**The Lexington-Fayette Urban County Government assumes no responsibility for Sealed Specification Responses that are not addressed and delivered as indicated above. Sealed Specification Responses that are not delivered to the Division of Central Purchasing by the stated time and date will be rejected.**
All bids must have the company name and address, bid invitation number, and the commodity/service on the outside of the envelope.

Bids are to include all shipping costs to the point of delivery located at: See Specifications.

Bid Security Required: _X_Yes __No Performance Bond Required: _X_Yes __No
*Cashier Check, Certified Check, Bid Bond (Personal checks and company checks will not be acceptable).*

| Commodity/Service |
|---|
| **Geosynthetic Material Supply** |
| See specifications. |

| **Check One:** | **Proposed Delivery:** |
|---|---|
| ___ Bid Specifications Met<br>_X_ Exceptions to Bid Specifications. *Exceptions shall be itemized and attached to bid proposal submitted.* | 45 days after acceptance of bid. |

**Procurement Card Usage**

___ Yes
_X_ No
The Lexington-Fayette Urban County Government will be using Procurement Cards to purchase goods and services and also to make payments. Will you accept Procurement Cards?

Submitted by: Chesapeake Containment Systems, Inc.
*Firm*
352 Earls Rd
*Address*
Middle River, MD 21220
*City, State & Zip*

***Bid must be signed: (original signature)***

RC President
***Signature of Authorized Company Representative – Title***
Ryan C. Kamp
*Representative's Name (Typed or printed)*
410-335-5886 443-303-1682
*Area Code - Phone – Extension* *Fax #*
RKamp@ccsliners.com
*E-Mail Address*

***The Affidavit in this bid must be completed before your firm can be considered for award of this contract.***

**AFFIDAVIT**

Comes the Affiant, Ryan Kamp, and after being first duly sworn under penalty of perjury as follows:

1. His/her name is Ryan Kamp and he/she is the individual submitting the bid or is the authorized representative of Chesapeake Containment Systems, Inc.,

the entity submitting the bid (hereinafter referred to as "Bidder").

2. Bidder will pay all taxes and fees, which are owed to the Lexington-Fayette Urban County Government at the time the bid is submitted, prior to award of the contract and will maintain a "current" status in regard to those taxes and fees during the life of the contract.

3. Bidder will obtain a Lexington-Fayette Urban County Government business license, if applicable, prior to award of the contract.

4. Bidder has authorized the Division of Central Purchasing to verify the above-mentioned information with the Division of Revenue and to disclose to the Urban County Council that taxes and/or fees are delinquent or that a business license has not been obtained.

5. Bidder has not knowingly violated any provision of the campaign finance laws of the Commonwealth of Kentucky within the past five (5) years and the award of a contract to the Bidder will not violate any provision of the campaign finance laws of the Commonwealth.

6. Bidder has not knowingly violated any provision of Chapter 25 of the Lexington-Fayette Urban County Government Code of Ordinances, known as "Ethics Act."

7. Bidder acknowledges that "knowingly" for purposes of this Affidavit means, with respect to conduct or to circumstances described by a statute or ordinance defining an offense, that a person is aware or should have been aware that his conduct is of that nature or that the circumstance exists.

Further, Affiant sayeth naught.

RCK

**STATE OF** Maryland

**COUNTY OF** Harford

The foregoing instrument was subscribed, sworn to and acknowledged before me by Ryan C. Kamp on this the 8th day of June, ~~2011.~~ 2012

My Commission expires: 4-27-14

Rebecca L. Kamp
Notary Public
State of Maryland
County of Harford

Rebecca L. Kamp
NOTARY PUBLIC, STATE AT LARGE

***Please refer to Section II. Bid Conditions, Item "U" prior to completing this form.***

## EQUAL OPPORTUNITY AGREEMENT

The Law

- Title VII of the Civil Rights Act of 1964 (amended 1972) states that it is unlawful for an employer to discriminate in employment because of race, color, religion, sex, age (40-70 years) or national origin.

- Executive Order No. 11246 on Nondiscrimination under Federal contract prohibits employment discrimination by contractor and sub-contractor doing business with the Federal Government or recipients of Federal funds. This order was later amended by Executive Order No. 11375 to prohibit discrimination on the basis of sex.

- Section 503 of the Rehabilitation Act of 1973 states:

  *The Contractor will not discriminate against any employee or applicant for employment because of physical or mental handicap.*

- Section 2012 of the Vietnam Era Veterans Readjustment Act of 1973 requires Affirmative Action on behalf of disabled veterans and veterans of the Vietnam Era by contractors having Federal contracts.

- Section 206(A) of Executive Order 12086, Consolidation of Contract Compliance Functions for Equal Employment Opportunity, states:

  *The Secretary of Labor may investigate the employment practices of any Government contractor or sub-contractor to determine whether or not the contractual provisions specified in Section 202 of this order have been violated.*

**********

The Lexington-Fayette Urban County Government practices Equal Opportunity in recruiting, hiring and promoting. It is the Government's intent to affirmatively provide employment opportunities for those individuals who have previously not been allowed to enter into the mainstream of society. Because of its importance to the local Government, this policy carries the full endorsement of the Mayor, Commissioners, Directors and all supervisory personnel. In following this commitment to Equal Employment Opportunity and because the Government is the benefactor of the Federal funds, it is both against the Urban County Government policy and illegal for the Government to let contracts to companies which knowingly or unknowingly practice discrimination in their employment practices. Violation of the above mentioned ordinances may cause a contract to be canceled and the contractors may be declared ineligible for future consideration.

Please sign this statement in the appropriate space acknowledging that you have read and understand the provisions contained herein. Return this document as part of your application packet.

Bidders

*I/We agree to comply with the Civil Rights Laws listed above that govern employment rights of minorities, women, Vietnam veterans, handicapped and aged persons.*

BCB — Chesapeake Containment Systems, Inc.

Signature — Name of Business

**WORKFORCE ANALYSIS FORM**

**Name of Organization:** Chesapeake Containment Systems, Inc **Date:** 6 / 8 / 12

| Categories | Total | White | | Latino | | Black | | Other | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M | F | M | F | M | F | M | F | M | F |
| Administrators | | | | | | | | | | | |
| Professionals | | 3 | | | | | | | | 3 | 0 |
| Superintendents | | 2 | | 3 | | 1 | | | | 6 | 0 |
| Supervisors | | 1 | | | | | | | | | |
| Foremen | | | | 4 | | 1 | | | | 5 | 0 |
| Technicians | | 4 | | 51 | | 1 | | 1 | | 57 | 0 |
| Protective Service | | | | | | | | | | | |
| Para-Professionals | | | | | | | | | | | |
| Office/Clerical | | 1 | 4 | | | | | | | 1 | 4 |
| Skilled Craft | | | | | | | | | | | |
| Service/Maintenance | | | | | | | | | | | |
| Total: | | | | | | | | | | 72 | 4 |

***Prepared by:*** Becky Kamp Director of Accounting + HR
*Name & Title*

**LFUCG STATEMENT OF GOOD FAITH EFFORTS**
**Bid/RFP/Quote #** 74-2012

By the signature below of an authorized company representative, we certify that we have utilized the following methods to obtain the maximum practicable participation by minority and women owned business enterprises on the project. Please indicate which methods you used by placing an X in the appropriate place.

____ Attended LFUCG Central Purchasing Economic Inclusion Outreach Event

____ Sponsored Economic Inclusion event to provide networking opportunities

____ Requested a list of MBE/WBE subcontractors or suppliers from LFUCG Economic Engine

____ Advertised for MBE/WBE subcontractors or suppliers in local or regional newspapers

____ Showed evidence of written notice of contracting and/or supplier opportunities to MBE/WBE firms at least seven days prior to the bid opening date

____ Provided copies of quotations submitted by MBE/WBE firms which were not used and/or responses from firms indicating they would not be submitting a quote

____ Provided plans, specifications, and requirements to interested MBE/WBE subcontractors

X Other

Please list any other methods utilized that aren't covered above.

limited items to sub contract to MBE. I have contacted trucking firms to see if they have an MBE option. Typically the manufacturer handles the freight.

The undersigned acknowledges that all information is accurate. Any misrepresentations may result termination of the contract and/or be subject to applicable Federal and State laws concerning false statements and claims.

Chesapeake Containment Systems, Inc.
**Company**

Ryan C. Kamp
**Company Representative**

6/8/12
**Date**

President
**Title**

**SELECTED VENDORS WILL SUBMIT PRICING ONLINE DURING THE ONLINE PRICING EVENT ON THURSDAY, JUNE 21, 2012. DO NOT SUBMIT PRICING WITH YOUR SEALED SPECIFICATIONS.**

## BID SCHEDULE

The Bidder agrees to supply the materials described in the Contract Documents and Specifications for the following lump sum and/or unit prices which shall include the furnishing of all materials, supplies, services, all items of cost, overhead, taxes (federal, state, local), and profit for the Contractor and any Subcontractor involved.

### Phase 4 Closure Haley Pike Landfill

| Item No. | Quantity | Item Description | Unit | Unit Price | Total Bid |
|---|---|---|---|---|---|
| 1 | 1,404,380 | 40-mil Textured LLDPE Geomembrane | SF | **Do not include pricing with sealed specifications** | **Do not include pricing with sealed specifications** |
| 2 | 2,808,760 | 6 oz. x 6 oz. Double-Sided Geocomposite | SF | **Do not include pricing with sealed specifications** | **Do not include pricing with sealed specifications** |

**NOTE: The Owner will award the contracts to the lowest responsible Bidder for each Bid Item contained in the Bid Schedule. Bidders may bid on the LLDPE Geomembrane, or the Geocomposite, or both.**

Respectfully Submitted,

BY: Chesapeake Containment Systems, Inc.
(NAME OF FIRM)

DATE: 6/8/12

BY: [signature], Ryan C. Kemp

TITLE: President

OFFICIAL ADDRESS, PHONE AND E-MAIL:

352 Early Rd
Middle River, MD 21220

CHESAPEAKE CONTAINMENT SYSTEMS INC CORPORATE SEAL MARYLAND

(Seal if Bid is by Corporation)

by signing this form you agree to all of the terms and associated forms.

# AIA® Document A310™ – 2010

## *Bid Bond*

**CONTRACTOR:**
*(Name, legal status and address)*

Chesapeake Containment Systems, Inc.
352 Earls Road
Baltimore, MD 21220

**SURETY:**
*(Name, legal status and principal place of business)*
American Safety Casualty Insurance Company
100 Galleria Parkway, SE, Ste. 700
Atlanta, GA 30339

**OWNER:**
*(Name, legal status and address)*
Lexington Fayette Urban County Government - Division of Central Purchasing
200 East Main St.
Lexington, KY 40507

**BOND AMOUNT:** $ Five Percent (5%) of Amount Bid or Seventy Thousand Dollars and No/100 ($70,000.00)

**PROJECT:**
*(Name, location or address, and Project number, if any)*
74-2012: Geosynthetic Material Supply

**ADDITIONS AND DELETIONS:**
The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.

The Contractor and Surety are bound to the Owner in the amount set forth above, for the payment of which the Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, as provided herein. The conditions of this Bond are such that if the Owner accepts the bid of the Contractor within the time specified in the bid documents, or within such time period as may be agreed to by the Owner and Contractor, and the Contractor either (1) enters into a contract with the Owner in accordance with the terms of such bid, and gives such bond or bonds as may be specified in the bidding or Contract Documents, with a surety admitted in the jurisdiction of the Project and otherwise acceptable to the Owner, for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof; or (2) pays to the Owner the difference, not to exceed the amount of this Bond, between the amount specified in said bid and such larger amount for which the Owner may in good faith contract with another party to perform the work covered by said bid, then this obligation shall be null and void, otherwise to remain in full force and effect. The Surety hereby waives any notice of an agreement between the Owner and Contractor to extend the time in which the Owner may accept the bid. Waiver of notice by the Surety shall not apply to any extension exceeding sixty (60) days in the aggregate beyond the time for acceptance of bids specified in the bid documents, and the Owner and Contractor shall obtain the Surety's consent for an extension beyond sixty (60) days.

