ClosureTurf®

ADVANCED FINAL COVER SYSTEM

The only final cover solution that provides a predictable benchmark of performance.

Created and Patented by: WG WatershedGeo® Unearthing Solutions

ClosureTurf® Overview

Superior Performance When Compared to EPA Subtitle D Landfill Final Covers

Watershed Geosynthetics, LLC (Watershed Geo) has prepared this document to present the benefits of using ClosureTurf® as an alternative final cover system for EPA Subtitle D landfill applications. ClosureTurf offers substantial technical and environmental benefits when compared to traditional and regulatory prescriptive final covers of landfills and other waste containment facilities.

ClosureTurf provides significant technical benefits, including elimination of soil erosion, enhanced geotechnical stability, accelerated construction schedule, and reduced post-closure maintenance. These benefits have been validated through extensive independent laboratory and field tests as well as real-world performance of more than 1,500 acres of ClosureTurf installations and operations. ClosureTurf is a more environmentally sound application too. It provides improved runoff water quality, minimum land disturbance, and significant carbon footprint reduction.

ClosureTurf Benefits

1) Regulatory Compliance

ClosureTurf is a three-component system comprised of a structured geomembrane, an engineered synthetic turf, and a specified infill. The EPA Subtitle D rules state that an alternative cover design may be used upon approval, as long as it provides equivalent protection against infiltration and erosion. As presented in this document later, ClosureTurf exceeds the equivalency performance requirements of the EPA Subtitle D prescriptive soil cover. Specifically, the analysis results have shown that the ClosureTurf system has much less leakage and erosion than the prescriptive soil cover.

2) Safety and Community Impact Reduction

ClosureTurf eliminates approximately 550 truck trips per acre from local roadways that would otherwise be used to transport soil to and from a borrow site (note: 1 truck load equals to 2 trips). This reduction in size, number and duration of equipment means an overall increase in safety on both the project site and roads (i.e., less possible accidents involved with equipment and vehicle operations), as well as reduction in dust at the site, mud on the roads, and noise impacts on the surrounding community. Most traditional closures also require destruction of land in the community for project soil sources, resulting in additional environmental impact and loss of future land use.

3) Sustainability

ClosureTurf reduces the carbon footprint of a final cover closure by approximately 80% when compared with traditional soil/vegetative covers. Additionally, ClosureTurf provides an ideal foundation for future beneficial uses, such as solar farms. Traditional post-closure plans identify the post-closure use simply as “dead space”. ClosureTurf has been used to install photovoltaic solar panel arrays on top it, allowing the unused space to be utilized as a renewable energy site. This feature is inherent with the ClosureTurf system and requires no special modifications to the cover system to accommodate possible future use for solar farms.

4) Water Quality

ClosureTurf provides clean runoff with very low turbidity because it does not have a soil layer, except for the thin (0.5-inch thick) layer of sand infill. The system significantly reduces sediment loading to surrounding channels and sedimentation/detention basins either onsite or offsite. ClosureTurf has a positive impact on overall storm water quality, allowing effluent levels to meet or be well below the regulatory turbidity limits.

5) Geotechnical Factors of Safety

ClosureTurf improves the geotechnical factors of safety of the final cover. By removing the soil layer, the veneer-type final cover failure that typically occurs through the interface between the soil and geosynthetic components of the traditional soil cover systems is no longer a focus of concern. In addition, the system has a light weight that is typically about 5 pounds per square foot (psf). Placement of ClosureTurf creates insignificant loading on the underlying waste and thus, insignificant waste settlement. As a comparison, the waste settlement caused by the much heavier traditional soil covers can potentially reverse drainage and create ponding, especially at landfill top decks where the slopes are usually relatively flat.

6) Water Conservation

ClosureTurf reduces the need of water for soil compaction and dust control during construction. It also eliminates the need of irrigation during the post-closure maintenance period for vegetation or re-vegetation of traditional soil cover systems.

7) Land Conservation

ClosureTurf does not required the destruction of land to obtain soils to achieve the closure. It optimizes land conservation through the elimination of excavation of borrow pits on native land, as well as providing space for renewable energy sites (e.g., solar farms) that might otherwise need to be constructed in other undeveloped areas.

8) Maintenance Cost Savings

ClosureTurf requires very low post-closure maintenance. The cost of maintenance is estimated to be as much as 90% less than traditional soil cover systems as a result of reduction in maintenance activities including vegetation, mowing, fertilization, irrigation, re-vegetation, erosion repairs, and stormwater pond cleaning associated with traditional soil covers.

9) Project Schedule/Installation Rate

ClosureTurf requires fewer resources to complete a final cover closure from pre-design through final acceptance. ClosureTurf installs 2 to 3 times faster than traditional soil covers and uses lighter and fewer pieces of equipment. The increase in project-completion efficiency means that owners, operators and their design/construction team can effectively cover more acreage with ClosureTurf than with traditional soil cover systems. Additionally, the standardization of engineering and construction details associated with ClosureTurf reduces the burden on the regulatory review and approval process.

10) Longevity

ClosureTurf is expected to have a design life of more than 100 years for the infilled engineered synthetic turf component based on field ultra violet (UV) test results. The underlying geomembrane will last much longer because of the UV protection provided by the infill and the engineered synthetic turf. Studies by the Geosynthetic Institute (GSI) show that the geomembrane can last more than 400 years under covered conditions.

ClosureTurf® Detail Description

ClosureTurf is an environmentally friendly and aesthetically pleasing engineered synthetic turf final cover system that is designed for long-term performance. This system eliminates or significantly reduces the challenges associated with traditional soil cover systems, including erosion control, veneer slope stability, and post-closure maintenance. A section of ClosureTurf is shown in Figure 1. Its components include the following from bottom to top:

- Structured Geomembrane, which is made of either high density polyethylene (HDPE) or linear low density polyethylene (LLDPE);
- Engineered Synthetic Turf, which is comprised of polyethylene (PE) fibers tufted through a double layer of woven polypropylene (PP) geotextile backing manufactured for high UV and heat resistance; and
- Specified Infill.

The ClosureTurf system is placed directly on top of the prepared subgrade.

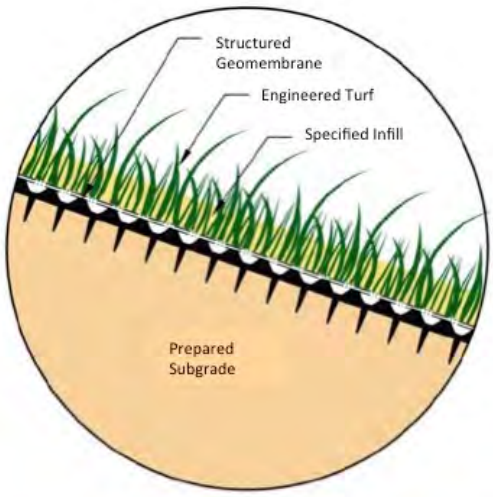


Figure 1 – Cross Section of ClosureTurf® System

ClosureTurf has been approved as an alternative final cover system in many states across the U.S. Approvals were based on a demonstration that ClosureTurf meets the minimum requirements defined in applicable State or Federal EPA regulations.

