# APPENDIX N - LABORATORY TESTING PHOTOGRAPY AND OBSERVATIONS


Fig. N. 1. Free swell testing of Site E bentonites.


Fig. N. 2. Indentations were observed in Site A GCL in plan (a) and profile (b) view.

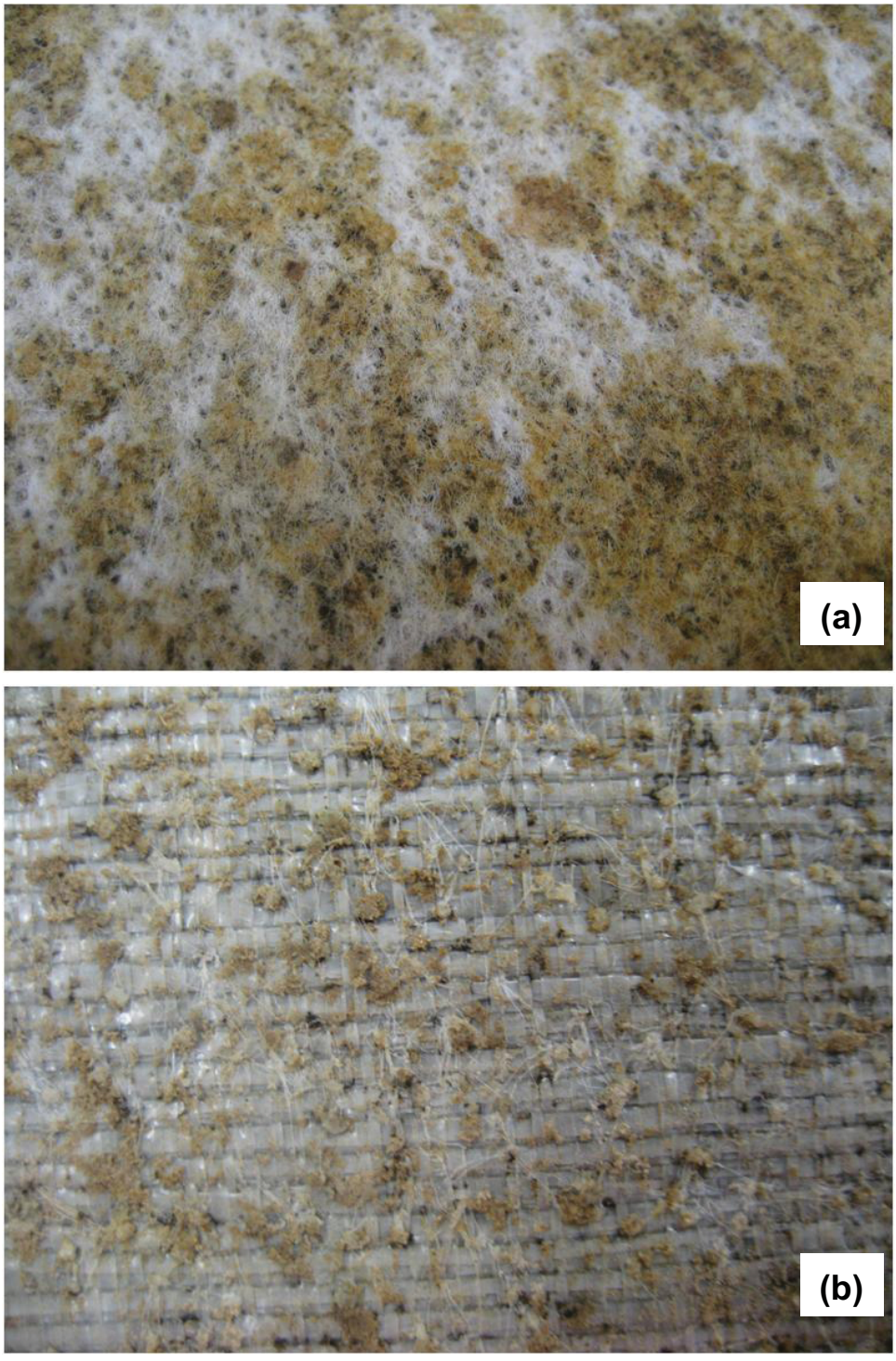


Fig. N. 3. Upper nonwoven geotextiles (a) and lower woven geotextile (b) of Site E higher hydraulic conductivity GCL prior to permeation. Dark staining visible at some needle punched fiber bundles.

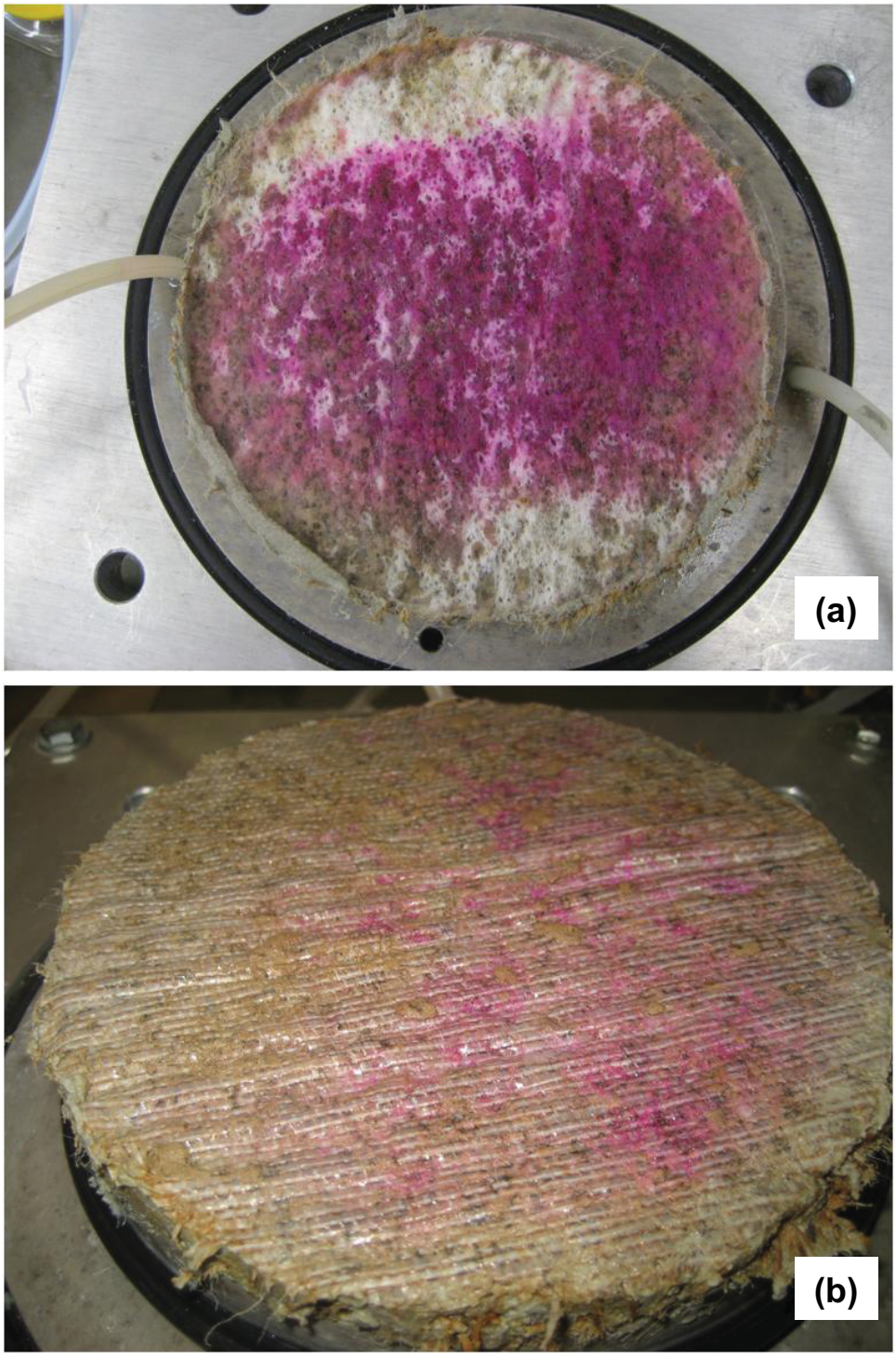


Fig. N. 4. Influent nonwoven geotextiles (a) and effluent woven geotextile (b) of Site E higher hydraulic conductivity GCL after permeation and dying.

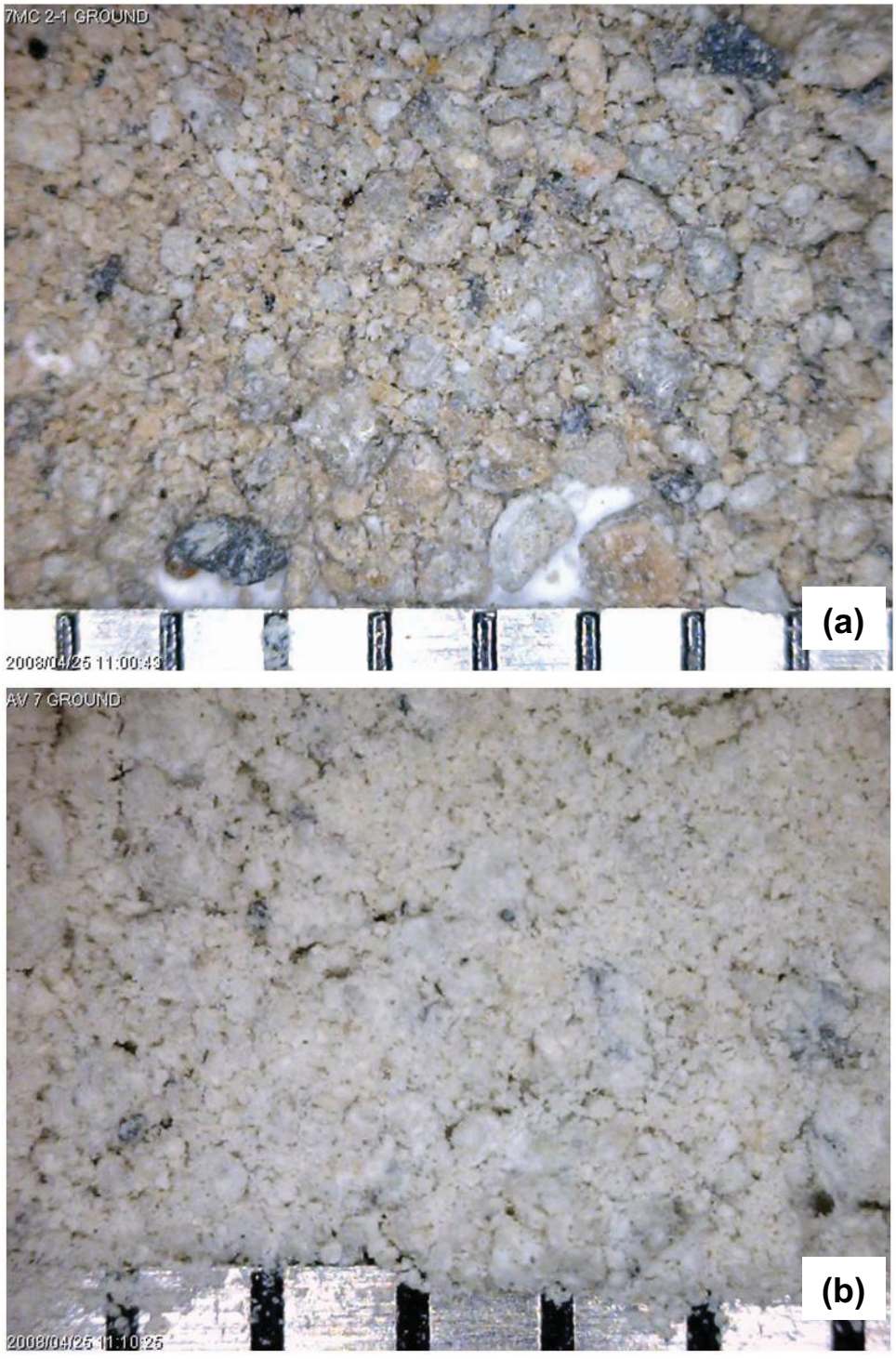


Fig. N. 5. Ground bentonite passing No. 20 sieve from Site E (a) and Site A (b).

Fig. N. 6. Bentonite from Site E TP1 during bound cation testing. Dark material is visible through the specimen.

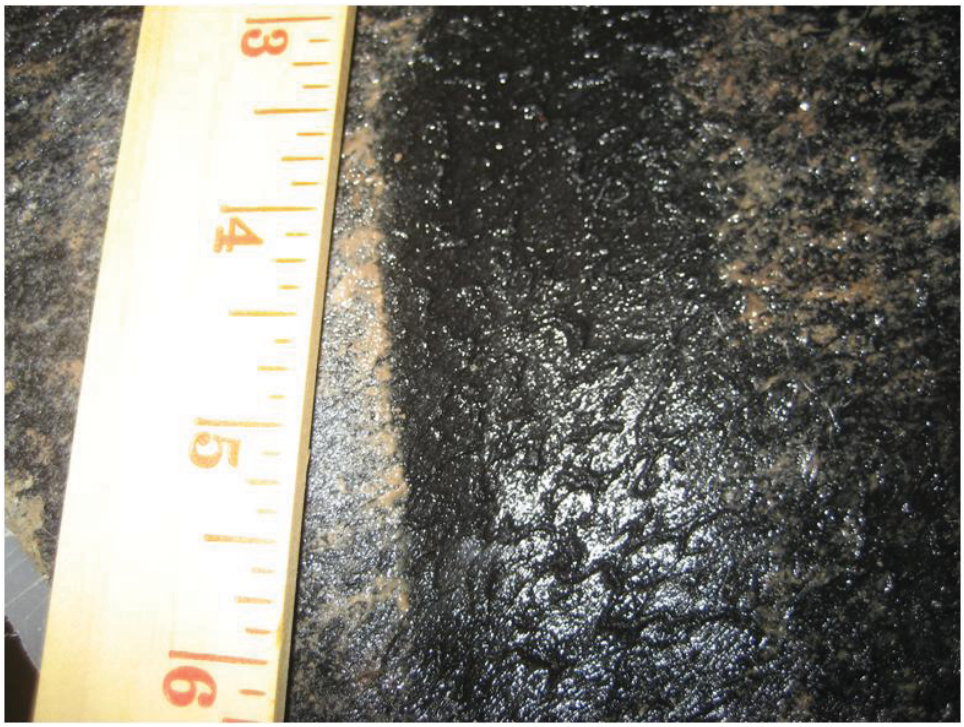


Fig. N. 7. Additional moisture visible under folds in GM exhumed from Site F TP1.

# APPENDIX O - EXPLORATION OF GCL LABORATORY TESTING METHODS

## O-1 EFFECT OF INCREASED EFFECTIVE STRESS DURING PERMEABILITY TESTING

After completion of permeability testing at an effective stress representative of field conditions (18 kPa), cell pressures were increased to ascertain the possible effect of increased overlying cover material. The average hydraulic gradient was maintained at approximately 150 for the duration of testing. Hydraulic conductivity is plotted versus pore volumes of flow for duplicate Site E-6 GCL specimens in Fig. O.1. The average hydraulic conductivity is also presented in Table O.1 with corresponding hydraulic conductivity at effective stress of 18 kPa ($k_{18}$) over hydraulic conductivity at increased effective stress ($k_{effective\ increased}$).

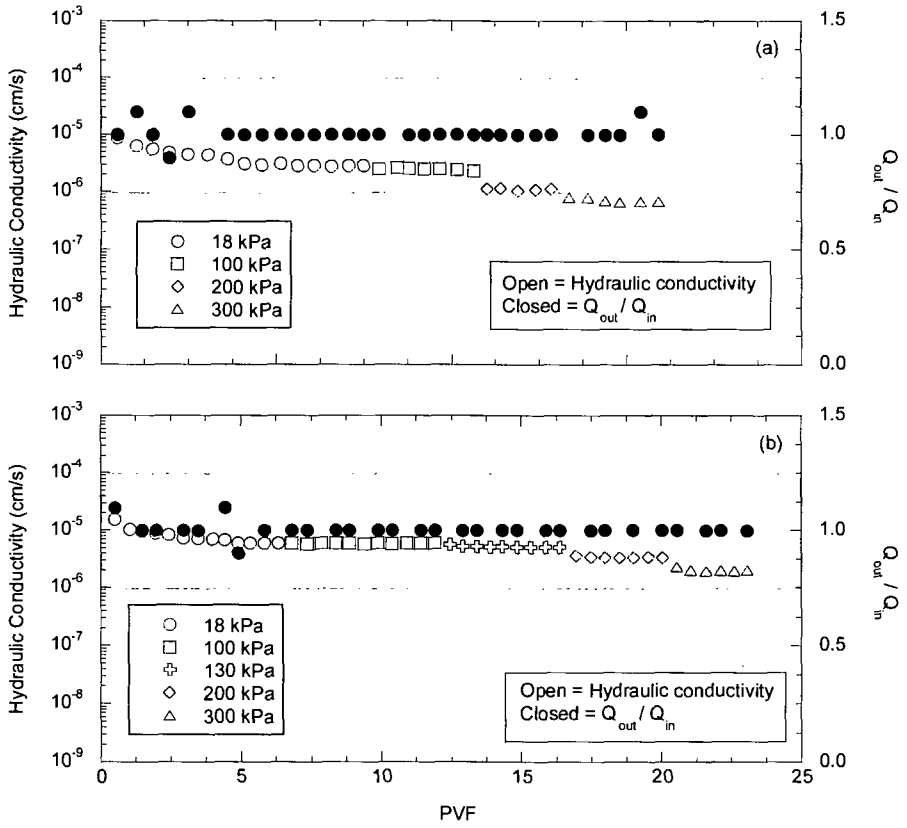


Fig. O. 1. Hydraulic conductivity and $Q_{out}$ / $Q_{in}$ as a function of pore volumes of flow for duplicate Site E-6 GCL permeated with standard water (Site E-6a (a), Site E-6b (b)).

Table O. 1. Final average hydraulic conductivity and $k_{18}/k_{ffective\ increased}$ at varying effective stresses for Site E-6 a & b GCLs.

| | Site E-6a | | Site E-6b | |
|---|---|---|---|---|
| Effective stress (kPa) | Final hydraulic conductivity (cm/s) | $k_{18}/k_{effective}$ | Final hydraulic conductivity (cm/s) | $k_{18}/k_{effective}$ |
| 18 | 2.84E-06 | 1.0 | 5.99E-06 | 1.0 |
| 100 | 2.43E-06 | 1.2 | 5.88E-06 | 1.0 |
| 130 | - | - | 5.06E-06 | 1.2 |
| 200 | 1.11E-06 | 2.6 | 3.34E-06 | 1.8 |
| 300 | 6.81E-07 | 4.2 | 1.99E-06 | 3.0 |

## O-2 EFFECT OF EDGE PASTE DEFECT IN PERMEABILITY TESTING

For all hydraulic conductivity tests, bentonite paste hydrated in the permeant liquid was frosted around the perimeter of the GCL specimen. The intention of this perimeter pasting is to eliminate possible flow paths the latex membrane. A hydraulic conductivity test was assembled with a generated gap in perimeter bentonite paste to asses the sensitivity of the perimeter bentonite paste assembly method. A 1 cm gap was place in the bentonite specimen pasting of Site E Test Pit 1 GCL specimen with a free swell index of 8 mL/2g (essentially calcium bentonite). A Site E GCL was chosen to provide a worst-case scenario where minimal self healing is possible. A profile of the assemble permeameter with bentonite paste gap is presented in Fig. O.2. Hydraulic conductivity profiles for a matching Site E Test Pit 1 specimen (same sample) and for the gap-pasted specimen are plotted versus PVF in Fig. O.3. The latex membrane closely formed over the bentonite paste gap after application of effective stress as shown in Fig. O.4. Both GCLs were permeated with standard water.

Fig. O. 2. GCL assembled with missing perimeter bentonite paste.

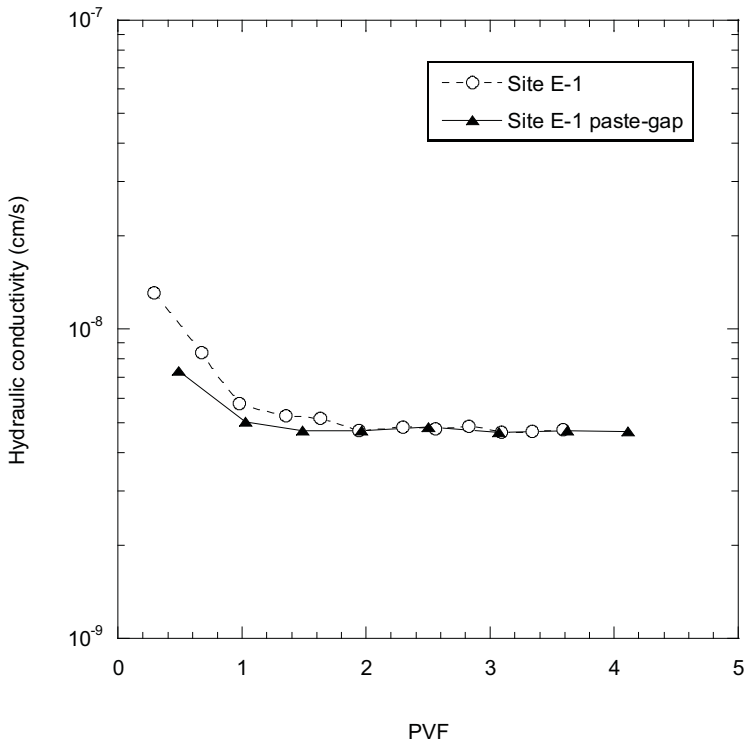


Fig. O. 3. Hydraulic conductivity versus pore volumes of flow for Site E-1 GCL and matching bentonite paste-gap specimen.

Fig. O. 4. Latex membrane over internal bentonite paste gap after application of effective stress, permeation, and disassembly.

## O-3 MANUFACTURER VERSUS UNIVERSITY OF WISCONSIN EXHUMED COMPOSTIE COVER GCL HYDRAULIC CONDUCTIVITIES

Duplicate GCL specimens were exhumed from each sampling location at Site B (4 samples) and from Test Pit 1 at Site E by the University of Wisconsin and the Manufacturer. University of Wisconsin hydraulic conductivity testing was conducted as detailed in Chapters 2,3 and 4. Manufacturer hydraulic conductivity testing was performed on 10.2 cm diameter specimen with de-aired deionized water as the permeant. A maximum effective stress of 34.4 kPa was employed with an initial head of 140.6 kPa. All tests were run until the flux ratio ASTM termination criterion was met. Hydraulic conductivities from the University of Wisconsin permeating with AW or DW are plotted versus hydraulic conductivities from the manufacturer in Fig. O.5.

