Case Studies of Extreme Weather Performance of Engineered Turf Final Cover System

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WatershedGeo Unearthing Solutions

Geosynthetics Conference

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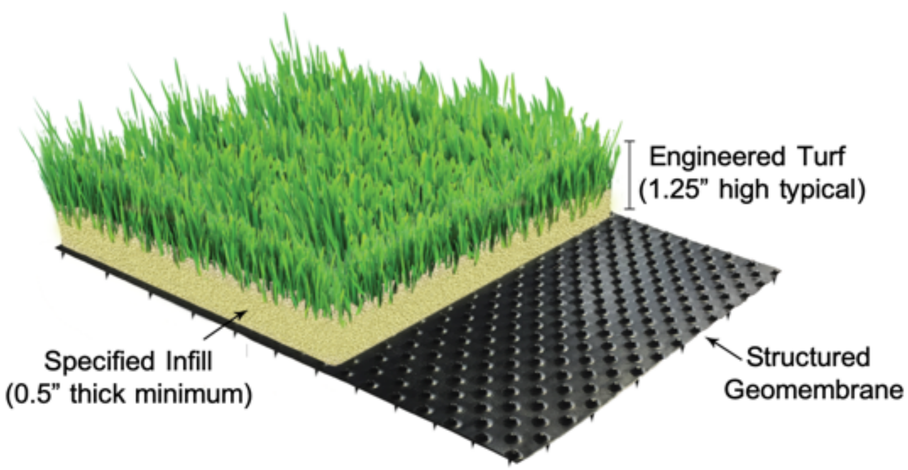
Outline

- Introduction
- Field Performance – Case Studies
  - Freezing Temperatures
  - Historic Rain Events
  - High Winds
- Remarks

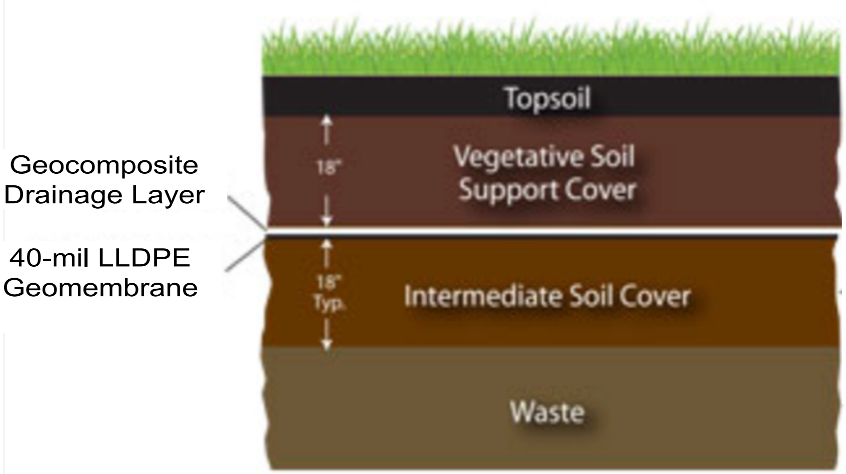
Introduction

- The Engineered Turf Final Cover System is comprised of:
  - A structured geomembrane: serves as the hydraulic barrier
  - An engineered turf: is made of synthetic grass blades tufted into a double-layer geotextile backing and provides ultraviolet (UV) and wind protection of underlying geomembrane
  - A specified sand infill: provides additional ballast against wind uplift, UV protection of engineered turf geotextile backing, and improves trafficability