The minimum technical requirements for Subtitle D final cover systems are presented in 40 CFR 258.60. The regulation allows for a prescriptive (minimum criteria) cover system or an alternative (performance based) cover system. The specific requirements of 40 CFR 258.60 for approval of an alternative final cover system are as follows:

"(B) The Director of an approved State may approve an alternative final cover design that includes:

(1) An infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs (a) (1) and (a) (2) of this section, and

(2) An erosion layer that provides equivalent protection from wind and water erosion as the erosion layer specified in paragraph (a) (3) of this section."

Engineering analysis results have demonstrated that the ClosureTurf final cover system: (1) results in a greater reduction in infiltration than the Subtitle D prescriptive cover; and (2) provides greater protection from erosion, while maintaining functional longevity with reduced post-closure maintenance burden. More than 2,800 acres of ClosureTurf has been (or is being) constructed in more than 25 states in the U.S., as shown in the project map below.

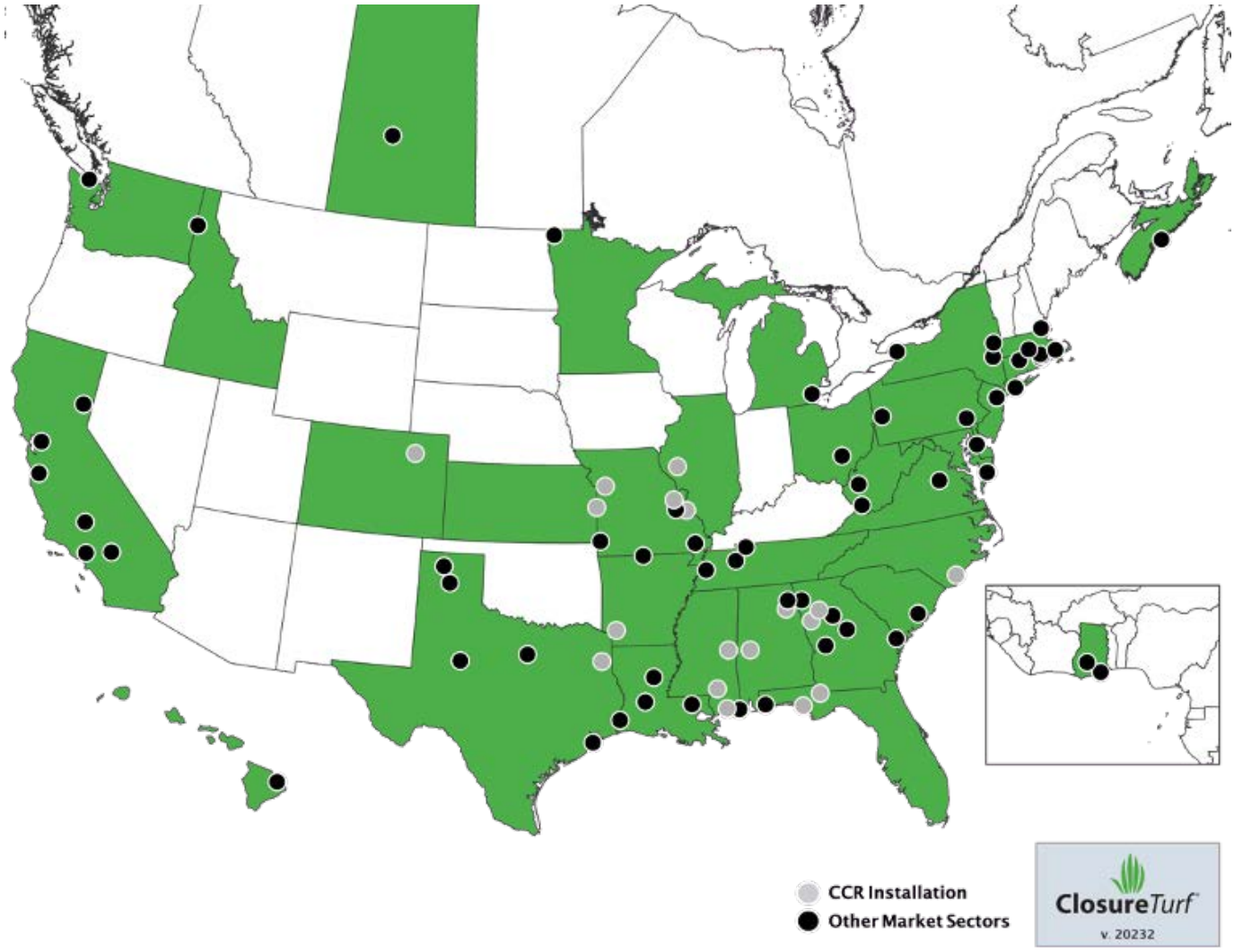


Figure 2 - Locations of ClosureTurf

Infiltration Equivalency Analysis

Infiltration through a cover system is typically evaluated using either of the following two methodologies: the Hydrologic Evaluation of Landfill Performance (HELP) Model or the Giroud Method. Both methods have been used to compare the infiltration performance of the ClosureTurf final cover system to the prescriptive Subtitle D soil cover. A summary of the results is shown in Table 1.

The results show that the ClosureTurf Final Cover System has much less infiltration than the prescriptive Subtitle D soil cover. These results are expected since ClosureTurf does not have a soil layer that can potentially hold significant hydraulic head over the geomembrane.

Table 1 – Summary of Results for Infiltration Equivalency Analysis

Infiltration Equivalency Analysis	ClosureTurf® Cover System	Prescriptive Subtitle D Cover System
Help Model for Site– Average Annual Infiltration (Cubic Feet/Acre/Year)	8.3	347
Giroud Method with Silty-Sandy Soil below the ClosureTurf Peak Daily Infiltration (Gallons/Acre/Day)	1.33	4.51
Giroud Method with Silty-Sandy Soil with Some Clay below the ClosureTurf Peak Daily Infiltration (Gallons/Acre/Day)	0.24	4.51

Erosion Control

Rainfall Erosion Control Testing

ClosureTurf was tested at TRI Environmental in accordance with ASTM 6459 - Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall- Induced Erosion. ClosureTurf was tested in a rainfall simulator to an intensity of over 6.5 in/hr with less than 0.04% loss of sand infill.

Figure 3 – Rainfall Erosion Control Testing on ClosureTurf® (3H:1V Slope)

The typical design criterion for sediment runoff on a traditional landfill soil cover is 3 tons/acre/year. The measured loss of sand infill (0.04%) of the ClosureTurf is approximately 0.03 tons/acre for a 6.5 in/hr rainfall intensity. Using ClosureTurf will significantly reduce sediment loads and runoff turbidity. Also, the ClosureTurf System filters the storm water and provides "clean" runoff as shown in the testing samples in Figure 4 below.

