

**APPENDIX D**  
**PRODUCT DATA SHEETS**

## APPENDIX D

### PRODUCT DATA SHEETS

This appendix includes manufacturer data sheets for materials included in the laboratory testing program discussed in Section 3.0.

#### BENTONITE FOR PERMEABILITY TESTING

A series of flexible-wall permeability tests were conducted on soils amended with one to three percent by dry weight of bentonite, discussed in Section 3.5. Wyo-Ben Envirogel 200 bentonite was added to the select samples prior to compaction. The amended soils were thoroughly mixed, moisture-conditioned, and remolded to the required density. The product data sheet for the Wyo-Ben Envirogel 200 is included in Appendix D-1.

#### GEOSYNTHETIC MATERIALS

As discussed in Section 3.7 of the report, interface shear testing was conducted to ensure stability of the proposed liner systems under the anticipated loading conditions. The focus of the interface shear testing program was on the liner systems for the tailings cells and the five-acre ore pad. Though double-lined, the evaporation ponds will be shallow, and liner stability is not considered a major concern. Interface shear testing was conducted to evaluate the following interfaces:

- 60 mil textured high density polyethylene (HDPE) geomembrane versus drainage geocomposite (*representative of the primary or secondary geomembrane liner in the tailings cells in contact with the Leak Collection and Recovery System [LCRS] layer on the cell slopes*);
- 60 mil textured HDPE geomembrane versus the following geosynthetic clay liners (GCL):
  - Bentomat CLT manufactured by CETCO Lining Technologies (CETCO), with clay side against the geomembrane (*a liner system considered for the tailings cells secondary composite liner*); and

- Bentomat ST manufactured by CETCO, with woven side against the geomembrane (*a liner system considered for the tailings cells secondary composite liner*).
- GCL materials versus native compacted soil materials, as follows:
  - Bentomat CLT manufactured by CETCO, with laminated HDPE side against soil (*a liner system considered for the five-acre ore pad*); and
  - Bentomat DN manufactured by CETCO, with white nonwoven side against soil (*a liner system considered for the five-acre ore pad, but also representative of the GCL adjacent to the subgrade for the tailings cells*).

The following geosynthetic materials were used for the testing program:

- *Geomembrane*: 60 mil double-sided textured HDPE geomembrane manufactured by Poly-Flex Inc.;
- *Drainage Geocomposite*: TexDrain 250 DS 6 drainage geocomposite manufactured by CETCO, comprised of a 250 mil geonet thermally bonded on both sides with a nonwoven geotextile;
- *Geosynthetic Clay Liners (GCL)*:
  - Bentomat CLT manufactured by CETCO, which is a reinforced GCL consisting of a layer of sodium bentonite between two geotextiles which are needle-punched together and laminated with a 20-mil textured HDPE geomembrane;
  - Bentomat ST manufactured by CETCO, which is a reinforced GCL consisting of a layer of sodium bentonite between woven and nonwoven geotextiles which are needle-punched together; and
  - Bentomat DN manufactured by CETCO, which is a reinforced GCL consisting of a layer of sodium bentonite between two nonwoven geotextiles which are needle-punched together.

Data sheets for the various geosynthetic materials are included in Appendix D-2. Prior to construction of the facilities, confirmatory interface shear testing will be conducted, per the project technical specifications.

**APPENDIX D-1**

**BENTONITE FOR PERMEABILITY TESTING**



# ENVIROGEL<sup>®</sup> 200

ENVIROGEL<sup>®</sup> 200 is a non-treated high swelling sodium bentonite processed specifically for soil/bentonite membranes installed where low permeability liners or caps are desired. Though appropriate in most soil types, ENVIROGEL<sup>®</sup> 200 is particularly effective as an amendment to clays and silts since the finely ground bentonite particles blend well to fill small void spaces inherent in fine grained soils.

## TYPICAL SIEVE ANALYSIS

Sieve Size	% Retained	% Passing
80	2.0	98.0
100	4.2	95.8
200	19.4	80.6
325	48.3	51.7
Processed Density: 56.0 ± 4.0 lb/ft <sup>3</sup>		

## APPLICATION RATE

ENVIROGEL<sup>®</sup> 200 is easily applied through a drop spreader for in-situ application, or can be preblended with soil in a pugmill operation. Typical addition rates will range from 2% to 8% depending upon base soil characteristics. A fine powder, it is highly efficient and disperses well into most types of soils.

