Alternative Cover Systems

RemTech 2017

[→] October 13, 2017

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[DURABILITY RUNS DEEP]

Outline

- Capping solutions
- Why use alternate cover systems
- Exposed geomembrane cap systems
- Geosynthetic Turf cap systems
  - What is it?
  - How is it installed?
- Benefits of alternative caps

Potential Applications

Solid Waste Landfills

Remediation Sites

Coal Combustion Impoundments

Industrial Waste Facilities

Tailings Impoundments

Superfund Sites

Leach Pad Closures

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Landfill Closure Options

Traditional Soil Cap

Exposed Geomembrane Cap

Turf Cap

Three common capping solutions and a needs based approach.

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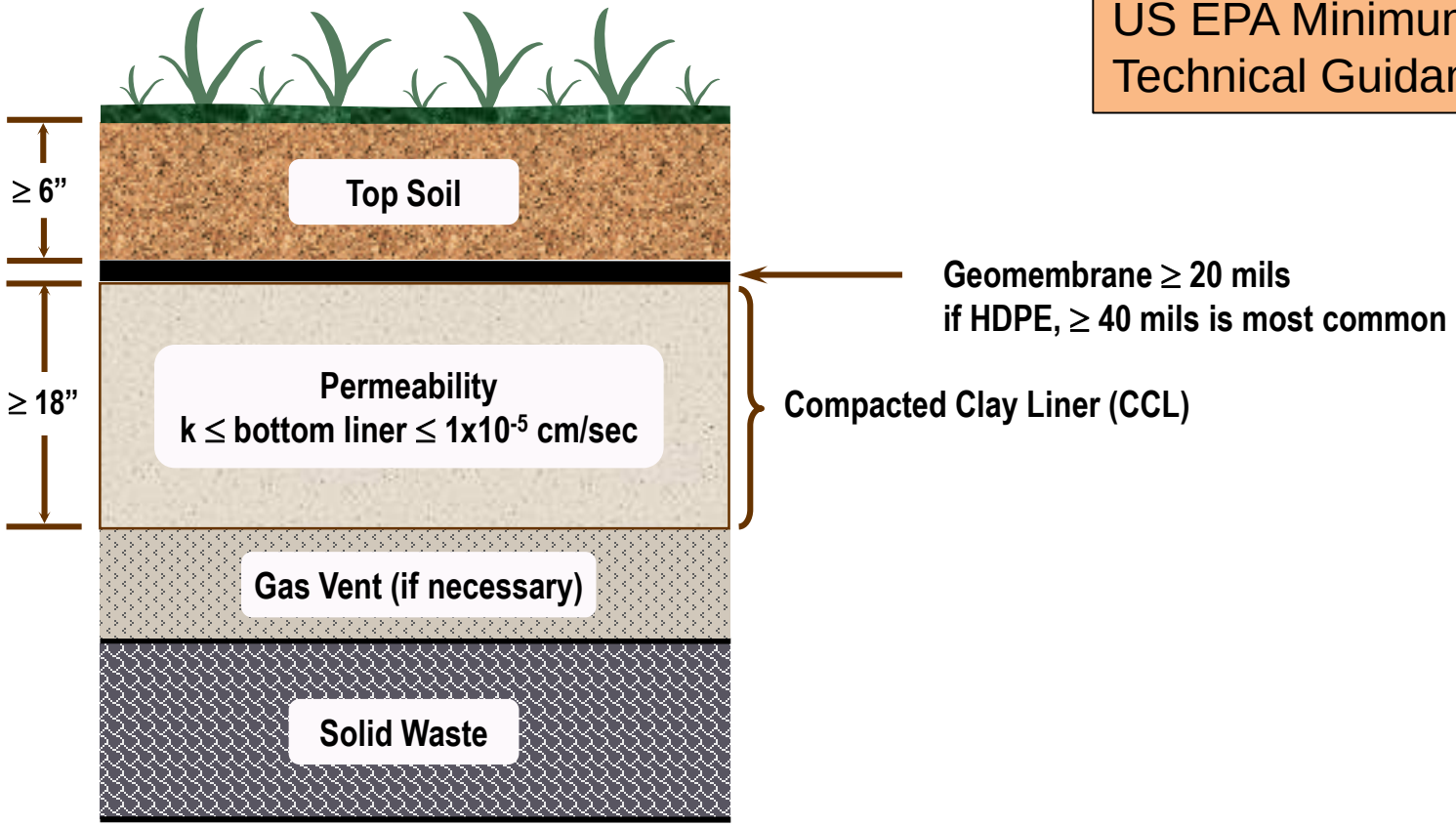
Soil Cover System – US EPA Subtitle D (Promulgated 1991)



US EPA Minimum Technical Guidance

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Why use alternate cover systems

Erosion problems

Lack of cover soil availability

Root penetration

Settlement issues

Lower maintenance

Veneer slope failures

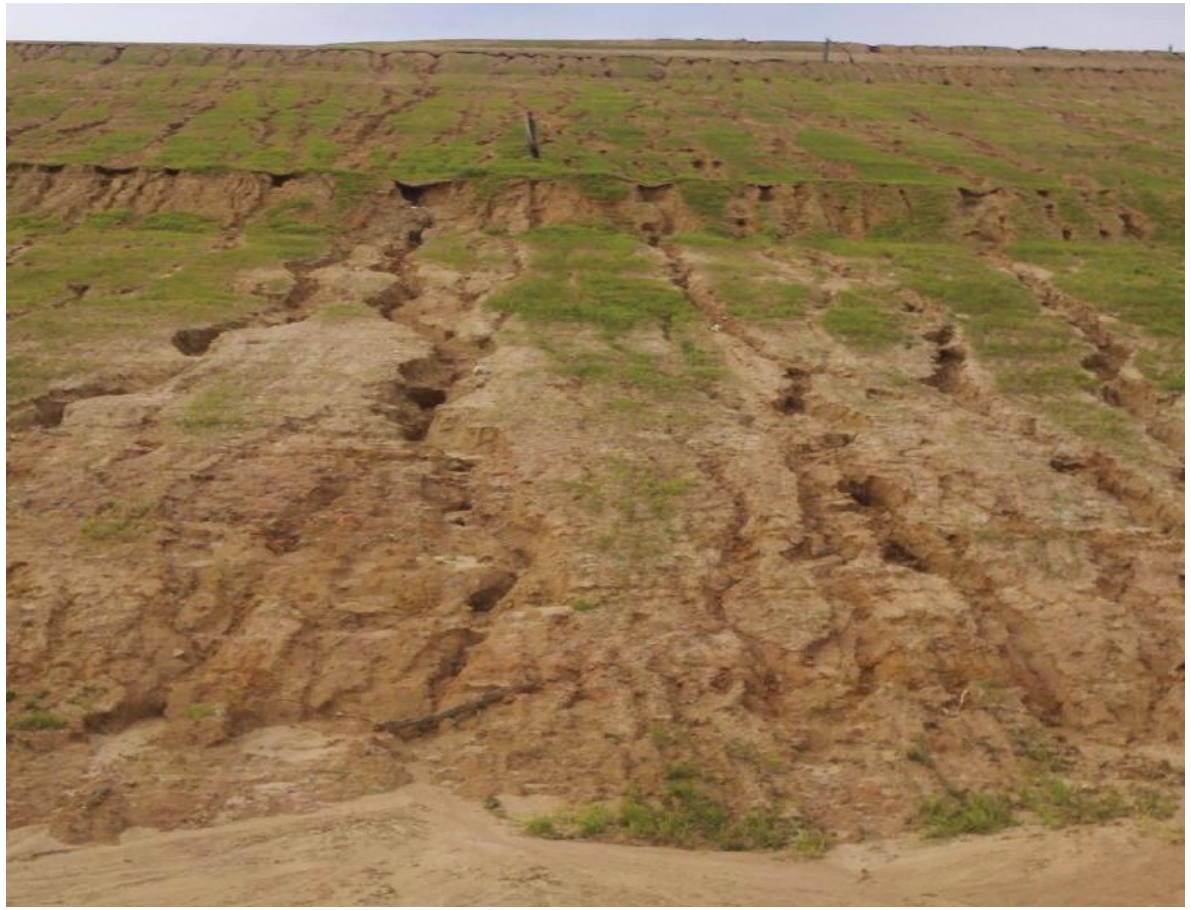
Increased airspace

Cost savings

Water conservation

Low carbon footprint

Increasing regulatory approval



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Alternative Cover Systems Drawbacks

Shorter service life

Final Closure Permit

Wind uplift

Landfill gas uplift

Increased velocity and volume of stormwater runoff

Potential damage by animals, hail etc.