Enhanced Water Quality

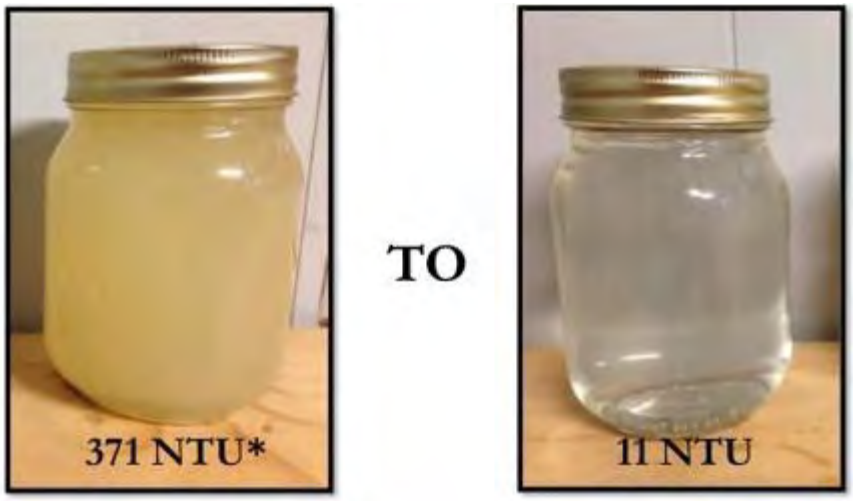


Figure 4 – Samples from Two Storm Water Ponds at the Same Facility

Pond 1 (left sample) for the soil cover and Pond 2 (right sample) for the ClosureTurf

Table 3 – Analytical Results from Storm Water Samples at a Southeastern Landfill

Parameter	Area with Soil Cover	Area with ClosureTurf®
Turbidity (NTU)	371	11
Total Suspended Solids-TSS (mg/L)	349	<4
pH	6.5	7.3
Total Organic Carbon-TOC (mg/L)	174	1
Toxic Release Inventory-TRI (mg/L)	16	0.5

In areas of channelized flow (bench drains, down chutes, and perimeter channels), the ClosureTurf can be infilled with HydroBinder® (sand cement infill) instead of sand. ClosureTurf with HydroBinder has been tested at Colorado State University Engineering Research Center (CSU) in accordance with ASTM D 7277 – Standard Test Method for Performance Testing of Articulated Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow. The results of the testing were analyzed in accordance with ASTM D 7276 - Standard Guide for Analysis and Interpretation of Test Data for Articulating Concrete Block (ACB) Revetment Systems in Open Channel Flow. Testing was performed up to the 5.5-ft overtop flume capacity which resulted in 40 fps in velocity. The photos in Figure 5 show this steady state testing being performed.

Figure 5 – Steady State Hydraulic Testing of ClosureTurf® with HydroBinder® at CSU

The full-scale wave overtopping testing for side slope protection was also performed on the ClosureTurf with HydroBinder at CSU. CSU has the world's largest wave overtopping simulator which they developed for the U.S. Army Corp of Engineers. Testing was performed on HydroTurf for 13 hours with 9 hours at the maximum capacity of the simulator (4.0 cfs/ft which represents a generic hurricane with a 0.2 percent annual exceedance probability; i.e., a 500-year event). The photos in Figure 6 show wave overtop testing on the HydroTurf.

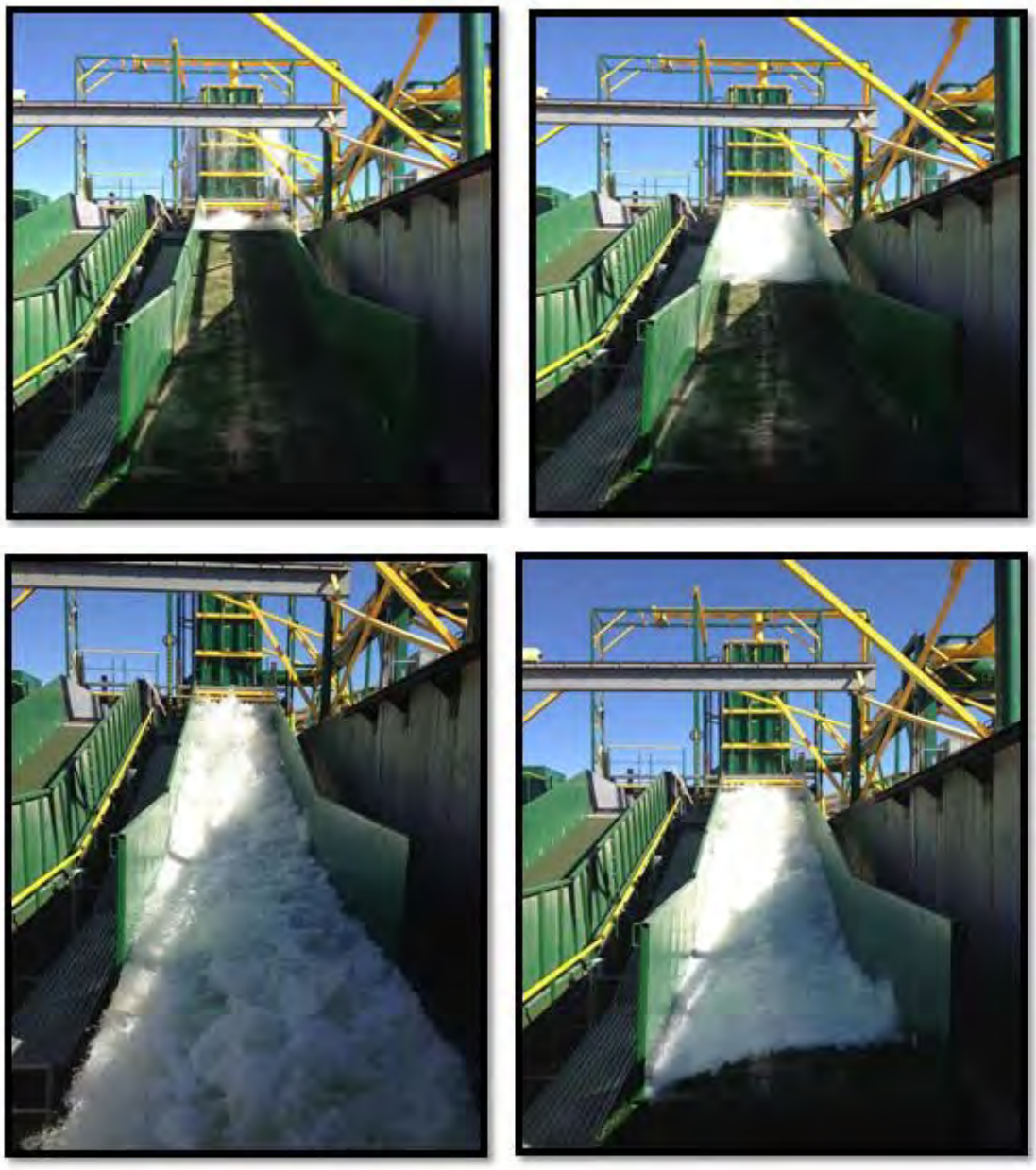


Figure 6 – Wave Overtopping Hydraulic Testing of ClosureTurf with HydroBinder

Longevity and Protection Provided by ClosureTurf

ClosureTurf® is not an exposed cover system. It is a hybrid system that provides full protection of the most critical element of the closure system – the geomembrane. ClosureTurf differs from exposed geomembrane systems as follows:

