the delay, activity duration consistent with whichever set of dates below applies, the actual start and finish dates of the delay or, if the delay is not finished, the actual start date and estimated completion date.

H. For potential delays, add an activity prior to each potentially delayed activity on the appropriate critical path(s). Data for added activities of this type shall include alternatives available to mitigate the delay including acceleration alternatives and further show the following: separate activity identification, activity description indicating cause of the potential delay and activity duration equal to zero work days.

2.04 SUPPORTING NARRATIVE

A. Status and scheduling reports identified below shall contain a narrative to document the project status, to explain the basis of Contractor's determination of durations, describe the Contract conditions and restraints incorporated into the schedule and provide an analysis pertaining to potential problems and practical steps to mitigate them.

B. The narrative shall specifically include:

1. Actual completion dates for activities completed during the monthly report period and actual start dates for activities commenced during the monthly report period.

2. Anticipated start dates for activities scheduled to commence during the following monthly report period.

3. Changes in the duration of any activity and minor logic changes.

4. The progress along the critical path in terms of days ahead or behind the Contract date.

5. If the Monthly Status Report indicates an avoidable delay to the Contract completion date or interim completion dates as specified in the Agreement, Contractor shall identify the problem, cause and the activities affected and provide an explanation of the proposed corrective action to meet the milestone dates involved or to mitigate further delays.

6. If the delay is thought to be unavoidable, the Contractor shall identify the problem, cause, duration, specific activities affected and restraints of each activity.

7. The narrative shall also discuss all change order activities whether included or not in the revised/current schedule of legal status. Newly introduced change order work activities and the CPM path(s) that they affect, must be specifically identified. All change order work activities added to the schedule shall conform to the sequencing and Contract Time requirements of the applicable Change Order.

8. Original Contract date(s) shall not be changed except by Contract change order. A revision need not be submitted when the foregoing situations arise unless required by Engineer. Review of a report containing added activities will not be construed to be concurrence with the duration or restraints for such added activities; instead the corresponding data as ultimately incorporated into the applicable Contract change order shall govern.

9. Should Engineer require additional data, this information shall be supplied by Contractor within 10 calendar days.

2.05 SUBMITTALS

A. Contractor shall submit estimated and preliminary progress schedules (as identified in the Terms and Conditions of the Contract and the General Conditions), monthly status reports, a start-up schedule and an as-built schedule report all as specified herein.

B. All schedules, including estimated and preliminary schedules, shall be in conformance with the Contract Documents.

C. The finalized progress schedule discussed in the Contract Documents shall be the first monthly status report and as such shall be in conformance with all applicable specifications contained herein.

D. Monthly Status Report submittals shall include three copies of a time-scaled (days after notice to proceed) diagram showing all contract activities and supporting narrative. The initial detailed schedule shall use the notice to proceed as the start date. The finalized schedule, if concurred with by Owner, shall be the work plan to be used by the contractor for planning, scheduling, managing and executing the work.

E. The schedule diagram shall be formatted as above. The diagram shall include (1) all detailed activities included in the preliminary and estimated schedule submittals, (2) calendar days prior to substantial completion, (3) summary activities for the remaining days. The critical path activities shall be identified, including critical paths for interim dates, if possible.

F. The Contractor shall submit monthly progress schedules with each month's application for payment.

G. Contractor shall submit three monthly status reports which will be retained by the Owner and Engineer.

2.06 MONTHLY STATUS REPORTS

A. Contractor shall submit three copies of detailed schedule status reports on a monthly basis with the Application for Payment. The first such status report shall be submitted with the first Application for Payment and include data as of the last day of the pay period. The Monthly Report shall include a "marked-up" copy of the latest detailed schedule of legal status and a supporting narrative including updated information as described above. The Monthly Report will be reviewed by Engineer and Contractor at a monthly schedule meeting and Contractor will address Engineer's comments on the subsequent monthly report. Monthly status reports shall be the basis for evaluating Contractor's progress.

B. The "marked-up" diagram shall show, for the latest detailed schedule of legal status, percentages of completion for all activities, actual start and finish dates and remaining durations, as appropriate. Activities not previously included in the latest detailed schedule of legal status shall be added, except that contractual dates will not be changed except by change order. Review of a marked-up diagram by Engineer will not be construed to constitute concurrence with the time frames, duration, or sequencing for such added activities; instead the corresponding data as ultimately incorporated into an appropriate change order shall govern.

2.07 STARTUP SCHEDULE

A. At least 60 calendar days prior to the date of substantial completion, Contractor shall submit a time-scaled (days after notice to proceed) diagram detailing the work to take place in the period between 60 days prior to substantial completion, together with a supporting narrative. Engineer shall have 10 calendar days after receipt of the submittal to respond. Upon receipt of Engineer's comments, Contractor shall make

the necessary revisions and submit the revised schedule within 10 calendar days. The resubmittal, if concurred with by Owner, shall be the Work Plan to be used by Contractor for planning, managing, scheduling and executing the remaining work leading to substantial completion.

B. The time-scaled diagram shall use the latest schedule of legal status for those activities completed ahead of the last 60 calendar days prior to substantial completion and detailed activities for the remaining 60-day period within the time frames outlined in the latest schedule of legal status.

C. Contractor will be required to continue the requirement for monthly reports, as outlined above. In preparing this report, Contractor must assure that the schedule is consistent with the progress noted in the startup schedule.

2.08 REVISIONS

A. All revised Schedule Submittals shall be made in the same form and detail as the initial submittal and shall be accompanied by an explanation of the reasons for such revisions, all of which shall be subject to review by Engineer and concurrence by Owner. The revision shall incorporate all previously made changes to reflect current as-built conditions. Minor changes to the approved submittal may be approved at monthly meetings; a minor change is not considered a revision in the context of this paragraph.

B. A revised schedule submittal shall be submitted for review, when required by Engineer, for one of the following reasons:

1. Owner or Engineer directs a change that affects the date(s) specified in the Agreement or alters the length of a critical path.

2. Contractor elects a change that affects the date(s) specified in the Agreement or alters the length of a critical path.

C. If, prior to agreement on an equitable adjustment to the Contract time, Engineer requires revisions to the schedule in order to evaluate planned progress, Contractor shall provide an interim revised submittal for review with change effect(s) incorporated as directed. Interim revisions to the documents which are recommended to the Owner for concurrence will be incorporated in the next Monthly Status Report.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01340

SHOP DRAWINGS, PROJECT DATA AND SAMPLES

FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT
TAMPA

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall submit to the Engineer for review and approval: working drawings, shop drawings, test reports and data on materials and equipment (hereinafter in this section called data), and material samples (hereinafter in this section called samples) as are required for the proper control of work, including, but not limited to those working drawings, shop drawings, data and samples for materials and equipment specified elsewhere in the Specifications and in the Contract Drawings.

B. Within thirty (30) calendar days after the effective date of the Agreement, the Contractor shall submit to the Engineer, a complete list of preliminary data on items for which Shop Drawings are to be submitted. Included in this list shall be the names of all proposed manufacturers furnishing specified items and the date on which each Shop Drawing shall be submitted. Review of this list by the Engineer shall in no way relieve the Contractor from submitting complete Shop Drawings and providing materials, equipment, etc., fully in accordance with the Specifications. This procedure is required in order to expedite final review of Shop Drawings.

C. The Contractor is to maintain an accurate updated submittal log and will bring this log to each scheduled progress meeting with the Owner and the Engineer. This log should include the following items:

1. Submittal description and number assigned.
2. Date to Engineer.
3. Date returned to Contractor (from Engineer).
4. Status of Submittal (No exceptions taken, returned for confirmation or resubmittal, rejected).
5. Date of Resubmittal and Return (as applicable).
6. Date material released (for fabrication).
7. Projected date of fabrication.
8. Projected date of delivery to site.
9. Projected date and required lead time so that product installation does not delay contact.
10. Status of O&M manuals submitted.

1.03 CONTRACTOR'S RESPONSIBILITY

A. It is the duty of the Contractor to check all drawings, data and samples prepared by or for him before submitting them to the Engineer for review. Each and every copy of the Drawings and data shall bear Contractor's stamp showing that they have been so checked. Shop drawings submitted to the Engineer without the Contractor's stamp will be returned to the Contractor for conformance with this requirement. Shop drawings shall indicate any deviations in the submittal from requirements of the contract Documents.

B. Determine and verify:

1. Field measurements.
2. Field construction criteria.
3. Catalog numbers and similar data.
4. Conformance with Specifications and indicate all variances from the Specifications.

C. The Contractor shall furnish the Engineer a schedule of Shop Drawing submittals fixing the respective dates for the submission of shop and working drawings, the beginning of manufacture, testing and installation of materials, supplies and equipment. This schedule shall indicate those that are critical to the progress schedule.

D. The Contractor shall not begin any of the work covered by a drawing, data, or a sample returned for correction until a revision or correction thereof has been reviewed and returned to him, by the Engineer, with No Exceptions Taken or Approved As Noted.

E. The Contractor shall submit to the Engineer all drawings and schedules sufficiently in advance of construction requirements to provide no less than twenty-one (21) calendar days for checking and appropriate action from the time the Engineer receives them.

F. The Contractor shall submit five (5) copies of descriptive or product data submittals to complement shop drawings for the Engineer plus the number of copies which the Contractor requires. The Engineer shall retain five (5) sets. All blueprint shop drawings shall be submitted with one (1) set of 3 mil thick polyester film reproducible. The Engineer will review the blueprints and return to the Contractor the set of marked-up sepias with appropriate review comments.

G. The Contractor shall be responsible for and bear all cost of damages which may result from the ordering of any material or from proceeding with any part of work prior to the completion of the review by Engineer of the necessary Shop Drawings.

1.04 ENGINEER'S REVIEW OF SHOP DRAWINGS AND WORKING DRAWINGS

A. The Engineer's review of drawings, data and samples submitted by the Contractor shall cover only general conformity to the Specifications, external connections and dimensions which affect the installation.

B. The review of drawings and schedules shall be general and shall not be construed:

1. As permitting any departure from the Contract requirements.
2. As relieving the Contractor of responsibility for any errors, including details, dimensions and materials.
3. As approving departures from details furnished by the Engineer, except as otherwise provided herein.

C. If the drawings or schedules as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of the Owner and to be so minor as not to involve a change in Contract Price or time for performance, the Engineer may return the reviewed drawings without noting any exception.

D. When reviewed by the Engineer, each of the Shop and Working Drawings shall be identified as having received such review being so stamped and dated. Shop Drawings stamped "REJECTED" and with required corrections shown shall be returned to the Contractor for correction and resubmittal.

E. Resubmittals will be handled in the same manner as first submittals. On resubmittals, the Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, to revisions other than the corrections requested by the Engineer on previous submissions. The Contractor shall make any corrections required by the Engineer.

F. If the Contractor considers any correction indicated on the drawings to constitute a change to the Contract Drawings or Specifications, the Contractor shall give written notice thereof to the Engineer.

G. The Engineer shall review a submittal/resubmittal a maximum of three (3) times after which cost of review shall be borne by the Contractor. The cost of engineering shall be equal to the Engineer's actual payroll cost.

H. When the Shop and Working Drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith

and shall make no further changes therein except upon written instructions from the Engineer.

I. No partial submittals shall be reviewed. Incomplete submittals shall be returned to the Contractor and shall be considered not approved until resubmitted.

1.05 SHOP DRAWINGS

A. When used in the Contract Documents, the term "Shop Drawings" shall be considered to mean Contractor's plans for material and equipment which become an integral part of the Project. These drawings shall be complete and detailed. Shop Drawings shall consist of fabrication, drawings, setting drawings, schedule drawings, manufacturer's scale drawings and wiring and control diagrams. Cuts, catalogs, pamphlets, descriptive literature and performance and test data, shall be considered only as supportive to required Shop Drawings as defined above.

B. Drawings and schedules shall be checked and coordinated with the work of all trades involved, before they are submitted for review by the Engineer and shall bear the Contractor's stamp of approval and original signature as evidence of such checking and coordination. Drawings or schedules submitted without this stamp of approval and original signature shall be returned to the Contractor for resubmission.

C. Each Shop Drawing shall have a blank area 3-1/2 inches by 3-1/2 inches, located adjacent to the title block. The title block shall display the following:

1. Number and title of the drawing.
2. Date of Drawing or revision.
3. Name of project building or facility.
4. Name of contractor and subcontractor submitting drawing.
5. Clear identification of contents and location of the work.
6. Specification title and number.

D. If drawings show variations from Contract requirements because of standard shop practice or for other reasons, the Contractor shall describe such variations in his letter of transmittal. If acceptable, proper adjustment in the contract shall be implemented where appropriate. If the Contractor fails to describe such variations, he shall not be relieved of the responsibility of executing the work in accordance with the Contract, even though such drawings have been reviewed.

E. Data on materials and equipment shall include, without limitation, materials and equipment lists, catalog sheets, cuts, performance curves, diagrams, materials of construction and similar descriptive material. Materials and equipment lists shall give, for each item thereon, the name and location of the supplier or manufacturer, trade name, catalog reference, size, finish and all other pertinent data.

F. For all mechanical and electrical equipment furnished, the Contractor shall provide a list including the equipment name and address and telephone number of the manufacturer's representative and service company so that service and/or spare parts can be readily obtained.

G. All manufacturers or equipment suppliers who proposed to furnish equipment or products shall submit an installation list to the Engineer along with the required shop drawings. The installation list shall include at least five installations where identical equipment has been installed and have been in operation for a period of at least one (1) year.

H. Only the Engineer will utilize the color "red" in marking shop drawing submittals.

I. Before final payment is made, the Contractor shall furnish to Engineer project as-built drawings.

1.06 WORKING DRAWINGS

A. When used in the Contract Documents, the term "working drawings" shall be considered to mean the Contractor's fabrication and erection drawings for structures such as roof trusses, steelwork, precast concrete elements, bulkheads, support of open cut excavation, support of utilities, groundwater control systems, forming and false work; underpinning; and for such other work as may be required for construction of the project.

B. Copies of working drawings as noted above, shall be submitted to the Engineer where required by the Contract Documents or requested by the Engineer and shall be submitted at least thirty (30) days (unless otherwise specified by the Engineer) in advance of their being required for work.

C. Working drawings shall be signed by a registered Professional Engineer, currently licensed to practice in the State of Florida and shall convey, or be accompanied by, calculation or other sufficient information to completely explain the structure, machine, or system described and its intended manner of use. Prior to commencing such work, working drawings must have been reviewed without specific exceptions by the Engineer, which review will be for general conformance and will not relieve the Contractor in any way from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error are assumed by the Contractor; the Owner and Engineer shall not have responsibility therefore.

1.07 SAMPLES

A. The Contractor shall furnish, for the review of the Engineer, samples required by the Contract Documents or requested by the Engineer. Samples shall be delivered to the Engineer as specified or directed. The Contractor shall prepay all shipping charges on

samples. Materials or equipment for which samples are required shall not be used in work until reviewed by the Engineer.

B. Samples shall be of sufficient size and quantity to clearly illustrate:

1. Functional characteristics of the product, with integrally related parts and attachment devices.

2. Full range of color, texture and pattern.

3. A minimum of two samples of each item shall be submitted.

C. Each sample shall have a label indicating:

1. Name of product.
2. Name of Contractor and Subcontractor.
3. Material or equipment represented.
4. Place of origin.
5. Name of Producer and Brand (if any).
6. Location in project.
   (Samples of finished materials shall have additional markings that will identify them under the finished schedules.)
7. Reference specification paragraph.

D. The Contractor shall prepare a transmittal letter in triplicate for each shipment of samples containing the information required above. He shall enclose a copy of this letter with the shipment and send a copy of this letter to the Engineer. Review of a sample shall be only for the characteristics or use named in such and shall not be construed to change or modify any Contract requirements.

E. Reviewed samples not destroyed in testing shall be sent to the Engineer or stored at the site of the work. Reviewed samples of the hardware in good condition will be marked for identification and may be used in the work. Materials and equipment incorporated in work shall match the reviewed samples. If requested at the time of submission, samples which failed testing or were rejected shall be returned to the Contractor at his expense.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01370

SCHEDULE OF VALUES

D.E.P.
SEP 1 4 2005
Southwest District Tampa

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall submit to the Engineer a Schedule of Values allocated to the various portions of the work, within 10 days after date of Notice to Proceed.

B. Upon request of the Engineer, the Contractor shall support the values with data which will substantiate their correctness.

C. The Schedule of Values shall be used only as the basis for the Contractor's Applications for Payment.

1.02 FORM AND CONTENT OF SCHEDULE OF VALUES

A. Schedule of Values will be considered for approval by Engineer upon Contractor's request. Identify schedule with:

1. Title of Project and location.
2. Project number.
3. Name and address of Contractor.
4. Contract designation.
5. Date of submission.

B. Schedule of Values shall list the installed value of the component parts of the work in sufficient detail to serve as a basis for computing values for progress payments during construction.

C. Follow the table of contents for the Contract Document as the format for listing component items for structures:

1. Identify each line item with the number and title of the respective major section of the specification.

2. For each line item, list sub values of major products or operations under item.

D. Follow the bid sheets included in this Contract Documents as the format for listing component items for pipe lines.

E. The sum of all values listed in the schedule shall equal the total Contract sum.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT
TAMPA

SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall employ a competent photographer to take construction record photographs or perform video taping, including furnishing all labor, materials, equipment and incidentals necessary to obtain photographs and/or video tapes of all construction areas. Construction progress information shall consist of photographs and digital photographs on a recordable compact disc (CD-R).

1.02 QUALIFICATIONS

A. All photography shall be done by a competent camera operator who is fully experienced and qualified with the specified equipment.

B. For the video recording, the audio portion should be done by a person qualified and knowledgeable in the specifics of the Contract, who shall speak with clarity and diction so as to be easily understood.

1.03 PROJECT PHOTOGRAPHS

A. Provide two prints of each photograph with each pay application.

B. Provide one recordable compact disc with digital photographs with each pay application.

C. Negatives:

1. All negatives shall remain the property of photographer.

2. The Contractor shall require that photographer maintain negatives for a period of two years from date of substantial completion of the project.

3. Photographer shall agree to furnish additional prints to Owner and Engineer at commercial rates applicable at time of purchase. Photographer shall also agree to participate as required in any litigation requiring the photographer as an expert witness.

D. The Contractor shall pay all costs associated with the required photography and prints. Any parties requiring additional photography or prints shall pay the photographer directly.

E. All project photographs shall be a single weight, color image. All finishes shall be smooth surface and glossy and all prints shall be 8 inches x 10 inches.

F. Each print shall have clearly marked on the back, the name of the project, the orientation of view, the date and time of exposure, name and address of the photographer and the photographers numbered identification of exposure.

G. All project photographs shall be taken from locations to adequately illustrate conditions prior to construction, or conditions of construction and state of progress. The Contractor shall consult with the Engineer at each period of photography for instructions concerning views required.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01410

TESTING AND TESTING LABORATORY SERVICES

FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT
TAMPA

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Owner shall employ and pay for the services of an independent testing laboratory to perform testing specifically indicated on the Contract Documents or called out in the Specifications. Owner may elect to have materials and equipment tested for conformity with the Contract Documents at any time.

1. Contractor shall cooperate fully with the laboratory to facilitate the execution of its required services.

2. Employment of the laboratory shall in no way relieve the Contractor's obligations to perform the work of the Contract.

1.02 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:

1. Release, revoke, alter or enlarge on requirements of Contract Documents.

2. Approve or accept any portion of the Work.

3. Perform any duties of the Contractor.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel; provide access to Work and/or to Manufacturer's operations.

B. Secure and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.

C. Provide to the laboratory the preliminary design mix proposed to be used for concrete, and other material mixes which require control by the testing laboratory.

D. Materials and equipment used in the performance of work under this Contract are subject to inspection and testing at the point of manufacture or fabrication. Standard specifications for quality and workmanship are indicated in the Contract Documents. The Engineer may require the Contractor to provide statements or certificates from the manufacturers and fabricators that the materials and equipment provided by them are manufactured or fabricated in full accordance with the standard specifications for

quality and workmanship indicated in the Contract Documents. All costs of this testing and providing statements and certificates shall be a subsidiary obligation of the Contractor and no extra charge to the Owner shall be allowed on account of such testing and certification.

E. Furnish incidental labor and facilities:

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

F. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.

1. When tests or inspections cannot be performed due to insufficient notice, Contractor shall reimburse Owner for laboratory personnel and travel expenses incurred due to Contractor's negligence.

G. Employ and pay for the services of the same or a separate, equally qualified independent testing laboratory to perform additional inspections, sampling and testing required for the Contractor's convenience and as approved by the Engineer.

H. If the test results indicate the material or equipment complies with the Contract Documents, the Owner shall pay for the cost of the testing laboratory. If the tests and any subsequent retests indicate the materials and equipment fail to meet the requirements of the Contract Documents, the contractor shall pay for the laboratory costs directly to the testing firm or the total of such costs shall be deducted from any payments due the Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01510

TEMPORARY AND PERMANENT UTILITIES

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT TAMPA

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

The Contractor shall be responsible for furnishing all requisite temporary utilities, i.e., power, water, sanitation, etc. The Contractor shall obtain and pay for all permits required as well as pay for all temporary usages. The Contractor shall remove all temporary facilities upon completion of work.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

A. Comply with National Electric Code.

B. Comply with Federal, State and Local codes and regulations and with utility company requirements.

C. Comply with County Health Department regulations.

PART 2 PRODUCTS

2.01 MATERIALS, GENERAL

Materials for temporary utilities may be "used." Materials for electrical utilities shall be adequate in capacity for the required usage, shall not create unsafe conditions and shall not violate requirements of applicable codes and standards.

2.02 TEMPORARY ELECTRICITY AND LIGHTING

Arrange with the applicable utility company for temporary power supply. Provide service required for temporary power and lighting and pay all costs for permits, service and for power used.

2.03 TEMPORARY WATER

A. Temporary water is available for construction from the on-site water reuse pipeline.

B. The Contractor shall protect piping and fitting against freezing.

2.04 TEMPORARY SANITARY FACILITIES

A. The Contractor shall provide sanitary facilities in compliance with all laws and regulations.

B. The Contractor shall service, clean and maintain facilities and enclosures.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall maintain and operate systems to assure continuous service.

B. The Contractor shall modify and extend systems as work progress requires.

3.02 REMOVAL

A. The Contractor shall completely remove temporary materials and equipment when their use is no longer required.

B. The Contractor shall clean and repair damage caused by temporary installations or use of temporary facilities.

END OF SECTION

SECTION 01580

PROJECT IDENTIFICATION AND SIGNS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnish, install and maintain County project identification signs.