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EXPOSED GEOMEMBRANE CLOSURES

Alternative Closure System Benefits

- No cover soil import
- No soil veneer stability issues
- Reduced capital costs
  - No vegetation or topsoil
- Reduced O&M costs
  - No watering, mowing or erosion control
- Visual inspection of GM
- Color options (white, black, green)
- End of life options: what does the future hold?

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Sabine Parish Louisiana – Exposed Geomembrane Cap

Installer: GSE Lining Technology

Green-surfaced HDPE geomembrane

Area: 80,000 square meters

Construction 1999

1.5 mm GSE Green Textured

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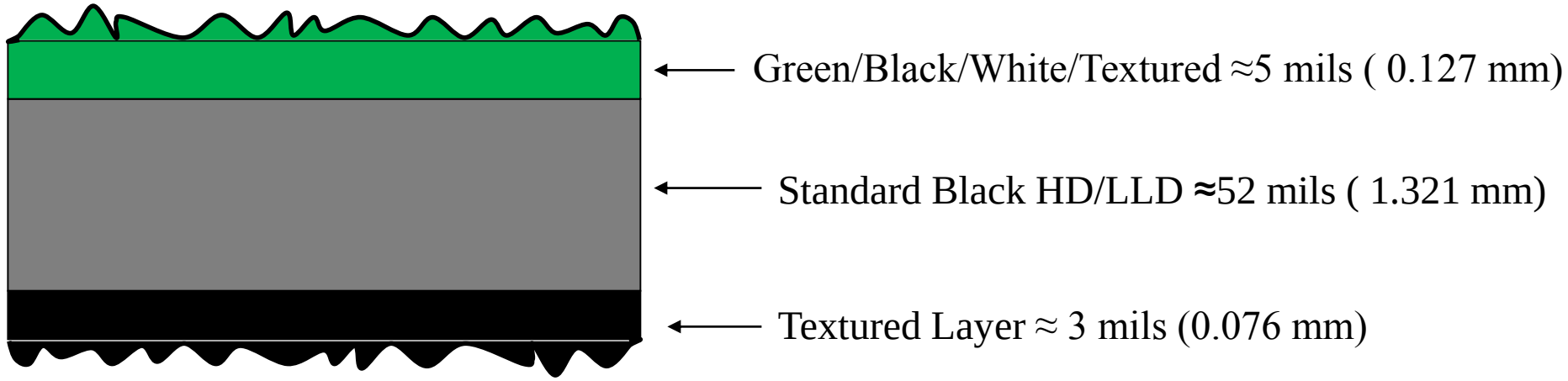
Co-extrusion Technology

Example: Textured 60 mil (1.5mm) Green HDPE Geomembrane



- Top surface HDPE for UV and chemical resistance
- Inner layer HDPE for UV and chemical
- Bottom surface can be conductive for leak location & monitoring

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All in the Recipe

Proper Material Selection:

Resin Polymer

Additives

Carbon Black

Higher Performing Geomembranes – Improved Recipe

- Multi-axial break resistance for settlement
- Greater resistance to stress cracking in exposed cold climate
- Resist damage from impact forces or equipment on exposed liner
- Longer life exposed and buried
- *All in the numbers*

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Geosynthetic Institute – Half-Life (in Years) at 20C

Geomembrane Type	Lab Predicted ASTM D 7238		Phoenix, AZ	
	Strength	Elongation	Strength	Elongation
HDPE 1.5 mm	76	69	97	91
LLDPE 1.0 mm	49	46	66	63
EPDM 1.0 mm	60	70	74	56

Koerner, George, PhD, PE, CQA. Geosynthetics Magazine October 2017.
Part of a 14 year study for geomembranes in lab and field

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Polk County Florida - Exposed Geomembrane Cap

GSE Green surfaced geomembrane at Polk County Florida

2001 install on a 20 acre cell

Polk County Florida - Exposed Geomembrane Cap

Vertical Anchor Trench
≈60 to 100 ft. apart

Vacuum-inducing Vents and
Gas Pressure Relief

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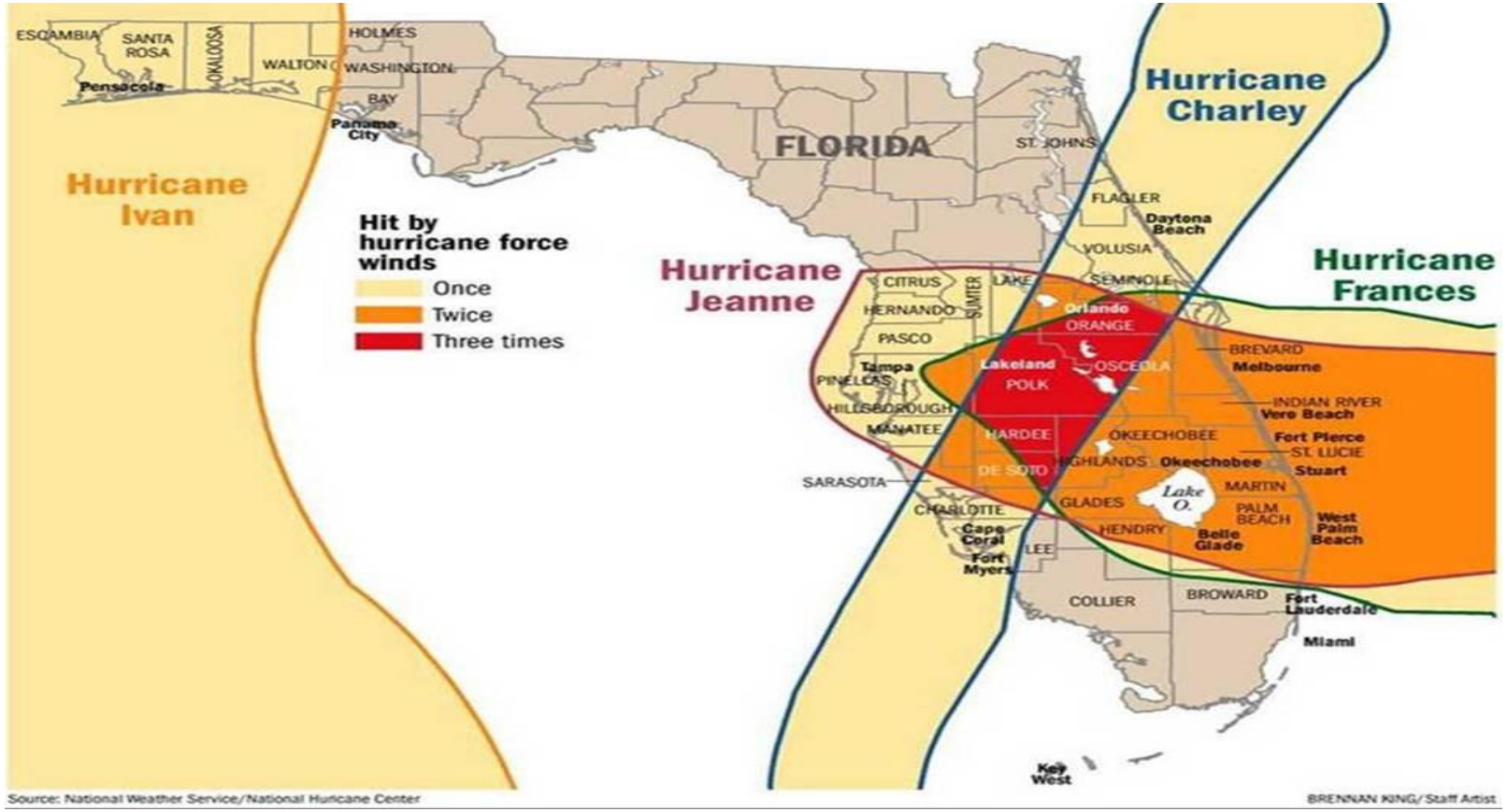
Polk County Hurricane Exposure



Polk County Post Hurricane Assessment

Despite standing 150 feet above ground level no single storm-related problem from any of the hurricanes.

