NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND SEALING OR LINING - FLEXIBLE MEMBRANE

(No.)
Code 521A

DEFINITION

A manufactured hydraulic barrier consisting of a functionally continuous layer of synthetic or partially synthetic, flexible material.

PURPOSE

To restrict, impede, and control seepage of water and contaminants from water and waste impoundments structures for water conservation and environmental protection.

CONDITION WHERE PRACTICE APPLIES

On ponds and water storage structures that require treatment to control seepage rates within acceptable limits.

On earthen waste storage ponds or lagoons and other waste impoundment structures that require treatment to control seepage of contaminants from the storage structure.

CRITERIA

Comply with all Federal, state, and local laws, rules, and regulations. Evaluate and avoid or minimize impact to cultural resources, wetlands and Federal and state protected species to the extent practicable during planning, design and implementation of this conservation practice in accordance with established National and Florida policy, General Manual (GM) Title 420-Part 401; Title 450-Part 401, Title 190-Parts 410.22 and 410.26, National Planning Procedures Handbook (NPPH) Florida Supplements to Parts 600.1 and 600.6, National Cultural Resources Procedures Handbook (NCRPH), National Food Security Act Manual (NFSAM), and the National Environmental Compliance Handbook (NECH).

Design. Construct all structures to be lined to meet all applicable NRCS standards. Install all inlets, outlets, ramps, and other appurtenances before, during, or after the liner placement and in a manner that does not damage or impair the proper operation of the liner.

Design and install the flexible membrane in accordance with manufacturer's recommendations. All flexible membrane installations shall be certified by the installer or manufacturer as meeting the material and installation requirements of the plans and specifications.

Follow manufacturer's recommendations with regard to protection from weather and exposure

Liner Materials. Flexible membrane liner materials shall meet the requirements of the specifications indicated in the following tables.

Table 1 - Minimum Bentonite Content for Geosynthetic Clay Liners

Type	Minimum Bentonite Content	
	Wastewater	Clear Water
GCL	0.75 lb/sq. ft.	

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Table 2 - Minimum Geomembrane Thickness Criteria

Type	Minimum Thickness	
	Wastewater	Clear Water
HDPE	40 mil	30 mil
LLDPE	40 mil	30 mil
LLDPE-R	36 mil	24 mil
PVC	40 mil	30 mil
EPDM	45 mil	
FPP	40 mil	30 mil
FPP-R	36 mil	24 mil
PE-R	NR	24 mil

Table 3 - Reference Specifications for Geomembranes

Type	Applicable Specification
HDPE	NRCS Material Specification. 594, Geomembrane Liner
LLDPE	
LLDPE-R	
PVC	
EPDM	
FPP	
FPP-R	
PE-R	

Table 4 - Reference Specifications for Geosynthetic Clay Liners

Type	Applicable Specification
GCL	NRCS Material Specification 595, Geosynthetic Clay Liner

1 mil = 1/1000 of an inch
HDPE – High Density Polyethylene Geomembrane
LLDPE – Linear Low Density Polyethylene Geomembrane
LLDPE-R – Reinforced Linear Low Density Polyethylene Geomembrane,
PVC – Polyvinyl Chloride Geomembrane
EPDM – Ethylene Propylene Diene Terpolymer Geomembrane
FPP – Flexible Polypropylene Geomembrane
FPP-R – Reinforced Flexible Polypropylene Geomembrane
PE-R – Reinforced, Slit –Film, Woven Polyethylene Geomembrane
NR – Not Recommended
GCL – Geosynthetic Clay Liner
NRCS – Natural Resources Conservation Service

Soils and foundation. Include a detailed soils investigation with special attention to the water table depth and seepage potential in each design. Evaluate soils to a depth no less than two feet below the final grade of any excavation during the soil investigations. In high-risk areas, follow the procedures outlined in the Agricultural Waste Management Field Handbook (AWMFH). Information and guidance on controlling seepage from waste storage ponds can be found in the AWMFH, Chapter 7.

Subgrade Preparation. Prepare subgrade to manufacturer's recommendations and applicable state regulations. Use subgrade materials that do not contain sharp, angular stones or any objects that could damage the liner or adversely impact its function unless a cushion layer is used.

Cushion. Place a cushion layer beneath the liner if the subgrade particles contain sharp angular stones that could damage the liner or particles greater than 3/8-inch for geomembrane liners and ½-inch for GCL's.

The cushion may be a 10-oz/sq yd or heavier non-woven geotextile or a layer at least 6 inches thick of soil meeting the particle size and shape requirements of the subgrade. Geotextile cushion material shall meet the requirements of GRI Test Method GT12(a). Follow the manufacturer's recommendations for any additional protective measures.

Cover Soil. Cover PVC and GCL liners with a minimum of 12 inches of soil measured perpendicular to the finished surface. Cover soil may be used on other liners but is not required

Cover soil shall be used as cover for liners when required for the proper performance, protection, and durability of the installation. Cover soils shall not contain sharp, angular stones or any objects that could damage the liner. Cover soil material shall have a maximum allowable particle size of 3/8-inch for geomembrane liners and ½-inch for geosynthetic clay liners, unless the liner is protected by a 10-oz/sq yd or heavier non-woven geotextile cushion material. Cover materials shall be stable against slippage down the slope under all operational and exposure conditions, such as rapid drawdown or saturation by precipitation.