If this Bond is issued in connection with a subcontractor's bid to a Contractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

When this Bond has been furnished to comply with a statutory or other legal requirement in the location of the Project, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such

furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

Signed and sealed this 21st day of June , 2012

| | |
|---|---|
| Rebecca L Kamp | Chesapeake Containment Systems, Inc. |
| *(Witness)* | *(Contractor as Principal)* |
| | By [illegible], President |
| | *(Title)* |
| | American Safety Casualty Insurance Company |
| | *(Surety)* *(Seal)* |
| Beatrice Saint-Felix | |
| *(Witness) Beatrice Saint-Felix* | *(Title) John Shaffer, Attorney-In-Fact* |

CHESAPEAKE CONTAINMENT SYSTEMS, INC. CORPORATE SEAL 2007 MARYLAND

NUMBER

ASB-534953

AMERICAN SAFETY INSURANCE

# POWER OF ATTORNEY

KNOW ALL MEN BY THESE PRESENTS, that American Safety Casualty Insurance Company has made, constituted and appointed, and by these presents does make, constitute and appoints STEPHEN SPENCER, WILLIAM COWAN, PAUL TROESCHEL, DAN WEST, JOHN SHAFFER, THOMAS DAVIS, PARKER WILLIAMS OF ROCKVILLE, MARYLAND

its true and lawful attorney-in-fact, for it and its name, place, and stead to execute on behalf of the said Company, as surety, bonds, undertaking and contracts of suretyship to be given to

**ALL OBLIGEES**

provided that no bond or undertaking or contract of suretyship executed under this authority shall exceed in amount the sum of

*****THREE MILLION***($3,000,000.00) DOLLARS*****

This Power of Attorney is granted and is signed and sealed by facsimile under and by the authority of the following Resolution adopted by the Board of Directors of the Company of the 6th day of August, 2009.

**RESOLVED**, that the President in conjunction with the Secretary or any Assistant Secretary may appoint attorneys-in-fact or agents with authority as defined or limited in the instrument evidencing the appointment in each case, for and on behalf of the Company, to execute and deliver and affix the seal of the Company to bands, undertakings, recognizances, and suretyship obligations of all kinds; and said officers may remove any such attorney-in-fact or agent and revoke any power of attorney previously granted to such persons.

**RESOLVED FURTHER**, that any bond, undertaking, recognizance, or suretyship obligation shall be valid and binding upon the company when: (i) when signed by the President or any Vice-President and attested and sealed (if a seal is required) by any Secretary or Assistant Secretary or (ii) when signed by the President or any Vice-President or Secretary or Assistant Secretary, and counter-signed and sealed (if a seal is required) by a duly authorized attorney-in-fact or agent; or (iii) when duly executed and sealed (if a seal is required) by one or more attorney-in-fact or agents pursuant to and within the limits of the authority evidenced by the power of attorney issued by the Company to such person or persons.

**RESOLVED FURTHER**, that the signature of any authorized officer and the seal of the Company may be affixed by facsimile to any power of attorney or certification thereof authorizing the execution and delivery of any bond, undertaking, recognizance, or other suretyship obligations of the Company; and such signature and seal when so used shall have the same force and effects as though manually affixed.

**IN WITNESS WHEREOF**, American Safety Casualty Insurance Company has caused its official seal to be hereunto affixed, and these presents to be signed by its President and attested by its Secretary this 6th day of August, 2009

Attest:

Ambuj Jain

SEAL

Joseph D. Scollo, Jr.

**STATE OF GEORGIA )**
**)**
**COUNTY OF COBB )**

On this 6th day of August, 2009, before me personally came Joseph D. Scollo, Jr., to me known, who, being by me duly sworn, did depose and say that he is the President of American Safety Casualty Insurance Company, the corporation described in and which executed the above instrument; that he knows the seal of the said corporation; that the seal affixed to the said instrument is such corporate seal; that is was so affixed by order of the Board of Directors of said corporation and that he signed his name thereto by like order.

JAMI BAILEY
Notary Public, Hall Co., GA
My Commission Expires Aug. 13, 2012

Jami Bailey, Notary Public

I, the undersigned, Secretary of American Safety Casualty Insurance Company, an Oklahoma corporation, DO HEREBY CERTIFY, that the foregoing and attached Power of Attorney remains in full force and has not been revoked; and furthermore that the Resolution of the Board of Directors, set forth in the said Power of Attorney, is now in force.

Signed and sealed in the City of Atlanta, in the State of Georgia

SEAL

Dated this 21 day of June 2012.

Ambuj Jain

ORIGINALS OF THIS POWER OF ATTORNEY ARE PRINTED WITH RED NUMERICAL NUMBERS

DUPLICATES SHALL HAVE THE SAME FORCE AND EFFECT AS AN ORIGINAL ONLY WHEN ISSUED IN CONJUNCTION WITH THE ORIGINAL

CHESAPEAKE
CONTAINMENT SYSTEMS, INC.

# Haley Pike Landfill

# Geosynthetic Supply Bid

# Geomembrane Option #1

# Agru America

352 Earls Road

Middle River, MD 21220

410-335-5886 phone

443.303.1682 fax

www.ccsliners.com

# Linear Low Density Polyethylene
# Micro Spike® Liner

## Product Data

| Property | Test Method | Values | | | |
|---|---|---|---|---|---|
| Thickness, nominal, (mm) | | 40 (1.0) | 60 (1.5) | 80 (2.0) | 100 (2.5) |
| Thickness (min. ave.), mil (mm) | ASTM D5994* | 38 (.95) | 57 (1.43) | 76 (1.90) | 95 (2.38) |
| Thickness (lowest indiv. for 8 of 10 spec.), mil (mm) | ASTM D5994* | 36 (.90) | 54 (1.35) | 72 (1.80) | 90 (2.25) |
| Thickness (lowest indiv. for 1 of 10 spec.), mil (mm) | ASTM D5994* | 34 (.85) | 51 (1.28) | 68 (1.70) | 85 (2.13) |
| ***The thickness values may be changed due to project specifications (i.e., absolute minimum thickness)** | | | | | |
| Asperity Height (min. ave.), mil (mm) | GRI GM12 | 16 (.41) | 16 (.41) | 16 (.41) | 16 (.41) |
| Density, g/cc, maximum | ASTM D792, Method B | 0.939 | 0.939 | 0.939 | 0.939 |
| *Tensile Properties* (ave. both directions) | ASTM D6693, Type IV | | | | |
| Strength @ Break (min. ave.), lb/in width (N/mm) | 2 in/minute | 112 (19.6) | 168 (29.4) | 224 (392) | 280 (49.0) |
| Elongation @ Break (min. ave.), % (GL=2.0in) | 5 specimens in each direction | 400 | 400 | 400 | 400 |
| Tear Resistance (min. ave.), lbs. (N) | ASTM D1004 | 25 (111) | 36 (160) | 50 (222) | 60 (267) |
| Puncture Resistance (min. ave.), lbs. (N) | ASTM D4833 | 50 (222) | 70 (310) | 90 (400) | 115 (512) |
| Carbon Black Content (range in %) | ASTM D4218 | 2 - 3 | 2 - 3 | 2 - 3 | 2 - 3 |
| Carbon Black Dispersion (Category) | ASTM D5596 | Only near spherical agglomerates for 10 views: 9 views in Cat. 1 or 2, and 1 view in Cat. 3 | | | |
| Oxidative Induction Time, minutes | ASTM D3895, 200°C, 1 atm $O_2$ | ≥100 | ≥100 | ≥100 | ≥100 |
| Melt Flow Index, g/10 minutes | ASTM D1238, 190°C, 2.16kg | ≤1.0 | ≤1.0 | ≤1.0 | ≤1.0 |
| Oven Aging | ASTM D5721 | 60 | 60 | 60 | 60 |
| with HP OIT, (% retained after 90 days) | ASTM D5885, 150°C, 500psi $O_2$ | | | | |
| UV Resistance | GRI GM11 | 20hr. Cycle @ 75°C/4 hr. dark condensation @ 60°C | | | |
| with HP OIT, (% retained after 1600 hours) | ASTM D5885, 150°C, 500psi $O_2$ | 35 | 35 | 35 | 35 |
| 2% Secant Modulus (max.), lb/in. (N/mm) | ASTM D5323 | 2400 (420) | 3600 (630) | 4800 (840) | 6000 (1050) |
| Axi-Symmetric Break Resistance Strain, % (min.) | ASTM D5617 | 30 | 30 | 30 | 30 |

**These product specifications meet or exceed GRI's GM17**

## Supply Information (Standard Roll Dimensions)

| Thickness | | Width | | Length | | Area (approx.) | | Weight (average) | |
|---|---|---|---|---|---|---|---|---|---|
| mil | mm | ft | m | ft | m | $ft^2$ | $m^2$ | lbs | kg |
| 40 | 1.0 | 23 | 7 | 600.1 | 182.9 | 13,782 | 1,280 | 3,325 | 1,510 |
| 60 | 1.5 | 23 | 7 | 410.1 | 125 | 9,419 | 875 | 3,356 | 1,522 |
| 80 | 2.0 | 23 | 7 | 328.1 | 100 | 7,535 | 700 | 3,306 | 1,500 |
| 100 | 2.5 | 23 | 7 | 246.1 | 75 | 5,651 | 525 | 3,167 | 1,436 |

**Notes:**

*All rolls are supplied with two slings. All rolls are wound on a 6 inch core. Special roll lengths are available on request.*



500 Garrison Road, Georgetown, South Carolina 29440 843-546-0600 800-373-2478 Fax: 843-527-2738
email: salesmkg@agruamerica.com www.agruamerica.com

# SAMPLE ONLY

LIMITED MATERIAL WARRANTY

CUSTOMER NAME:
PROJECT:

TYPE MATERIAL:

The company, referred to herein as AGRU AMERICA, warrants that AGRU AMERICA liners will correspond to the specifications as indicated in AGRU AMERICA technical records, catalogs, guidelines and test certificates at the time when sold.

AGRU AMERICA warrants that the material is faultless and resistant for a period of N/A years, prorated from the point of time sold when properly installed, covered and used for: N/A.

AGRU AMERICA's liability under this warranty is not applicable when damage is caused by:

Natural phenomena such as thunderstorms, floods, earthquakes, acts of war or other acts of God;
Chemicals that are not suitable for HDPE liners according to chemical resistance guides or from experience.

Further, AGRU AMERICA is not liable for damages due to the misapplication, incorrect installation, and damages resulting from any kind of inadequate handling. In the event that any defects are noticed in the liner, AGRU AMERICA must be notified in writing within thirty (30) days.

AGRU AMERICA shall be given an opportunity to ascertain the cause of damages. AGRU AMERICA reserves the right to decide how damages will be settled.

Under no circumstances will AGRU AMERICA assume liability for consequential damages due to defective liner or incorrect installation. AGRU AMERICA will not be responsible for failures arising from incorrect welding of seams in the installation.

Further, AGRU AMERICA's warranty will be void in the event that the buyer performs repairs or makes alterations without the express approval of AGRU AMERICA in writing. AGRU AMERICA's maximum liability under this warranty will not exceed the purchase price of liner and will only be in force when payment has been made in full and further claims regardless of the legal suppositions are not applicable.

This warranty is only valid on condition that the generally approved technical standards and in particular the guidelines for the installation of the liner are followed.

For AGRU AMERICA, Inc.

**SAMPLE**
Authorized Official (Date)

**SAMPLE**
Paul W. Barker (Date)
Vice President

# SAMPLE ONLY

# MANUFACTURING QUALITY CONTROL

SALES OFFICE:

AGRU AMERICA, INC.

500 Garrison Road

Georgetown, SC 29440

Toll Free: (800) 373-2478

Telephone: (843) 546-0600

Fax: (843) 527-2738

salesmkg@agruamerica.com

www.agruamerica.com

July 10, 2006

# AGRU AMERICA, INC. - QA/QC

## Manufacturing – Quality Assurance/Quality Control

**AGRU AMERICA, Inc.** extrudes high density polyethylene (HDPE) and linear low density polyethylene (LLDPE) geomembrane, HDPE Geonet, and Geocomposite products at its plant located at 500 Garrison Road, Georgetown, South Carolina, 29440.