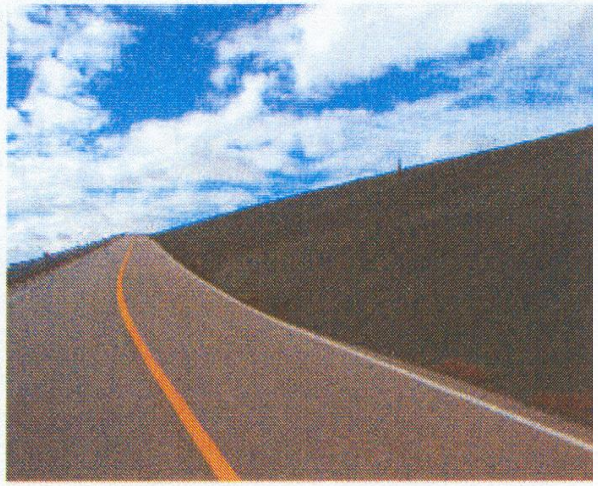


Figure 11. NCLF EGC two days after Hurricane Jeanne (View 1).

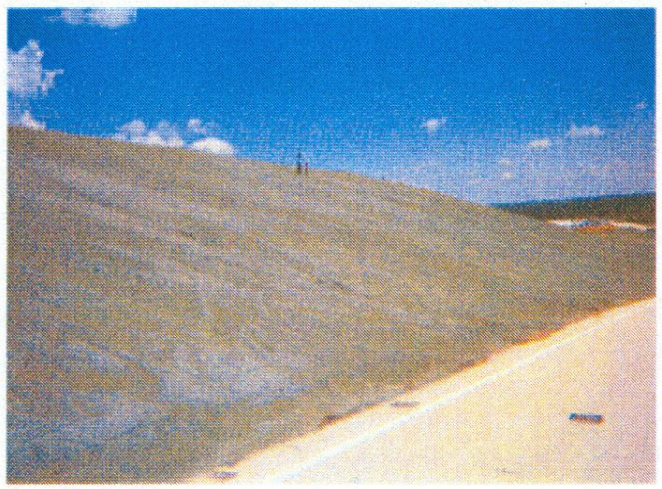


Figure 12. NCLF EGC two days after Hurricane Jeanne (View 2).

Figure 13. NCLF EGC two days after Hurricane Jeanne (View 3).

**Roberts, Bonilla, Kelner, Choate, (2005), The EGC Takes on Three Hurricanes in Polk County, MSW Management.*

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Stormwater Control

- Stormwater control measures
- Larger collection ditches
- Polk County ranged from 30” to 75” per year
- 3 direct hurricanes during 2004 at Polk County resulted in 20” of rain

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Long-Term Care Plan – Polk County 13 years

- Weekly/Monthly/Quarterly site inspection
- Rainfall, gas, and leachate generation measurements
- Subsidence measurements (Avg 8.7’ across site)
- Post-hurricane damage assessment (3 direct strikes in 2004)
- Geomembrane welding repairs
- Annual coupon sample testing and analysis
- Predicted life to exceed 50 years

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Equipment Traffic

- Foot traffic on textured
- Low ground pressure equipment; ATV, lite trucks
- Heavier equipment on roadways
  - Concrete, sand, geocomposite encapsulated
- Surface under geomembrane important
- Heavier equipment with driver care
  - No sharp turns
  - No donuts

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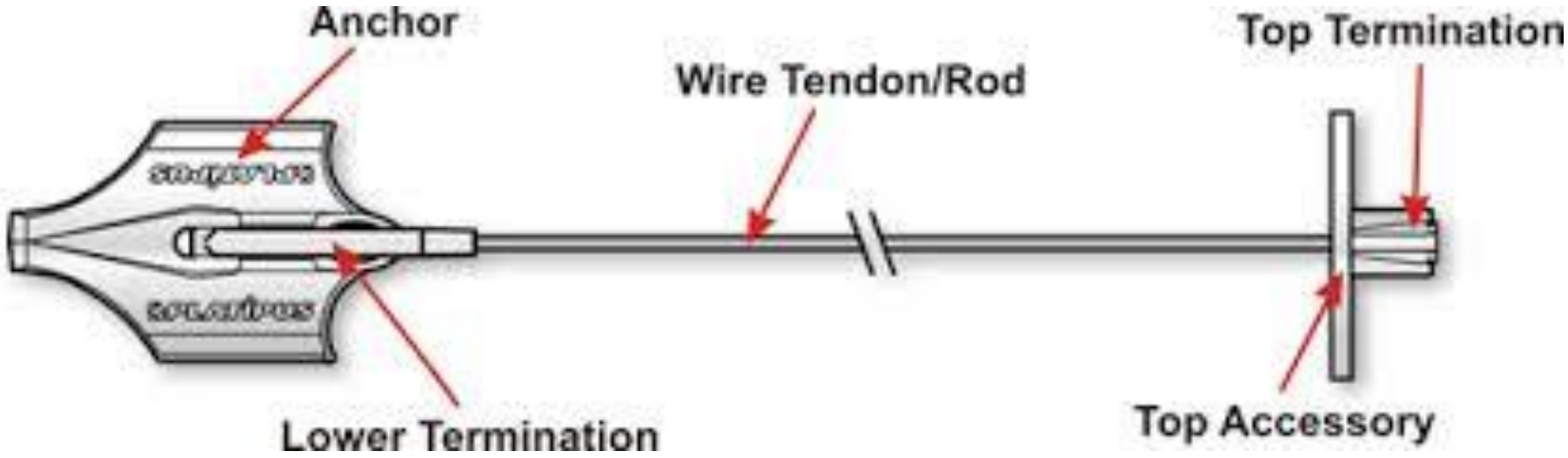
EXPOSED GEOMEMBRANE CAP SYSTEM INSTALLATION

Midshore Maryland Exposed Geomembrane Cap System

- Maryland, USA
- Designed by Geosyntec Consultants
- 300,000 SM of High Performance, 1.5mm HDT Green
- Ballast: Earth Anchors – 7,000
- Installed by Chesapeake Containment Systems
- 2015

Earth Anchoring



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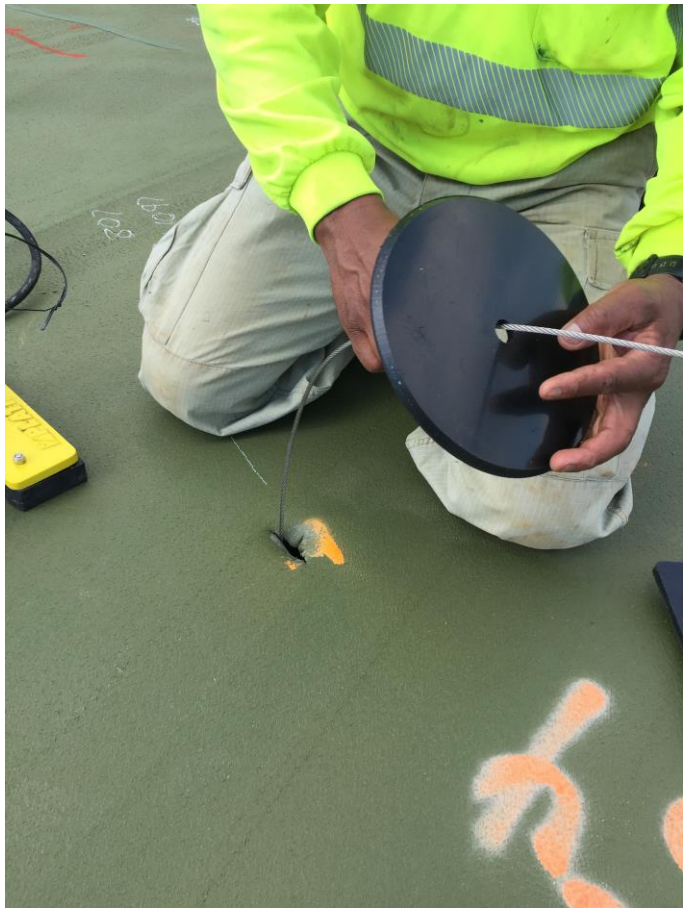
Platipus Earth Anchoring Systems