B. Remove signs on completion of construction.

C. Allow no other signs to be displayed.

1.02 PROJECT IDENTIFICATION SIGN (COUNTY)

A. One painted sign, of not less than 32 square feet (3 square meters) area, with painted graphic content to include:

1. Title of Project.
2. Name of Owner.
3. Names and titles of authorities as directed by Owner.
4. Prime Contractor.

B. Graphic design, style of lettering and colors: As approved by the Engineer and subject to approval of the Owner.

C. Erect on the site at a lighted location of high public visibility, adjacent to main entrance to site, as approved by the Engineer and the Owner

1.03 INFORMATIONAL SIGNS

A. Painted signs with painted lettering, or standard products.

1. Size of signs and lettering: as required by regulatory agencies, or as appropriate to usage.

2. Colors: as required by regulatory agencies, otherwise of uniform colors throughout project.

B. Erect at appropriate locations to provide required information.

FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
JUN 19 2006
SOUTHWEST DISTRICT
TAMPA

1.04 QUALITY ASSURANCE

A. Sign Painter: Professional experience in type of work required.

B. Finishes, Painting: Adequate to resist weathering and fading for scheduled construction period.

PART 2 PRODUCTS

2.01 SIGN MATERIALS

A. Structure and Framing: May be new or used, wood or metal, in sound condition structurally adequate to work and suitable for specified finish.

A. Sign Surfaces: Exterior softwood plywood with medium density overlay, standard large sizes to minimize joints.

1. Thickness: As required by standards to span framing members, to provide even, smooth surface without waves or buckles.

C. Rough Hardware: Galvanized.

D. Paint: Exterior quality, as specified in the Contract Documents.

PART 3 EXECUTION

3.01 PROJECT IDENTIFICATION SIGN

A. Paint exposed surface or supports, framing and surface material; one coat of primer and one coat of exterior paint.

B. Paint graphics in styles, size and colors selected.

3.02 MAINTENANCE

The Contractor shall maintain signs and supports in a neat, clean condition; repair damages to structures, framing or sign.

3.03 REMOVAL

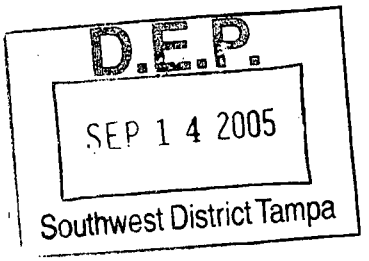
The Contractor shall remove signs, framing, supports and foundations at completion of project.

END OF SECTION

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
JUN 19 2006
SOUTHWEST DISTRICT TAMPA

SECTION 01590

ENGINEER'S FIELD OFFICE



PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

Contractor shall furnish, install and maintain one temporary field office during the entire construction period for the sole use of the Engineer.

1.02 OTHER REQUIREMENTS

1. Prior to installation of the Engineer's field office, the Contractor shall consult with the Engineer on location, access and related facilities.

2. All site use approvals shall be obtained by the Contractor.

3. Upon completion of construction, the Contractor shall remove the field office and restore the site to its original condition.

1.03 REQUIREMENTS FOR FACILITIES

1. Construction:

    1. The field office shall be structurally sound, weather tight, with floors raised aboveground.

    2. At Contractor's option, portable or mobile buildings may be used.

2. Office for Field Engineer:

    1. A separate office for sole use of the Engineer with secure entrance doors, key and lock shall be provided.

    2. Area: 250 sq. ft. minimum, with minimum dimension of 8 feet.

    3. Windows:

        1. Minimum of three (3).
        2. Operable sash and insect screens.
        3. Locate field office to provide maximum view of construction areas.

4. Furnishings:

1. Two standard size chairs and desks with three drawers each.
2. One drafting table: 39"x72"x36" high, with one equipment drawer.
3. One metal, double-door storage cabinet with lock and key.
4. One plan rack to hold a minimum of six sets of project drawings.
5. One standard four-drawer legal-size metal filing cabinet with lock and key.
6. Six linear feet of bookshelves.
7. One swivel armchair.
8. Two straight chairs.
9. One drafting table stool.
10. One wastebasket.
11. One tackboard, 36"x30".
12. One fire extinguisher.
13. One first aid kit.

5. Services:

1. Adequate lighting.
2. Exterior lighting at entrance door.
3. Automatic heating and mechanical cooling equipment to maintain comfort conditions.
4. Minimum of four 110-volt duplex electric convenience outlets, at least one on each wall.
5. Electric distribution panel: Two circuits minimum 110 volt, 60 hertz service.
6. Convenience access to drinking water and toilet facilities.
7. Telephone: One private direct line instrument.
8. Fax: combination fax/duplicator.

PART 2 PRODUCTS

2.01 MATERIALS, EQUIPMENT, FURNISHINGS

May be new or used, but must be serviceable, adequate for required purpose and must adhere to all applicable codes or regulations including the Manatee County Building Codes.

PART 3 EXECUTION

3.01 PREPARATION

Fill and grade site as necessary for temporary structure to provide positive surface drainage.

3.02 INSTALLATION

1. Construct temporary field office on proper foundation and provide connections for all utility services.

    1. Secure portable or mobile building when used.

    2. Provide steps and landings at entrance doors.

END OF SECTION

SECTION 01600

MATERIAL AND EQUIPMENT

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT TAMPA

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Material and equipment incorporated into the work:

1. Conform to applicable specifications and standards.

2. Comply with size, make, type and quality specified, or as specifically approved in writing by the Engineer.

3. Manufactured and Fabricated Products:

   a. Design, fabricate and assemble in accordance with the best engineering and shop practices.

   b. Manufacture like parts of duplicate units to standard sizes and gages, to be interchangeable.

   c. Two or more items of the same kind shall be identical and manufactured by the same manufacturer.

   d. Products shall be suitable for service conditions.

   e. Equipment capacities, sizes and dimensions shown or specified shall be adhered to unless variations are specifically approved in writing.

4. Do not use material or equipment for any purpose other than that for which it is specified.

5. All material and equipment incorporated into the project shall be new.

1.02 MANUFACTURER'S INSTRUCTIONS

A. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including two copies to Engineer.

1. Maintain one set of complete instructions at the job site during installation and until completion.

B. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements.

1. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding.

2. Do not proceed with work without clear instructions.

C. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by the Contract Documents.

1.03 TRANSPORTATION AND HANDLING

A. Arrange deliveries of products in accordance with construction schedules, coordinate to avoid conflict with work and conditions at the site.

1. Deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

2. Immediately on delivery, inspect shipments to assure compliance with requirements of Contract Documents and approved submittals and that products are properly protected and undamaged.

B. Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.

1.04 STORAGE AND PROTECTION

A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible

1. Store products subject to damage by the elements in weather tight enclosures.

2. Maintain temperature and humidity within the ranges required by manufacture's instructions.

B. Exterior Storage

1. Store fabricated products above the ground, on blocking or skids to prevent soiling or staining. Cover products which are subject to deterioration with impervious sheet coverings and provide adequate ventilation.

2. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.

C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions and free from damage or deterioration.

D. Protection After Installation

1. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. Remove when no longer needed.

1.05 SUBSTITUTIONS AND PRODUCT OPTIONS

A. Products List

1. Within 30 days after Contract date, submit to Engineer a complete list of major products proposed to be used.

B. Contractor's Options

1. For products specified only by reference standard, select any product meeting that standard.

2. For products specified by naming one or more products or manufacturers and "or equal," Contractor must submit a request for substitutions of any product or manufacturer not specifically named.

3. Requests for substitutions of products and "or equal" by the Contractor shall be submitted in a timely manner so as not to adversely affect the construction schedule.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01620

STORAGE AND PROTECTION

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
JUN 19 2006
SOUTHWEST DISTRICT TAMPA

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

Provide secure storage and protection for products to be incorporated into the work and maintenance and protection for products after installation and until completion of Work.

1.02 STORAGE

A. Store products immediately on delivery and protect until installed in the Work.

1. Store in accord with manufacturer's instructions, with seals and labels intact and legible.

B. Store products subject to damage by elements in substantial weather tight enclosures.

1. Maintain temperatures within ranges required by manufacturer's instructions.

2. Provide humidity control for sensitive products, as required by manufacturer's instructions.

3. Store unpacked products on shelves, in bins or in neat piles, accessible for inspection.

C. Exterior Storage

1. Provide substantial platform, blocking or skids to support fabricated products above ground to prevent soiling or staining.

a. Cover products, subject to discoloration or deterioration from exposure to the elements, with impervious sheet coverings. Provide adequate ventilation to avoid condensation.

b. Prevent mixing of refuse or chemically injurious materials or liquids.

D. Arrange storage in manner to provide easy access for inspection.

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1.03 MAINTENANCE OF STORAGE

A. Maintain periodic system of inspection of stored products on scheduled basis to assure that:

1. State of storage facilities is adequate to provide required conditions.

2. Required environmental conditions are maintained on continuing basis.

3. Surfaces of products exposed to elements are not adversely affected.

   a. Any weathering of products, coatings and finishes is not acceptable under requirements of these Contract Documents.

B. Mechanical and electrical equipment which requires servicing during long term storage shall have complete manufacturer's instructions for servicing accompanying each item, with notice of enclosed instructions shown on exterior of package.

1. Equipment shall not be shipped until approved by the Engineer. The intent of this requirement is to reduce on-site storage time prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer.

2. All equipment having moving parts such as gears, electric motors, etc. and/or instruments shall be stored in a temperature and humidity controlled building approved by the Engineer until such time as the equipment is to be installed.

3. All equipment shall be stored fully lubricated with oil, grease, etc. unless otherwise instructed by the manufacturer.

4. Manufacturer's storage instructions shall be carefully studied by the Contractor and reviewed with the Engineer. These instructions shall be carefully followed.

5. Moving parts shall be rotated a minimum of once weekly to insure proper lubrication and to avoid metal-to-metal "welding." Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to insure that the equipment does not deteriorate from lack of use.

6. Lubricants shall be changed upon completion of installation and as frequently as required, thereafter during the period between installation and acceptance.

7. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

1.04 PROTECTION AFTER INSTALLATION

A. Provide protection of installed products to prevent damage from subsequent operations. Remove when no longer needed, prior to completion of work.

B. Control traffic to prevent damage to equipment and surfaces.

C. Provide coverings to protect finished surfaces from damage.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01700

CONTRACT CLOSEOUT

FLORIDA DEPARTMENT OF
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APR 07 2006
SOUTHWEST DISTRICT
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PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

Comply with requirements stated in Conditions of the Contract and in Specifications for administrative procedures in closing out the work.

1.02 SUBSTANTIAL COMPLETION

A. The Contractor shall submit the following items when the Contractor considers the work to be substantially complete:

1. A written notice that the work or designated portion thereof, is substantially complete.

2. A list of items to be completed or corrected.

B. After receipt of such notice, the Engineer and Owner shall make an inspection to determine the status of completion.

C. Project record documents and operations and maintenance manuals must be submitted before the project shall be considered substantially complete.

D. If the Engineer determines that the work is not substantially complete:

1. The Engineer shall notify the Contractor in writing, stating the reasons.

2. The Contractor shall remedy the deficiencies in the work and send a second written notice of substantial completion to the Engineer.

3. The Engineer shall reinspect the work.

E. When the Engineer finds that the work is substantially complete:

1. He shall prepare and deliver to the Owner a tentative Certificate of Substantial Completion (Manatee County Project Management Form PMD-8) with a tentative list of the items to be completed or corrected before final payment.

2. The Engineer shall consider any objections made by the Owner as provided in Conditions of the Contract. When the Engineer considers the work

substantially complete, he will execute and deliver to the Owner and the Contractor a definite Certificate of Substantial Completion (Manatee County Project Management Form PMD-8) with a revised tentative list of items to be completed or corrected.

1.03 FINAL INSPECTION

1. When the Contractor considered the work to be complete, he shall submit written certification stating that:

    1. The Contract Documents have been reviewed.

    2. The work has been inspected for compliance with Contract Documents.

    3. The work has been completed in accordance with Contract Documents.

    4. The equipment and systems have been tested in the presence of the Owner=s representative and are operational.

    5. The work is completed and ready for final inspection.

2. The Engineer shall make an inspection to verify the status of completion after receipt of such certification.

3. If the Engineer determines that the work is incomplete or defective:

    1. The Engineer shall promptly notify the Contractor in writing, listing the incomplete or defective work.

    2. The Contractor shall take immediate steps to remedy the stated deficiencies and send a second written certification to Engineer that the work is complete.

    3. The Engineer shall reinspect the work.

4. Upon finding the work to be acceptable under the Contract Documents, the Engineer shall request the Contractor to make closeout submittals.

5. For each additional inspection beyond a total of three (3) inspections for substantial and final completion due to the incompleteness of the work, the Contractor shall reimburse the Owner for the Engineer's fees.

1.04 CONTRACTOR'S CLOSEOUT SUBMITTALS TO ENGINEER

1. Project Record Documents (prior to substantial completion).

2. Operation and maintenance manuals (prior to substantial completion).

3. Warranties and Bonds.

4. Evidence of Payment and Release of Liens: In accordance with requirements of General and Supplementary Conditions.

5. Certification letter from Florida Department of Transportation and Manatee County Department of Transportation, as applicable.

6. Certificate of Insurance for Products and Completed Operations.

7. Final Reconciliation, Warranty Period Declaration, and Contractor=s Affidavit (Manatee County Project Management Form PMD-8).

1.05 FINAL ADJUSTMENT OF ACCOUNTS

1. Submit a final statement of accounting to the Engineer.

2. Statement shall reflect all adjustments to the Contract Sum:

    1. The original Contract Sum.

    2. Additions and deductions resulting from:

        1. Previous Change Orders
        2. Unit Prices
        3. Penalties and Bonuses
        4. Deductions for Liquidated Damages
        5. Other Adjustments

    3. Total Contract Sum, as adjusted.

    4. Previous payments.

    5. Sum remaining due.

3. Project Management shall prepare a final Change Order, reflecting approved adjustments to the Contract Sum which were not previously made by Change Orders.

1.06 FINAL APPLICATION FOR PAYMENT

Contractor shall submit the final Application for Payment in accordance with procedures and requirements stated in the Conditions of the Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01710

CLEANING

FLORIDA DEPARTMENT OF
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SOUTHWEST DISTRICT
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PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

Execute cleaning during progress of the work and at completion of the work, as required by the General Conditions.

1.02 DISPOSAL REQUIREMENTS

Conduct cleaning and disposal operations to comply with all Federal, State and Local codes, ordinances, regulations and anti-pollution laws.

PART 2 PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 EXECUTION

3.01 DURING CONSTRUCTION

A. Execute periodic cleaning to keep the work, the site and adjacent properties free from accumulation of waste materials, rubbish and wind-blown debris, resulting from construction operations.

B. Provide on-site containers for the collection of waste materials, debris and rubbish.

C. Remove waste materials, debris and rubbish from the site periodically and dispose of at the working face of the on-site Stage I Landfill

3.02 DUST CONTROL

A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

3.03 FINAL CLEANING

A. Employ skilled workmen for final cleaning.

B. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.

C. Prior to final completion or Owner occupancy, Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces and all work areas to verify that the entire work is clean.

END OF SECTION

SECTION 01730

OPERATING AND MAINTENANCE DATA

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT TAMPA

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Compile product data and related information appropriate for Owner's maintenance and operation of products furnished under Contract.

Prepare operating and maintenance data as specified in this and as referenced in other pertinent sections of Specifications.

B. Instruct Owner's personnel in maintenance of products and equipment and systems.

C. Provide three (3) sets of operating and maintenance manuals for each piece of equipment provided within this Contract.

1.02 FORM OF SUBMITTALS

A. Prepare data in form of an instructional manual for use by Owner's personnel.

B. Format:

1. Size: 8-1/2 inches x 11 inches

2. Paper: 20 pound minimum, white, for typed pages

3. Text: Manufacturer's printed data or neatly typewritten

4. Drawings:

   a. Provide reinforced punched binder tab, bind in with text.

   b. Fold larger drawings to size of text pages.

5. Provide fly-leaf for each separate product or each piece of operating equipment.

   a. Provide typed description of product and major component parts of equipment.

   b. Provide indexed tabs.

6. Cover: Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS." List:

a. Title of Project.

b. Identity of separate structures as applicable.

c. Identity of general subject matter covered in the manual.

C. Binders:

1. Commercial quality three-ring binders with durable and cleanable plastic covers.

2. Maximum ring size: 1 inch.

3. When multiple binders are used, correlate the data into related consistent groupings.

1.03 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit three copies of complete manual in final form.

B. Content for each unit of equipment and system, as appropriate:

1. Description of unit and component parts.

a. Function, normal operating characteristics and limiting conditions.

b. Performance curves, engineering data and tests.

c. Complete nomenclature and commercial number of replaceable parts.

2. Operating Procedures:

a. Start-up, break-in, routine and normal operating instructions.

b. Regulation, control, stopping, shut-down and emergency instructions.

c. Summer and winter operating instructions.

d. Special operating instructions.

3. Maintenance Procedures:

   a. Routine operations.

   b. Guide to "trouble-shooting."

   c. Disassembly, repair and reassembly.

   d. Alignment, adjusting and checking.

4. Servicing and lubricating schedule.

   a. List of lubricants required.

5. Manufacturer's printed operating and maintenance instructions.

6. Description of sequence of operation by control manufacturer.

7. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.

   a. List of predicted parts subject to wear.

   b. Items recommended to be stocked as spare parts.

8. As installed control diagrams by controls manufacturer.

9. Each contractor's coordination drawings.

   a. As installed color-coded piping diagrams.

10. Charts of valve tag numbers, with location and function of each valve.

11. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.

12. Other data as required under pertinent sections of specifications.

C. Content, for each electric and electronic system, as appropriate:

1. Description of system and component parts.

   a. Function, normal operating characteristics and limiting conditions.

   b. Performance curves, engineering data and tests.

c. Complete nomenclature and commercial number of replaceable parts.

2. Circuit directories of panel boards.

a. Electrical service.

b. Controls.

c. Communications.

3. As-installed color-coded wiring diagrams.

4. Operating procedures:

a. Routine and normal operating instructions.

b. Sequences required.

c. Special operating instructions.

5. Maintenance procedures:

a. Routine operations.

b. Guide to "trouble-shooting."

c. Disassembly, repair and reassembly.

d. Adjustment and checking.

6. Manufacturer's printed operating and maintenance instructions.

7. List of original manufacture's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.

8. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.

D. Prepare and include additional data when the need for such data becomes apparent during instruction on Owner's personnel.

E. Additional requirements for operating and maintenance data: Respective sections of Specifications.

1.04 SUBMITTAL SCHEDULE

A. Submit one copy of completed data in final form fifteen days prior to substantial completion.

1. Copy will be returned after substantial completion, with comments (if any).

B. Submit two copies of approved data in final form. Final acceptance will not be provided until the completed manual is received and approved.

1.05 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to final inspection or acceptance, fully instruct Owner's designated operating and maintenance personnel in operation, adjustment and maintenance of products, equipment and systems.

B. Operating and maintenance manual shall constitute the basis of instruction.

1. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01740

WARRANTIES AND BONDS

FLORIDA DEPARTMENT OF
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SOUTHWEST DISTRICT
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PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Compile specified warranties and bonds.

B. Compile specified service and maintenance contracts.

C. Co-execute submittals when so specified.

D. Review submittals to verify compliance with Contract Documents.

E. Submit to Engineer for review and transmittal to Owner.

1.02 SUBMITTAL REQUIREMENTS

A. Assemble warranties, bonds and service and maintenance contracts, executed by each of the respective manufacturers, suppliers and subcontractors.

B. Number of original signed copies required: Two each.

C. Table of Contents: Neatly typed, in orderly sequence. Provide complete information for each item.

1. Product or work item.

2. Firm, with name of principal, address and telephone number.

3. Scope.

4. Date of beginning of warranty, bond or service and maintenance contract.

5. Duration of warranty, bond or service maintenance contract.

6. Provide information for Owner's personnel:

   a. Proper procedure in case of failure.

   b. Instances which might affect the validity of warranty or bond.

7. Contractor, name of responsible principal, address and telephone number.

1.03 FORM OF SUBMITTALS

A. Prepare in duplicate packets.

B. Format:

1. Size 8-1/2-inch x 11-inch punched sheets for standard 3-ring binder.

   a. Fold larger sheets to fit into binders.

2. Cover: Identify each packet with typed or printed title "WARRANTIES AND BONDS." List:

   a. Title of Project.

   b. Name of Contractor.

C. Binders: Commercial quality, three-ring, with durable and cleanable plastic covers.

1.04 TIME OF SUBMITTALS

A. Make submittals within ten days after date of substantial completion and prior to final request for payment.

B. For items of work, where acceptance is delayed materially beyond date of substantial completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

1.05 SUBMITTALS REQUIRED

A. Submit warranties, bonds, service and maintenance contracts as specified in respective sections of Specifications.

B. Approval by the Owner of all documents required under this section is a pre-requisite to requesting a final inspection and final payment

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 02064

MODIFICATIONS TO EXISTING STRUCTURES, PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

Furnish all labor, materials, equipment and incidentals required to modify, alter and/or convert existing structures as shown or specified and as required for the installation of piping, equipment and appurtenances. Existing piping and equipment shall be removed and dismantled as necessary for the performance of facility alterations in accordance with the requirements herein specified.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall cut, repair, reuse, excavate, demolish or otherwise remove parts of the existing structures or appurtenances, as indicated on the Contract Drawings, herein specified, or necessary to permit completion of the work under this Contract. The Contractor shall dispose of surplus materials resulting from the above work at the working face of the on-site existing Manatee County Class I Stage III Landfill.

B. The Contractor shall dismantle and remove all existing equipment, piping, and other appurtenances required for the completion of the work. Where called for or required, the contractor shall cut existing pipelines for the purpose of making connections thereto. Anchor bolts for equipment and structural steel removed shall be cut off one inch below the concrete surface. Surface shall be finished as specified in the Contract Documents.

C. At the time that a new connection is made to an existing pipeline, additional new piping, extending to it, shall be installed.

D. No existing structure, equipment, or appurtenance shall be shifted, cut, removed, or otherwise altered except with the express approval of and to the extent approved by the Engineer.

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E. When removing materials or portions of existing utility pipelines and/or structures or when making openings in walls and partitions, the Contractor shall take all precautions and use all necessary barriers and other protective devices so as not to damage the structures beyond the limits necessary for the new work, and not to damage the structures or contents by falling or flying debris. Unless otherwise permitted, line drilling will be required in cutting existing concrete.

F. Materials and equipment removed in the course of making alterations and additions shall remain the property of the Owner, except that items not salvageable, as determined by the Engineer and the Owner, shall become the property of the Contractor to be disposed of by him off the work site at his own place of disposal. Operating equipment shall be thoroughly cleaned, lubricated, and greased for protection during prolonged storage.

G. All alterations to existing utility pipes and structures shall be done at such time and in such manner as to comply with the approved time schedule. So far as possible before any part of the work is started, all tools, equipment, and materials shall be assembled and made ready so that the work can be completed without delay.

H. All workmanship and new materials involved in constructing the alterations shall conform to the General Specifications for the classes of work insofar as such specifications are applicable.

I. All cutting of existing concrete or other material to provide suitable bonding to new work shall be done in a manner to meet the requirements of the respective section of these Specifications covering the new work. When not covered, the work shall be carried on in the manner and to the extent directed by the Resident Project Representative.

J. Surfaces of seals visible in the completed work shall be made to match as nearly as possible the adjacent surfaces.

K. Where necessary or required for the purpose of making connections, the Contractor shall cut existing pipelines in a manner to provide an approved joint. Where required, he shall use flanges, or provide Dresser Couplings, all as required.