- Access and drivability of exposed geomembrane systems are severely limited without means of protecting the geomembrane;
- Exposed geomembranes are vulnerable to wildlife trafficking;
- The engineered turf component of ClosureTurf serves as a protective ballast providing physical protection and weathering protection to the underlying geomembrane;
- Since ClosureTurf looks and feels like natural vegetation, it is much more aesthetically pleasing than an exposed geomembrane system; and
- ClosureTurf has a much longer functional longevity than exposed geomembrane systems.

For ClosureTurf, the engineered synthetic turf layer provides protection of the structured geomembrane so that it is not exposed to the environment. If properly maintained, the engineered synthetic turf layer will have a 100+ year functional longevity. The results of 10 years of independent weathering data for the synthetic turf yarns are shown in Figure 7. When this data is extrapolated to 100 years, the yarn has an approximate 65% retained tensile strength. In other words, the projected half-life of the engineered turf layer far exceeds 176 years. This longevity has been independently evaluated by multiple organizations who are experienced in the longevity performance of geosynthetics.

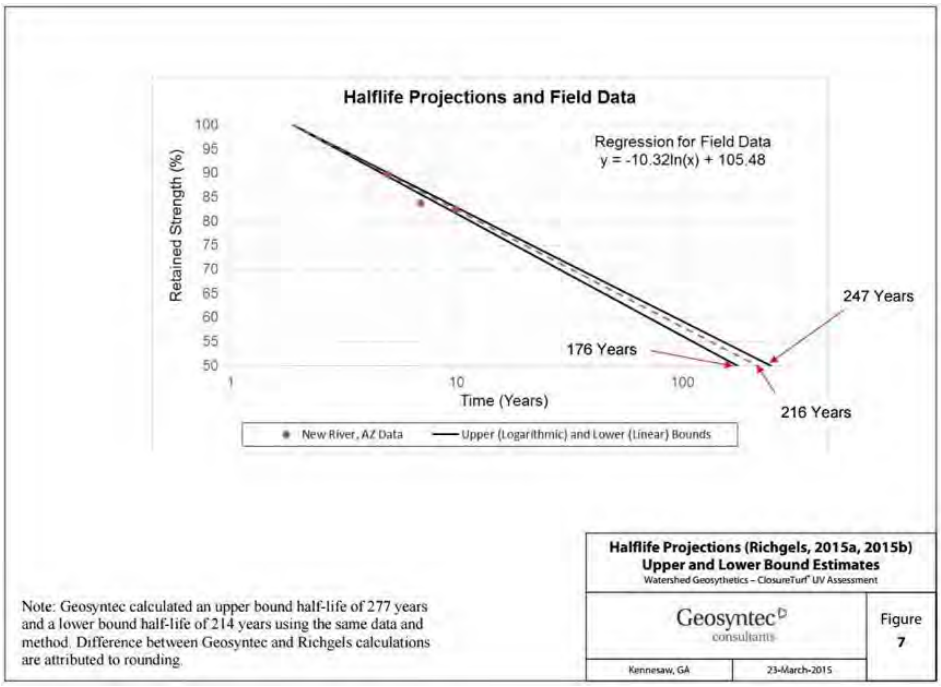


Figure 7 – Longevity Data Analysis Results

Traffic Loading Evaluation

Rubber tired vehicles are allowed to drive on the ClosureTurf system. Typically, the suggested ground pressure for vehicles on landfill side slopes is less than 35 psi; and the suggested ground pressure for vehicles on top decks (10% or less) and designed access roads is less than 120 psi. The allowed ground pressure should be verified and approved by the design engineer.

Aerodynamic Evaluation

ClosureTurf has unique aerodynamic features that react against the wind causing a resistance to the uplift component. It was tested in the wind tunnel at the Georgia Tech Research Institute (GTRI) at wind speed up to 120 mph and no wind uplift was observed. The photo in Figure 8 shows the wind tunnel test results at 170 fps (120 mph).

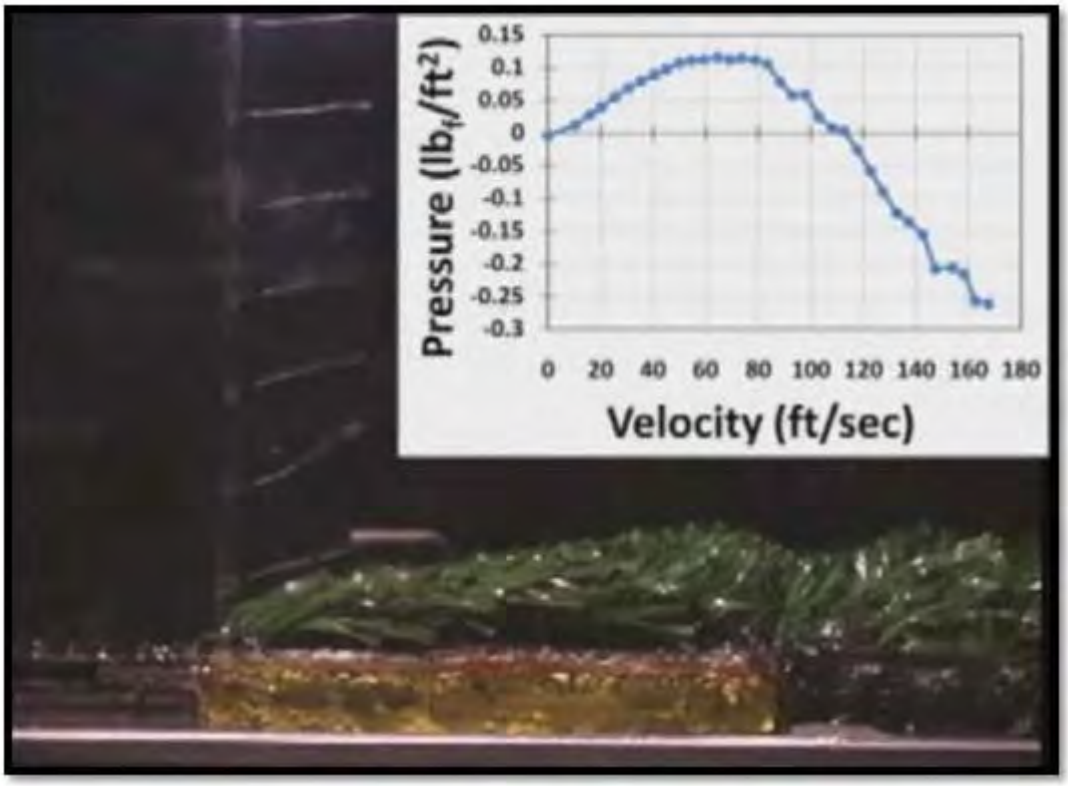


Figure 8 – Wind Tunnel Test of ClosureTurf

Carbon Footprint

ClosureTurf is estimated to result in approximately 1/5 of the carbon footprint of a traditional soil cover. The major factors influencing the carbon footprint are the number of truck loads to haul the materials and the equipment used to construct the cover system. Carbon footprint calculations are shown in the following chart in Figure 9.