Cover soil shall be placed within 24 hours after placement of the liner to minimize the potential for damage from various sources, including precipitation, wind, and ultra-violet exposure.

GCL liners shall have a uniform confinement pressure as recommended by the manufacturer, which shall not be compromised by the pres-

ence of a drainage layer or venting system under the liner.

Anchorage. Anchor liners to prevent uplift due to wind or slippage down the side slope.

Safety. Include appropriate safety features in the design to minimize the hazards of the structure. Provide warning signs, fences, ladders, ropes, bars, rails, and other devices, as appropriate, to ensure the safety of humans, livestock, domestic animals, and wildlife.

Provide a means of emergency egress for all facilities with exposed flexible membranes. For those facilities with intended access points, provide emergency egress at each access point.

Underliner Drainage and Venting. Subsurface conditions such as soil type and groundwater levels will dictate the direction and scope of the design of the drainage and venting system beneath the geomembrane liner. An inadequate drainage and venting system may result in floating of the geomembrane liner. Hydrostatic pressures from fluctuating groundwater levels or leakage through the liner may cause the liner to float. Gas production and buildup beneath the liner due to the presence of organic material in the soil or leachate leakage through the liner may cause "whales" or bubbling of the liner.

Groundwater and Leakage Drainage. If the groundwater level may be near the invert elevation of the pond, groundwater monitoring should be conducted during the site investigation to verify the expected water table location. In some situations, it may be necessary to install groundwater monitoring wells for a year or more to determine the ground water levels and gather enough information to properly determine the required flow capacity of the drainage system. If high water tables could adversely affect the proper functioning of the structure, interceptor or relief-type drainage systems should be included to control uplift pressures. Leakage through the liner due to liner damage should also be considered. Giroud and Bonaparte (1989) recommend designing the drainage system based on a frequency of one hole (0.16 in^2) per acre of surface area.

Construct seams according to manufacturer's recommendations and test to assure water tightness. Place the bottom of the liner a minimum of one foot above seasonal high water table when used in a manure storage or treatment facility.

Gas Venting. The need for venting for wastewater pond liners shall be investigated as part of the design. Site conditions which may be conducive to gas production include sites which have been subject to long-term seepage of animal waste into the foundation soil, sites with naturally occurring organics in the soil, or fine grained foundation soils where fluctuating groundwater levels may trap gases present in the soil. Venting of wastewater pond liners may not be required if other site conditions exist to allow dissipation of gas pressure from beneath the liner. One such condition is the presence of clean granular foundation soils (SW, SP, GW or GP).

If venting is required, follow manufacturer's recommendations regarding vent type and spacing. A minimum vent spacing of 50 feet is recommended.

Drainage and Venting System Design. The use of a geosynthetic such as a geonet or geocomposite under the liner to facilitate collection, drainage of liquids and venting of gas should be considered. If drainage and/or venting is needed, the geocomposite manufacturer's recommendations shall be followed in the system design. The allowable flow rate of the geocomposite shall be determined in accordance with GRI Standard GC8. The pond bottom should be sloped, typically a minimum of 1 percent, to permit positive flow of the liquids or gases. In most cases, the geocomposite will serve both purposes of drainage and venting. In large impoundments, the bottom may need to be sloped in multiple directions in order to decrease the required drainage and venting flow travel distances.

Construct seams according to manufacturer's recommendations and test to assure water tightness. Place the bottom of the liner a minimum of one foot above seasonal high water table when used in a manure storage or treatment facility.

CONSIDERATIONS

Consider venting of wastewater pond liners not covered with soil unless other site conditions exist to allow dissipation of gas pressure from beneath the liner. One such condition is the

presence of granular foundation soils (SW, GW or GP). A minimum vent spacing of 50 feet is recommended.

If high water tables could adversely affect the proper functioning of the facility, consider interceptor or relief type drainage systems to control uplift pressures.

The number of penetrations through the liner should be minimized. Trenching and backfilling of fill pipes should be detailed such that charging of the underside of the liner with subsurface water is prevented.

For GCL liners, wastewater and subgrade and cover soils should be analyzed to ensure that undesirable cation exchange (calcium and/or magnesium for sodium) will not occur in the GCL.

A leak detection system is recommended beneath all liners, especially geomembranes.

Consider including provision for the liner protection from damage during cleaning operations in designs.

If agitation operations may result in abrasion or other mechanical damage to the liner, then protective measures should be provided as needed to ensure the integrity of the liner, such as increasing the liner thickness above the minimum values indicated above or providing protective ramps and aprons at agitation locations.

Consider covering all liners with soil to prevent damage from domestic animals and wildlife and to provide a means of escape for animals.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for specific field sites in accordance with this standard and describe the requirements for applying the practice to achieve its intended uses.