L. The Contractor shall provide flumes, hoses, piping and other related items to divert or provide suitable plugs, bulkheads, or other means to hold back the flow of water or other liquids, all as required in the performance of the work under this Contract.

M. Care shall be taken not to damage any part of existing or new constructed works.

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3.02 CONNECTING TO EXISTING PIPING AND EQUIPMENT

The Contractor shall verify exact location, material, alignment, joint, etc. of existing piping and equipment prior to making the connections called out in the Drawings. The verifications shall be performed with adequate time to correct any potential alignment or other problems prior to the actual time of connection. The Resident Project Representative must be present for all tie-ins for a visual inspection.

END OF SECTION

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SECTION 02220

FILLING AND COMPACTION FOR EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. The earthwork consists of site preparation and placing the soil bedding under and protective soil cover over the geomembrane. Work includes: stripping existing vegetation from the area to be capped with the geomembrane, filling depressions with suitable fill, finish grading of the surface so that there are no depressions that would hold water, placing additional bedding soil as needed in areas where the existing intermediate soil cover over the solid waste is less than the 6-inch thickness required or gradation for the soil bedding has soil particles greater than ½ inch in size, compacting the bedding soil, hand picking the surface to remove any natural or man made item that could puncture the geomembrane, and after the geomembrane and geocomposite are in place, covering the geomembrane or the geocomposite/geomembrane with the protective soil cover.

B. Definitions:

1. Maximum Density: Maximum weight in pounds per cubic foot of a specific material.

2. Optimum Moisture Content: The optimum moisture content shall be determined by ASTM D 1557 specified to determine the maximum dry density for relative compaction. Field moisture content shall be determined on the basis of the fraction passing the 3/4-inch sieve.

3. Suitable: Suitable materials for fills shall be non-cohesive, non-plastic granular local sand which shall be free from vegetation, organic material, marl, silt or muck.

4. Unsuitable: Unsuitable materials are highly organic soil (peat or muck) classified as A-8 in accordance with AASHTO Designation M 145.

5. Bedding Soil: The Bedding Soil for the geomembrane is a minimum 6-inch soil layer directly under the geomembrane for the purpose of protective the geomembrane from puncture. It shall be non-cohesive, non-plastic granular local silty sand with 100% passing the ½ inch sieve, and shall be free from vegetation, organic material, marl or muck.

6. Protective Cover Soil: The Protective Cover Soil is a protective soil layer at least 24-inches thick over the geomembrane or double-sided geocomposite capping

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drainage layer. It shall be non-cohesive, non-plastic granular local silty sand with 100% passing the ½ inch sieve and shall be free from vegetation, organic material, marl or muck.

1.02 QUALITY ASSURANCE

A. An independent Geotechnical Testing Laboratory employed by the Owner shall make tests to assure the Work is conducted in accordance with the Contract Documents. The Contractor shall schedule work so as to permit reasonable time for testing before placing succeeding lifts and shall keep the laboratory informed of progress.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:

1. All fill material shall be subject to the acceptance of the Engineer.

2. All fill material shall be free of organic material, trash, or other objectionable material. Excess or unsuitable material as designated by the Engineer shall be removed from the job site by the Contractor and hauled to the working face of the on-site Stage III Landfill for disposal.

B. Bedding Soil

1. The Bedding Soil is a minimum 6-inch soil layer directly under the geomembrane for the purpose of protective the geomembrane from puncture. It shall be non-cohesive, non-plastic granular local silty sand with 100% passing the ½ inch sieve, and shall be free from vegetation, organic material, marl or muck.

2. The Contractor shall identify borrow sources and submit site specific soils analyses which confirm compliance of the borrow source with the material specification requirements before delivery of material to the site.

C. Protective Cover Soil

1. The Protective Cover Soil is a protective soil layer at least 24-inches thick over the geomembrane or double-sided geocomposite capping drainage layer. It shall be non-cohesive, non-plastic granular local silty sand with 100% passing the ½ inch sieve and shall be free from vegetation, organic material, marl or muck. The Protective Cover Soil shall have a permeability range between $2x10^{-4}$ and $1x10^{-6}$ centimeters per second and a minimum friction angle of 23 degrees.

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2. The Contractor shall identify borrow sources and submit site specific soils analyses which confirm compliance of the borrow source with the material specification requirements before delivery of material to the site.

PART 3 - EXECUTION

3.01 FOUNDATION PREPARATION AND PLACEMENT OF BEDDING SOIL

A. The Contractor shall prepare the foundation for the cap by stripping existing vegetation from the area to be capped with the geomembrane, filling depressions with suitable fill, finish grading of the surface so that there are no depressions that would hold water, placing additional bedding soil as needed in areas where the existing intermediate soil cover over the solid waste is less than the 6-inch thickness required or gradation for the soil bedding has soil particles greater than ½ inch in size. Any debris from foundation preparation shall be hauled to the on-site Stage III Landfill working face for disposal.

B. The foundation shall be proof-rolled with a self-propelled vibratory compactor capable of delivering a minimum impact force of 30,000 to 35,000 pounds per drum to the soils. Each pass should overlap the preceding pass by 30 percent to ensure complete coverage. Any depressions that develop from proof rolling shall be backfilled with bedding soil and the area proof rolled again. Any unsuitable foundation material shall be removed and replaced with suitable material.

C. The Contractor shall provide workers for hand picking the surface to remove any natural or man made item that could puncture the geomembrane. This would include stones, trash, bones, sticks, wire, etc.

3.02 PLACEMENT OF THE PROTECTIVE COVER SOIL

A. The protective cover soil shall be placed in a single lift with a final thickness not less than 24 inches as measured from the top of the geomembrane or double-sided capping geocomposite drainage layer. The Contractor shall place indicators on the surface of the geomembrane or double-sided capping geocomposite drainage layer to guide the placing of the cover soil. The indicators shall be such that the indicator does not puncture or damage the geomembrane or double-sided capping geocomposite drainage layer. The indicators shall be submitted for approval by the Construction Quality Assurance Monitor prior to placement. The Contractor shall take care not to damage the geomembrane and double-sided capping geocomposite drainage layer. Further information on covering the geomembrane and double sided capping geocomposite drainage layer is included in Section 02776 Geomembrane. The protective cover soil shall be within 2% +/- of the optimum water content at the time of placement.

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3.03 TESTS

A. A Geotechnical Testing Laboratory employed by the Owner shall make the following tests:

PROPERTY	UNITS	FREQUENCY	VALUE	TEST METHOD
Organic Content	%	Note 1	Not Detected, except in top 6-inches where 5% maximum by weight is acceptable.	ASTM D 2974-87
Gradation	N/A	1 per 5,000 tons	Per Specifications	ASTM D 2487
Thickness	Inches	2 per acre	Bedding soil 6 in. min. Cover soil – 24 in. min. All tests must pass.	ASTM D 1777 (See Note 3)
Moisture Content	%	1 per 5,000 tons	2 % +/- Optimum	ASTM D 1557
Field Density for Bedding Soil		1 per acre	93%	ASTM D 1557
Final Elevation for Protective Cover Soil	+/- 0.1 Feet	100 ft. spacing	No depressions and 2 % minimum slope.	N/A
Friction Angle of Protective Cover Soil and Bedding soil	Degrees	3 tests	23 degrees minimum	ASTM D3080-04 Direct Shear Test of Soils Under Consolidated Drained Conditions
Permeability of Protective Cover Soil	Centimeters Per second	1 per 20,000 tons	Maximum permeability 2×10^{-4} cm/sec (Permeability range between 2×10^{-4} cm/sec and 1×10^{-6} cm/sec)	ASTM D5084-03 Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter – Method A

1. If needed based on visual observation of the soil to confirm organic content.
2. The test frequency is the minimum frequency. The Engineer shall increase the frequency as needed to confirm that the materials meet the specifications.
3. The testing firm shall use a rubber tipped digging tool to check the thickness of the final protective soil cover. All digging shall be by hand. Care shall be taken not to damage the geomembrane or geocomposite.

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3.04 SITE GRADING

A. The construction tolerance for elevations shall be ±0.1 foot. Due to landfill settlement, the Engineer may adjust the final elevations as shown on the drawings based on the actual elevations found on the surface of the landfill at the time of capping. All surfaces shall be graded to secure effective drainage. A slope of at least two (2) percent shall be provided on the final landfill contours for drainage to the storm water collection swales.

END OF SECTION

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SECTION 02221

TRENCHING, BEDDING AND BACKFILL FOR PIPE

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PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment, surveying and incidentals necessary to perform all excavation, backfill, compaction, grading, trench protection or other related work required to complete the piping work shown on the Drawings and specified herein.

B. Prior to commencing work, the Contractor shall examine the site and undertake his own subsurface investigations if needed, and take into consideration all conditions that may affect his work.

1.02 PROTECTION

A. Sheeting and Bracing in Excavations:

1. If needed, the Contractor shall properly construct sheeting and bracing as required to support the sides of excavations to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction and to protect adjacent structures from undermining or other damage. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

B. Drainage

1. The Contractor shall construct and place all pipelines, bedding and cover in-the-dry.

2. The Contractor shall, at all times during construction, provide and maintain proper equipment and facilities to remove promptly and dispose of properly all water entering excavations and keep such excavations dry so as to obtain a satisfactory undisturbed subgrade foundation condition until pipes have been completed. Any water that collects in the excavation shall be pumped to the nearest leachate collection manhole.

3. The Contractor shall furnish all materials and equipment to perform all work required for handling water that may be encountered during construction of pipelines.

PART 2 PRODUCTS

2.01 MATERIALS

A. General

1. Materials for use as backfill shall be described below. For each material, the Contractor shall notify the Engineer of the source of the material and shall furnish the Engineer, for approval, a representative sample weighing approximately 50 pounds.

2. Additional materials shall be furnished as required from off-site sources and hauled to the site.

B Common Fill

1. Common fill material used in trenches for backfill shall be free from organic matter, muck or marl and rock exceeding 1/2" in diameter. Common fill shall not contain broken concrete, masonry, rubble or other similar materials.

2. Material falling within the above specification, encountered during the excavation, may be stored in segregated stockpiles for reuse. All material which, in the opinion of the Engineer, is not suitable for reuse or is contaminated with solid waste shall be hauled to the working face of the on-site Stage III landfill by the Contractor for disposal.

C. Pipe Bedding

1. Coarse aggregate shall be used for pipe bedding at locations indicated on the Drawings.

2. Coarse aggregate for pipe bedding for pipes installed in areas out side the limits of the geomembrane shall be size No. 57 with gradation as noted in Table 1 of Section 901 of Florida Department of Transportation, Construction of Roads and Bridges.

3. Coarse aggregate for pipe bedding for pipes installed within the limits of the geomembrane shall be size No. 7 with gradation as noted in Table 1 of Section 901 of Florida Department of Transportation, Construction of Roads and Bridges. Pipe bedding that may come in contact with the geomembrane shall contain no particles greater than ½ inch in size.

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PART 3 EXECUTION

3.01 TRENCH EXCAVATION, BACKFILLING AND COMPACTION

A. Excavation for all trenches required for the installation of pipes shall be made to the depths indicated on the Drawings and in such manner and to such widths as will give suitable room for placing the pipe bedding and laying the pipe within the trenches.

B. Backfilling over pipes shall begin as soon as practicable after the pipe has been laid, jointed and inspected and the trench filled with compacted pipe bedding material to the mid-diameter of the pipe.

C. Any space remaining between the pipe and sides of the trench shall be packed full by hand shovel with common fill and thoroughly compacted with a tamper as fast as placed, up to a level of one foot above the top of the pipe.

D. The filling shall be carried up evenly on both sides with at least one man tamping for each man shoveling material into the trench.

E. The remainder of the trench above the compacted backfill, as just described above, shall be filled and thoroughly compacted.

F. Trench backfill shall be placed in layers not to exceed nine inches in depth as measured before compaction. Each layer shall be compacted to at least 95 percent of the maximum density as determined by AASHTO T-180.

3.02 PIPELINE GRADE

A. Pipelines shall follow the grades as shown on the drawings. If invert elevations or slopes are not given, then the pipeline shall follow the grade of the landfill. The minimum slope for all landfill gas collection pipes is 2%, and for storm water pipes it is 4%. Minute adjustments in lines or grades may be made if found necessary as the work progresses due to discrepancies in the landfill topography or in order to obtain satisfactory construction, but in no case shall the slopes be less than the minimum specified.

B. The record drawings shall include a final survey of all pipes installed with record elevations taken at a minimum of 100 ft apart along the pipe or at any change in slope.

END OF SECTION

SECTION 02276

TEMPORARY EROSION AND SEDIMENTATION CONTROL

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PART 1 GENERAL

1.01 DESCRIPTION

A. The work specified in this Section consists of the provision, maintenance and removal of temporary erosion and sedimentation controls as necessary.

B. Temporary erosion controls include, but are not limited to mulching, netting, watering, and sodding on-site surfaces and ditches to ensure that erosion during construction will be controlled to keep eroded soils within the limits of construction.

C. Temporary sedimentation controls include, but are not limited to silt dams, traps, barriers, and appurtenances at the foot of sloped surfaces and in ditches to ensure that sedimentation during construction will be controlled to keep eroded soils within the limits of construction.

D. The Contractor is responsible for providing effective temporary erosion and sediment control measures as needed during construction or until final controls become effective.

PART 2 PRODUCTS

2.01 EROSION CONTROL

A. Netting - fabricated.

B. Sod.

C. Mulch

2.02 SEDIMENTATION CONTROL

A. Bales - clean, seed-free cereal hay type.

B. Netting - fabricated of material acceptable to the Owner.

PART 3 EXECUTION

3.01 EROSION CONTROL

A. Minimum procedures in problem areas shall be:

1. Apply mulch loosely and to a thickness of between 3/4-inch and 1-1/2 inches.
2. Apply netting over mulched areas on sloped surfaces if needed.
3. Place sod in problem areas, stake on slopes if necessary to keep the sod in place and water.

3.02 SEDIMENTATION CONTROL

A. The Contractor shall install and maintain silt dams, traps, barriers, and appurtenances as needed during construction to keep eroded soils within the limits of construction.

3.03 PERFORMANCE

A. The Contractor, at his own expense, shall immediately take whatever steps are necessary to correct any deficiencies of the temporary erosion and sediment control measures employed if they fail to keep eroded soils within the limits of construction.

END OF SECTION

SECTION 02485

SODDING

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PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials and equipment necessary to place sod in the areas designated on the drawings, and satisfactorily return all disturbed areas to their original conditions.

B. Work shall include furnishing and placing sod, fertilizing, planting, watering and maintenance until the sod is established and accepted by Engineer/Owner.

1.02 QUALITY ASSURANCE

A. Requirements

It is the intent of this Specification that the Contractor is obliged to deliver a satisfactory stand of grass. If necessary, the Contractor shall repeat any or all of the work, including grading, fertilizing, watering and sodding at no additional cost to the Owner until a satisfactory stand is obtained. A satisfactory stand of grass is herein defined as full cover over sodded areas free of weeds, alive and growing with no bare spots.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fertilizer

The fertilizer shall be of the slow-release type meeting the following minimum requirements: 12 percent nitrogen, 8 percent phosphorus, 8 percent potassium; 40 percent other available materials derived from organic sources. At least 50 percent of the phosphoric acid shall be from normal super phosphate or an equivalent source, which will provide a minimum of two units of sulfur. The amount of sulfur shall be indicated on the quantitative analysis card attached to each bag or other container. Fertilizer shall be uniform in composition, dry and free flowing delivered to sites in original unopened containers bearing manufacturer's statement or guarantee.

B. Sodding

Sod shall be provided as required on the construction drawings or at locations as directed by the Engineer in accordance with Florida Department of Transportation,

Specifications Section 575 and 981. The Contractor shall furnish Bahia grass sod. Placement and watering requirements shall be in accordance with FDOT Specifications Section 575, except that no additional payment will be made for placement and/or watering. This cost shall be included in the Contract price bid for sodding.

E. Water

Reuse water is available on-site from an effluent pipeline coming from the adjacent Manatee County Wastewater Treatment plant, and is suitable for use in watering the sod. The Contractor shall furnish all necessary hose, equipment, attachments and accessories for the adequate irrigation of sod as may be required to establish the sod.

PART 3 EXECUTION

3.01 INSTALLATION

A. When the surfaces are ready, the Contractor shall commence work placing sod including fine grading as necessary and as directed by the Engineer.

B. Finish Grading

Areas to be sodded shall be finish graded and debris removed. Soft spots and uneven grades shall be eliminated. The Engineer shall approve the finish grade of all areas to be sodded prior to sod placement.

C. Protection

Sodded areas shall be protected against traffic or other use by placing warning signs or erecting barricades as necessary. The Contractor as directed by the Engineer shall repair any areas damaged prior to acceptance by the Owner.

3.02 CLEANUP

Soil or similar materials spilled onto paved areas shall be removed promptly, keeping those areas as clean as possible at all times. Upon completion of sodding operations, all excess soil, stones and debris remaining shall be removed from the construction areas.

3.03 SOD MAINTENANCE

Maintain landscape work for a period of 90 days immediately following complete installation of work or until Owner accepts project. Watering, weeding, cultivating, restoration of grade, mowing and trimming, protection from insects and diseases,

fertilizing and similar operations as needed to ensure normal growth and good health for sod shall be included at no additional cost to the Owner.

3.04 REPAIRS TO SODDED AREAS DISTURBED BY CONTRACTOR'S OPERATORS

Sodded areas planted under this Contract and all existing sodded areas damaged by the Contractor's operation shall be repaired at once by proper soil preparation, fertilizing and sodding, in accordance with these Specifications.

END OF SECTION

SECTION 02575

PAVEMENT REPAIR AND RESTORATION

PART 1 GENERAL

1.01 SCOPE OF WORK

The Contractor shall furnish all labor, materials, equipment, and incidentals required and remove and replace pavements over trenches excavated for installation of pipes and appurtenances as shown on the Contract Drawings.

1.02 GENERAL

A. The Contractor shall repair in a manner satisfactory to the County, all damage done to existing structures, pavement, driveways, paved areas, curbs and gutters, sidewalks, shrubbery, grass, trees, utility poles, utility pipe lines, conduits, drains, catch basin, flagstones, or stabilized areas or driveways and including all obstructions not specifically named herein, which results from this Project.

B. The Contractor shall keep the surface of the backfilled area of excavation in a safe traffic bearing condition and firm and level with the remaining pavement until the pavement is restored in the manner specified herein. All surface irregularities that are dangerous or obstructive to traffic are to be removed. The repair shall conform to applicable requirements of Manatee County Transportation Department requirements for pavement repair and as described herein, including all base, sub-base and asphalt replacement.

C. All materials and workmanship shall meet or exceed the County requirements and as called for in the Contract Documents and nothing herein shall be construed as to relieve the Contractor from this responsibility.

D. All street, road and highway repair shall be made in accordance with the FDOT and County details indicated on the Drawings and in accordance with the applicable requirements and approval of affected County and State agencies.

PART 2 PRODUCTS

2.01 PAVEMENT SECTION

A. Asphaltic concrete shall consist of asphalt cement, coarse aggregate, fine aggregate and mineral filler conforming to FDOT Type S-III Asphalt. Pavement replacement thickness shall match that removed but in no case shall be less than 1-1/2" compacted

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thickness. All asphalt concrete pavement shall be furnished, installed and tested in accordance with FDOT Specifications for Road and Bridge Construction.

B. Asphalt or crushed concrete or approved equal base material shall be furnished and installed under all pavement sections restored under this Contract. Asphalt base shall have a minimum 6" compacted thickness, meet requirements for FDOT ABC III (Minimum Marshall Stability of 1000) and be furnished, installed and tested in accordance with the requirements of the FDOT Standards. Crushed concrete base shall be 10" minimum compacted thickness. Crushed concrete aggregate material shall have a minimum LBR of 140 compacted to 99% T-180 AASHTO density. Asphalt base and crushed concrete base are acceptable. Other bases shall be submitted for approval.

C. Prime and tack will be required and applied in accordance with Section 300 - FDOT Specifications: Prime and Tack Coat for Base Courses.

PART 3 EXECUTION

3.01 CUTTING PAVEMENT

A. The Contractor shall saw cut in straight lines and remove pavement as necessary to install the new pipelines and appurtenances and for making connections to existing pipelines.

B. Prior to pavement removal, the Contractor shall mark the pavement for cuts nearly paralleling pipelines and existing street lines. Asphalt pavement shall be cut along the markings with a rotary saw or other suitable tool. Concrete pavement shall be scored to a depth of approximately two (2) inches below the surface of the concrete along the marked cuts. Scoring shall be done by use of a rotary saw, after which the pavement may be broken below the scoring with a jackhammer or other suitable equipment.

C. The Contractor shall not machine pull the pavement until it is completely broken and separated along the marked cuts.

D. The pavement adjacent to pipe line trenches shall neither be disturbed or damaged. If the adjacent pavement is disturbed or damaged, irrespective of cause, the Contractor shall remove and replace the pavement. In addition, the base and sub-base shall be restored in accordance with these Specifications, Florida Dept. of Transportation Standard Specifications and as directed by the Engineer.

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3.02 PAVEMENT REPAIR AND REPLACEMENT

A. The Contractor shall repair, to meet or exceed original surface material, all existing pavement cut or damaged by construction under this Contract. He shall match the original grade unless otherwise specified or shown on the Drawings. Materials and construction procedures for base course and pavement repair shall conform to those of the Florida Dept. of Transportation.

B. The Contractor's repair shall include the preparation of the subbase and base, place and maintain the roadway surface, any special requirements whether specifically called for or implied and all work necessary for a satisfactory completion of this work. Stabilized roads and drives shall be finished to match the existing grade. Dirt roads and drives shall have the required depth of backfill material as shown on the Contract Drawings.

C. The width of all asphaltic concrete repairs shall extend the full width and length of the excavation or to the limits of any damaged section. The edge of the pavement to be left in place shall be cut to a true edge with a saw or other approved method so as to provide a clean edge to abut the repair. The line of the repair shall be reasonably uniform with no unnecessary irregularities.

3.03 MISCELLANEOUS RESTORATION

Sidewalks cut or damaged by construction shall be restored in full sections or blocks to a minimum thickness of four inches. Concrete curb or curb and gutter shall be restored to the existing height and cross section in full sections or lengths between joints. RCP pipe shall be repaired or installed in accordance with manufacturer's specifications. Grassed yards, shoulders and parkways shall be restored to match the existing sections with grass sod of a type matching the existing grass.

3.04 SPECIAL REQUIREMENTS

The restoration of all surfaces, as described herein, disturbed by the installation of pipelines shall be completed as soon as is reasonable and practical. The complete and final restoration of both paved and shell stabilized roads within a reasonable time frame is of paramount importance. To this end, the Contractor shall, as part of his work schedule, complete the restoration of any area of road within five weeks after removing the original surface. Successful leak testing shall be performed prior to restoring any area of road. All restoration and replacement or repairs are the responsibility of the Contractor.