## SUGGESTED SPECIFICATIONS

- 2.1 The bentonite supplied as a soil sealant shall be high-swelling sodium montmorillonite clay referred to as Wyoming Bentonite or Sodium Bentonite. The bentonite shall be ENVIROGEL<sup>®</sup> 200 as manufactured by Wyo-Ben, Inc., Billings, Montana, or an equal approved by the engineer prior to bid.
- 2.2 High swelling is defined as the ability of 2 grams of bentonite, when mechanically reduced to a minus 100 mesh, to swell in water to an apparent volume of 16 ccs or more when added a little at a time to 100 ccs of distilled water contained in a graduated cylinder.
- 2.3 The colloid content of the bentonite shall exceed 70% and is measured by evaporating and weighing the suspended portion from a 2% distilled water solution after 24 hours of sedimentation.
- 2.4 Dry fineness of the soil sealant shall be:  
80% maximum passing 200 mesh

**ENVIROGEL<sup>®</sup> 200 is available in bulk, both truck and rail, bulk sacks containing approximately 3,000 lbs. each, or 50 lb. or 100 lb. multi-walled paper bags, palletized for easy handling. It can be transferred by either pneumatic or mechanical conveyance systems.**

**APPENDIX D-2**  
**GEOSYNTHETIC MATERIALS**

# TEXTURED HDPE GEOMEMBRANE

## ENGLISH UNITS

### Minimum Average Values

Property	Test Method	40 mil	60 mil	80 mil	100 mil
Thickness, mils	ASTM D 5994				
minimum average		38	57	76	95
lowest individual of 8 of 10 readings		36	54	72	90
lowest individual of 10 readings		34	51	68	85
Asperity Height <sup>1</sup> , mils	GRI GM12	10	10	10	10
Sheet Density, g/cc	ASTM D 1505/D 792	0.940	0.940	0.940	0.940
<b>Tensile Properties<sup>2</sup></b>	ASTM D 6693				
1. Yield Strength, lb/in		84	126	168	210
2. Break Strength, lb/in		60	90	120	150
3. Yield Elongation, %		12	12	12	12
4. Break Elongation, %		100	100	100	100
Tear Resistance, lb	ASTM D 1004	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	60	90	120	150
Stress Crack Resistance <sup>3</sup> , hrs	ASTM D 5397 (App.)	300	300	300	300
Carbon Black Content <sup>4</sup> , %	ASTM D 1603	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	--Note 5--			
Oxidative Induction Time (OIT)					
Standard OIT, minutes	ASTM D 3895	100	100	100	100
Oven Aging at 85°C	ASTM D 5721				
High Pressure OIT - % retained after 90 days	ASTM D 5885	80	80	80	80
UV Resistance <sup>6</sup>	GRI GM11				
High Pressure OIT <sup>7</sup> - % retained after 1600 hrs	ASTM D 5885	50	50	50	50
<b>Seam Properties</b>	ASTM D 6392 (@ 2 in/min)				
1. Shear Strength, lb/in		80	120	160	200
2. Peel Strength, lb/in - Hot Wedge		60	91	121	151
- Extrusion Fillet		52	78	104	130
<b>Roll Dimensions</b>					
1. Width (feet):		23	23	23	23
2. Length (feet)		750	500	375	300
3. Area (square feet):		17,250	11,500	8,625	6,900
4. Gross weight (pounds, approx.)		3,500	3,500	3,470	3,470

1 Of 10 readings; 8 must be  $\geq$  7 mils and lowest individual reading must be  $\geq$  5 mils.

2 Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 1.3 inches; Break elongation is calculated using a gauge length of 2.0 inches.

3 The yield stress used to calculate the applied load for the SP-NCTL test should be the mean value via MQC testing.

4 Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation can be established.