Our USA Manufacturing Quality Assurance Program is dependent on the utilization of an in-house laboratory which is, when necessary, complemented with testing performed by certified outside laboratories such as:

- Precision Geosynthetic Laboratories; Anaheim, CA
  Telephone (714) 520-9631; Fax (714) 520-9637
- TRI/Environmental, Inc.; Austin, Texas
  Telephone (512) 263-2101; Fax (512) 263-2558

  And other GRI-LAP accredited laboratories.

## Raw Material – Manufacturer's Certificate of Conformity

HDPE and LLDPE resin is supplied to our plant in bulk and subjected to the following procedures:

- Prior to shipment, our resin supplier submits a certificate of analysis. Once approved, the resin is released for shipment to our plant.
- One sample is taken from each rail car after arrival and tested as follows:
  Melt Index ASTM D1238 190°C, 2.16kg, and Density ASTM D792.
- Once the tests have been completed and results found to be in compliance with our requirements, the resin is then unloaded into our silo system.
- At this stage, our supplier has performed one battery of tests and Agru America has performed one to verify the manufacturer's certificate of analysis.
- Off specification resin is returned to the supplier.
- The Manufacturer's MFI Test Data is reported on the Quality Certificate (Agru America's MFI Testing is done to verify this data).

## GEOMEMBRANE

### The Extrusion Process

The resin is conveyed through a vacuum pump system and flexible hoses to a dryer hopper, feeding the resin by gravity into an 8-inch barrel. This barrel is divided into five heating zones, each heating zone being computer controlled and constantly monitored.

A screw in the barrel turns at a prescribed and monitored speed. It conveys the resin slowly to full plastication, and then the plasticated resin is fed through a manifold into a coat hanger die having a width of approximately 24 feet. The die lips are open to a prescribed distance governed by the thickness of the geomembrane to be extruded.

Exiting the die, the plasticated resin forms a controlled and monitored bead, which feeds into a chrome three-roll stack in a prescribed pattern. Each chrome roll is set at a prescribed temperature, controlled by water circulation.

Exiting the controlled cooling of the roll stack, the geomembrane travels down the take off haulers towards the winder. On the way to the take off, the liner is trimmed to bring the finished width to the applicable standard. Trimmings are granulated.

The trimmed edge of one side of the geomembrane is marked at every 3.28 ft with thickness, Agru America name and year of manufacture. This marking also serves as product identification.

The geomembrane is visually inspected for surface defects as it travels down the take off by both the extruder and the winder operators.

The geomembrane is wound on a recycled HDPE core having 6" ID (150mm), 7" OD (175mm) and 22'8" (6.8m) length. Each smooth roll weighs approximately 3,000 pounds (1360 kg). Microspike® rolls weigh approximately 3,200 pounds (1450 kg). All rolls are fitted with two nylon slings when shipped.

**Post Extrusion Quality Control**

Once start-up conditions are over and commercial extrusion is initiated, post-production quality control comes into operation. A series of test procedures are performed based upon either our Standard Frequency of testing (attached), or frequencies required by customer specifications.

A sample approximately 11" by the full width of the geomembrane is taken from every roll. Based on the specified test frequencies, certain specimens are die cut, tested and the results summarized on the Quality Certificate issued by our Quality Control Department. The certificate is signed electronically by the Quality Control Manager. The Quality Control Manager reports directly to the President of the Company.

Rolls failing to comply with either Customer Project Specifications and/or our own latest revision to our published data sheets are set aside and re-classified as off-spec (Class B rolls).

Quality Certificates are provided for all rolls of geomembranes (sample smooth & Microspike® certificates are attached), with the exception of off-spec (Class B rolls).

Sometimes a third party Quality Assurance representative is mandated by the owner of a project to oversee our manufacturing QA. We gladly subscribe to this procedure and make all our records available 24 hours a day for the duration of the mandate.

The following roll identification items are reported in our Quality Certificate:

**Roll number**

(example) **203366 -01**

| | |
|---|---|
| First digit | machine |
| Second and third digits | week of year |
| Fourth digit | day of week (Monday=1, Sunday=7) |
| Last two digits | roll number (first roll of week is 01, etc.) |

The two last digits separated from the others indicate the year the roll was produced.

Using the above key:

Roll #203366 -06 was produced on Liner Machine #2 on Wednesday in the third week in 2006.

**Product Description** (liner type: Smooth, Microspike®, Drain®, Super Gripnet®, etc.)

**Roll Length & Width in feet & meters**

**Raw material lot and/or batch number and supplier/product identification** (from Resin Manufacturer's Certificate of Analysis – sample attached)

The following test results are reported in the Geomembrane Quality Certificate, derived from our Standard Test Frequency (attached) and/or supplied raw material manufacturer Certificates of Analysis:

| Test / Method | Results Reported & Modifications to Standard (if any) |
|---|---|
| Thickness<br>†ASTM D5199(Smooth), or †D5994(Textured)<br>**(Both Modified)** | Minimum, Maximum, and Average Sheet Thickness in mm and mils.<br>**Modification from Standard** = Measurements are taken upon sample reaching Lab Temperature Equilibrium. |
| Asperity Height<br>†GRI GM12 **(Modified)**<br>Textured liner only | Asperity height in mils<br>**Modifications from Standard** = Edge samples are collected from the smooth/textured junction, **not** 1 foot from edge. ASTM D5994 specimens are used for this test, not direct placement. |
| Density<br>†ASTM D792 | Density in g/cc |
| Melt Flow Index<br>†ASTM D1238 | g/10minutes (Conditions =190°C, 2.16kg).<br>**NOTE:** Resin Manufacturer's **Certificate of Analysis result** is reported. Our testing verifies this result. |
| Carbon Black Content<br>†ASTM D4218 | % Carbon Black by weight |
| Carbon Black Dispersion<br>†ASTM D5596 | Category (Only near spherical agglomerates per GRI GM 13 & 17) |
| Tensile Strength<br>†ASTM D6693<br>Type IV, 2 inches / minute<br>**(Modified)** | Average Strength @ Yield in psi, ppi, & N/mm<br>Average Strength @ Break in psi, ppi, & N/mm<br>Average Elongation @ Yield in %<br>Average Elongation @ Break in %<br>**Modification from Standard** = Average of MD & TD results are reported<br>**NOTE 1:** The D6693 results equate to the following **D638 Modifications**:<br>Gage Length for Yield = 1.3", for Break = 2"<br>**NOTE 2:** Yield data not reported for LLDPE |
| Dimensional Stability<br>†ASTM D1204 **(Modified)** | Average Dimensional Change in %<br>**Modification from Standard** = Average Dimensional Change of MD & TD is reported. Test is run upon sample reaching Lab Temperature Equilibrium |
| Tear Resistance<br>†ASTM D1004 **(Modified)** | Tear Resistance in Lbs & N.<br>**Modifications from Standard** = Test is run upon sample reaching Lab Temperature Equilibrium. Average Tear Resistance of MD & TD is reported. |
| Puncture Resistance<br>†ASTM D4833<br>†FTMS 101C Method 2065<br>**(Both Modified)** | Puncture Resistance in Lbs & N.<br>**Modification from Standard** = Test is run upon sample reaching Lab Temperature Equilibrium. |
| Environmental Stress Crack Resistance (ESCR)<br>†ASTM D1693 **(CERTIFIED)** | This test is n longer run by Agru America, and the result is now certified by Agru America for 1500 hours (Certification letter is attached, as well as GAI-LAP's approval of the certification.) |
| Notched Constant Tensile Load<br>†ASTM D5397 (Single Point, Appx.) | Pass / Fail at 300 hours (or as required by customer specifications)<br>This test run on HDPE only, and on smooth edge of textured liners. |
| Oxidative Induction Time (OIT)<br>†ASTM D3895<br>Standard, 200°C, 1atm. | OIT Time in minutes. **Modification from Standard** = One run only – if result is below 120 minutes, a second run is done to verify the first. |

**†GRI-LAP Accredited for this method (INCLUDING Modifications)**

The following Test methods are also performed per railcar in our Standard MQC, but results are **not** reported on our Quality Certificates (results can be forwarded if necessary).

| Test / Method | Results Reported |
|---|---|
| Low Temperature Brittleness<br>ASTM D746<br>**THIS TEST OUTSOURCED TO AN ACCREDITED 3rd PARTY LAB** | Pass / Fail for each specimen (5 specimens in both MD & TD), % of samples passing.<br>**NOTE:** Standard MQC Temperature tested to is **-60°C**. Lower Temperatures can be done if required by customer specifications. |

**Additional Test Procedures**
**(Available if Specified from GRI-LAP Accredited Third Party Labs)**

| | |
|---|---|
| Hydrostatic Resistance | ASTM D751 |
| Volatile Loss | ASTM D1203 |
| Resistance to Soil Burial | ASTM D3083<br>using ASTM D638 Type IV dumbbell at 2"/min. |
| Water Absorption | ASTM D570 |
| Coefficient of Thermal Expansion | ASTM D696 |
| Friction Angle<br>Direct Shear Method | ASTM D5321 |
| Moisture Vapor Transmission Rate<br>100°F - 100% RH | ASTM E96 |
| Transmissivity (Profiled)<br>Various gradients & confining pressure | ASTM D4716 |
| Multi-axial Tensile Strain at Rupture (percent) | ASTM D5617 |
| Modulus of Elasticity (or 2% Secant Modulus) | ASTM D638 (Modulus) or ASTM D5323 |

**Drainage Net (Geonet)**

AGRU America drainage net is made from a blend of high quality virgin HDPE and a carbon black masterbatch. The purpose of the carbon black is to protect the plastic from UV damage in the field application.

All raw materials as well as the finished products are conistently monitored by specially trained lab technicians. Raw materials are tested as above for Geomembrane.

The blend of raw materials is plasticized by an extruder, which presses the melt through a screen changer to filter out impurities. The plastic is then fed into a rotating die which creates the net. The cooling of the net takes place in a water tank at a tightly controlled temperature. A series of nip rollers pull the net out of the tank and through the downstream equipment to the winders. The net is cut to length automatically and wound onto a 4" OD cardboard core.

Before the finished rolls are taken out of the winder frame, the quality control technician either releases the material into stock or classifies the material as scrap.

When approved by QC, the rolls are stretch wrapped and transferred to the storage yard.

Geocomposite

In addition to the drainage net, AGRU America offers geocomposites which consist of geotextiles laminated to one or both sides of the net.

All geotextiles used for this lamination process are being inspected to meet AGRU America's (or project) specifications.

The lamination process takes place just before the net reaches the winders at the end of the extrusion line. After melting the surface of the HDPE drainage net, a geotextile is pressed into the net by means of a calender. The outer 6 inches of net are not laminated and the geotextile overlaps the net by an additional 6 inches on both sides of the product.

Before the finished rolls are taken out of the winder frame, the quality control technician either releases the material into stock or classifies the material as scrap.
When approved by QC, the rolls are stretch wrapped and transferred to the storage yard.