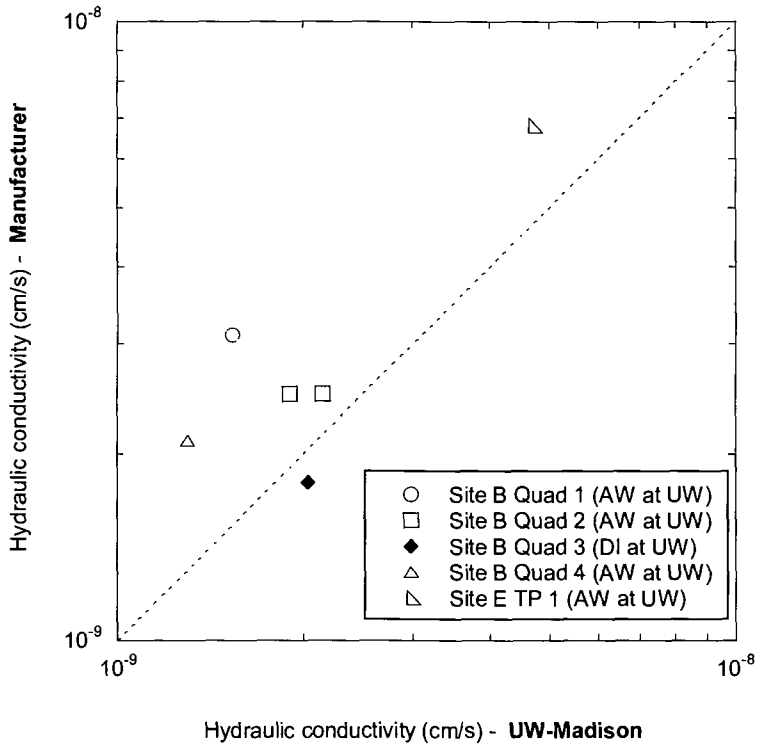


Fig. O. 5. Site B hydraulic conductivity versus testing facility for Site B GCL duplicate samples.

## O-4. EFFECTS OF DESSICATION CYCLES ON EXHUMED COMPOSITE COVER GCLs.

Desiccation tests were conducted on Site A and Site E GCL specimens after permeation with SW. GCLs were removed from their permeameter, and the surrounding bentonite paste was manually removed with a small spatula. The GCL specimen was then placed between 2 geotextiles, 2 geocomposite drainage layers, and 2 rigid HDPE plates. The upper HDPE plate was then loaded vertically until a pressure (18-24 kPa) equal to the in-situ effective stress was achieved. GCLs were allowed to air dry for until their daily mass reached a steady state.

The saturated hydraulic conductivity before and after application of desiccation cycle(s) is plotted in Fig. O.6.

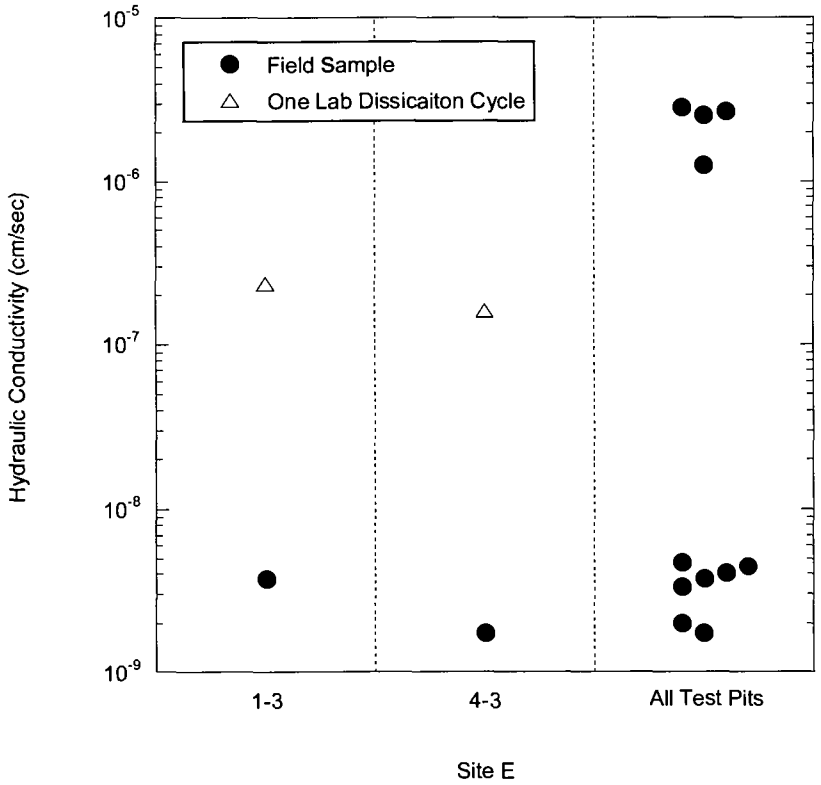


Fig. O. 6. Hydraulic conductivity after exhumation and application of desiccation cycle(s).

# APPENDIX P – SUPPLEMENTAL GRAPHS AND TABLES FROM GEOSYNTHETIC MEMBRANE (GM) AND GEOSYNTHETIC DRAINAGE LAYER (GDL) TESTS

Table P1. Coefficient of variation (CoV) for each engineering property of exhumed geosynthetics.

| | Altamont, CA | Apple Valley, CA | Boardman, OR | Cedar Rapids, IA | Eau Claire, WI | Helena, MT | Omaha, NE | Polson, MT | Underwood, ND |
|---|---|---|---|---|---|---|---|---|---|
| Wide Strip Yield Strength | 2.3 | 3.8 | 4.1 | 1.8 | 5.1 | 3.0 | 8.7 | 10.2 | 2.6 |
| Narrow Strip Yield Strength | 7.3 | 10.7 | 9.5 | 12.9 | 15.7 | 2.4 | 17.0 | 6.2 | 9.4 |
| Narrow Strip Break Strength | 9.7 | 25.4 | 15.4 | 8.6 | 22.8 | 14.9 | 32.7 | 37.0 | 8.0 |
| Wide Strip Yield Strain | 3.0 | 2.6 | 4.0 | 12.6 | 23.2 | 4.4 | 28.8 | 8.3 | 26.1 |
| Narrow Strip Yield Strain | 10.8 | 8.8 | 16.0 | 9.6 | 34.7 | 9.4 | 22.8 | 16.9 | 7.8 |
| Narrow Strip Break Strain | 8.5 | 31.2 | 9.8 | 6.1 | 36.7 | 11.3 | 32.1 | 66.1 | 5.1 |
| Ply Adhesion | 27.3 | 19.8 | 30.2 | 47.0 | 43.0 | 66.4 | 34.9 | - | 58.9 |
| Permittivity at 10 mm | 15.4 | 10.1 | 30.4 | 35.3 | 43.3 | 57.1 | 47.7 | - | 23.3 |
| Permittivity at 50 mm | 22.1 | 5.8 | 25.7 | 20.7 | 41.2 | 46.1 | 42.4 | - | 35.9 |
| Transmissivity (24 kPa) | 80.0 | - | 55.8 | 23.7 | 64.5 | 4.2 | 23.1 | - | 41.9 |
| Transmissivity (48 kPa) | 66.8 | - | 48.5 | 23.9 | - | 3.4 | 27.3 | - | 38.8 |
| Transmissivity (480 kPa) | 82.4 | - | 46.8 | 29.2 | 38.6 | 5.3 | 34.3 | - | 41.9 |

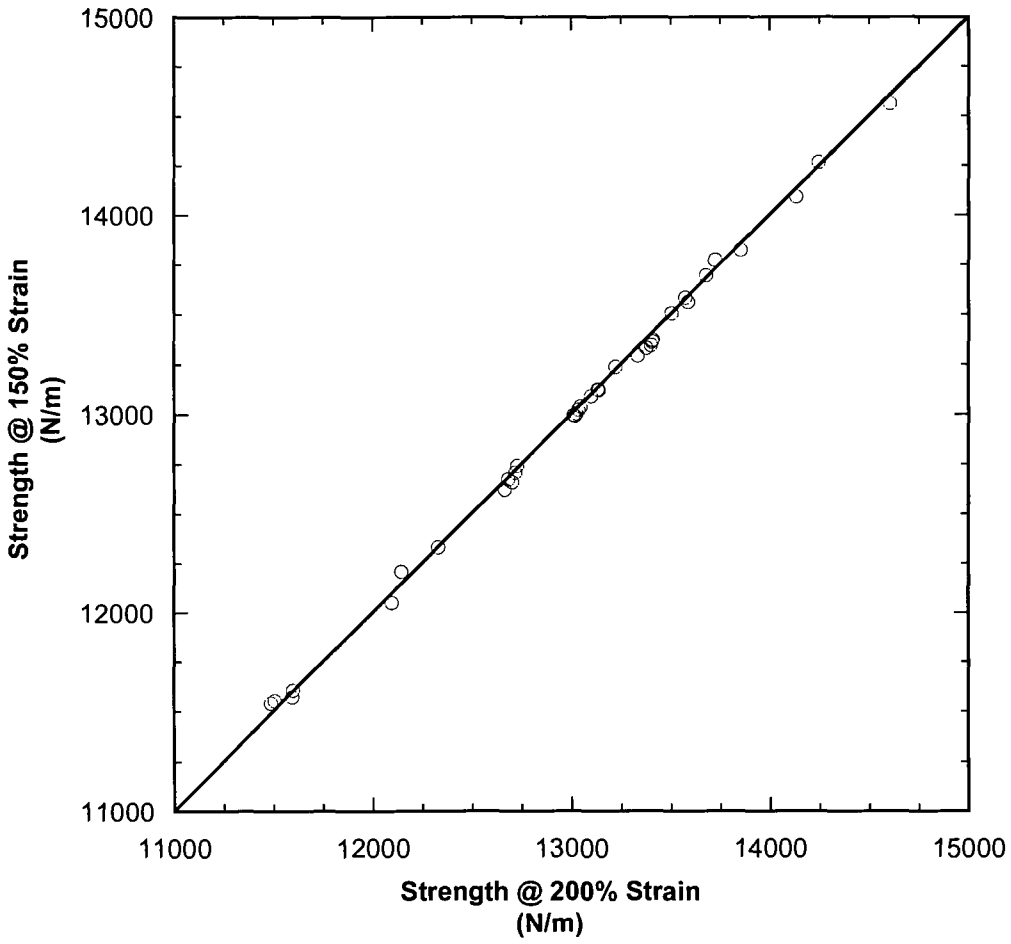


Fig. P1. Comparison of wide-width tensile strengths corresponding to 150 and 200% strain for Eau Claire samples.

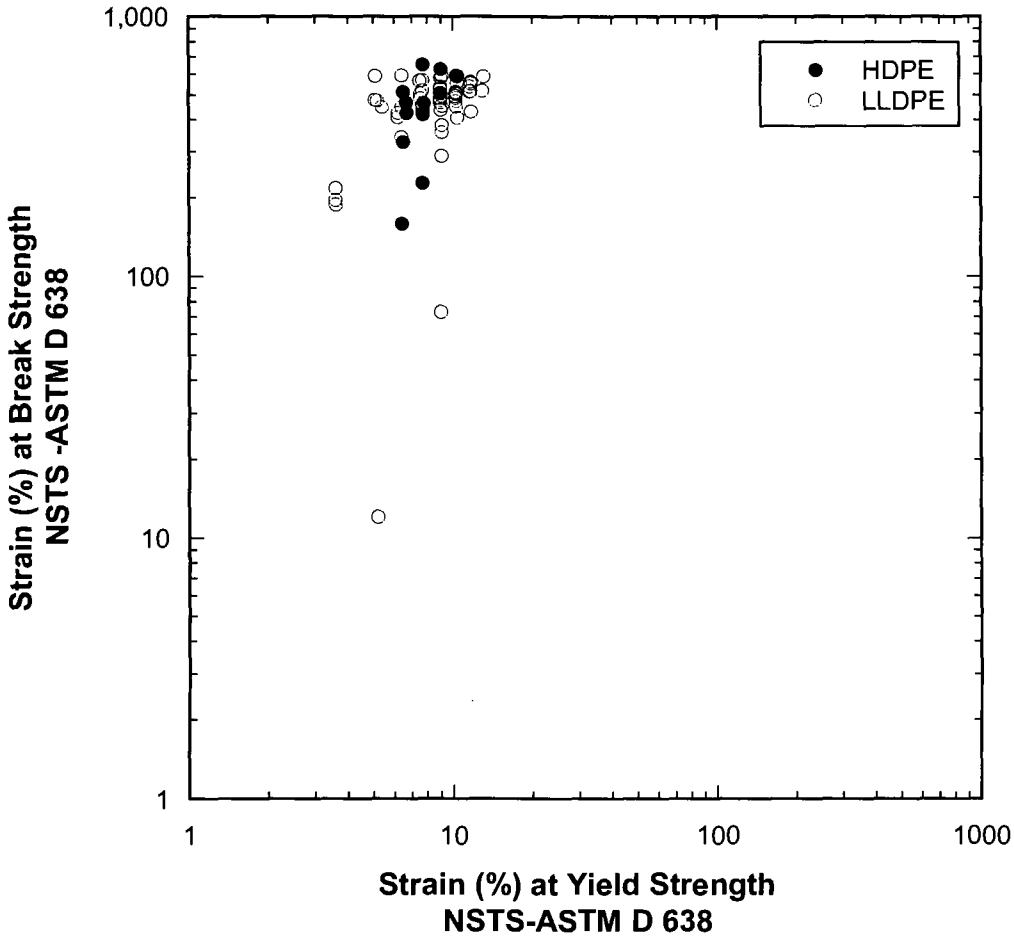


Fig. P2. Comparison between strains at narrow strip break strength and yield strength.

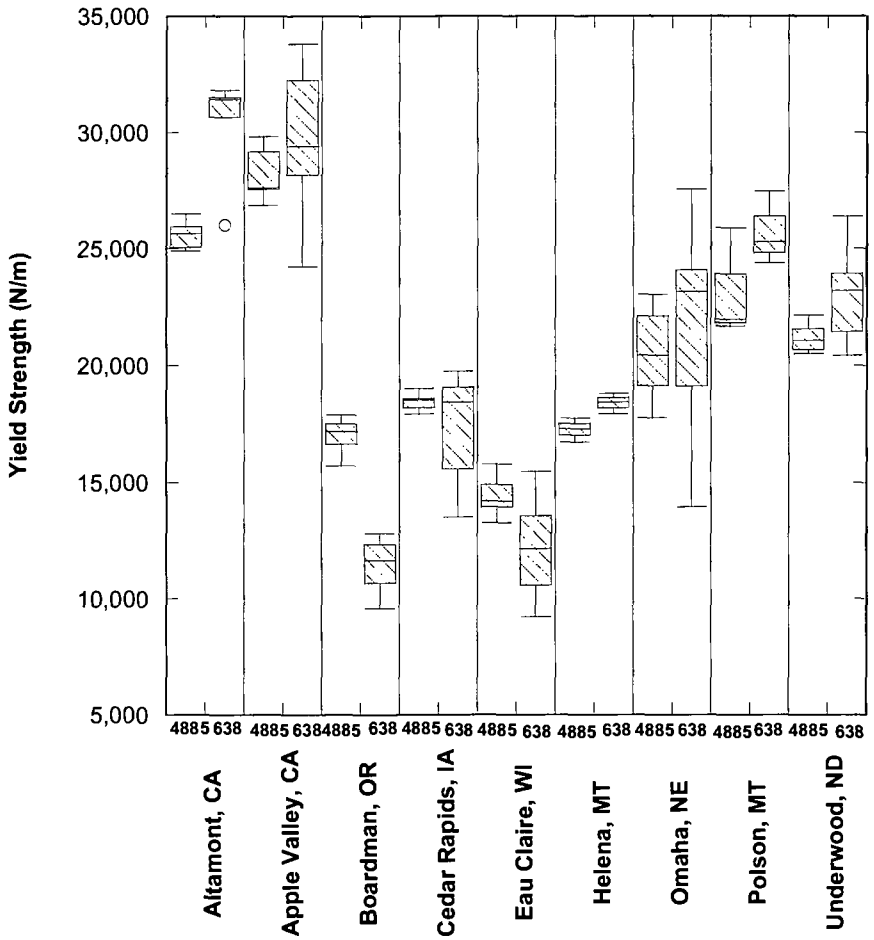


Fig. P3. Box plots comparing wide-strip and narrow-strip dumbbell tensile strengths.

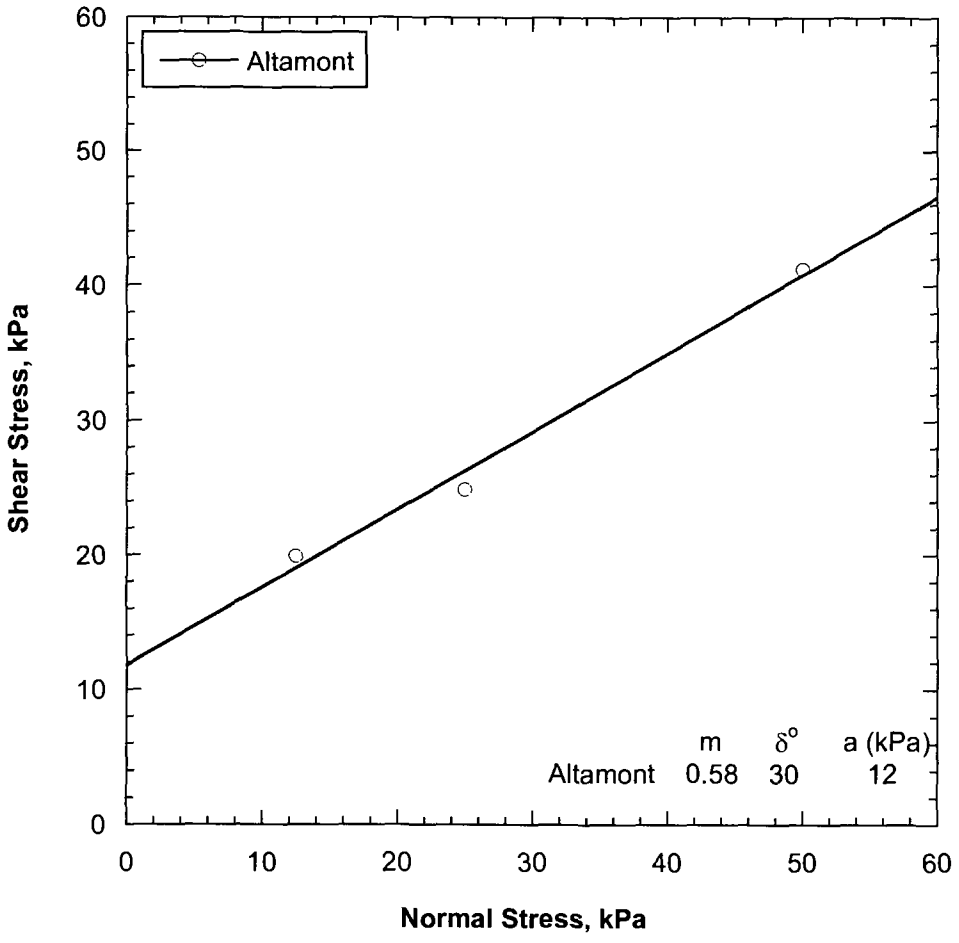


Fig. P4. Peak interface shear strength envelope for GM-GDL interface at Altamont.

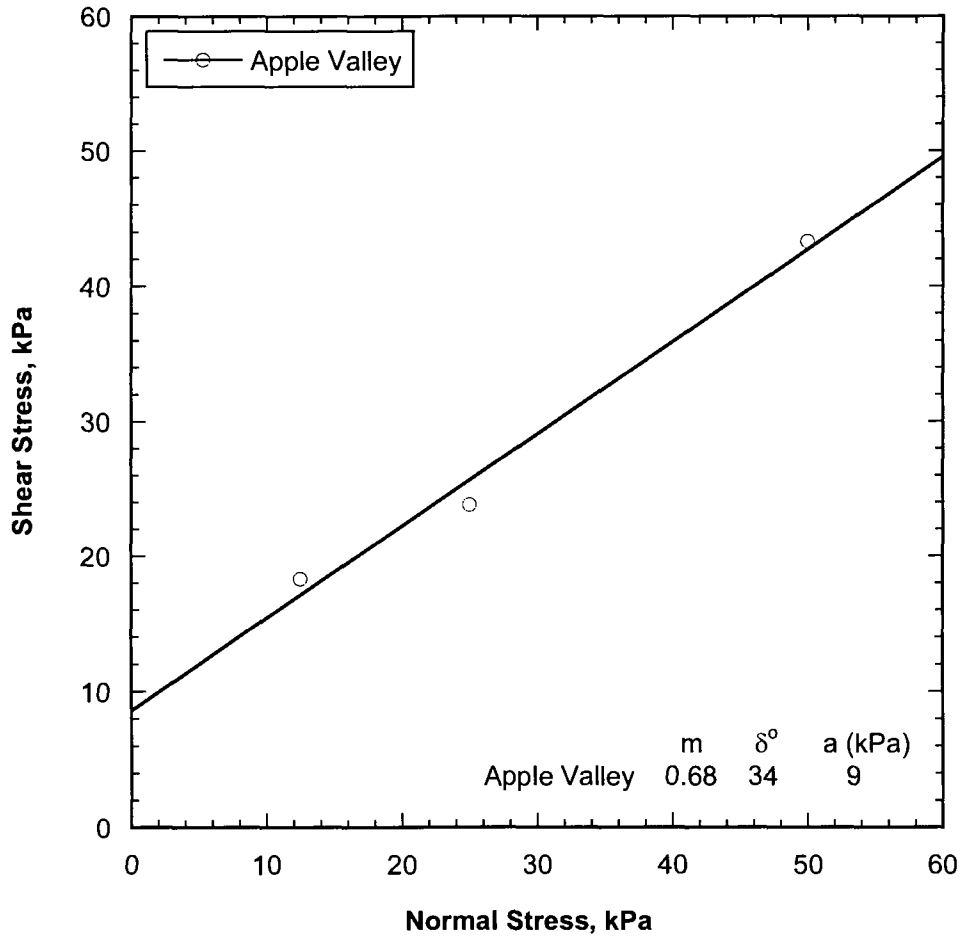


Fig. P5. Peak interface shear strength envelope for GM-GDL interface at Apple Valley.

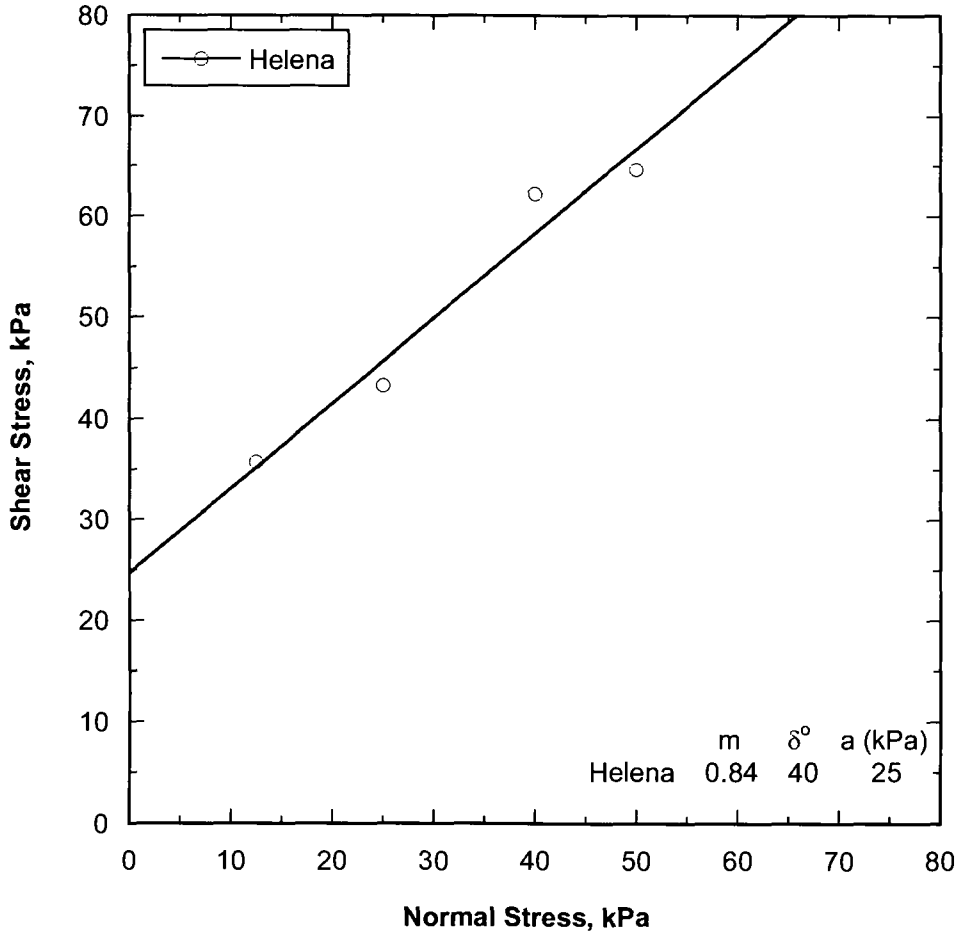


Fig. P6. Peak interface shear strength envelope for GM-GDL interface at Helena.

