An Innovative Design for Coal Ash Impoundment Capping and Closures with Significant Cost, Performance, and Environmental Co-Benefits Soilless Solar Caps
Subtitle D - Subpart F - Section 258.60(b)  
Alternative Final Cover Design and State Regulatory Equivalency Approval

The Director of an approved State may approve alternative final cover systems that can achieve equivalent performance at the minimum design specified in Section 258.60(a). This provides an opportunity to incorporate different technologies or improvements into cover designs, and to address site specific conditions.

The Director of an approved State may approve an alternative final cover that includes:

- An infiltration layer that achieves an equivalent reduction in infiltration as the permitted infiltration layer.
- An erosion layer that provides equivalent protection from wind and water erosion as the permit erosion layer.
Exposed Geomembrane Caps

Exposed Geomembrane Caps vs. Traditional Grass-topped Landfill Cover
Tessman Road Landfill
Solar Energy Cover
In 2010 Tessman Road Landfill Solar Energy Cover was the winner of the
- SWANA Gold Excellence Award for Landfill Secondary Use
- ACEC National Engineering Excellence Award
Hickory Ridge Landfill
Solar Energy Cover

- Permitted as Final Closure in 2009
- 10 acre Phase I and 38 acre Phase II Landfills (48 acres)
- 7,000+ Solar Panels to Produce over 1 MW of Renewable Energy over a 10-acre South Facing Slope
- Designed for Local Conditions
- Conform to Permitted Closure Grades
- Construction Completion July 2011
In 2012 Hickory Ridge Landfill Solar Energy Cover was the winner of the
• Georgia Engineering Excellence Awards Grand Conceptor
• ACEC National Honor Engineering Excellence Award
• American Association of Environmental Engineers National Honor Award for Environmental Sustainability
Hickory Ridge Solar Energy Cover
Solar Energy Covers

Design Benefits:

- Promotes Positive Drainage
- Minimizes Infiltration
- No Soil Loss
- Reduce Maintenance
- High Quality Stormwater Runoff
- Accommodates Different Slopes and Surfaces
Solar Energy Covers

Performance Benefits:

- Access to Inspect Liner
- Confirmation of Liner Integrity
- Address Liner Repairs
- Laminate Solar Panels Don’t Require Bracing
- Stable Surface for Solar Panels
Solar Energy Cover Design

Major design considerations:

- Wind uplift
- Stormwater control
- Resistance to impact and puncture
- Anchoring system (anchor trenches and benches)
- Passive or active gas collection system
- Environmental exposure
- Access-vehicles/monitoring
- Safety
- Aesthetics
Soilless Caps Comparison

Traditional Final Cover System

- 6" Topsoil Layer with Vegetation
- 18" to 24" Protective Soil Layer
- Geocomposite Drainage Layer
- Geomembrane
- 6" Subgrade Foundation Soil Layer
- 6" to 12" Intermediate Cover Soil Layer

Exposed Geomembrane Final Cover System

- Exposed Geomembrane
- Solar Laminates (Optional)
- 6" Subgrade Foundation Soil Layer
- 6" to 12" Intermediate Cover Layer

Synthetic Turf & Geomembrane System

- Geotextiles
- Geomembrane with Studs/Spike
- Synthetic Turf
- 5" to 1" Sand Ballast
- 6" Subgrade Foundation Soil Layer
- 6" to 12" Intermediate Cover Layer

Synthetic Turf & Geomembrane System

- Synthetic Turf
- 6" Subgrade Foundation Layer
A Subtitle D landfill final cover system uses a geosynthetic and usually a geocomposite with a **vegetated soil ballast system**. This construction cost is mostly dependent on local soil availability and long-term care costs depend on **vegetation and erosion maintenance**.

25-Acre Landfill Estimated Costs:
- **Construction:** $4M (soil = $18/CY)
- **30-Year LTC Cost:** $320,000
An exposed geomembrane cover uses a single geomembrane cover and a series of anchor trenches or anchor pins to counter wind uplift conditions. It can be designed for specific wind requirements, to easily accommodate secondary use as a solar energy generation facility, and is an advantageous alternative in areas of low soil availability and varying (steep & flat) slopes.