Anchor Plates



Anchor Tensioning

Tensioning Complete

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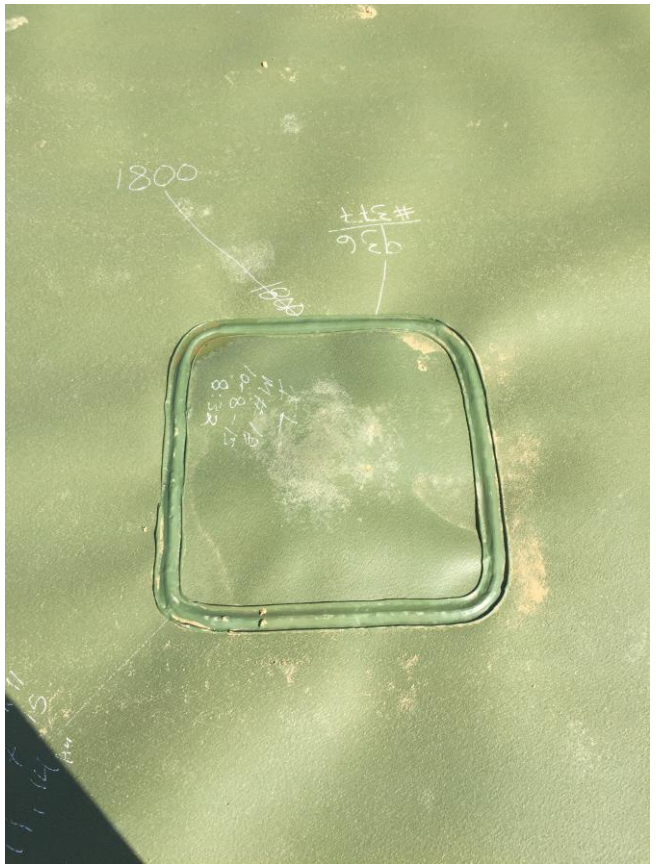
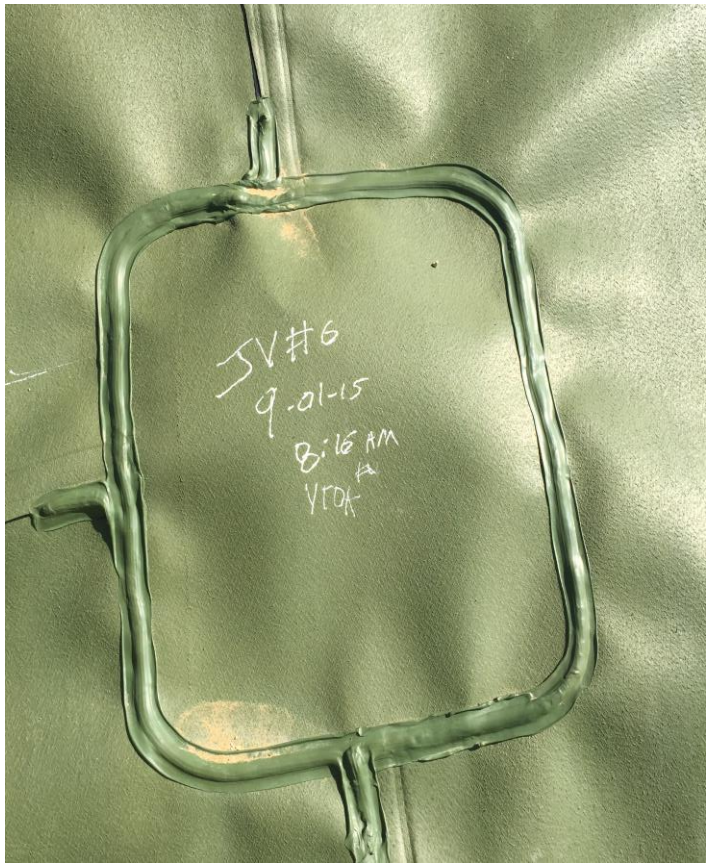
Covering the Anchor





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Green Exposed Geomembrane Cap

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Green Exposed Geomembrane Cap

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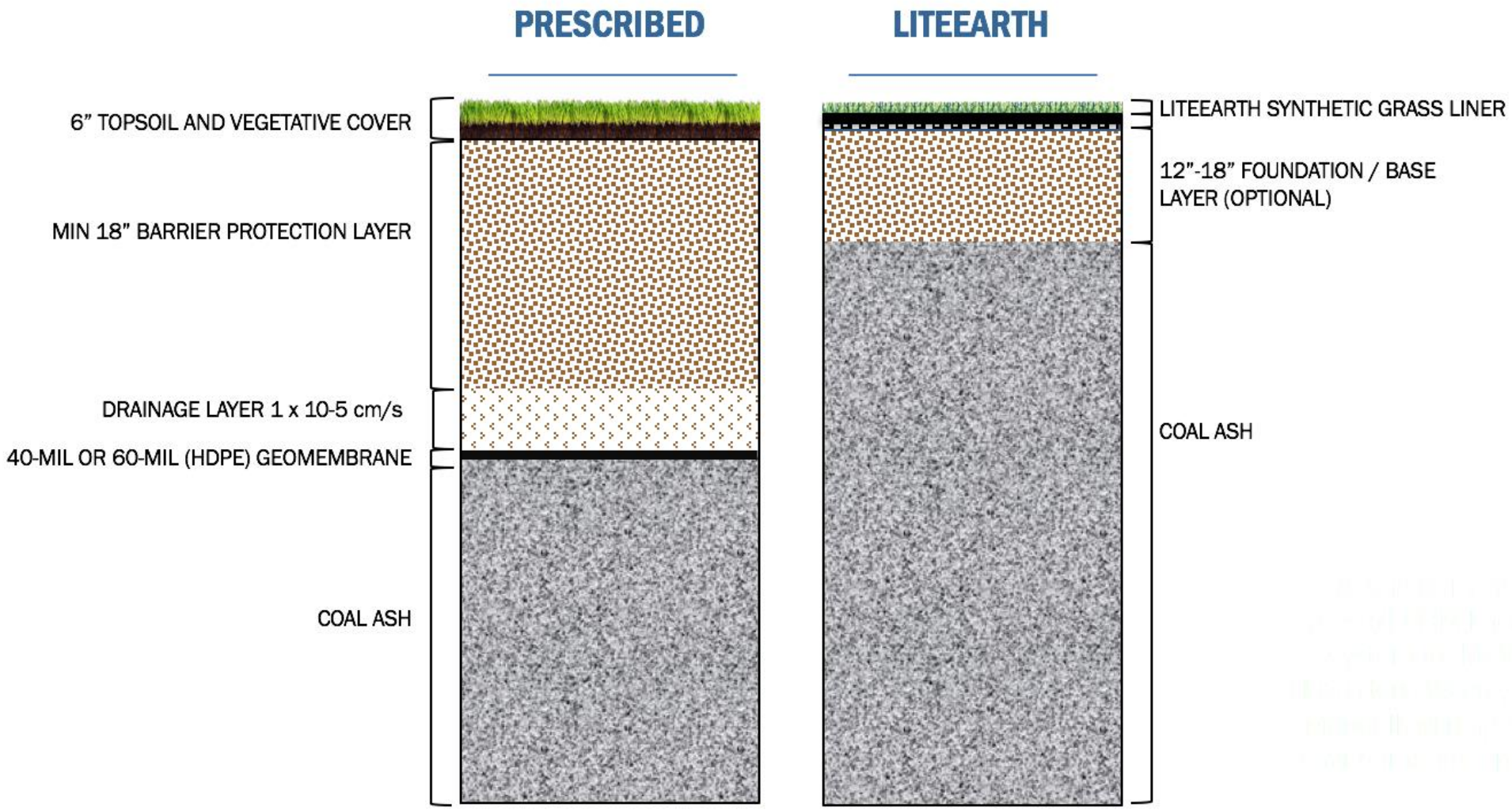
[→] SYNTHETIC TURF CAPPING SYSTEM