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3.05 CLEANUP

After all repair and restoration or paving has been completed, all excess asphalt, dirt and other debris shall be removed from the roadways. All existing storm sewers and inlets shall be checked and cleaned of any construction debris.

3.06 MAINTENANCE OR REPAIR

All wearing surfaces shall be maintained by the Contractor in good order suitable for traffic prior to completion and acceptance of the work.

END OF SECTION

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LANDFILL GAS WELL AND WELLHEAD

PART 1 GENERAL

1.01 SCOPE OF APPLICATION

A. Supply all equipment, materials, and labor needed to install landfill gas (LFG) extraction wells and wellheads as specified herein and as indicated on the Drawings.

1.02 REFERENCES

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

1. ASTM C136 - Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

2. ASTM C702 - Standard Practice for Reducing Field Samples of Aggregate to Testing Size.

3. ASTM D1557 - Standard Test Method of Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb. (4.54 kg) Rammer and 18-inch (457 mm) Drop.

4. ASTM D2487 - Standard Test Method for Classification of Soils for Engineering Purposes.

5. ASTM D2488 - Standard Practice for Description of Soils (Visual-Manual Procedure).

6. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

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

1.03 SUBMITTALS

A. Submit to the Engineer Certificates of Compliance on materials furnished, and manufacturer's brochures containing complete information and instructions

pertaining to the storage, handling, installation, and inspection of pipe and appurtenances furnished.

B. The Contractor shall submit to the Engineer samples of all well backfill materials furnished.

C. The Contractor shall keep detailed well logs and construction diagrams for all wells drilled, including the elevation at top of ground, total depth of the well, the static water level, the temperature of spoils, depth, thickness, and description of soil or waste strata and the occurrence of any water-bearing zones. Well logs shall be submitted to the Engineer.

1.04 SITE CONDITIONS

A. Obstructions and saturated conditions such as asbestos, sludge, concrete, steel and other solid wastes are sometimes encountered when drilling in a landfill, many of which can be drilled through. Contractor is expected to make reasonable effort to drill through obstructions and saturated conditions and will be paid for offset re-drilling and boring abandonment only with prior approval in writing by Owner. Contractor will be paid for abandonment of abandoned hole and for well installation at new location.

PART 2 PRODUCTS

2.01 AGGREGATE

A. The aggregate shall be non-calcareous washed well graded granite that is a natural stone with a gradation between 1-inch to 3-inch diameter size.

B. The granite shall be that as specified in FDOT Standard Specifications for Road and Bridge Construction (Latest Edition) Section 901-2.2. The granite shall be a coarse aggregate produced from the crushing of granites that are sound and durable. The Los Angeles Abrasion requirement of FDOT 901-1.3 is modified to permit a maximum loss up to 50 (FM 1-T 096). Maximum amount of mica schist permitted is five percent (AASHTO T 189).

2.02 BENTONITE WELL SEAL

A. The landfill gas extraction well shall be sealed using 3/8" bentonite chips. The bentonite chips shall be placed dry in the well at the depths indicated on the drawings, and water added to the well to hydrate the bentonite chips in place.

2.03 SOLID WALL PIPE

A. All pipe and fittings shall be high-density polyethylene pipe (HDPE), SDR 11. Refer to Section 15051 for HDPE pipe.

2.04 PERFORATED PIPE

A. Perforations in HDPE extraction well piping shall be 5/8-inch diameter hole spaced 90 degrees around the circumference of the pipe, and 3 inches on center along the pipe, and approximately 16 holes per foot.

2.05 WELL HEADS

A. The well head is a CES Landtec Accu-Flo Model 200 standard wellhead, LFG&E PC1000 FX standard wellhead, or approved equal. The wellhead shall use Schedule 80 PVC with 2-inch PVC gate valve, sliding compression fittings, ultra flex connections and 48-inches of 2" diameter flex hose.

PART 3 EXECUTION

3.01 DRILLING

A. Extraction wells are to be 36-inch diameter, drilled to the depth shown on the Drawings. All borings shall be made with bucket type augers. Auger lengths shall be clearly marked on the equipment so as to permit checking the depth of the boring. The invert of the landfill is at El.29 +/-. The depths of the borings as given on the Drawings are designed to penetrate the landfill to approximately 75% of the depth of the solid waste as measured at the location of the well. The Contractor shall verify the ground elevation at each well prior to starting the drilling, and verify the design depth as given on the drawings using the ground elevation and the landfill invert elevation of 29. If there is a discrepancy, the Contractor shall notify the Engineer prior to boring the well.

B. The boring depths shown on the Drawings may be adjusted in the field by the Engineer if obstructions or water is encountered. If water is encountered in a boring, the Contractor may be directed to drill beyond the point at which it was encountered. If wet conditions remain, the boring may be terminated and the length of perforated pipe adjusted by the Engineer, or the well may be relocated. If wet conditions cease (e.g., due to trapped water layer), then drilling will continue to the design depth. If an obstruction is encountered, the Engineer may terminate the boring or relocate it.

C. As soon as drilling is completed, a safety screen shall be placed over the top of the bore. This screen shall stay in place until backfilling is within 4 feet of the surface. Safety screen size should be large enough to accommodate all backfill materials and any tools used during backfill yet not large enough for any human to accidentally fall through.

D. The bore for the well shall be straight and the well pipe shall be installed in the center of the borehole. The Contractor will take all tension off of the pipe by mechanical means and center the pipe in the middle of the borehole before starting to backfill.

3.02 BACKFILLING

A. Backfilling of the well shall commence immediately after well drilling is completed and the well piping has been installed in the borehole. Backfill materials shall be installed as indicated on the Drawings and as approved by the Engineer.

B. The aggregate shall be poured or scooped through the screen at a rate that will not endanger the integrity of the well casing.

C. The well seal will be formed by evenly distributing the bentonite chips around the annulus of the well and then adding at least 10 gallons of fresh water in a manner that will allow for a thorough saturation of the bentonite material. This process will be continued until a minimum plug thickness of 2 feet has been achieved (approximately 15 sacks).

D. The bentonite well seal shall be backfilled as per the material specifications. The Contractor shall soak each lift prior to filling the next one.

E. Soil backfill shall be rodded in the boring to provide even distribution and compaction.

F. Wellhead shall be installed on the extraction well as shown on the drawings.

3.03 DISPOSAL

A. Refuse from well drilling operations shall be disposed of in accordance with landfill operations at the landfill working face. The Contractor shall haul the refuse to the working face of the landfill.

3.04 ABANDONMENT OF GAS WELLS

A. Casing Backfilling:

1. The casing shall be backfilled with uniform-sized gravel to the top of the perforated section of the pipe, followed by a non-shrink cement-bentonite grout to within four feet of the ground surface. The grout shall be installed using tremie methods. The tremie pipe shall be placed within two feet of the bottom of the casing. The grout level shall be maintained at least five feet above the discharge end of the tremie pipe during pumping.

2. The grout mix shall consist of one sack of cement, 10 to 12 gallons of water, and one pound of powdered bentonite. One teaspoon of aluminum powder or other approved "non-shrink" additive shall be added per sack of cement to reduce shrinkage of the grout mix during set up and to improve the seal of the casing.

3. The grout shall be allowed to set-up and harden for at least 24 hours before removing the upper portion of the casing. A second or third grouting effort may be required to raise the level of the grout in the casing. The surface of the grout is expected to settle as grout seeps into slots at the bottom of the casing.

B. Casing Removal:

1. The casing shall be removed to a depth of at least four feet below ground surface. This can be accomplished by (1) over drilling the casing with an auger of similar drilling tool or (2) locally excavating with a backhoe and breaking or cutting the casing at the required depth.

2. When the casing is over drilled, the diameter of the drilling tools shall bore a hole at least equal to the original borehole.

3. When the casing is removed by localized excavation, the excavation shall encompass the entire area of the original borehole.

C. Final Cover Backfill:

1. After the casing has been removed to at least four feet below ground surface, the resulting borehole or excavation shall be backfilled to the existing ground surface.

END OF SECTION

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SECTION 02712

DOUBLE-SIDED CAPPING GEOCOMPOSITE DRAINAGE LAYER

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A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of the double sided capping geocomposite drainage layer (GDL), including all necessary and incidental items, in accordance with the Contract Drawings and these Specifications.

2. Reference Standards:

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

GRI-GC8, Standard Guide for Determination of the Allowable Flow Rate of a Drainage Geocomposite

ASTM D4716, Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using Constant Head.

ASTM D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Process Plastometer.

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

ASTM D 1621, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.

ASTM D 4218, Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle Furnace Technique

ASTM D 4491, Standard Test Method for Water Permeability of Geotextiles by the Permitivity Method.

ASTM D 4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

ASTM D 4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.

ASTM D 4632, Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).

ASTM D 4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.

ASTM D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 6241, Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile- Related Products Using a 50-mm Probe.

ASTM D 5199, Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.

ASTM F 904, Standard Test Methods for Comparison of Bond Strength or Ply Adhesion of Similar Laminates Made from Flexible Materials

ASTM G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

3. Quality Assurance:

Quality Assurance during installation of GDL will be provided by the Owner.

B. MATERIALS

1 The polymer used to manufacture the Geonet core of the GDL shall be polyethylene. Manufacturer shall certify that no regrind material is used in the geonet manufacturing process.

2 The drainage core of the GDL shall be manufactured by extruding polyethylene to form a triaxial void maintaining structure. The geonet shall meet the property requirements listed in Table 1.

3 The geotextile of the GDL shall be UV resistant, continuous filament, needle punched, nonwoven polypropylene geotextile. The geotextile shall meet the property requirements listed in Table 2.

4 The GDL shall be Tenflow 70-2 manufactured by Tenax Corporation (800-356-8495), or engineer approved equivalent drainage material (aggregate or geosynthetic). Any alternative GDL material submitted for engineer approval must demonstrate performance equivalency to all the property requirements and testing methods as indicated in Tables 1& 2, as well as Note 5 below. Labels on each roll of GDL shall identify the length, width, lot and roll numbers, and name of Manufacturer.

5 The manufacturer of the GDL shall submit documents for the engineer's review that the GDL to be supplied to the project site has proven installation. As a minimum, the manufacturer shall certify that:

(a) The proposed GDL has been installed at least 10 million square feet. The proposed GDL has been installed at least 10 projects that are in operations for a minimum two years.

(b) The proposed GDL has been installed at least 5 landfill closure projects.

(c) It has not supplied any drainage product that has been documented to be contributing towards a catastrophic system failure.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit one copy of a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for the GDL attesting that the GDL meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample (12" x 12") of the GDL to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.

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

3. Quality Control Certificates: For GDL delivered to the site, quality control certificates, signed by the Manufacturer's quality manager shall be provided for every roll of GDL. Each certification shall have the roll identification number(s), test methods, frequency, and test results. At a minimum, the test results and frequency of testing shall be as shown in Table 3 of this section.

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

TABLE 1: REQUIRED GEOCOMPOSITE DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	UNITS	VALUE
Geonet			
Structure	Triaxial		
Thickness (min.)	ASTM D 5199	mil	325
Tensile Strength (min.)	ASTM D 4595	lb/ ft	450
Density (min.)	ASTM D 1505	g/cm^3	0.94
Melt Flow Index (max.)	ASTM D 1238	g/10 min	1.0
Carbon Black Content (min.)	ASTM D 4218	%	2
Creep Reduction Factor[1]	GRI- GC8	-	1.1
Geocomposite			
Ply Adhesion (min.)	ASTM F 904	lb/inch	0.5
Transmissivity[2] –Machine Direction (min.) @240 psf load	ASTM D 4716 GRI –GC8	(m^2/sec)	7.0E-03 @ gradient 0.1 4.0E-03 @ gradient 0.33

Notes:

1. The creep reduction factor is determined from 10,000 hour test duration, extrapolated to 30 years and using a compressive load of 2,000 psf. SIM (Stepped isothermal method) method is acceptable for confirmation only, but is not acceptable for baseline data to determine the creep reduction factor.

2. Transmissivity tests shall use the normal compressive load for the two foot thick protective cover soil of 240 psf at hydraulic gradients of 0.1 and 0.33. Testing boundary conditions from the top to bottom are: upper steel load plate/ local silty sand form the borrow area proposed as the source for the protective cover soil / Geocomposite / Geomembrane / lower load plate with a minimum seating period of 1 hour.

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TABLE 2: REQUIRED GEOTEXTILE PROPERTIES

PROPERTY	TEST METHOD	UNITS	VALUE
Serviceability Class	Class 2		
AOS (MaxARV)	ASTM D4751	US Sieve (mm)	70 (0.21)
Permittivity (MARV)	ASTM D4491 Falling head	sec^{-1}	0.5
Grab Tensile Strength (MARV)	ASTM D4632	lbs	157
Trapezoid Tear (MARV)	ASTM D4533	lbs	56
Puncture Strength (MARV)	ASTM D4833	lbs	56
CBR Puncture Strength (MARV)	ASTM D6241	lbs	346
UV Resistance @500 Hours (MIN)	ASTM G154	%	70

TABLE 3: REQUIRED MANUFACTURER'S QUALITY CONTROL TEST DATA AND CONSTRUCTION QUALITY CONTROL (CQA) TESTING

PROPERTY	TEST METHOD	VALUE	FREQUENCY	CQA Testing Frequency (See Note 1)
Resin Tests				
DENSITY (min.)	ASTM D1505	0.94 g/cm^3	Per Lot	No Test
MELT FLOW INDEX (max.)	ASTM D1238	1.0 g/10 min	Per Lot	No Test
Geonet Tests				
THICKNESS (min.)	ASTM D5199	325 mil (8.26 mm)	50,000 ft^2	250,000 ft^2
CARBON BLACK CONTENT (min.)	ASTM D4218	2 % min 2-3% range	50,000 ft^2	250,000 ft^2
TENSILE STRENGTH-MD (min.)	ASTM D4595	450 lbs/ft	50,000 ft^2	250,000 ft^2
Geotextile Tests				
WEIGHT	ASTM D3776	6Oz/sy	100,000 ft^2	250,000 ft^2
AOS (Max ARV)	ASTM D4751	70 US Sieve (021mm)	500,000 ft^2	1,000,000 ft^2
PERMITTVITY (MARV)	ASTM D4491 Falling head	0.5 sec^{-1}	500,000 ft^2	1,000,000 ft^2
GRAB TENSILE STRENGTH (MARV)	ASTM D4632	157 lbs	100,000 ft^2	250,000 ft^2
TRAPEZOID TEAR (MARV)	ASTM D4533	56 lbs	100,000 ft^2	250,000 ft^2
PUNCTURE STRENGTH (MARV)	ASTM D4833	56 lbs	100,000 ft^2	250,000 ft^2
CBR PUNCTURE STRENGTH (MARV)	ASTM D6241	346 lbs	500,000 ft^2	1,000,000 ft^2
Geocomposite Tests				
PLY ADHESION (min.)	ASTM D904	0.5 lbs/in	100,000 ft^2	250,000 ft^2
TRANSMISSIVITY-MD (See Note 2)	ASTM D4716 GRI-GC8	7.0E-03m^2/sec @ gradient 0.1 4.03E-03 m^2/sec @ gradient 0.33	200,000 ft^2	500,000 ft^2

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1. CQA Testing is the responsibility of the Owner.
2. Transmissivity tests shall use the normal compressive load for the two foot thick protective cover soil of 240 psf at hydraulic gradients of 0.1 and 0.33. Testing boundary conditions from the top to bottom are: upper steel load plate/ local silty sand form the borrow area proposed as the source for the protective cover soil / Geocomposite / Geomembrane / lower load plate with a minimum seating period of 1 hour.
3. MARV – Minimum Average Roll Value; MaxARV – Maximum Average Roll Value.

D. CONSTRUCTION

1. Handling and Placement

- After the geomembrane has been installed, tested and approved by the Engineer, the surface shall be cleaned and free of excess dirt and debris.

- The Contractor and the Installer shall handle all geocomposite in such a manner as to ensure it is not damaged in any way. Precautions shall also been taken to prevent damage to underlying layers during placement of the geocomposite.

- The geocomposite roll should be installed in the direction of the slope, following the labeled instructions as provided by the manufacturer with respect to the top/bottom sides.

- Only full-length rolls shall be used at the top of the slope.

- In the presence of wind, all geocomposite shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

- If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.

- The geocomposite shall be placed in the anchor trench at the top of the slope to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.

- If there are any obstructions (such as outlet pipes or monitoring wells) while deploying the geocomposite, the geocomposite shall be cut to fit around the obstruction. Care shall be taken as to make sure there is no gap between the obstruction and the geocomposite. The geocomposite shall be cut in a way that the lower geotextile and geonet core is in contact with the obstruction and the upper geotextile has an excess overhang. There must be enough of the upper geotextile to be able to tuck the upper geotextile back under the geocomposite to protect the exposed geonet core, and prevent soil particles from migrating into the geonet core flow channels.

2. Seams and Overlaps

Each component of the geocomposite (geotextile(s) and geonet) shall be secured or seamed to the like component at overlaps.

a. Geonet Component

- Adjacent edges of geonet along the length of the geocomposite, shall be overlapped 2-3

inches, as seen Figure 1. These overlaps shall be joined by tying the geonet cores together with white or yellow cable ties or plastic fasteners. These ties shall be spaced at a maximum of every 5 feet along the roll length, or a maximum of 2 feet if the geocomposite is installed vertically.

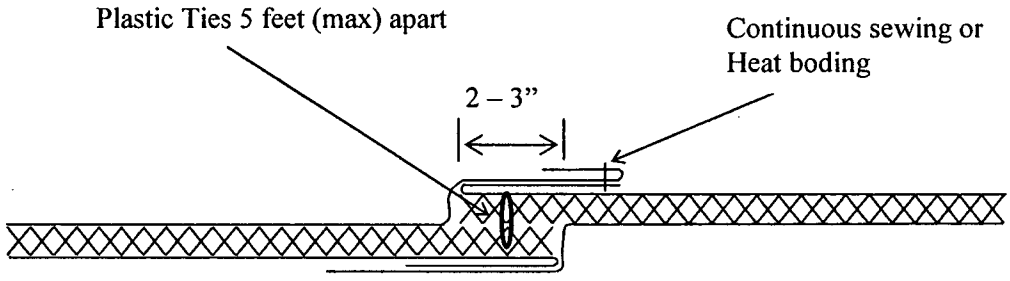

Figure 1: Overlap Along Roll Length ((MD)

- Adjoining geocomposite rolls (end to end) along the roll width shall be shingled down in the direction of the slope, with the geonet portion of the top geocomposite overlapping the geonet portion of the bottom geocomposite a minimum of 12 inches across the roll width, see Figure 2. Geonet shall be tied every 12 inches across the roll width and every 6 inches in the anchor trench or as specified by the Engineer.

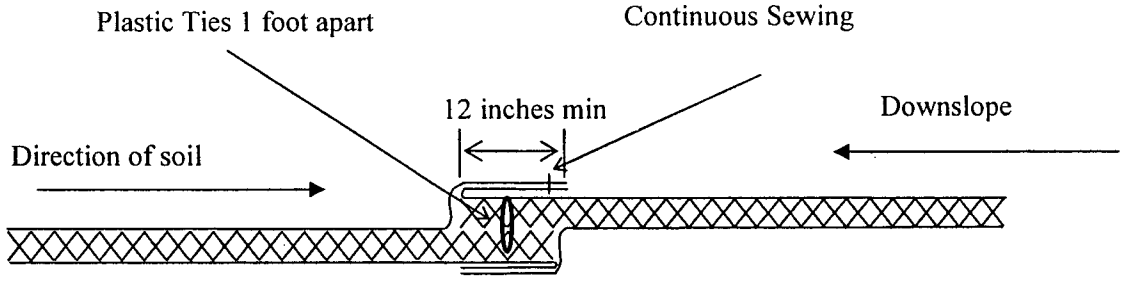

Figure 2: Overlap Along Roll Width (CD)

b. Geotextile Component

- The bottom layer of geotextile (if any) shall be overlapped.
- The top layers of geotextile shall be sewn together, or at the discretion of the Engineer may

be heat bonded or wedge welded. Geotextiles shall be overlapped a minimum of 4 inches prior to seaming or heat bonding, geotextile sewing seams to be used are Prayer, "J", or Butterfly, see details in Figure 3. The seam shall be a two-thread, double-lock stitch, or a double row of single-thread, chain stitch. If heat bonding is to be used, care must be taken to avoid burn through of the geotextile. It is important that the geotextiles be joined continuously along to the roll as to prevent any fugitive particle migration into the geonet core flow channels.

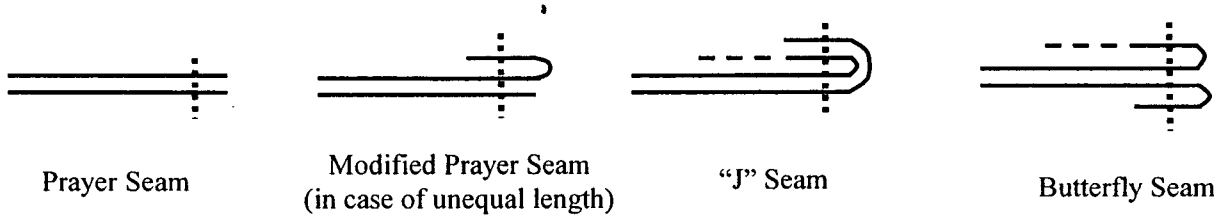

Figure 3: Geotextile Sewing Seams Details

3. REPAIR

- Any small holes or tears in the top geotextile shall be patched with an 8" x 8" geotextile piece. The patching geotextile shall be the same as the original one. Apply the spray adhesive *(3M Super 77 adhesive is the recommended)* to one side of the 8" x 8"textile patch. Center and apply the 8" x 8" textile patch over the blemish, hole, tear or thin spot in the geotextile. Firmly press 8" x 8" textile patch over the repair area. If the damaged area of the geotextile is greater than this standard patch size, a bigger size patch is recommended using a multitude of 8" x 8" patches. If the geotextile is damaged beyond 50 percent of the width of the roll, a continuous piece of fabric the same width as the geocomposite may be cap-stripped directly to the adjacent seams by sewing a portion of the new geotextile in place.

- Any large rips, tears or damage areas on the deployed geocomposite core shall be removed and patched by placing a patch extending 12" beyond the edges of the damaged areas. The patch shall be secured to the original geonet tying every 6 inches with approved tying devices. If the hole or tear width across the roll is more than 50% percent the width of the roll, the damaged area shall be cut out.

4. Cover Soil Placement

- Placement of the cover soil is recommended to proceed immediately following placement and inspection of the geocomposite.

- In applying fill material, no equipment shall drive directly across geocomposite. If any tear or local damage occurs to the geotextile, geonet or geocomposite, patching technique as described in the above section shall be used.

- The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure (LGP). The cover soil shall be placed on the geocomposite from the bottom of the slope proceeding upwards and in a manner, which prevents instability of the cover soil or damage to the geocomposite. Unless otherwise specified by the Engineer, all equipment for spreading fill material overlying the geocomposite shall comply with the following:

Maximum Equipment Ground Pressure (psi)	Minimum Separation Thickness (inches)
< 5	12
5 - 10	18
>10	24

- Compaction of the initial lift placed over the geocomposite must be performed in a manner that does not damage the geocomposite.