All drainage net and geocomposite rolls are labeled as follows:

- one label on each face of the roll
- two hand written roll numbers on the stretch wrap packaging
- one label on the laboratory sample
- numbering system is as above for geomembrane

The following test results are reported in the Geonet/Composite Quality Certificate, derived from our Test Results and/or supplied raw material manufacturer Certificates of Analysis:

| Test / Method | Results Reported & Modifications to Standard (if any) |
|---|---|
| Thickness (Geonet)<br>†ASTM D5199 | Minimum, Maximum, and Average Geonet Thickness in mm and mils.<br>**Modification from Standard** = Measurements are taken upon sample reaching Lab Temperature Equilibrium. English Units reported |
| Density (Geonet)<br>†ASTM D792 | Geonet Density in g/cc |
| Melt Flow Index (Geonet)<br>†ASTM D1238 | g/10minutes (Conditions =190°C, 2.16kg).<br>**NOTE:** Resin Manufacturer's **Certificate of Analysis result** is reported. Our testing verifies this result. |
| Carbon Black Content (Geonet)<br>†ASTM D4218 | % Carbon Black by weight |
| Peak Tensile Strength (Geonet)<br>†ASTM D5035 or<br>†ASTM D7179<br>**(Both Modified)** | MD Only tested, TD upon request only.<br>Peak Strength @ Break in ppi<br>**Modification from Standard** = English Units reported |
| Mass Per Unit Area (Geonet)<br>†ASTM D5261 | Average Mass per Unit Area in $lb/ft^2$<br>**Modification from Standard** = English Units reported |
| Transmissivity (Geonet)<br>†ASTM D4716 | Transmissivity, $m^2$ / sec<br>Plate to Plate , 21°C, **gradient = 1.0, load = 15,000psf, seat time = 15 minutes** is Agru America's Standard Geonet MQC Transmissivity test (may be changed per project MQC specs) |
| Transmissivity (Geocomposite)<br>†ASTM D4716 | Transmissivity, $m^2$ / sec<br>Plate to Plate , 21°C, **gradient = 0.1, load = 10,000psf, seat time = 15 minutes** is Agru America's Standard Geocomposite MQC Transmissivity test (may be changed per project MQC specs) |
| Ply Adhesion (Geocomposite)<br>†ASTM D7005 | Peel Strength, lbs/in, min. ave. |

**†GRI-LAP Accredited for this method (INCLUDING Modifications)**

# Standard Frequency of Testing

## Product Data

| Property | Test Method | Frequency of testing (minimum)* |
|---|---|---|
| Thickness (min. ave.), mil | ASTM D5994/D5199 | per roll |
| Asperity Height (min. ave.), mil | GRI GM-12 (for textured liner) | per roll, alternating top/bottom for dbl sided textured liner only |
| Density, g/cc, minimum | ASTM D792, Method B | 200,000 lbs (railcar) |
| Tensile Properties (ave. both directions) | ASTM D6693, Type IV | |
| Strength @ Yield (min. ave.), lb/in width | 2 in/minute | |
| Elongation @ Yield (min. ave.), % (GL=1.3in) | 5 specimens in each direction | 20,000 lbs |
| Strength @ Break (min. ave.), lb/in width | | |
| Elongation @ Break (min. ave.), % (GL=2.0in) | | |
| Tear Resistance, lbs. (min. ave.) | ASTM D1004 | 45,000 lbs |
| Puncture Resistance, lbs. (min. ave.) | ASTM D4833 | 45,000 lbs |
| Carbon Black Content (range in %) | ASTM D4218 | 20,000 lbs |
| Carbon Black Dispersion (Category) | ASTM D5596 | 45,000 lbs |
| Stress Crack Resistance (NCTL), hours | ASTM D5397, Appendix | 200,000 lbs (railcar) |
| Oxidative Induction Time, minutes | ASTM D3895, 200°C, 1 atm $O_2$ | 200,000 lbs (railcar) on finished liner |
| Melt Flow Index, g/10 minutes | ASTM D1238, 190°C, 2.16kg | 200,000 lbs (railcar) on incoming resin |
| Low Temperature Brittleness, °C | ASTM D746, -60°C | 200,000 lbs (railcar) on finished liner |
| Oven Aging | ASTM D5721 | per resin formulation |
| with HP OIT, (% retained after 90 days) | ASTM D5885, 150°C, 500psi $O_2$ | |
| UV Resistance | GRI GM11 | per resin formulation |
| with HP OIT, (% retained after 1600 hours) | ASTM D5885, 150°C, 500psi $O_2$ | |
| 2% Secant Modulus, lb/in. (max.) | ASTM D5323 | per resin formulation-**for LLDPE liner only** |
| Axi-Symmetric Break Resistance Strain, % (min.) | ASTM D5617 | per resin formulation-**for LLDPE liner only** |

**These test frequencies meet or exceed GRI's GM-13**

***Theses test frequencies may be changed based on project specifications, and represent the minimum MQC testing performed. Additional costs may be incurred if required testing is greater than listed above**



Executive Offices: 500 Garrison Road, Georgetown, SC 29440 843-546-0600 800-321-1379 Fax: 843-546-0516
Sales Office: 700 Rockmead, Suite 150, Kingwood, TX 77339 281-358-4741 800-373-2478 Fax: 281-358-5297
email: salesmkg@agruamerica.com

Chevron Phillips Chemical Company LP

CoA Date: 07/14/2004

# Certificate of Analysis

Shipped To: AGRU AMERICA INC
500 GARRISON RD
GEORGETOWN SC 29440
USA

Recipient: GRANT PALMER
Fax:

CPC Delivery #: 86671544
PO #: 03814
Weight: 190000 LB
Ship Date: 07/14/2004
Package: BULK
Mode: Hopper Car
Car #: GOCX058461
Seal No: 301173

Product:
MARLEX POLYETHYLENE K307 BULK

Lot Number: 8140404

| Property | Test Method | Value | Unit |
|---|---|---|---|
| Melt Index | ASTM D1238 | 0.260 | g/10mi |
| HLMI Flow Rate | ASTM D1238 | 22.00 | g/10mi |
| Density | ASTM D1505 | 0.9380 | g/cm3 |
| Pellet Count | P02.08.03 | 30.000 | pel/g |
| Production Date | | 3/22/04 | |

The data set forth herein have been carefully compiled by Chevron Phillips Chemical Company LP.
**However, there is no warranty of any kind, either expressed or implied, applicable to its use, and the user assumes all risk and liability in connection therewith.**

Jackie Edwards
Certification Systems Specialist

For CoA questions contact Carol Meza at 713-475-3625

agru america
quality control dept.

# quality certificate

ROLL # **211351-06** Lot #: **MM193612** **Liner Type: MICROSPIKE™ HDPE**

| Measurement ASTM D5994 (Modified) | | METRIC | | ENGLISH | | Thickness..... | 1.5 mm | 60 mil |
|---|---|---|---|---|---|---|---|---|
| | MIN: | 1.46 | mm | 57 | mil | Length..... | 125 m | 410.1 feet |
| | MAX: | 1.81 | mm | 71 | mil | Width..... | 7.00 m; | 23.0 feet |
| Asperity GRI GM12: 30 mil ODD # : TOP EVEN #: BOTTOM | AVE: | 1.58 | mm | 62 | mil | OIT(Standard) ASTM D3895 minutes 143 | | |

| | | | | | TEST RESULTS | |
|---|---|---|---|---|---|---|
| Specific Gravity ASTM D792 | Density | g/cc | | | .944 | |
| MFI ASTM D1238 COND. E GRADE: 7002 | Melt Flow Index 190°C /2160 g | g/10 min | | | .24 | |
| Carbon Black Content ASTM D4218 | Range | % | | | 2.35 | |
| Carbon Black Dispersion ASTM D5596 | Category | | | | 1 | |
| Tensile Strength ASTM D6693 ASTM D638 (Modified) ( 2 inches / minute ) | Average Strength @ Yield | 27 N/mm | 152 ppi | | 2,448 | psi |
| | Average Strength @ Break | 31 N/mm | 177 ppi | | 2,842 | psi |
| Elongation ASTM D6693 ASTM D638 (Modified) ( 2 inches / minute ) Lo = 1.3" Yield | Average Elongation @ Yield | % | | | 17.46 | |
| Lo = 2.0" Break | Average Elongation @ Break | % | | | 502.2 | |
| Dimensional Stability ASTM D1204 (Modified) | Average Dimensional change | % | | | -.61 | |
| Tear Resistance ASTM D-1004 (Modified) | Average Tear Resistance | 245.1 N | | | 55.095 | lbs |
| Puncture Resistance FTMS 101 Method 2065 (Modified) | Load | 437.3 N | | | 98.324 | lbs |
| Puncture Resistance ASTM D4833 (Modified) | Load | 614.2 N | | | 138.08 | lbs |
| ESCR ASTM D1693 | Minimum Hrs w/o Failures | 1500 hrs | | | CERTIFIED | |
| Notched Constant Tensile Load ASTM D5397 | pass / fail @ 30% | 300 hrs | | | ONGOING | |

Customer: **Environmental Specialties**
PO: **6208 Big Run Landfill**
Destination **Ashland, KY**

Date: **3-15-06**

Signature: [signature]

Quality Control Department

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REV 03
12/23/05

agru america quality control dept

# quality certificate

ROLL # **206769-06** Lot # **CSG812000** **Liner Type:SMOOTH LLDPE**

| | | METRIC | ENGLISH | | | |
|---|---|---|---|---|---|---|
| Thickness Measurement ASTM D5199 (Modified) | MIN: | **1.425** mm | **56** mil | Thickness | **1.5mm** | **60mil** |
| | MAX: | **1.703** mm | **67** mil | Length | **128** m | **420** feet |
| | AVE: | **1.558** mm | **61** mil | Width | **6.86** m | **22.5** feet |
| | | | | OIT(Standard) ASTM D3895 | minutes | **144** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Specific Gravity ASTM D792 | | Density | | g/cc | | | **.937** |
| MFI ASTM D1238 COND. E GRADE: | **7104** | Melt Flow Index 190°C /2160 g | - | g /10 min | | | **.32** |
| Carbon Black Content ASTM D4218 | | Range | | % | | | **2.46** |
| Carbon Black Dispersion ASTM D5596 | | Category | | | | | **1** |
| Tensile Strength ASTM D6693 ASTM D638 (Modified) ( 2 inches / minute ) | | Average Strength @ Break | **53** | N/mm | **300** | ppi | **5,005** psi |
| Elongation ASTM D-6693 ASTM D638 (Modified) ( 2 inches / minute ) Lo = 1.3" Yield Lo = 2.0" Break | | Average Elongation @ Break | | % | | | **931.1** |
| Dimensional Stability ASTM D1204 (Modified) | | Average Dimensional Change | | % | | | **-0.20** |
| Tear Resistance ASTM D1004 (Modified) | | Average Tear Resistance | **204** | N | | | **45.966** lbs |
| Puncture Resistance FTMS 101 Method 2065 (Modified) | | Load | **455** | N | | | **102.37** lbs |
| Puncture Resistance ASTM D4833 (Modified) | | Load | **550** | N | | | 123.56 lbs |
| ESCR ASTM D1693 | | Minimum Hrs w / o Failures | 1500 hrs | | | | **CERTIFIED** |

Customer:
PO:
Destination

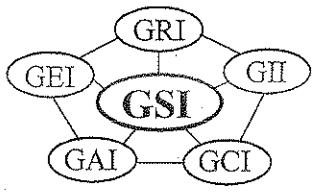
Date: **2-13-06**

Signature: _____

Quality Control Department

60LLSM.FRM
REV 02
12/23/05

*Geosynthetic Institute*
475 Kedron Avenue
Folsom, PA 19033-1208 USA
TEL (610) 522-8440
FAX (610) 522-8441




June 7, 2007

Mr. Grant Palmer
Laboratory Director
Agru-America Inc.
500 Garrison Road
Georgetown, SC 29440

Re: GAI-LAP Accreditation

Dear Grant:

The Geosynthetic Institute (GSI) is pleased to acknowledge Agru-America Inc. on its repertoire of Geosynthetic Accreditation Institute's-Laboratory Accreditation Program (GAI-LAP) accredited tests. This letter should serve as notification that Agru-America Inc. located in Georgetown, SC is currently accredited for the following twenty test methods until June 30, 2008.

1. ASTM D792 Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
2. ASTM D1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting
3. ASTM D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
4. ASTM D1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
5. ASTM D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics
6. ASTM D3895 Test Methods for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
7. ASTM D4218 Test Method for Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
8. ASTM D4716 Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
9. ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products

10. ASTM D5035 Test Method for Breaking Strength and Elongation of Textile Fabrics (Strip Method)
11. ASTM D5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
12. ASTM D5261 Test Method for Measuring Mass per Unit Area of Geotextiles
13. ASTM D5397 Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes using Notched Constant Tension Load Test
14. ASTM D5596 Test Methods for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
15. ASTM D5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
16. ASTM D6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
17. ASTM D7005 Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites
18. ASTM D7179 Test Method for Determining the Geonet Breaking Force
19. FTM STD. No. 101c (method 2065), Puncture Resistance and Elongation Test (1/8 in. radius probe)
20. GRI GM-12 Asperity Measurement of Textured Geomembranes Using a Depth Gage

A certificate to this affect has been enclosed, signed and sealed. Any questions regarding your accreditation should be directed to George or Robert Koerner at (610) 522-8440. Once again congratulation and thank you for participating in the GAI-LAP.