LiteEarth Compared to Typical Capping



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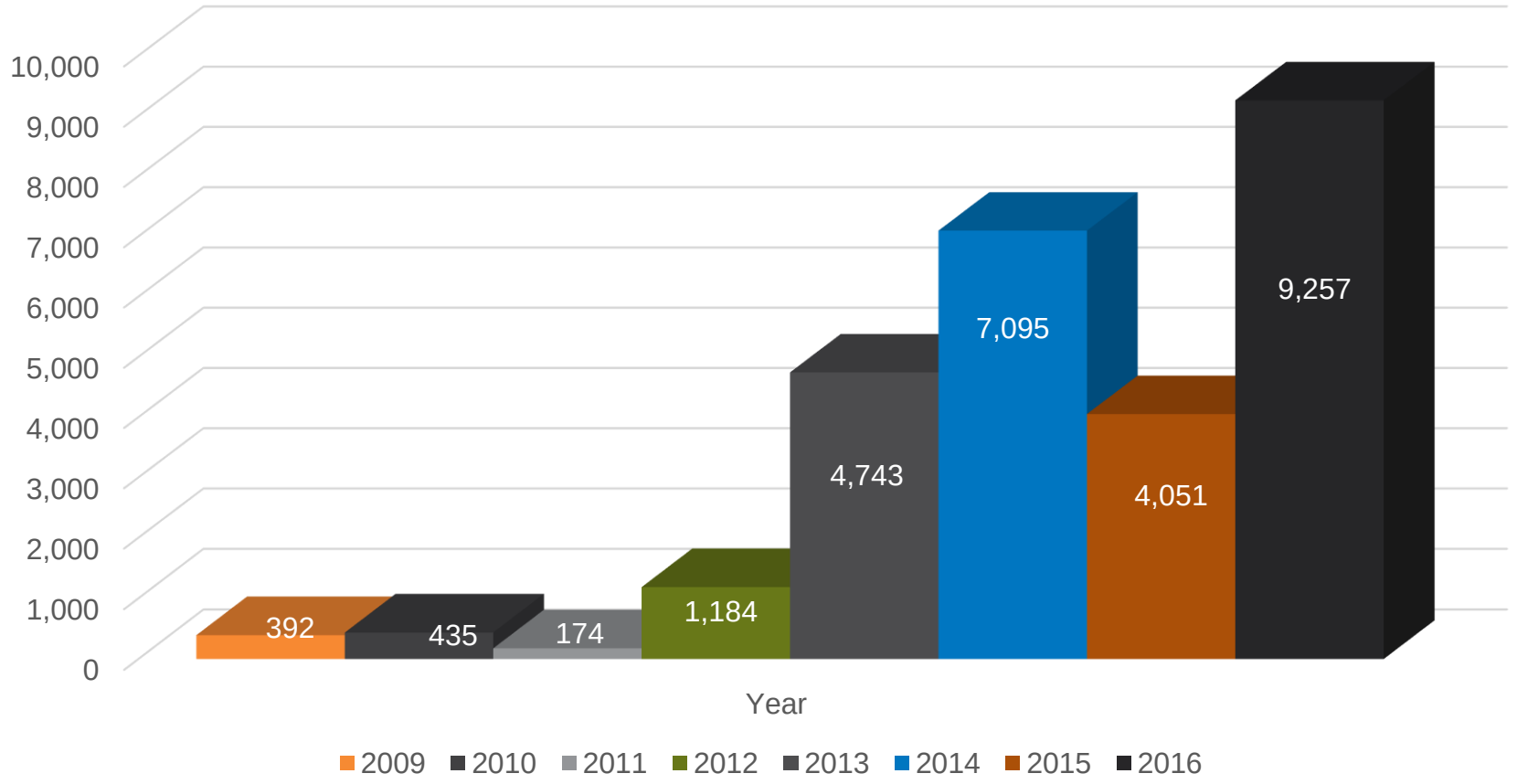
Synthetic Turf Growth (square feet X 1,000)



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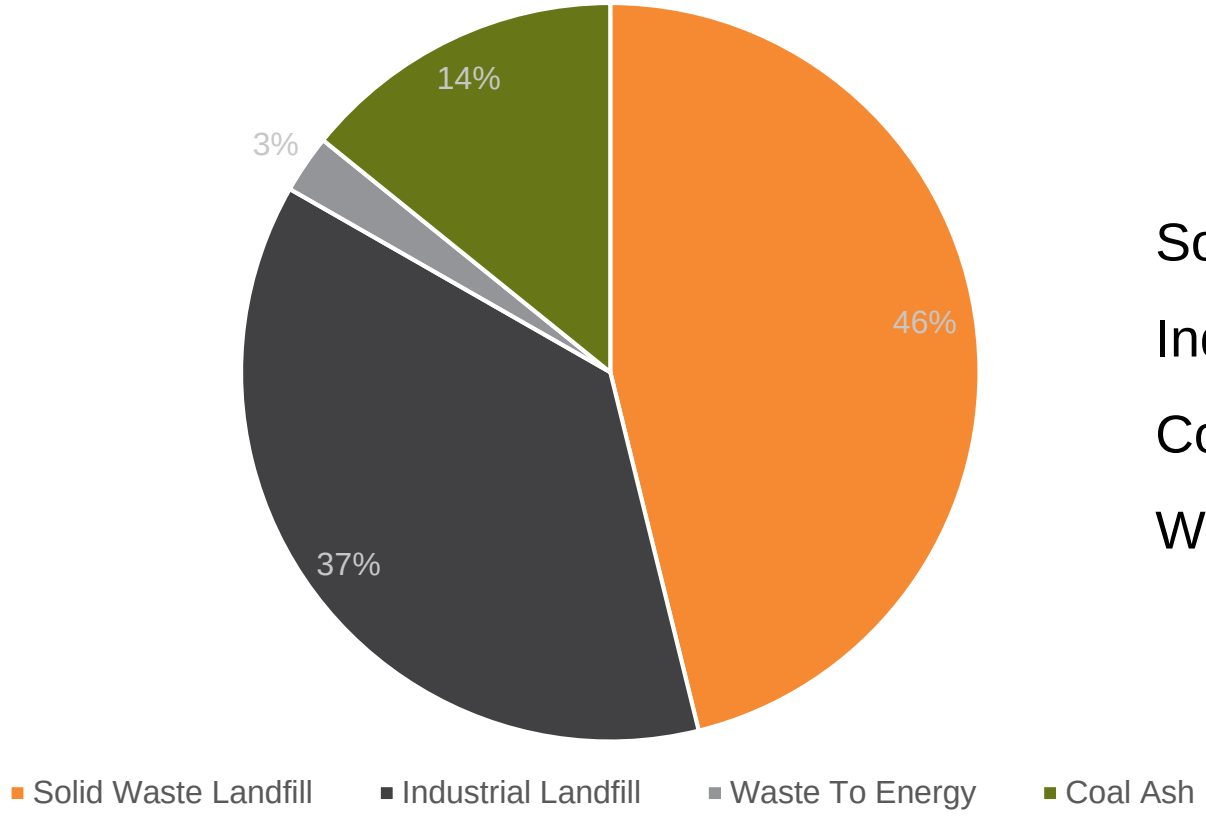
Market Segment Sales (square feet X 1,000)