5 Carbon black dispersion for 10 different views: Nine in Categories 1 and 2 with one allowed in Category 3.

6 The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

7 UV resistance is based on percent retained value regardless of the original HP-OIT value.

This data is provided for informational purposes only and is not intended as a warranty or guarantee. Poly-Flex, Inc. assumes no responsibility in connection with the use of this data. These values are subject to change without notice. REV.11/06

# Products

## PRODUCT SELECTIONS

TexDrain is available in a wide range of product combinations allowing economical performance driven product selection.

### TEXDRAIN 200 GEONET - PROPERTIES

Property	Test	Units	Typical Value
Thickness	ASTM D 5199	Mil	200
Mass per Unit Area	ASTM D 5261	lb/ft <sup>2</sup>	.162
Density, min.	ASTM D 1505	g/cc	.94
Carbon Black Content, min.	ASTM D 1603	%	2
Tensile Strength	ASTM D 5035 mod	lbs/inch	45
Transmissivity* (MD)	ASTM D 4716	gal/min. ft	4.8
Transmissivity*, (MD)	ASTM D 4716	m <sup>2</sup> /s	1 x 10 <sup>-3</sup>

\* tested between two metal plates at 15,000 lb/ ft<sup>2</sup> with a hydraulic gradient of 1.0

### TEXDRAIN 250 GEONET - PROPERTIES

Property	Test	Units	Typical Value
Thickness	ASTM D 5199	Mil	250
Mass per Unit Area	ASTM D 5261	lb/ft <sup>2</sup>	.20
Density, min.	ASTM D 1505	g/cc	.94
Carbon Black Content, min.	ASTM D 1603	%	2
Tensile Strength	ASTM D 5035 mod	lbs/inch	60
Transmissivity* (MD)	ASTM D 4716	gal/min. ft	7.2
Transmissivity* (MD)	ASTM D 4716	m <sup>2</sup> /sec	1.5 x 10 <sup>-3</sup>

\* tested between two metal plates at 15,000 lb/ ft<sup>2</sup> with a hydraulic gradient of 1.0

TexDrain Geonet can be combined with a broad range of nonwoven geotextiles, thermally bonded to either one or two sides to achieve a wide range of product performance. The chart below illustrates typical transmissivity data for several common products. For more complete data, refer to the latest TexDrain Certified Properties Sheet.

Product	Transmissivity (gal/min. ft)	Transmissivity (m <sup>2</sup> / sec)
TexDrain 200 SS 6	0.97	2 x 10 <sup>4</sup>
TexDrain 200 SS 8	0.48	1 x 10 <sup>4</sup>
TexDrain 200 DS 6	0.48	1 x 10 <sup>4</sup>
TexDrain 200 DS 8	0.19	4 x 10 <sup>3</sup>
TexDrain 250 SS 6	1.44	3 x 10 <sup>4</sup>
TexDrain 250 SS 8	0.48	1 x 10 <sup>4</sup>
TexDrain 250 DS 6	1.44	3 x 10 <sup>4</sup>
TexDrain 250 DS 8	0.48	1 x 10 <sup>4</sup>

The above values, unless otherwise specified, are the minimum acceptable average test results for any roll based on the specified test methods and do not refer to an individual test specimen. The data provided is for informational purposes only and is not intended as a warranty or guarantee. Values are subject to change without notice. Rev. 11/02



