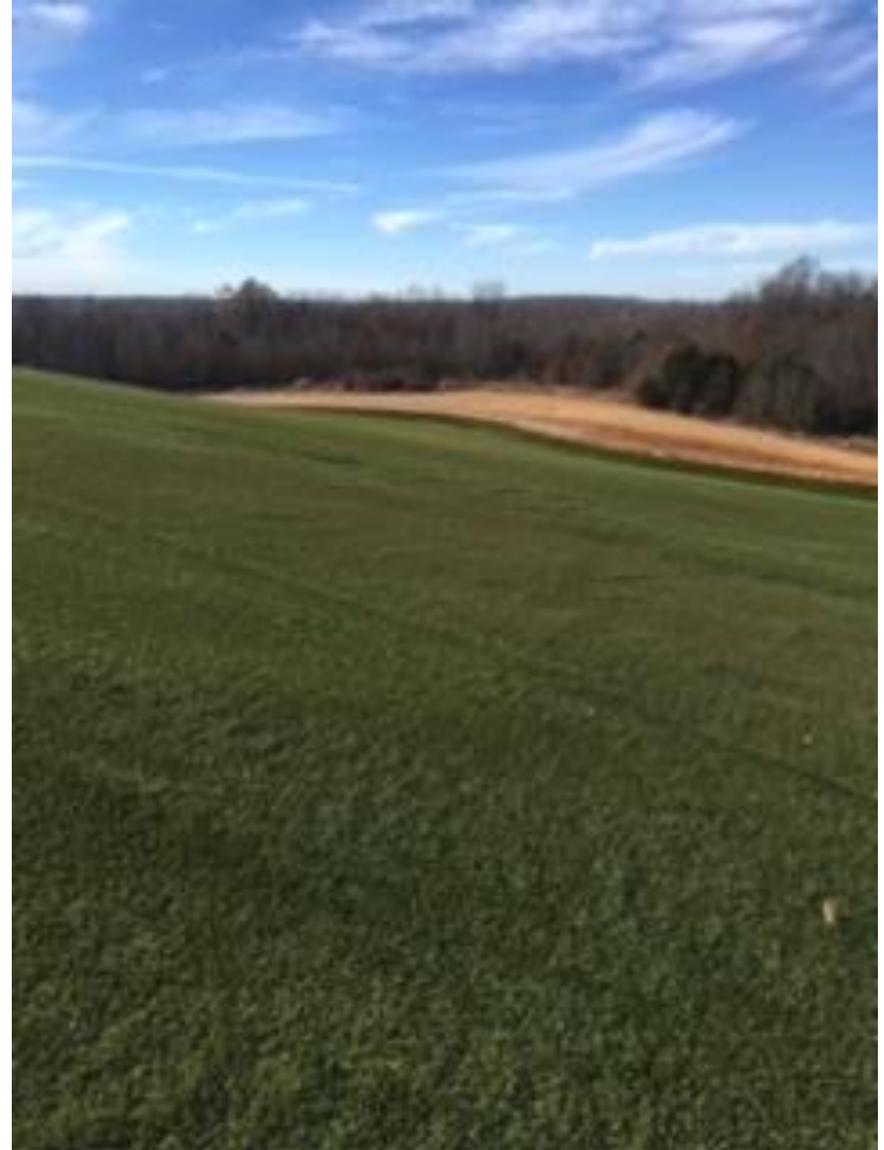




# Missouri Solid Waste Forum

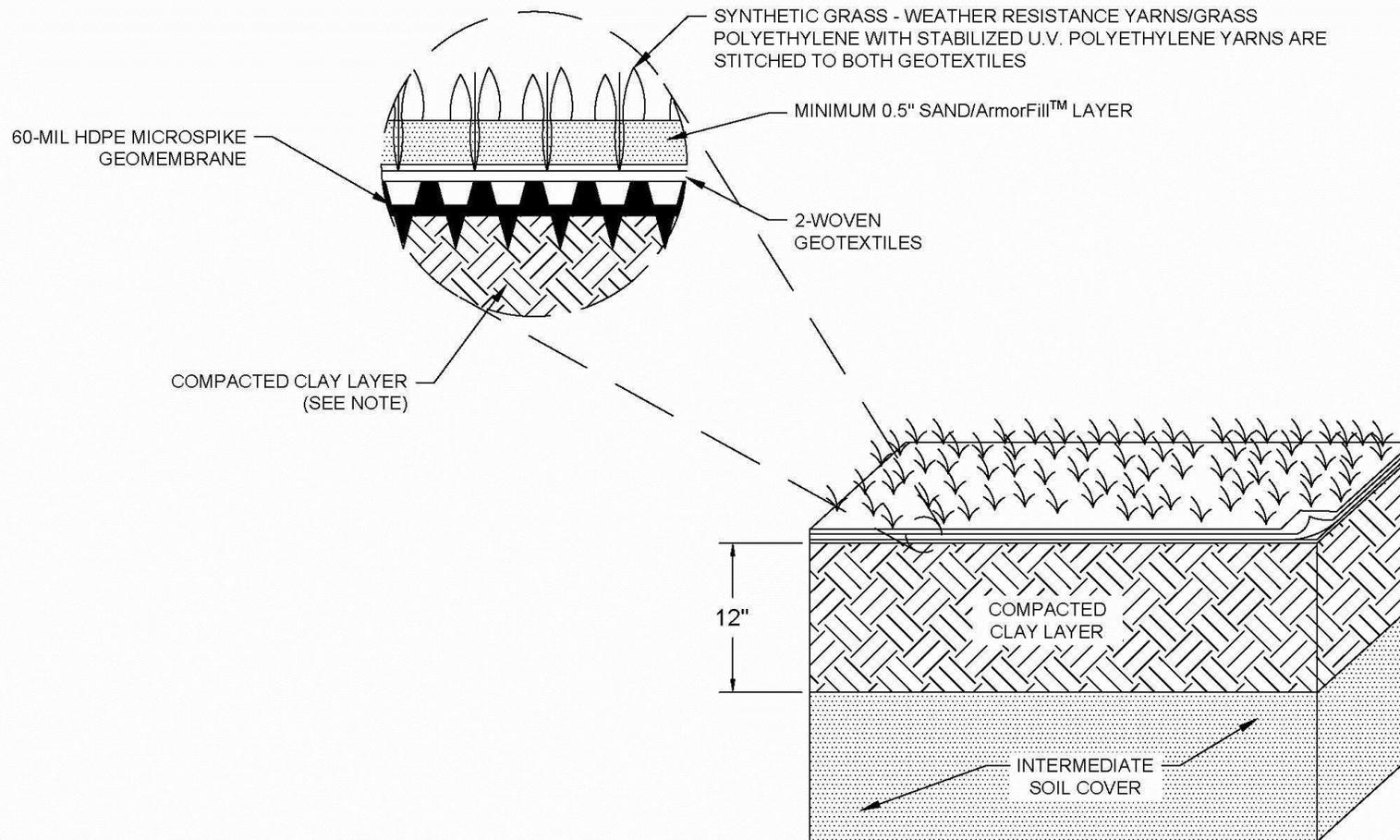
## ClosureTurf<sup>®</sup> Discussion

Floyd Cotter, PE  
February 21, 2018



# City of Washington Struckoff Sanitary Landfill

- Nearing end of active life
- Clay borrow material nearly exhausted
- Permit Modification to allow ClosureTurf® submitted August 1, 2017
- MDNR issued review comments October 12, 2017