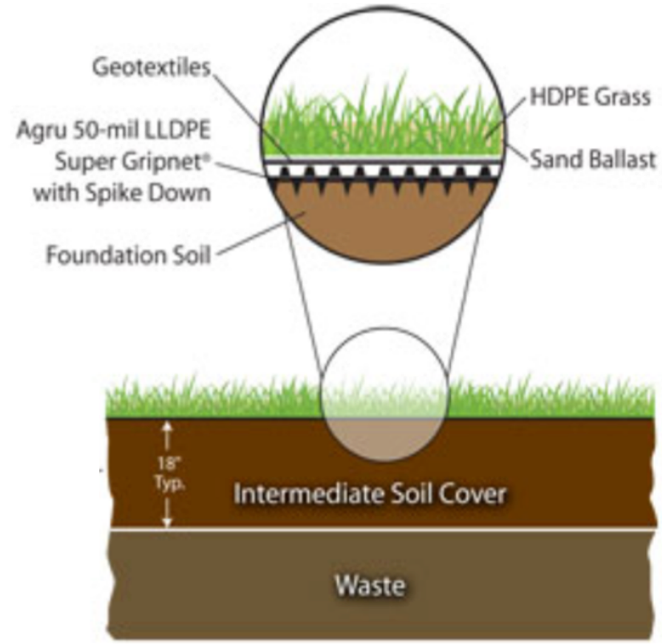


Introduction

- The Engineered Turf Cover has been accepted as an alternative to the prescriptive soil cover in the US.



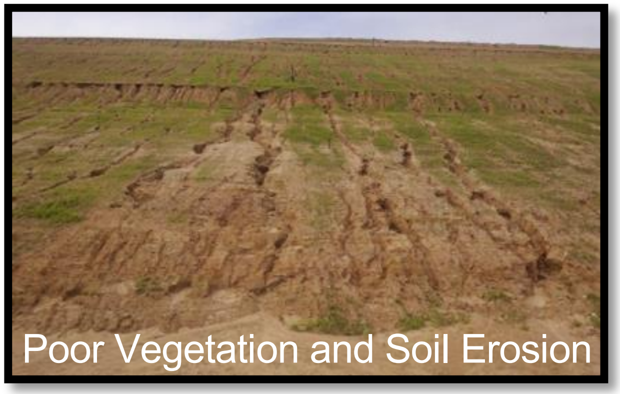
An Example of Traditional Soil Cover



Engineered Turf Cover

Introduction

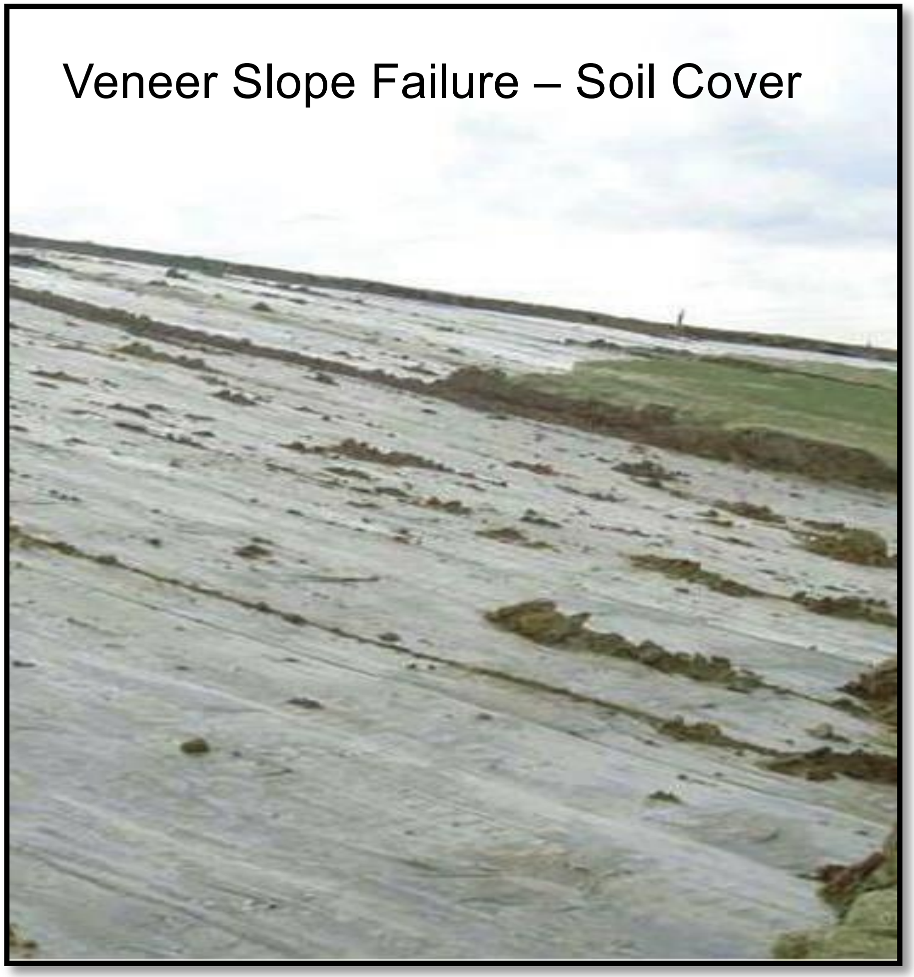
- The Engineered Turf Cover has been developed to address challenges with traditional soil covers:
  - Soil erosion/desiccation
  - Final cover veneer stability
  - Lack of soil
  - Post-closure maintenance