1500 West Shure Drive  
Arlington Heights, Illinois 60004 U.S.A.

PH 847.392.5800 800.527.9948 FX 847.577.5571 www.cetco.com



## BENTOMAT® CLT CERTIFIED PROPERTIES

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY ft <sup>2</sup> (m <sup>2</sup> )	REQUIRED VALUES
Bentonite Swell Index <sup>1</sup>	ASTM D 5890	1 per 50 tonnes	24 mL/2g min.
Bentonite Fluid Loss <sup>1</sup>	ASTM D 5891	1 per 50 tonnes	18 mL max.
Bentonite Mass/Area <sup>2</sup>	ASTM D 5993	40,000 ft <sup>2</sup> (4,000 m <sup>2</sup> )	0.75 lb/ft <sup>2</sup> (3.6 kg/m <sup>2</sup> ) min
GCL Grab Strength <sup>3</sup>	ASTM D 6768	200,000 ft <sup>2</sup> (20,000 m <sup>2</sup> )	45 lbs/in (70 N/cm) MARV
GCL Peel Strength <sup>3</sup>	ASTM D 6496	40,000 ft <sup>2</sup> (4,000 m <sup>2</sup> )	3.5 lbs/in (6.1 N/cm) min
GCL Index Flux <sup>4</sup>	ASTM D 5887	Periodic	1 x 10 <sup>-9</sup> m <sup>3</sup> /m <sup>2</sup> /sec max
GCL Hydraulic Conductivity <sup>4</sup>	ASTM D 5887	Periodic	5 x 10 <sup>-10</sup> cm/sec max
GCL Hydrated Internal Shear Strength <sup>5</sup>	ASTM D 5321 ASTM D 6243	Periodic	500 psf (24 kPa) typical

***Bentomat CLT is a reinforced GCL consisting of a layer of sodium bentonite between two geotextiles, which are needlepunched together and laminated to a 20-mil (0.5mm) textured HDPE geomembrane.***

### Notes

<sup>1</sup> Bentonite property tests performed at a bentonite processing facility before shipment to CETCO's GCL production facilities.

<sup>2</sup> Bentonite mass/area reported at 0 percent moisture content.

<sup>3</sup> All tensile strength testing is performed in the machine direction using ASTM D 6768. All peel strength testing is performed using ASTM D 6496. Upon request, tensile and peel results can be reported per modified ASTM D 4632 using 4 inch grips.

<sup>4</sup> ASTM D5887 Index flux and hydraulic conductivity testing with deaired distilled/deionized water at 80 psi (551 kPa) cell pressure, 77 psi (531 kPa) headwater pressure and 75 psi (517 kPa) tailwater pressure. Reported value is equivalent to 92 gal/acre/day. This flux value is equivalent to a permeability of 5x10<sup>-10</sup> cm/sec for typical GCL thickness. ASTM D 5887 testing is performed only on a periodic basis because the membrane is essentially impermeable.

<sup>5</sup> Peak value measured at 200 psf (10 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.



1500 W. Shure Drive Arlington Heights, IL 60004 USA 800.527.9948 Fax 847.577.5571

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## BENTOMAT® ST CERTIFIED PROPERTIES

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY ft <sup>2</sup> (m <sup>2</sup> )	REQUIRED VALUES
Bentonite Swell Index <sup>1</sup>	ASTM D 5890	1 per 50 tonnes	24 ml/2g min.
Bentonite Fluid Loss <sup>1</sup>	ASTM D 5891	1 per 50 tonnes	18 ml max.
Bentonite Mass/Area <sup>2</sup>	ASTM D 5993	40,000 ft <sup>2</sup> (4,000 m <sup>2</sup> )	0.75 lb/ft <sup>2</sup> (3.6 kg/m <sup>2</sup> ) min
GCL Grab Strength <sup>3</sup>	ASTM D 6768	200,000 ft <sup>2</sup> (20,000 m <sup>2</sup> )	30 lbs/in (53 N/cm) MARV
GCL Peel Strength <sup>3</sup>	ASTM D 6496	40,000 ft <sup>2</sup> (4,000 m <sup>2</sup> )	3.5 lbs/in (6.1 N/cm) min
GCL Index Flux <sup>4</sup>	ASTM D 5887	Weekly	1 x 10 <sup>-8</sup> m <sup>3</sup> /m <sup>2</sup> /sec max
GCL Hydraulic Conductivity <sup>4</sup>	ASTM D 5887	Weekly	5 x 10 <sup>-9</sup> cm/sec max
GCL Hydrated Internal Shear Strength <sup>5</sup>	ASTM D 5321 ASTM D 6243	Periodic	500 psf (24 kPa) typ @ 200 psf

**Bentomat ST is a reinforced GCL consisting of a layer of sodium bentonite between a woven and a nonwoven geotextiles, which are needlepunched together.**

### Notes

<sup>1</sup> Bentonite property tests performed at a bentonite processing facility before shipment to CETCO's GCL production facilities.

<sup>2</sup> Bentonite mass/area reported at 0 percent moisture content.