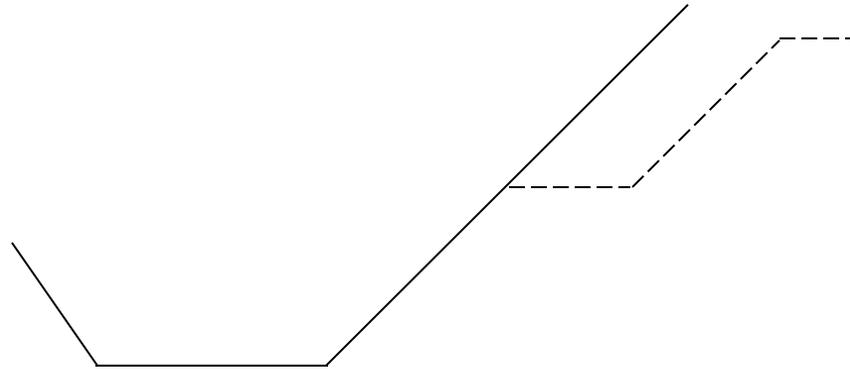


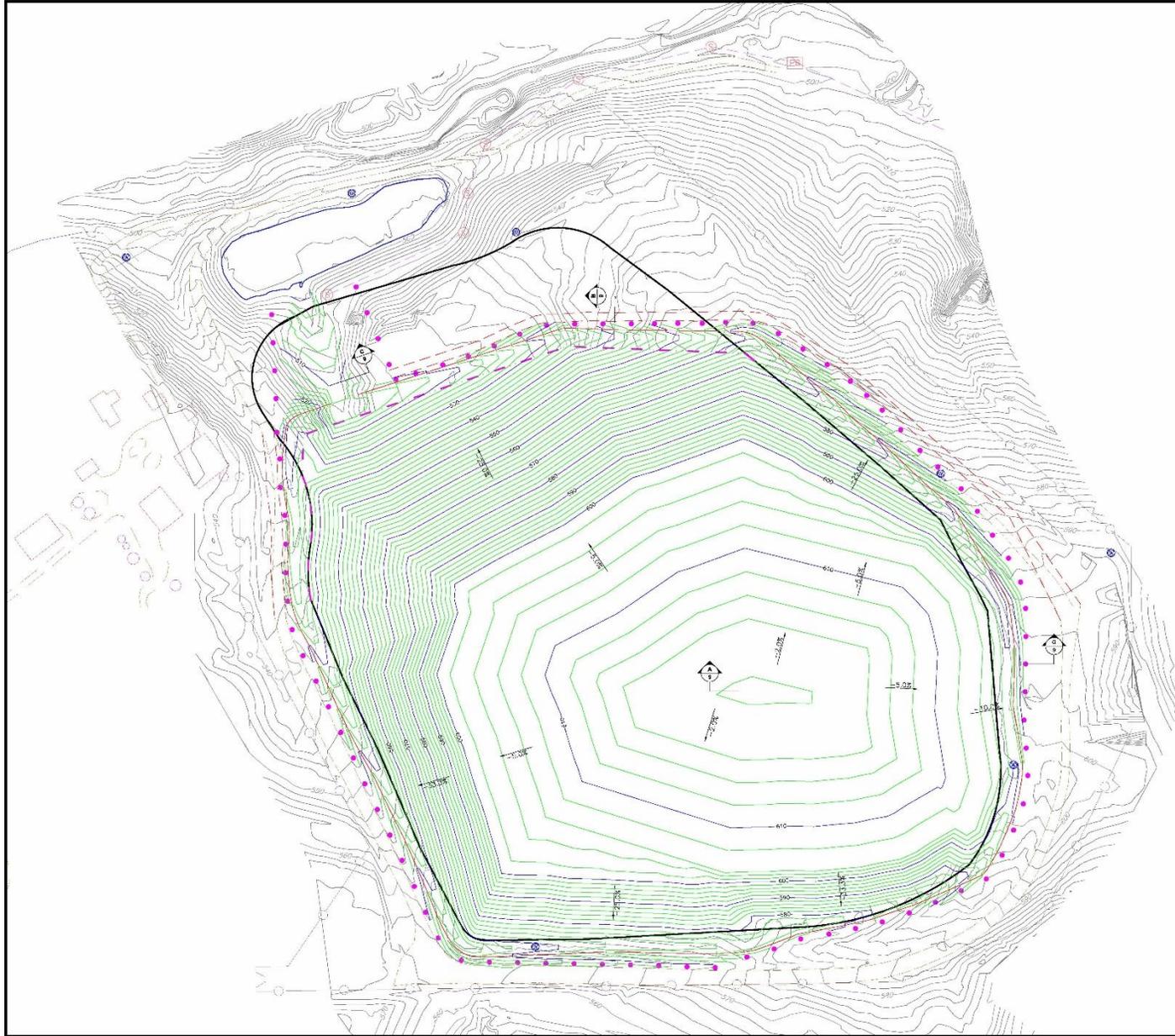
NOTE:

1. ArmorFill™ TO BE INSTALLED WITHIN FLOWLINE OF TERRACES AND BOTTOM OF CHANNELS.
2. THE COMPACTED CLAY LAYER MUST HAVE A MAXIMUM PERMEABILITY OF  $1 \times 10^{-5}$  CM/SEC.
3. THE TOP 6 INCHES OF THE INTERMEDIATE SOIL COVER MUST BE FREE OF PARTICLES GREATER THAN 1 INCH IN DIAMETER.