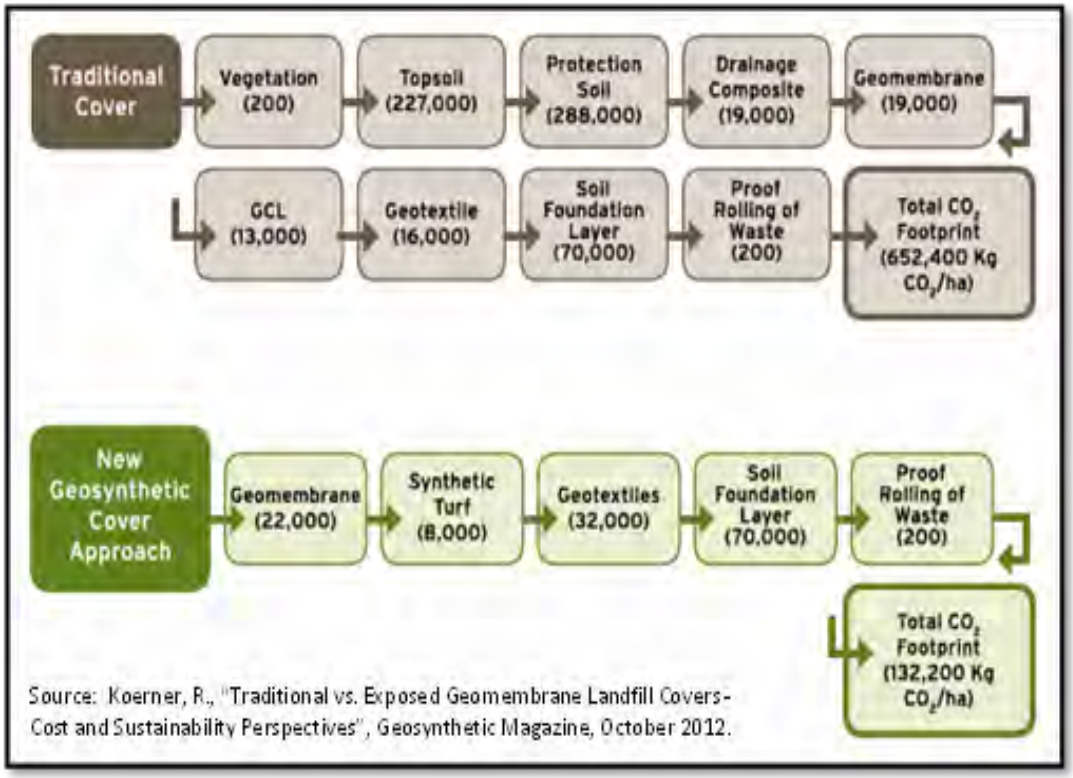


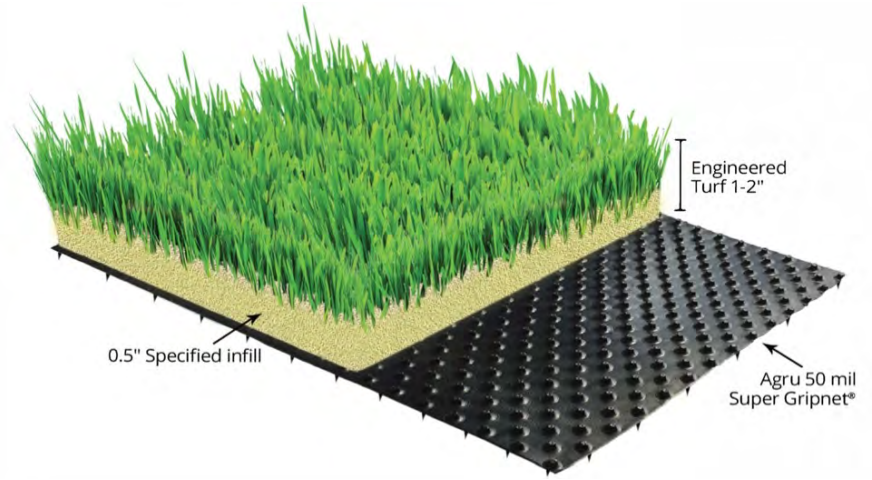
Figure 9 – Carbon Footprint Evaluation of ClosureTurf vs. Traditional Soil Cover