Poor Vegetation and Soil Erosion

Desiccation and Cracking

Veneer Slope Failure – Soil Cover



Geosynthetics Conference

Baldwin County Landfill, GA

Completed: 2017; Closure Area: 23 acres

Portola Landfill, CA

Completed: 2014; Closure Area: 10 acres

Mississippi Phosphates Corporation Site, Pascagoula, MS

Currently Under Construction; Closure Area: 220 acres

Field Performance – Freezing Temperatures

Central Landfill, Johnston, RI

Completed: 2017; Closure Area: 18 acres

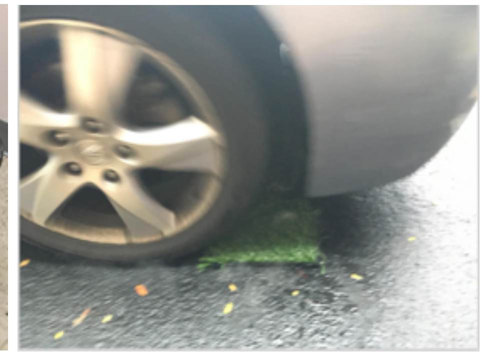
Winter storm, Skylar, brought high winds and over a foot of snow in March 2019 as the third Nor'easter to strike the Northeast during that winter.

Field Performance – Freezing Temperatures

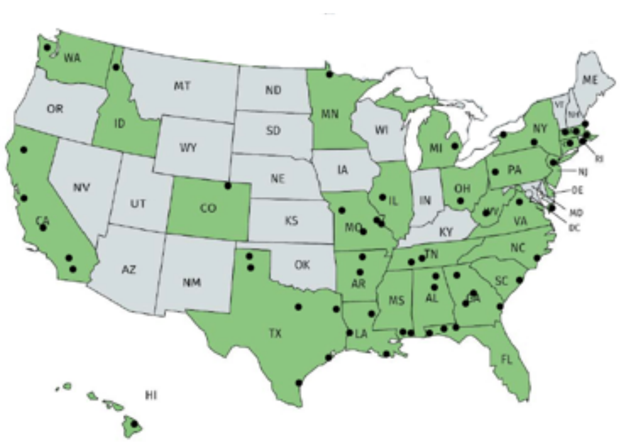
Deep Freeze Experiment by the Geosynthetic Institute (GSI)



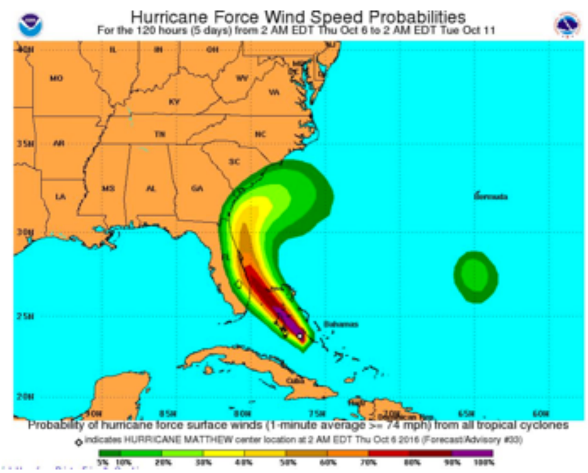




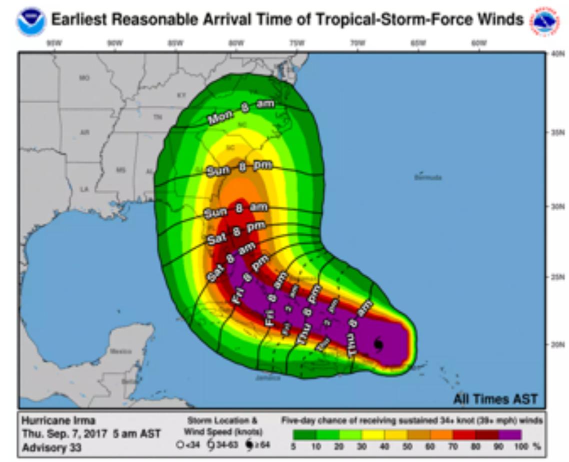
Field Performance – Historic Rain Events