E. FAILING CQA Tests:

In case of any failing CQA tests, "blocking" tests on before and after the failing roll(s) shall be conducted to identify the affected rolls in the lot. The rejected rolls shall be excluded from the lot in consideration. The product manufacturer shall be responsible for any cost associated with blocking testing.

END OF SECTION

SECTION 02720

LANDFILL TERRACE UNDERDRAIN

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT TAMPA

PART 1 GENERAL

1.01 SCOPE OF APPLICATION

A. Supply all equipment, materials, and labor needed to install the landfill terrace under drain pipe and aggregate.

1.02 SUBMITTALS

A. Submit to the Engineer Certificates of Compliance on materials furnished, and manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, and inspection of pipe and appurtenances furnished.

B. The Contractor shall submit to the Engineer samples of the aggregate.

PART 2 PRODUCTS

2.01 AGGREGATE

A. The aggregate shall be natural stone per FDOT Specification 901 with a gradation for #7 coarse aggregate per FDOT Table 1 (1/2 inch to No 4.)

2.02 SLOTTED PIPE

A. The 8-inch diameter terrace under drain pipe and fittings shall meet the requirements of AASHTO M-252, Type S (corrugated outside/smooth inside), and shall be ADS N-12 pipe or approved equal.

B. The joints may be non-gasketed external joints covering a minimum of two corrugations at each end.

C. The slotted pipe shall meet AAHSTO Class II Perforations, and have a water inlet area no less than 1.18 in^2/ft. The slots shall be located in the outside valleys of the corrugations using ADS standard perforation pattern. The slot width shall be 0.125 inches and the length 1.25 inches.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the under drain pipe and aggregate in the locations as shown on the drawing. Install the pipe per the recommendation of the manufacturer.

B. The aggregate shall be poured over the pipe at a rate that will not endanger the integrity of the pipe.

END OF SECTION

SECTION 02776

GEOMEMBRANE

FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT
TAMPA

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: The work shall include furnishing all labor, materials, quality control, warranties, transportation, storage, supervision, management, and installation equipment necessary for watertight installation and testing of the geomembrane portion of the landfill cap system, as herein specified and as shown on the Drawings. The supply and installation of these materials shall be in strict accordance with the Engineer's Specifications and Drawings and be subject to the terms and conditions therein. The geomembrane barrier layer will be a 40-mil white-surfaced linear low-density polyethylene (LLDPE) geomembrane liner. The geomembrane will be textured on the side slopes, and smooth on all slopes flatter than 5H:1V. The LLDPE geomembrane used in the barrier layer will be a semi-crystalline thermoplastic with at least 40 mils average thickness as defined by method GRI GM13, with a maximum water vapor transmission rate of 2.4 g/(m^2xday), have a chemical and physical resistance to materials it may come in contact with and withstand exposure to the natural environmental stresses and forces throughout the installation, seaming process and settlement of the waste during the closure and long-term care period. The geomembrane shall be as manufactured by GSE Lining Technology, Inc., Poly-Flex, Inc., Agru America or approved equal.

B. The installation of the geomembrane shall be performed in conjunction with other work, including but not limited to, placement of the bedding soil, double-sided capping geocomposite, landfill gas collection system and placement of protective soil cover and sod.

C. Applicable Standards: All geomembrane material supplied and installed as part of this Work shall comply or exceed conditions described in the current Industry Standard GRI test method GM13 and applicable American Standards and Test Methods (ASTM) guidelines. The geomembrane shall meet the requirements of Florida Department of Environmental Protection (FDEP) Rule Chapter 62-701, F.A.C.

1.02 DEFINITIONS AND RESPONSIBILITY

A. Geomembrane shall be strictly defined to be linear low-density polyethylene (LLDPE) in this specification section.

B. The Contractor is responsible for all construction quality control (CQC) needed for the manufacturing and installation of the geomembrane. The Owner is responsible for all

construction quality assurance (CQA) needed for the manufacturing and installation of the geomembrane.

C. Manufacturer Qualifications:

1. Qualified Manufacturer shall be a company, corporation, or firm regularly engaged in the development and manufacture of geomembrane liners with a history of successful production of geomembrane for a minimum period of five (5) years. A single Manufacturer shall manufacture the geomembrane rolls. The Manufacturer shall submit written information as follows:

   a) Quality Control procedures (manual) for production. The manual shall define sampling procedures, test frequencies, and methods. The Manufacturer shall, at a minimum, comply with the quality control specification for this project.

   b) Statement from the Manufacturer stating the manufacturing quality control measures specified for this project will be followed and the manufactured geomembrane products will meet or exceed the product specifications for this project.

2. The Manufacturer shall have successfully supplied geomembrane liner for a minimum of six (6) projects, during the last five (5) years, of similar size and scope totaling to a minimum of ten (10) million square feet of installed geomembrane. Projects shall be considered similar only if the Manufacturer had total manufacturing responsibility for geomembrane production and the installed geomembrane has successfully fulfilled its primary function for a minimum of two (2) years. The Manufacturer shall submit written information as follows;

   a) Name and location of project and date of installation.

   b) Contact name and phone number for each project.

   c) Geomembrane thickness and surface area geomembrane installed.

D. Installer Qualifications:

1. Qualified Installer shall be a company, Corporation, or firm regularly engaged in the deployment and installation of geomembrane liners with a successful history of a minimum of five (5) years. A single Installer shall install the geomembrane. The Installer shall submit written information as follows:

   a) Daily installation quantity shall be sufficient to meet the demands of the project schedule for this project.

b) Quality Control procedures (manual) for field installation. The Installer shall, at a minimum, comply with the specifications for this project.

Quality Control (QC) Field Program: The Contractor/Installer's QC program shall provide for recording all inspection and testing of all work items to ensure conformance to applicable specifications and drawings with respect to materials, workmanship, construction, functional performance, and identification. This program shall be subject to approval by the Engineer. The QC program shall contain as a minimum:

- Storage and Handling
- Panel Identification
- Panel Inspection
- Panel Layout Drawings/Shop Drawings
- Seam Identification
- Seaming Process and Equipment
- Seaming Inspection
- Non-Destructive Tests (Seams, Repairs, Geomembrane Boots)
- Destructive Tests
- Laboratory Test
- Methods for Testing and Calibration of Field Testing Equipment
- Corrective Actions (Including Surveyed Locations)
- Procedures for Development of Record Drawings
- Weather Contingencies
- Record Keeping

c) Statement from the Installer stating the installation quality control measures specified for this project will be followed and the installed geomembrane products will meet or exceed the product specifications for this project.

2. The Installer shall have successfully installed geomembrane materials for at least six (6) projects, during the last five (5) years, of similar size and function totaling a minimum of ten (10) million square feet of installed geomembrane. Projects shall be considered similar only if the Installer had total installation responsibility for geomembrane installation and the installed geomembrane has successfully fulfilled its primary function for a minimum of two (2) years. The Installer shall submit written information as follows:

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a) Name and location of project and date of installation.

b) Contact name and phone number for each project.

c) Geomembrane thickness and surface area geomembrane installed.

d) All personnel performing seaming operations shall be qualified by experience. At least one seamer shall have experience seaming a minimum of 1,000,000 linear feet of geomembrane seams using the same type of seaming apparatus to be used at the site. 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. No field work shall take place without the site supervisor or foreman being present on site.

1.03 SUBMITTALS

A. SHOP DRAWINGS: The Contractor shall submit to the Engineer, for approval, information on the following;

1. Twenty-one (21)-contract days after Notice of Award.

   a) Warranty (Materials)
   b) Warranty (Workmanship)

2. A minimum of thirty (30) contract days prior to the geomembrane installation;

   a) Manufacturer's Qualifications
   b) Manufacturers Quality Control Plan
   c) Statement from Manufacturer Product meets or exceeds these specifications
   d) Installer's Qualifications
   e) Installers Quality Control Plan, including proposed installation procedures
   f) Geomembrane Resin Information & Quality Control Certificates
   g) Geomembrane Manufacturer Material Information & Quality Control Certificates
   h) Statement from Installer that installed product will meet or exceed these specifications
   i) Geomembrane Accessories
   j) Resumes' of installation personnel
   k) Panel Layout(s) and Details
   l) Extrudate Rod Resin Information
   m) Procedures for Non-Destructive testing on field fabricated geomembrane penetration boots.

2. During installation;

a) Seam quality under conditions outside of the approved weather conditions (If any)
b) Proposals for night operations (If proposed)

3. If during geomembrane installation additional material or labor is required; (Note materials or labor shall not be used until the proper documentation is received and approved by the Engineer). Documentation shall include the following;

a) Geomembrane Resin Information & Quality Control Certificates
b) Geomembrane Manufacturer Information & Quality Control Certificates
c) Geomembrane Accessories
d) Resumes' of installation personnel
e) Panel Layout(s) and Details

4. After completion of installation;

a) Record (As-Built) Drawings
b) Contractors Written Certification
c) Warranties (Materials and Workmanship)

B. Detailed informational requirements for the shop drawing submittals are described within this specification section. The Contractor shall be required to submit and receive approval from the Engineer for all submittals described within this specification section.

1.04 WARRANTY

A. The Contractor shall guarantee the materials of all products supplied, on a prorated basis, as part of this work for a minimum period of twenty (20) years following final acceptance of the geomembrane installation by the Owner.

B. The Contractor shall guarantee the workmanship of all services supplied as part of this work for a minimum period of one (1) years following final acceptance of the geomembrane installation by the Owner.

PART 2 - PRODUCTS

2.01 GEOMEMBRANE RESIN RAW MATERIALS

A. The geomembrane shall be manufactured from virgin, first-quality polyethylene resin, and shall be designed and manufactured specifically for use in geomembrane systems. Reclaimed or reworked polymer shall not be used or added to the resin. The polyethylene

resin shall meet or exceed the contract specifications for the following properties, at a minimum, and be recorded on the Quality Control Certificates:

Density	ASTM D1505	0.92 g/cm^3 (max)
Melt Index	ASTM D1238 Condition E, 190 C, 2.16 Kg	$\leq$1 g/10 min.

B. The frequency of testing the resin batches shall be per manufacturer or supplier's quality control plan but shall not be less than one (1) test per lot.

C. Testing of the resin shall be conducted to demonstrate that the resin meets or exceeds the contract specifications. Any geomembrane manufactured from non-complying resin shall be rejected and shall not be delivered to the project.

D. At the Engineer's discretion, additional conformance sampling may be conducted. If the results of the Manufacturer and Engineer differ, the Engineer shall repeat the testing and the Manufacturer shall be allowed to monitor the testing. The latter of the tests will prevail, provided that the applicable test methods have been followed. The additional tests shall be at no cost to the Owner or Engineer if it is determined that the specifications have not been complied with.

E. The Manufacturer shall submit written documentation on the geomembrane raw materials and resin batches;

1. Resin supplier's name, plant location or identification, and production date(s) of resin.

2. Copies of Quality Control Certificates, issued on company letterhead and shall be signed by responsible parties, employed by the manufacturer, supplier, or independent laboratory (such as the production manager), with test results conducted by the manufacturer or resin production plant.

3. The manufacturer shall submit written documentation that no reclaimed or reworked polymer was added to the resin during the geomembrane manufacturing process to be used for this project.

4. The manufacturer shall submit written documentation correlating each individual geomembrane roll delivered to the project to the respective resin batches.

2.02 GEOMEMBRANE MANUFACTURING

A. The geomembrane for this project shall consist of a linear low-density polyethylene (LLDPE) sheet and shall meet the contract specification for the properties shown on Table 02776-A. In addition the geomembrane shall:

1. Contain no more than one (1) percent, by weight, additives, fillers, or extenders. (Note Carbon Black not included in this limitation)
2. Be free of striations, folds, crimps, abrasions, pinholes, or bubbles on the surface.
3. Be produced so as to be free of holes, blisters, undispersed raw materials, or any sign or contamination by foreign materials.
4. Be manufactured in a single layer, i.e. thinners layers shall not be welded together to produce the final required thickness.

B. Geomembrane Manufacturing Quality Control;

1. The carbon black shall be added to the pure polyethylene resin as part of the roll manufacturing process.

2. Rolls manufactured with inclusions, bubbles, or not complying with the specifications shall be rejected and not delivered to the project. Geomembrane thickness shall be monitored continuously during manufacturing. No geomembrane shall be accepted which fails to meet minimum specified thickness.

3. The geomembrane shall be tested at the frequency and for the parameters given in Table 02776-A. The Manufacturer shall perform this testing or the manufacturer's certified testing laboratory. Samples, which do not satisfy the contract specifications, shall be cause to reject applicable rolls. If a geomembrane sample fails to meet specifications, subsequent tests shall be performed at random on additional geomembrane samples produced from the same resin batch to determine whether all rolls produced from the same batch shall be regarded as unsatisfactory and therefore rejected. This additional testing, at the Manufacturers discretion and expense, may be performed to more closely identify the rolls, which do not comply with the specifications.

4. Samples shall be taken across the entire width of the rolls. The averaged test results of the geomembrane samples shall meet or exceed the specifications. Certifications of the test results obtained shall be provided to the Engineer and recorded on the Quality Control Certificates.

Table 02776-A - Material Properties for White-Surfaced Linear Low Density Polyethylene (LLDPE) Geomembrane PER GEOSYNTHETIC RESEARCH INSTITUTE (GRI) TEST METHOD GM17 (SEE NOTE 1)

Property	Test Method	Units	Value	Manufacturer Test Frequency	CQA Test Frequency
Thickness – Smooth Minimum Average Lowest Individual Reading	ASTM D 5199	 mil mil	 40 36	Per roll	100,000 ft.^{2}
Thickness – Textured Minimum Average Lowest Individual Reading	ASTM D 5994	 mil mil	 40 36	Per roll	100,000 ft.^{2}
Density (max)	ASTM D 1505	g/cm3	0.939	Per 200,000 lbs	500,000 ft.^{2}
Carbon Black Content Range	ASTM D 1603, modified	%	2 - 3	Per 45,000 lbs	500,000 ft.^{2}
Carbon Black Dispersion	ASTM D 5596	Note 2		Per 45,000 lbs	500,000 ft.^{2}
2% Modulus – (max)	ASTM D 5323	Lb/in	2400	Per formulation	
Tensile Properties (Each Direction)	ASTM D 6693 Type IV			Per 20,000 lbs	100,000 ft.^{2}
Smooth Strength at Break Elongation at Break	"	 lb/in %	 152 800	"	"
Textured Strength at Break Elongation at Break	"	 lb/in %	 60 250	"	"
Tear Resistance	ASTM D 1004	lb	22	Per 45,000 lbs	100,000 ft.^{2}
Smooth Puncture Resistance	ASTM D 4833	lb	56	Per 45,000 lbs	100,000 ft.^{2}
Textured Puncture Resistance	ASTM D 4833	lb	44	Per 45,000 lbs	100,000 ft.^{2}
Oxidative Induction Time	ASTM D 3895	Min.	100	Per 200,000 lbs	500,000 ft.^{2}
Textured - Asperity Height (min. Ave.)	GRI GM-12	Mil	10	Every 2nd roll Both sides	500,000 ft.^{2}
Interface Friction Angles (See Note 3)	ASTM D-5321 Saturated Conditions	Degrees Minimum For all	22	One test	One test
Hot Wedge Seams Shear Strength Peel Strength	ASTM D-6392 (See Note 4)	 lb/in lb/in	 60 50	N/A	Every 500 feet of seam
Extrusion Fillet Seam Shear Strength Peel Strength	ASTM D-6392 (See Note 4)	 lb/in lb/in	 60 44	N/A	Every 500 feet of seam

Note 1 40 mil Smooth LLDPE shall be per Table 1(a), and Textured LLDPE shall be per Table 2(a) of GRI Test Method GM17.

Note 2 Only near spherical agglomerates are considered. Nine of ten views shall be Category 1 or 2. No more than one view shall be Category 3.

Note 3 Interface friction angle test shall be conducted for the actual materials that will be used at the site. The test shall include the interface friction angle for the following interfaces: protective cover soil/double sided capping geocomposite/textured/bedding soil, and Soil/smooth geomembrane/soil with a reduction is friction angle to 17 degrees minimum.

Note 4 All seam strengths shall be those values as listed in GRI-GM19.

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5. The Manufacturer shall submit the Quality Control Certificates, on company letterhead, and shall be signed by responsible parties, employed by the manufacturer or independent laboratory (such as the production manager). The Quality Control Certificates shall include;

   a) Geomembrane Roll Number and resin batch identification

   b) Sampling Procedures

   c) Results of Quality Control tests, including description of test methods used.

6. The Manufacturer shall certified in writing, on company letterhead and signed by a responsible party (such as the production manager), that geomembrane manufactured from materials meeting or exceeding this projects specifications, has already passed the EPA Test Method 9100 using leachate that is representative of actual leachate generated by a municipal solid waste landfill.

2.03 ACCESSORY MATERIALS

A. Accessory materials used for seaming sheets, sealing around pipes and geomembrane penetrations and other installation-related applications shall be submitted to the Engineer for approval.

B. All geomembrane penetrations shall be sealed in such a manner, approved by the Engineer, as to provide a leak-proof seal around the penetrations.

PART 3 - TRANSPORTATION, HANDLING, STORAGE, EQUIPMENT

3.01 DESCRIPTION

A. The Contractor shall provide transportation, labor, and handling for delivery of the geomembrane to the project location. The Contractor shall provide special transportation or handling requirements required for the geomembrane.

B. The equipment for transportation, handling, loading, and unloading the geomembrane shall be of sufficient size and capacity to safely and efficiently handle to geomembrane materials. The type, size, and capacity shall be according to Manufacturer/Installer requirements.

C. The Contractor shall provide all equipment and labor necessary for the loading, unloading, and handling of the geomembrane. The Contractor and CQA Monitor shall inspect the delivered materials for damage. Repairs, if approved by the Engineer, to

damaged materials caused by transportation or handling of the geomembrane shall be at no additional cost to the Owner. Excessively damaged materials shall be rejected and replaced by the Contractor at no additional cost to the Owner.

D. The materials shall be unloaded by the Contractor in areas designated by the Owner. If the Owner has not specified a storage area, the Contractor shall determine an area for storage of the materials to meet the project schedule requirements. In any case the materials shall not be stored or unloaded in areas, which will impair the operations of the landfill facility or be deleterious to the materials. Roll suspect of damage shall be segregated from the undamaged rolls.

E. Storage and protection requirements of the materials. The Manufacturer/Installer shall specify storage requirements for the materials. Protection shall be provided from puncture, cutting, ultraviolet radiation, precipitation, dirt or other damaging or deleterious conditions.

F. The Contractor shall be responsible for all damages to the materials incurred prior to final acceptance of the line system.

PART 4 - GEOMEMBRANE MATERIAL ACCEPTABILITY

4.01 ON-SITE INSPECTION AND CONFORMANCE TESTING

A. Upon delivery to the project site, the Contractor, Installer and CQA Monitor shall inspect the geomembrane material and Engineer or Owner's Representative to confirm that proper labeling, transportation, handling, and storage procedures are followed. Damaged materials will be identified and repaired or rejected at the discretion of the Engineer or Owner's Representative. Materials to be repaired will be repaired following the repair specifications established for this project. Repairs will be at no additional cost to the Owner. Rejected materials will be identified and removed from the project site at no additional cost to the Owner.

B. Upon delivery to the project site, the CQA Monitor shall sample the geomembrane every 100,000 square feet of material to be installed. The on-site conformance sampling shall ensure compliance with the specifications established for this project. The CQA samples shall be sent to a geosynthetic testing laboratory and tested per the CQA testing frequencies given in Table 02776-A. This initial on-site conformance testing shall be at the Owner's expense.

C. Samples shall be taken across the entire width of the rolls. The averaged test results of the geomembrane samples shall meet or exceed the contract specifications.

D. Samples, which do not satisfy the contract specifications, shall be cause to reject applicable rolls. If a geomembrane sample fails to meet specifications, subsequent tests

shall be performed at random on additional geomembrane samples produced from the same resin batch to determine whether all rolls produced from the same batch shall be regarded as unsatisfactory and therefore rejected. This additional testing, at no additional cost to the Owner, may be performed to more closely identify the rolls, which do not comply with the specifications. Rejected rolls will not be installed and shall be removed from the project site at no additional cost to the Owner.

4.02 GEOMEMBRANE MATERIAL ACCEPTABILITY

A. Geomembrane materials shall be accepted, by the Engineer, for installation only upon receipt and approval of the following:

1. Information received and approved, by the Engineer, regarding resin quality control for delivered materials.

2. Information received and approved, by the Engineer, regarding geomembrane manufacturing quality control for delivered materials.

3. The results of the Construction Quality Assurance testing on samples taken by the CQA Monitor for geomembrane delivered materials, and indicating that all geomembrane meets the specifications.

4. Approved repair methods established for damaged materials.

PART 5 - GEOMEMBRANE INSTALLATION

5.01 EXECUTION

A. The Installer shall submit information, prior to installation, on the following;

1. All personnel performing supervisory and seaming operations shall be qualified by experience or certification. The Installer shall submit written information as follows:

a) Resumes of personnel performing the installation shall be submitted to the Engineer for approval. At least one seamer shall have experience seaming a minimum of 1,000,000 lineal feet of seam using the same type of seaming apparatus to be use on this project. The most experienced seamer shall provide direct supervision, as required, over the less experienced seamers. No field seaming shall take place without the Installer's site supervisor or foreman being present.

b) Resume(s) of supervisory personnel supervising the installation shall be submitted to the Engineer for approval. At least one supervisor shall have

installation experience of a minimum of three (3) million square feet of similar geomembrane and experience using the same type of seaming apparatus to be use on this project.

2. The Installer shall submit a Panel Layout and related installation details:

   a) The panel layout shall be drawn, using applicable drafting standards, to the same scale indicated on the Engineer's Drawings for easy comparison. The panel layout shall be on the installer's letterhead.

   b) The panel layout shall indicate panel configuration, numbering, and dimensions, geomembrane penetrations, access roads, and berms. The layout drawing(s) shall indicate individual panel dimensions, estimated waste quantities, and estimated installed square footage.

   c) The Installer shall submit drawings, using applicable drafting standards, detailing geomembrane details and cross sections showing seam overlaps for extrusion and fusion welds, geomembrane penetrations, booting details, geomembrane connection details and is sufficient in detail for construction.

3. Documentation shall be submitted, from the Installer, that the extrudate rods are from similar resin materials as the geomembrane resin specified for this project.

B. Geomembrane Deployment

1. Layout Drawings: The Installer shall have received a set of layout and detail drawing submittal approved by the Engineer. If the Installer changes the configuration of the geomembrane or details, as shown on the approved submittals, due to field conditions, the Installer shall request prior approval by the Engineer. The layout drawings, as modified and/or approved by the Engineer shall become part of these specifications.

2. Limits of Geosynthetic Deployment: The limits of geosynthetic deployment shall have the configuration as shown on the Drawings. The limits shall be surveyed and clearly identified, i.e. stacked, to the Installer. Any deviations from the limits defined in the Drawings shall be approved by the Engineer and recorded on the Record (As-Built) panel layout.