# Design Advantages

- Eliminate terraces and benches
- Perimeter Stormwater control

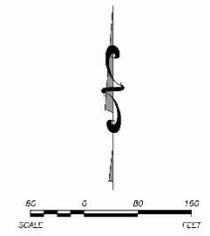




**LEGEND:**

|  |  |
|--|--|
|  | PERMITTED WASTE LIMITS / WASTE DISPOSAL BOUNDARY |
|  | PROPOSED CELL BOUNDARY                           |
|  | EXISTING 2' CONTOUR                              |
|  | EXISTING 10' CONTOUR                             |
|  | PROPOSED 2' FINAL COVER WITH STORMWATER CONTOUR  |
|  | PROPOSED 10' FINAL COVER WITH STORMWATER CONTOUR |
|  | EXISTING ROAD                                    |
|  | EXISTING BUILDING                                |
|  | EXISTING FENCE                                   |
|  | EXISTING TANKS                                   |
|  | EXISTING WATER SURFACE                           |
|  | EXISTING SANITARY SEWER LINE                     |
|  | EXISTING SANITARY SEWER MANHOLE                  |
|  | EXISTING SANITARY SEWER PUMP STATION             |
|  | EXISTING GROUNDWATER MONITORING WELLS            |
|  | PROPOSED 4-INCH DIAMETER STEEL BOLLARD           |
|  | PROPOSED CLOSURE/TURF ANCHOR TRENCH              |
|  | PROPOSED ROAD                                    |

- NOTES:**
- EXISTING CONTOURS ARE A COMPILATION OF AVAILABLE SURVEY DATA. THE SURVEYS USED INCLUDE:
    - MARCH 25, 1888 SURVEY IN PERIMETER AREA
    - MAY, 2017 SURVEY WITHIN THE PERMITTED FOOTPRINT
  - PROPOSED 4-INCH DIAMETER STEEL BOLLARDS TO BE PLACED 5 FEET APART AROUND THE LANDFILL.



|   |  |  |                          |
|---|--|--|--------------------------|
| SHEET TITLE<br><b>PROPOSED FINAL COVER WITH STORMWATER</b>  | REV  | DATE                                   | DESCRIPTION              |
|   |  |  |                          |
| PROJECT TITLE<br><b>MAJOR PERMIT MODIFICATION</b>   | CITY OF WASHINGTON<br>STRUCKHOFF SANITARY LANDFILL<br>825 STRUCKHOFF LANE<br>WASHINGTON, MO, 65080 |  |                          |
|   | C-EXT  |  |                          |
| <b>SCS ENGINEERS</b><br>13 ENCLAVE DRIVE, SUITE 1<br>PARKVILLE, MISSOURI 64074<br>PHONE: (816) 221-0001 FAX: (816) 221-0002 | DRAWN BY: PINKY<br>CHECKED BY: JAY<br>DATE: 02/07/18   | DATE PLOTTED: 02/07/18<br>PLOT BY: JAY | PROJECT NO.<br>18-001    |
|   | CADD FILE:<br>18-001-001.dwg   | DATE:<br>02/07/18                      | DRAWING NO.:<br><b>7</b> |

*“provide the construction quality assurance (CQA) procedures for all design components used for the construction of the Closure Turf<sup>®</sup> final cover system”*

*- Missouri Department of Natural Resources, Comment Letter regarding Proposed Alternative Final Cover, October 12, 2017*

# CQA Procedures HDPE Super Grip Net and Low Perm Soil layers

- Same as Subtitle D Cap

# CQA Procedures Closure Turf

- Testing for required material properties(GRI Test Method GM 19)
- Observations for proper handling, placement and defect repair



**Closure Turf Deployment**



**Seam Preparation**



**Heat Tacking**



## Welding

# CQA Procedures Sand Layer

- Verify no damage during placement
- Verify thickness is consistently achieved



*“address post-closure care and maintenance of the Closure Turf® AFC system. Please provide procedures for conducting visual inspections and recording information. “*