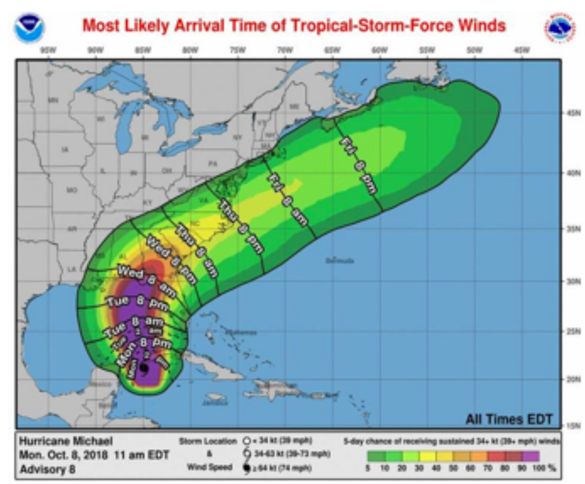
Project Location Map



Hurricane Matthew, October 2016



Hurricane Irma, September 2017



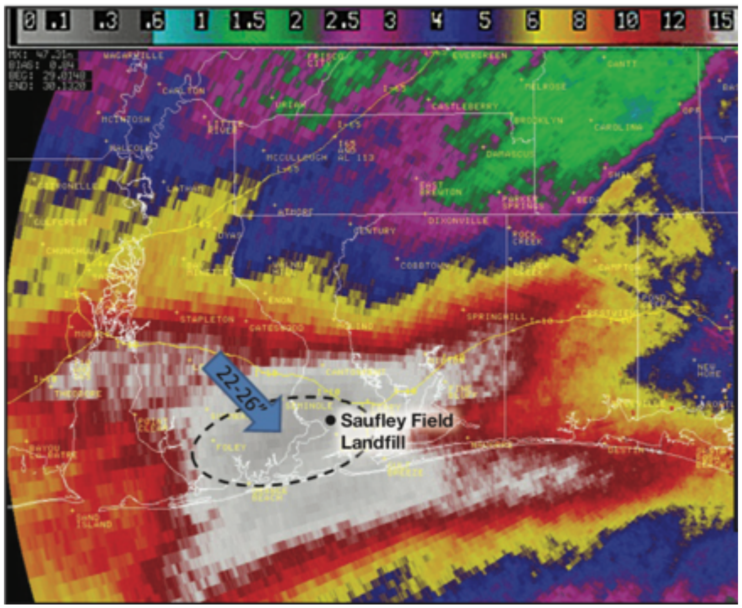
Hurricane Michael, October 2018

Hurricane Dorian, September 2019

Field Performance – Historic Rain Events

Saufley Field Road Landfill, Pensacola, FL

Completed: 2013; Closure Area: 25 acres



- The site received over 22 to 26 inches of rain in 24 hours on April 29th and 30th, 2014 (a 500-yr storm event).
- There was no impact on the surrounding community, no damage to report, and no immediate attention required.

Field Performance – Historic Rain Events

Saufley Field Road Landfill, Pensacola, FL

Engineered Turf Downchute with Cementitious Infill (October 2014)

Typical Failure of a Rock Downchute (from another landfill site; shown as an example)