3. Panel Identification for Field deployment: Each panel shall be given an "identification code" (number or letter-number) consistent with the layout plan. The panel identification code shall be related, through a table or chart, to the original resin, and the constituent.

4. Field Panel Placement:

a) Location: Field panels shall be installed as approved or modified at the location and positions indicated in the layout drawings. Instructions on the wrapping containing the geomembrane materials shall be followed to assure that the rolls are unrolled and in the proper direction for seaming.

b) Installation Schedule: Field panels may be installed using any one of the following schedules:

1) All field panels shall be placed prior to field seaming

2) Field panels shall be placed one at a time and each field panel shall be seamed immediately after its placement (in order to minimize the number of unseamed field panels exposed to wind).

3) Any combination of the above.

c) Weather Conditions: Geomembrane placement shall not proceed at an ambient temperature below 40°F, unless otherwise authorized in writing by the Engineer. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of pond water, or in the presence of excessive winds.

d) Method of Placement: The Contractor shall ensure that:

1) No equipment used shall damage the geomembrane by handling, trafficking, leakage of hydrocarbons or other means;

2) No personnel working on the geomembrane shall smoke, wear damaging shoes, or engage in other activities, which could damage the geomembrane;

3) The method used to unroll the panels shall not cause scratches, wrinkles, or crimps in the geomembrane and shall not damage the supporting soil, or other elements of the liner system;

4) The prepared surface underlying the geomembrane must not be allowed to deteriorate after acceptance, and must remain acceptable up to the time of geomembrane placement;

5) Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, shall be placed to prevent uplift by wind (in case of high winds, continuous loading

is along edges of panels to minimize risk of wind flow under the panels);

6) Geomembrane panels shall be positioned in a slackened condition so that they will conform to subgrade irregularities without being stretched taut when covered with fill. Geomembrane panels shall be positioned such that wrinkles exceeding 12-inches do not occur at the overlaps where field seaming is to be completed; and

7) Direct contact with the geomembrane shall be minimized; i.e., geotextiles, extra geomembrane, or other suitable materials shall protect the geomembrane in excessively high pedestrian traffic areas.

8) Damage: the Contractor at no cost to the Owner shall replace or cap any field panel or portion thereof, which becomes torn such that there is a break or hole in the geomembrane; twisted such that the geomembrane will not lie flat on the bedding soil; or crimped such that the thickness of the geomembrane at the crimp is less than the specifications or the crimp will not allow the geomembrane to lie flat against the bedding soil. Damaged panels or portions of damaged panels, which have been rejected, shall be removed from the work area.

D. Field Seaming:

1. Seam Layout: In general, seams shall 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 field seams shall be minimized. No horizontal seams, (oriented parallel to the toe of slope) shall be permitted on sideslopes greater than 5(H): 1(V) unless approved by the Engineer. No seams shall be located in the areas of potential stress concentrations.

2. Requirements of Personnel: All personnel performing seaming operations shall be qualified as previously indicated.

3. Overlapping and Temporary Bonding:

a) The panels of geomembrane shall be overlapped by a minimum of three inches for extrusion welding, five inches for fusion welding, and five inches for double wedge fusion welding, but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam.

b) The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane or underlying components of the liner system; in particular, the temperature of the air at the nozzle of any spot welding apparatus shall be controlled such that the geomembrane is not damaged.

4. Seam Preparation:

a) Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.

b) If seam overlap grinding is required, the process shall be completed according to the geomembrane Installer's instructions within one hour of the seaming operation and in a way that does not damage the geomembrane.

c) Seams shall be aligned with the fewest possible number of wrinkles and no "fishmouths."

5. Seaming Equipment and Products: Approved processes for field seaming are extrusion welding and fusion welding (hot air excluded). Only apparatus, which have been specifically approved by make and model, shall be used. Proposed alternate processes shall be documented and submitted for approval prior to any seaming being performed. Seam welding equipment shall be equipped with adequate temperature gauges to assure that proper seaming temperatures are maintained. Temperature gauges will be monitored and readings recorded every four hours by the geomembrane Installer.

a) Extrusion Process: The Installer shall provide documentation, for approval to the Engineer, on the welding apparatus planned to be used at the site prior to any geomembrane seaming work. The Installer shall provide documentation regarding the extrudate to the Engineer and shall certify that the extrudate is compatible with the specifications, and in any event is comprised of the same resins as the geomembrane sheeting. The geomembrane Installer shall maintain at least one spare operable seaming apparatus on site. Equipment used for seaming shall not damage the geomembrane, and the geomembrane shall be especially protected from damage in areas of heavy pedestrian or other traffic. The extruder shall be purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel. Whenever the extruder is stopped, the barrel shall be purged of all heat degraded extrudate.

The electric generator shall be placed on a protective base such that no damage occurs to the geomembrane. Similarly, a protective insulation plate or fabric shall be placed beneath the hot welding apparatus after usage.

b) Fusion Process: The Installer shall provide documentation, or approval to the Engineer, on the welding apparatus planned to be used at the site prior to any geomembrane seaming work. The fusion-welding apparatus must be automated vehicular-mounted devices. The fusion-welding apparatus shall be equipped with gauges giving the applicable temperatures and pressures. The geomembrane Installer shall maintain at least one spare operable seaming apparatus on site. Equipment used for seaming shall not damage the geomembrane, and the geomembrane shall be protected from damage in heavily trafficked areas. For cross seams associated with fusion welding, the edge of the cross seams shall be ground to a smooth incline (top and bottom) prior to welding. The electric generator shall be placed on a protective base such that no damage occurs to the geomembrane. Similarly, a protective insulating plate or fabric shall be placed beneath the hot welding apparatus after usage. A movable protective layer may be used directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets. The double wedge fusion welding apparatus must be a self-propelled unit containing a high-temperature split wedge used to melt the plastic along the weld lines on the overlapped panels. The geomembrane panels are then squeezed together by pressure rollers so that the two sheets fuse together. The temperature, pressure, and welding speed are independently adjustable so that consistently high quality seams are produced. The split wedge system produces two fusion weld lines separated by an unwelded channel.

6. Weather Conditions for Seaming:

a) Unless authorized in writing by the Engineer, no seaming shall be attempted at ambient temperatures below 40°F or above 104°F. At ambient temperatures between 40°F and 50°F, seaming shall be allowed if the geomembrane is preheated by either sun or hot air device, and if there is no excessive cooling resulting from wind. At ambient temperatures above 50°F, no preheating shall be required. In all cases, the geomembrane shall be dry, clean and protected from wind damage.

b) If the geomembrane Installer wishes to use methods which may allow seaming at ambient temperatures below 40°F or above 104°F, he shall demonstrate by seaming and testing trial seams under actual field conditions and he shall certify in writing that the seam so produced under these conditions is equivalent to those produced under normally approved conditions, and that the overall geomembrane's physical and chemical properties will not fall below the material and seam specifications for this project. In addition, an addendum to the contract between the Owner and the Contractor is required which specifically states that the seaming procedure does not cause any physical or chemical modification to the geomembrane that will generate any short- or long-term damage to the geomembrane.

c) All seaming operations shall cease upon the presence of any precipitation (i.e. drizzle, sprinkle, etc.)

7. Trial Seams:

a) Trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period, and at least once each four hours, for each seaming apparatus used that day. Also, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least three feet long by one foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as previously indicated.

b) Two adjoining specimens, each one-inch wide, shall be cut from the trial seam sample by the geomembrane Installer. The specimens shall be tested respectively in shear and peel using a field tensiometer, and shall not fail the seam specifications established for this project. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial welds are achieved.

c) After completion of the above-described tests, the remaining portion of the trial seam sample can be discarded. Alternatively, the remaining portion of the trial seam can be subjected to destructive testing. If a trial seam sample fails a test, then a

destructive test seam sample shall be taken from the seams completed by the seamer during the shift related to the considered trial seam. These samples shall be forwarded to the Engineer and, if they fail the tests, the procedure indicated in Section 5.01 (D) 10. shall apply. The conditions of this paragraph shall be considered as met for a given seam if a destructive seam test sample has already been taken from the considered seam(s).

8. General Seaming Procedures: The general seaming procedure used by the geomembrane Installer shall be as follows:

a) For fusion welding, a movable protective layer of plastic may 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.

b) Seaming shall extend the entire length of the panels, including seams within the anchor trench.

c) 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.

d) If seaming operations are carried out at night, written approval, by the Engineer, shall be required 24 hours in advance of the intended night operation. Adequate illumination shall be provided. If during the course of the night operations, the Engineer or Owner's Representative decide the illumination is inadequate, proper illumination shall be provided or night operations shall be ceased. Contract specifications for placing and seaming the geomembrane shall apply to the night operations.

e) 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 inches beyond the cut in all directions.

f) The seam bond strength shall be greater than or equal to the sheet.

g) A width of one (1) foot along the edge, and between the surfaces to be welded, of the liner shall be cleaned to remove all extraneous materials (i.e. sand, silt, oily films, water, etc.) which could be

detrimental to the seaming process. The extraneous materials shall be wiped, brushed, or blown from the area to be welded.

8. Non-Destructive Seam Continuity Testing:

a) Concept: The geomembrane Installer shall non-destructively test all repairs and field seams over their full length using a vacuum test unit, air pressure (for double fusion seams only), or other approved method. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. The installer in accordance with Section 5.01 (D) 10 shall complete any required repairs. Test results shall be forwarded to the Engineer. The following procedures shall apply to locations where seams cannot be non-destructively tested:

1) All such seams shall be cap-stripped with the same geomembrane.

2) If the seam is accessible to testing equipment prior to final installation, the seam shall be nondestructively tested prior to final installation.

3) If the seam cannot be tested prior to final installation, the seaming and cap-stripping operations shall be observed by the Engineer for uniformity and completeness. The Contractor shall identify these problem areas prior to beginning installation of the liner system.

4) The Contractor shall identify these problem areas prior to beginning installation of the liner system.

b) Vacuum Testing:

1) The equipment shall be comprised of the following:

(a) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, and a soft neoprene gasket attached to the bottom, porthole or valve assembly, and a vacuum gauge.

(b) A steel or aluminum vacuum tank and pump assembly equipped with a pressure controller and pipe connections.

(c) A rubber pressure/vacuum hose with fittings and connections.

(d) A bucket, water, and wide paint brush or mop.

(e) A soapy solution.

2) The following procedures shall be followed:

(a) Energize the vacuum pump and reduce the tank pressure to approximately 10 inches of mercury, i.e., 5 psi gauge. All gauges shall read zero (0) psi when the vacuum pump is not turned on. Gauges not reading zero (0) psi shall be replaced.

(b) Wet a strip of geomembrane approximately 4 inches by 24 inches with the soapy solution.

(c) Place the box over the wetted area.

(d) Close the bleed valve and open the vacuum valve.

(e) Ensure that a leak tight seal is created.

(f) For a period of not less than 15 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles, which would indicate defects in the geomembrane.

(g) If no bubble appears after 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches overlap, and repeat the process.

(h) All areas where soap bubbles appear shall be marked and repaired in accordance with Section 5.01 (D) 10.

c) Air Pressure Testing (For Double Fusion Seam Only): The following procedures are applicable to those processes, which produce a double seam with an enclosed space.

1) The equipment shall be comprised of the following:

(a) An air pump (manual or motor driven) equipped with a pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane. All gauges shall read zero (0) psi when the air pump is not turned on. Gauges not reading zero (0) psi shall be replaced.

(b) A rubber hose with fittings and connections.

(c) A sharp hollow needle, or other approved pressure feed device.

2) The following procedures shall be followed:

(a) Seal both ends of the seam to be tested.

(b) Insert needle or other approved pressure feed device into the tunnel created by the fusion weld.

(c) Insert a protective cushion between the air pump and the geomembrane.

(d) Energize the air pump to a pressure between 25 and 30 psi, close valve, and sustain pressure for approximately 5 minutes.

(e) If loss of pressure exceeds 2 psi or does not stabilize, locate faulty area and repair in accordance with Section 5.01 (D) 10.

(f) After a seam has passed a pressure test, release pressure at the end of seam that is opposite the air pump and pressure gauge assembly so as to ensure that the seam is continuous and has been completely tested.

(g) Remove needle or other approved pressure feed device and repair in accordance with Section 5.01 (D) 10.

3) All field fabricated geomembrane penetration boots shall be non-destructively tested before the boot is installed. The boot and boot seams shall be non-destructively tested, in addition to visual inspection, using one of the following methods - hydraulically, air-

pressure, or smoke. The Installer shall submit procedures for non-destructively testing field fabricated geomembrane penetration boots, for the Engineer's approval, prior to any geomembrane installation.

9. Destructive Testing:

a) Concept: the Engineer shall perform Destructive seam tests at selected locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming. The seam strength shall be greater than or equal to the sheet.

b) Location and Frequency: Destructive test samples shall be collected at a minimum average frequency of one test location per 500 feet of seam length. The Engineer reserves the right to increase the testing frequency should test results or seam conditions warrant. Test locations shall be determined during seaming, and may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding. The Engineer shall choose the locations. The geomembrane Installer will not be informed in advance of the locations where the seam samples will be taken.

c) Sampling Procedure: Samples shall be cut by the geomembrane Installer at locations designated by the Engineer as the seaming progresses in order to obtain laboratory test results before the geomembrane is covered by another material. Each sample shall be numbered and the sample number and location identified on the Record (As-Built) panel layout drawing. A report completed by the installer's CQA personnel shall accompany each test strip listing the welder's number, date, time of day, welding machine's welding temperature, sheet temperature, sample location, and nominal thickness. All holes in the geomembrane resulting from the destructive seam sampling shall be immediately repaired in accordance with the repair procedures described in Section 5.01 (D) 12. The continuity of the new seams in the repaired area shall be tested according to Section 5.01 (D) 8.

d) Size of Samples: The samples shall be 12 inches wide by 44 inches long with the seam centered lengthwise. One 1-inch wide strip shall be cut from each end of the sample and the Installer shall test these in the field. The remaining sample shall be cut into three parts and distributed as follows:

1) One portion to the Contractor for laboratory testing, 12 inches x 12 inches; and

2) One portion for the Engineer for laboratory testing, 12 inches x 18 inches; and

3) One portion to the Engineer for archive storage, 12 inches x 12 inches.

e) Field Testing: The two 1-inch wide strips shall be tested, by the Installer, in the field, by hand or tensiometer, for peel and shear respectively and shall not fail to meet the specifications established for this project. If any field test sample fails to pass, then the procedures outlined in 5.01 (D) 10 shall be followed.

f) Laboratory Testing: Testing by the Engineer will include "Seam Strength" and "Peel Adhesion." The minimum acceptable values to be obtained in these tests are those indicated Table 02776-A Material Properties for Linear Low Density Polyethylene (LLDPE) Geomembrane. A total of five (5) specimens will be tested, from each sample, for each test method. Five (5) specimens must pass for each test in order for the seam to pass destructive test. The results will not be averaged. Specimens will be selected alternately by test from the samples (i.e., peel, shear, peel, and shear). The Engineer will provide test results to the Contractor no more than 24 hours after the samples are received at the laboratory. The only exception shall be weekends or official holidays. On weekends and holidays the laboratories are closed. Arrangements to schedule testing of destructive samples on weekends and holidays shall be approved by the Engineer 24 hours in advance. Additional costs for lab work on holidays or weekends shall be at no additional expense to the Owner.

g) Procedures for Destructive Test Failure: The following procedures shall apply whenever a sample fails the destructive test, whether the test is conducted by the Engineer's specified laboratory, the geomembrane Installer's laboratory, or by field tensiometer. The geomembrane Installer shall have two options, the cost of which shall be at no additional expense to the Owner:

1) The geomembrane Installer can reconstruct the seam between any two passed test locations.

2) The geomembrane Installer can trace the welding path to an intermediate location (at 10 feet) minimum from the location of the failed test in each direction) and take a specimen for an additional field test at each location. If these additional specimens pass the tests, then full laboratory destructive samples shall be taken. These additional tests shall be at the expense of the Contractor. If these laboratory samples pass the tests, then the seam shall be reconstructed between these locations. If either sample fails, then the process shall be repeated to establish the zone in which the seam should be reconstructed. In any case, all acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 130 feet of reconstructed seam, a sample taken from within the reconstructed zone must pass destructive testing. Whenever a sample fails, additional testing may be required for seams that were welded by the same welder and/or welding apparatus or welded during the same time shift. Such additional testing shall be at the Contractor's expense.

10. Defects and Repairs:

a) Identification: All seams and non-seam areas of the geomembrane will be examined for identification 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 examination. The geomembrane surface shall be broomed or washed by the Contractor if the amount of dust or mud inhibits examination. The Contractor shall ensure that this examination of the geomembrane precedes any seaming of that section.

b) Evaluation: Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Section 5.01 (D) 8, as appropriate. Each location, which fails the nondestructive testing, shall be marked by the CQA monitor and repaired by the geomembrane Installer. Work shall not proceed with any materials which will cover locations which have been repaired until laboratory test results with passing values are available, non-destructive testing passed and the repair has been documented by the Engineer or Owner's Representative.

c) Repair Procedures:

1) Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the geomembrane Installer. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Engineer and the Installer. The procedures available include:

(a) Patching: used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.

(b) Grinding and rewelding: used to repair small sections of extruded seams.

(c) Spot welding or seaming: used to repair small tears, pinholes, or other minor, localized flaws.

(d) Capping: used to repair portions of failed seams, less than five (5) feet in length. An extruded weld or fusion weld shall be permitted.

(e) Topping: used to repair inadequate seams areas, which have an exposed edge, for lengths of seams less than five (5) feet in length. An extruded weld will be permitted along the outside edge.

(f) Removing the bad seam and replacing with a strip of new material welded into place. Used with large lengths of fusion seams (greater than five (5) feet in length). The strip shall be additional geomembrane material which is fusion welded over the failed seam. The cap strip shall be air-tested and vacuum tested.

2) In addition, the following provisions shall be satisfied:

(a) Surfaces of the geomembrane, which are to be repaired, shall be abraded no more than one hour prior to the repair.

(b) All surfaces must be clean and dry at the time of repair.

(c) All seaming equipment used in repairing procedures must be approved.

(d) The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the Engineer and Installer.

(e) Patches or caps shall extend at least six inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least three inches.

(f) The geomembrane below large caps should be appropriately cut to avoid water or gas collection between the two sheets.

d) Verification of Repairs: Each repair shall be identified, tested, and logged. Each repair shall be nondestructively tested using the methods described in Section 5.01 (D) 8, as appropriate. Repairs, which pass the nondestructive 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 Engineer. Failed tests indicate that the repair shall be redone and retested until a passing test results. The Contractor shall not cover any portion of the geomembrane until the Installer and Engineer have completed the documentation of the repair.

e) Wrinkles: When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the Engineer shall identify all areas of the geomembrane with wrinkles greater than 12-inches. The geomembrane Installer shall cut and reseam all wrinkles so identified. The seam, thus produced, shall be tested like any other seam.

f) Bridging or Induced Tension: Bridging is defined as areas where the geomembrane is not in contact with the subgrade due to a void in the subgrade or the sheet is pulled in tension so as to span over depressions in the subgrade. Areas likely to promote bridging, i.e. trenches, toe of slopes, etc., and shall be loaded with sandbags after deployment and after seaming. Induced tension is stress introduced into the geomembrane during installation or covering. These areas will likely result in bridging. Areas bridging

excessively shall be identified and repaired by either of the following methods:

1) The geomembrane shall be cut, by the Installer, so the tension is relieved and the geomembrane conforms to the subgrade contours. The cut geomembrane shall be repaired and tested according to the specifications regarding repairs and testing.

2) The geomembrane shall be cut, by the Installer, and subgrade material shall be added and placed, in accordance with the contract specifications, so as bring the geomembrane in contact with the subgrade. The cut geomembrane shall be repaired and tested according to the specifications regarding repairs and testing.

g) Repairs, test sample locations, and defects in the geomembrane shall be replaced at no additional cost to the Owner until final acceptance of the geomembrane lining system. Repairs shall only be made by qualified members of the Installer's organization or authorized personnel.

h) Wrinkles, gas bubbles, bridging, and inducing tension in the geomembrane system shall be avoided by the Contractor or subcontractors. Areas in the geomembrane which exhibit wrinkles, gas bubbles, bridging, and tension shall be repaired and documented before any cover material or other geosynthetic materials are placed over these areas. These repairs will be at no additional cost to the Owner.

PART 6 - MATERIALS IN CONTACT WITH THE GEOMEMBRANE

6.01 GENERAL

A. General: The following provisions require the Contractor to take all necessary precautions so that the installation of materials does not damage the geomembrane. Installation on rough surfaces, such as concrete, shall be carefully performed to minimize damage. If approved, the Contractor as protection for the geomembrane may use additional loosely placed geotextile or geomembrane sections.

B. Protective Soil Cover: Placement of protective soil cover (See Specification Section 02220) on the geomembrane shall not proceed at an ambient temperature below 40°F (5°C) or above 104°F (40 degrees C), unless otherwise approved by the Engineer. Equipment used for placing granular material shall not be driven directly on the exposed

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geomembrane. A minimum thickness of 1 foot of granular material is specified between a light dozer (such as a wide pad caterpillar D-4 or lighter) and the geomembrane. The dozer movement shall be forward and backward, no turning will be allowed until a minimum of 2 feet of cover is placed above the geomembrane. All turning of equipment will be off the area underlain by geomembrane. A minimum thickness of 3 feet of granular material is specified between rubber-tired vehicles and the geomembrane. In areas of heavy traffic such as access ramps, granular material thickness should be at least 3 feet. In any case, the following table shall be complied with:

Equipment Ground Pressure	Minimum Lift Thickness
psi	inches
≤4	12
4-8	18
8-16	24
≥16	36

C. Concrete: Geotextile or excess geomembrane layers shall be used between concrete and the geomembrane as required. Construction methods used shall not damage the geomembrane.

D. Contact with other Geosynthetics: When placing any geosynthetic materials on top of installed geomembranes, the Contractor shall not use any equipment or apply any pressure directly on the installed geomembrane that may damage the materials.

PART 7 - FINAL ACCEPTANCE

7.01 GEOMEMBRANE ACCEPTANCE

A. The Contractor shall retain all ownership and responsibility for the geomembrane in the lining system until acceptance by the Owner. Full compensation for the geomembrane installation shall not occur until the Owner accepts the lining system. The Owner will accept the liner system when:

1. The entire geomembrane liner system installation is completed.

2. All documentation of installation is completed.

3. Verification of the adequacy of all field seams and repairs, including associated testing, is complete.

4. Written certification documents have been received and approved by the Engineer. Certifications documents include:

   a) Final approval of all required submittals by the Engineer.