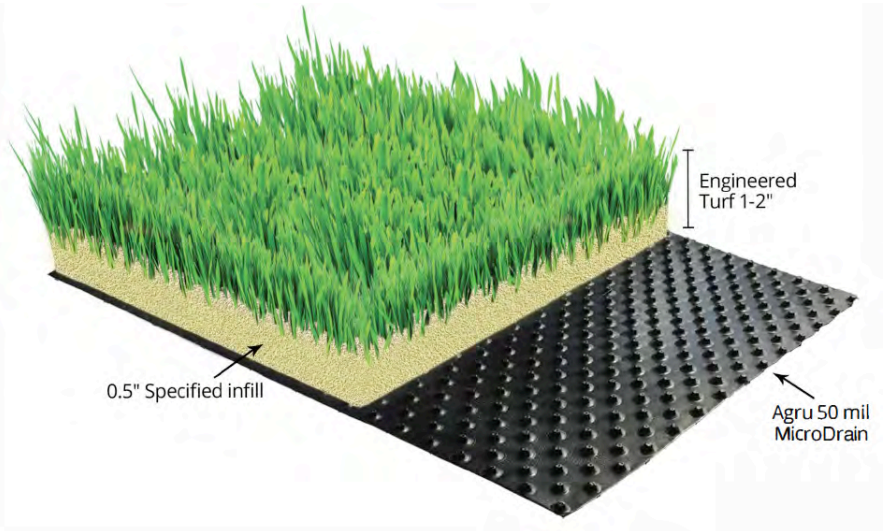
Landfill Gas Emission Control

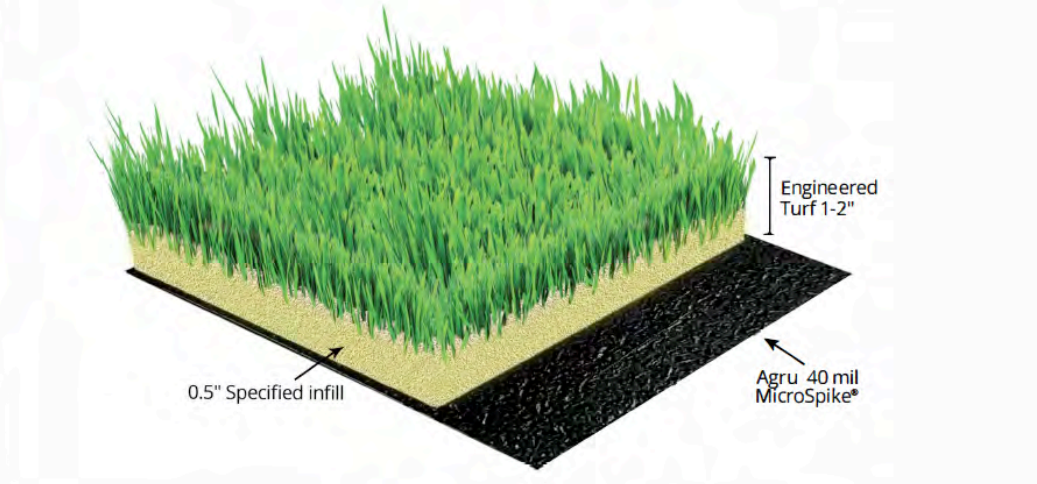
ClosureTurf controls landfill gas fugitive emissions by encapsulating the closed areas with the geomembrane. When the patented ClosureTurf Surficial Gas Collection system is utilized, high gas collection efficiency and significant reduction in condensate generation can be realized. The ClosureTurf system also has patented pressure relief valves to release gas pressure buildup in case the landfill gas collection and control system is temporarily not functioning (e.g., flare shutdowns).

ClosureTurf® System & Design

System Options



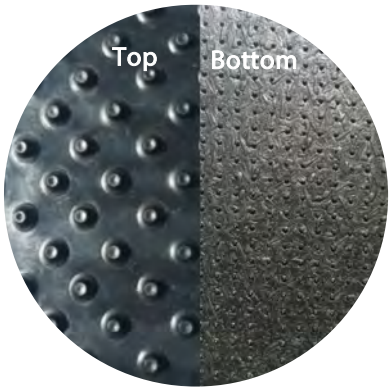




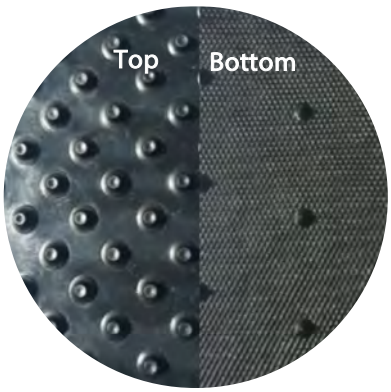
Components

1. Structured HDPE or LLDPE Geomembrane

AGRU MicroSpike®
(40 mil)



AGRU MicroDrain®
(50 mil)



AGRU Super GripNet®
(50 or 60 mil)

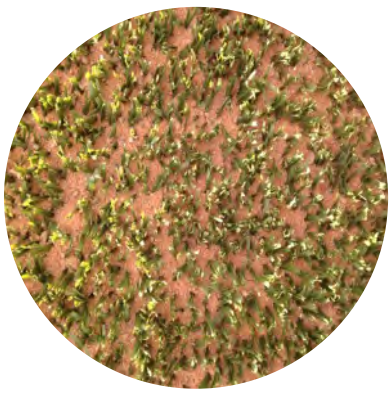
2. Engineered Turf

Olive

Blend

Tan

3. Specified Infill

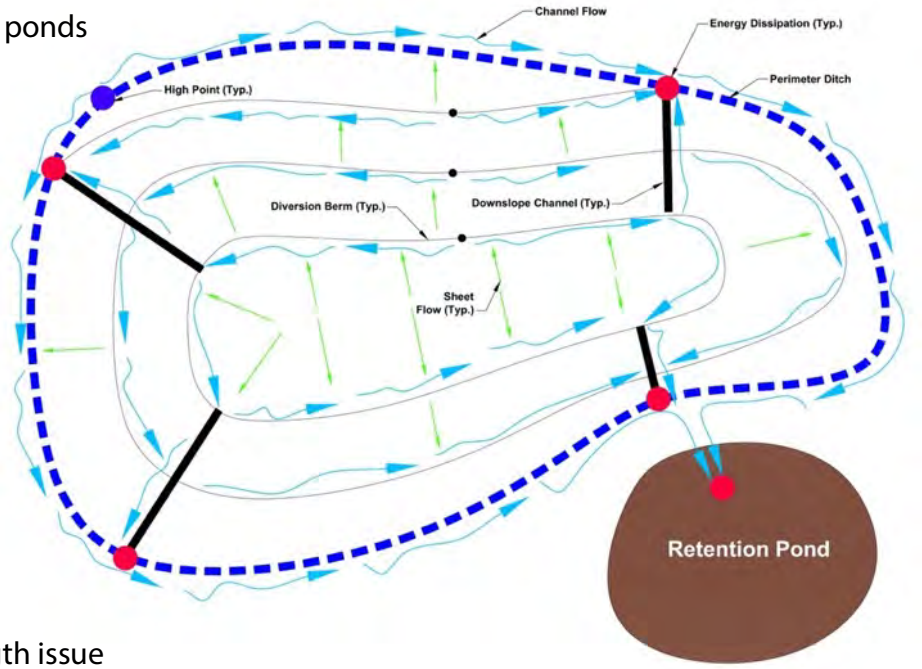


Specified Sand Infill

HydroBinder®
For areas where designer would normally spec riprap, pipe or articulated concrete block

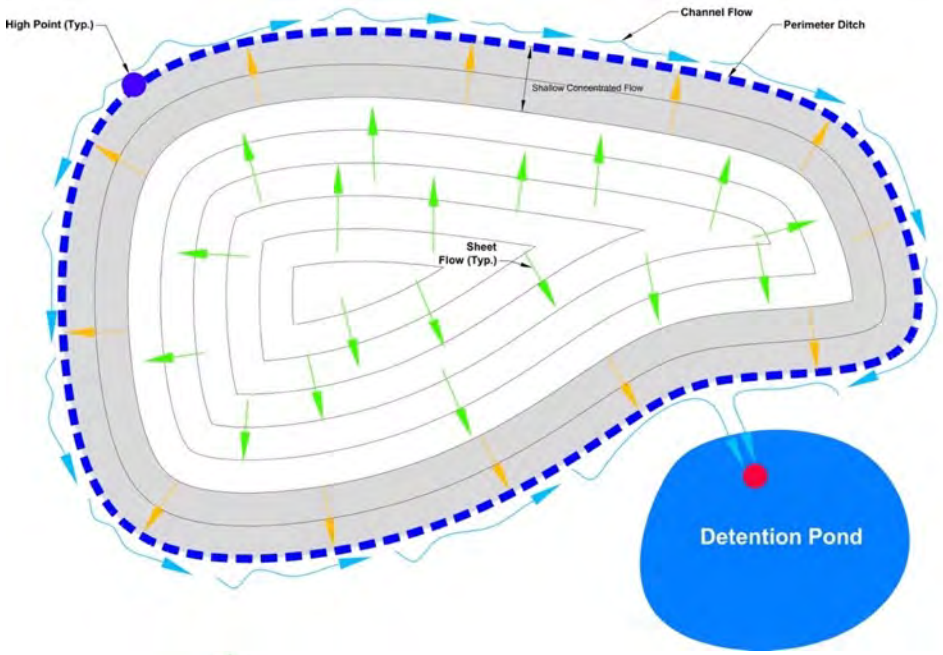
Typical Hydrology Design

- Mitigate the volume & sheer forces with diversion berms
  - Channelize the storm water
  - Help convey runoff of cover system
- Benches go to downchutes
- Downchutes go to retention ponds