Best Regards,

George R. Koerner

George R. Koerner, Ph.D., P.E. & CQA
Director Designate GSI

**Accreditation #:**
GAI-LAP - 26 - 97
TEL (610) 522-8440

Geosynthetic Institute
475 Kedron, Ave.
Folsom, PA 19033

# Agru America, Inc.

*is granted accreditation*
*for designated geosynthetic test methods in accordance with the Geosynthetic Accreditation Institute - Laboratory Accreditation Program (GAI-LAP), as published in its annual directory.*
*This accreditation is valid until June 30, 2008.*

Robert M. Koerner, Ph.D., P.E.
Director

GRI GEI GII GSI GAI GCI

George R. Koerner, Ph.D., P.E. & CQA
Auditor

CHESAPEAKE
CONTAINMENT SYSTEMS, INC.

# Haley Pike Landfill

# Geosynthetic Supply Bid

# Geomembrane Option #2

# GSE

352 Earls Road
Middle River, MD 21220
410-335-5886 phone
443.303.1682 fax
www.ccsliners.com

The Pioneer Of Geosynthetics

SINCE 1972

Product Data Sheet - Minimum

# GSE UltraFlex Textured Geomembrane

GSE UltraFlex Textured is a co-extruded textured linear low density polythylene (LLDPE) geomembrane available on one or both sides. It is manufactured from the highest quality resin specifically formulated for flexible geomembranes. This product is used in applications that require increased frictional resistance, flexibility and elongation properties where differential or localized subgrade settlements may occur such as in a landfill closure application.

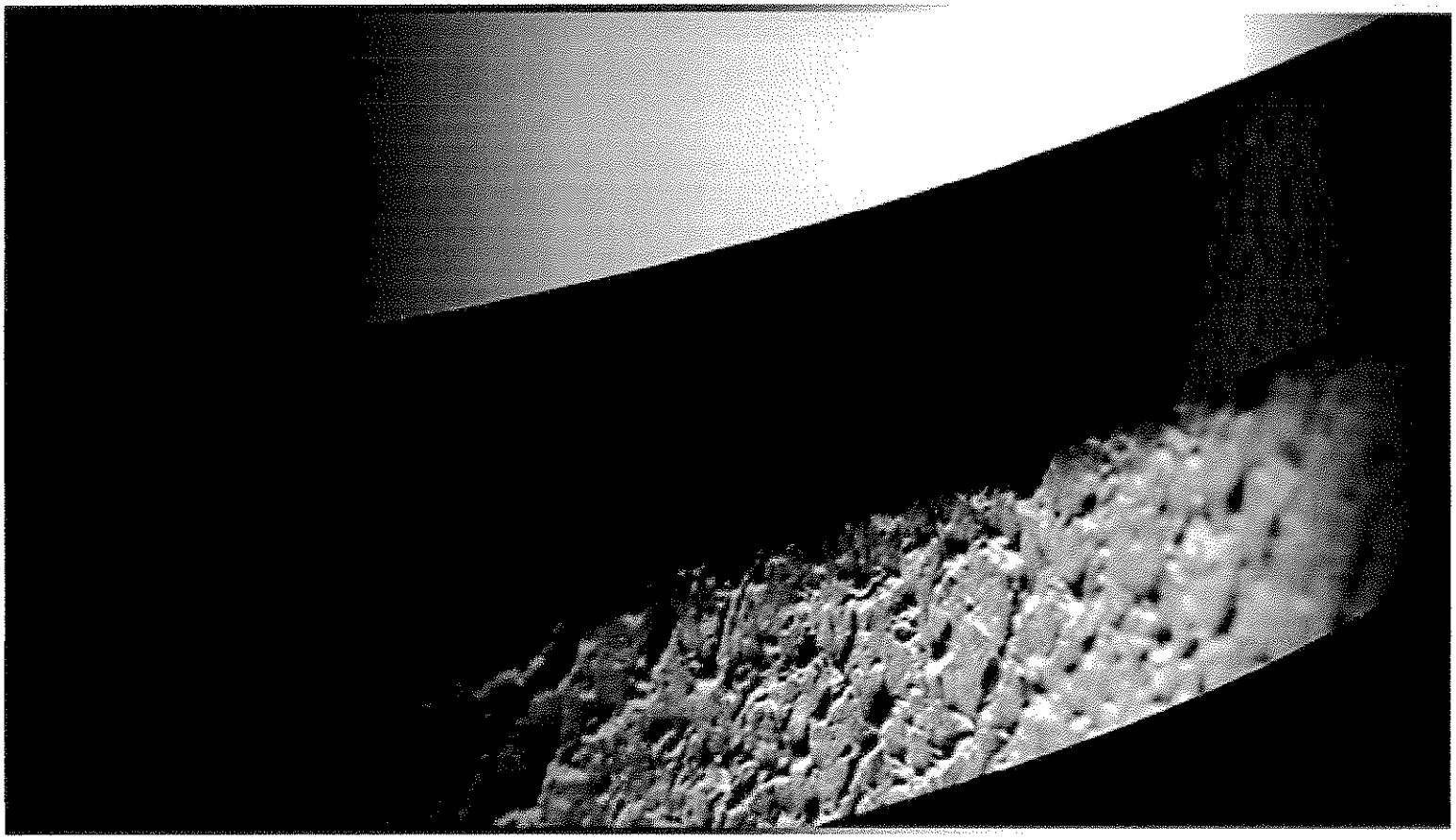
***Product Specifications*** *These product specifications meet or exceed GRI GM17.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | |
|---|---|---|---|---|---|---|
| | | | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm) | ASTM D 5994 | every roll | 40 (1.00) | 60 (1.50) | 80 (2.00) | 100 (2.50) |
| Density, g/cm$^3$ | ASTM D 1505 | 200,000 lb | 0.92 | 0.92 | 0.92 | 0.92 |
| Tensile Properties (each direction) | ASTM D 6693, Type IV | 20,000 lb | | | | |
| Strength at Break, lb/in-width (N/mm) | Dumbell, 2 ipm | | 115 (20) | 168 (29) | 224 (39) | 270 (47) |
| Elongation at Break, % | G.L. 2.0 in (51 mm) | | 500 | 500 | 500 | 500 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 25 (111) | 38 (169) | 50 (222) | 60 (266) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 65 (289) | 95 (422) | 125 (556) | 140 (622) |
| Carbon Black Content, % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[1] | Note[1] | Note[1] | Note[1] |
| Asperity Height, mil (mm) | ASTM D 7466 | second roll | 18 (0.45) | 18 (0.45) | 18 (0.45) | 18 (0.45) |
| Oxidative Induction Time, min | ASTM D 3895, 200° C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | |
| Roll Length[2], ft (m) | Double-Sided Textured | | 700 (213) | 520 (158) | 400 (122) | 330 (100) |
| | Single-Sided Textured | | 650 (198) | 420 (128) | 320 (98) | 250 (76) |
| Roll Width[2], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft$^2$ (m$^2$) | Double-Sided Textured | | 15,750 (1,463) | 11,700 (1,087) | 9,000 (836) | 7,425 (689) |
| | Single-Sided Textured | | 14,625 (1,359) | 9,450 (878) | 7,200 (669) | 5,625 (522) |

**NOTES:**

- [1]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [2]Roll lengths and widths have a tolerance of ± 1%.
- GSE UltraFlex Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77° C when tested according to ASTM D 746.
- *Modified.

Manufacturing Quality Assurance Manual



# Geomembrane Products

GSE

## Table of Contents

## 1.0 INTRODUCTION

This manual provides an overview of the GSE Manufacturing Quality Assurance Program for geomembrane products. It is intended for use by GSE's customers to enhance their understanding of the quality system under which GSE geomembrane products are manufactured.

## 2.0 COMMITMENT TO QUALITY

GSE is committed to meeting or exceeding customer's requirements and industry standards. This commitment to quality is established through a documented quality management system, continuous employee training, investment in technology and emphasis on process control. GSE has allocated resources to ensure that this commitment to quality translates into the best products and services for its customers.

## 3.0 MANUFACTURING QUALITY ASSURANCE

GSE has an on-site quality assurance laboratory at each manufacturing facility worldwide. Each facility has a fully equipped, well staffed, dedicated laboratory with strict guidelines to maintain a high level of quality and up-to-the-minute results on GSE's finished products.

GSE has a rigorous set of minimum standards and an effective test program to assure compliance has been established. These procedures and requirements are frequently reviewed and adjusted to assure compliance with current market demands and/or predetermined project specifications. Also raw materials and process parameters are controlled to provide products complying with GSE's minimum characteristics and regulatory standards.

## 4.0 MANUFACTURING QUALITY ASSURANCE ORGANIZATION

GSE quality assurance department assures that only products meeting GSE and/or the customer's requirements are released for shipment. The quality assurance personnel are directly responsible for monitoring, testing, and providing feedback to the manufacturing department ensuring the production of the specified product quality. Each member of the quality assurance team must participate in detailed training that includes factory exposure.

The GSE quality assurance team consists of the manufacturing quality assurance laboratories, engineering staff and manufacturing personnel. The combination of expertise and experience from these groups provide GSE with the proper tools to maintain the highest level of product quality and customer service in the industry.

## 5.0 STAFF & SCHEDULING

The quality assurance laboratories are staffed during any manufacturing run. A continuous communication link is maintained between the laboratory and manufacturing personnel, maximizing production efficiency and product quality.

## 6.0 PRODUCT IDENTIFICATION & DOCUMENTATION

A. *Roll Numbering*
Each roll of geomembrane is assigned a unique roll number. The quality assurance laboratory maintains records documenting the raw materials and resulting product quality information.

B. *Approval Procedure*
Results for each tested roll of product are checked against GSE and/or customer's specifications for compliance. The quality assurance laboratory approves those materials that meet both of these requirements for shipment.

C. *Non-Conformance*
Material that does not meet GSE's minimum standards is given a roll number, but is rejected and separated from the approved material. The rejected material is identified as non-conformaning and will not be used. Material that meets GSE's minimum standards, but does not meet a stricter customer's specifications will not be allocated to that customer, but will be placed into inventory as a GSE's standard material.

D. *Documentation*
Quality assurance certificates are generated and supplied for each roll of geomembrane product to include all relevant quality assurance information about the material.

## 7.0 RECORDS RETENTION

GSE maintains reports and/or samples for products produced and sold. Records and/or samples are maintained according to GSE's standard retention policy as outlined below.

| MATERIAL | ITEM | YEAR |
|---|---|---|
| Raw Materials | Resin Supplier Test Reports and Certifications | ≥ 2 |
| | GSE Resin Test Reports | ≥ 2 |
| | Resin Sample Retain (Archive) | ≥ 2 |
| Geomembranes | Raw Test Data (in computer database) | ≥ 5 |
| | Quality Control Certificates | ≥ 5 |
| | Sample Retain (approximately one square foot) | ≥ 5 |

## 8.0 TESTING CAPABILITIES

GSE maintains high capacity, state-of-the-art laboratory equipment suitable for performing the procedures listed in Appendixes A-H in Houston, Texas. The quality assurance laboratory is accredited by the GAI-LAP Program. The appropriate certificates are maintained for review upon request by authorized parties.

A. *Routine Testing*
GSE has developed a strict and thorough quality assurance program, which exceeds all industry's standards and/or customer's specifications including GRI GM13, "Test Properties, Testing Frequency

and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes and GRI GM17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes. The testing program covers raw materials as shown in Appendix A and the finished goods as shown in Appendixes B-H and is adhered to by all GSE's quality assurance laboratories. The laboratory equipment used by GSE represents the most modern equipment available and meets or exceeds the requirements of all the test standards used.

B. *Other Testing Capabilities*
In addition to routine testing, GSE laboratories are equipped to perform a wide variety of other tests as required for unusual requests or product development. Further, although the GSE's laboratories are fully equipped and able to perform the most routinely specified tests in the industry, there are some tests that are more economically performed by a dedicated testing facility. GSE believes requirements for such testing should be carefully considered and defined in terms of specific design requirements if they are found to be necessary.