Solid Waste: 12,614 square feet

Industrial: 10,145 square feet

Coal Ash: 3,877 square feet

WTE: 697 square feet

Worldwide Leader in Synthetic Turf

- ISO 9001 Quality Certified, Synthetic Turf Council Certified Manufacturer and a FIFA Preferred Producer
- 300 million square feet produced for sports fields, commercial and residential landscape, rooftops and airports in the most demanding climates
- Highest Manufacturing Quality Assurance (MQA) processes and procedures at Act Global Georgia production facilities
- Three manufacturing facilities on three continents serving clients in 70 countries

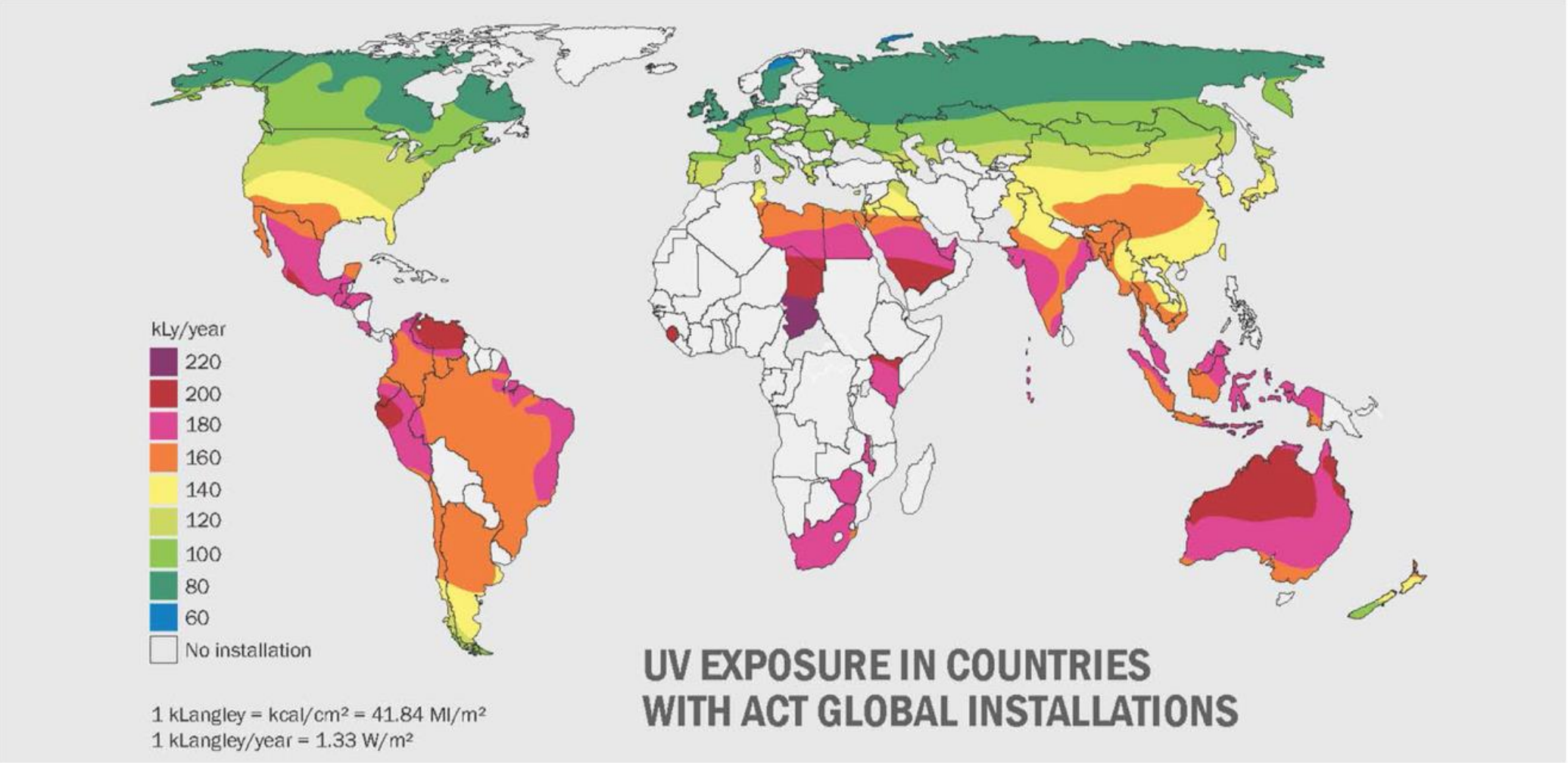
SPORTS – Brazil National World Cup Training Facility

LANDSCAPE– Residential/Commercial

AVIATION TURF– US Air Force Academy, 1.4 million sf

Extreme Climate

Turf has Maximum UV Inhibitors



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Key Material and Components

High Performance Turf

- Advanced polyethylene yarn and polypropylene woven primary with high UV stabilizer packages and special resin formulas; 2X more UV stabilizer.
- Special spine 300+ micron, true monofilament fibers and woven primary independently tested for extreme weathering conditions
- Monofilament does not fibrillate and retains resilience without INFILL = NO WIND or WATER EROSION
- Minimal annual maintenance, no seeding, mowing, fertilizing, pesticides, watering

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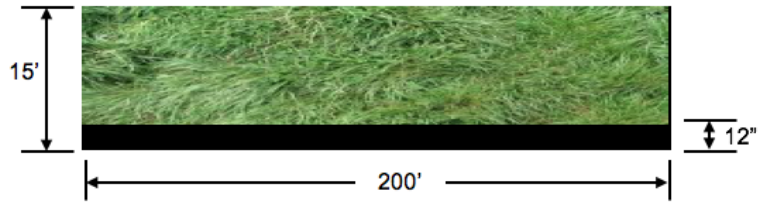
Monolithic Liner System

ISO 9001 Quality

- Performed at Act Global's synthetic turf manufacturing facility in Calhoun, GA
- Factory bonding of the synthetic grass composite to EPDM through high compression/heated rollers for permanently "welding" of the components
- Proven synthetic elastomer hot melt technology for bonding EPDM and like substrates

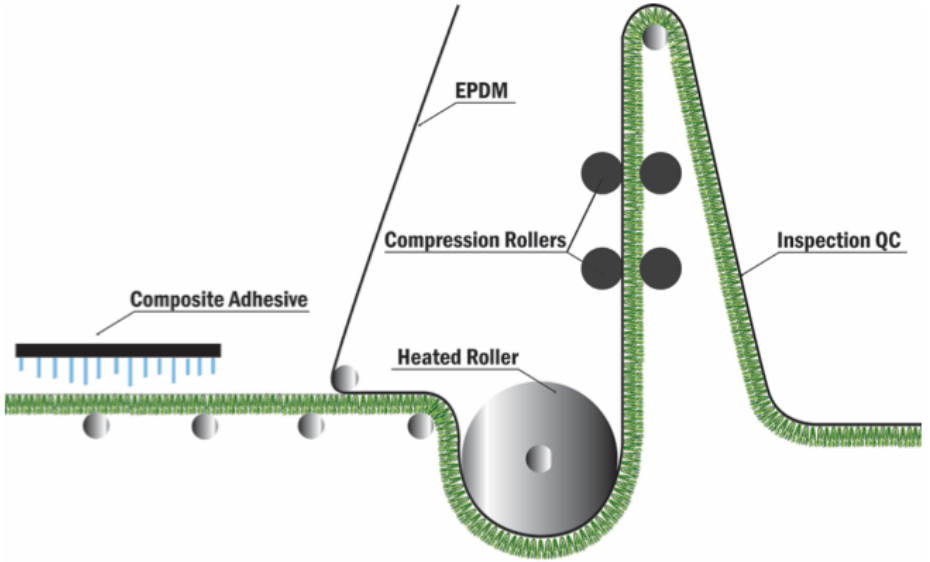
Finished Liner Rolls

- Roll size: 15' x up to 200'
- 12" exposed composite (EPDM & Polypropylene primary) for mechanical anchors and seaming
- System weight: 8.8 oz./sf
- Custom colors available