*- Missouri Department of Natural Resources, Comment Letter regarding Proposed Alternative Final Cover, October 12, 2017*



## Monitoring & Maintenance Guidelines

08-2017



## ClosureTurf® Post Closure Monitoring & Maintenance Guideline

| A. Site Information                   |   | B. Contact Information |    |    |
|---------------------------------------|---|------------------------|----|----|
| Facility Name:                        |   | Site Operator:         |    |    |
| Address:                              |   | Phone #:               |    |    |
| Closure Date:                         |   | Inspected By:          |    |    |
| Date of Last Inspection               |   | Date of Inspection     |    |    |
| C. ClosureTurf® Maintenance Checklist |   |                        |    |    |
|                                       |   | Yes                    | No | NA |
| 1                                     | If the cap has an active gas collection system, are all components of the system in good working order? |                        |    |    |
| 2                                     | Material movement (ballooning) due to gas build up?   |                        |    |    |
| 3                                     | Evidence of damage due to Wildlife?   |                        |    |    |
| 4                                     | Evidence of damage due to unauthorized post-closure use?  |                        |    |    |
| 5                                     | Evidence of ponding water?  |                        |    |    |
| 6                                     | Do all drainage swales have positive drainage?  |                        |    |    |
| 7                                     | Noticeable drainage channel ballast movement?   |                        |    |    |
| 8                                     | Areas with exposed Geotextile?  |                        |    |    |
| 9                                     | Areas with exposed Geomembrane?   |                        |    |    |
|                                       |   |                        |    |    |

Inspected By: \_\_\_\_\_ Approved By: \_\_\_\_\_

# Georgia Post Closure Monitoring Requirements.

Quarterly visual inspections/reports by professional engineer

Annual testing for degradation of original material properties.

*“address how the closure and post-closure financial assurance instrument (FAI) will be calculated ... The SWMP is particularly concerned about post-closure maintenance costs... Research into other states that have approved similar artificial turf systems as final cover revealed FAI requirements for maintenance costs vary considerably.”*

*- Missouri Department of Natural Resources, Comment Letter regarding Proposed Alternative Final Cover, October 12, 2017*

# ALTERNATIVE FINAL COVER SYSTEMS AND REGULATORY POST-CLOSURE CARE



MAY 2017



[WWW.SWANA.ORG](http://WWW.SWANA.ORG)

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## Alternative Final Cover Systems and Regulatory Post-Closure Care

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*Prepared for:*

**SWANA Applied Research Foundation  
FY2016 Disposal Subscribers**

**May 2017**



© Solid Waste Association of North America 2017

- Compilation of 9 States Regulatory Policies for Engineered Turf Final Cover Systems
- Conclusion
  - Viewed similar to Subtitle D
  - Not replaced at the end of the service life

# City of Washington

- Closure Cost Estimate (27 Acres)
  - Subtitle D \$4,000,000 to \$5,000,000 (clay source currently not located)
  - ClosureTurf® \$4,109,000
- Post Closure Cost Estimate
  - Subtitle D \$1,900,000
  - ClosureTurf® \$1,800,000

*“State of Louisiana Approval Letter, includes an approval letter for the LaSalle-Grant Parish Landfill to use “Closure Turf®” as an alternative final cover. Please provide details on what type of “Closure Turf®” was approved, and compare this to the final cover that was originally permitted in the state of Louisiana.” Please provide information from other states that have approved AFC systems in comparison to that state’s original Subtitle-D final cover system requirements.”*

*- Missouri Department of Natural Resources, Comment Letter regarding Proposed Alternative Final Cover, October 12, 2017*