Comparison of Downchute Performance

Field Performance – Historic Rain Events

Saufley Field Road Landfill, Pensacola, FL

Before Installation of Engineered Turf Cover

After Installation of Engineered Turf Cover

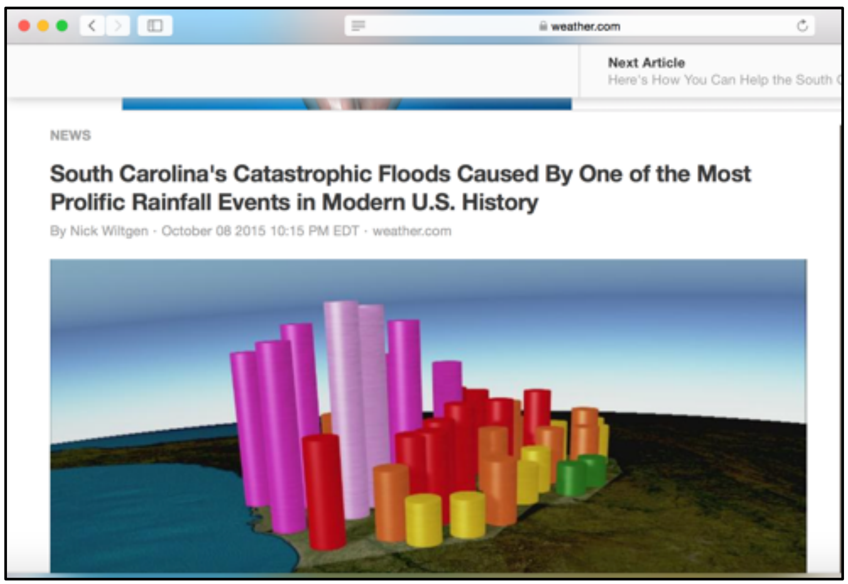
Comparison of Runoff Quality

Field Performance – Historic Rain Events

Berkeley County Landfill, SC

Completed: 2013; Closure Area: 12 acres

The Engineered Turf Cover survived ~26 inches of rain during a four-day period from October 1st to 5th, 2015 (1-in-1000 event).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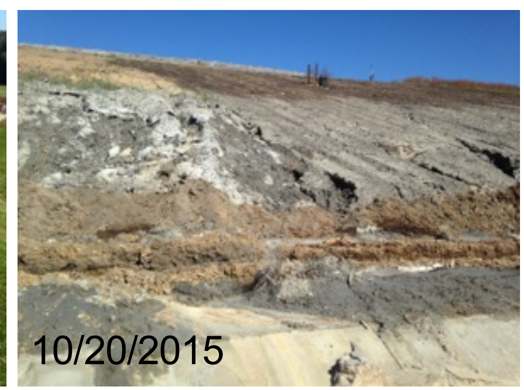
NEWS

South Carolina's Catastrophic Floods Caused By One of the Most Prolific Rainfall Events in Modern U.S. History