<sup>3</sup> All tensile strength testing is performed in the machine direction using ASTM D 6768. All peel strength testing is performed using ASTM D 6496. Upon request, tensile and peel results can be reported per modified ASTM D 4632 using 4 inch grips.

<sup>4</sup> Index flux and permeability testing with deaired distilled/deionized water at 80 psi (551kPa) cell pressure, 77 psi (531 kPa) headwater pressure and 75 psi (517 kPa) tailwater pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of 5x10<sup>-9</sup> cm/sec for typical GCL thickness. Actual flux values vary with field condition pressures. The last 20 weekly values prior the end of the production date of the supplied GCL may be provided.

<sup>5</sup> Peak values measured at 200 psf (10 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

*CETCO has developed an edge enhancement system that eliminates the need to use additional granular sodium bentonite within the overlap area of the seams. We call this edge enhancement, SuperGroove™, and it comes standard on both longitudinal edges of Bentomat® ST. It should be noted that SuperGroove™ does not appear on the end-of-roll overlaps and recommend the continued use of supplemental bentonite for all end-of-roll seams.*



1500 W. Shure Drive Arlington Heights, IL 60004 USA 800.527.9948 Fax 847.577.5571

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## BENTOMAT® DN CERTIFIED PROPERTIES

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY ft <sup>2</sup> (m <sup>2</sup> )	REQUIRED VALUES
Bentonite Swell Index <sup>1</sup>	ASTM D 5890	1 per 50 tonnes	24 mL/2g min.
Bentonite Fluid Loss <sup>1</sup>	ASTM D 5891	1 per 50 tonnes	18 mL max.
Bentonite Mass/Area <sup>2</sup>	ASTM D 5993	40,000 ft <sup>2</sup> (4,000 m <sup>2</sup> )	0.75 lb/ft <sup>2</sup> (3.6 kg/m <sup>2</sup> ) min
GCL Grab Strength <sup>3</sup>	ASTM D 6768	200,000 ft <sup>2</sup> (20,000 m <sup>2</sup> )	50 lbs/in (88 N/cm) MARV
GCL Peel Strength <sup>3</sup>	ASTM D 6496	40,000 ft <sup>2</sup> (4,000 m <sup>2</sup> )	3.5 lbs/in (6.1 N/cm) min
GCL Index Flux <sup>4</sup>	ASTM D 5887	Weekly	1 x 10 <sup>-8</sup> m <sup>3</sup> /m <sup>2</sup> /sec max
GCL Hydraulic Conductivity <sup>4</sup>	ASTM D 5887	Weekly	5 x 10 <sup>-9</sup> cm/sec max
GCL Hydrated Internal Shear Strength <sup>5</sup>	ASTM D 5321 ASTM D 6243	Periodic	500 psf (24 kPa) typ @ 200 psf

**Bentomat DN is a reinforced GCL consisting of a layer of sodium bentonite between two nonwoven geotextiles, which are needlepunched together.**

### Notes

<sup>1</sup> Bentonite property tests performed at a bentonite processing facility before shipment to CETCO's GCL production facilities.

<sup>2</sup> Bentonite mass/area reported at 0 percent moisture content.

<sup>3</sup> All tensile strength testing is performed in the machine direction using ASTM D 6768. All peel strength testing is performed using ASTM D 6496. Upon request, tensile and peel results can be reported per modified ASTM D 4632 using 4 inch grips.

<sup>4</sup> Index flux and permeability testing with deaired distilled/deionized water at 80 psi (551kPa) cell pressure, 77 psi (531 kPa) headwater pressure and 75 psi (517 kPa) tailwater pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of 5x10<sup>-9</sup> cm/sec for typical GCL thickness. Actual flux values vary with field condition pressures. The last 20 weekly values prior the end of the production date of the supplied GCL may be provided.

<sup>5</sup> Peak values measured at 200 psf (10 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

*CETCO has developed an edge enhancement system that eliminates the need to use additional granular sodium bentonite within the overlap area of the seams. We call this edge enhancement, SuperGroove™, and it comes standard on both longitudinal edges of Bentomat® DN. It should be noted that SuperGroove™ does not appear on the end-of-roll overlaps and recommend the continued use of supplemental bentonite for all end-of-roll seams.*



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