Benchless Design

- Eliminates critical slope length issue
- Diversion berms and downslope channels are no longer required
- Stormwater is kept in sheet flow and shallow concentrated flow
- Stormwater Quality Volume is unnecessary
- Sediment Volume calculations are not required



HydroBinder® Features & Benefits

HydroBinder is a specialized pozzolanic infill created specifically for bench drains, downchutes and perimeter channels on landfill covers. It will flex and move with typical differential settlements that occur on permanent covers. It provides superior hydraulic performance capable of handling high sheer stress and large flows resulting in very high velocities.

ClosureTurf® Installation

1. Subgrade Preparation

2. Surficial Gas Management System (if applicable)

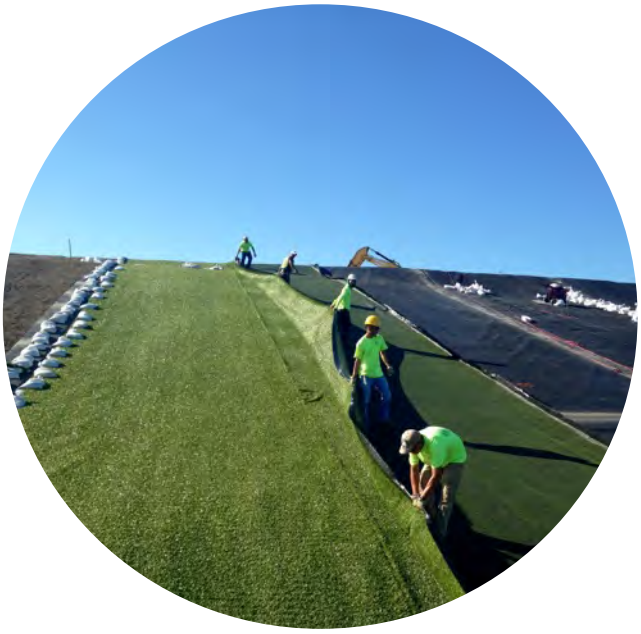
3. Structured Geomembrane

Geomembrane arrives on site in rolls.

Workers manually unroll the membrane down the slope.

Geomembrane seams are heat welded together.

4. Engineered Synthetic Turf



Workers manually unroll the engineered turf down the slope and position for seaming.

Turf seams are sewn together.

Turf seams are heat welded together.

5. Sand Infill

Sand slinger evenly distributes sand on the engineered turf.

Sand is brushed into the turf.

6. Pressure Relief Valves

Before valve is installed.

After valve is installed.

ClosureTurf integrates easily with traditional gas systems.

ClosureTurf® Water Quality

Closed landfills can generate large amounts of surface runoff. With a traditional soil cap, rainstorms will ultimately transport sediment and dissolved materials such as fertilizers and chemical components. They also require a water collection area to allow the sediment to settle out before it can be released off site. This requires more space, more monitoring and is ultimately more expensive.

Because soil loss from runoff is virtually eliminated with ClosureTurf®, water quality is no longer an issue. The sand infill component acts as a natural filter as the water moves down the slope and surface water runoff pond maintenance can be reduced proportional to the area covered. When retention ponds no longer require sediment storage and sediment baffles, overall volume of the pond is significantly increased. Surface water runoff areas that are lined with a cementitious infill will no longer need water quality orifices, sediment removal berms and sediment routing baffles installed in the sediment ponds. In fact, the name "sediment pond" may be changed to "surface water pond" because there is no longer a significant sediment element contributing to the total volume required. Also, the ponds can be considered DE-tention ponds rather than RE-tention ponds because water is only held long enough to mitigate the design-storm event. Another unique feature of ClosureTurf is the ability to rely on sheet flow versus accumulated concentrated flows (such as exists with on-slope berms and down chutes). This results in dramatically increasing time of concentration. And, since there will be no sediment component, pond size can be adjusted accordingly.

One of the most important issues concerning proper site erosion control is the turbidity of the surface water as it is discharged from the site. A third-party analysis was performed that compared turbidity on a closed cell of ClosureTurf versus a cell with a soil cover cap at the same landfill. The study was done at a site having a history of NTU exceedance due to the very fine sediment soils that are common to the region. Data samples collected showed ClosureTurf at 11 NTU's and the soil cap at 371 NTU's (shown in image on right). After years of attempting a wide variety of erosion control methods, the landfill owner was finally able to get well below the minimum Turbidity values required by the regulations.

The hydrology and erosion elimination characteristics of ClosureTurf provide many environmental benefits that contribute to water quality. It results in very low storm water runoff turbidity and provides water quality improvement across the spectrum. Most importantly, it can consistently provide repeatable water quality results for every design storm event.

Watershed Geo Technical Services

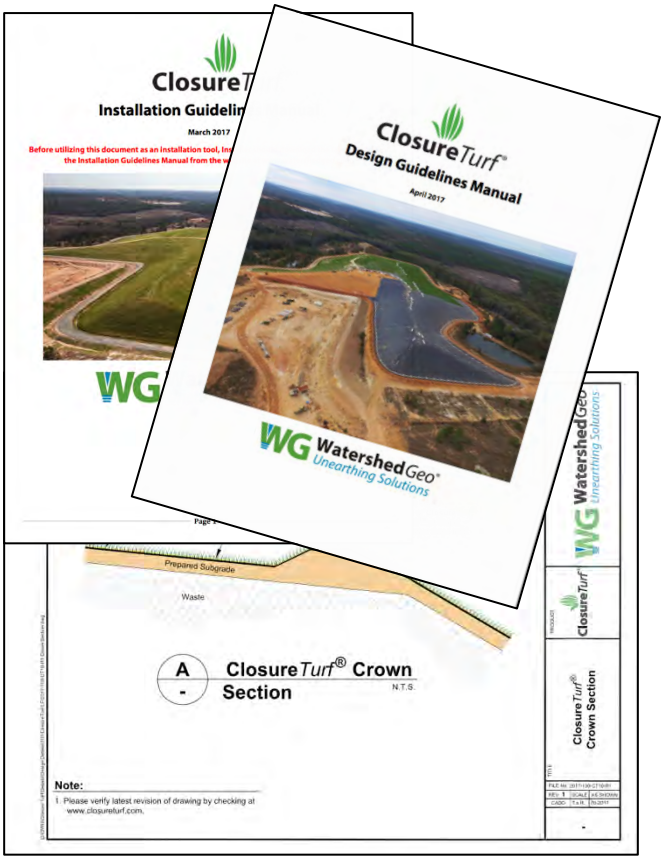
Our expert staff consists of hydrologists, geotechnical and civil engineers. Together, we have spent our entire careers:

