LANDFILL CLOSURE

Solid Waste Training Institute (SWTI)

Landfill Closure

"Traditional" covers are described by regulation as meeting minimum standards by including design features.

Alternative covers employ different principles or materials than in the conventional design, and are generally required to have equivalent performance as the conventional cover.

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258.60 Closure criteria

(a) Owners or operators of all municipal solid waste landfill (MSWLF) units must install a final cover system that is designed to minimize infiltration and erosion. The final cover system must be designed and constructed to:

(1) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1×10^{-5} cm/sec, whichever is less, and

(2) Minimize infiltration through the closed MSWLF by the use of an infiltration layer that contains a minimum 18-inches of earthen material, and

(3) Minimize erosion of the final cover by the use of an erosion layer that contains a minimum 6-inches of earthen material that is capable of sustaining native plant growth.

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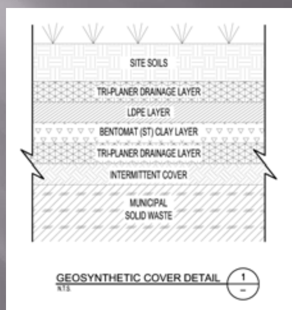

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Landfill Closure

258.60 Closure criteria

(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.

(3) The Director of an approved State may establish alternative requirements for the infiltration barrier in a paragraph (b)(1) of this section, after public review and comment, for any owners or operators of MSWLFs that dispose of 20 tons of municipal solid waste per day or less, based on an annual average. Any alternative requirements established under this paragraph must:

(i) Consider the unique characteristics of small communities;

(ii) Take into account climatic and hydrogeologic conditions; and

(iii) Be protective of human health and the environment.

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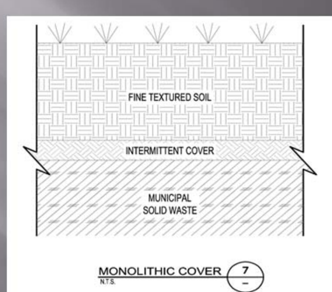

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Landfill Closure

Landfill Cover

"Have a permeability less than or equal to the permeability of any bottom liner…"

"Minimize infiltration through the closed MSWLF…"

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The regulations are ambiguous regarding performance requirements.

For conventional covers, performance expectations are avoided by specifying a minimum thickness and saturated hydraulic conductivity.

This approach is acceptable for conventional covers, which can be constructed to meet regulations without defining their performance.

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This regulation creates a dilemma for alternative cover designs that must be equivalent to the conventional cover.

Alternative covers rely on multiple mechanisms to control water that cannot be described by a single material parameter.

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The primary hydrologic function of the cover is to "minimize" percolation of water into the waste.

RCRA does not define "minimize" or clarify that a final cover must restrict percolation to a standard.

In the EPA clarification it states "always interpreted the language in this section to be a performance standard"

The performance standard refers to the "saturated hydraulic conductivity" of the cover materials.

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The EPA's Alternative Cover Assessment Program (ACAP) developed field-scale evaluations of both conventional and alternative cover designs.

These tests show that the performance of any cover depends on multiple factors, with climate being the most important factor.

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Landfill Closure

One size does not fit all.

Engineering and design must be site specific.

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Choosing Cover Design

Often a "traditional" cover is less expensive to build than an alternative cover.

- Local resources
- Regulatory
  A "traditional" cover requires less "regulatory flexibility".

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Choosing Cover Design

- Design
  Standardized design
  A "traditional" cover design is less involved and often requires only "off the shelf" materials.
- Public Relations
  A "traditional" cover has a lower risk for regulatory and public opinion backlash.

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Choosing Cover Design

Failure of an alternative cover frequently results in loss of public trust , regulatory support, and requires extensive outlay of resources.

Failure of a traditional cover generally will less extensive and easier to identify.