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Equipment Ground Pressure	Minimum Lift Thickness
psi	inches
≤4	12
4-8	18
8-16	24
≥16	36

C. Pipe Penetrations Seals: Pipe penetrations shall be sealed using a boot as shown on the drawings. A pipe sleeve shall be placed around the vertical landfill gas wells to allow for settlement without straining the boot. The boot may be prefabricated or fabricated in the field from the same geomembrane as used for the cap. The boot shall be attached to the geomembrane cap with an extrusion weld. The boot shall be secured to the pipe or pipe sleeve using two ¾" wide stainless steel bands. A 0.25" x 1.5" neoprene gasket shall be placed between the geomembrane and the pipe or pipe sleeve as shown on the drawings. The end of the boot shall be sealed to the pipe or pipe sleeve using silicone or an extrusion weld as shown on the drawings. Where a pipe sleeve is used, the void between the pipe and pipe sleeve shall be filled with bentonite.

D. Contact with other Geosynthetics: When placing any geosynthetic materials on top of installed geomembranes, the Contractor shall not use any equipment or apply any pressure directly on the installed geomembrane that may damage the materials.

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b) Record (As-Built) Drawings.

5. Upon completion of the covering operation, the Contractor shall certify the following to the Owner:

a) The geomembrane has been constructed in accordance with the approved project plans and specifications.

b) The cover material meets all requirements of the approved project plans and specifications. The geomembrane has not been damaged during the covering operation or construction.

c) Receipt of the final geomembrane warranties.

7.02 RECORD (AS-BUILT) DRAWINGS

A. The Contractor shall submit a Record Panel Layout and related installation details of the actual geomembrane lining system:

1. The record panel layout shall be drawn, using applicable drafting standards, to the same scale indicated on the Engineer's Drawings for easy comparison. The record panel layout shall be on the installer's letterhead.

2. The record panel layout shall indicate installed field panel and seam numbering, configuration and dimensions, geomembrane penetrations, access roads, and berms. The record panel layout drawing(s) shall indicate individual panel dimensions and estimated installed square footage.

3. The locations of destructive samples with the correct corresponding sample number shall be located on the record panel layout.

4. The record panel layout shall have surveyed locations of the limits of geomembrane deployment.

5. The Installer shall submit detail drawings, using applicable drafting standards, of record (as-built) geomembrane penetrations details, booting details, and connection details, etc.

B. The Contractor shall submit a Record Survey of spot elevations (grade shots) of the geomembrane elevations of the installed lining system:

1. The record panel layout shall be drawn, using applicable drafting standards, to the same scale indicated on the Engineer's Drawings for easy comparison.

2. The surveyor shall sign and seal the spot elevation survey.

3. The spot elevations (grade shots) shall be taken at every 100-foot grid increment marker. The drawing shall indicate the design elevation prior to installation and the installed elevation at each survey point.

4. The spot elevations (grade shots) shall also be taken at every 100-foot increment within the bottom of the leachate collection trenches. The drawing shall indicate the design elevation prior to installation and the installed elevation at each survey point.

END OF SECTION

SECTION 15051

HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 07 2006
SOUTHWEST DISTRICT TAMPA

PART 1 GENERAL

1.01 SCOPE OF APPLICATION

A. Supply and installation of High Density Polyethylene (HDPE) pipe and fittings in nominal pipe sizes of 6-inch through 36 inches for the landfill gas collection system header and lateral pipes, landfill gas extraction wells and storm water pipes. All pipes are smooth wall exterior and interior. All pipes are solid wall pipe except for that portion of the landfill gas extraction well pipe that must be perforated as indicated on the drawings.

1.02 REFERENCES

A. ASTM D-1248: Specification for Polyethylene Plastics Molding and Extrusion Materials.

B. ASTM D-2513: Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.

C. ASTM D-3261: Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

D. ASTM D-3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

1.03 SUBMITTALS

A. Pipe Certifications.

1.04 MANUFACTURER'S QUALITY ASSURANCE

A. The pipe and fittings manufacturer shall have an established quality assurance program responsible for inspecting incoming and outgoing materials. At a minimum, incoming polyethylene materials shall be inspected for density per ASTM D-1505, melt flow rate per ASTM D-1238, and contamination. The supplier shall certify all incoming polyethylene materials. Quality Assurance shall verify certification. Incoming materials shall be approved by Quality Assurance before processing into finished goods.

B. The pipe and fittings manufacturer shall have an established quality assurance program responsible for assuring the long-term performance of materials and products. Representative samples of polyethylene materials shall be tested against the physical property requirements of this specification. Each extrusion line and molding machine shall be qualified to produce pressure-rated products by taking representative production samples and performing sustained pressure tests in accordance with ASTM D-1598.

C. Quality assurance test for representative pipe and fitting samples shall include:

Test	Standard	Pipe	Fittings
Ring ESCR	ASTM F-1248	Yes	Not Applicable
Sustained pressure at 176°F/725 psi hoop stress	ASTM D-1598	Yes (f_0>100 h)	Yes (f_0>100 h)
Sustained pressure at 73°F/1600 psi hoop stress	ASTM D-1598	Yes (f_0>1000 h)	Yes (f_0>1000 h)

D. All outgoing materials shall be inspected for diameter, wall thickness, length, straightness, out-of-roundness, concentricity, toe-in, inside and outside surface finish, markings, and end cut. Quality Control shall perform tests of density, melt flow rate, carbon content, and carbon dispersion. In addition, samples of the pipe provided shall be tested for hoop tensile strength and ductility by either quick burst per ASTM D-1599 or ring tensile per ASTM D-2290. Molded fittings shall be subject to x-ray inspection for voids, and tests for knot-line strength. All fabricated fittings shall be inspected for fusion quality and alignment.

E. The pipe and fitting manufacturer shall maintain permanent QC and QA records.

1.05 PACKAGING DELIVERY AND HANDLING

A. The pipe and fitting manufacturer shall package products for shipment in a manner suitable for safe transport by commercial carrier. When delivered, a receiving inspection shall be performed, and any shipping damage reported to the pipe and fittings manufacturer. Pipe and fittings shall be handled, installed, and tested in accordance with manufacturer's recommendations, and the requirements of this specification.

PART 2 PRODUCTS

2.01 PHYSICAL PROPERTIES

A. Materials used for the manufacture of polyethylene pipe and fittings shall meet the following physical property requirements:

Property	Unit	Test Procedure	Value
Material Designation	-	PPI/ASTM	-
PPI Material Listing	-	PPI TR-4	PE 3408
Material Classification	-	ASTM D-1248	III C 5 P34
Cell Classification	-	ASTM D-3350	345434C or 355434C
Density	g/cm^3	ASTM D-1505	>0.941
Melt Index [E]	g/10 min	ASTM D-1238	<0.15
Flexural Modulus	psi	ASTM D-790	>110,000 and <160,000
Tensile Strength	psi	ASTM D-638	3000 to 3500
ESCR [C]	hours	ASTM D-1693	f_0>5000
HDB	psi	ASTM D-2837	1600 23°C
UV Stabilizer [C]	% Carbon Black	ASTM D-1603	2 to 3
Elastic Modulus	psi	ASTM D-638	110,000
Brittleness Temperature	°F	ASTM D-746	<-180
Vicat Softening Temperature	°F	ASTM D-1525	255
Thermal Expansion	in/in/°F	ASTM D-696	8 x 10E-5
Hardness	Shore D	ASTM D-2240	64
Molecular Weight Category	-	-	Extra High

B. There shall be no evidence of splitting, cracking or breaking when the pipe is tested in accordance with Section 2.03F.

C. Ring Stiffness Constant (RSC) values for the pipe can be directly related to the pipe's class designation. (Nominal RSC of Class 40 pipe = 40, etc.). The minimum RSC is 90% of the nominal.

D. The pipe and fittings shall be homogenous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties.

E. Clean rework or recycled material generated by the manufacturer's own production may be used so long as the pipe or fittings produced meet all the requirements of this specification.

2.02 PIPE AND FITTINGS:

A. Dimensions:

1. Pipe Dimensions: The nominal inside diameter of the pipe shall be true to the specified pipe size in accordance with ASTM D-2513. Standard laying lengths shall be 40 feet ±2". The pipe SDR shall be as indicated on the drawings.

2. Fitting Dimensions: Fittings such as coupling, wyes, tees, adaptors, etc., for use in laying pipe shall have standard dimensions that conform to ASTM D-3261.

B. Where possible, pipe and fittings should be produced by the same manufacturer from identical materials meeting the requirements of this specification. Special or custom fittings may be exempted from this requirement.

C. Pipe and fittings shall be pressure rated to meet the service pressure requirements specified by the Engineer. Whether molded or fabricated, fittings shall be fully pressure rated to at least the same service pressure rating as the pipe to which joining is intended.

D. Molded fittings shall meet the requirements of ASTM D-3261 and this specification. At the point of fusion, the outside diameter and minimum wall thickness of fitting butt fusion outlets shall meet the diameter and wall thickness specifications of the mating system pipe. Fitting markings shall include a production code from which the location and date of manufacture can be determined. Upon request, the manufacturer shall provide an explanation of his production code.

E. Marking:

1. Each standard and random length of pipe and fitting in compliance with this standard shall be clearly marked with the following information:

a) ASTM Standard Designation
b) Pipe Size
c) Class and Profile Number
d) Production Code
e) Standard Dimension Ratio

2.03 SOURCE QUALITY CONTROL

A. The pipe and fitting manufacturer shall certify that samples of his production pipe have undergone stress regression testing, evaluation, and validation in accordance with ASTM D-2837 and PPI TR-3. Under these procedures, the minimum hydrostatic design basis shall be certified by the pipe and fitting manufacturer to be 1600 psi at 73.4°F and 800 psi at 140°F.

B. Material shall be listed in the name of the pipe and fitting manufacturer by the Plastics Pipe Institute (PPI) in PPI TR-4 with the following Standard Grade ratings:

		73.4°F	140°F
1.	Hydrostatic Design Basis	(HDB) 1600 psi	800 psi
2.	Hydrostatic Design Stress	(HDS) 800 psi	400 psi

C. PPI material listing in the name of the resin supplier is not acceptable in meeting this requirement.

D. Inspection Requirements:

1. Notification: If inspection is specified by the purchaser, the manufacturer shall notify the purchaser in advance of the date, time and place of testing of the pipe in order that the purchaser may be represented at the test.

2. Access: The Owner's representative shall have free access to the inspection area of the manufacturer's plant. The manufacturer shall make available to the Owner's representative, without charge, all reasonable facilities for determining whether the pipe meets the requirements of this specification.

3. Certification: As the basis of the acceptance of the material, the manufacturer will furnish a certificate of conformance of these specifications upon request. When prior agreement is being made in writing between the purchaser and the manufacturer, the manufacturer will furnish other conformance certification in the form of affidavit of conformance, test results, or copies of test reports.

E. Test Methods

1. Flattening: Three specimens of pipe, a minimum of 12 inches long, shall be flattened between parallel plates in a suitable press until the distance between the plates is 40 percent of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is

completed within 2 to 5 minutes. Remove the load, and examine the specimens for splitting cracking or breaking.

2. Pipe Ring Stiffness Constant: The pipe ring stiffness constant shall be determined utilizing procedures similar to those outlined in ASTM D-2412. The stiffness of HDPE pipe is defined in terms of the load, applied between parallel plates, which causes 1% reduction of pipe diameter. Test specimens shall be a minimum of two-pipe diameter or 4 feet in length, whichever is less.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to Specifications or following:

1. Fractures or cracks passing through pipe wall, except single crack not exceeding 2 inches in length at either end of pipe which could be cut off and discarded. Pipes within one shipment shall be rejected if defects exist in more than 5% of shipment or delivery.
2. Cracks sufficient to impair strength, durability or serviceability of pipe.
3. Defects indicating improper proportioning, mixing, and molding.
4. Damaged ends, where such damage prevents making satisfactory joint.

B. Acceptance of fittings, stubs or other specifically fabricated pipe sections shall be based on visual inspection at job site and documentation of conformance to these Specifications.

C. Notify surveyor prior to backfilling trench to allow surveyor to obtain as-built top of pipe coordinates and elevations.

3.02 INSTALLATION

A. Trench, backfill, and compact in accordance with Section 02221.

B. Heat Fusion of Pipe:

1. Weld in accordance with manufacturer's recommendation for butt fusion methods. Provide fusion operators certified by the pipe manufacturer.
2. Butt fusion equipment for joining procedures shall be capable of meeting conditions recommended by pipe manufacturer including, but not limited to, temperature requirements, alignment, and fusion pressures.
3. For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with manufacturer's recommendations.

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A. Pipe may be rejected for failure to conform to Specifications or following:

1. Fractures or cracks passing through pipe wall, except single crack not exceeding 2 inches in length at either end of pipe which could be cut off and discarded. Pipes within one shipment shall be rejected if defects exist in more than 5% of shipment or delivery.
2. Cracks sufficient to impair strength, durability or serviceability of pipe.
3. Defects indicating improper proportioning, mixing, and molding.
4. Damaged ends, where such damage prevents making satisfactory joint.

B. Acceptance of fittings, stubs or other specifically fabricated pipe sections shall be based on visual inspection at job site and documentation of conformance to these Specifications.

C. Notify surveyor prior to backfilling trench to allow surveyor to obtain as-built top of pipe coordinates and elevations at 100-foot intervals along the pipe and at changes in slope.

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A. Trench, backfill, and compact in accordance with Section 02221.

B. Heat Fusion of Pipe:

1. Weld in accordance with manufacturer's recommendation for butt fusion methods. Provide fusion operators certified by the pipe manufacturer.
2. Butt fusion equipment for joining procedures shall be capable of meeting conditions recommended by pipe manufacturer including, but not limited to, temperature requirements, alignment, and fusion pressures.

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4. Do not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade.
5. Do not subject pipe to strains that will overstress or buckle piping or impose excessive stress on joints.
6. Branch saddle fusions shall be joined in accordance with manufacturer's recommendations and procedures. Branch saddle fusion equipment shall be of size to facilitate saddle fusion within trench.
7. Before butt fusing pipe, inspect each length for presence of dirt, sand, mud, shavings, and other debris or animals. Remove debris from pipe.
8. Cover at end of each working day open ends of fused pipe. Cap to prevent entry by animals or debris.
9. Use compatible fusion techniques when polyethylenes of different melt indexes are fused together. Refer to manufacturer's specifications for compatible fusion.

C. Flange Jointing:

1. Use on flanged pipe connection sections.
2. Connect slip-on carbon steel backup flanges with stainless steel nuts and bolts.
3. Butt fuse fabricated flange adapters to pipe.
4. Observe following precautions in connection of flange joints.
   a) Align flanges or flange/valve connections to provide tight seal. Require nitrile-butadiene gaskets if needed to achieve seal. Gaskets are required for flange/valve connections.
   b) Place U.S. Standard round washers as may be required on some flanges in accordance with manufacturer's recommendations. Bolts shall be lubricated in accordance with manufacturer's recommendations.
   c) Tighten flange bolts in sequence and accordance with manufacturer's recommendations. CAUTION: Do not over-torque bolts.
5. Pull bolt down by degrees to uniform torque in accordance with manufacturer's recommendation.
6. Protect below grade bolts and flanges by covering with a 5 mil polyethylene wrap. Duct tape wrap to HDPE pipe.
7. Electrofusion couplers, where used, shall be installed per the manufacturer's specifications.

D. Pipe Placement:

1. Grade control equipment shall be of type to accurately maintain design grades and slopes during installation of pipe.
2. Remove standing water in trench before pipe installation.

3. Unless otherwise specifically stated, install pipe in accordance with manufacturer's recommendations.
4. Maximum lengths of fused pipe to be handled as one section shall be placed according to manufacturer's recommendations as to pipe size, pipe SDR, and topography so as not to cause excessive gouging or surface abrasion; but not to exceed 400 ft.
5. Cap pipe sections longer than single joining (usually 40 ft.) on both ends during placement except during fusing operations.
6. Notify ENGINEER prior to installing pipe into trench and allow time for Engineer's inspection to correct irregularities found during inspection.
7. Complete tie-ins or backfilling activity.
8. Allow pipe sufficient time to adjust to trench temperature prior to testing, segment tie-ins or backfilling activity.
9. Install reducers adjacent to laterals and tees.
10. To reduce branch saddle stress, install saddles at slope equal to, and continuous with, lateral piping.
11. Place in trench by allowing minimum 12-in./100 ft. for thermal contraction and expansion.
12. Coordinate construction of pipes near access roads with OWNER to limit impediment of landfill operations or operations of other Contractors.

3.03 PIPE TESTING

A. Air Test all pipe sections of the landfill gas collection system (Storm water pipes and landfill gas extraction well pipe do not have to be pressure tested.) and fittings after placement in trench, in accordance with manufacturer's recommendations. Follow the piping manufacturer's recommendations for testing. Pipe should be tested in section not to exceed 2,000 feet. At a minimum, test pipe sections for one hour at 10 psig. Pressure drop over one hour shall not exceed one percent after correcting pressure drop for temperature. Wells and other system openings should be blocked off for testing. Pressure test below ground systems only. Special precautions are required for this type of testing. Alternatively, a vacuum test can be conducted. Submit vacuum test procedure to Engineer for approval.

3.04 PIPE CLEANING

A. All pipes shall be flushed with water, or cleaned by other means approved by the Engineer so as to remove all pipe cuttings and other debris from the pipe.

END OF SECTION

Q. CLOSURE PROCEDURES (62-701.610,FAC)

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

R. LONG TERM CARE REQUIREMENTS (62-701.620,FAC)

X	R 1			1.	Maintaining the gas collection and monitoring system; (62-701.620(5), FAC)
X	R 2			2.	Right of property access requirements; (62-701.620(6),FAC)
X	R 3			3.	Successors of interest requirements; (62-701.620(7),FAC)
X	R 4			4.	Requirements for replacement of monitoring devices; (62-701.620(9),FAC)
X	R 5			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)

	S 1		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).
	S 2		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).
	S 3		X*	3.	Describe funding mechanisms for providing proof of financial assurance and include appropriate financial assurance forms; (62-701.630(5),(6),&(9), FAC).

* No Change means no change from "Application and Engineering Report for Renewal of Landfill Operation Permit for Lena Road Landfill", (3-hole punched bound documents) dated April 30, 2004 (received by FDEP on May 14, 2004), as revised, replaced or amended (information inserted into original) dated September 9, 2004, October 6, 2004, December 14, 2004, February 7, 2005 and March 17, 2005.

Part Q Closure Procedures (62-701.610, FAC)

1. Survey monuments - The final elevation of this landfill is more than 20 feet above the natural land surface, so no survey monuments are required. This is submitted as "N/A".
2. Final survey report – A final survey will be submitted per 62-701.610(3), FAC.
3. Certification of closure construction completion – Upon completion of the closure, a certification of closure construction completion will be submitted per 62-701.610(4), FAC.
4. Declaration to the public – After the Department approves the closure, the landfill owner shall file a declaration to the public in the deed records in the office of the county clerk of the county in which the landfill is located per 62-701.610(5), FAC.
5. Official date of closing – The official date of closing shall be determined per 62-701.610(6). Upon receipt of the documents required in 62-701.610, FAC subsections (3), (4) and (5) the Department shall within 30 days acknowledge by letter to the facility operator that notice of termination of operations and closing of the facility has been received. The date of this letter will be the official date of closing.
6. Use of closed landfill area – This landfill is not closed. The facility owner at this time has no plans to use the closed landfill area. After closure, if the facility owner decides to use the closed landfill area, the facility owner shall seek consultation with the Department per 62-701.610(7), FAC.
7. Relocation of wastes – This section applies to closed landfills. The facility owner does not plan to relocate waste after the landfill is closed. This section is not applicable for this application. If after closure the facility operator decides to relocate waste, the facility operator will relocate waste per 62-701.610(8), FAC.

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Q. CLOSURE PROCEDURES (62-701.610,FAC)

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

R. LONG TERM CARE REQUIREMENTS (62-701.620,FAC)

X	R 1			1.	Maintaining the gas collection and monitoring system; (62-701.620(5), FAC)
X	R 2			2.	Right of property access requirements; (62-701.620(6),FAC)
X	R 3			3.	Successors of interest requirements; (62-701.620(7),FAC)
X	R 4			4.	Requirements for replacement of monitoring devices; (62-701.620(9),FAC)
X	R 5			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)

	S 1		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).
	S 2		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).
	S 3		X*	3.	Describe funding mechanisms for providing proof of financial assurance and include appropriate financial assurance forms; (62-701.630(5),(6),&(9), FAC).

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LTC Plan

Part R. Long Term Care Requirement (62-701.620, FAC)

1. Maintaining the gas collection and monitoring system – After closure the facility operator shall maintain the gas collection and monitoring system for the long-term care period of the landfill per 62-701.620 (5).
2. Right-of Access – The landfill owner or operator shall possess or acquire a sufficient interest in, or a right to use, the property for which a permit is issued, including the access route onto the property to carry out the requirements of this rule. The permittee shall retain the right of entry to the landfill property for the long-term care period, after termination of solid waste operations, for inspection, monitoring and maintenance of the site.
3. Successors in interest - Any person acquiring rights or ownership, possession or operation of a permitted landfill through lease or transfer of property shall be subject to all requirements of the permit for the facility and shall provide any required proof of financial responsibility to the Department in accordance with this rule. Any lease or transfer of property shall include specific conditions to delineate:
   a. The previous owner or operator is responsible for closure and shall maintain any required proof of financial responsibility until the person acquiring ownership, possession or operation of the landfill establishes the required proof of financial responsibility with the Department;
   b. Responsibility for the continuance of monitoring, maintenance, and correction of deficiencies or problems;
   c. Mineral rights attached to the property and the rights to any recoverable materials that may be buried on the property or landfill gases that may be produced. A Department permit shall be required if any on-site operations subsequent to closing of a landfill involve disturbing the landfill, and;
   d. Transfer of permit - Transfer of a landfill permit shall be in accordance with the provisions of Rule 62-4.120, F.A.C., and this rule.
4. Replacement of monitoring devices - If a monitoring well or other device required by the monitoring plan is destroyed or fails to operate for any reason, the landfill owner or operator shall, immediately upon discovery, notify the Department in writing. All inoperative monitoring devices shall be replaced with functioning devices within 60 days of the discovery of the malfunctioning unit unless the landfill owner or operator is notified otherwise in writing by the Department.
5. Following completion of the long-term care period for each solid waste management unit, the owner or operator shall notify the Department that a certification, signed and sealed by a professional engineer, verifying that long-term care has been completed in accordance with the closure plan, has been placed in the operating record.

Q. CLOSURE PROCEDURES (62-701.610,FAC)

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

R. LONG TERM CARE REQUIREMENTS (62-701.620,FAC)

X	R 1			1.	Maintaining the gas collection and monitoring system; (62-701.620(5), FAC)
X	R 2			2.	Right of property access requirements; (62-701.620(6),FAC)
X	R 3			3.	Successors of interest requirements; (62-701.620(7),FAC)
X	R 4			4.	Requirements for replacement of monitoring devices; (62-701.620(9),FAC)
X	R 5			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)

	S 1		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).
	S 2		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).
	S 3		X*	3.	Describe funding mechanisms for providing proof of financial assurance and include appropriate financial assurance forms; (62-701.630(5),(6),&(9), FAC).