- In the landfill business (design, construction, maintenance and management)
- Specifying proper use of geosynthetics
- Managing individual sites through closure and post---closure

Engineering Support

Our staff can provide support throughout the entire closure process, from design and installation to post-closure inspections and maintenance. Some of our day-to-day activities for clients that are performed at no charge include:

- Choosing the correct profile based on hydrology criteria, slope design and other design considerations
- Design guidelines and specifications
- CAD drawings and custom support
- Installation guidelines
- Takeoffs to ensure accuracy in material waste and overlap
- Value engineering/ design considerations to optimize costs
- Surficial gas collection management system support
- Gas system planning for collection valves and vents



Post Closure Support

We also provide a performance agreement option for our clients. ClosureTurf reduces most of the costs and challenges associated with post closure care. However, periodic inspections and maintenance should be performed to ensure the product continues to perform as designed. The performance agreement is an affordable tool developed to help ensure the integrity over the life of the product. It also provides accurate record keeping for those involved with the management of the site. This is especially helpful if site managers switch roles.

ClosureTurf® Cost Savings

Cost savings, both short- and long- term, can be recognized in several ways with ClosureTurf.

Airspace

ClosureTurf allows an additional two feet of airspace because the soil layer is eliminated, if the landfill is permitted by the final cover top elevation. The value of the airspace can be realized in many ways, including additional income with the gained two-feet expansion, lower annual bonding obligations, lower the cost per ton of those bonding requirements and potentially receive a one-time significant credit to their financial bottom line.

Closure Design

With the benchless design approach, the following items can reduce overall costs.

- Reduction/elimination of diversion berms and down slope channels
- Reduction/elimination of energy dissipation devices
- Reduction/elimination of sediment storage and water quality volumes
- Detention of storm water rather than retention allowing for smaller pond volume
- Reduction/elimination of maintenance

Elimination/Reduction of Deep Gas Wells

Deep gas wells extending to within feet of the base liner were designed so that their expected radius of influence to collect gas would overlap. One aspect of a gas design not often discussed was that the "radius of influence" of each gas well was not a 2D object as drawn, but rather a 3D area of influence. The gas that migrated above the well screen and beyond the vertical radius of influence would certainly cause pressure to build on the final cover system. Deep gas wells also introduced many new problems. The change in temperature at ~200 feet deep versus the surface temperature caused large quantities of condensate. Condensate, simply stated, is instant leachate. Since the wells must be designed to allow the free flow of gas, they are prone to watering in both from the percolation of leachate and the creation of leachate as the deep well produces condensate. This is a major reason why deep wells must be replaced from time to time. With the patented surficial gas management system used in conjunction with ClosureTurf, landfill gas is collected without the expense of these deep wells, potentially eliminating or at least greatly reducing the need all together.

Borrow Soil

Borrow pits necessitate the destruction of land. ClosureTurf greatly reduces the destruction of native, undisturbed land that is only being destroyed to provide soil for a landfill cover. Eliminating the need for a borrow pit makes environmental as well as economic sense. Depending upon the proximity of borrow sources, soil can be a costly item to get on site. ClosureTurf eliminate this layer and reduces the need for construction vehicles to transport.

Incremental Closures

ClosureTurf makes it easy to install in small, incremental closures. This closure method reduces both fugitive emissions and the infiltration of leachate which provides significant savings for the owner.

Accelerated Project Schedule

The consistency offered by a standardized system such as ClosureTurf provides efficiencies that can be easily realized, from pre-design through construction. A significantly larger amount of closure acreage can be constructed using ClosureTurf than a traditional soil cover, effectively allowing more projects to be constructed with a given set of fixed resources. Typically, ClosureTurf installs 2 to 3 times faster than traditional covers.

Post Closure Care

The annual maintenance costs for ClosureTurf runs, on average, as much as 90% lower than those for a traditional soil and vegetated cover system. The following is an example of a maintenance activity comparison.

Traditional Cap	ClosureTurf
Mowing (4 events per year)	Not Required
Erosion Control (2 events per year)	Not Required
Reseeding (1/3 area once per year)	Not Required
Fertilizing (1/3 area once per year)	Not Required
Soil Replacement (typical 1 ton/per acre per year avg – per EPA)	Sand infill replacement (<2% total area per 5 years)
Pond Cleanout (avg once per every 4 years)	Not Required
Major Storm Repair (4 hours equipment after 1 event/year)	Not Required
Site Inspection (1 inspection per quarter)	Site inspection (Every 5 to 10 years)
Financial assurance (-2% per year)	Financial assurance (-2% per year)

- Over a 30-year period, the average cost to maintain a prescriptive soil cover is estimated to be $1,200 - $1,500 acre/year. ClosureTurf averages around $250 acre/year.
- Several ClosureTurf sites have experienced hurricane-force winds and multiple 100- year storms. The most severe storm event occurred at a 25-acre closure in Pensacola Florida, with the storm occurrence exceeding 500-years (25+ inches of rain over 24 hours). The required maintenance to bring the installation back to specification was performed solely with 1 infill spreader and a 3- man crew over 2.5 days.
- The projected long-term performance is well in excess of 100 years for the turf and 400 years for the geomembrane. As part of a redundant protection approach, the engineered turf backing is designed to resist UV from potential exposure. Any infill that may be dislodged due to unanticipated concentrated flows or settlement does not require immediate or even annual infill addition (suggest a 5–year evaluation of infill condition).
- Sites experience less erosion (5 to 10 tons per acre per year for soil versus a negligible amount for ClosureTurf).
- ClosureTurf provides predictability of final cover performance and post-closure maintenance costs that is not dependant on site-specific or weather-related factors. Furthermore, this predictable performance is economically competitive with typical methods.

Landfill Gas Collection

The ClosureTurf Surficial Gas Collection System is designed to allow LFG to rise to the waste surface. The collection points across the surface which are integrated into the geomembrane component can relieve the gas actively or passively based on specific site needs and desires. This collection mechanism provides for an increased quantity of gas collected as well as an increase in quality of gas collected all because gas collection can be performed at the surface of a landfill. Surface collection also reduces potential oxygen intrusion through wells and supports a safer gas management system with much lower exposure to oxygen migration into the landfill.

Reduction of Leakage

The HELP Model and JP Giroud Model analyses prove ClosureTurf has significantly less leakage than traditional soil covers.