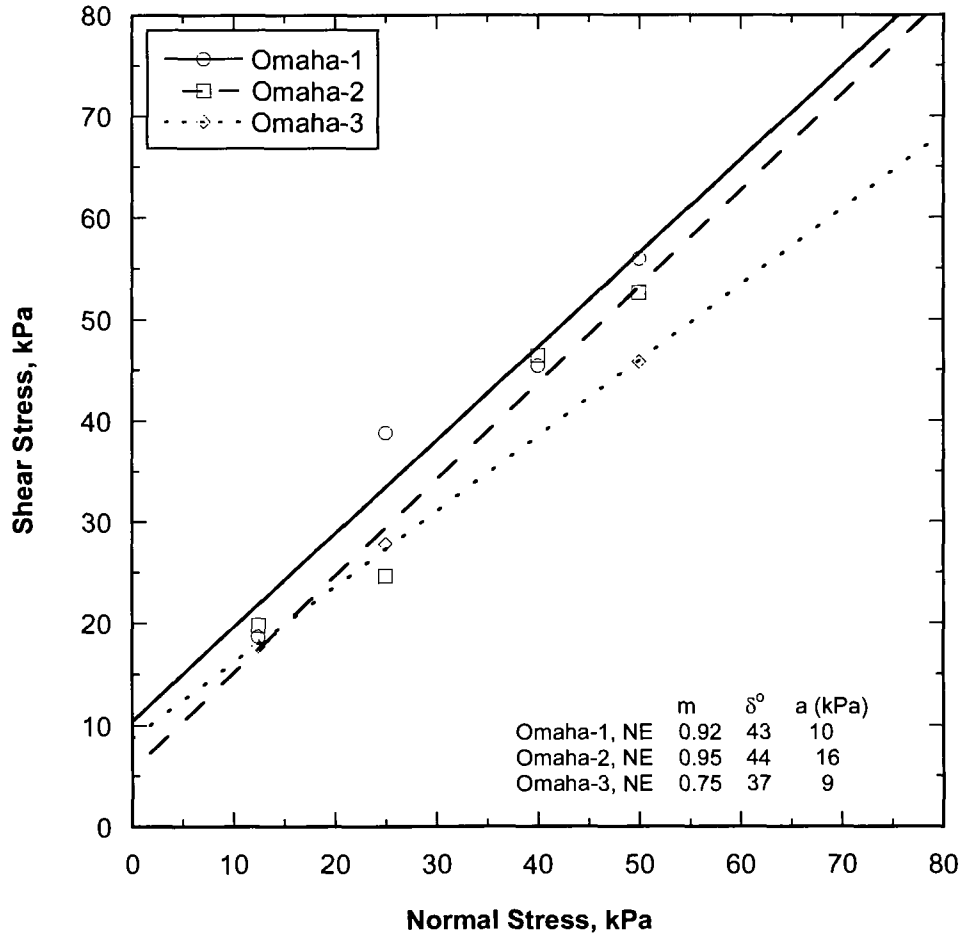


Fig. P7. Peak interface shear strength envelopes for GM-GDL interface at Omaha.

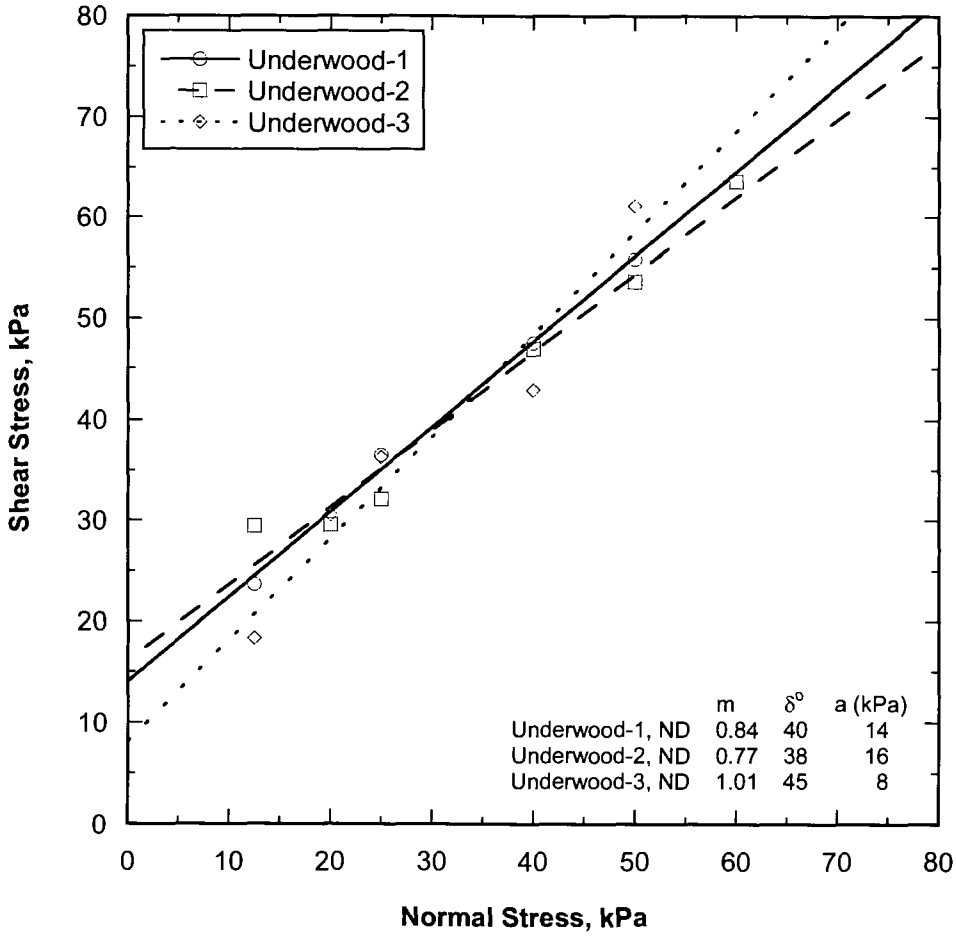


Fig. P8. Peak interface shear strength envelopes for GM-GDL interface at Underwood.

# APPENDIX Q – PHOTOGRAPHS OF GM AND GDL TESTING


Fig. Q1. MTS Sintech 10/GL load frame equipped with Curtis Geo-Grips used for tensile testing.


Fig. Q2. Close up of a wide-strip tensile testing of GM.

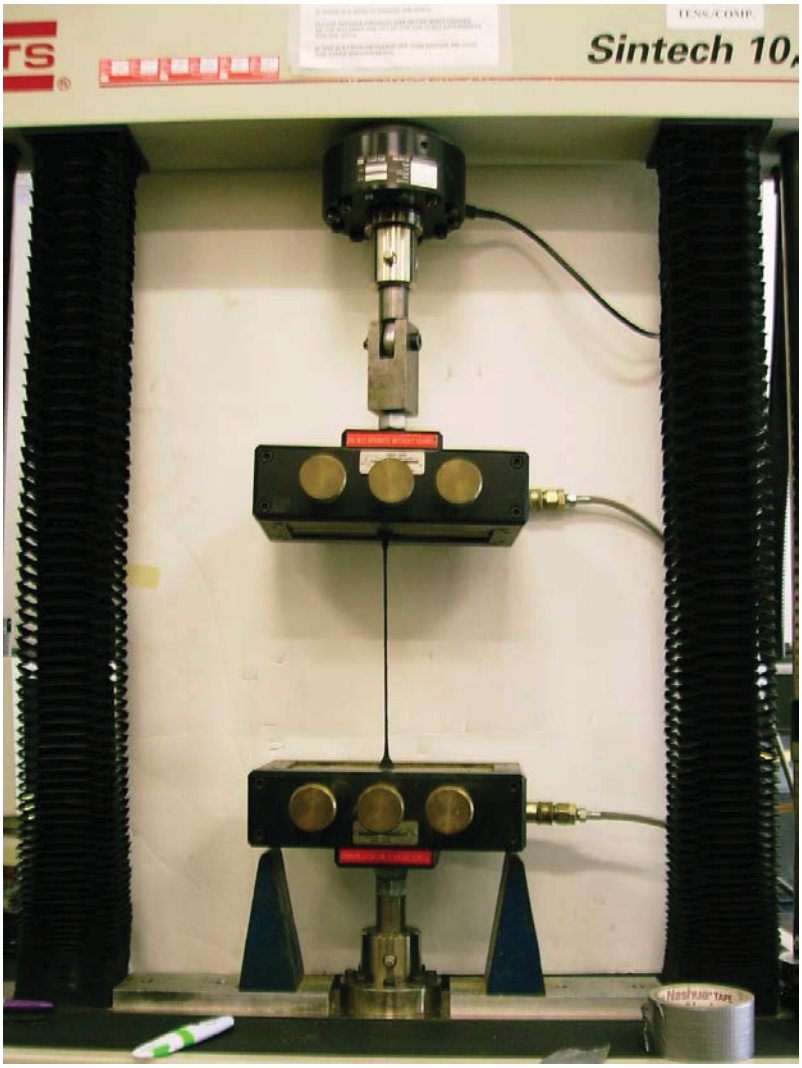


Fig. Q3. Photograph showing narrow strip specimen under tension.

Fig. Q4. Photograph of large-scale direct shear box used for interface shear tests.

Fig. Q5. Photograph of permittivity device.

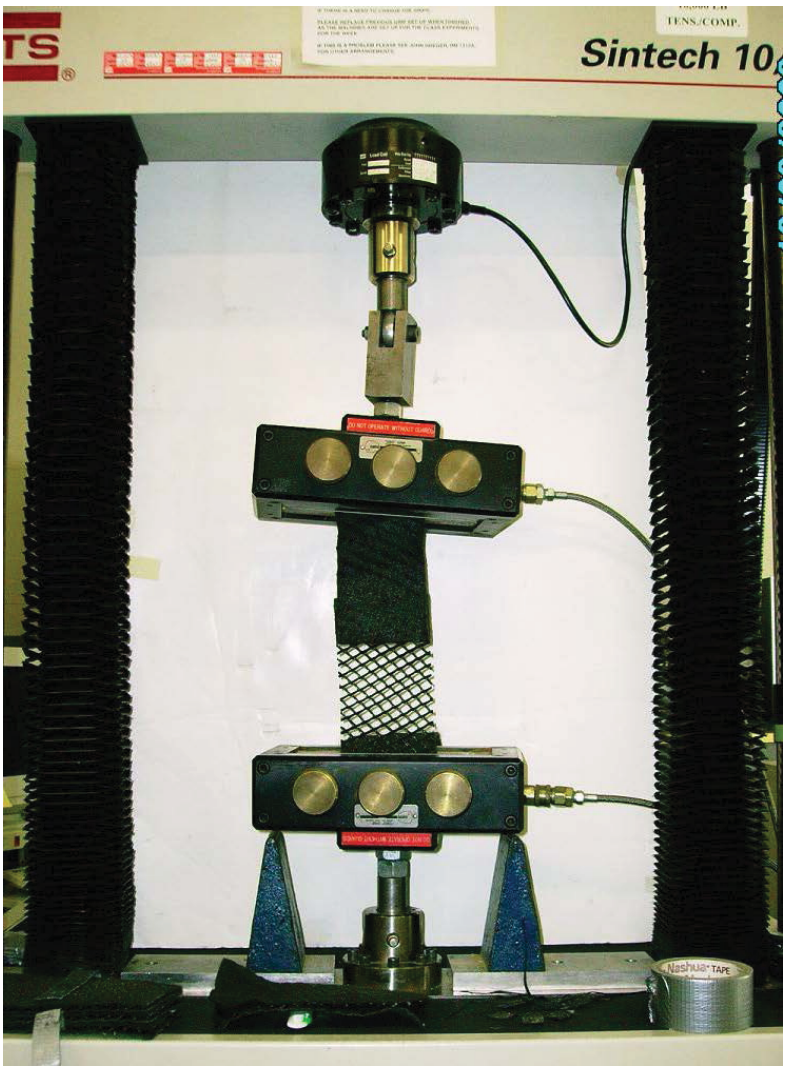


Fig. Q6. Photograph of ply adhesion test.

# APPENDIX R – GM TEST DATA

Table R1. Wide-strip yield strengths (ASTM D 4885).

| Identification | | Wide Strip Yield Strength (N/m) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Specimen # | | | | | |
| | | 1 | 2 | 3 | Mean | Max. | Min. |
| Altamont, CA | CMP - GM2 | 26491 | 25946 | 25718 | **26052** | 26491 | 25718 |
| | CMP - GM3 | 25049 | 25577 | 24898 | **25175** | 25577 | 24898 |
| Apple Valley, CA | GM1 | 29407 | 29833 | 29179 | **29473** | 29833 | 29179 |
| | GM6 | 26864 | 27241 | 27618 | **27241** | 27618 | 26864 |
| | GM8 | 27654 | 27546 | 28303 | **27834** | 28303 | 27546 |
| Boardman, OR | GM1 | 17895 | 17872 | 17423 | **17730** | 17895 | 17423 |
| | GM4 | 17815 | 17062 | 17512 | **17463** | 17815 | 17062 |
| | Thin Cover | 16480 | 15728 | 16625 | **16278** | 16625 | 15728 |
| Cedar Rapids, IA | Bottom Comp.1 | 18764 | 18599 | 18424 | **18596** | 18764 | 18424 |
| | Bottom Comp.3 | 19037 | 18583 | 18532 | **18717** | 19037 | 18532 |
| | Clay Bottom 2 | 18203 | 18204 | 17927 | **18111** | 18204 | 17927 |
| Eau Claire, WI | TP1 | 13046 | 12868 | 13169 | **13028** | 13169 | 12868 |
| | TP2 | 14407 | 14600 | 14120 | **14376** | 14600 | 14120 |
| | TP3 | 14910 | 14861 | 14471 | **14747** | 14910 | 14471 |
| | TP4 | 13720 | 13132 | 12994 | **13282** | 13720 | 12994 |
| Helena, MT | GM-AB | 17281 | 16723 | 17747 | **17250** | 17747 | 16723 |
| Omaha, NE | GM-A1B | 22454 | 23009 | 22169 | **22544** | 23009 | 22169 |
| | GM-A2B | 20620 | 19960 | 20220 | **20267** | 20620 | 19960 |
| | GM-CB | 19976 | 22026 | 21728 | **21243** | 22026 | 19976 |
| | GM-CM | 18252 | 17758 | 18311 | **18107** | 18311 | 17758 |
| Polson, MT | GM-CM | 21647 | 25878 | 21949 | **23158** | 25878 | 21647 |
| Underwood, ND | GM-CC3 | 21076 | 21112 | 20945 | **21044** | 21112 | 20945 |
| | GM-CC5 | 20515 | 20675 | 20582 | **20591** | 20675 | 20515 |
| | GM-ET | 21758 | 22133 | 21548 | **21813** | 22133 | 21548 |

Table R2. Narrow-strip yield and break strengths (ASTM D 638).

| Identification | | Strenght (N/m) | Narrow Strip Test | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Specimen # | | | | | |
| | | | 1 | 2 | 3 | Mean | Max. | Min. |
| **Altamont, CA** | **CMP - GM2** | @ Yield | 26000 | 31833 | 31500 | **29778** | 31833 | 26000 |
| | | @ Break | 44383 | 38133 | 47800 | **43439** | 47800 | 38133 |
| | **CMP - GM3** | @ Yield | 30650 | 31517 | 31367 | **31178** | 31517 | 30650 |
| | | @ Break | 50900 | 46700 | 48750 | **48783** | 50900 | 46700 |
| **Apple Valley, CA** | **GM1** | @ Yield | 26667 | 30133 | 32250 | **29683** | 32250 | 26667 |
| | | @ Break | 32266 | 39416 | 35466 | **35716** | 39416 | 32266 |
| | **GM6** | @ Yield | 33550 | 33817 | 28833 | **32067** | 33817 | 28833 |
| | | @ Break | 39550 | 36900 | 21266 | **32572** | 39550 | 21266 |
| | **GM8** | @ Yield | 29400 | 28167 | 24217 | **27261** | 29400 | 24217 |
| | | @ Break | 22033 | 30433 | 20316 | **24261** | 30433 | 20316 |
| **Boardman, OR** | **GM1** | @ Yield | 11183 | 9600 | 10683 | **10489** | 11183 | 9600 |
| | | @ Break | 29633 | 24683 | 20700 | **25005** | 29633 | 20700 |
| | **GM4** | @ Yield | 10323 | 11783 | 11633 | **11246** | 11783 | 10323 |
| | | @ Break | 27150 | 27533 | 25983 | **26889** | 27533 | 25983 |
| | **Thin Cover** | @ Yield | 12650 | 12333 | 12800 | **12594** | 12800 | 12333 |
| | | @ Break | 24800 | 29133 | 35850 | **29928** | 35850 | 24800 |
| **Cedar Rapids, IA** | **Bottom Comp.1** | @ Yield | 19083 | 18683 | 19083 | **18950** | 19083 | 18683 |
| | | @ Break | 40233 | 38216 | 36166 | **38205** | 40233 | 36166 |
| | **Bottom Comp.3** | @ Yield | 19767 | 18417 | 15567 | **17917** | 19767 | 15567 |
| | | @ Break | 32250 | 40200 | 33750 | **35400** | 40200 | 32250 |
| | **Clay Bottom 2** | @ Yield | 15967 | 15050 | 13500 | **14839** | 15967 | 13500 |
| | | @ Break | 32600 | 33933 | 34850 | **33794** | 34850 | 32600 |

Table R2. Narrow-strip yield and break strengths (ASTM D 638) (Continued).

| Identification | | Strenght (N/m) | Narrow Strip Test | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Specimen # | | | | | |
| | | | 1 | 2 | 3 | Mean | Max. | Min. |
| Eau Claire, WI | TP1 | @ Yield | 12433 | 10550 | 9216 | **10733** | 12433 | 9216 |
| | | @ Break | 21850 | 20283 | 20916 | **21016** | 21850 | 20283 |
| | TP2 | @ Yield | 15466 | 13600 | 14750 | **14605** | 15466 | 13600 |
| | | @ Break | 30366 | 33733 | 29166 | **31088** | 33733 | 29166 |
| | TP3 | @ Yield | 11516 | 13500 | 13266 | **12761** | 13500 | 11516 |
| | | @ Break | 30100 | 29450 | 16200 | **25250** | 30100 | 16200 |
| | TP4 | @ Yield | 10283 | 11850 | 10583 | **10905** | 11850 | 10283 |
| | | @ Break | 33266 | 34033 | 34866 | **34055** | 34866 | 33266 |
| Helena, MT | GM-AB | @ Yield | 17933 | 18417 | 18800 | **18383** | 18800 | 17933 |
| | | @ Break | 22866 | 20766 | 27666 | **23766** | 27666 | 20766 |
| Omaha, NE | GM-A1B | @ Yield | 24433 | 23717 | 21450 | **23200** | 24433 | 21450 |
| | | @ Break | 42633 | 43033 | 36250 | **40639** | 43033 | 36250 |
| | GM-A2B | @ Yield | 18650 | 19000 | 19271 | **18974** | 19271 | 18650 |
| | | @ Break | 41416 | 46383 | 42683 | **43494** | 46383 | 41416 |
| | GM-CB | @ Yield | 22683 | 23583 | 23683 | **23316** | 23683 | 22683 |
| | | @ Break | 44366 | 44133 | 53383 | **47294** | 53383 | 44133 |
| | GM-CM | @ Yield | 13950 | 16250 | 17300 | **15833** | 17300 | 13950 |
| | | @ Break | 6983 | 25950 | 27550 | **20161** | 27550 | 6983 |
| Polson, MT | GM-CM | @ Yield | 27467 | 24383 | 25283 | **25711** | 27467 | 24383 |
| | | @ Break | 14483 | 30133 | 31100 | **25239** | 31100 | 14483 |
| Underwood, ND | GM-CC3 | @ Yield | 23917 | 21183 | 21417 | **22172** | 23917 | 21183 |
| | | @ Break | 55033 | 54133 | 46166 | **51777** | 55033 | 46166 |
| | GM-CC5 | @ Yield | 20417 | 21533 | 20833 | **20928** | 21533 | 20417 |
| | | @ Break | 48050 | 56166 | 47566 | **50594** | 56166 | 47566 |
| | GM-ET | @ Yield | 26000 | 26383 | 23767 | **25383** | 26383 | 23767 |
| | | @ Break | 53700 | 58183 | 53466 | **55116** | 58183 | 53466 |

## Table R3. Wide-strip yield strains (ASTM D 638).

| Identification | | Wide Strip Yield Strain (%) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Specimen # | | | | | |
| | | 1 | 2 | 3 | Mean | Max. | Min. |
| Altamont, CA | CMP - GM2 | 16.7 | 17.3 | 17.4 | **17.1** | 17.4 | 16.7 |
| | CMP - GM3 | 17.0 | 18.0 | 18.0 | **17.7** | 18.0 | 17.0 |
| Apple Valley, CA | GM1 | 14.7 | 15.1 | 15.7 | **15.2** | 15.7 | 14.7 |
| | GM6 | 15.6 | 15.2 | 15.6 | **15.5** | 15.6 | 15.2 |
| | GM8 | 14.9 | 15.8 | 15.7 | **15.5** | 15.8 | 14.9 |
| Boardman, OR | GM1 | 17.1 | 18.6 | 19.0 | **18.2** | 19.0 | 17.1 |
| | GM4 | 19.8 | 18.9 | 18.5 | **19.1** | 19.8 | 18.5 |
| | Thin Cover | 18.3 | 18.7 | 17.9 | **18.3** | 18.7 | 17.9 |
| Cedar Rapids, IA | Bottom Comp.1 | 23.1 | 26.3 | 33.5 | **27.6** | 33.5 | 23.1 |
| | Bottom Comp.3 | 24.4 | 23.2 | 26.9 | **24.8** | 26.9 | 23.2 |
| | Clay Bottom 2 | 26.5 | 27.3 | 30.6 | **28.1** | 30.6 | 26.5 |
| Eau Claire, WI | TP1 | 23.5 | 30.4 | 34.9 | **29.6** | 34.9 | 23.5 |
| | TP2 | 19.7 | 19.2 | 17.9 | **18.9** | 19.7 | 17.9 |
| | TP3 | 21.0 | 19.8 | 18.5 | **19.8** | 21.0 | 18.5 |
| | TP4 | 19.8 | 21.2 | 21.2 | **20.7** | 21.2 | 19.8 |
| Helena, MT | GM-AB | 18.3 | 16.9 | 18.2 | **17.8** | 18.3 | 16.9 |
| Omaha, NE | GM-A1B | 23.6 | 20.7 | 19.8 | **21.4** | 23.6 | 19.8 |
| | GM-A2B | 22.7 | 22.4 | 30.0 | **25.0** | 30.0 | 22.4 |
| | GM-CB | 20.2 | 21.6 | 20.5 | **20.8** | 21.6 | 20.2 |
| | GM-CM | 11.3 | 11.2 | 11.6 | **11.4** | 11.6 | 11.2 |
| Polson, MT | GM-CM | 18.0 | 16.0 | 15.4 | **16.5** | 18.0 | 15.4 |
| Underwood, ND | GM-CC3 | 24.7 | 32.0 | 36.9 | **31.2** | 36.9 | 24.7 |
| | GM-CC5 | 40.5 | 46.8 | 49.5 | **45.6** | 49.5 | 40.5 |
| | GM-ET | 23.6 | 28.5 | 41.8 | **31.3** | 41.8 | 23.6 |

