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 sheet of synthetic or partially synthetic, flexible material.

PURPOSE

To control seepage from water and waste impoundments 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 waste storage and waste treatment facilities built in or excavated earth, and which require treatment to prevent the migration of contaminants from the site.

CRITERIA

Structures to be lined shall have been constructed to meet all applicable NRCS standards. All inlets, outlets, ramps, and other appurtenances may be installed before, during, or after the liner placement, but shall be done in a manner that does not damage or impair the proper operation of the liner.

All flexible membranes shall be certified by the manufacturer to be suitable for the intended use.

Design of the flexible membrane shall be in accordance with manufacturer recommendations. All flexible membrane installations shall meet the material and installation requirements of the plans and specifications provided for each installation, and shall be certified by the installer.

Minimum Criteria for Membranes

Type	Limiting Parameter
HDPE	40 mil thickness
LLDPE	40 mil thickness
PVC	30 mil thickness
GCL	0.75 lb./sq ft (bentonite)
EPDM	45 mil thickness

HDPE = High Density Polyethylene
LLDPE = Linear Low Density Polyethylene
PVC = Polyvinyl Chloride
GCL = Geosynthetic Clay Liner
EPDM = Synthetic Rubber

Select soil materials shall be used as cover for liners where 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. Maximum allowable particle size of soil cover material shall be 3/8-in (10 mm), unless the liner is cushioned by a needle punched, non-woven geotextile. Cover

material shall be stable under all operational and exposure conditions.

Subgrade preparation shall conform to manufacturer recommendations. Subgrade materials shall not contain sharp, angular stones or any objects that could damage the liner or adversely impact its function.

All structures shall be fenced to protect the liner from damage and for the safety of humans, livestock, wildlife, and pets.

Manufacturer recommendations shall be followed with regard to protection from weather and exposure.

If venting is used, manufacturer recommendations shall be followed regarding vent type and spacing.

CONSIDERATIONS

Venting should be considered if gas build up under the liner is anticipated.

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

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for specific field sites in accordance with this standard and shall describe the requirements for applying the practice to achieve its intended uses.

OPERATION AND MAINTENANCE

A plan for operation and maintenance of the liner shall be prepared.

Natural Resources Conservation Service
Construction Specifications

POND SEALING OR LINING, FLEXIBLE MEMBRANE

1. SCOPE

Work shall consist of the furnishing and installing all flexible membrane, filter, and cover material in accordance with the lines and grades shown on the plans. Location of the flexible membrane shall be as shown on the drawings or as staked in the field.

2. INSTALLATION

a. Subgrade preparation. The area to be lined shall be drained and allowed to dry until the surface is firm and can support the personnel and equipment that must travel over it during installation of the lining.

All banks and fills in the area to be lined must be sloped no steeper than 1 horizontal to 1 vertical for exposed linings and 2 1/2 to 1 for buried linings.

The foundation area for flexible membrane linings shall be smooth and free of projections that can damage the lining. Stumps and roots shall be removed. Rocks, hard clods, and other such material shall be removed, rolled so as to provide a smooth surface, or covered with a cushion of fine soil.

If needed, an effective sterilant shall be applied to the subgrade at the rate recommended by the manufacturer.

An anchor trench shall be excavated completely around the area to be lined at the planned elevation of the top of the lining. The trench shall be 8 to 10 inches (200 to 250 mm) deep and about 12 inches (300 mm) wide.

All lining material shall be free of damage or defect. Each package delivered to the job site shall bear the name of the material, the manufacturer's name or symbol, the quantity therein, and the thickness or weight of the material.

b. Placement. Membranes shall be loosely spread over the subgrade. Polyethylene film requires about 5 percent slack for satisfactory results.

All field splices shall be made according to the manufacturer's recommended technique, using materials furnished for this purpose. The joints shall be watertight and capable of maintaining their integrity throughout the expected life of the lining.

Approximately 30 inches (760 mm) of the top of the lining shall be placed in the anchor trench and anchored with compacted backfill.