By Nick Wiltgen · October 08 2015 10:15 PM EDT · weather.com

Engineered Turf Cover Area



Soil Cover Area

Field Performance – Historic Rain Events

Berkeley County Landfill, SC

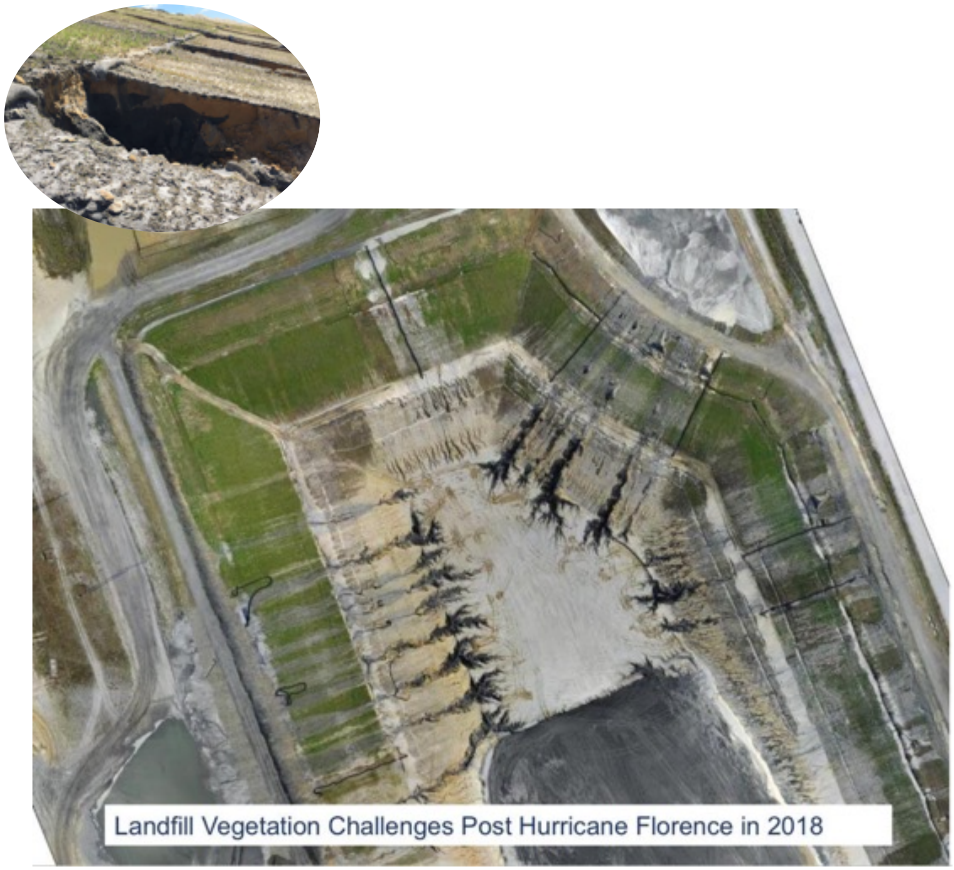
Engineered Turf Cover Area

Soil Cover Area

Perimeter Channels (Nov. 2018)

Field Performance – Historic Rain Events

A CCR Landfill located in Wilmington, NC

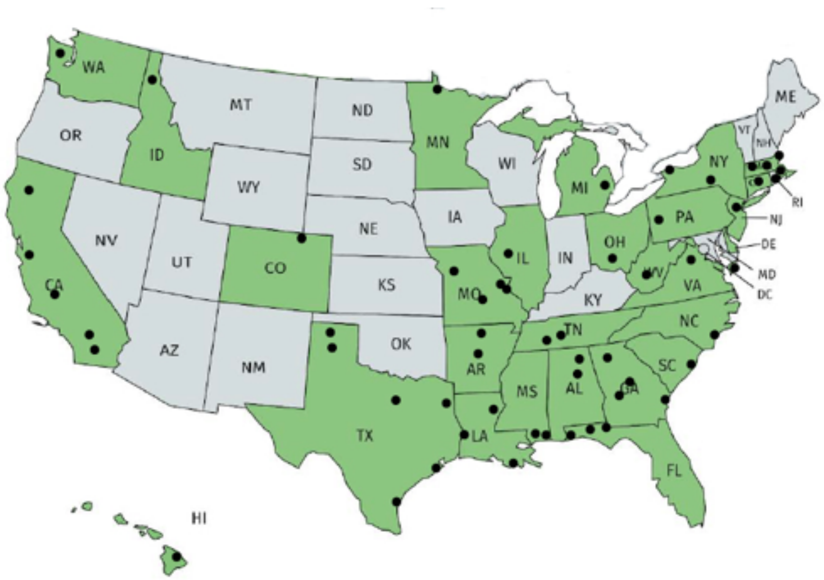


Interim Soil Cover
(after Hurricane Florence in 2018)

During Installation of Engineered Turf Cover
(after Hurricane Dorian in 2019)

Reference: "Experience with Geosynthetics in Challenging Regulatory Environments" presented by Evan Andrews at Coal Combustion Residuals (CCRs): Current Regulations and Solutions, Charlotte, NC, November 6, 2019.

Field Performance – High Winds



Project Location Map

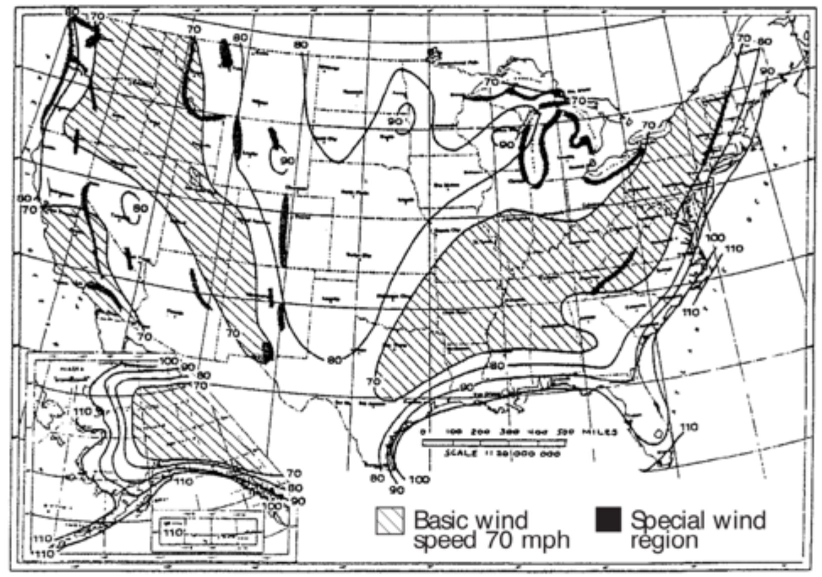


***Figure 1**. Maximum design wind velocities.*

"Geomembrane covers: Part 1 - geomembrane stresses," By Gregory N. Richardson, Ph.D. P.E., principal of GN Richardson and Assoc. GFR, Volume 18, Number 7, September 2000.