Table R4. Narrow-strip yield and break strains (ASTM D 638).

| Identification | | Strain (%) | Narrow Strip Test | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Specimen # | | | | | |
| | | | 1 | 2 | 3 | Mean | Max. | Min. |
| Altamont, CA | CMP - GM2 | @ Yield | 7.7 | 9.0 | 9.0 | **8.6** | 9.0 | 7.7 |
| | | @ Break | 651.3 | 507.4 | 627.8 | **595.5** | 651.3 | 507.4 |
| | CMP - GM3 | @ Yield | 9.0 | 10.4 | 10.3 | **9.9** | 10.4 | 9.0 |
| | | @ Break | 627.7 | 589.8 | 591.1 | **602.9** | 627.7 | 589.8 |
| Apple Valley, CA | GM1 | @ Yield | 6.7 | 6.5 | 6.7 | **6.6** | 6.7 | 6.5 |
| | | @ Break | 468.4 | 511.4 | 424.0 | **467.9** | 511.4 | 424.0 |
| | GM6 | @ Yield | 7.8 | 7.7 | 7.7 | **7.7** | 7.8 | 7.7 |
| | | @ Break | 464.3 | 423.7 | 227.5 | **371.8** | 464.3 | 227.5 |
| | GM8 | @ Yield | 6.4 | 7.7 | 6.5 | **6.9** | 7.7 | 6.4 |
| | | @ Break | 158.2 | 418.5 | 327.0 | **301.2** | 418.5 | 158.2 |
| Boardman, OR | GM1 | @ Yield | 7.6 | 5.4 | 6.2 | **6.4** | 7.6 | 5.4 |
| | | @ Break | 502.1 | 446.2 | 407.8 | **452.0** | 502.1 | 407.8 |
| | GM4 | @ Yield | 5.2 | 7.6 | 6.4 | **6.4** | 7.6 | 5.2 |
| | | @ Break | 473.5 | 483.8 | 445.9 | **467.7** | 483.8 | 445.9 |
| | Thin Cover | @ Yield | 6.2 | 5.1 | 7.5 | **6.3** | 7.5 | 5.1 |
| | | @ Break | 423.5 | 476.0 | 562.1 | **487.2** | 562.1 | 423.5 |
| Cedar Rapids, IA | Bottom Comp.1 | @ Yield | 10.3 | 9.0 | 10.3 | **9.9** | 10.3 | 9.0 |
| | | @ Break | 491.7 | 477.3 | 449.9 | **473.0** | 491.7 | 449.9 |
| | Bottom Comp.3 | @ Yield | 10.4 | 10.3 | 7.7 | **9.5** | 10.4 | 7.7 |
| | | @ Break | 406.7 | 493.0 | 455.1 | **451.6** | 493.0 | 406.7 |
| | Clay Bottom 2 | @ Yield | 9.1 | 10.3 | 10.2 | **9.9** | 10.3 | 9.1 |
| | | @ Break | 452.5 | 472.0 | 495.5 | **473.3** | 495.5 | 452.5 |

Table R4. Narrow-strip yield and break strains (ASTM D 638) (Continued).

| Identification | | Strain (%) | Narrow Strip Test | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Specimen # | | | | | |
| | | | 1 | 2 | 3 | Mean | Max. | Min. |
| Eau Claire, WI | TP1 | @ Yield | 11.7 | 9.0 | 9.0 | **9.9** | 11.7 | 9.0 |
| | | @ Break | 428.9 | 436.8 | 466.8 | **444.2** | 466.8 | 428.9 |
| | TP2 | @ Yield | 3.6 | 3.6 | 3.6 | **3.6** | 3.6 | 3.6 |
| | | @ Break | 194.6 | 216.8 | 187.9 | **199.8** | 216.8 | 187.9 |
| | TP3 | @ Yield | 9.0 | 9.0 | 9.1 | **9.0** | 9.1 | 9.0 |
| | | @ Break | 524.4 | 485.2 | 289.0 | **432.9** | 524.4 | 289.0 |
| | TP4 | @ Yield | 9.0 | 10.4 | 9.1 | **9.5** | 10.4 | 9.0 |
| | | @ Break | 582.0 | 554.5 | 587.2 | **574.6** | 587.2 | 554.5 |
| Helena, MT | GM-AB | @ Yield | 9.1 | 9.1 | 7.7 | **8.6** | 9.1 | 7.7 |
| | | @ Break | 380.6 | 357.0 | 443.3 | **393.6** | 443.3 | 357.0 |
| Omaha, NE | GM-A1B | @ Yield | 10.3 | 10.3 | 7.7 | **9.4** | 10.3 | 7.7 |
| | | @ Break | 485.2 | 508.7 | 449.8 | **481.2** | 508.7 | 449.8 |
| | GM-A2B | @ Yield | 7.7 | 7.7 | 9.0 | **8.1** | 9.0 | 7.7 |
| | | @ Break | 516.6 | 566.3 | 534.8 | **539.2** | 566.3 | 516.6 |
| | GM-CB | @ Yield | 10.3 | 9.1 | 9.1 | **9.5** | 10.3 | 9.1 |
| | | @ Break | 511.3 | 494.3 | 593.8 | **533.1** | 593.8 | 494.3 |
| | GM-CM | @ Yield | 5.2 | 5.1 | 6.4 | **5.6** | 6.4 | 5.1 |
| | | @ Break | 12.0 | 588.5 | 591.1 | **397.2** | 591.1 | 12.0 |
| Polson, MT | GM-CM | @ Yield | 9.0 | 6.4 | 7.7 | **7.7** | 9.0 | 6.4 |
| | | @ Break | 73.1 | 341.1 | 431.5 | **281.9** | 431.5 | 73.1 |
| Underwood, ND | GM-CC3 | @ Yield | 10.7 | 11.7 | 10.3 | **10.9** | 11.7 | 10.3 |
| | | @ Break | 550.9 | 550.6 | 500.9 | **534.1** | 550.9 | 500.9 |
| | GM-CC5 | @ Yield | 13.0 | 13.1 | 11.6 | **12.6** | 13.1 | 11.6 |
| | | @ Break | 517.9 | 584.8 | 512.6 | **538.4** | 584.8 | 512.6 |
| | GM-ET | @ Yield | 11.7 | 11.7 | 11.6 | **11.7** | 11.7 | 11.6 |
| | | @ Break | 515.3 | 559.8 | 533.6 | **536.2** | 559.8 | 515.3 |

# APPENDIX S – GDL TEST DATA

Table S1. Transmissivity of GDLs (ASTM D 4716).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2$/s)** | **Mean θ ($m^2$/s)** | **Transmissivity θ ($m^2$/s)** | **Mean θ ($m^2$/s)** | **Transmissivity θ($m^2$/s)** | **Mean θ ($m^2$/s)** |
| ALTAMONT, CA | Alt. Bottom of Lysimeter | 1 | 2.1E-04 | 2.1E-04 | 7.9E-05 | 8.1E-05 | 2.1E-05 | 2.0E-05 |
| | | | 2.2E-04 | | 8.4E-05 | | 2.0E-05 | |
| | | | 2.0E-04 | | 8.1E-05 | | 1.9E-05 | |
| | | 2 | 8.5E-05 | 8.4E-05 | 5.6E-05 | 5.5E-05 | 2.0E-05 | 2.0E-05 |
| | | | 8.3E-05 | | 5.5E-05 | | 2.0E-05 | |
| | | | 8.3E-05 | | 5.3E-05 | | 1.9E-05 | |
| | | 3 | 8.2E-05 | 8.1E-05 | 5.2E-05 | 5.0E-05 | 1.3E-05 | 1.2E-05 |
| | | | 8.0E-05 | | 5.0E-05 | | 1.2E-05 | |
| | | | 8.0E-05 | | 4.9E-05 | | 1.2E-05 | |
| | CMP-GC3 | 1 | 2.6E-04 | 2.6E-04 | 1.5E-04 | 1.4E-04 | 2.3E-05 | 2.2E-05 |
| | | | 2.6E-04 | | 1.5E-04 | | 2.2E-05 | |
| | | | 2.6E-04 | | 1.4E-04 | | 2.1E-05 | |
| | | 2 | 2.9E-04 | 2.8E-04 | 1.5E-04 | 1.5E-04 | 2.3E-05 | 2.2E-05 |
| | | | 2.8E-04 | | 1.5E-04 | | 2.2E-05 | |
| | | | 2.8E-04 | | 1.4E-04 | | 2.2E-05 | |
| | | 3 | 3.4E-04 | 3.3E-04 | 1.5E-04 | 1.5E-04 | 3.1E-05 | 3.0E-05 |
| | | | 3.2E-04 | | 1.5E-04 | | 3.0E-05 | |
| | | | 3.2E-04 | | 1.5E-04 | | 2.9E-05 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| ALTAMONT, CA | CMP-Bottom of Lysimeter | 1 | 2.4E-04 | 2.4E-04 | 1.7E-04 | 1.7E-04 | 9.7E-05 | 9.7E-05 |
| | | | 2.4E-04 | | 1.7E-04 | | 9.7E-05 | |
| | | | 2.4E-04 | | 1.7E-04 | | 9.7E-05 | |
| | | 2 | 4.9E-05 | 4.8E-05 | 4.4E-05 | 4.4E-05 | 2.9E-05 | 2.8E-05 |
| | | | 4.8E-05 | | 4.4E-05 | | 2.8E-05 | |
| | | | 4.8E-05 | | 4.3E-05 | | 2.8E-05 | |
| | | 3 | 4.2E-05 | 4.2E-05 | 3.7E-05 | 3.7E-05 | 2.1E-05 | 2.1E-05 |
| | | | 4.2E-05 | | 3.7E-05 | | 2.1E-05 | |
| | | | 4.1E-05 | | 3.6E-05 | | 2.1E-05 | |
| | CMP-GC2 | 1 | 3.6E-05 | 3.5E-05 | 3.1E-05 | 3.1E-05 | 1.7E-05 | 1.7E-05 |
| | | | 3.5E-05 | | 3.1E-05 | | 1.7E-05 | |
| | | | 3.4E-05 | | 3.1E-05 | | 1.7E-05 | |
| | | 2 | 3.8E-05 | 3.8E-05 | 3.5E-05 | 3.4E-05 | 2.1E-05 | 2.1E-05 |
| | | | 3.8E-05 | | 3.4E-05 | | 2.1E-05 | |
| | | | 3.7E-05 | | 3.4E-05 | | 2.0E-05 | |
| | | 3 | 4.7E-05 | 4.6E-05 | 3.6E-05 | 3.6E-05 | 1.8E-05 | 1.7E-05 |
| | | | 4.6E-05 | | 3.6E-05 | | 1.7E-05 | |
| | | | 4.5E-05 | | 3.6E-05 | | 1.7E-05 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| BOARDMAN, OR | LOWER GEOCOMPOSITE | 1 | 1.7E-04 | 1.8E-04 | 1.6E-04 | 1.6E-04 | 8.0E-05 | 7.9E-05 |
| | | | 1.8E-04 | | 1.6E-04 | | 7.9E-05 | |
| | | | 1.8E-04 | | 1.6E-04 | | 7.7E-05 | |
| | | 2 | 3.3E-04 | 3.4E-04 | 5.5E-05 | 5.5E-05 | 2.8E-05 | 2.8E-05 |
| | | | 3.4E-04 | | 5.5E-05 | | 2.8E-05 | |
| | | | 3.4E-04 | | 5.5E-05 | | 2.7E-05 | |
| | | 3 | 7.2E-05 | 7.2E-05 | 5.8E-05 | 5.8E-05 | 2.9E-05 | 2.9E-05 |
| | | | 7.2E-05 | | 5.8E-05 | | 2.9E-05 | |
| | | | 7.1E-05 | | 5.8E-05 | | 2.8E-05 | |
| | GEOCOMPOSITE 1 UPPER | 1 | 1.9E-04 | 1.9E-04 | 1.5E-04 | 1.5E-04 | 5.6E-05 | 5.3E-05 |
| | | | 1.9E-04 | | 1.5E-04 | | 5.3E-05 | |
| | | | 1.8E-04 | | 1.5E-04 | | 5.2E-05 | |
| | | 2 | 1.7E-04 | 1.6E-04 | 1.3E-04 | 1.3E-04 | 6.2E-05 | 6.1E-05 |
| | | | 1.6E-04 | | 1.3E-04 | | 6.1E-05 | |
| | | | 1.6E-04 | | 1.2E-04 | | 6.0E-05 | |
| | | 3 | 1.6E-04 | 1.6E-04 | 1.2E-04 | 1.2E-04 | 5.9E-05 | 5.7E-05 |
| | | | 1.6E-04 | | 1.2E-04 | | 5.7E-05 | |
| | | | 1.5E-04 | | 1.2E-04 | | 5.5E-05 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| **BOARDMAN, OR** | **Thick Cover 3** | 1 | 6.8E-05 | 6.6E-05 | 4.7E-05 | 4.7E-05 | 2.4E-05 | 2.3E-05 |
| | | | 6.6E-05 | | 4.6E-05 | | 2.3E-05 | |
| | | | 6.5E-05 | | 4.6E-05 | | 2.3E-05 | |
| | | 2 | 1.9E-04 | 1.9E-04 | 1.5E-04 | 1.5E-04 | 7.7E-05 | 7.5E-05 |
| | | | 1.9E-04 | | 1.5E-04 | | 7.4E-05 | |
| | | | 1.9E-04 | | 1.5E-04 | | 7.3E-05 | |
| | | 3 | 5.5E-05 | 5.7E-05 | 4.3E-05 | 4.3E-05 | 2.3E-05 | 2.3E-05 |
| | | | 5.8E-05 | | 4.3E-05 | | 2.3E-05 | |
| | | | 5.7E-05 | | 4.3E-05 | | 2.3E-05 | |
| **CEDAR RAPIDS, IA** | **CLAY BOTTOM 1** | 1 | 3.1E-04 | 3.0E-04 | 1.8E-04 | 1.8E-04 | 8.5E-05 | 8.4E-05 |
| | | | 3.0E-04 | | 1.8E-04 | | 8.3E-05 | |
| | | | 3.0E-04 | | 1.8E-04 | | 8.3E-05 | |
| | | 2 | 2.7E-04 | 2.8E-04 | 2.7E-04 | 2.7E-04 | 1.6E-04 | 1.6E-04 |
| | | | 2.8E-04 | | 2.7E-04 | | 1.6E-04 | |
| | | | 2.8E-04 | | 2.6E-04 | | 1.6E-04 | |
| | | 3 | 2.8E-04 | 2.8E-04 | 2.8E-04 | 2.8E-04 | 1.8E-04 | 1.8E-04 |
| | | | 2.8E-04 | | 2.8E-04 | | 1.8E-04 | |
| | | | 2.7E-04 | | 2.7E-04 | | 1.7E-04 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| CEDAR RAPIDS, IA | BOTTOM COMPOSITE 2 | 1 | 3.1E-04 | 3.1E-04 | 2.8E-04 | 2.8E-04 | 1.5E-04 | 1.5E-04 |
| | | | 3.1E-04 | | 2.7E-04 | | 1.5E-04 | |
| | | | 3.0E-04 | | 2.7E-04 | | 1.5E-04 | |
| | | 2 | 3.2E-04 | 3.2E-04 | 3.1E-04 | 3.1E-04 | 1.8E-04 | 1.7E-04 |
| | | | 3.2E-04 | | 3.1E-04 | | 1.7E-04 | |
| | | | 3.2E-04 | | 3.1E-04 | | 1.7E-04 | |
| | | 3 | 4.9E-04 | 4.8E-04 | 3.9E-04 | 3.9E-04 | 2.3E-04 | 2.3E-04 |
| | | | 4.9E-04 | | 3.8E-04 | | 2.3E-04 | |
| | | | 4.7E-04 | | 3.9E-04 | | 2.3E-04 | |
| EAU CLAIRE, WI | TP1-GC-1 | 1 | 4.6E-04 | 4.4E-04 | N/A | | 2.1E-04 | 2.0E-04 |
| | | | 4.5E-04 | | | | 2.0E-04 | |
| | | | 4.7E-04 | | | | 2.0E-04 | |
| | | 2 | 2.5E-04 | | | | 1.2E-04 | |
| | | | 2.4E-04 | | | | 1.2E-04 | |
| | | | 2.4E-04 | | | | 1.2E-04 | |
| | | 3 | 6.2E-04 | | | | 2.9E-04 | |
| | | | 6.0E-04 | | | | 2.8E-04 | |
| | | | 5.9E-04 | | | | 2.8E-04 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| **EAU CLAIRE, WI** | **TP1-GC-2** | 1 | 5.6E-04 | 5.4E-04 | N/A | | 2.2E-04 | 2.3E-04 |
| | | | 5.7E-04 | | | | 2.2E-04 | |
| | | | 5.6E-04 | | | | 2.2E-04 | |
| | | 2 | 5.1E-04 | | | | 2.5E-04 | |
| | | | 5.2E-04 | | | | 2.5E-04 | |
| | | | 5.1E-04 | | | | 2.4E-04 | |
| | | 3 | 5.4E-04 | | | | 2.3E-04 | |
| | | | 5.6E-04 | | | | 2.2E-04 | |
| | | | 5.3E-04 | | | | 2.2E-04 | |
| | **TP1-GC-3** | 1 | 2.3E-04 | 3.4E-04 | N/A | | 1.1E-04 | 1.4E-04 |
| | | | 2.3E-04 | | | | 1.1E-04 | |
| | | | 2.3E-04 | | | | 1.0E-04 | |
| | | 2 | 4.2E-04 | | | | 1.6E-04 | |
| | | | 4.3E-04 | | | | 1.6E-04 | |
| | | | 4.2E-04 | | | | 1.6E-04 | |
| | | 3 | 3.8E-04 | | | | 1.5E-04 | |
| | | | 3.7E-04 | | | | 1.5E-04 | |
| | | | 3.7E-04 | | | | 1.5E-04 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| **EAU CLAIRE, WI** | **TP2-GC-1** | 1 | 3.2E-04 | 2.8E-04 | N/A | | 1.1E-04 | 1.1E-04 |
| | | | 3.2E-04 | | | | 1.1E-04 | |
| | | | 3.3E-04 | | | | 1.0E-04 | |
| | | 2 | 2.8E-04 | | | | 1.2E-04 | |
| | | | 2.9E-04 | | | | 1.1E-04 | |
| | | | 2.9E-04 | | | | 1.1E-04 | |
| | | 3 | 2.2E-04 | | | | 1.1E-04 | |
| | | | 2.3E-04 | | | | 1.0E-04 | |
| | | | 2.2E-04 | | | | 1.0E-04 | |
| | **TP2-GC-2** | 1 | 1.0E-03 | 6.1E-04 | N/A | | 2.6E-04 | 1.7E-04 |
| | | | 1.1E-03 | | | | 2.7E-04 | |
| | | | 1.0E-03 | | | | 2.6E-04 | |
| | | 2 | 5.0E-04 | | | | 1.3E-04 | |
| | | | 5.1E-04 | | | | 1.3E-04 | |
| | | | 4.9E-04 | | | | 1.2E-04 | |
| | | 3 | 2.9E-04 | | | | 1.2E-04 | |
| | | | 2.9E-04 | | | | 1.2E-04 | |
| | | | 3.0E-04 | | | | 1.2E-04 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| **EAU CLAIRE, WI** | **TP2-GC-3** | 1 | 3.7E-04 | 4.0E-04 | N/A | | 1.5E-04 | 1.5E-04 |
| | | | 3.7E-04 | | | | 1.4E-04 | |
| | | | 3.7E-04 | | | | 1.4E-04 | |
| | | 2 | 3.7E-04 | | | | 1.2E-04 | |
| | | | 3.6E-04 | | | | 1.2E-04 | |
| | | | 3.6E-04 | | | | 1.2E-04 | |
| | | 3 | 4.7E-04 | | | | 1.9E-04 | |
| | | | 4.8E-04 | | | | 1.8E-04 | |
| | | | 4.7E-04 | | | | 1.8E-04 | |
| | **TP3-GC-1** | 1 | 2.0E-04 | 3.0E-04 | N/A | | 7.5E-05 | 1.2E-04 |
| | | | 1.9E-04 | | | | 7.8E-05 | |
| | | | 1.9E-04 | | | | 7.7E-05 | |
| | | 2 | 4.7E-04 | | | | 2.0E-04 | |
| | | | 4.6E-04 | | | | 2.0E-04 | |
| | | | 4.7E-04 | | | | 2.0E-04 | |
| | | 3 | 2.4E-04 | | | | 7.3E-05 | |
| | | | 2.3E-04 | | | | 7.3E-05 | |
| | | | 2.3E-04 | | | | 7.2E-05 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| **EAU CLAIRE, WI** | **TP3-GC-2** | 1 | 1.6E-03 | 7.2E-04 | N/A | | 1.6E-04 | 1.4E-04 |
| | | | 1.6E-03 | | | | 1.6E-04 | |
| | | | 1.6E-03 | | | | 1.6E-04 | |
| | | 2 | 2.1E-04 | | | | 9.9E-05 | |
| | | | 2.0E-04 | | | | 9.8E-05 | |
| | | | 2.1E-04 | | | | 9.8E-05 | |
| | | 3 | 3.7E-04 | | | | 1.6E-04 | |
| | | | 3.7E-04 | | | | 1.6E-04 | |
| | | | 3.7E-04 | | | | 1.6E-04 | |
| | **TP3-GC-3** | 1 | 3.4E-04 | 3.6E-04 | N/A | | 1.5E-04 | 1.3E-04 |
| | | | 3.4E-04 | | | | 1.5E-04 | |
| | | | 3.4E-04 | | | | 1.5E-04 | |
| | | 2 | 4.1E-04 | | | | 1.2E-04 | |
| | | | 4.2E-04 | | | | 1.2E-04 | |
| | | | 4.1E-04 | | | | 1.2E-04 | |
| | | 3 | 3.3E-04 | | | | 1.2E-04 | |
| | | | 3.4E-04 | | | | 1.2E-04 | |
| | | | 3.5E-04 | | | | 1.2E-04 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| **EAU CLAIRE, WI** | **TP3-GC-4** | 1 | 5.3E-04 | 5.7E-04 | N/A | | 1.7E-04 | 1.4E-04 |
| | | | 5.3E-04 | | | | 1.6E-04 | |
| | | | 5.3E-04 | | | | 1.6E-04 | |
| | | 2 | 3.1E-04 | | | | 1.3E-04 | |
| | | | 3.0E-04 | | | | 1.3E-04 | |
| | | | 3.1E-04 | | | | 1.2E-04 | |
| | | 3 | 8.9E-04 | | | | 1.5E-04 | |
| | | | 8.7E-04 | | | | 1.4E-04 | |
| | | | 8.7E-04 | | | | 1.4E-04 | |
| | **TP4-GC-1** | 1 | 4.5E-04 | 3.3E-04 | N/A | | 2.0E-04 | 1.2E-04 |
| | | | 4.3E-04 | | | | 2.0E-04 | |
| | | | 4.2E-04 | | | | 1.9E-04 | |
| | | 2 | 3.9E-04 | | | | 1.6E-04 | |
| | | | 3.8E-04 | | | | 1.5E-06 | |
| | | | 3.8E-04 | | | | 1.5E-04 | |
| | | 3 | 1.9E-04 | | | | 6.5E-05 | |
| | | | 1.9E-04 | | | | 6.5E-05 | |
| | | | 1.8E-04 | | | | 6.4E-05 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| **EAU CLAIRE, WI** | **TP4-GC-2** | 1 | 1.2E-03 | 5.7E-04 | N/A | | 2.2E-04 | 1.2E-04 |
| | | | 1.2E-03 | | | | 2.2E-04 | |
| | | | 1.3E-03 | | | | 2.2E-04 | |
| | | 2 | 2.4E-04 | | | | 6.2E-05 | |
| | | | 2.4E-04 | | | | 6.2E-05 | |
| | | | 2.4E-04 | | | | 6.1E-05 | |
| | | 3 | 2.4E-04 | | | | 7.3E-05 | |
| | | | 2.4E-04 | | | | 7.2E-05 | |
| | | | 2.4E-04 | | | | 7.0E-05 | |
| | **TP4-GC-3** | 1 | 4.5E-04 | 5.6E-04 | N/A | | 8.9E-05 | 1.0E-04 |
| | | | 4.3E-04 | | | | 8.9E-05 | |
| | | | 4.4E-04 | | | | 8.8E-05 | |
| | | 2 | 2.8E-04 | | | | 1.4E-04 | |
| | | | 2.8E-04 | | | | 1.4E-04 | |
| | | | 2.9E-04 | | | | 1.4E-04 | |
| | | 3 | 9.5E-04 | | | | 7.4E-05 | |
| | | | 1.0E-03 | | | | 7.4E-05 | |
| | | | 9.6E-04 | | | | 7.4E-05 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| **EAU CLAIRE, WI** | **TP4-GC-4** | 1 | 2.6E-04 | 2.7E-04 | N/A | | 1.1E-04 | 1.2E-04 |
| | | | 2.6E-04 | | | | 1.1E-04 | |
| | | | 2.6E-04 | | | | 1.1E-04 | |
| | | 2 | 3.0E-04 | | | | 1.4E-04 | |
| | | | 3.0E-04 | | | | 1.4E-04 | |
| | | | 3.0E-04 | | | | 1.4E-04 | |
| | | 3 | 2.7E-04 | | | | 1.2E-04 | |
| | | | 2.7E-04 | | | | 1.2E-04 | |
| | | | 2.6E-04 | | | | 1.2E-04 | |
| **HELENA, MT** | **GC-AB** | 1 | 2.3E-04 | 2.3E-04 | 2.2E-04 | 2.2E-04 | 1.3E-04 | 1.3E-04 |
| | | | 2.4E-04 | | 2.2E-04 | | 1.3E-04 | |
| | | | 2.3E-04 | | 2.2E-04 | | 1.3E-04 | |
| | | 2 | 2.5E-04 | 2.5E-04 | 2.3E-04 | 2.3E-04 | 1.4E-04 | 1.4E-04 |
| | | | 2.5E-04 | | 2.4E-04 | | 1.4E-04 | |
| | | | 2.5E-04 | | 2.3E-04 | | 1.4E-04 | |
| | | 3 | 2.3E-04 | 2.3E-04 | 2.2E-04 | 2.2E-04 | 1.3E-04 | 1.3E-04 |
| | | | 2.3E-04 | | 2.2E-04 | | 1.3E-04 | |
| | | | 2.3E-04 | | 2.2E-04 | | 1.2E-04 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| OMAHA, NE | GC-A1B | 1 | 1.7E-04 | 1.7E-04 | 1.5E-04 | 1.5E-04 | 7.0E-05 | 6.8E-05 |
| | | | 1.7E-04 | | 1.5E-04 | | 6.7E-05 | |
| | | | 1.7E-04 | | 1.5E-04 | | 6.6E-05 | |
| | | 2 | 1.7E-04 | 1.7E-04 | 1.6E-04 | 1.5E-04 | 9.0E-05 | 8.9E-05 |
| | | | 1.7E-04 | | 1.5E-04 | | 9.0E-05 | |
| | | | 1.7E-04 | | 1.5E-04 | | 8.9E-05 | |
| | | 3 | 1.5E-04 | 1.4E-04 | 1.3E-04 | 1.3E-04 | 8.4E-05 | 8.3E-05 |
| | | | 1.4E-04 | | 1.3E-04 | | 8.3E-05 | |
| | | | 1.4E-04 | | 1.3E-04 | | 8.2E-05 | |
| | GC-A2B | 1 | 1.8E-04 | 1.8E-04 | 1.5E-04 | 1.5E-04 | 7.7E-05 | 7.5E-05 |
| | | | 1.8E-04 | | 1.5E-04 | | 7.5E-05 | |
| | | | 1.8E-04 | | 1.5E-04 | | 7.3E-05 | |
| | | 2 | 1.2E-04 | 1.1E-04 | 8.3E-05 | 8.2E-05 | 4.1E-05 | 4.0E-05 |
| | | | 1.1E-04 | | 8.2E-05 | | 4.0E-05 | |
| | | | 1.1E-04 | | 8.1E-05 | | 3.9E-05 | |
| | | 3 | 1.0E-04 | 1.0E-04 | 9.1E-05 | 9.1E-05 | 4.1E-05 | 3.9E-05 |
| | | | 1.0E-04 | | 9.1E-05 | | 3.9E-05 | |
| | | | 9.9E-05 | | 8.9E-05 | | 3.7E-05 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| OMAHA, NE | GC-CB | 1 | 1.7E-04 | 1.7E-04 | 1.5E-04 | 1.5E-04 | 8.2E-05 | 8.1E-05 |
| | | | 1.7E-04 | | 1.5E-04 | | 8.1E-05 | |
| | | | 1.7E-04 | | 1.5E-04 | | 8.1E-05 | |
| | | 2 | 1.9E-04 | 1.8E-04 | 1.7E-04 | 1.7E-04 | 9.1E-05 | 9.0E-05 |
| | | | 1.8E-04 | | 1.7E-04 | | 9.0E-05 | |
| | | | 1.8E-04 | | 1.7E-04 | | 8.8E-05 | |
| | | 3 | 2.2E-04 | 2.2E-04 | 2.2E-04 | 2.2E-04 | 1.2E-04 | 1.2E-04 |
| | | | 2.3E-04 | | 2.1E-04 | | 1.2E-04 | |
| | | | 2.2E-04 | | 2.1E-04 | | 1.2E-04 | |
| | GC-CM | 1 | 1.2E-04 | 1.2E-04 | 1.0E-04 | 1.0E-04 | 5.2E-05 | 5.2E-05 |
| | | | 1.2E-04 | | 1.0E-04 | | 5.2E-05 | |
| | | | 1.2E-04 | | 1.0E-04 | | 5.1E-05 | |
| | | 2 | 1.5E-04 | 1.5E-04 | 1.3E-04 | 1.3E-04 | 5.4E-05 | 5.2E-05 |
| | | | 1.5E-04 | | 1.3E-04 | | 5.1E-05 | |
| | | | 1.5E-04 | | 1.3E-04 | | 5.0E-05 | |
| | | 3 | 2.0E-04 | 2.0E-04 | 1.9E-04 | 1.9E-04 | 1.1E-04 | 1.1E-04 |
| | | | 2.0E-04 | | 1.9E-04 | | 1.1E-04 | |
| | | | 2.0E-04 | | 1.8E-04 | | 1.0E-04 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| UNDERWOOD, ND | GC-CC3 | 1 | 2.4E-04 | 2.4E-04 | 2.3E-04 | 2.3E-04 | 1.0E-04 | 9.7E-05 |
| | | | 2.4E-04 | | 2.3E-04 | | 9.6E-05 | |
| | | | 2.4E-04 | | 2.3E-04 | | 9.2E-05 | |
| | | 2 | 3.5E-04 | 3.4E-04 | 3.0E-04 | 3.0E-04 | 1.4E-04 | 1.4E-04 |
| | | | 3.5E-04 | | 3.0E-04 | | 1.3E-04 | |
| | | | 3.4E-04 | | 3.0E-04 | | 1.3E-04 | |
| | | 3 | 4.1E-04 | 4.2E-04 | 3.6E-04 | 3.6E-04 | 1.6E-04 | 1.6E-04 |
| | | | 4.1E-04 | | 3.5E-04 | | 1.6E-04 | |
| | | | 4.3E-04 | | 3.6E-04 | | 1.5E-04 | |
| | GC-CC5 | 1 | 1.3E-04 | 1.4E-04 | 1.2E-04 | 1.2E-04 | 4.7E-05 | 4.6E-05 |
| | | | 1.4E-04 | | 1.2E-04 | | 4.5E-05 | |
| | | | 1.3E-04 | | 1.2E-04 | | 4.4E-05 | |
| | | 2 | 1.3E-04 | 1.3E-04 | 1.2E-04 | 1.2E-04 | 5.1E-05 | 4.9E-05 |
| | | | 1.3E-04 | | 1.2E-04 | | 4.8E-05 | |
| | | | 1.3E-04 | | 1.2E-04 | | 4.7E-05 | |
| | | 3 | 1.6E-04 | 1.6E-04 | 1.4E-04 | 1.4E-04 | 6.6E-05 | 6.4E-05 |
| | | | 1.5E-04 | | 1.4E-04 | | 6.4E-05 | |
| | | | 1.6E-04 | | 1.4E-04 | | 6.1E-05 | |

