March 11, 2014

Mail To:

Bill Sabatka
Arcadis U.S., Inc.
211 North Florence, Suite 202
El Paso, Texas 79901

email: bill.sabatka@arcadis-us.com

Bill To:

<= Same

Dear Mr. Sabatka:

Thank you for consulting TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report of the laboratory testing for the sample(s) listed below.

Project:	**ASARCO El Paso- Category 1 Landfill Cell 3**
TRI Job Reference Number:	E2386-88-04
Material(s) Tested:	One Agru 40 mil Microspike LLDPE Geomembrane(s)
Test(s) Requested:	Thickness (ASTM D 5994) Density (ASTM D 1505) Carbon Black Content (ASTM D 4218) Carbon Dispersion (ASTM D 5596) Tensile Properties (ASTM D 6693)

If you have any questions or require any additional information, please call us at 1-800-880-8378

Sincerely,

MPatel

Mansukh Patel
Laboratory Manager
Geosynthetic Services Division
www.GeosyntheticTesting.com

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

GEOMEMBRANE TEST RESULTS

TRI Client: Arcadis U.S., Inc.
Project: ASARCO El Paso- Category 1 Landfill Cell 3

Material: Agru 40 mil Microspike LLDPE Geomembrane
Sample Identification: 832763-13
TRI Log #: E2386-88-04

PARAMETER	TEST REPLICATE NUMBER										MEAN	STD. DEV.
	1	2	3	4	5	6	7	8	9	10		
Thickness (ASTM D 5994)												
Thickness (mils)	44	43	43	48	45	44	46	45	46	44	45 ✓ 43	2 << min
Density (ASTM D 1505)												
Density (g/cm3)	0.933	0.933	0.933								0.933✓	0.000
Carbon Black Content (ASTM D 4218)												
% Carbon Black	2.27	2.31									2.29✓	0.03
Carbon Black Dispersion (ASTM D 5596)												
Rating - 1st field view	1	1	1	1	1							
Rating - 2nd field view	1	1	1	1	1							
Tensile Properties (ASTM D 6693, 2 ipm strain rate)												
MD Yield Strength (ppi)	88	85	95	91	79						88	6
TD Yield Strength (ppi)	82	101	94	90	93						92	7
MD Break Strength (ppi)	130	141	137	133	128						134	5
TD Break Strength (ppi)	114	137	122	115	123						122	9
MD Yield Elongation (%)	32	34	25	23	30						29	5
TD Yield Elongation (%)	25	25	20	21	21						22	2
MD Break Elongation (%)	384	419	476	466	474						444	41
TD Break Elongation (%)	521	525	489	504	539						516	19

MD Machine Direction TD Transverse Direction

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TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. - AUSTIN, TX 78733 - USA | PH: 800.880.TEST OR 512.263.2101

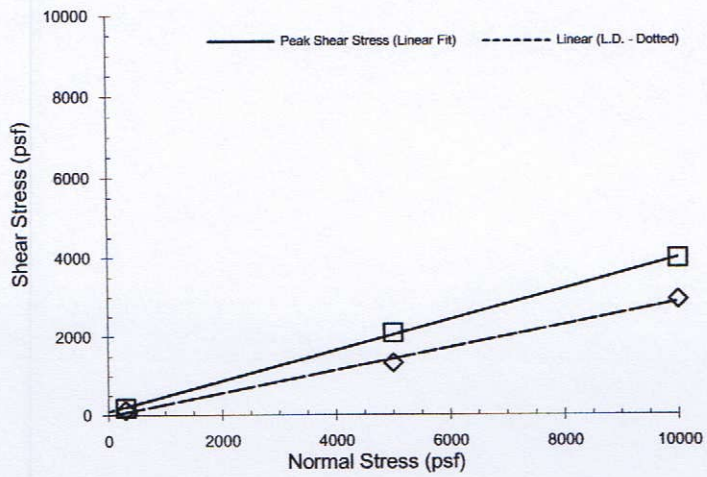
Interface Friction Test Report

Client: **Arcadis**
Project: **Former Asarco Smelter**
Date: 03-10-2014 to 03-14-2014

TRI Log#: E2388-16-06
Test Method: ASTM D6243

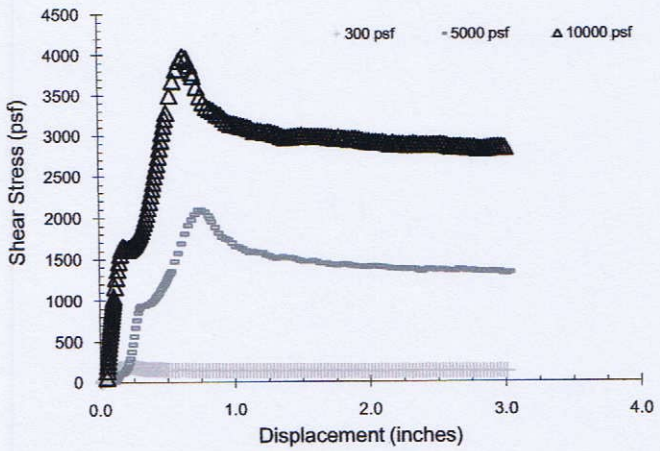
John M. Allen, P.E., 03/14/2014
Quality Review/Date

Tested Interface: Bentomat DN GCL (10319) vs. Agru 40 mil LLDPE Microspike Geomembrane (832763-13)



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	21.4	16.2
Y-intercept or Adhesion (psf):	93	-17

Shearing occurred at the interface.