## 9.0 MATERIAL QUALITY ASSURANCE

GSE has established strict specifications for all raw materials and finished products. Test results must fall within the acceptable limits of GSE and customer's specifications.

A. *Raw Material*
GSE uses two types of raw materials in the manufacture of geomembrane products: natural resin and masterbatch . Natural resin is the base material that is used to make a geomembrane. It contains stabilizers to prevent degradation from occurring during and after extrusion. Masterbatch is the term referring to the concentrated carbon black material blended with the natural resin to produce the finished product. The natural resin and masterbatch are blended at the appropriate ratio at the manufacturing stage. The masterbatch can contain other additives depending upon the geomembrane product to be produced. GSE verifies the properties of each lot of raw material prior to their utilization.

When natural resin is received, samples are taken and subjected to the tests outlined in Appendix A. All test data are entered into the computer database and checked for accuracy, consistency and compliance with GSE's specifications. The material is not accepted unless all standard test requirements are met and the GSE's test values meet the requirements set forth in the raw material specifications.

Copies of the supplier's certificate of analysis (COA) for each lot of resin utilized in the production of the materials supplied to a specific project are supplied as standard documentation. In addition, the GSE's test results for each lot of resin are provided in a separate report upon request. Virgin resin is normally received in rail car lots. If resin is received by other transport and/or in other quantities, an equivalent suitable sampling procedure is provided (i.e. not less than one sample per shipment or one sample for each 50,000 lb, 23,000 kg).

B. *Geomembrane Products*

GSE has implemented a strict and thorough quality assurance program for all geomembrane products. The geomembrane product line can be broken into two primary categories: smooth and textured products. The tables contain GSE's minimum properties and test frequencies for all GSE geomembrane products, such as GSE Green (green surface geomembrane), GSE White (light-reflective geomembrane) and GSE Conductive (field spark-testable geomembrane) as shown in Appendixes B-H.

1. On-Line Manufacturing Quality Assurance
   The quality assurance program for finished product begins during the manufacturing process. Each manufacturing line is equipped with state-of-the-art monitoring devices that provide feedback on the physical quality of the materials being produced. Each geomembrane production line is equipped with both a thickness gauge and spark-testing device.

   a. Thickness Measurement
      As geomembrane is being produced, thickness readings are taken continuously over the length and width of the roll. These data are used to establish the minimum, maximum and average thickness values for each roll and are verified by thickness testing upon sampling of the finished goods.

   b. Spark Testing
      An electrical spark detector is in place on each manufacturing sheet line. This apparatus provides immediate notification of holes in the finished product. If a hole is detected, an alarm is triggered and the hole is identified. Rolls containing holes are rejected from standard product inventory.

2. Smooth Geomembrane Materials
   Smooth geomembrane products available include high density and linear low density polyethylene materials with 2-3% carbon black. Specialty materials include GSE White, GSE Conductive, and GSE Green geomembranes.

   *a. Sampling*
      Geomembrane rolls are sampled for QA testing according to the frequencies in Appendix B. An approximate one-foot by roll width sample is cut for quality assurance testing. Test specimens are taken from five positions across the width of the roll. A retain or archive sample approximately 12 in x 12 in (30 cm x 30 cm) is taken one of the five positions on an alternating basis from the laboratory sample. The retain is labeled and kept for future reference.

   *b. Evaluation of Results*
      All data are entered into a computer database for calculation and comparison to GSE and/or customer's specifications. If materials do not meet GSE's minimum requirements and/or the customer's specifications, the manufacturing personnel will appropriately make the adjustments. Only products meeting GSE's minimums and/or customer's specifications will be approved for shipment.

c. *Reporting*
Every roll of material has a quality assurance roll certificate or Roll Test Data Report (RTDR). This report identifies the standards on which the GSE's approval is based along with the actual test results demonstrated by the material.

3. Co-extruded Textured Geomembranes
Textured geomembrane is produced utilizing a round die with co-extrusion technology. The texture is produced in a process in which one or both of the outer layers of a three-layer extrusion are blended with nitrogen gas. Nitrogen bubbles form in the molten resin and escape upon exiting the die, creating a rough, textured surface. GSE standard, GSE White, GSE Green, and GSE Conductive geomembranes are available with co-extruded texturing.

a. *Sampling*
Geomembrane rolls are sampled for QA testing according to the frequencies in Appendixes B-H. An approximate one-foot by roll width sample is cut for quality assurance testing. Specimens for testing are taken from five positions across the width of the roll. Specimens for testing the machine and transverse direction tensile are cut from each of the five positions. A retain or archive sample approximately 12 in x 12 in (30 cm x 30 cm) is taken from the corresponding transverse direction position from the laboratory sample. The retain is labeled and kept for future reference. Evaluation of results and reporting practices are the same as for smooth geomembranes.

C. *Third Party Conformance Sampling*
Some specifications require independent quality assurance and/or conformance testing. GSE can provide assistance with the sampling of products by arranging for the conformance samples to be taken during production. By taking samples during production rather than on-site or after production, the customer can be assured that the samples are clean and available for conformance testing in a timely manner.

GSE encourages customers to audit GSE manufacturing and other manufacturing quality assurance facilities to collect samples and conduct independent conformance testing prior to shipment of materials.

D. *Product Shipping*
It is GSE's policy to ship only products that have been tested and approved. All shipments are packaged according to industry's standard practices and/or customer's specifications. Only approved handling methods are used to move rolls into and out of shipping containers, please see the GSE Installation Quality Assurance Manual for more details.

GSE 01/18/10 USA

# Appendix A: Minimum Testing Frequencies and Properties for GSE Raw Materials

## TABLE 1. MINIMUM TESTING FREQUENCIES

| Property | Test Method[1] | Natural Resin |
|---|---|---|
| Density | ASTM D 1505 | once per rail car compartment |
| Melt Flow Index | ASTM D 1238 (190/2.16) | once per rail car compartment |
| OIT | ASTM D 3895 (1 ATM at 200° C) | once per resin lot[2] |
| Carbon Black Content | ASTM D 1603, modified | N/A |
| Carbon Black Dispersion | ASTM D 5996 | NA |

**NOTES:**

[1]GSE utilizes test equipment and procedures that enable effective and economical confirmation that the product will conform to specifications based on the noted procedures. Some test procedures have been modified for application to geosynthetics. All procedures and values are subject to change without prior notification.

[2]OIT for LLDPE/VFPE resin is performed on a representative finished product for each lot of resin rather than on the natural (without carbon black) resin.

## TABLE 2. MINIMUM PROPERTIES FOR GSE RAW MATERIALS

| Property | Test Method[1] | HDPE | LLDPE/VFPE |
|---|---|---|---|
| Density [g/cm³] | ASTM D 1505 | 0.932 | 0.915 |
| Melt Flow Index [g/10 min] | ASTM D 1238 (190/2.16) | ≤ 1.0 | ≤ 1.0 |
| OIT [minutes] | ASTM D 3895 (1 ATM at 200° C) | 100 | 100[2] |

**NOTES:**

[1]GSE utilizes test equipment and procedures that enable effective and economical confirmation that the product will conform to specifications based on the noted procedures. Some test procedures have been modified for application to geosynthetics. All procedures and values are subject to change without prior notification.

[2]OIT for LLDPE/VFPE resin is performed on a representative finished product for each lot of resin rather than on the natural (without carbon black) resin.

# Appendix B: GSE HD Smooth Data Sheet

***Product Specifications***

*These product specifications meet or exceed GRI GM13.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | | |
|---|---|---|---|---|---|---|---|
| | | | 30 mil | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5199 | every roll | 30 (0.75)<br>27 (0.69) | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.30) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| Tensile Properties (each direction) | ASTM D 6693, Type IV | 20,000 lb | | | | | |
| Strength at Break, lb/in-width (N/mm) | Dumbell, 2 ipm | | 120 (21) | 152 (26) | 243 (42) | 327 (57) | 410 (71) |
| Strength at Yield, lb/in-width (N/mm) | | | 66 (11) | 84 (14) | 132 (23) | 177 (30) | 212 (37) |
| Elongation at Break, % | G.L. 2.0 in (51 mm) | | 700 | 700 | 700 | 700 | 700 |
| Elongation at Yield, % | G.L. 1.3 in (33 mm) | | 13 | 13 | 13 | 13 | 13 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 21 (93) | 28 (124) | 42 (186) | 58 (257 ) | 73 (324) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 65 (289) | 85 (378) | 125 (556) | 160 (711) | 195 (867) |
| Carbon Black Content, % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[1] | Note[1] | Note[1] | Note[1] | Note[1] |
| Notched Constant Tensile Load, hr | ASTM D 5397, Appendix | 200,000 lb | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Oxidative Induction Time, min | ASTM D 3895, 200° C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | | |
| Roll Length[2], ft (m) | | | 1,120 (341) | 870 (265) | 560 (171) | 430 (131) | 340 (104) |
| Roll Width[2], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | | | 25,200 (2,341) | 19,575 (1,819) | 12,600 (1,171) | 9,675 (899) | 7,650 (711) |

**NOTES:**

- [1]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [2]Roll lengths and widths have a tolerance of ± 1%.
- GSE HD is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77° C when tested according to ASTM D 746.
- *Modified.

# Appendix B: GSE HD Textured Data Sheet

***Product Specifications***

*These product specifications meet or exceed GRI GM13.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | | |
|---|---|---|---|---|---|---|---|
| | | | 30 mil | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5994 | every roll | 30 (0.75)<br>27 (0.69) | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.30) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| Tensile Properties (each direction)<br>Strength at Break, lb/in-width (N/mm)<br>Strength at Yield, lb/in-width (N/mm)<br>Elongation at Break, %<br>Elongation at Yield, % | ASTM D 6693, Type IV<br>Dumbell, 2 ipm<br><br><br>G.L. 2.0 in (51 mm)<br>G.L. 1.3 in (33 mm) | 20,000 lb | <br>66 (11)<br>68 (11)<br>100<br>12 | <br>75 (13)<br>90 (15)<br>100<br>12 | <br>115 (20)<br>132 (23)<br>100<br>12 | <br>155 (27)<br>177 (31)<br>100<br>12 | <br>230 (40)<br>225 (39)<br>100<br>12 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 24 (106) | 32 (142) | 45 (200) | 60 (266) | 75 (333) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 65 (289) | 95 (422) | 130 (578) | 160 (711) | 190 (845) |
| Carbon Black Content, % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[1] | Note[1] | Note[1] | Note[1] | Note[1] |
| Asperity Height, mil (mm) | ASTM D 7466 | second roll | 16 (0.40) | 18 (0.45) | 18 (0.45) | 18 (0.45) | 18 (0.45) |
| Notched Constant Tensile Load[2], hr | ASTM D 5397, Appendix | 200,000 lb | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Oxidative Induction Time, min | ASTM D 3895, 200°C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | | |
| Roll Length[3], ft (m) | Double-Sided Textured<br>Single-Sided Textured | | 830 (253)<br>840 (256) | 700 (213)<br>650 (198) | 520 (158)<br>420 (128) | 400 (122)<br>320 (98) | 330 (101)<br>250 (76) |
| Roll Width[3], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | Double-Sided Textured<br>Single-Sided Textured | | 18,675 (1,735)<br>18,900 (1,755) | 15,750 (1,463)<br>14,625 (1,359) | 11,700 (1,087)<br>9,450 (878) | 9,000 (836)<br>7,200 (669) | 7,425 (690)<br>5,625 (523) |

**NOTES:**

- [1]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [2]NCTL for GSE HD Textured is conducted on representative smooth membrane samples.
- [3]Roll lengths and widths have a tolerance of ± 1%.
- GSE HD Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix C: GSE Green Smooth Data Sheet