Table S1. Transmissivity of GDLs (ASTM D 4716) (Continued).

| | | | σ = 24 kPa | | σ = 48 kPa | | σ = 480 kPa | |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **Sample #** | **Specimen #** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ ($m^2/s$)** | **Mean θ ($m^2/s$)** | **Transmissivity θ($m^2/s$)** | **Mean θ ($m^2/s$)** |
| UNDERWOOD, ND | GC-ET | 1 | 2.0E-04 | 2.0E-04 | 1.9E-04 | 1.8E-04 | 8.8E-05 | 8.5E-05 |
| | | | 2.0E-04 | | 1.8E-04 | | 8.5E-05 | |
| | | | 2.0E-04 | | 1.6E-04 | | 8.2E-05 | |
| | | 2 | 2.0E-04 | 2.0E-04 | 2.0E-04 | 1.9E-04 | 8.8E-05 | 8.5E-05 |
| | | | 2.1E-04 | | 1.9E-04 | | 8.5E-05 | |
| | | | 2.0E-04 | | 1.9E-04 | | 8.3E-05 | |
| | | 3 | 2.2E-04 | 2.2E-04 | 2.1E-04 | 2.1E-04 | 8.9E-05 | 8.6E-05 |
| | | | 2.3E-04 | | 2.1E-04 | | 8.6E-05 | |
| | | | 2.2E-04 | | 2.1E-04 | | 8.3E-05 | |

Table S2. Permittivity of GDLs (ASTM D 4491).

| | | | | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | | # | Date | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| ALTAMONT | CMP - Bottom of Lysimeter | 1 | 11/19/07 | 12.03 | 552.4 | 0.43 | 0.40 | 1.8E-02 | 23.81 | 372.7 | 0.74 | 0.72 | 1.3E-02 |
| | | | | 8.73 | 366.9 | 0.40 | | | 20.92 | 325.1 | 0.73 | | |
| | | | | 9.96 | 418.3 | 0.39 | | | 21.77 | 334.6 | 0.72 | | |
| | | | | 10.68 | 448.1 | 0.39 | | | 27.36 | 417.3 | 0.72 | | |
| | | | | 8.98 | 370.4 | 0.39 | | | 22.27 | 333.2 | 0.70 | | |
| | | 2 | 05/28/08 | 9.77 | 596.1 | 0.57 | 0.57 | 1.3E-02 | 36.05 | 556.3 | 0.73 | 0.71 | 9.7E-03 |
| | | | | 7.09 | 435.7 | 0.58 | | | 30.87 | 471.2 | 0.72 | | |
| | | | | 6.57 | 401.5 | 0.57 | | | 23.78 | 362.2 | 0.72 | | |
| | | | | 6.44 | 383.3 | 0.56 | | | 25.18 | 378.2 | 0.71 | | |
| | | | | 8.07 | 470.2 | 0.55 | | | 23.97 | 357.4 | 0.70 | | |
| | | 3 | 05/28/08 | 7.42 | 418.8 | 0.53 | 0.52 | 8.3E-03 | 23.31 | 326.9 | 0.66 | 0.65 | 7.1E-03 |
| | | | | 6.88 | 380.0 | 0.52 | | | 22.48 | 310.1 | 0.65 | | |
| | | | | 7.43 | 410.2 | 0.52 | | | 22.30 | 308.4 | 0.65 | | |
| | | | | 8.78 | 479.8 | 0.51 | | | 21.30 | 291.3 | 0.64 | | |
| | | | | 6.77 | 366.1 | 0.51 | | | 21.84 | 297.9 | 0.64 | | |
| | | 4 | 05/28/08 | 9.41 | 515.8 | 0.52 | 0.50 | 1.0E-02 | 23.19 | 290.2 | 0.59 | 0.57 | 2.7E-02 |
| | | | | 8.14 | 443.6 | 0.51 | | | 22.63 | 281.2 | 0.58 | | |
| | | | | 8.01 | 423.8 | 0.50 | | | 26.08 | 289.8 | 0.52 | | |
| | | | | 7.18 | 383.7 | 0.50 | | | 29.83 | 365.6 | 0.58 | | |
| | | | | 7.68 | 401.4 | 0.49 | | | 25.97 | 317.2 | 0.57 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| ALTAMONT | CMP - GC3 | 1 | 05/28/08 | 7.44 | 415.0 | 0.52 | 0.48 | 2.7E-02 | 21.86 | 320.8 | 0.69 | 0.66 | 2.3E-02 |
| | | | | 8.03 | 418.7 | 0.49 | | | 23.29 | 336.9 | 0.68 | | |
| | | | | 7.82 | 395.6 | 0.48 | | | 22.97 | 324.5 | 0.66 | | |
| | | | | 7.67 | 380.6 | 0.47 | | | 23.90 | 332.0 | 0.65 | | |
| | | | | 7.23 | 350.4 | 0.46 | | | 25.83 | 346.3 | 0.63 | | |
| | | 2 | 05/28/08 | 7.63 | 408.7 | 0.50 | 0.45 | 4.9E-02 | 27.91 | 291.2 | 0.49 | 0.48 | 1.3E-02 |
| | | | | 12.70 | 666.4 | 0.49 | | | 21.33 | 220.3 | 0.49 | | |
| | | | | 14.77 | 681.9 | 0.43 | | | 23.37 | 237.2 | 0.48 | | |
| | | | | 9.17 | 400.7 | 0.41 | | | 28.36 | 281.8 | 0.47 | | |
| | | | | 7.29 | 305.5 | 0.39 | | | 27.90 | 272.4 | 0.46 | | |
| | | 3 | 05/28/08 | 5.58 | 316.2 | 0.53 | 0.50 | 2.5E-02 | 30.23 | 537.0 | 0.84 | 0.80 | 2.8E-02 |
| | | | | 8.91 | 483.0 | 0.51 | | | 21.19 | 373.3 | 0.83 | | |
| | | | | 9.43 | 495.1 | 0.49 | | | 25.23 | 431.2 | 0.80 | | |
| | | | | 6.05 | 312.0 | 0.49 | | | 25.22 | 423.0 | 0.79 | | |
| | | | | 7.87 | 390.1 | 0.47 | | | 24.03 | 392.8 | 0.77 | | |
| | | 4 | 05/28/08 | 11.00 | 695.1 | 0.59 | 0.55 | 2.9E-02 | 30.43 | 470.5 | 0.73 | 0.68 | 4.7E-02 |
| | | | | 9.09 | 549.5 | 0.57 | | | 24.29 | 373.0 | 0.72 | | |
| | | | | 8.87 | 514.9 | 0.55 | | | 22.14 | 332.8 | 0.71 | | |
| | | | | 8.46 | 482.3 | 0.54 | | | 24.77 | 335.6 | 0.64 | | |
| | | | | 10.60 | 587.1 | 0.52 | | | 25.69 | 345.1 | 0.63 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permit-tivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| ALTAMONT | Alt - Bottom of Lysimeter | 1 | 05/28/08 | 9.97 | 442.6 | 0.42 | 0.39 | 1.7E-02 | 29.37 | 524.4 | 0.84 | 0.82 | 1.8E-02 |
| | | | | 9.72 | 417.6 | 0.40 | | | 28.58 | 504.5 | 0.83 | | |
| | | | | 6.68 | 280.0 | 0.39 | | | 22.31 | 385.2 | 0.81 | | |
| | | | | 9.14 | 371.3 | 0.38 | | | 22.60 | 394.9 | 0.82 | | |
| | | | | 9.27 | 371.2 | 0.38 | | | 20.93 | 353.3 | 0.79 | | |
| | | 2 | 05/28/08 | 8.93 | 579.2 | 0.61 | 0.56 | 4.4E-02 | 27.62 | 366.1 | 0.62 | 0.60 | 2.5E-01 |
| | | | | 7.19 | 449.3 | 0.59 | | | 25.64 | 303.0 | 0.56 | | |
| | | | | 6.52 | 396.9 | 0.57 | | | 25.05 | 257.5 | 0.48 | | |
| | | | | 9.52 | 526.1 | 0.52 | | | 33.01 | 231.4 | 0.33 | | |
| | | | | 8.33 | 450.3 | 0.51 | | | 18.02 | 388.0 | 1.01 | | |
| | | 3 | 05/28/08 | 12.07 | 335.5 | 0.26 | 0.20 | 4.3E-02 | 20.52 | 405.9 | 0.93 | 0.83 | 8.9E-02 |
| | | | | 18.68 | 451.7 | 0.23 | | | 19.38 | 366.4 | 0.89 | | |
| | | | | 9.10 | 199.5 | 0.21 | | | 22.35 | 397.9 | 0.84 | | |
| | | | | 13.08 | 246.4 | 0.18 | | | 20.72 | 341.4 | 0.77 | | |
| | | | | 14.23 | 227.6 | 0.15 | | | 21.19 | 318.5 | 0.71 | | |
| | | 4 | 05/28/08 | 8.04 | 534.3 | 0.62 | 0.58 | 4.3E-02 | 21.88 | 365.3 | 0.78 | 0.75 | 2.7E-02 |
| | | | | 7.83 | 504.8 | 0.61 | | | 21.37 | 350.2 | 0.77 | | |
| | | | | 8.51 | 521.7 | 0.58 | | | 23.67 | 377.2 | 0.75 | | |
| | | | | 8.33 | 485.6 | 0.55 | | | 30.94 | 478.6 | 0.73 | | |
| | | | | 7.81 | 431.6 | 0.52 | | | 24.00 | 368.2 | 0.72 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permit-tivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| APPLE VALLEY | Lysimeter Base | 1 | 05/29/08 | 7.45 | 606.2 | 0.77 | 0.74 | 2.7E-02 | 22.89 | 502.5 | 1.03 | 1.03 | 3.2E-02 |
| | | | | 4.92 | 394.2 | 0.75 | | | 23.61 | 545.6 | 1.09 | | |
| | | | | 6.12 | 484.6 | 0.74 | | | 14.87 | 324.4 | 1.03 | | |
| | | | | 5.55 | 438.6 | 0.74 | | | 18.34 | 395.7 | 1.01 | | |
| | | | | 10.12 | 747.2 | 0.69 | | | 15.77 | 337.4 | 1.01 | | |
| | | 2 | 05/29/08 | 9.84 | 867.2 | 0.83 | 0.76 | 4.4E-02 | 15.70 | 294.2 | 0.88 | 0.87 | 8.0E-03 |
| | | | | 6.37 | 515.5 | 0.76 | | | 18.02 | 336.4 | 0.88 | | |
| | | | | 7.23 | 576.9 | 0.75 | | | 14.58 | 272.4 | 0.88 | | |
| | | | | 6.58 | 514.5 | 0.74 | | | 20.34 | 374.6 | 0.87 | | |
| | | | | 6.67 | 504.8 | 0.71 | | | 18.20 | 334.2 | 0.86 | | |
| | | 3 | 05/29/08 | 6.80 | 598.5 | 0.83 | 0.80 | 2.0E-02 | 26.23 | 628.8 | 1.13 | 1.11 | 1.8E-02 |
| | | | | 10.67 | 922.4 | 0.81 | | | 15.86 | 380.5 | 1.13 | | |
| | | | | 5.98 | 512.8 | 0.81 | | | 15.14 | 363.2 | 1.13 | | |
| | | | | 6.83 | 575.5 | 0.79 | | | 17.77 | 416.0 | 1.10 | | |
| | | | | 7.36 | 607.3 | 0.78 | | | 15.89 | 368.4 | 1.09 | | |
| | | 4 | 05/29/08 | 7.62 | 743.7 | 0.92 | 0.84 | 5.0E-02 | 18.20 | 384.3 | 0.99 | 0.99 | 4.6E-03 |
| | | | | 6.02 | 553.0 | 0.86 | | | 16.55 | 349.9 | 0.99 | | |
| | | | | 8.52 | 739.1 | 0.82 | | | 17.28 | 363.5 | 0.99 | | |
| | | | | 5.87 | 510.7 | 0.82 | | | 19.61 | 411.1 | 0.99 | | |
| | | | | 8.00 | 673.4 | 0.79 | | | 16.67 | 348.5 | 0.98 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity ψ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permit -tivity ψ ($s^{-1}$) | Mean | Std. Dev. |
| BOARDMAN | Geocomposite 1 Upper | 1 | 05/29/08 | 6.77 | 494.3 | 0.69 | 0.66 | 1.7E-02 | 38.02 | 731.8 | 0.90 | 0.87 | 5.4 E-02 |
| | | | | 8.79 | 626.1 | 0.67 | | | 29.71 | 573.5 | 0.91 | | |
| | | | | 11.37 | 789.4 | 0.65 | | | 31.67 | 601.5 | 0.89 | | |
| | | | | 7.37 | 510.4 | 0.65 | | | 32.68 | 615.9 | 0.89 | | |
| | | | | 6.33 | 433.5 | 0.64 | | | 26.20 | 433.8 | 0.78 | | |
| | | 2 | 05/29/08 | 6.73 | 555.2 | 0.78 | 0.70 | 5.0E-02 | 45.88 | 751.8 | 0.77 | 0.76 | 1.8 E-02 |
| | | | | 7.25 | 551.3 | 0.72 | | | 28.35 | 464.2 | 0.77 | | |
| | | | | 12.15 | 885.7 | 0.69 | | | 22.85 | 380.1 | 0.78 | | |
| | | | | 8.49 | 593.7 | 0.66 | | | 24.25 | 388.0 | 0.75 | | |
| | | | | 7.03 | 488.1 | 0.65 | | | 35.23 | 552.0 | 0.74 | | |
| | | 3 | 05/29/08 | 8.11 | 599.9 | 0.70 | 0.67 | 2.2E-02 | 45.73 | 894.7 | 0.92 | 0.90 | 1.9 E-02 |
| | | | | 8.70 | 636.4 | 0.69 | | | 24.89 | 480.4 | 0.91 | | |
| | | | | 7.39 | 524.1 | 0.67 | | | 21.37 | 406.4 | 0.89 | | |
| | | | | 7.94 | 555.0 | 0.66 | | | 20.21 | 380.8 | 0.89 | | |
| | | | | 13.07 | 892.1 | 0.64 | | | 23.05 | 427.0 | 0.87 | | |
| | | 4 | 05/29/08 | 9.97 | 744.5 | 0.70 | 0.66 | 3.4E-02 | 34.31 | 522.7 | 0.72 | 0.70 | 1.2 E-02 |
| | | | | 6.59 | 475.4 | 0.68 | | | 31.87 | 479.8 | 0.71 | | |
| | | | | 7.62 | 530.4 | 0.65 | | | 31.67 | 469.7 | 0.70 | | |
| | | | | 7.70 | 520.9 | 0.64 | | | 26.16 | 386.6 | 0.69 | | |
| | | | | 9.15 | 597.8 | 0.61 | | | 28.94 | 422.1 | 0.69 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| | | | | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | | # | Date | Time (s) | Volume ($cm^3$) | Permittivity ψ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permit -tivity ψ ($s^{-1}$) | Mean | Std. Dev. |
| BOARDMAN | Thcik Cover | 1 | 05/29/08 | 10.30 | 456.3 | 0.42 | 0.41 | 5.6E-03 | 28.64 | 320.7 | 0.53 | 0.52 | 7.7E-03 |
| | | | | 14.98 | 652.0 | 0.41 | | | 24.23 | 267.9 | 0.52 | | |
| | | | | 10.42 | 453.2 | 0.41 | | | 24.40 | 268.6 | 0.52 | | |
| | | | | 8.42 | 364.5 | 0.41 | | | 39.11 | 423.3 | 0.51 | | |
| | | | | 12.27 | 523.1 | 0.40 | | | 24.70 | 267.1 | 0.51 | | |
| | | 2 | 05/29/08 | 10.92 | 465.5 | 0.40 | 0.39 | 8.3E-03 | 32.53 | 290.9 | 0.42 | 0.42 | 5.2E-03 |
| | | | | 15.89 | 665.8 | 0.39 | | | 31.83 | 285.3 | 0.42 | | |
| | | | | 13.52 | 561.2 | 0.39 | | | 38.20 | 337.7 | 0.42 | | |
| | | | | 14.30 | 577.2 | 0.38 | | | 37.48 | 330.1 | 0.41 | | |
| | | | | 8.48 | 346.5 | 0.38 | | | 27.05 | 235.1 | 0.41 | | |
| | | 3 | 05/29/08 | 12.98 | 591.6 | 0.43 | 0.42 | 1.1E-02 | 31.25 | 336.5 | 0.51 | 0.50 | 4.6E-03 |
| | | | | 10.98 | 497.5 | 0.43 | | | 50.27 | 536.8 | 0.50 | | |
| | | | | 9.58 | 431.1 | 0.42 | | | 28.33 | 301.7 | 0.50 | | |
| | | | | 21.11 | 918.8 | 0.41 | | | 31.48 | 333.9 | 0.50 | | |
| | | | | 13.14 | 564.0 | 0.40 | | | 33.36 | 350.3 | 0.49 | | |
| | | 4 | 05/29/08 | 8.05 | 390.0 | 0.46 | 0.43 | 1.6E-02 | 24.02 | 236.4 | 0.46 | 0.44 | 2.2E-02 |
| | | | | 18.48 | 862.4 | 0.44 | | | 33.17 | 289.0 | 0.41 | | |
| | | | | 10.36 | 466.2 | 0.42 | | | 25.27 | 246.5 | 0.46 | | |
| | | | | 8.70 | 394.6 | 0.43 | | | 29.20 | 271.7 | 0.44 | | |
| | | | | 11.95 | 527.6 | 0.42 | | | 31.55 | 288.7 | 0.43 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| | | | | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | | # | Date | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| CEDAR RAPIDS | Clay Bottom 1 | 1 | 05/29/08 | 6.14 | 523.9 | 0.80 | 0.77 | 2.9E-02 | 13.31 | 337.7 | 1.19 | 1.16 | 2.5E-02 |
| | | | | 6.69 | 570.6 | 0.80 | | | 14.66 | 368.3 | 1.18 | | |
| | | | | 5.09 | 420.1 | 0.78 | | | 11.95 | 297.9 | 1.17 | | |
| | | | | 7.50 | 600.9 | 0.75 | | | 14.68 | 355.5 | 1.14 | | |
| | | | | 8.08 | 632.9 | 0.74 | | | 14.29 | 346.2 | 1.14 | | |
| | | 2 | 05/29/08 | 6.93 | 541.8 | 0.74 | 0.62 | 8.6E-02 | 39.88 | 505.8 | 0.60 | 0.57 | 2.2E-02 |
| | | | | 9.84 | 714.4 | 0.68 | | | 70.82 | 868.4 | 0.58 | | |
| | | | | 6.71 | 419.7 | 0.59 | | | 41.33 | 498.9 | 0.57 | | |
| | | | | 8.54 | 504.6 | 0.56 | | | 70.22 | 820.4 | 0.55 | | |
| | | | | 8.66 | 491.5 | 0.53 | | | 43.69 | 503.7 | 0.54 | | |
| | | 3 | 05/29/08 | 6.57 | 716.4 | 1.03 | 1.01 | 1.5E-02 | 20.47 | 658.6 | 1.51 | 1.47 | 2.7E-02 |
| | | | | 5.93 | 643.1 | 1.02 | | | 20.03 | 627.5 | 1.47 | | |
| | | | | 5.76 | 624.8 | 1.02 | | | 17.10 | 534.1 | 1.47 | | |
| | | | | 5.99 | 641.9 | 1.01 | | | 15.99 | 497.2 | 1.46 | | |
| | | | | 6.99 | 734.1 | 0.99 | | | 18.63 | 569.6 | 1.44 | | |
| | | 4 | 05/29/08 | 6.62 | 683.9 | 0.97 | 0.92 | 3.3E-02 | 19.57 | 446.1 | 1.07 | 1.06 | 6.3E-03 |
| | | | | 4.87 | 478.9 | 0.92 | | | 15.51 | 351.8 | 1.07 | | |
| | | | | 7.06 | 691.6 | 0.92 | | | 16.78 | 378.0 | 1.06 | | |
| | | | | 8.87 | 834.7 | 0.88 | | | 15.23 | 344.5 | 1.06 | | |
| | | | | 6.16 | 590.7 | 0.90 | | | 16.89 | 379.2 | 1.06 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP1 GC-1 | 1 | 11/19/07 | 13.98 | 308.1 | 0.21 | 0.20 | 4.1E-03 | 78.27 | 416.4 | 0.25 | 0.25 | 3.6E-03 |
| | | | | 14.42 | 311.4 | 0.20 | | | 64.67 | 345.2 | 0.25 | | |
| | | | | 14.20 | 304.5 | 0.20 | | | 60.33 | 319.5 | 0.25 | | |
| | | | | 14.70 | 309.5 | 0.20 | | | 58.98 | 307.2 | 0.24 | | |
| | | | | 14.23 | 298.3 | 0.20 | | | 59.52 | 307.3 | 0.24 | | |
| | | 2 | 11/19/07 | 13.53 | 507.3 | 0.35 | 0.34 | 1.3E-02 | 54.11 | 553.7 | 0.48 | 0.48 | 1.2E-02 |
| | | | | 12.86 | 482.6 | 0.35 | | | 47.25 | 505.3 | 0.50 | | |
| | | | | 10.12 | 365.8 | 0.34 | | | 42.42 | 434.9 | 0.48 | | |
| | | | | 12.39 | 436.9 | 0.33 | | | 38.50 | 390.2 | 0.48 | | |
| | | | | 15.11 | 518.0 | 0.32 | | | 38.09 | 383.3 | 0.47 | | |
| | | 3 | 11/19/07 | 23.18 | 412.2 | 0.17 | 0.16 | 3.9E-03 | 58.02 | 285.4 | 0.23 | 0.22 | 6.2E-03 |
| | | | | 22.46 | 396.3 | 0.17 | | | 61.98 | 298.4 | 0.23 | | |
| | | | | 16.39 | 280.6 | 0.16 | | | 61.14 | 289.2 | 0.22 | | |
| | | | | 18.42 | 315.9 | 0.16 | | | 59.39 | 278.3 | 0.22 | | |
| | | | | 17.38 | 291.5 | 0.16 | | | 56.31 | 257.2 | 0.21 | | |
| | | 4 | 11/19/07 | 21.20 | 252.1 | 0.11 | 0.11 | 3.4E-03 | 78.92 | 425.7 | 0.25 | 0.26 | 1.4E-03 |
| | | | | 20.03 | 238.2 | 0.11 | | | 60.30 | 327.9 | 0.26 | | |
| | | | | 22.61 | 262.9 | 0.11 | | | 55.59 | 303.7 | 0.26 | | |
| | | | | 21.39 | 249.4 | 0.11 | | | 58.83 | 320.8 | 0.26 | | |
| | | | | 21.05 | 263.9 | 0.12 | | | 64.60 | 353.1 | 0.26 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP1 GC-2 | 1 | 11/19/07 | 14.27 | 315.1 | 0.21 | 0.20 | 4.1E-03 | 61.61 | 368.9 | 0.28 | 0.28 | 4.5E-03 |
| | | | | 15.36 | 332.8 | 0.20 | | | 62.75 | 368.4 | 0.28 | | |
| | | | | 13.70 | 293.8 | 0.20 | | | 53.52 | 315.6 | 0.28 | | |
| | | | | 15.27 | 323.0 | 0.20 | | | 52.36 | 303.1 | 0.27 | | |
| | | | | 13.45 | 282.3 | 0.20 | | | 52.92 | 303.8 | 0.27 | | |
| | | 2 | 11/19/07 | 8.77 | 420.4 | 0.45 | 0.42 | 1.7E-02 | 62.77 | 693.9 | 0.52 | 0.51 | 8.3E-03 |
| | | | | 7.89 | 359.5 | 0.43 | | | 46.62 | 509.7 | 0.51 | | |
| | | | | 10.14 | 456.1 | 0.42 | | | 35.18 | 379.7 | 0.51 | | |
| | | | | 6.73 | 299.0 | 0.42 | | | 29.86 | 318.5 | 0.50 | | |
| | | | | 6.67 | 286.9 | 0.40 | | | 25.30 | 269.1 | 0.50 | | |
| | | 3 | 11/20/07 | 24.08 | 456.2 | 0.18 | 0.17 | 3.7E-03 | 58.89 | 274.3 | 0.22 | 0.22 | 3.2E-03 |
| | | | | 17.95 | 337.9 | 0.18 | | | 61.30 | 284.3 | 0.22 | | |
| | | | | 17.75 | 328.7 | 0.17 | | | 62.30 | 282.4 | 0.21 | | |
| | | | | 16.84 | 311.0 | 0.17 | | | 65.55 | 298.2 | 0.21 | | |
| | | | | 14.65 | 262.9 | 0.17 | | | 59.42 | 267.4 | 0.21 | | |
| | | 4 | 11/20/07 | 11.58 | 524.9 | 0.43 | 0.43 | 1.5E-03 | 55.64 | 661.5 | 0.56 | 0.56 | 3.4E-03 |
| | | | | 9.55 | 432.4 | 0.43 | | | 41.20 | 490.5 | 0.56 | | |
| | | | | 10.33 | 471.8 | 0.43 | | | 32.36 | 384.7 | 0.56 | | |
| | | | | 9.52 | 433.0 | 0.43 | | | 31.42 | 368.9 | 0.55 | | |
| | | | | 9.37 | 424.9 | 0.43 | | | 29.17 | 344.0 | 0.55 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP1 GC-3 | 1 | 11/20/07 | 10.33 | 435.5 | 0.40 | 0.39 | 7.3E-03 | 51.37 | 455.1 | 0.42 | 0.42 | 4.2E-03 |
| | | | | 11.48 | 484.7 | 0.40 | | | 38.52 | 340.2 | 0.42 | | |
| | | | | 7.52 | 310.5 | 0.39 | | | 34.20 | 302.5 | 0.42 | | |
| | | | | 8.17 | 335.5 | 0.39 | | | 37.08 | 324.4 | 0.41 | | |
| | | | | 7.33 | 295.9 | 0.38 | | | 32.77 | 294.8 | 0.42 | | |
| | | 2 | 11/20/07 | 8.95 | 624.7 | 0.66 | 0.64 | 1.6E-02 | 29.42 | 498.5 | 0.80 | 0.79 | 8.6E-03 |
| | | | | 6.70 | 468.7 | 0.66 | | | 29.34 | 493.9 | 0.79 | | |
| | | | | 5.77 | 392.7 | 0.64 | | | 25.61 | 428.6 | 0.79 | | |
| | | | | 5.33 | 355.3 | 0.63 | | | 21.15 | 353.6 | 0.79 | | |
| | | | | 5.37 | 356.6 | 0.62 | | | 21.08 | 346.8 | 0.77 | | |
| | | 3 | 11/20/07 | 6.61 | 371.4 | 0.53 | 0.51 | 1.4E-02 | 26.48 | 368.6 | 0.65 | 0.65 | 5.9E-03 |
| | | | | 5.23 | 290.5 | 0.52 | | | 26.02 | 362.3 | 0.65 | | |
| | | | | 6.70 | 361.5 | 0.51 | | | 24.05 | 332.2 | 0.65 | | |
| | | | | 7.02 | 372.2 | 0.50 | | | 21.37 | 293.3 | 0.65 | | |
| | | | | 6.92 | 365.3 | 0.50 | | | 24.48 | 333.7 | 0.64 | | |
| | | 4 | 11/20/07 | 7.23 | 394.1 | 0.51 | 0.50 | 7.8E-03 | 30.23 | 384.6 | 0.60 | 0.60 | 2.9E-03 |
| | | | | 12.64 | 670.7 | 0.50 | | | 26.20 | 333.9 | 0.60 | | |
| | | | | 6.36 | 344.3 | 0.51 | | | 23.89 | 302.8 | 0.60 | | |
| | | | | 7.21 | 383.9 | 0.50 | | | 25.70 | 325.1 | 0.59 | | |
| | | | | 7.92 | 415.6 | 0.49 | | | 28.08 | 353.4 | 0.59 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| | | | | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | | # | Date | Time (s) | Volume ($cm^3$) | Permittivity ψ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permittivity ψ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP2 GC-1 | 1 | 11/20/07 | 8.12 | 484.2 | 0.56 | 0.54 | 1.7E-02 | 24.69 | 485.8 | 0.93 | 0.87 | 3.5E-02 |
| | | | | 7.62 | 445.1 | 0.55 | | | 22.14 | 418.6 | 0.89 | | |
| | | | | 8.22 | 469.7 | 0.54 | | | 20.10 | 371.8 | 0.87 | | |
| | | | | 6.03 | 341.0 | 0.53 | | | 20.81 | 374.1 | 0.85 | | |
| | | | | 5.23 | 287.1 | 0.52 | | | 18.70 | 333.4 | 0.84 | | |
| | | 2 | 11/20/07 | 9.60 | 349.4 | 0.34 | 0.33 | 7.4E-03 | 48.76 | 493.3 | 0.48 | 0.47 | 7.2E-03 |
| | | | | 7.80 | 272.5 | 0.33 | | | 38.23 | 384.0 | 0.47 | | |
| | | | | 11.07 | 388.3 | 0.33 | | | 32.97 | 327.9 | 0.47 | | |
| | | | | 8.41 | 292.7 | 0.33 | | | 65.05 | 632.9 | 0.46 | | |
| | | | | 9.60 | 328.9 | 0.32 | | | 51.42 | 507.1 | 0.46 | | |
| | | 3 | 11/20/07 | 9.40 | 458.7 | 0.46 | 0.45 | 7.1E-03 | 33.69 | 465.9 | 0.65 | 0.64 | 9.7E-03 |
| | | | | 10.85 | 516.7 | 0.45 | | | 29.49 | 402.6 | 0.64 | | |
| | | | | 7.16 | 344.2 | 0.45 | | | 28.46 | 383.1 | 0.63 | | |
| | | | | 9.85 | 460.9 | 0.44 | | | 30.07 | 401.4 | 0.63 | | |
| | | | | 6.17 | 292.4 | 0.45 | | | 26.47 | 353.6 | 0.63 | | |
| | | 4 | 11/20/07 | 7.21 | 299.6 | 0.39 | 0.37 | 1.2E-02 | 30.03 | 259.4 | 0.41 | 0.39 | 7.7E-03 |
| | | | | 9.01 | 356.8 | 0.37 | | | 50.77 | 429.4 | 0.40 | | |
| | | | | 8.65 | 346.5 | 0.38 | | | 39.21 | 328.2 | 0.39 | | |
| | | | | 11.81 | 457.5 | 0.36 | | | 43.95 | 366.4 | 0.39 | | |
| | | | | 8.83 | 337.3 | 0.36 | | | 39.68 | 325.1 | 0.39 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP2 GC-2 | 1 | 11/21/07 | 10.14 | 335.3 | 0.31 | 0.31 | 3.4E-03 | 55.58 | 502.7 | 0.43 | 0.41 | 7.9E-03 |
| | | | | 9.32 | 310.9 | 0.31 | | | 44.13 | 386.6 | 0.41 | | |
| | | | | 8.66 | 286.7 | 0.31 | | | 44.71 | 387.4 | 0.41 | | |
| | | | | 8.11 | 275.3 | 0.32 | | | 38.61 | 335.5 | 0.41 | | |
| | | | | 11.48 | 381.1 | 0.31 | | | 36.20 | 312.3 | 0.41 | | |
| | | 2 | 11/21/07 | 6.08 | 469.1 | 0.73 | 0.70 | 2.5E-02 | 45.10 | 803.3 | 0.84 | 0.81 | 1.9E-02 |
| | | | | 5.93 | 452.9 | 0.72 | | | 23.80 | 415.7 | 0.82 | | |
| | | | | 5.26 | 396.2 | 0.71 | | | 24.31 | 416.1 | 0.80 | | |
| | | | | 5.89 | 435.8 | 0.70 | | | 17.72 | 299.3 | 0.79 | | |
| | | | | 5.52 | 388.8 | 0.66 | | | 19.37 | 325.9 | 0.79 | | |
| | | 3 | 11/21/07 | 8.12 | 538.6 | 0.62 | 0.60 | 1.5E-02 | 44.40 | 728.3 | 0.77 | 0.77 | 4.4E-03 |
| | | | | 7.19 | 470.0 | 0.61 | | | 27.71 | 452.6 | 0.77 | | |
| | | | | 6.34 | 397.5 | 0.59 | | | 28.88 | 477.7 | 0.78 | | |
| | | | | 6.12 | 386.5 | 0.59 | | | 22.10 | 365.7 | 0.78 | | |
| | | | | 4.75 | 300.9 | 0.60 | | | 27.18 | 446.1 | 0.77 | | |
| | | 4 | 11/21/07 | 7.47 | 474.6 | 0.60 | 0.57 | 2.0E-02 | 25.35 | 406.4 | 0.75 | 0.74 | 1.2E-02 |
| | | | | 6.68 | 415.1 | 0.58 | | | 21.34 | 341.8 | 0.75 | | |
| | | | | 5.31 | 329.7 | 0.58 | | | 22.27 | 352.9 | 0.75 | | |
| | | | | 5.59 | 332.7 | 0.56 | | | 20.54 | 316.4 | 0.72 | | |
| | | | | 5.61 | 326.6 | 0.55 | | | 20.56 | 325.2 | 0.74 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity ψ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permittivity ψ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP2 GC-3 | 1 | 11/21/07 | 9.26 | 340.7 | 0.35 | 0.33 | 1.5E-02 | 53.16 | 415.1 | 0.37 | 0.35 | 1.1E-02 |
| | | | | 11.73 | 415.3 | 0.33 | | | 47.52 | 360.2 | 0.36 | | |
| | | | | 14.48 | 506.5 | 0.33 | | | 42.43 | 319.2 | 0.35 | | |
| | | | | 15.24 | 511.3 | 0.32 | | | 39.39 | 290.2 | 0.35 | | |
| | | | | 14.25 | 464.4 | 0.31 | | | 46.78 | 337.5 | 0.34 | | |
| | | 2 | 11/21/07 | 10.98 | 398.8 | 0.34 | 0.32 | 1.4E-02 | 51.87 | 394.5 | 0.36 | 0.35 | 7.7E-03 |
| | | | | 7.98 | 276.6 | 0.33 | | | 48.37 | 365.2 | 0.36 | | |
| | | | | 8.99 | 306.4 | 0.32 | | | 47.27 | 350.6 | 0.35 | | |
| | | | | 9.61 | 323.0 | 0.32 | | | 46.06 | 336.4 | 0.34 | | |
| | | | | 10.28 | 330.9 | 0.30 | | | 39.87 | 287.6 | 0.34 | | |
| | | 3 | 11/21/07 | 10.39 | 244.0 | 0.22 | 0.21 | 6.6E-03 | 53.94 | 344.2 | 0.30 | 0.29 | 4.7E-03 |
| | | | | 12.12 | 276.2 | 0.21 | | | 51.68 | 322.2 | 0.29 | | |
| | | | | 23.43 | 552.6 | 0.22 | | | 53.27 | 331.0 | 0.29 | | |
| | | | | 20.24 | 449.1 | 0.21 | | | 50.28 | 311.2 | 0.29 | | |
| | | | | 12.61 | 278.6 | 0.21 | | | 50.92 | 310.8 | 0.29 | | |
| | | 4 | 11/21/07 | 19.04 | 415.4 | 0.21 | 0.19 | 1.2E-02 | 61.63 | 297.1 | 0.23 | 0.22 | 5.3E-03 |
| | | | | 15.43 | 319.7 | 0.19 | | | 63.08 | 298.0 | 0.22 | | |
| | | | | 15.47 | 305.6 | 0.19 | | | 58.12 | 270.3 | 0.22 | | |
| | | | | 15.96 | 305.7 | 0.18 | | | 63.15 | 289.7 | 0.22 | | |
| | | | | 13.67 | 254.7 | 0.18 | | | 57.23 | 259.7 | 0.21 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP3 GC-1 | 1 | 11/21/07 | 21.34 | 394.2 | 0.17 | 0.17 | 3.7E-03 | 81.66 | 487.6 | 0.28 | 0.27 | 8.1E-03 |
| | | | | 21.98 | 402.2 | 0.17 | | | 62.57 | 364.4 | 0.27 | | |
| | | | | 16.73 | 303.7 | 0.17 | | | 52.96 | 302.4 | 0.27 | | |
| | | | | 17.73 | 313.8 | 0.17 | | | 54.82 | 307.5 | 0.26 | | |
| | | | | 17.00 | 298.7 | 0.17 | | | 51.79 | 287.0 | 0.26 | | |
| | | 2 | 11/21/07 | 20.20 | 336.9 | 0.16 | 0.15 | 4.7E-03 | 60.94 | 276.4 | 0.21 | 0.21 | 5.6E-03 |
| | | | | 16.95 | 275.7 | 0.15 | | | 58.39 | 261.3 | 0.21 | | |
| | | | | 19.62 | 311.5 | 0.15 | | | 56.28 | 246.0 | 0.21 | | |
| | | | | 18.00 | 281.1 | 0.15 | | | 58.82 | 253.8 | 0.20 | | |
| | | | | 16.81 | 259.9 | 0.15 | | | 62.89 | 266.8 | 0.20 | | |
| | | 3 | 11/21/07 | 8.70 | 367.9 | 0.40 | 0.39 | 5.4E-03 | 49.95 | 536.1 | 0.50 | 0.51 | 6.5E-03 |
| | | | | 7.44 | 310.5 | 0.39 | | | 40.17 | 441.4 | 0.52 | | |
| | | | | 6.76 | 283.6 | 0.39 | | | 34.98 | 378.2 | 0.51 | | |
| | | | | 7.85 | 325.1 | 0.39 | | | 30.58 | 326.3 | 0.50 | | |
| | | | | 7.50 | 305.8 | 0.38 | | | 35.74 | 380.5 | 0.50 | | |
| | | 4 | 11/21/07 | 10.54 | 440.3 | 0.39 | 0.38 | 1.2E-02 | 45.87 | 433.1 | 0.44 | 0.43 | 8.3E-03 |
| | | | | 8.66 | 348.8 | 0.38 | | | 40.08 | 376.9 | 0.44 | | |