Test Conditions	
Upper Box & Lower Box	Bentomat DN GCL (black side) hydrated under 150 psf for 36 hours prior to mounting Agru 40 mil LLDPE Microspike geomembrane (shiny side)
Box Dimensions: 12"x12"x4"	
Interface Conditioning:	Interface soaked loaded at 2.5 psi/hr to the shearing load which was applied for a minimum of 16 hours prior to shear
Test Condition: Wet	
Shearing Rate: 0.04 inches/minute	

Test Data			
Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	11	56	103
Normal Stress (psf)	300	5000	10000
Corrected Peak Shear Stress (psf)	187	2094	3981
Corrected Large Displacement Shear Stress (psf)	126	1327	2938
Peak Secant Angle (degrees)	31.9	22.7	21.7
Large Displacement Secant Angle (degrees)	22.8	14.9	16.4
Asperity (mils)	31.6	33.0	30.6

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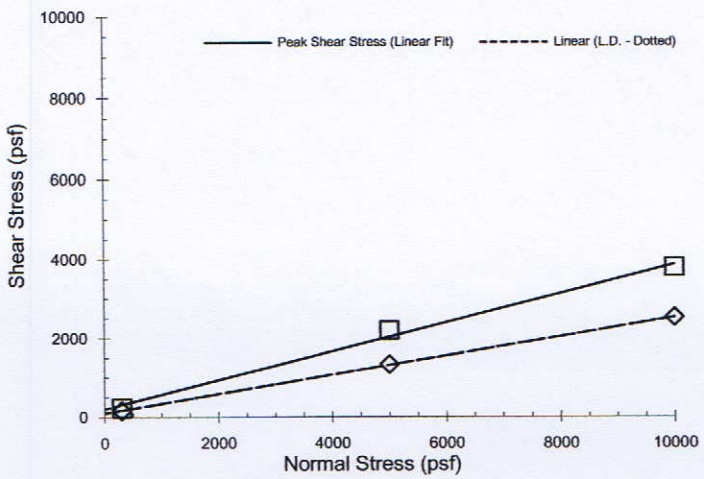
Interface Friction Test Report

Client: **Arcadis**
Project: **Former Asarco Smelter**
Date: 03-20-2014 to 03-24-2014

TRI Log#: E2388-16-06
Test Method: ASTM D6243

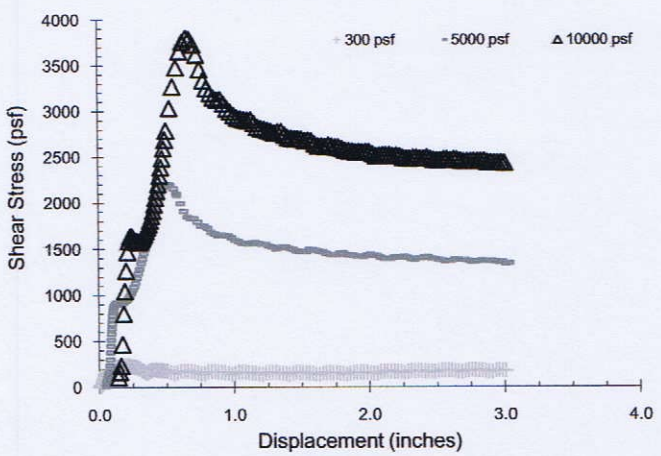
John M. Allen, P.E., 03/25/2014
Quality Review/Date

Tested Interface: Bentomat DN GCL (10) vs. Agru 40 mil LLDPE Microspike Geomembrane (832763-13)



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	20.2	13.7
Y-intercept or Adhesion (psf):	208	99

Shearing occurred at the interface.



Test Conditions	
Upper Box & Lower Box	Bentomat DN GCL (black side) hydrated under 150 psf for 36 hours prior to mounting Agru 40 mil LLDPE Microspike geomembrane (shiny side)
Box Dimensions: 12"x12"x4"	
Interface Conditioning:	Interface soaked loaded at 2.5 psi/hr to the shearing load which was applied for a minimum of 16 hours prior to shear
Test Condition: Wet	
Shearing Rate: 0.04 inches/minute	

Test Data			
Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	11	56	103
Normal Stress (psf)	300	5000	10000
Corrected Peak Shear Stress (psf)	236	2205	3803
Corrected Large Displacement Shear Stress (psf)	164	1337	2535
Peak Secant Angle (degrees)	38.1	23.8	20.8
Large Displacement Secant Angle (degrees)	28.7	15.0	14.2
Asperity (mils)	29.0	31.0	29.2

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