***Product Specifications***

*These product specifications meet or exceed GRI GM13.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | | |
|---|---|---|---|---|---|---|---|
| | | | 30 mil | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm) | ASTM D 5199 | every roll | 30 (0.75) | 40 (1.00) | 60 (1.50) | 80 (2.00) | 100 (2.50) |
| Lowest individual reading (-10%) | | | 27 (0.69) | 36 (0.91) | 54 (1.40) | 72 (1.80) | 90 (2.30) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| Tensile Properties (each direction) | ASTM D 6693, Type IV | 20,000 lb | | | | | |
| Strength at Break, lb/in-width (N/mm) | Dumbell, 2 ipm | | 120 (21) | 152 (26) | 243 (42) | 327 (57) | 410 (71) |
| Strength at Yield, lb/in-width (N/mm) | | | 66 (11) | 84 (14) | 132 (23) | 177 (30) | 212 (37) |
| Elongation at Break, % | G.L. 2.0 in (51 mm) | | 700 | 700 | 700 | 700 | 700 |
| Elongation at Yield, % | G.L. 1.3 in (33 mm) | | 13 | 13 | 13 | 13 | 13 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 21 (93) | 28 (124) | 42 (186) | 58 (257 ) | 73 (324) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 65 (289) | 85 (378) | 125 (556) | 160 (711) | 195 (867) |
| Carbon Black Content[1], % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[2] | Note[2] | Note[2] | Note[2] | Note[2] |
| Notched Constant Tensile Load, hr | ASTM D 5397, Appendix | 200,000 lb | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Oxidative Induction Time, min | ASTM D 3895, 200°C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | | |
| Roll Length[3], ft (m) | | | 1,120 (341) | 870 (265) | 560 (171) | 430 (131) | 340 (104) |
| Roll Width[3], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | | | 25,200 (2,341) | 19,575 (1,819) | 12,600 (1,171) | 9,675 (899) | 7,650 (711) |

**NOTES:**

- [1]GSE Green may have an overall ash content greater than 3.0% due to the green layer. These values apply to the black layer only.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]Roll lengths and widths have a tolerance of ± 1%.
- GSE Green is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix C: GSE Green Textured Data Sheet

***Product Specifications*** *These product specifications meet or exceed GRI GM13.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | | |
|---|---|---|---|---|---|---|---|
| | | | 30 mil | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5994 | every roll | 30 (0.75)<br>27 (0.69) | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.30) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| Tensile Properties (each direction)<br>Strength at Break, lb/in-width (N/mm)<br>Strength at Yield, lb/in-width (N/mm)<br>Elongation at Break, %<br>Elongation at Yield, % | ASTM D 6693, Type IV<br>Dumbell, 2 ipm<br><br><br>G.L. 2.0 in (51 mm)<br>G.L. 1.3 in (33 mm) | 20,000 lb | <br>66 (11)<br>68 (11)<br>100<br>12 | <br>75 (13)<br>90 (15)<br>100<br>12 | <br>115 (20)<br>132 (23)<br>100<br>12 | <br>155 (27)<br>177 (31)<br>100<br>12 | <br>230 (40)<br>225 (39)<br>100<br>12 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 24 (106) | 32 (142) | 45 (200) | 60 (266) | 75 (333) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 65 (289) | 95 (422) | 130 (578) | 160 (711) | 190 (845) |
| Carbon Black Content[1], % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[2] | Note[2] | Note[2] | Note[2] | Note[2] |
| Asperity Height, mil (mm) | ASTM D 7466 | second roll | 16 (0.40) | 18 (0.45) | 18 (0.45) | 18 (0.45) | 18 (0.45) |
| Notched Constant Tensile Load[3], hr | ASTM D 5397, Appendix | 200,000 lb | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Oxidative Induction Time, min | ASTM D 3895, 200°C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | | |
| Roll Length[4], ft (m) | Double-Sided Textured<br>Single-Sided Textured | | 830 (253)<br>840 (256) | 700 (213)<br>650 (198) | 520 (158)<br>420 (128) | 400 (122)<br>320 (98) | 330 (101)<br>250 (76) |
| Roll Width[4], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | Double-Sided Textured<br>Single-Sided Textured | | 18,675 (1,735)<br>18,900 (1,755) | 15,750 (1,463)<br>14,625 (1,359) | 11,700 (1,087)<br>9,450 (878) | 9,000 (836)<br>7,200 (669) | 7,425 (690)<br>5,625 (523) |

**NOTES:**

- [1]GSE Green Textured may have an overall ash content greater than 3.0% due to the green layer. These values apply to the black layer only.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]NCTL for Green Textured is conducted on representative smooth membrane samples.
- [4]Roll lengths and widths have a tolerance of ± 1%.
- GSE Green Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix D: GSE White Smooth Data Sheet

***Product Specifications***

*These product specifications meet or exceed GRI GM13.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | | |
|---|---|---|---|---|---|---|---|
| | | | **30 mil** | **40 mil** | **60 mil** | **80 mil** | **100 mil** |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5199 | every roll | 30 (0.75)<br>27 (0.69) | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.30) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| Tensile Properties (each direction) | ASTM D 6693, Type IV | 20,000 lb | | | | | |
| Strength at Break, lb/in-width (N/mm) | Dumbell, 2 ipm | | 120 (21) | 152 (26) | 243 (42) | 327 (57) | 410 (71) |
| Strength at Yield, lb/in-width (N/mm) | | | 66 (11) | 84 (14) | 132 (23) | 177 (30) | 212 (37) |
| Elongation at Break, % | G.L. 2.0 in (51 mm) | | 700 | 700 | 700 | 700 | 700 |
| Elongation at Yield, % | G.L. 1.3 in (33 mm) | | 13 | 13 | 13 | 13 | 13 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 21 (93) | 28 (124) | 42 (186) | 58 (257 ) | 73 (324) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 65 (289) | 85 (378) | 125 (556) | 160 (711) | 195 (867) |
| Carbon Black Content[1], % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[2] | Note[2] | Note[2] | Note[2] | Note[2] |
| Notched Constant Tensile Load, hr | ASTM D 5397, Appendix | 200,000 lb | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Oxidative Induction Time, min | ASTM D 3895, 200°C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | | |
| Roll Length[3], ft (m) | | | 1,120 (341) | 870 (265) | 560 (171) | 430 (131) | 340 (104) |
| Roll Width[3], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | | | 25,200<br>(2,341) | 19,575<br>(1,819) | 12,600<br>(1,171) | 9,675<br>(899) | 7,650<br>(711) |

**NOTES:**

- [1]GSE White may have an overall ash content greater than 3.0% due to the white layer. These values apply to the black layer only.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]Roll lengths and widths have a tolerance of ±1%.
- GSE White is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix D: GSE White Textured Data Sheet

***Product Specifications*** *These product specifications meet or exceed GRI GM13.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | | |
|---|---|---|---|---|---|---|---|
| | | | 30 mil | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5994 | every roll | 30 (0.75)<br>27 (0.69) | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.30) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| Tensile Properties (each direction)<br>Strength at Break, lb/in-width (N/mm)<br>Strength at Yield, lb/in-width (N/mm)<br>Elongation at Break, %<br>Elongation at Yield, % | ASTM D 6693, Type IV<br>Dumbell, 2 ipm<br><br><br>G.L. 2.0 in (51 mm)<br>G.L. 1.3 in (33 mm) | 20,000 lb | <br>66 (11)<br>68 (11)<br>100<br>12 | <br>75 (13)<br>90 (15)<br>100<br>12 | <br>115 (20)<br>132 (23)<br>100<br>12 | <br>155 (27)<br>177 (31)<br>100<br>12 | <br>230 (40)<br>225 (39)<br>100<br>12 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 24 (106) | 32 (142) | 45 (200) | 60 (266) | 75 (333) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 65 (289) | 95 (422) | 130 (578) | 160 (711) | 190 (845) |
| Carbon Black Content[1], % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[2] | Note[2] | Note[2] | Note[2] | Note[2] |
| Asperity Height, mil (mm) | ASTM D 7466 | second roll | 16 (0.40) | 18 (0.45) | 18 (0.45) | 18 (0.45) | 18 (0.45) |
| Notched Constant Tensile Load[3], hr | ASTM D 5397, Appendix | 200,000 lb | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Oxidative Induction Time, min | ASTM D 3895, 200°C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | | |
| Roll Length[4], ft (m) | Double-Sided Textured<br>Single-Sided Textured | | 830 (253)<br>840 (256) | 700 (213)<br>650 (198) | 520 (158)<br>420 (128) | 400 (122)<br>320 (98) | 330 (101)<br>250 (76) |
| Roll Width[4], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | Double-Sided Textured<br>Single-Sided Textured | | 18,675 (1,735)<br>18,900 (1,755) | 15,750 (1,463)<br>14,625 (1,359) | 11,700 (1,087)<br>9,450 (878) | 9,000 (836)<br>7,200 (669) | 7,425 (690)<br>5,625 (523) |

**NOTES:**

- [1]GSE White may have an overall ash content greater than 3.0% due to the white layer. These values apply to the black layer only.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]NCTL for GSE White Textured is conducted on representative smooth membrane samples.
- [4]Roll lengths and widths have a tolerance of ± 1%.
- GSE White Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix E: GSE Conductive Smooth Data Sheet

***Product Specifications***

*These product specifications meet or exceed GRI GM13.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | |
|---|---|---|---|---|---|---|
| | | | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5199 | every roll | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.30) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.94 | 0.94 | 0.94 | 0.94 |
| Tensile Properties (each direction)<br>Strength at Break, lb/in-width (N/mm)<br>Strength at Yield, lb/in-width (N/mm)<br>Elongation at Break, %<br>Elongation at Yield, % | ASTM D 6693, Type IV<br>Dumbell, 2 ipm<br><br>G.L. 2.0 in (51 mm)<br>G.L. 1.3 in (33 mm) | 20,000 lb | <br>152 (26)<br>84 (14)<br>700<br>13 | <br>243 (42)<br>132 (23)<br>700<br>13 | <br>327 (57)<br>177 (30)<br>700<br>13 | <br>410 (71)<br>212 (37)<br>700<br>13 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 28 (124) | 42 (186) | 58 (257) | 73 (324) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 85 (378) | 125 (556) | 160 (711) | 195 (867) |
| Carbon Black Content[1], % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[2] | Note[2] | Note[2] | Note[2] |
| Notched Constant Tensile Load, hr | ASTM D 5397, Appendix | 200,000 lb | 1,000 | 1,000 | 1,000 | 1,000 |
| Oxidative Induction Time, min | ASTM D 3895, 200°C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | |
| Roll Length[3], ft (m) | | | 870 (265) | 560 (171) | 430 (131) | 340 (104) |
| Roll Width[3], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | | | 19,575 (1,819) | 12,600 (1,171) | 9,675 (899) | 7,650 (711) |

**NOTES:**

- [1]GSE Conductive may have an overall ash content greater than 3.0%. These values apply to the non-conductive black layers.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]Roll lengths and widths have a tolerance of ± 1%.
- GSE Conductive is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix E: GSE Conductive Textured (Single-Sided) Data Sheet

***Product Specifications*** *These product specifications meet or exceed GRI GM13.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | |
|---|---|---|---|---|---|---|
| | | | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5994 | every roll | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.30) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.94 | 0.94 | 0.94 | 0.94 |
| Tensile Properties (each direction)<br>Strength at Break, lb/in-width (N/mm)<br>Strength at Yield, lb/in-width (N/mm)<br>Elongation at Break, %<br>Elongation at Yield, % | ASTM D 6693, Type IV<br>Dumbell, 2 ipm<br><br>G.L. 2.0 in (51 mm)<br>G.L. 1.3 in (33 mm) | 20,000 lb | <br>75 (13)<br>90 (15)<br>100<br>12 | <br>115 (20)<br>132 (23)<br>100<br>12 | <br>155 (27)<br>177 (31)<br>100<br>12 | <br>230 (40)<br>225 (39)<br>100<br>12 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 32 (142) | 45 (200) | 60 (266) | 75 (333) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 95 (422) | 130 (578) | 160 (711) | 190 (845) |
| Carbon Black Content[1], % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[2] | Note[2] | Note[2] | Note[2] |
| Asperity Height, mil (mm) | ASTM D 7466 | second roll | 18 (0.45) | 18 (0.45) | 18 (0.45) | 18 (0.45) |
| Notched Constant Tensile Load[3], hr | ASTM D 5397, Appendix | 200,000 lb | 1,000 | 1,000 | 1,000 | 1,000 |
| Oxidative Induction Time, min | ASTM D 3895, 200°C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | |
| Roll Length[4], ft (m) | | | 650 (198) | 420 (128) | 320 (98) | 250 (76) |
| Roll Width[4], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft², (m²), ft | | | 14,625 (1,359) | 9,450 (878) | 7,200 (669) | 5,625 (523) |