As a minimum include the following items in the plans and specifications:

- Plan view of system layout, including containment structure, collection points, waste transfer locations or pipeline, and topography of the site.
- Required liner properties, type and thickness of liner, cushion materials, and pipeline materials.
- Subgrade details including tolerances on smoothness of the finished grade.
- Method of installation, including seaming requirements, and requirements for attachment of appurtenances.
- Method and details to protect liner, including soil cover, etc.;
- Structural details.
- Drain and vent location and details.
- Minimum qualifications of installers.
- Warranty requirements, if desired.
- Quality control testing requirements.
- Fence and signage requirements, if required.
- Quantity of materials.
- Location of utilities and notification requirements.

OPERATION AND MAINTENANCE

A plan for operation and maintenance (O&M) of the liner and structure shall be prepared. The O&M Plan shall to be consistent with purpose and type of liner chosen, intended life, safety requirements, and design criteria. The O&M plan shall contain requirements including, but not limited to, the following items:

1. Design capacity and liquid level of the structure.
2. A description of the normal operation, safety concerns and maintenance requirements including but not limited to:
    - Exclusion of animals and equipment from the liner.
    - Protection of the liner during initial filling.
    - Agitation.
    - Pumping procedures.
3. Monitoring procedures for leak detection systems, including alarm level leakage rates and actions to be taken if these rates are exceeded.
4. Repair procedures.
5. Periodic inspection of the following:

- Visible portions of the liner for tears punctures, or other damage;
- Liner interface with inlets, outlets, ramps, or other appurtenances for damage;
- Liquid level in the structure;
- Ballooning of the liner indicating presence of gas beneath the liner.

REFERENCES

General Manual
Title 420-Part 401
Title 450-Part 401
Title 190-Parts 410.22 and 410.26
Florida NRCS Conservation Practice Standards
Irrigation Reservoir, Code 436
Pond, Code 378
National Cultural Resources Procedures Handbook
National Environmental Compliance Handbook
National Food Security Act Manual
National Planning Procedures Handbook
Florida Supplements to Parts 600.1 and 600.6
NRCS Material Specification 594,Geomembrane Liner
NRCS Material Specification 595, Geosynthectic Clay Liner
ASTM D 5887-09, Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
ASTM D 5890-06, Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners

ASTM D 5891-02(2009), Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners

ASTM D 5993-99(2009), Test Method for Measuring of Mass Per Unit of Geosynthetic Clay Liners.

ASTM D 6102-06, Guide for Installation of Geosynthetic Clay Liners.

ASTM D 6214-98(2008), Test Method for Determining the Integrity of Field Seams Used in Joining Geomembranes by Chemical Fusion Methods.

ASTM D 6392-08, Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

ASTM D 6497-02(2010), Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.

ASTM D 7176-06, Specification for Non-Reinforced Polyvinyl Chloride (PVC) Geomembranes Used in Buried Applications.

ASTM D 7272-06, Test Method for Determining the Integrity of Seams Used in Joining Geomembranes by Pre-manufactured Taped Methods.

ASTM D 7408-08, Specification for Non Reinforced PVC (Polyvinyl Chloride) Geomembrane Seams.

ASTM D 7465-08, Specification for Ethylene Propylene Diene Terpolymer (EPDM) Sheet Used in Geomembrane Applications.

Koerner, R.M. 2005. Designing with Geosynthetics, 5th ed. Pearson Prentice Hall, Upper Saddle River, NJ.

Geosynthetic Research Institute, GRI Standard GC8, Standard Specification for Determination of the Allowable Flow Rate of a Drainage Geocomposite.

Geosynthetic Research Institute, GRI Test Method GT12(a) – ASTM Version, Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials.

Geosynthetic Research Institute, GRI Test Method GM13, Standard Specification for Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

Geosynthetic Research Institute, GRI Test Method GM17, Standard Specification for Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.

Geosynthetic Research Institute, GRI Standard GM18, Standard Specification for Test Methods, Test Properties and Testing Frequencies for Flexible Polypropylene Nonreinforced (fPP) and Reinforced (fPP-R) Geomembranes.

Geosynthetic Research Institute, GRI Test Method GM19, Standard Specification for Seam

Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

Geosynthetic Research Institute, GRI Test Method GM21, Standard Specification for Test Methods, Properties, and Frequencies for Ethylene Propylene Diene Terpolymer (EPDM) Nonreinforced and Scrim Reinforced Geomembranes.

Geosynthetic Research Institute, GRI Test Method GM25, Standard Specification for Test Methods, Test Properties and Testing Frequency for Reinforced Linear Low Density Polyethylene (LLDPE-R) Geomembranes.

Giroud, J.P., and R. Bonaparte. 1989. Leakage through liners constructed with geomembranes—Part 1. Geomembrane Liners. In Geotextiles and Geomembranes, vol. 8, pgs. 27–67.

Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182, September 1993.

USDA-Natural Resources Conservation Service, National Engineering Handbook, Part 642, Specifications for Construction Contracts.