Composite Adhesive

- Operating range: -60 degrees F to 240 degrees F
- Not water soluble
- Comparative testing to 60 years
- Flash point 400 degrees F



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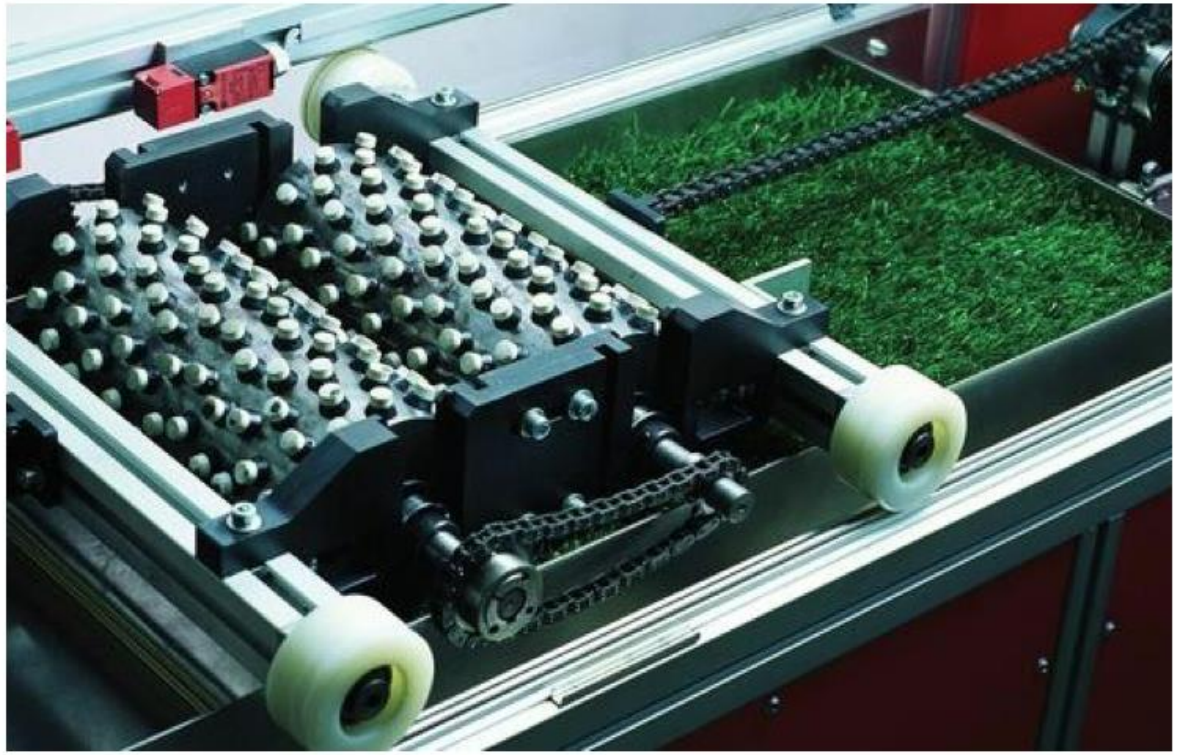
Extensive Testing

- Fully tested for stability, longevity and performance in the most demanding environments
- MQA (Manufacturing Quality Assurance –Act Global)
- Components and Composite tested by accredited, independent laboratories for:
  - **Thickness**
  - **Tensile properties**
  - **Puncture resistance**
  - **Linear Friction**
  - **Tear resistance**
  - **Multi-axial tensile**
  - **Methane gas permeability**
  - **Seam peel and sheer**
  - **Ply adhesion**
  - **Comparative interface friction**
  - **Falling head permittivity**
  - **UV weathering**



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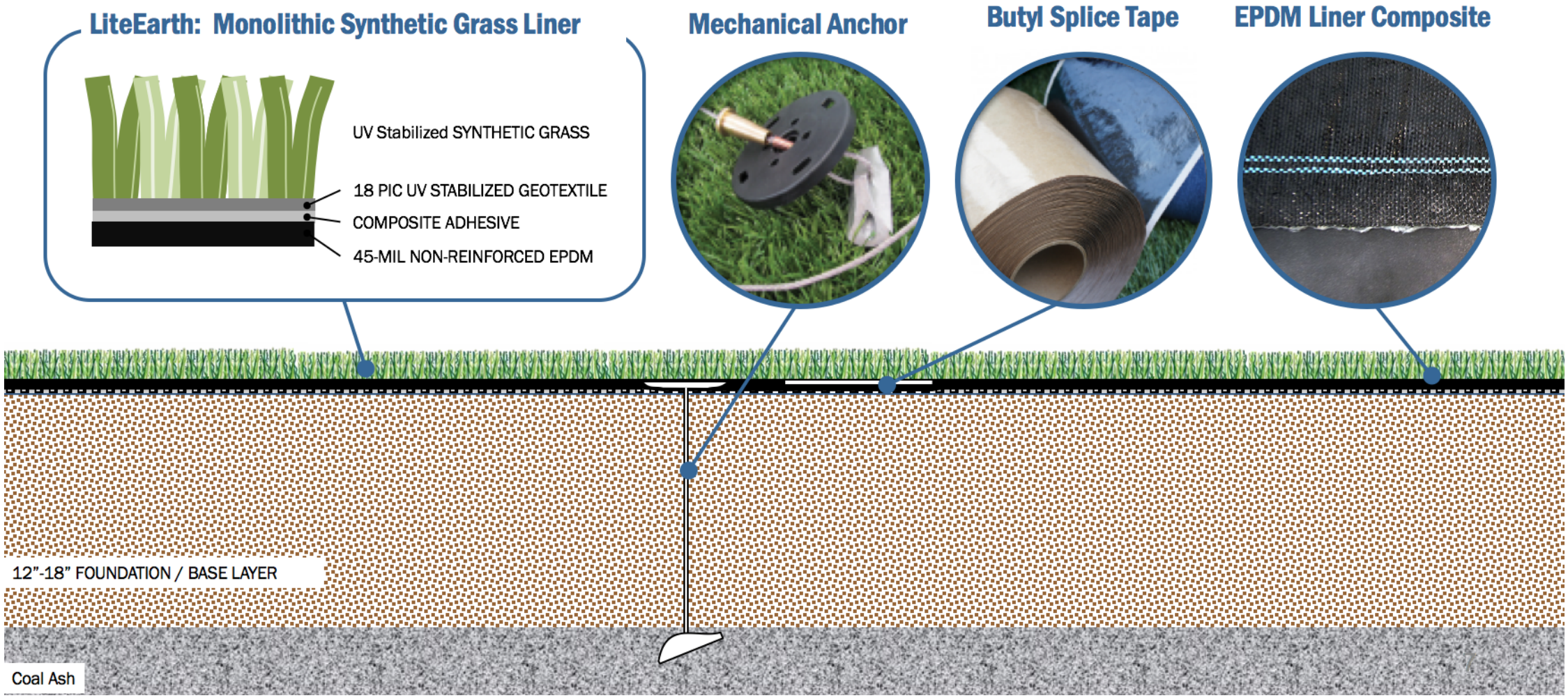
LITEEARTH INSTALLATION