# Comparative State Data

**WG** WatershedGeo<sup>®</sup>  
Unearthing Solutions

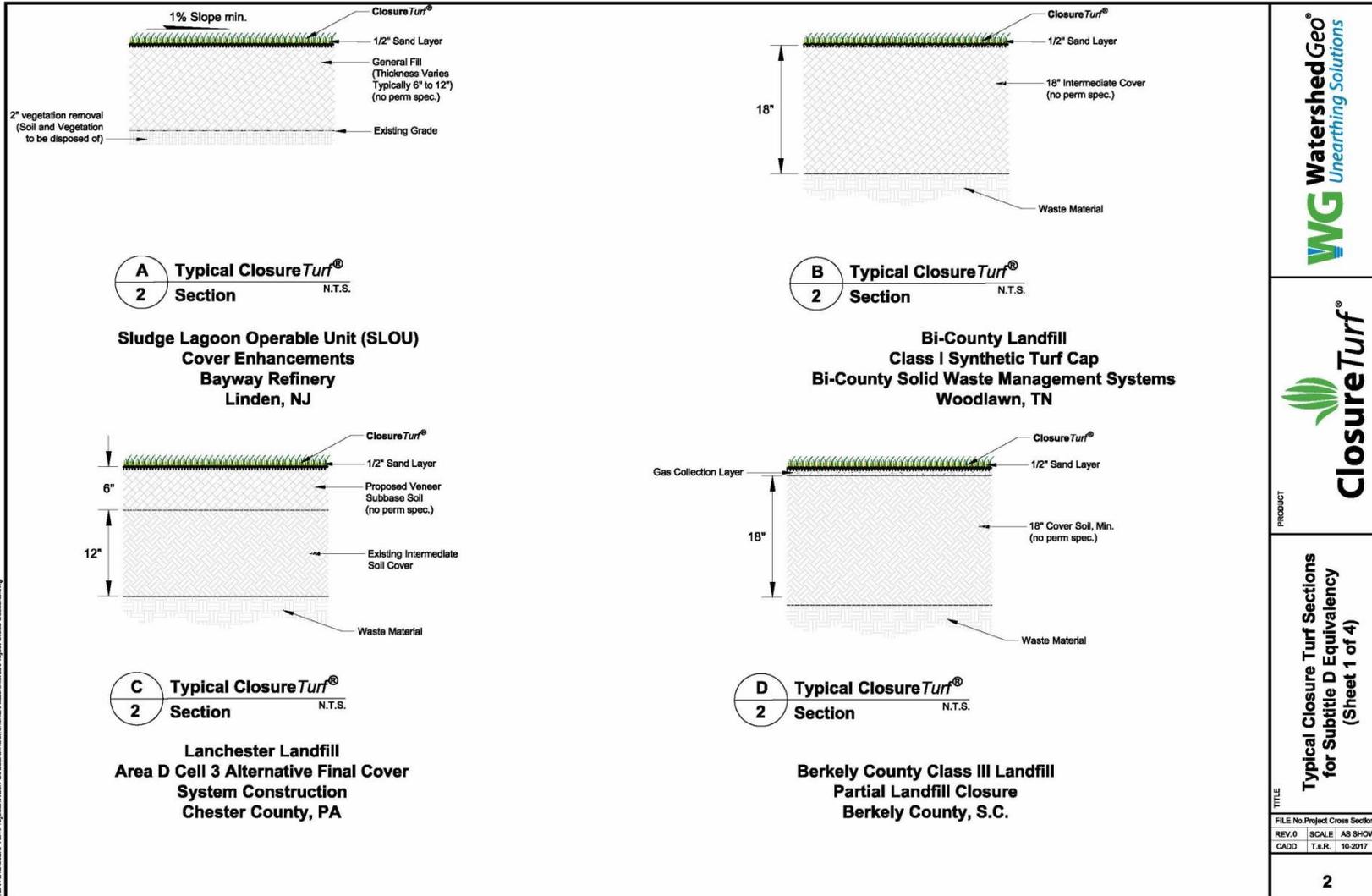
**ClosureTurf<sup>®</sup>**

PRODUCT

**Typical Closure Turf Sections  
for Subtitle D Equivalency  
(Sheet 1 of 4)**

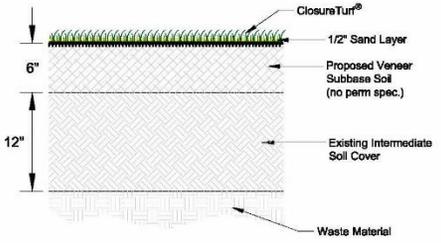
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REV. 0 SCALE AS SHOWN  
CADD T&R 10-2017