**NOTES:**

- [1]GSE Conductive Textured may have an overall ash content greater than 3.0%. These values apply to the non-conductive black layers.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]NCTL for GSE Conductive Textured is conducted on representative smooth membrane samples.
- [4]Roll lengths and widths have a tolerance of ± 1%.
- GSE Conductive Textured Single-Sided is available in rolls weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix F: GSE Conductive White Smooth Data Sheet

***Product Specifications*** *These product specifications meet or exceed GRI GM13.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | |
|---|---|---|---|---|---|---|
| | | | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5199 | every roll | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.30) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.94 | 0.94 | 0.94 | 0.94 |
| Tensile Properties (each direction)<br>Strength at Break, lb/in-width (N/mm)<br>Strength at Yield, lb/in-width (N/mm)<br>Elongation at Break, %<br>Elongation at Yield, % | ASTM D 6693, Type IV<br>Dumbell, 2 ipm<br><br>G.L. 2.0 in (51 mm)<br>G.L. 1.3 in (33 mm) | 20,000 lb | <br>152 (26)<br>84 (14)<br>700<br>13 | <br>243 (42)<br>132 (23)<br>700<br>13 | <br>327 (57)<br>177 (30)<br>700<br>13 | <br>410 (71)<br>212 (37)<br>700<br>13 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 28 (124) | 42 (186) | 58 (257 ) | 73 (324) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 85 (378) | 125 (556) | 160 (711) | 195 (867) |
| Carbon Black Content[1], % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[2] | Note[2] | Note[2] | Note[2] |
| Notched Constant Tensile Load, hr | ASTM D 5397, Appendix | 200,000 lb | 1,000 | 1,000 | 1,000 | 1,000 |
| Oxidative Induction Time, min | ASTM D 3895, 200°C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | |
| Roll Length[3], ft (m) | | | 870 (265) | 560 (171) | 430 (131) | 340 (104) |
| Roll Width[3], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | | | 19,575 (1,819) | 12,600 (1,171) | 9,675 (899) | 7,650 (711) |

**NOTES:**

- [1]GSE Conductive White may have an overall ash content greater than 3.0% due to the white and conductive outer layers. These values apply to the non-conductive black layers.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]Roll lengths and widths have a tolerance of ± 1%.
- GSE Conductive White is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix F: GSE Conductive White Textured (Single-Sided) Data Sheet

***Product Specifications*** *These product specifications meet or exceed GRI GM13.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | |
|---|---|---|---|---|---|---|
| | | | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5994 | every roll | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.30) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.94 | 0.94 | 0.94 | 0.94 |
| Tensile Properties (each direction)<br>Strength at Break, lb/in-width (N/mm)<br>Strength at Yield, lb/in-width (N/mm)<br>Elongation at Break, %<br>Elongation at Yield, % | ASTM D 6693, Type IV<br>Dumbell, 2 ipm<br><br>G.L. 2.0 in (51 mm)<br>G.L. 1.3 in (33 mm) | 20,000 lb | <br>75 (13)<br>90 (15)<br>100<br>12 | <br>115 (20)<br>132 (23)<br>100<br>12 | <br>155 (27)<br>177 (31)<br>100<br>12 | <br>230 (40)<br>225 (39)<br>100<br>12 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 32 (142) | 45 (200) | 60 (266) | 75 (333) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 95 (422) | 130 (578) | 160 (711) | 190 (845) |
| Carbon Black Content[1], % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[2] | Note[2] | Note[2] | Note[2] |
| Asperity Height, mil (mm) | ASTM D 7466 | second roll | 18 (0.45) | 18 (0.45) | 18 (0.45) | 18 (0.45) |
| Notched Constant Tensile Load[3], hr | ASTM D 5397, Appendix | 200,000 lb | 1,000 | 1,000 | 1,000 | 1,000 |
| Oxidative Induction Time, min | ASTM D 3895, 200°C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | |
| Roll Length[4], ft (m) | | | 650 (198) | 420 (128) | 320 (98) | 250 (76) |
| Roll Width[4], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft², (m²), ft | | | 14,625 (1,359) | 9,450 (878) | 7,200 (669) | 5,625 (523) |

**NOTES:**

- [1]GSE Conductive White Textured may have an overall ash content greater than 3.0% due to the white and conductive outer layers. These values apply to the non-conductive black layers.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]NCTL for GSE Conductive White Textured is conducted on representative smooth membrane samples.
- [4]Roll lengths and widths have a tolerance of ± 1%.
- GSE Conductive White Textured Single-Sided is available in rolls weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix G: GSE UltraFlex Smooth Data Sheet

***Product Specifications***

*These product specifications meet or exceed GRI GM17.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | |
|---|---|---|---|---|---|---|
| | | | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm) | ASTM D 5199 | every roll | 40 (1.00) | 60 (1.50) | 80 (2.00) | 100 (2.50) |
| Lowest individual reading (-10%) | | | 36 (0.91) | 54 (1.40) | 72 (1.80) | 90 (2.28) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.92 | 0.92 | 0.92 | 0.92 |
| Tensile Properties (each direction) | ASTM D 6693, Type IV | 20,000 lb | | | | |
| Strength at Break, lb/in-width (N/mm) | Dumbell, 2 ipm | | 170 (29) | 240 (42) | 320 (56) | 380 (66) |
| Elongation at Break, % | G.L. 2.0 in (51 mm) | | 800 | 800 | 800 | 800 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 22 (97) | 33 (146) | 44 (195) | 55 (244) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 70 (311) | 100 (444) | 130 (578) | 155 (689) |
| Carbon Black Content, % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[1] | Note[1] | Note[1] | Note[1] |
| Oxidative Induction Time, min | ASTM D 3895, 200° C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | |
| Roll Length[2], ft (m) | | | 870 (265) | 560 (171) | 430 (131) | 340 (103) |
| Roll Width[2], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | | | 19,575 (1,819) | 12,600 (1,171) | 9,675 (899) | 7,650 (710) |

**NOTES:**

- [1]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [2]Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and ITB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix G: GSE UltraFlex Textured Data Sheet

***Product Specifications*** *These product specifications meet or exceed GRI GM17.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | |
|---|---|---|---|---|---|---|
| | | | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5994 | every roll | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.28) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.92 | 0.92 | 0.92 | 0.92 |
| Tensile Properties (each direction)<br>Strength at Break, lb/in-width (N/mm)<br>Elongation at Break, % | ASTM D 6693, Type IV<br>Dumbell, 2 ipm<br>G.L. 2.0 in (51 mm) | 20,000 lb | <br>115 (20)<br>500 | <br>168 (29)<br>500 | <br>224 (39)<br>500 | <br>270 (47)<br>500 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 25 (111) | 38 (169) | 50 (222) | 60 (266) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 65 (289) | 95 (422) | 125 (556) | 140 (622) |
| Carbon Black Content, % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[1] | Note[1] | Note[1] | Note[1] |
| Asperity Height, mil (mm) | ASTM D 7466 | second roll | 18 (0.45) | 18 (0.45) | 18 (0.45) | 18 (0.45) |
| Oxidative Induction Time, min | ASTM D 3895, 200° C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | |
| Roll Length[2], ft (m) | Double-Sided Textured<br>Single-Sided Textured | | 700 (213)<br>650 (198) | 520 (158)<br>420 (128) | 400 (122)<br>320 (98) | 330 (100)<br>250 (76) |
| Roll Width[2], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | Double-Sided Textured<br>Single-Sided Textured | | 15,750 (1,463)<br>14,625 (1,359) | 11,700 (1,087)<br>9,450 (878) | 9,000 (836)<br>7,200 (669) | 7,425 (689)<br>5,625 (522) |

**NOTES:**

- [1]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [2]Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix H: GSE UltraFlex White Smooth Data Sheet

***Product Specifications***

*These product specifications meet or exceed GRI GM17.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | |
|---|---|---|---|---|---|---|
| | | | 40 mil | 60 mil | 80 mil | 100 mil |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5199 | every roll | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.28) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.92 | 0.92 | 0.92 | 0.92 |
| Tensile Properties (each direction)<br>Strength at Break, lb/in-width (N/mm)<br>Elongation at Break, % | ASTM D 6693, Type IV<br>Dumbell, 2 ipm<br>G.L. 2.0 in (51 mm) | 20,000 lb | <br>170 (29)<br>800 | <br>240 (42)<br>800 | <br>320 (56)<br>800 | <br>380 (66)<br>800 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 22 (97) | 33 (146) | 44 (195) | 55 (244) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 70 (311) | 100 (444) | 130 (578) | 155 (689) |
| Carbon Black Content[1], % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[2] | Note[2] | Note[2] | Note[2] |
| Oxidative Induction Time, min | ASTM D 3895, 200° C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | |
| Roll Length[3], ft (m) | | | 870 (265) | 560 (171) | 430 (131) | 340 (103) |
| Roll Width[3], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | | | 19,575 (1,819) | 12,600 (1,171) | 9,675 (899) | 7,650 (710) |

**NOTES:**

- [1]GSE UltraFlex White may have an overall ash content greater than 3.0% due to the white layer. These values apply to the black layer only.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex White is available in rolls weighing approximately 3,900 lb (1,769 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

# Appendix H: GSE UltraFlex White Textured Data Sheet

***Product Specifications*** *These product specifications meet or exceed GRI GM17.*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE VALUE | | | |
|---|---|---|---|---|---|---|
| | | | **40 mil** | **60 mil** | **80 mil** | **100 mil** |
| Thickness, (minimum average) mil (mm)<br>Lowest individual reading (-10%) | ASTM D 5994 | every roll | 40 (1.00)<br>36 (0.91) | 60 (1.50)<br>54 (1.40) | 80 (2.00)<br>72 (1.80) | 100 (2.50)<br>90 (2.28) |
| Density, g/cm³ | ASTM D 1505 | 200,000 lb | 0.92 | 0.92 | 0.92 | 0.92 |
| Tensile Properties (each direction)<br>Strength at Break, lb/in-width (N/mm)<br>Elongation at Break, % | ASTM D 6693, Type IV<br>Dumbell, 2 ipm<br>G.L. 2.0 in (51 mm) | 20,000 lb | <br>115 (20)<br>500 | <br>168 (29)<br>500 | <br>224 (39)<br>500 | <br>270 (47)<br>500 |
| Tear Resistance, lb (N) | ASTM D 1004 | 45,000 lb | 25 (111) | 38 (169) | 50 (222) | 60 (266) |
| Puncture Resistance, lb (N) | ASTM D 4833 | 45,000 lb | 65 (289) | 95 (422) | 125 (556) | 140 (622) |
| Carbon Black Content[1], % (Range) | ASTM D 1603*/4218 | 20,000 lb | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 |
| Carbon Black Dispersion | ASTM D 5596 | 45,000 lb | Note[2] | Note[2] | Note[2] | Note[2] |
| Asperity Height, mil (mm) | ASTM D 7466 | second roll | 18 (0.45) | 18 (0.45) | 18 (0.45) | 18 (0.45) |
| Oxidative Induction Time, min | ASTM D 3895, 200° C; $O_2$, 1 atm | 200,000 lb | >140 | >140 | >140 | >140 |
| **TYPICAL ROLL DIMENSIONS** | | | | | | |
| Roll Length[3], ft (m) | Double-Sided Textured<br>Single-Sided Textured | | 700 (213)<br>650 (198) | 520 (158)<br>420 (128) | 400 (122)<br>320 (98) | 330 (100)<br>250 (76) |
| Roll Width[3], ft (m) | | | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) | 22.5 (6.9) |
| Roll Area, ft² (m²) | Double-Sided Textured<br>Single-Sided Textured | | 15,750 (1,463)<br>14,625 (1,359) | 11,700 (1,087)<br>9,450 (878) | 9,000 (836)<br>7,200 (669) | 7,425 (689)<br>5,625 (522) |

**NOTES:**

- [1]GSE UltraFlex White Textured may have an overall ash content greater than 3.0% due to the white layer. These values apply to the black layer only.
- [2]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [3]Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex White Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.