For covered membranes, the material to be used as a protective cover shall be free of large clods, sharp rocks, sticks, and other objects that can puncture the lining. The cover shall

be placed to the specified depth without damage to the membrane.

c. Materials. All materials are to meet the requirements indicated in Tables 1, 2, 3, 4, 5, 6, 7, 8, and 9 as appropriate.

Table 1. Requirements for polyethylene and ethylene co-polymer plastic film.

Test Description		Requirements		Test Method
		Type I Polyethylene	Type II Co-polymer	
Tensile strength, each direction, minimum average	lb/in^2	1,800	2,000	ASTM-D-882, Method "A"
Ultimate elongation, each minimum average	pct	500	500	ASTM-D-882, Method "A"
Impact resistance, minimum average	g/mil	45	65	ASTM-D-1709, Method "B"
Water vapor permeability	perm-mil	0.7	1.5	ASTM-E-96
Tear resistance, each direction, minimum	g/mil	80	80	ASTM-D-1922
Soil burial				
Tensile strength change, each direction, maximum	pct	5	5	ASTM-D-3083
Elongation loss, each direction, maximum	pct	20	20	
Lumionous transmittance, maximum	pct	1.0	1.0	National Bureau of Standards Publication PS-17

Table 2. Requirements for reinforced rubber sheeting.

Test Description		Requirements: Up to 20 mil thick	Requirements: 20 mil thick and greater	Test Method
Breaking strength, minimum	lb/in	75	100	ASTM-D-751
Warp direction	lb/in	75	100	
Fill direction				
Ultimate elongation, each				ASTM-D-751
Warp direction	pct	30	30	
Ozone resistance,				
Procedure "B"	days	7	7	ASTM-D-1149
50 pphm, 100°F				and
				ASTM-D-518
Hydrostatic strength retained				Federal Spec.
				CCC 191b
after ozone exposure, 7	pct	100	100	Method 5512
days (Mullen)				ASTM-D-518
Heat aging, 7 days at				ASTM-D-573
212°F	pct	90	90	
Tensile strength retained	pct	90	90	
Elongation retained				
Tear resistance, minimum,				ASTM-D-751
Warp or fill direction	lb	8	8	(tongue)
Hydrostatic burst (Mullen,				
Minimum	lb/in^2	100	175	ASTM-D-751([1])
Dimensional stability, 7 days				
at 212°F	pct	$\pm$1.0	$\pm$1.0	
Change in length or width				
Low-temperature flexibility				Federal Specification
(optional)		-40°F	-40°F	CCC 191b,
No cracking or flaking				Method 5874
Commercial field splice				Commercial
Strength	pct	75	75	field
Shear force, minimum				splice 1 in.
Tensile				wide
				strip, pulled in
				shear at 10
				in./min, after 7

	days cure at room temperature

[1]A 1-ft^2 sample. 10 in. bench marks in warp and fill direction, placed on aluminum or stainless plate in changing air over.

Table 3. Requirements for reinforced rubber sheeting.

Test Description		Requirements		Test Method
		Type A	Type B	
Tensile Strength, minimum	lb/in^2	1,200	1,200	ASTM-D-412
Modulus at 300% elongation, Minimum	lb/in^2	600	600	ASTM-D-412
Ultimate elongation, Minimum	pct	300	300	ASTM-D-412
Shore "A" hardness		60 ± 10	60 ± 10	ASTM-D-2240
Ozone resistance, Prodedure "A"	pct			ASTM-D-1149
No cracks, 50 pphm at 100°F, 20% elongation	days	7	--	ASTM-D-518
No cracks, 100 pphm at 100°F, 50% elongation	days			ASTM-D-518
Heat again, 7 days at 212°F,	pct	75	75	
Tensile strength retained	pct	75	75	
Elongation retained				
Water vapor permeability at 80°F, maximum	perm mil	0.002	0.05	ASTM-E-96 (procedure BW)
Tear resistance, minimum	lb/in^2	150	150	ASTM-D-624 Die "B"
Dimensional stability, 7 days at 212°F	pct	±0.5	±0.5	
Change in length or width				
Commercial field splice Strength 60 shear force, Minimum tensile	pct	60	60	Commercial field splice 1 in. wide strip, pulled in shear at 10 in./min, after 7 days cure at room temperature

NOTE: Type "A" sheeting is recommended for general-purpose outdoor use. Type "B" material is recommended for use if an extreme outdoor environment requires a highly weatherable lining.