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Choosing Cover Design
Designing a Water Balance Cover requires a comprehensive knowledge of
Hydrogeology
Meteorology
Geotechnical Engineering
Computer Modeling
Construction Management
Regulatory Compliance.
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Choosing Cover Design
With the proper design team and site, alternative cover designs are a viable option.
Constructed with on-site materials
Local Labor
Cost Effective
Long Term Maintenance
Ease of Expansion
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Choosing Cover Design
With the proper installation, alternative cover designs
As effective or more effective than Traditional Covers
Easier to repair
Native Viewshed
Wider varieties of End Use
Long-term natural alternative
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Issues for the Site Owner
Cost
Short-Term
Long-Term
Expertise
Site Knowledge
Design Expertise
Permitting
Regulatory Relations
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Issues for the Design Team

Feasibility study
- Local Resources
- Political Desire
- Cost Comparisons

Site characterization
- Climate
- Soils
- Vegetation
- Construction Season

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Issues for the Regulator

Change in Design Philosophy

Review Site Characterization

Performance expectation and evaluation

Monitoring and long-term issues

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Alternative Cover

Water Balance Modeling

1. Develop conceptual model
2. Select software
3. Collect and organize data
4. Implement software (input and run)
5. Evaluate and report on output

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Model Input

Soil Water Storage

Water is retained in the soil due to capillary forces that create suction. Above the free water surface, capillary forces hold the column of water within the capillary tube under suction. Adsorptive forces between the water molecules and the solid surface also contribute to retaining water.

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Model Input

Soil Water Characteristic Curve

Field capacity and wilting point are benchmark water contents that are part of the continuous relationship between water content and suction called the "Soil Water Characteristic Curve" (SWCC). The SWCC describes water content for any soil as a function of suction.

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Model Input

Climate and Meteorology

- Precipitation: Annual average and extreme, seasonal time series of average, snowfall, snow depth.
- Temperature: Annual average and extreme, seasonal time series of average, heating degree days, cooling degree days, growing degree days.
- Severe weather: Extended periods of drought, extended wet periods.
- Shifts and trends: Long-term trends or shifts in precipitation and temperature.
- Other parameters: Solar radiation, humidity, and wind speed.

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Model Input

Soil Physical and Chemical Properties

- Texture or particle size content
- Compaction
- Porosity
- pH
- Electrical Conductivity
- Cation Exchange Capacity
- Sodium Adsorption Ratio
- Soil fertility: nutrients and phytotoxic elements

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Model Input

Soil Biology and Microbiology

- Organic matter content: amount
- Carbon/nitrogen ratio
- Seed bank, rhizomes
- Soil fauna
- Microbiology

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Model Input

Plant Community Characteristics

- Species Richness: List of established plants accounting for seasonal variation, species in seed bank, ecotypes
- Leaf Area Index
- Root Depth
- Plant Materials: Ease of establishment, commercial availability seed, transplants and native ecotypes

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Reality Check

One of the most important factors to remember when using a computer model to predict the water balance is that a prediction is not reality.

Whenever a prediction is made, the modeler should conduct a “reality check” to make sure the prediction is reasonable.

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Reality Check

Models are sensitive to the input parameters.

Models are not reality and often simplify or ignore natural processes that occur in real covers

Make sure the output is sensible. Is runoff < 10-15% of annual water balance? Does percolation occur when storage capacity is exceeded?

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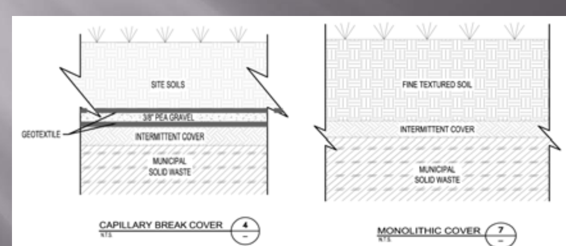
Design Cover



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Cover Construction

Each region has specific construction seasons and weather conditions. Care must be taken to ensure sufficient time

- Review
- QA/QC Inspection
- Testing
- Safety Coordination
- Construction
- Permit Compliance
- Performance Testing

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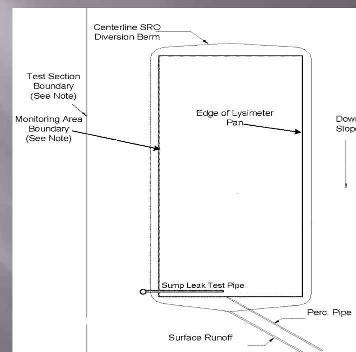
Cover Evaluation



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Landfill Closure

Decisions for the Owner

Selection of the Design Team
Selection of the Cover
Work with the Regulator
Design Cover
Construct Cover

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