| | | | | 7.90 | 316.3 | 0.38 | | | 39.62 | 365.0 | 0.43 | | |
| | | | | 8.31 | 323.1 | 0.37 | | | 49.35 | 450.1 | 0.43 | | |
| | | | | 9.51 | 365.4 | 0.36 | | | 43.20 | 390.4 | 0.42 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP3 GC-2 | 1 | 11/21/07 | 14.19 | 575.9 | 0.38 | 0.38 | 2.7E-03 | 80.48 | 1129.8 | 0.66 | 0.63 | 2.1E-02 |
| | | | | 9.92 | 409.6 | 0.39 | | | 49.97 | 683.2 | 0.64 | | |
| | | | | 9.87 | 405.3 | 0.39 | | | 39.28 | 525.7 | 0.63 | | |
| | | | | 6.42 | 262.7 | 0.38 | | | 34.87 | 456.3 | 0.62 | | |
| | | | | 8.28 | 336.9 | 0.38 | | | 30.39 | 393.3 | 0.61 | | |
| | | 2 | 11/21/07 | 5.87 | 390.9 | 0.63 | 0.60 | 2.0E-02 | 43.56 | 663.2 | 0.72 | 0.73 | 3.0E-02 |
| | | | | 5.02 | 321.2 | 0.60 | | | 35.75 | 540.6 | 0.71 | | |
| | | | | 6.74 | 421.9 | 0.59 | | | 23.43 | 351.6 | 0.71 | | |
| | | | | 4.76 | 307.8 | 0.61 | | | 22.95 | 378.9 | 0.78 | | |
| | | | | 5.66 | 345.4 | 0.57 | | | 21.06 | 333.4 | 0.74 | | |
| | | 3 | 11/21/07 | 7.50 | 335.0 | 0.42 | 0.41 | 8.0E-03 | 38.62 | 514.9 | 0.63 | 0.61 | 1.1E-02 |
| | | | | 8.69 | 384.5 | 0.42 | | | 26.81 | 355.7 | 0.62 | | |
| | | | | 7.93 | 349.7 | 0.41 | | | 26.00 | 336.3 | 0.61 | | |
| | | | | 6.58 | 288.1 | 0.41 | | | 27.01 | 349.7 | 0.61 | | |
| | | | | 9.68 | 410.8 | 0.40 | | | 23.96 | 307.1 | 0.60 | | |
| | | 4 | 11/21/07 | 6.90 | 450.2 | 0.61 | 0.58 | 2.8E-02 | 28.85 | 484.9 | 0.79 | 0.78 | 1.4E-02 |
| | | | | 7.05 | 446.1 | 0.60 | | | 21.49 | 360.8 | 0.79 | | |
| | | | | 6.87 | 426.9 | 0.58 | | | 20.23 | 337.1 | 0.78 | | |
| | | | | 7.74 | 468.1 | 0.57 | | | 54.38 | 881.5 | 0.76 | | |
| | | | | 6.83 | 391.5 | 0.54 | | | 21.61 | 350.1 | 0.76 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP3 GC-3 | 1 | 11/26/07 | 12.67 | 341.3 | 0.25 | 0.24 | 1.2E-02 | 40.67 | 326.7 | 0.38 | 0.36 | 1.6E-02 |
| | | | | 11.23 | 297.9 | 0.25 | | | 33.11 | 259.2 | 0.37 | | |
| | | | | 18.03 | 458.7 | 0.24 | | | 47.58 | 353.1 | 0.35 | | |
| | | | | 13.80 | 340.2 | 0.23 | | | 49.67 | 367.5 | 0.35 | | |
| | | | | 13.37 | 319.3 | 0.22 | | | 43.89 | 317.1 | 0.34 | | |
| | | 2 | 11/26/07 | 11.37 | 464.8 | 0.38 | 0.37 | 1.6E-02 | 45.17 | 424.2 | 0.44 | 0.42 | 1.3E-02 |
| | | | | 10.23 | 410.8 | 0.38 | | | 39.15 | 361.6 | 0.43 | | |
| | | | | 9.23 | 362.7 | 0.37 | | | 43.95 | 396.1 | 0.42 | | |
| | | | | 8.36 | 316.9 | 0.36 | | | 40.77 | 361.5 | 0.42 | | |
| | | | | 9.87 | 363.3 | 0.35 | | | 42.61 | 369.9 | 0.41 | | |
| | | 3 | 11/26/07 | 7.87 | 570.5 | 0.68 | 0.66 | 2.3E-02 | 25.92 | 528.8 | 0.96 | 0.93 | 2.1E-02 |
| | | | | 7.43 | 530.3 | 0.67 | | | 21.67 | 432.1 | 0.94 | | |
| | | | | 5.11 | 356.6 | 0.66 | | | 22.11 | 433.9 | 0.92 | | |
| | | | | 6.37 | 437.3 | 0.65 | | | 15.92 | 309.2 | 0.91 | | |
| | | | | 6.05 | 401.1 | 0.62 | | | 17.20 | 332.0 | 0.91 | | |
| | | 4 | 11/26/07 | 17.73 | 1114.4 | 0.59 | 0.57 | 2.6E-02 | 22.02 | 295.5 | 0.63 | 0.65 | 1.4E-02 |
| | | | | 6.14 | 384.9 | 0.59 | | | 26.08 | 367.4 | 0.66 | | |
| | | | | 6.80 | 413.8 | 0.57 | | | 25.37 | 354.2 | 0.66 | | |
| | | | | 7.20 | 423.6 | 0.55 | | | 22.30 | 308.8 | 0.65 | | |
| | | | | 7.45 | 420.2 | 0.53 | | | 26.67 | 358.4 | 0.63 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permit-tivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP3 GC-4 | 1 | 11/26/07 | 10.92 | 486.9 | 0.42 | 0.39 | 1.9E-02 | 31.03 | 473.5 | 0.72 | 0.68 | 2.9E-02 |
| | | | | 10.58 | 451.4 | 0.40 | | | 22.43 | 330.4 | 0.69 | | |
| | | | | 8.98 | 374.6 | 0.39 | | | 41.98 | 606.9 | 0.68 | | |
| | | | | 8.61 | 347.0 | 0.38 | | | 38.70 | 540.0 | 0.66 | | |
| | | | | 8.92 | 351.9 | 0.37 | | | 22.95 | 314.5 | 0.64 | | |
| | | 2 | 11/26/07 | 11.89 | 265.4 | 0.21 | 0.23 | 2.1E-02 | 57.08 | 325.5 | 0.27 | 0.25 | 1.9E-02 |
| | | | | 10.92 | 302.5 | 0.26 | | | 71.02 | 399.9 | 0.26 | | |
| | | | | 11.31 | 300.8 | 0.25 | | | 60.37 | 305.6 | 0.24 | | |
| | | | | 12.34 | 308.1 | 0.23 | | | 61.61 | 306.9 | 0.23 | | |
| | | | | 14.48 | 336.4 | 0.22 | | | 96.77 | 468.3 | 0.23 | | |
| | | 3 | 11/26/07 | 10.36 | 240.8 | 0.22 | 0.23 | 8.0E-03 | 45.67 | 387.0 | 0.40 | 0.38 | 1.6E-02 |
| | | | | 21.96 | 556.6 | 0.24 | | | 40.55 | 338.8 | 0.39 | | |
| | | | | 10.52 | 261.2 | 0.23 | | | 42.18 | 339.8 | 0.38 | | |
| | | | | 12.45 | 304.4 | 0.23 | | | 40.61 | 321.2 | 0.37 | | |
| | | | | 12.77 | 302.5 | 0.22 | | | 37.89 | 289.3 | 0.36 | | |
| | | 4 | 11/26/07 | 18.80 | 414.7 | 0.21 | 0.19 | 1.1E-02 | 35.42 | 447.8 | 0.59 | 0.49 | 5.7E-02 |
| | | | | 15.08 | 319.6 | 0.20 | | | 19.80 | 193.3 | 0.46 | | |
| | | | | 16.86 | 347.7 | 0.19 | | | 22.70 | 230.4 | 0.48 | | |
| | | | | 15.20 | 300.3 | 0.19 | | | 32.12 | 323.0 | 0.47 | | |
| | | | | 22.78 | 436.6 | 0.18 | | | 27.30 | 268.7 | 0.46 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP4 GC-1 | 1 | 11/26/07 | 5.89 | 392.9 | 0.63 | 0.60 | 2.6E-02 | 54.14 | 1154.5 | 1.00 | 0.94 | 4.7E-02 |
| | | | | 5.48 | 355.8 | 0.61 | | | 26.30 | 542.3 | 0.97 | | |
| | | | | 5.30 | 335.7 | 0.60 | | | 24.05 | 479.5 | 0.94 | | |
| | | | | 5.95 | 373.0 | 0.59 | | | 25.98 | 503.4 | 0.91 | | |
| | | | | 7.08 | 419.9 | 0.56 | | | 27.61 | 518.1 | 0.88 | | |
| | | 2 | 11/26/07 | 11.96 | 842.8 | 0.66 | 0.59 | 5.4E-02 | 27.83 | 356.0 | 0.60 | 0.57 | 2.2E-02 |
| | | | | 9.08 | 596.4 | 0.62 | | | 29.42 | 368.1 | 0.59 | | |
| | | | | 9.95 | 616.7 | 0.58 | | | 26.61 | 324.3 | 0.57 | | |
| | | | | 9.11 | 527.3 | 0.54 | | | 27.12 | 322.3 | 0.56 | | |
| | | | | 7.36 | 415.9 | 0.53 | | | 28.92 | 335.6 | 0.55 | | |
| | | 3 | 11/26/07 | 7.70 | 547.7 | 0.67 | 0.63 | 2.8E-02 | 28.89 | 628.5 | 1.02 | 0.98 | 3.3E-02 |
| | | | | 6.42 | 433.6 | 0.64 | | | 20.11 | 430.6 | 1.01 | | |
| | | | | 7.45 | 489.8 | 0.62 | | | 18.08 | 380.1 | 0.99 | | |
| | | | | 6.48 | 423.3 | 0.61 | | | 21.11 | 430.8 | 0.96 | | |
| | | | | 7.81 | 493.9 | 0.59 | | | 20.05 | 401.4 | 0.94 | | |
| | | 4 | 11/26/07 | 6.70 | 445.6 | 0.63 | 0.58 | 3.7E-02 | 20.42 | 299.5 | 0.69 | 0.64 | 2.8E-02 |
| | | | | 6.61 | 431.4 | 0.61 | | | 27.92 | 386.9 | 0.65 | | |
| | | | | 7.03 | 438.6 | 0.59 | | | 24.05 | 322.2 | 0.63 | | |
| | | | | 6.27 | 376.4 | 0.56 | | | 23.48 | 313.3 | 0.63 | | |
| | | | | 6.37 | 361.0 | 0.53 | | | 22.52 | 296.9 | 0.62 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permit-tivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP4 GC-2 | 1 | 11/27/07 | 5.02 | 419.2 | 0.79 | 0.76 | 1.3E-02 | 28.40 | 711.2 | 1.18 | 1.18 | 7.1E-03 |
| | | | | 5.34 | 430.6 | 0.76 | | | 15.75 | 397.3 | 1.19 | | |
| | | | | 6.33 | 508.6 | 0.76 | | | 12.58 | 316.2 | 1.18 | | |
| | | | | 8.80 | 703.3 | 0.75 | | | 12.11 | 308.1 | 1.20 | | |
| | | | | 5.84 | 475.3 | 0.77 | | | 13.05 | 328.0 | 1.18 | | |
| | | 2 | 11/27/07 | 11.02 | 494.2 | 0.42 | 0.42 | 2.4E-03 | 30.12 | 442.4 | 0.69 | 0.71 | 1.3E-02 |
| | | | | 11.34 | 506.3 | 0.42 | | | 31.55 | 483.7 | 0.72 | | |
| | | | | 8.27 | 366.1 | 0.42 | | | 27.05 | 413.2 | 0.72 | | |
| | | | | 9.77 | 436.3 | 0.42 | | | 20.23 | 309.7 | 0.72 | | |
| | | | | 8.08 | 357.7 | 0.42 | | | 22.75 | 347.8 | 0.72 | | |
| | | 3 | 11/27/07 | 10.55 | 727.5 | 0.65 | 0.64 | 4.8E-03 | 46.39 | 1068.2 | 1.08 | 1.07 | 1.3E-02 |
| | | | | 9.40 | 640.7 | 0.64 | | | 27.39 | 629.2 | 1.08 | | |
| | | | | 6.53 | 447.0 | 0.64 | | | 20.23 | 458.6 | 1.07 | | |
| | | | | 5.67 | 384.0 | 0.64 | | | 22.67 | 509.3 | 1.06 | | |
| | | | | 5.33 | 361.3 | 0.64 | | | 21.20 | 475.7 | 1.06 | | |
| | | 4 | 11/27/07 | 14.89 | 372.5 | 0.24 | 0.23 | 6.1E-03 | 43.77 | 310.0 | 0.33 | 0.27 | 4.6E-02 |
| | | | | 9.58 | 242.1 | 0.24 | | | 47.15 | 306.5 | 0.31 | | |
| | | | | 11.64 | 288.8 | 0.23 | | | 46.14 | 243.9 | 0.25 | | |
| | | | | 11.61 | 283.6 | 0.23 | | | 47.17 | 236.3 | 0.24 | | |
| | | | | 15.98 | 377.1 | 0.22 | | | 50.92 | 248.3 | 0.23 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| | | | | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Identification | | # | Date | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP4 GC-3 | 1 | 11/27/07 | 8.77 | 434.4 | 0.47 | 0.44 | 2.9E-02 | 33.53 | 693.3 | 0.97 | 0.92 | 3.9E-02 |
| | | | | 8.78 | 425.0 | 0.46 | | | 14.27 | 288.2 | 0.95 | | |
| | | | | 8.33 | 391.8 | 0.44 | | | 18.42 | 360.0 | 0.92 | | |
| | | | | 7.55 | 338.1 | 0.42 | | | 19.36 | 368.7 | 0.90 | | |
| | | | | 10.61 | 444.6 | 0.39 | | | 17.89 | 333.4 | 0.88 | | |
| | | 2 | 11/27/07 | 7.95 | 558.2 | 0.66 | 0.62 | 3.8E-02 | 29.55 | 559.4 | 0.89 | 0.89 | 3.6E-03 |
| | | | | 6.92 | 474.0 | 0.64 | | | 25.67 | 484.5 | 0.89 | | |
| | | | | 6.15 | 405.9 | 0.62 | | | 20.23 | 379.8 | 0.88 | | |
| | | | | 7.15 | 444.7 | 0.58 | | | 17.89 | 336.2 | 0.88 | | |
| | | | | 7.70 | 468.4 | 0.57 | | | 17.52 | 328.5 | 0.88 | | |
| | | 3 | 11/27/07 | 7.17 | 362.9 | 0.48 | 0.46 | 1.5E-02 | 29.67 | 598.5 | 0.95 | 0.89 | 3.9E-02 |
| | | | | 17.36 | 839.2 | 0.45 | | | 19.23 | 375.3 | 0.92 | | |
| | | | | 10.48 | 515.6 | 0.46 | | | 22.30 | 421.1 | 0.89 | | |
| | | | | 7.14 | 343.3 | 0.45 | | | 17.77 | 327.2 | 0.87 | | |
| | | | | 8.05 | 371.4 | 0.43 | | | 18.33 | 332.4 | 0.85 | | |
| | | 4 | 11/27/07 | 7.08 | 485.2 | 0.64 | 0.60 | 3.6E-02 | 22.87 | 391.8 | 0.81 | 0.81 | 6.4E-03 |
| | | | | 7.09 | 478.7 | 0.63 | | | 22.20 | 384.0 | 0.81 | | |
| | | | | 8.05 | 503.7 | 0.59 | | | 20.15 | 352.7 | 0.82 | | |
| | | | | 6.92 | 421.5 | 0.57 | | | 22.30 | 385.4 | 0.81 | | |
| | | | | 5.55 | 333.7 | 0.57 | | | 27.42 | 476.4 | 0.82 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| EAU CLAIRE | TP4 GC-4 | 1 | 11/27/07 | 8.62 | 401.6 | 0.44 | 0.41 | 1.6E-02 | 33.23 | 541.6 | 0.77 | 0.71 | 4.8E-02 |
| | | | | 16.55 | 727.5 | 0.41 | | | 20.30 | 321.0 | 0.74 | | |
| | | | | 9.09 | 392.9 | 0.41 | | | 22.95 | 354.6 | 0.73 | | |
| | | | | 8.05 | 345.8 | 0.40 | | | 17.81 | 249.5 | 0.66 | | |
| | | | | 8.73 | 367.3 | 0.40 | | | 23.02 | 326.2 | 0.67 | | |
| | | 2 | 11/27/07 | 11.61 | 718.8 | 0.58 | 0.54 | 3.7E-02 | 21.20 | 333.9 | 0.74 | 0.71 | 3.9E-02 |
| | | | | 6.98 | 425.4 | 0.57 | | | 20.93 | 327.5 | 0.74 | | |
| | | | | 7.95 | 456.5 | 0.54 | | | 24.21 | 369.0 | 0.72 | | |
| | | | | 8.92 | 487.9 | 0.51 | | | 22.73 | 333.2 | 0.69 | | |
| | | | | 9.05 | 477.8 | 0.50 | | | 20.31 | 279.2 | 0.65 | | |
| | | 3 | 11/27/07 | 11.34 | 286.9 | 0.24 | 0.22 | 1.3E-02 | 39.61 | 439.1 | 0.52 | 0.49 | 2.2E-02 |
| | | | | 15.80 | 369.8 | 0.22 | | | 28.02 | 299.3 | 0.50 | | |
| | | | | 15.55 | 351.8 | 0.21 | | | 42.98 | 451.3 | 0.49 | | |
| | | | | 15.09 | 332.4 | 0.21 | | | 33.59 | 352.2 | 0.49 | | |
| | | | | 12.25 | 265.9 | 0.20 | | | 28.14 | 275.8 | 0.46 | | |
| | | 4 | 11/27/07 | 11.02 | 474.7 | 0.41 | 0.36 | 3.5E-02 | 38.52 | 436.6 | 0.53 | 0.53 | 1.1E-02 |
| | | | | 9.70 | 397.0 | 0.38 | | | 29.17 | 333.9 | 0.54 | | |
| | | | | 9.46 | 354.2 | 0.35 | | | 34.39 | 384.4 | 0.53 | | |
| | | | | 8.09 | 289.5 | 0.34 | | | 29.45 | 326.4 | 0.52 | | |
| | | | | 12.36 | 418.9 | 0.32 | | | 31.39 | 340.2 | 0.51 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| HELENA | GC - AB | 1 | 09/11/08 | 16.68 | 630.2 | 0.36 | 0.34 | 2.7E-02 | 28.45 | 535.5 | 0.89 | 0.83 | 4.4E-02 |
| | | | | 12.48 | 457.5 | 0.34 | | | 23.05 | 416.8 | 0.85 | | |
| | | | | 16.87 | 584.5 | 0.33 | | | 24.45 | 429.6 | 0.83 | | |
| | | | | 14.61 | 482.0 | 0.31 | | | 24.84 | 426.2 | 0.81 | | |
| | | | | 13.67 | 550.8 | 0.38 | | | 31.83 | 519.7 | 0.77 | | |
| | | 2 | 09/11/08 | 12.48 | 921.2 | 0.69 | 0.65 | 3.9E-02 | 26.17 | 644.2 | 1.16 | 1.08 | 5.7E-02 |
| | | | | 8.02 | 573.9 | 0.67 | | | 14.02 | 333.0 | 1.12 | | |
| | | | | 8.20 | 570.2 | 0.65 | | | 18.71 | 411.6 | 1.03 | | |
| | | | | 10.55 | 698.8 | 0.62 | | | 17.37 | 391.5 | 1.06 | | |
| | | | | 12.56 | 796.6 | 0.60 | | | 19.45 | 423.2 | 1.02 | | |
| | | 3 | 09/11/08 | 15.86 | 462.1 | 0.27 | 0.25 | 1.7E-02 | 10.23 | 514.5 | 2.36 | 2.23 | 1.1E-01 |
| | | | | 17.33 | 489.5 | 0.27 | | | 14.89 | 725.1 | 2.29 | | |
| | | | | 16.52 | 453.8 | 0.26 | | | 7.78 | 377.1 | 2.28 | | |
| | | | | 14.53 | 371.6 | 0.24 | | | 12.08 | 546.0 | 2.13 | | |
| | | | | 13.40 | 334.4 | 0.23 | | | 12.39 | 554.0 | 2.10 | | |
| | | 4 | 09/11/08 | 8.83 | 734.1 | 0.78 | 0.70 | 6.9E-02 | 20.45 | 327.9 | 0.75 | 0.72 | 2.8E-02 |
| | | | | 6.42 | 516.2 | 0.76 | | | 32.70 | 513.4 | 0.74 | | |
| | | | | 7.39 | 542.7 | 0.69 | | | 41.30 | 635.3 | 0.72 | | |
| | | | | 7.40 | 511.4 | 0.65 | | | 45.55 | 681.4 | 0.70 | | |
| | | | | 13.17 | 868.7 | 0.62 | | | 28.86 | 419.3 | 0.68 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| OMAHA | GC - CB | 1 | 07/11/08 | 43.05 | 337.8 | 0.07 | 0.07 | 1.1E-03 | 38.08 | 218.5 | 0.27 | 0.23 | 3.2E-02 |
| | | | | 53.08 | 421.3 | 0.07 | | | 51.96 | 283.7 | 0.26 | | |
| | | | | 43.10 | 345.6 | 0.08 | | | 39.71 | 190.7 | 0.23 | | |
| | | | | 37.80 | 299.5 | 0.07 | | | 41.11 | 182.4 | 0.21 | | |
| | | | | 51.03 | 393.2 | 0.07 | | | 43.59 | 181.0 | 0.20 | | |
| | | 2 | 07/11/08 | 12.14 | 424.0 | 0.33 | 0.28 | 3.9E-02 | 20.95 | 406.5 | 0.91 | 0.77 | 1.1E-01 |
| | | | | 12.52 | 407.1 | 0.31 | | | 35.83 | 645.1 | 0.85 | | |
| | | | | 15.23 | 446.9 | 0.28 | | | 21.25 | 338.7 | 0.75 | | |
| | | | | 17.09 | 450.1 | 0.25 | | | 27.11 | 407.0 | 0.71 | | |
| | | | | 9.80 | 246.1 | 0.24 | | | 20.95 | 281.3 | 0.63 | | |
| | | 3 | 07/11/08 | 22.39 | 771.6 | 0.32 | 0.28 | 3.5E-02 | 40.36 | 271.3 | 0.32 | 0.30 | 1.3E-02 |
| | | | | 13.80 | 450.6 | 0.31 | | | 46.05 | 301.0 | 0.31 | | |
| | | | | 11.17 | 336.9 | 0.28 | | | 61.11 | 386.5 | 0.30 | | |
| | | | | 13.02 | 371.1 | 0.27 | | | 33.58 | 208.9 | 0.29 | | |
| | | | | 15.30 | 379.6 | 0.23 | | | 30.46 | 183.5 | 0.28 | | |
| | | 4 | 07/11/08 | 10.36 | 754.2 | 0.68 | 0.60 | 5.8E-02 | 18.45 | 390.5 | 1.00 | 0.96 | 4.2E-02 |
| | | | | 14.08 | 956.9 | 0.64 | | | 13.48 | 283.8 | 0.99 | | |
| | | | | 9.64 | 608.5 | 0.59 | | | 15.65 | 325.2 | 0.98 | | |
| | | | | 10.36 | 619.4 | 0.56 | | | 15.92 | 313.4 | 0.93 | | |
| | | | | 8.42 | 485.1 | 0.54 | | | 12.33 | 236.6 | 0.90 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| OMAHA | GC - CM | 1 | 07/11/08 | 11.42 | 742.4 | 0.61 | 0.52 | 6.5E-02 | 25.23 | 322.5 | 0.60 | 0.58 | 1.4E-02 |
| | | | | 10.40 | 604.7 | 0.55 | | | 23.86 | 297.4 | 0.59 | | |
| | | | | 12.05 | 649.3 | 0.51 | | | 18.65 | 231.0 | 0.58 | | |
| | | | | 9.77 | 491.3 | 0.47 | | | 20.86 | 252.9 | 0.57 | | |
| | | | | 9.83 | 468.0 | 0.45 | | | 23.28 | 279.6 | 0.56 | | |
| | | 2 | 07/11/08 | 15.11 | 769.9 | 0.48 | 0.43 | 3.8E-02 | 24.70 | 407.5 | 0.78 | 0.74 | 2.6E-02 |
| | | | | 7.05 | 336.3 | 0.45 | | | 19.80 | 316.1 | 0.75 | | |
| | | | | 10.59 | 479.6 | 0.43 | | | 24.89 | 381.2 | 0.72 | | |
| | | | | 10.52 | 446.7 | 0.40 | | | 19.18 | 298.7 | 0.73 | | |
| | | | | 9.86 | 403.5 | 0.38 | | | 20.86 | 314.5 | 0.71 | | |
| | | 3 | 07/11/08 | 7.98 | 545.7 | 0.64 | 0.56 | 5.8E-02 | 23.86 | 372.4 | 0.73 | 0.71 | 1.9E-02 |
| | | | | 5.61 | 353.5 | 0.59 | | | 22.89 | 350.2 | 0.72 | | |
| | | | | 9.02 | 533.3 | 0.56 | | | 28.21 | 421.3 | 0.70 | | |
| | | | | 9.80 | 546.8 | 0.52 | | | 27.67 | 404.7 | 0.69 | | |
| | | | | 9.83 | 517.4 | 0.49 | | | 22.61 | 351.0 | 0.73 | | |
| | | 4 | 07/11/08 | 16.31 | 1079.9 | 0.62 | 0.56 | 4.4E-02 | 21.46 | 500.7 | 1.10 | 1.03 | 4.0E-02 |
| | | | | 6.17 | 376.5 | 0.57 | | | 16.02 | 346.2 | 1.02 | | |
| | | | | 8.34 | 484.9 | 0.55 | | | 14.09 | 310.8 | 1.04 | | |
| | | | | 9.67 | 543.8 | 0.53 | | | 16.55 | 359.0 | 1.02 | | |
| | | | | 10.20 | 551.6 | 0.51 | | | 15.78 | 332.2 | 0.99 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| | | | | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Identification | | # | Date | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| OMAHA | GC - A1B | 1 | 07/11/08 | 19.11 | 600.0 | 0.30 | 0.24 | 3.8E-02 | 47.89 | 215.2 | 0.21 | 0.20 | 7.5E-03 |
| | | | | 14.42 | 394.8 | 0.26 | | | 59.36 | 255.1 | 0.20 | | |
| | | | | 14.56 | 366.7 | 0.24 | | | 44.30 | 185.5 | 0.20 | | |
| | | | | 15.58 | 357.3 | 0.22 | | | 51.58 | 210.8 | 0.19 | | |
| | | | | 15.45 | 325.0 | 0.20 | | | 52.11 | 228.2 | 0.21 | | |
| | | 2 | 07/11/08 | 13.93 | 454.2 | 0.31 | 0.27 | 2.5E-02 | 32.64 | 323.7 | 0.47 | 0.42 | 3.2E-02 |
| | | | | 12.89 | 391.4 | 0.29 | | | 25.11 | 233.4 | 0.44 | | |
| | | | | 18.64 | 530.4 | 0.27 | | | 23.11 | 201.6 | 0.41 | | |
| | | | | 11.61 | 314.8 | 0.25 | | | 26.90 | 227.9 | 0.40 | | |
| | | | | 11.87 | 308.2 | 0.24 | | | 21.15 | 173.3 | 0.39 | | |
| | | 3 | 07/11/08 | 11.61 | 677.6 | 0.55 | 0.45 | 6.7E-02 | 24.17 | 330.4 | 0.64 | 0.57 | 4.3E-02 |
| | | | | 9.95 | 506.2 | 0.48 | | | 69.08 | 856.6 | 0.58 | | |
| | | | | 9.84 | 455.0 | 0.43 | | | 28.81 | 343.3 | 0.56 | | |
| | | | | 7.55 | 329.8 | 0.41 | | | 26.92 | 311.3 | 0.54 | | |
| | | | | 9.67 | 384.5 | 0.37 | | | 25.64 | 292.1 | 0.54 | | |
| | | 4 | 07/11/08 | 12.40 | 686.1 | 0.52 | 0.48 | 3.6E-02 | 20.42 | 351.3 | 0.81 | 0.73 | 5.5E-02 |
| | | | | 8.33 | 450.1 | 0.51 | | | 23.28 | 380.2 | 0.77 | | |
| | | | | 11.36 | 585.3 | 0.48 | | | 22.18 | 342.4 | 0.73 | | |
| | | | | 14.21 | 679.2 | 0.45 | | | 25.37 | 376.4 | 0.70 | | |
| | | | | 9.58 | 444.5 | 0.44 | | | 25.05 | 358.4 | 0.67 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| | | | | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | | # | Date | Time (s) | Volume ($cm^3$) | Permittivity ψ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permit -tivity ψ ($s^{-1}$) | Mean | Std. Dev. |
| OMAHA | GC - A2B | 1 | 07/11/08 | 15.86 | 521.4 | 0.31 | 0.23 | 5.6E-02 | 23.02 | 204.6 | 0.42 | 0.42 | 1.9E-02 |
| | | | | 10.52 | 292.8 | 0.26 | | | 25.03 | 219.9 | 0.41 | | |
| | | | | 12.77 | 283.9 | 0.21 | | | 34.05 | 331.9 | 0.46 | | |
| | | | | 12.80 | 259.9 | 0.19 | | | 20.36 | 177.9 | 0.41 | | |
| | | | | 14.48 | 266.9 | 0.17 | | | 21.36 | 192.4 | 0.42 | | |
| | | 2 | 07/11/08 | 11.45 | 441.9 | 0.36 | 0.32 | 2.9E-02 | 22.45 | 378.6 | 0.79 | 0.71 | 5.7E-02 |
| | | | | 9.80 | 354.8 | 0.34 | | | 20.27 | 323.9 | 0.75 | | |
| | | | | 11.70 | 399.8 | 0.32 | | | 24.73 | 367.1 | 0.70 | | |
| | | | | 15.23 | 489.1 | 0.30 | | | 34.89 | 501.3 | 0.68 | | |
| | | | | 9.70 | 300.7 | 0.29 | | | 15.30 | 212.8 | 0.65 | | |
| | | 3 | 07/11/08 | 13.28 | 668.5 | 0.47 | 0.36 | 7.4E-02 | 46.67 | 356.2 | 0.36 | 0.31 | 3.2E-02 |
| | | | | 8.73 | 366.8 | 0.40 | | | 72.48 | 504.7 | 0.33 | | |
| | | | | 9.70 | 360.6 | 0.35 | | | 159.80 | 1017.4 | 0.30 | | |
| | | | | 9.67 | 324.5 | 0.32 | | | 26.42 | 162.5 | 0.29 | | |
| | | | | 10.68 | 324.0 | 0.29 | | | 37.03 | 221.3 | 0.28 | | |
| | | 4 | 07/11/08 | 8.78 | 500.0 | 0.54 | 0.48 | 4.7E-02 | 23.36 | 447.6 | 0.90 | 0.81 | 6.3E-02 |
| | | | | 6.65 | 363.2 | 0.51 | | | 21.17 | 381.3 | 0.85 | | |
| | | | | 8.83 | 440.6 | 0.47 | | | 21.02 | 362.8 | 0.81 | | |
| | | | | 10.86 | 509.2 | 0.44 | | | 16.64 | 273.8 | 0.77 | | |
| | | | | 9.52 | 430.7 | 0.43 | | | 19.84 | 312.4 | 0.74 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| UNDERWOOD | GC - CC3 | 1 | 08/07/08 | 13.65 | 462.9 | 0.32 | 0.25 | 5.5E-02 | 30.77 | 625.1 | 0.96 | 0.87 | 1.0E-01 |
| | | | | 15.89 | 487.8 | 0.29 | | | 22.50 | 455.1 | 0.95 | | |
| | | | | 16.14 | 404.2 | 0.24 | | | 59.83 | 1154.3 | 0.91 | | |
| | | | | 24.52 | 544.1 | 0.21 | | | 24.14 | 431.1 | 0.84 | | |
| | | | | 18.56 | 370.0 | 0.19 | | | 25.18 | 382.6 | 0.71 | | |
| | | 2 | 08/07/08 | 12.43 | 568.0 | 0.43 | 0.37 | 4.7E-02 | 27.52 | 240.3 | 0.41 | 0.40 | 8.0E-03 |
| | | | | 13.14 | 571.0 | 0.41 | | | 30.09 | 261.5 | 0.41 | | |
| | | | | 8.96 | 356.2 | 0.37 | | | 28.36 | 245.0 | 0.41 | | |
| | | | | 10.83 | 399.3 | 0.35 | | | 44.36 | 373.3 | 0.40 | | |
| | | | | 13.67 | 454.9 | 0.31 | | | 45.55 | 380.4 | 0.39 | | |
| | | 3 | 08/07/08 | 9.45 | 676.4 | 0.67 | 0.65 | 2.8E-02 | 44.27 | 987.6 | 1.05 | 0.98 | 5.2E-02 |
| | | | | 9.73 | 698.4 | 0.67 | | | 22.11 | 473.1 | 1.01 | | |
| | | | | 8.92 | 627.2 | 0.66 | | | 17.14 | 351.3 | 0.96 | | |
| | | | | 8.89 | 606.9 | 0.64 | | | 19.27 | 388.3 | 0.95 | | |
| | | | | 9.83 | 635.4 | 0.61 | | | 17.12 | 333.6 | 0.92 | | |
| | | 4 | 08/07/08 | 32.30 | 516.5 | 0.15 | 0.15 | 2.2E-03 | 16.33 | 356.7 | 1.03 | 0.97 | 4.2E-02 |
| | | | | 18.33 | 292.0 | 0.15 | | | 14.92 | 314.3 | 0.99 | | |
| | | | | 26.77 | 417.9 | 0.15 | | | 18.08 | 381.3 | 0.99 | | |
| | | | | 21.71 | 343.4 | 0.15 | | | 20.20 | 398.7 | 0.93 | | |
| | | | | 22.95 | 354.1 | 0.15 | | | 16.58 | 329.2 | 0.93 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| ID | | # | Date | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| UNDERWOOD | GC - CC5 | 1 | 08/07/08 | 6.71 | 441.3 | 0.62 | 0.60 | 2.6E-02 | 29.78 | 760.3 | 1.20 | 1.13 | 4.5E-02 |
| | | | | 7.48 | 491.3 | 0.62 | | | 16.42 | 400.6 | 1.15 | | |
| | | | | 8.80 | 569.9 | 0.61 | | | 24.58 | 585.9 | 1.12 | | |
| | | | | 6.83 | 432.4 | 0.60 | | | 12.52 | 293.1 | 1.10 | | |
| | | | | 8.70 | 513.2 | 0.55 | | | 14.48 | 334.0 | 1.08 | | |
| | | 2 | 08/07/08 | 6.77 | 485.8 | 0.67 | 0.63 | 4.2E-02 | 19.52 | 335.9 | 0.81 | 0.78 | 1.9E-02 |
| | | | | 10.77 | 758.6 | 0.66 | | | 23.48 | 389.8 | 0.78 | | |
| | | | | 9.61 | 638.0 | 0.62 | | | 17.12 | 284.2 | 0.78 | | |
| | | | | 8.05 | 516.1 | 0.60 | | | 19.77 | 322.5 | 0.77 | | |
| | | | | 7.58 | 460.9 | 0.57 | | | 19.17 | 309.6 | 0.76 | | |
| | | 3 | 08/07/08 | 7.90 | 412.4 | 0.49 | 0.47 | 2.1E-02 | 23.67 | 433.2 | 0.86 | 0.83 | 3.2E-02 |
| | | | | 14.68 | 751.2 | 0.48 | | | 20.52 | 371.1 | 0.85 | | |
| | | | | 11.33 | 564.8 | 0.47 | | | 16.70 | 297.7 | 0.84 | | |
| | | | | 9.64 | 461.6 | 0.45 | | | 22.86 | 391.0 | 0.80 | | |
| | | | | 9.11 | 426.5 | 0.44 | | | 19.64 | 327.3 | 0.78 | | |
| | | 4 | 08/07/08 | 9.23 | 787.8 | 0.80 | 0.70 | 8.6E-02 | 22.05 | 370.6 | 0.79 | 0.77 | 2.0E-02 |
| | | | | 10.83 | 882.7 | 0.77 | | | 17.83 | 300.2 | 0.79 | | |
| | | | | 8.40 | 622.4 | 0.70 | | | 17.14 | 283.6 | 0.78 | | |
| | | | | 8.68 | 594.5 | 0.64 | | | 27.02 | 440.9 | 0.77 | | |
| | | | | 8.14 | 512.2 | 0.59 | | | 21.78 | 343.8 | 0.74 | | |