2



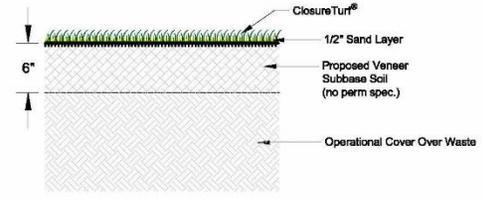
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# Comparative State Data



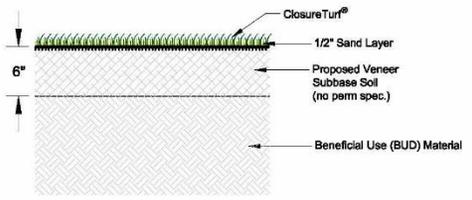
**A**  
1 Detail N.T.S.  
**Typical ClosureTurf® Section**

**Georgia EPD Approval**  
**Union Hill Church Road Landfill**  
**Baldwin County, Georgia**



**B**  
1 Detail N.T.S.  
**Typical ClosureTurf® Section**

**Massachusetts DEP Approval**  
**Covanta of Seamass, Carver, MA**



**C**  
1 Detail N.T.S.  
**Typical ClosureTurf® Section**

**Rhode Island Approval**  
**Cranston, Rhode Island**

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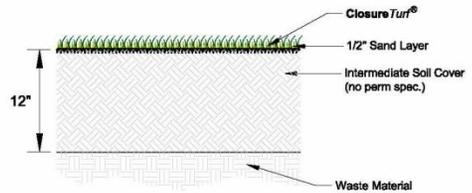


TITLE

**Typical Closure Turf Sections**  
**for Subtitle D Equivalency**  
**(Sheet 4 of 4)**

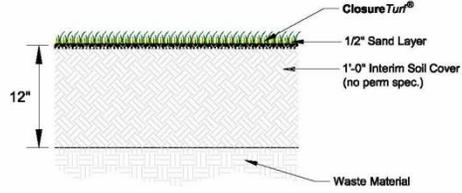
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| FILE No. | Project Cross Sections |
| REV. 0   | SCALE AS SHOWN         |
| DATE     | T.A.R. 10-2017         |

# Comparative State Data



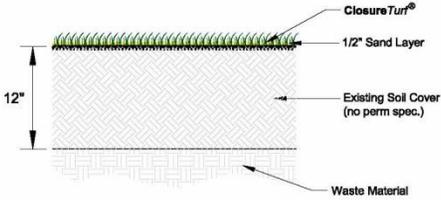
**A**  
**3** Typical ClosureTurf®  
Section N.T.S.

**IESI Weatherford Landfill**  
**Parker County, TX**



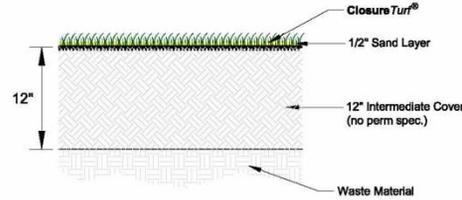
**A**  
**3** Typical ClosureTurf®  
Section N.T.S.

**Timberlane Landfill**  
**Allen Parrish**  
**Oakdale, LA**



**C**  
**3** Typical ClosureTurf®  
Section N.T.S.

**Tangipahoa Regional Solid Waste Facility**  
**Tangipahoa Parish Government**  
**Independence, LA**



**D**  
**3** Typical ClosureTurf®  
Section N.T.S.

**Seneca Landfill**  
**Alternative Final Cover System**  
**Butler County, PA**



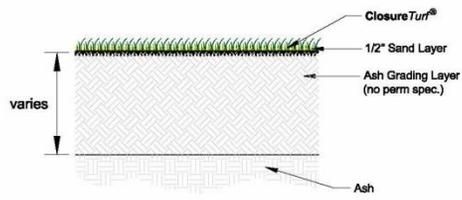
PRODUCT

**Typical Closure Turf Sections**  
**for Subtitle D Equivalency**  
**(Sheet 2 of 4)**

|          |                        |
|----------|------------------------|
| TITLE    |                        |
| FILE No. | Project Cross Sections |
| REV.0    | SCALE AS SHOWN         |
| CADD     | T.&R. 10-2017          |