There has been no report of damage to the Engineered Turf Cover due to wind uplift.

Field Performance – High Winds

Wind Tunnel Testing at Georgia Tech Research Institute, 2010

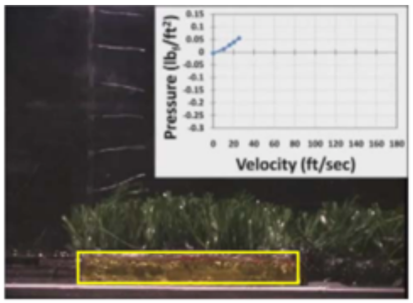


Figure 3a: Vinf = 25 ft/sec

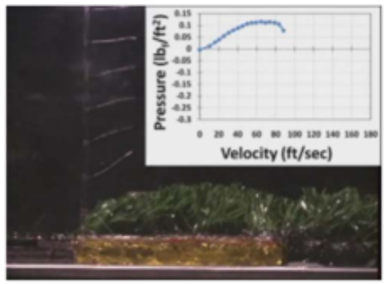


Figure 3c: Vinf = 90 ft/sec

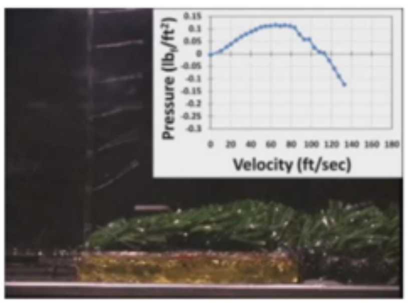


Figure 3e: Vinf = 135 ft/sec

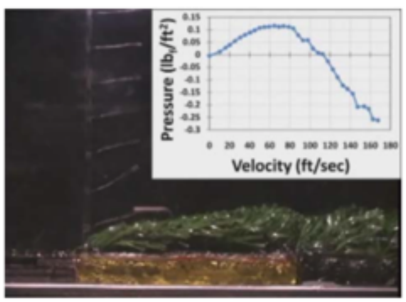
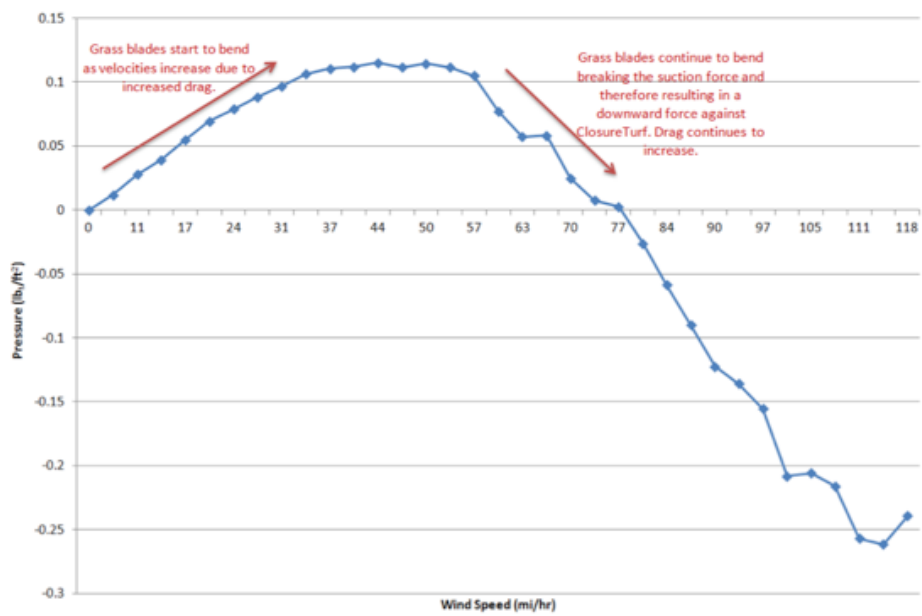