25-Acre Landfill Estimated Costs:
- Construction: $1.9M
- 30-Year LTC: $150,000
A **synthetic turf/geomembrane cover** uses a geomembrane barrier layer overlaid with a synthetic grass layer for improved aesthetics and protection. One patented system uses sand ballast to hold the synthetic turf in place, whereas another bonds the protective layers directly to the geomembrane barrier layer. Both systems are advantages in areas of low soil availability and varying (steep & flat) slopes.

### 25-Acre Landfill Estimated Costs:
- **Construction:** $2.3M
- **30-Year LTC:** $165,000
ClosureTurf™
LiteEarth™

EPDM BACKING

BONDING ADHESIVE

SPlicING TAPE

LITEEARTH TURF

ONE COMPANY | Many Solutions®
Stormwater Impacts

Stormwater from EGC

Stormwater from soil cap
# Landscaping Impacts

## Greenhouse Gas Accounting

- **Mowing:** 650 lbs CO2e/acre/yr
- **Fertilizer:** 1,260 lbs CO2e/acre/yr
- **Pesticides:** 44 lbs CO2e/acre/yr
- **Irrigation:** 1,480 lbs CO2e/acre/yr

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*Landscape impacts and environmental considerations are crucial in maintaining and managing green spaces.*
Exposed Geomembrane Caps vs. Traditional Grass-topped Landfill Cover – Storm Performance

Polk County, Florida
16.5 acres, 2001
Photovoltaic Laminates

- **Flexible Photovoltaic Laminates**
  - Designed originally for rooftop application
  - Flexible, lightweight, durable
  - Works well in shadow and low light
  - High heat tolerant
  - Power ratings of 68W to 144W
  - Can be welded or glued
  - 20-year guarantee
HDPE in Exposed Geomembrane Solar Covers

Aucilla Regional Landfill, Florida
March 2011
Thin Film PV Systems

- 215,000 watts per acre

Shipping Container example

Photo provided by Xunlight
Crystalline PV Systems

- 610,000 watts per acre

Typical 210+ Watt Crystalline Panel

Solarmax STRS™ System

What is STRS?

Our system is unique due to our proprietary system that allows for the attachment of plastic frames that are welded directly to a thermoplastic geomembrane.

The STRS frame is installed in a controlled environment to ensure the highest quality standard.

Applications
- Exposed Landfill Covers
- Mine Tailings
- Floating Covers for Ponds
- Commercial Rooftops
- Ash Pile Covers
- Un-engineered Slopes

Benefits
- Erosion Control
- Rain Water Collection/Shedding
- Evaporation Control
- Vegetation Control
- Non-Corrosive
- Use of land once considered unusable
- Universal topographic installation
- Low Profile
Solar Electricity Block Diagram
Flexible Solar Panel and Wiring
Electrical Combiner Boxes at Toe of Slope
CCR Disposal Facilities

A Beneficial Alternative to Soil Caps

- Simple cap design that promotes positive drainage on varied slopes (Can Accommodate Steep and Relatively Flat Slopes)
- Improves exterior slope stability
- No ongoing soil loss or windblown ash
- Reduced maintenance
- Promote positive image of sustainability and beneficial reuse of a closed facility
CCR Disposal

Surface Impoundment Closures
CCR Disposal Facilities

Surface Impoundment Closures
CCR Disposal Facilities

Surface Impoundment Closures
Coal Combustion Residuals (CCR)
Coal Ash Disposal Facilities

A Beneficial Alternative to Soil Caps
Solar Energy Closure Cap for CCP Monofills and Impoundments

- Meet USEPA Subtitle D Equivalency Requirements
- Low Maintenance
- Excellent Stormwater Runoff Quality
- Prevent and Confirm Storm Water infiltration
- Can Accommodate Steep and Relatively Flat Slopes
- Cost Benefits
- Ideal Secondary Use of the Facility
- Positive Public Perception