* No Change means no change from "Application and Engineering Report for Renewal of Landfill Operation Permit for Lena Road Landfill", (3-hole punched bound documents) dated April 30, 2004 (received by FDEP on May 14, 2004), as revised, replaced or amended (information inserted into original) dated September 9, 2004, October 6, 2004, December 14, 2004, February 7, 2005 and March 17, 2005.

T. CERTIFICATION BY APPLICANT AND ENGINEER OR PUBLIC OFFICER

1. Applicant:

The undersigned applicant or authorized representative of Manatee County Government

Utility Operations Department is aware that statements made in this form and attached information are an application for a renewal of Landfill Closure 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.

Signature of Applicant or Agent

Daniel T. Gray
Utility Operations Director
Name and Title (please type)

dan.gray@co.manatee.fl.us
E-Mail address (if available)

4410 66th Street West
Mailing Address

Bradenton, FL 34210
City, State, Zip Code

(941) 792-8811
Telephone Number

Date: May 24, 2005

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.

Signature

Joseph L. Miller P.E. Project Manager
Name and Title (please type)

39177
Florida Registration Number
(please affix seal)

482 South Keller Road
Mailing Address

Orlando, Florida 32810-6101
City, State, Zip Code

jlmiller@pbsj.com
E-Mail address (if available)

(407) 647-7275, Ext. 4153
Telephone Number

Date: May 24, 2005

APPENDIX
A

Department of Environmental Protection

Jeb Bush
Governor

Southwest District
3804 Coconut Palm Drive
Tampa, Florida 33619

David B. Struhs
Secretary

NOTICE OF PERMIT

January 11, 2002

Manatee County
c/o Mr. Daniel Gray
Utilities Operations Director
4410 - 66th Street West
Bradenton, FL 34210

Dear Mr. Gray:

Enclosed is a Modification Number 39884-008 to Closure Permit Number **39884-004-SF**, issued pursuant to Section(s) 403.087(1), Florida Statues.

A person whose substantial interests are affected by the Department's proposed agency action may file a timely petition for an administrative hearing under sections 120.569 and 120.57 of the Florida Statutes, or may choose to pursue mediation as an alternative remedy under section 120.573 before the deadline for filing a petition. Choosing mediation will not adversely affect the right to a hearing if mediation does not result in a settlement. The procedures for pursuing mediation are set forth below.

A person may pursue mediation by reaching a mediation agreement with all parties to the proceeding (which include the applicant, the Department, and any person who has filed a timely and sufficient petition for a hearing) and by showing how the substantial interests of each mediating party are affected by the Department's action or proposed action. The agreement must be filed in (received by) the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, Florida 32399-3000, by the same deadline as set forth above for the filing of a petition.

The agreement to mediate must include the following:

(a) The names, addresses, and telephone numbers of any persons who may attend the mediation;

(b) The names, address, and telephone number of the mediator selected by the parties, or a provision for selecting a mediator within a specified time;

(c) The agreed allocation of the costs and fees associated with the mediation;

(d) The agreement of the parties on the confidentiality of discussions and documents introduced during mediation;

(e) The date, time, and place of the first mediation session, or a deadline for holding the first session, of no mediator has yet been chosen;

(f) The name of each party's representative who shall have authority to settle or recommend settlement; and

(g) Either an explanation of how the substantial interests of each mediating party will be affected by the action or proposed action addressed in this notice of intent or a statement clearly identifying the petition for hearing that each party has already filed, and incorporating it by reference.

(h) The signatures of all parties or their authorized representatives.

As provided in section 120.573 of the Florida Statutes, the timely agreement of all parties to mediate will toll the time limitations imposed by sections 120.569 and 120.57 for requesting and holding an administrative hearing. Unless otherwise agreed by the parties, the mediation must be concluded within sixty days of the execution of the agreement. If mediation results in settlement of the administrative dispute, the Department must enter a final order incorporating the agreement of the parties. Persons whose substantial interests will be affected by such a modified final decision of the Department have a right to petition for a hearing only in accordance with the requirements for such petitions set forth above, and must therefore file their petitions within fourteen days of receipt of this notice. If mediation terminates without settlement of the dispute, the Department shall notify all parties in writing that the administrative hearing processes under sections 120.569 and 120.57 remain available for disposition of the dispute, and the notice will specify the deadlines that they will apply for challenging the agency action and electing remedies under those two statutes.

The petition for an administrative hearing must conform to the requirements of Chapters 62-110 and 28-106, F.A.C., and must be filed (received) in the Department's Office of General Counsel, 3900 Commonwealth Boulevard, Tallahassee, 32399-3000, within fourteen (14) days of receipt of this notice. Failure to file a petition within fourteen (14) days constitutes a waiver of any right such person has to an administrative determination (hearing) pursuant to Section 120.57, Florida Statutes. This permit is final and effective on the date filed with the Clerk of the Department unless a request for extension of time in which to file a petition is filed within the time specified for filing a petition and conforms to Rule 62-110, F.A.C. Upon timely filing of a petition or a request for an extension of time this permit will not be effective until further Order of the Department.

When the Order (Permit or Permit Modification) is final, any party to the Department has the right to seek judicial review of the Order pursuant to Section 120.68, Florida Statutes, by the filing of a Notice of Appeal pursuant to Rule 9.110, Florida Rules of Appellate Procedure, with the Clerk of the Department in the Office of General Counsel, 3900 Commonwealth Boulevard, Tallahassee, 32399-3000; and by filing a copy of the Notice of Appeal accompanied by the applicable filing fees with the appropriate District Court of Appeal. The Notice of Appeal must be filed within 30 days from the date the Final Order is filed with the Clerk of the Department.

Executed in Tampa Florida.

STATE OF FLORIDA DEPARTMENT
OF ENVIRONMENTAL PROTECTION

Kim B. Ford, P.E.
Solid Waste Section
Division of Waste Management

KBF/ab
Attachment

cc: Gus DiFonzo, Manatee County
Joseph Miller, P.E., PBS&J
Robert Butera, P.E., FDEP Tampa
Susan Pelz, P.E., FDEP Tampa (permit notebook)
Richard Tedder, P.E., FDEP Tallahassee
Douglas Beason, OGC Tallahassee

CERTIFICATE OF SERVICE

This is to certify that this NOTICE OF PERMIT and all copies were mailed before the close of business on January 11, 2002 to the listed persons.

FILING AND ACKNOWLEDGMENT FILED, on this date, pursuant to §120.52(10), Florida Statutes, with the designated Department Clerk, receipt of which is hereby acknowledged.

Clerk

01-11-02
Date

Department of Environmental Protection

Jeb Bush
Governor

Southwest District
3804 Coconut Palm Drive
Tampa, Florida 33619

David B. Struhs
Secretary

January 11, 2002

PERMITTEE:
Manatee County
c/o Mr. Daniel Gray
Utilities Operations Director
4410 - 66th Street West
Bradenton, FL 34210

Re: Modification #39884-008 to existing Closure Permit
Permit No.: 39884-004-SF, Manatee County
Lena Road Landfill - Stage I Closure

Dear Mr. Gray:

Your existing closure permit No. 39884-004-SF is hereby modified as follows:

SPECIFIC CONDITIONS	FROM	TO	TYPE OF MODIFICATION
Permit expiration	Existing	Amended	Permit expiration extended until 07/27/2005

This letter and its attachments constitute a complete permit and replace all previous permits and permit modifications for the above referenced facility.

Sincerely

Deborah A. Getzoff
Director of District Management
Southwest District

DAG/kbf/ab
Attachments

Department of Environmental Protection

Jeb Bush
Governor

Southwest District
3804 Coconut Palm Drive
Tampa, Florida 33619

David B. Struhs
Secretary

PERMITTEE
Manatee County
c/o Mr. Daniel Gray
Utilities Operations Director
4410 - 66th Street West
Bradenton, FL 34210

PERMIT/CERTIFICATION
GMS ID No: 4041C02025
Permit No: 39884-004-SF
Date of Issue: **07/27/2000**
Expiration Date: **07/27/2005**
County: Manatee
Lat/Long: 27°28'00"N
82°27'00"W
Sec/Town/Rge: 1,6 & 31/34S/19E
Project: Lena Road Landfill - Stage I Closure

This permit is issued under the provisions of Chapter 403, Florida Statutes, and Florida Administrative Code Rule(s) 62-4 and 62-701. The above named permittee is hereby authorized to perform the work or operate the facility shown on the application and approved drawing(s), plans and other documents, attached hereto or on file with the Department and made a part hereof and specifically described as follows:

To close approximately 60 acres of Stage I of the Lena Road Landfill, subject to the specific and general conditions attached, located at 3333 Lena Road, Bradenton, Manatee County, Florida. The specific conditions attached are for the partial closure of a:

1. Class I Landfill Disposal Facility - Stage I

General Information: The closure will connect to the previously closed areas and extend over the south and east portions of Stage I down to the perimeter slurry wall. Surface runoff will be collected by drain pipes discharging to the existing stormwater management system for Stage I. The closure will include extensions and connections to the recently completed gas control system.

Replaces Permit No.: N/A, new

This permit contains compliance items summarized in Attachment 1 that shall be complied with and submitted to the Department by the dates noted. If the compliance dates are not met and submittals are not received by the Department on the dates noted, enforcement action may be initiated to assure compliance with the conditions of this permit.

Printed on recycled paper.

GENERAL CONDITIONS:

1. The terms, conditions, requirements, limitations and restrictions set forth in this permit, are "permit conditions" and are binding and enforceable pursuant to Sections 403.141, 403.161, 403.727, or 403.861, Florida Statutes. The permittee is placed on notice that the Department will review this permit periodically and may initiate enforcement action for any violation of these conditions.

2. This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings, exhibits, specifications, or conditions of this permit may constitute grounds for revocation and enforcement action by the Department.

3. As provided in subsections 403.087(6) and 403.722(5), F.S., the issuance of this permit does not convey any vested rights or any exclusive privileges. Neither does it authorize any injury to public or private property or any invasion of rights, nor any infringement of federal, State, or local laws or regulations. This permit is not a waiver of or approval of any other Department permit that may be required for other aspects of the total project which are not addressed in this permit.

4. This permit conveys no title to land or water, does not constitute State recognition or acknowledgment of title, and does not constitute authority for the use of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the State. Only the Trustees of the Internal Improvement Trust Fund may express State opinion as to title.

5. This permit does not relieve the permittee from liability for harm or injury to human health or welfare, animal, or plant life, or property caused by the construction or operation of this permitted source, or from penalties therefore; nor does it allow the permittee to cause pollution in contravention of Florida Statutes and Department rules, unless specifically authorized by an order from the Department.

6. The permittee shall properly operate and maintain the facility and systems of treatment and control (and related appurtenances) that are installed and used by the permittee to achieve compliance with the conditions of this permit, are required by Department rules. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with the conditions of the permit and when required by Department rules.

GENERAL CONDITIONS:

7. The permittee, by accepting this permit, specifically agrees to allow authorized Department personnel, upon presentation of credentials or other documents as may be required by law and at reasonable times, access to the premises where the permitted activity is located or conducted to:

(a) Have access to and copy any records that must be kept under conditions of the permit;

(b) Inspect the facility, equipment, practices, or operations regulated or required under this permit; and

(c) Sample or monitor any substances or parameters at any location reasonably necessary to assure compliance with this permit or Department rules.

Reasonable time may depend on the nature of the concern being investigated.

8. If, for any reason, the permittee does not comply with or will be unable to comply with any condition or limitation specified in this permit, the permittee shall immediately provide the Department with the following information:

(a) A description of and cause of noncompliance; and

(b) The period of noncompliance, including dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate, and prevent recurrence of the noncompliance.

The permittee shall be responsible for any and all damages which may result and may be subject to enforcement action by the Department for penalties or for revocation of this permit.

9. In accepting this permit, the permittee understands and agrees that all records, notes, monitoring data and other information relating to the construction or operation of this permitted source which are submitted to the Department may be used by the Department as evidence in any enforcement case involving the permitted source arising under the Florida Statutes or Department rules, except where such use is prescribed by Sections 403.111 and 403.73, F.S. Such evidence shall only be used to the extent it is consistent with the Florida Rules of Civil Procedure and appropriate evidentiary rules.

10. The permittee agrees to comply with changes in Department rules and Florida Statues after a reasonable time for compliance; provided, however, the permittee does not waive any other rights granted by Florida Statutes or Department rules.

GENERAL CONDITIONS:

11. This permit is transferable only upon Department approval in accordance with Rule 62-4.120 and 62-730.300, Florida Administrative Code, as applicable. The permittee shall be liable for any non-compliance of the permitted activity until the transfer is approved by the Department.

12. This permit or a copy thereof shall be kept at the work site of the permitted activity.

13. This permit also constitutes:

(a) Determination of Best Available Control Technology (BACT)

(b) Determination of Prevention of Significant Deterioration (PSD)

(c) Certification of compliance with State Water Quality Standards (Section 401, PL 92-500)

(d) Compliance with New Source Performance Standards

14. The permittee shall comply with the following:

(a) Upon request, the permittee shall furnish all records and plans required under Department rules. During enforcement actions, the retention period for all records will be extended automatically unless otherwise stipulated by the Department.

(b) The permittee shall hold at the facility or other location designated by this permit records of all monitoring information (including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation) required by the permit, copies of all reports required by this permit, and records of all data used to complete the application for this permit. These materials shall be retained at least three years from the date of the sample, measurement, report, or application unless otherwise specified by Department rule.

(c) Records of monitoring information shall include:

1. the date, exact place, and time of sampling or measurements;
2. the person responsible for performing the sampling or measurements;
3. the dates analyses were performed;
4. the person responsible for performing the analyses;
5. the analytical techniques or methods used;
6. the results of such analyses.

GENERAL CONDITIONS:

15. When requested by the Department, the permittee shall within a reasonable time furnish any information required by law which is needed to determine compliance with the permit. If the permittee becomes aware the relevant facts were not submitted or were incorrect in the permit application or in any report to the Department, such facts or information shall be corrected promptly.

16. In the case of an underground injection control permit, the following permit conditions also shall apply:

(a) All reports or information required by the Department shall be certified as being true, accurate and complete.

(b) Reports of compliance or noncompliance with, or any progress reports on, requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.

(c) Notification of any noncompliance which may endanger health or the environment shall be reported verbally to the Department within 24 hours and again within 72 hours, and a final written report provided within two weeks.

1. The verbal reports shall contain any monitoring or other information which indicate that any contaminant may endanger an underground source of drinking water and any noncompliance with a permit condition or malfunction of the injection system which may cause fluid migration into or between underground sources of drinking water.

2. The written submission shall contain a description of and a discussion of the cause of the noncompliance and, if it has not been corrected, the anticipated time the noncompliance is expected to continue, the steps being taken to reduce, eliminate, and prevent recurrence of the noncompliance, and all information required by Rule 62-28.230(4)(b), F.A.C.

(d) The Department shall be notified at least 180 days before conversion or abandonment of an injection well, unless abandonment within a lesser period of time is necessary to protect waters of the State.

GENERAL CONDITIONS:

17. The following conditions also shall apply to a hazardous waste facility permit.

(a) The following reports shall be submitted to the Department:

1. Manifest discrepancy report. If a significant discrepancy in a manifest is discovered, the permittee shall attempt to rectify the discrepancy. If not resolved within 15 days after the waste is received, the permittee shall immediately submit a letter report, including a copy of the manifest, to the Department.

2. Unmanifested waste report. The permittee shall submit an unmanifested waste report to the Department within 15 days of receipt of unmanifested waste.

3. Biennial report. A biennial report covering facility activities during the previous calendar year shall be submitted by March 1 of each even numbered year pursuant to Chapter 62-730, F.A.C.

(b) Notification of any noncompliance which may endanger health or the environment, including the release of any hazardous waste that may endanger public drinking water supplies or the occurrence of a fire or explosion from the facility which could threaten the environment or human health outside the facility, shall be reported verbally to the Department within 24 hours, and a written report shall be provided within 5 days. The verbal report shall include the name, address, I.D. number, and telephone number of the facility, its owner or operator, the name and quantity of materials involved, the extent of any injuries, an assessment of actual or potential hazards, and the estimated quantity and disposition of recovered material. The written submission shall contain:

1. A description and cause of the noncompliance.

2. If not corrected, the expected time of correction, and the steps being taken to reduce, eliminate, and prevent recurrence of the noncompliance.

(c) Reports of compliance or noncompliance with, or any progress reports on, requirements in any compliance schedule shall be submitted no later than 14 days after each schedule date.

(d) All reports or information required by the Department by a hazardous waste permittee shall be signed by a person authorized to sign a permit application.

SPECIFIC CONDITIONS:

1. **Permit Application Documentation.** This permit is valid for the Stage I closure in accordance with the reports, plans and other information as follows:

- Application and supporting information received on April 4, 2000;
- Letter of response by HDR, with revised plan sheets and replacement pages received on June 2, 2000;

and in accordance with all applicable requirements of Department rules.

2. **Permit Modifications.** Any construction subject to Department Solid Waste regulations not previously approved as part of this permit shall require a separate Department permit unless the Department determines a permit modification to be more appropriate, or unless otherwise approved in writing by the Department. Permits shall be modified in accordance with the requirements of 62-4.080, F.A.C. A modification which is reasonably expected to lead to substantially different environmental impacts which require a detailed review by the Department is considered a substantial modification.

3. **Permit Renewal.** No later than **one hundred eighty (180) days** before the expiration of the Department Permit, the permittee shall apply for a renewal of a permit, if necessary for continuing related activities, on forms and in a manner prescribed by the Department, in order to assure conformance with all applicable Department rules. Permits shall be renewed at least every five years as required by F.A.C. 62-4.070(4).

4. **Construction Schedule and Progress Report.** No later than **two (2) weeks after** the pre-construction conference, the owner or operator shall submit a construction schedule which includes estimated dates for related solid waste construction activities to the Department. The Engineer of Record or another qualified professional engineer shall make periodic inspections during construction to ensure that design integrity is maintained. An updated construction schedule and progress chart shall be submitted to the Department **monthly.**

5. **Quality Assurance.** A construction quality assurance plan shall provide personnel with adequate information to achieve continuous compliance with the construction requirements. The plan shall include or refer to specifications and construction methods which use established engineering practices for construction and provide for quality control testing procedures and sampling frequencies, pursuant to F.A.C. 62-701.400(7) and (8). Sampling and testing shall be conducted by trained personnel during construction and after construction completion. Such personnel will be under the direction of the construction quality assurance professional engineer, to assure the project will comply with the standards. The engineer or his designee shall be on-site at all times during construction to monitor construction activities.

SPECIFIC CONDITIONS:

6. **Laboratory and Field Testing Requirements.** Field testing during the construction activities shall be conducted under the direct supervision of the Certifying Engineer or his designee representing the owner. A laboratory experienced in the testing of geosynthetics, independent of the liner manufacturer and installer, shall perform the required conformance testing and testing of seam shear and peel strength.

7. **Certification of Construction Completeness.** Within **sixty (60) days** after the specified construction has been completed, the following activities shall be completed:

a. The owner or operator shall submit a Certification of Construction Completion, Form 62-701.900(2), signed and sealed by the responsible professional engineer for the construction to the Department for approval, and shall arrange for Department representatives to inspect the construction in the company of the permittee, the engineer, and the facility operator.

b. The owner or operator shall submit Record Drawings showing all changes (i.e. additions, deletions, revisions to the plans previously approved by the Department including site grades and elevations). The Record Drawings shall include, but not be limited to, details such as the as-built elevations of the liner system and completed final cover, ditches, and piping.

c. The owner or operator shall submit a narrative indicating all changes in plans and the cause of the deviations and certification by the design engineer to the Department.

d. The engineer of record shall provide a report to verify conformance with the project specifications and applicable requirements of F.A.C. Rule 62-701.400(7) and (8). The report including all testing results for the entire project shall be submitted to the Department along with the completion of construction documents.

8. **Control of Nuisance Conditions.** The operating authority shall be responsible for the control of odors and fugitive particulates arising from the construction. Such control shall minimize the creation of nuisance conditions on adjoining property. If a complaint is received from the general public concerning activities regulated by this permit, and the Department personnel confirms that the complaint is based on a violation of the standards and criteria applicable to the permittee pursuant to this permit, then the permittee must take immediate corrective action to abate the violation.

SPECIFIC CONDITIONS:

9. **Facility Maintenance and Repair.** If there is any damage to any portion of the site facilities regulated by this permit or failure of any portion of the associated systems, and such damage or failure may adversely affect the continued compliance with this permit, then the permittee shall **immediately (within 24 hours)** notify the Department explaining such occurrence and remedial measures to be taken and time needed for repairs. Written detailed notification shall be submitted to the Department **within seven (7) days** following the occurrence.

10. **Professional Certification.** Where required by Chapter 471 (P.E.) or Chapter 492 (P.G.), Florida Statutes, applicable portions of permit applications and supporting documents which are submitted to the Department for public record shall be signed and sealed by the professional(s) who prepared or approved them.

11. **General Conditions.** The permittee shall be aware of and operate under the "General Conditions". General Conditions are binding upon the permittee and enforceable pursuant to Chapter 403, Florida Statutes.

12. **Permit Acceptance.** By acceptance of this Permit, the Permittee certifies that he/she has read and understands the obligations imposed by the Specific and General Conditions contained herein, including date of permit expiration and renewal deadlines. It is a violation of this permit for failure to comply with all conditions and deadlines.

ATTACHMENT 1

SPECIFIC CONDITION	SUBMITTAL DUE DATE	REQUIRED ITEM
4.	2 weeks after pre-construction conference	Submit construction schedule
4.	Monthly	Update construction schedule
7.	Within 60 days after construction is complete	Submit Certification of Construction Completion, Arrange for inspection, submit Record Drawings, submit narrative describing all deviations.

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

Form Title Certification of Construction Completion
Effective Date May 19, 1994

DEP Application No. _____
(Filled by DEP)

Certification of Construction Completion of a Solid Waste Management Facility

DEP Construction Permit No:_____County:_____

Name of Project:_____

Name of Owner:_____

Name of Engineer:_____

Type of Project:_____

_____

Cost: Estimate $_____ Actual $_____

Site Design: Quantity:_____ ton/day Site Acreage:_____ Acres

Deviations from Plans and Application Approved by DEP:_____

_____

_____

_____

_____

Address and Telephone No. of Site:_____

_____

Name(s) of Site Supervisor:_____

Date Site inspection is requested:_____

This is to certify that, with the exception of any deviation noted above, the construction of the project has been completed in substantial accordance with the plans authorized by Construction

Permit No.:_____ Dated:_____

Date:_____ _____
Signature of Professional Engineer

Northwest District
160 Governmental Center
Pensacola, FL 32501-5794
904-444-8360

Northeast District
7825 Baymeadows Way, Ste. B200
Jacksonville, FL 32256-7590
904-448-4300

Central District
3319 Maguire Blvd., Ste. 232
Orlando, FL 32803-3767
407-894-7555

Southwest District
3804 Coconut Palm Dr.
Tampa, FL 33619
813-744-6100

South District
2295 Victoria Ave., Ste. 364
Fort Myers, FL 33901-3881
941-332-6975

Southeast District
400 North Congress Ave.
West Palm Beach FL 33401
561-681-6600