Table S2. Permittivity of GDLs (ASTM D 4491) (Continued).

| | | | | 50 mm constant head | | | | | 10 mm constant head | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | | # | Date | Time (s) | Volume ($cm^3$) | Permittivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. | Time (s) | Volume ($cm^3$) | Permitt -ivity $\psi$ ($s^{-1}$) | Mean | Std. Dev. |
| UNDERWOOD | GC - ET | 1 | 08/07/08 | 7.53 | 508.7 | 0.64 | 0.53 | 9.3E-02 | 21.08 | 521.4 | 1.16 | 1.13 | 3.4E-02 |
| | | | | 8.67 | 554.0 | 0.60 | | | 11.89 | 282.2 | 1.12 | | |
| | | | | 10.27 | 593.0 | 0.54 | | | 15.78 | 366.5 | 1.09 | | |
| | | | | 10.45 | 521.6 | 0.47 | | | 16.67 | 412.3 | 1.16 | | |
| | | | | 9.87 | 428.6 | 0.41 | | | 17.77 | 415.2 | 1.10 | | |
| | | 2 | 08/07/08 | 7.73 | 685.8 | 0.83 | 0.77 | 5.6E-02 | 40.05 | 744.0 | 0.87 | 0.74 | 1.1E-01 |
| | | | | 7.64 | 660.2 | 0.81 | | | 25.77 | 445.3 | 0.81 | | |
| | | | | 8.27 | 691.2 | 0.79 | | | 22.42 | 361.2 | 0.76 | | |
| | | | | 7.52 | 592.1 | 0.74 | | | 21.52 | 297.4 | 0.65 | | |
| | | | | 10.23 | 757.0 | 0.70 | | | 24.02 | 315.2 | 0.62 | | |
| | | 3 | 08/07/08 | 10.83 | 618.3 | 0.54 | 0.52 | 1.9E-02 | 23.95 | 594.4 | 1.17 | 1.08 | 5.6E-02 |
| | | | | 10.20 | 580.4 | 0.54 | | | 16.77 | 392.8 | 1.10 | | |
| | | | | 7.30 | 407.8 | 0.53 | | | 16.83 | 385.1 | 1.08 | | |
| | | | | 9.87 | 530.4 | 0.51 | | | 14.83 | 327.6 | 1.04 | | |
| | | | | 9.58 | 501.8 | 0.49 | | | 16.67 | 364.1 | 1.03 | | |
| | | 4 | 08/07/08 | 14.31 | 1172.7 | 0.77 | 0.70 | 6.9E-02 | 30.52 | 545.8 | 0.84 | 1.00 | 1.9E-01 |
| | | | | 5.73 | 465.2 | 0.76 | | | 68.45 | 1106.4 | 0.76 | | |
| | | | | 8.73 | 650.5 | 0.70 | | | 20.14 | 495.6 | 1.16 | | |
| | | | | 17.05 | 1179.0 | 0.65 | | | 13.11 | 317.8 | 1.14 | | |
| | | | | 7.77 | 505.6 | 0.61 | | | 11.67 | 274.4 | 1.11 | | |

Table S3. Ply adhesion (N/m) of GDLs (ASTM D 7005).

| | APPLE VALLEY | | | | ALTAMONT | |
|---|---|---|---|---|---|---|
| | Composite Lys. Base | | Clay-Lys. Base-1 | | CMP-GC3 | |
| | A | B | A | B | A | B |
| 1 | 241 | 276 | 314 | 388 | 935 | 844 |
| 2 | 383 | 228 | 312 | 298 | 1168 | 694 |
| 3 | 312 | 399 | 392 | 274 | 548 | 686 |
| 4 | 325 | 435 | 378 | 423 | 742 | 976 |
| 5 | 465 | 438 | 302 | 387 | 564 | 1179 |
| | BOARDMAN | | | | | |
| | Composite 1 Upper | | Thin Cover | | Thick Cover 3 | |
| | A | B | A | B | A | B |
| 1 | 1199 | 1107 | 762 | 1038 | 870 | 947 |
| 2 | 873 | 796 | 771 | 795 | 724 | 833 |
| 3 | 563 | 266 | 769 | 755 | 719 | 610 |
| 4 | 288 | 451 | 696 | 838 | 871 | 779 |
| 5 | 219 | 763 | 757 | 652 | 576 | 769 |
| | CEDAR RAPIDS | | | | | |
| | Clay Bottom 1 | | Composite Bottom | | Bottom Composite 4 | |
| | A | B | A | B | A | B |
| 1 | 311 | 688 | 309 | 276 | 148 | 237 |
| 2 | 293 | 611 | 330 | 302 | 265 | 142 |
| 3 | 269 | 522 | 164 | 245 | 223 | 198 |
| 4 | 547 | 286 | 166 | 283 | 265 | 258 |
| 5 | 471 | 243 | 172 | 220 | 155 | 219 |
| | EAU CLAIRE | | | | | |
| | TP1-GC-1 | | TP1-GC-2 | | TP1-GC-3 | |
| | A | B | A | B | A | B |
| 1 | 374 | - | 287 | 309 | 228 | 204 |
| 2 | 48 | - | 379 | 321 | 222 | 190 |
| 3 | 240 | 32 | 363 | 428 | 200 | 105 |
| 4 | - | - | 387 | 305 | 124 | 223 |
| 5 | 31 | 294 | 292 | 373 | 47 | 238 |

* All results are in N/m.
* A and B represent a randomly assigned top and bottom of the sample.

Table S3. Ply adhesion (N/m) of GDLs (ASTM D 7005) (Continued).

| | EAU CLAIRE | | | | | |
|---|---|---|---|---|---|---|
| | TP2-GC-1 | | TP2-GC-2 | | TP2-GC-3 | |
| | A | B | A | B | A | B |
| 1 | 439 | 479 | 409 | 767 | 384 | 414 |
| 2 | 505 | 413 | 622 | 322 | 470 | 354 |
| 3 | 575 | 438 | 249 | 850 | 543 | 283 |
| 4 | 538 | 438 | 751 | 260 | 467 | 568 |
| 5 | 693 | 398 | 136 | 726 | 356 | 486 |
| | EAU CLAIRE | | | | | |
| | TP3-GC-1 | | TP3-GC-2 | | TP3-GC-3 | |
| | A | B | A | B | A | B |
| 1 | 453 | 331 | 647 | 383 | 316 | 487 |
| 2 | 540 | 454 | 694 | 431 | 442 | 438 |
| 3 | 500 | 494 | 516 | 485 | 601 | 359 |
| 4 | 327 | 401 | 354 | 527 | 607 | 411 |
| 5 | 372 | 516 | 362 | 474 | 551 | 476 |
| | EAU CLAIRE | | | | | |
| | TP3-GC-4 | | TP4-GC-1 | | TP4-GC-2 | |
| | A | B | A | B | A | B |
| 1 | 130 | 371 | 593 | 986 | 514 | 490 |
| 2 | 297 | 329 | 973 | 231 | 418 | 524 |
| 3 | 179 | 154 | 686 | 156 | 424 | 318 |
| 4 | 243 | 336 | 414 | 787 | 701 | 428 |
| 5 | 409 | 221 | 241 | 735 | 637 | 356 |
| | EAU CLAIRE | | | | HELENA | |
| | TP4-GC-3 | | TP4-GC-4 | | GC-AB1 | |
| | A | B | A | B | A | B |
| 1 | 639 | 640 | 600 | 484 | 171 | 703 |
| 2 | 638 | 397 | 685 | 506 | 109 | 779 |
| 3 | 536 | 848 | 485 | 464 | 1053 | 251 |
| 4 | 561 | 362 | 520 | 535 | 965 | 724 |
| 5 | 648 | 421 | 495 | 404 | 71 | 872 |

* All results are in N/m.
* A and B represent a randomly assigned top and bottom of the sample.

Table S3. Ply adhesion (N/m) of GDLs (ASTM D 7005) (Continued).

| | OMAHA | | | | | |
|---|---|---|---|---|---|---|
| | GC-CB | | GC-A1B | | GC-A2B | |
| | A | B | A | B | A | B |
| 1 | 297 | 216 | 337 | 514 | 312 | 124 |
| 2 | 322 | 226 | 472 | 308 | 395 | 254 |
| 3 | 193 | 287 | 398 | 444 | 260 | 365 |
| 4 | 345 | 217 | 362 | 562 | 415 | 266 |
| 5 | 336 | 218 | 504 | 562 | 359 | 129 |
| | UNDERWOOD | | | | | |
| | GC-CC3 | | GC-CC5 | | GC-ET | |
| | A | B | A | B | A | B |
| 1 | 666 | 338 | 356 | 533 | 1178 | 2065 |
| 2 | 101 | 725 | 270 | 548 | 1532 | 1234 |
| 3 | 533 | 665 | 858 | 379 | 1466 | 1595 |
| 4 | 792 | 962 | 909 | 347 | 1206 | 1252 |
| 5 | 658 | 391 | 647 | 191 | 1095 | 1609 |

* All results are in N/m.
* A and B represent a randomly assigned top and bottom of the sample.

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C.H. Benson*, W.M. Albright**, D.O. Fratta*, J.M. Tinjum*, E. Kucukkirca*, S.H. Lee*, J. Scalia*, P.D. Schlicht*, and X. Wang*


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*Geological Engineering
University of Wisconsin-Madison
1415 Engineering Drive
Madison, WI 53706

**Desert Research Institute
2215 Raggio Parkway
Reno, NV 89512


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U.S. Nuclear Regulatory Commission
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Jacob Philip, Project Manager

11. ABSTRACT (200 words or less)


This study demonstrates that engineering properties of cover soils change while in service and that long-term engineering properties should be used as input to models employed for performance assessments. Recommendations for appropriate input are made based on the data that were collected. Increases in the saturated hydraulic conductivity, saturated volumetric water content, and the air entry suction (as characterized by van Genuchten's alpha parameter) occurred due to formation of soil structure, regardless of climate, cover design, or service life. Substantial changes in hydraulic conductivity were observed in some geosynthetic clay liners (GCLs) that did not hydrate completely and underwent cation exchange. Changes in geomembranes and geosynthetic drainage layers were modest or small, and computations based on antioxidant depletion rates suggest that the minimum service life of geomembranes is in the order of 50-125 years (the actual service life will be longer). The findings indicate that covers should be monitored to ensure that they are functioning as intended. Monitoring using pan lysimeters combined with secondary measurements collected for interpretive purposes is recommended. Future research investments should include an evaluation of remote sensing technologies for cover monitoring and analog studies to estimate properties of earthen and geosynthetic cover materials corresponding to service lives of 100s to 1000s of years.


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