Key Components



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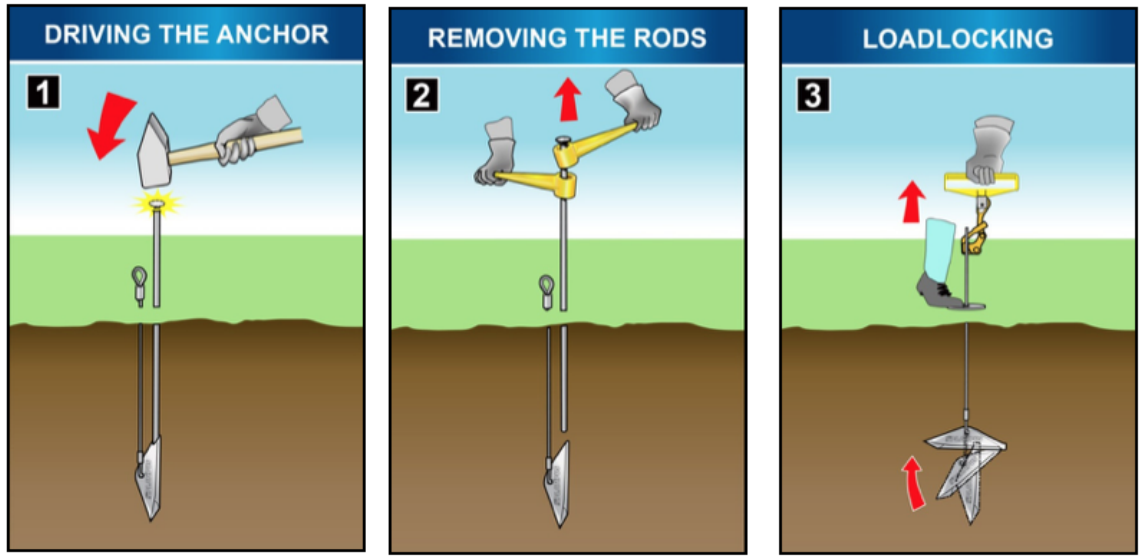
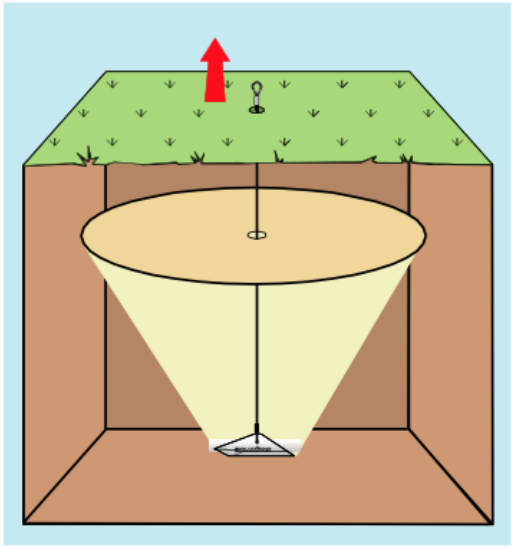
Anchor Installation



Anchor Reinforced: Percussive Driven Earth Anchor (PDEA) system includes the correct anchor, associated tendon, load plate and top terminations such as a wedge grip as specified by the Engineer Of Record (EOR)



As the load exerted increases, a body of soil above the anchor is compressed and provides resistance to any further anchor movement. The size and spread of this body of soil is referred to as the Frustum Cone

The size and spread of a Frustum Cone will depend upon:

- The shear angle of the soil
- The size of the anchor
- The depth of installation
- The load applied

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Proven Seaming Technology

- 6 inch high-performance butyl splicing tape
- Industry proven adhesive primer technology with rapid flash-off and curing cycle
- Successful performance for more than 35 years

Physical Characteristic	Standard	Units	EPDM[1]	HDPE[2]	LLDPE[3]
Seaming method			Tape	Thermal Weld	Thermal Weld
Seam inspection method			Air Lance	ASTM 5820 Pressure Test	
Peel Strength	ASTM D 7272	ppi	28		
Shear Strength	ASTM D 7272	ppi	144		
Peel Strength	ASTM D 6392	ppi		76	63
Shear Strength	ASTM D 6392	ppi		100	75

[1]45 mil non-reinforced EPDM seamed to polypropylene primary, as tested by TRI
[2]50 mil textured HDPE, GM13
[3]50 mil textured LLDPE, GM19

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Sand Infill or Additional Ballast Unnecessary

Sand must be dry

Turf must be dry (11:00 am)

Sand washes out

8:1 slope, sand floats

Need specialized equipment

Need special sand

Swales need binding agent

[→] DESIGN CONSIDERATIONS

Large Scale Flume Testing (ASTM 6460)

- Flow levels of 2.3in, 4.0in, 6.7in, and 10.7in (30 minutes each)
- No loss of grass, no tearing, no slope or channel requirements
- LiteEarth equivalent to well established natural grass

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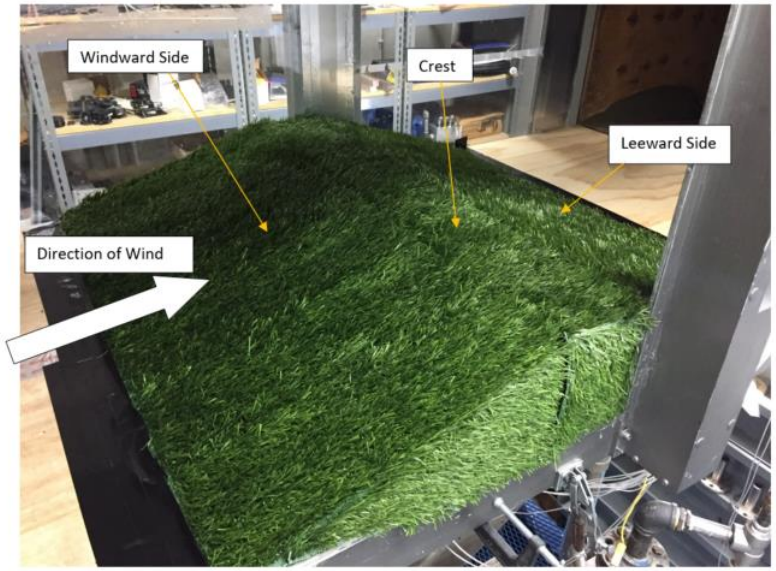
Wind Tunnel Testing

- Wind Tunnel Testing recently completed by Georgia Tech Research Institute (GTRI)
- Subsonic wind tunnel
- Tested up to 120 mph



Long-Term Value and Payback

- Expected life cycle beyond 60 years
- Extreme weather and high UV tolerance
- “O” Erosion Design, including steep slopes
- Easy to monitor surface and repair
- Minimal thermal expansion/contraction
- Minimal maintenance annually, < 5% of natural sod
- High wind speed resistance
- Can be installed in progressive intermediate stages
- Can be designed for cross over recreational use
- 30 Year Manufacturer's permeability and performance warranty

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Closure System Costs – Value Added

Option	Prescribed Final Closure	Exposed Geomembrane	Artificial Turf + Geomembrane
Closure Costs	$12,695,800	$8,077,200	$14,733,600
Post-Closure Costs	$1,135,800	$565,000	$565,000
Custodial Care Costs	$16,704,000	$7,500,000	$9,915,000
Subtotal - Costs	**$30,535,600**	**$16,142,200**	**$25,213,600**
Added Revenues - Airspace Savings	---	$(6,969,600)	$(6,969,600)
Total Net Costs	**$30,535,600**	**$9,172,600**	**$18,244,000**
Net Cost Savings		**$21,363,000**	**$12,291,600**
Cover Replacement			
- Costs		$2,395,800	$4,356,000
- % Replacement	---	100%	50%
- No. Replacements	---	9	6
- Service Life	---	50	100
Total Service Life	**750**	**500**	**700**

Source: Wastecon 2015 – Orlando Florida

End of Life Options – Alternative Closure Added Benefits

- Accessibility
- Waste settlement and reopen landfill
- Value in that garbage in 20 years?
- 30 years of escrow = new synthetic cap
- Easy addition of solar modules
- Regulatory changes in 30 years? 91 years?

We’ve Got You Covered

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