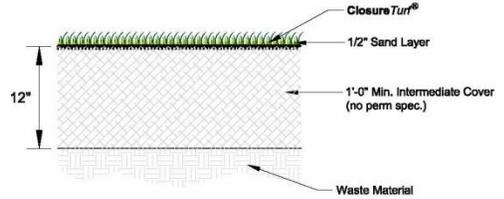
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# Comparative State Data



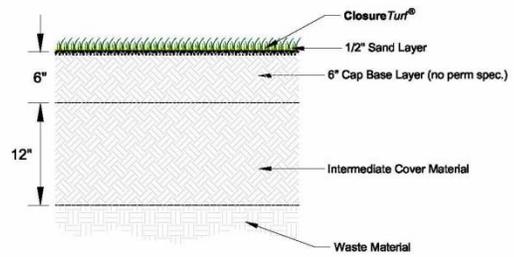
**A**  
4 Section  
N.T.S.

**Georgia Pacific  
Foundation Directly on Ash Waste  
GA**



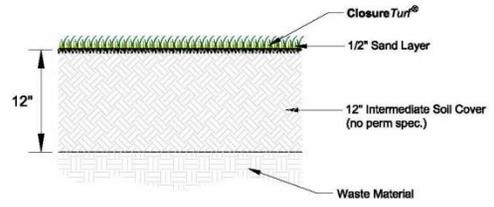
**B**  
4 Section  
N.T.S.

**Saufly Landfill, FL  
\* Closed C&D Landfill**



**C**  
4 Section  
N.T.S.

**Cover System Details  
ClosureTurf Alternative  
Hartford Landfill, CT**



**D**  
4 Section  
N.T.S.

**Alternate Intermediate Cover  
Timber Ridge Landfill  
Richwoods, MO**



PRODUCT

**Typical Closure Turf Sections  
for Subtitle D Equivalency\***  
(Sheet 3 of 4)

|                                 |       |          |
|---------------------------------|-------|----------|
| FILE No. Project Cross Sections |       |          |
| REV. 0                          | SCALE | AS SHOWN |
| CADD                            | T.&R. | 10-2017  |

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*“A comparison of the effects of freeze/thaw on the proposed AFC system and the currently required Subtitle-D final cover system is needed to determine equivalency. Additionally, the SWMP is interested in affects freezing temperatures and freeze/thaw conditions may have on a geomembrane liner that is exposed to the elements versus a geomembrane liner insulated by 24 inches of vegetative soil. An examination of a similar system currently used as intermediate cover at the Timber Ridge Sanitary Landfill would likely be ideal for this purpose”*

*- Missouri Department of Natural Resources, Comment Letter regarding Proposed Alternative Final Cover, October 12, 2017*

**Geosynthetic Institute**  
475 Kedron Avenue  
Folsom, PA 19033-1208 USA  
TEL (610) 522-8440  
FAX (610) 522-8441



## **GSI White Paper #28**

### **“Cold Temperature and Free-Thaw Cycling Behavior of Geomembranes and Their Seams”**

by

Y. (Grace) Hsuan, Ph.D.  
Professor of Civil, Architectural and  
Environmental Engineering  
Drexel University  
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[ghsuan@coe.drexel.edu](mailto:ghsuan@coe.drexel.edu)

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610-522-8440  
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Alice I. Comer, P.E.  
Project Manager  
Formally With U. S. Bureau of Reclamation  
Denver, Colorado

**June 17, 2013**

Table 1 – Experimental Design of Different Parts of Comer and Hsuan (1996) Study

| Part | Cyclic Temperature Range | Maximum Cycles | Incubation Condition | Tensile Test Temperature |
|------|--------------------------|----------------|----------------------|--------------------------|
| I    | +20°C to -20°C           | 200            | relaxed              | +20°C                    |
| II   | +20°C to -20°C           | 200            | relaxed              | -20°C                    |
| III  | +30°C to -20°C           | 500            | constrained          | +20°C                    |

# Conclusion of GSI Study

- Colder the temperature the more brittle and less ductile
- No change in the tensile behavior due to freeze thaw

# Key Considerations

- Appropriate Post Closure FAI
- Soil layer thickness and perm requirement
  - Environmental cost/benefits analysis soil borrow