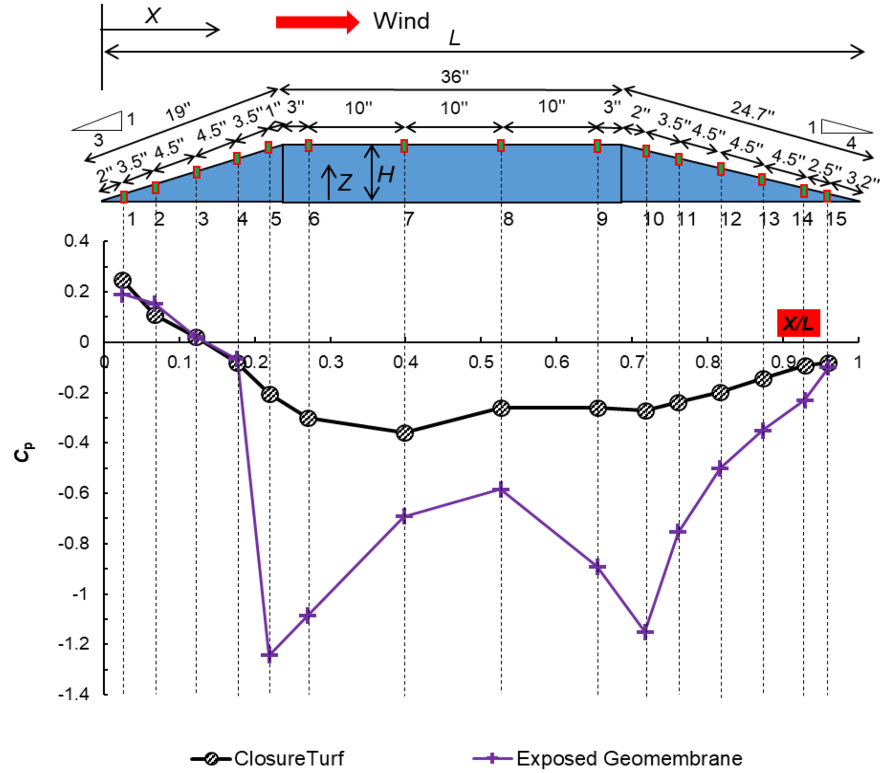
Figure 3f: Vinf = 170 ft/sec



The measured uplifting force was less than the weight of the engineered turf and changed to downward force as the turf blades bent towards the ground by wind.

Field Performance – High Winds

Wind Tunnel Testing at Iowa State University, 2018 - 2019



Wind pressure coefficient:

$$C_p = \frac{\Delta P}{0.5\rho U(H)^2}$$

"+": downward compression

"-": upward lifting

Zheng, J.X., et al. (2020), "Wind Tunnel Study of ClosureTurf Landfill Final Cover System," Geo-Congress 2020, GSP 316, PP. 650 – 658.

Remarks

- ❖ The Engineered Turf Cover has performed well and outperforms traditional soil covers under extreme weather conditions.
- ❖ Additional measures can be considered during design, installation, and maintenance to mitigate/minimize weather impact.

	Design Considerations	Installation Considerations	Maintenance Considerations
Bridging due to thermal contraction	• Limit the number of drainage benches or have no benches • Load drainage benches/swales or perimeter channels with properly sized rocks • Smooth transition between tack-on bench and side slope	• Use temporary sandbags to help control bridging, especially at seam locations	• Minor bridging usually does not need to be repaired as it does not affect overall drainage. • Severe bridging can be repaired by cutting and laying down the turf and geomembrane and welding new pieces of turf and geomembrane. • Add weight (e.g., rocks and sand tubes)
Wrinkles due to thermal expansion	N/A	• Apply wrinkle management best practices	• Cover exposed geotextile backing along wrinkles with sand and use binder • Wrinkle repairs are usually not needed as wrinkles do not affect performance.
Sand migration due to hydraulic shear of water flow	• Use coarser and more angular sand as the infill (e.g., manufactured sand) • Follow Watershed Geo's sand infill specifications	N/A	• Place sand infill to cover exposed geotextile backing at least every 5 years • Use binder to improve erosion resistance of sand

THANKS!

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