Table 4. Requirements of polyvinyl chloride plastic sheeting.

Test Description		Requirements	Test Method
Tensile strength, each direction, minimum average	lb/in^2	2,000	ASTM-D-882
Elongation at break, minimum	pct	250	ASTM-D-882, Method A
Volatile loss, maximum	pct	0.7	ASTM-D-1203, Method A
		300	
Tear resistance, each direction, minimum	g/mil	160	ASTM-D-1922
Resistance to soil burial (percent change maximum in original value)	pct	-5	ASTM-D-3083 (120-day soil burial)
Breaking factor	pct	-20	
Elongation at break	pct	±10	
Modulus at 100% elongation			
Bonded seam strength, percent breaking factor	pct	80	ASTM-D-3083 Para. 9.3 (1-in. width)

Table 5. Unreinforced chlorsulfonated polyethylene.

Test Description		Minimum Requirements	Test Method
Tensile strength, minimum pounds per square inch	pct	1,000	ASTM-D-412
Ultimate elongation, minimum	pct	250	ASTM-D-412
Ozone resistance, 50 pphm, 20% strain, 100°F, 8,000 hr.	pct	+0	ASTM-D-1149
Heat aging, 14 days at 212°F			ASTM-D-412
Tensile strength, minimum pounds per square inch	pct	1,000	
Elongation at break	pct	150	
Tear resistance, minimum	lb/in	250	ASTM-D-624 Die B

Commercial field splice			ASTM-D-882,
Strength, shear force, minimum tensile	pct	60	Method A, 7 days cure
Weight change after 7 days at 70°C in water, maximum	pct	5	ASTM-D-471

Table 6. Reinforced chlorsulfonated polyethylene.

Test Description		Minimum Requirements 30 mils thick and greater	Test Method
Breaking strength, minimum			ASTM-D-751
Rubber	lb/in	100	
Fabric	lb/in	75	
Ultimate elongation, maximum			ASTM-D-751
Rubber	pct	150	
Fabric	pct	20	
Ozone resistance, 50 pphm, 20% strain, 100°F, 8,000 hr.	pct	+0	ASTM-D-1149
Hydrostatic strength after ozone exposure, 7 days (Mullen), percent retained	pct	100	Fed. Spec. CCC 191b Method 5512, ASTM-D-518
Heat aging, 14 days at 212°F of original	pct	90	ASTM-D-412
Tensile strength	pct	90	
Elongation percent retained of original			
Tear resistance, minimum			ASTM-D-751
Warp or fill direction	pct	10	(Tongue)
Puncture resistance, pounds minimum	pct	120	FTMS 101B, Method 2031
Commercial field splice			
Strength, shear force, percent of minimum break	pct	75	ASTM-D-882, 7 days cure

Table 7. Requirements for high density polyethylene (HDPE).

Test Description	Requirements		Test Method
	80 mils	100 mils	
Minimum tensile properties (each direction)			ASTM-D-638
1. Tensile strength yield (pounds/inch width)	120	150	
2. Tensile strength at break (pounds/inch width)	120	150	
3. Elongation at yield (percent)	10	10	
4. Elongation at break (percent)	500	500	
5. Modulus of elasticity (pounds/sq. in.)	80,000	80,000	
Tear resistance (pounds, minimum)	40	40	ASTM-D-1004
Low temperature	-40°F	-40°F	ASTM-D-746
Dimensional stability (each direction, percent change, maximum)	±3	±3	ASTM-D-1024 212°F, 15 min.
Resistance to soil burial[1] (percent change maximum in original value)			ASTM-D-3083 (120-day soil burial)
1. Tensile strength yield	±10	±10	
2. Tensile strength at break	±10	±10	
3. Elongation at yield	±10	±10	
4. Elongation at break	±10	±10	
5. Modulus of elasticity	±10	±10	
Bonded seam strength[2] (factory seam, breaking factor, pounds/inch width)	108	135	ASTM-D-3038
Environmental stress crack (minimum, hours)	500	500	ASTM-D-1693

[1]Test value of "after exposure" sample is based on precut sample dimensions; 120-day test is 120-day test is required for initial certification.

[2]Factory bonded seam strength is the responsibility of the fabricator.

Table 8. Requirements for supported extended polyurethane.

Property	Test Method	Supported finished material[2] Type 1	Type 2	Type 3	Type 4
Thickness	ASTM-D-751				
1. Overall (mils, minimum)		25	45	30	70
Minimum Tensile Properties	ASTM-D-751				
1. Breaking Strength-fabric TD		50	70	110	100
(pounds, minimum)		70	120	120	140
Breaking Strength-Composites MD		90	160	130	220
TD		75	160	130	160
Tear Strength (pounds, minimum) composite	ASTM-D-751 Tongue Method 8 x 8-in sample				
1. Initial		2.5	4.5	35	4.5
2. After Heat Aging	212°F, 30 days	2.5	4.5	35	4.5
Low Temperature Composite	ASTM-D-2136 1/8 in mandrel, 4 hr. Pass	-40°F	-40°F	-40°F	-40°F
Unsupported sheet, 100 mils			Below -60°F		
Dimensional Stability (each direction percentage change maximum)	ASTM-D-1204 212°F, 1 hr.	-0.8	-0.5	-1.3	-0.7
Resistance to Soil Burial[1] (percent change maximum in original values)	ASTM-D-3083 365-day soil burial 30-mil sheet (as modified in Appendix A)				
a. Unsupported sheet	ASTM-D-882				
1. Breaking Factor				+15	
2. Elongation at Break				-15	
3. Initial Modulus				+30	
b. Membrane Fabric Breaking Factor	ASTM-D-751	TBD	TBD	TBD	TBD
Bonded Seam Strength (pounds, minimum)	ASTM-D-751 (As modified in Appendix A. 12 in/min)		greater than single layer		
Hydrostatic Resistance (pounds per square inch, minimum)	ASTM-D-751 Method A, Procedure l	80	210	250	280
Ozone Resistance	ASTM-D-1149 (As modified in 7 days, 100 pphm 104°F, 1/8 in bent loop)			NA	
Ply Adhesion (each direction, pounds/in. width minimum)	ASTM-D-413 Machine Method Type A			NA	
Volatile Loss, percent (unsupported)	ASTM-D-1203 Method A 30-mil sheet			0.4	
(Puncture Resistance, pounds)	FTMS 101B, (Method 2065)	25	50	45	70

[1]Test value of "after exposure" sample is based on precut sample dimensions; 120-day test is required for initial certification.
[2]Supporting Fabrics:
Type 1: Nylon 6.6 2.0 oz/ya^2
Type 2: Polypropylene 3.1 oz/ya^2
Type 3: Composite of 2 layers 0.5 oz/ya^2 nylon 6.6 plus 5 x 5 1000d polyester scrim (4.1 oz/ya^2 total)
Type 4: Polypropylene 4.4 oz/ya^2

Table 9. Requirements for reinforced ethylene interpolymer alloy.

Test Description	Requirements	Test Method
Thickness, mils minimum		ASTM-D-751
1. Overall	27	
Breaking Strength, lb. min.	400	ASTM-D-751, Method A
Tear Strength, lb. min.		ASTM-D-751, Tongue Method 8 x 8 in. sample
1. Initial	125	
2. After aging	75	
Low Temperature	-30°	ASTM-D-2136 1/8 in. mandrel 4 hr. pass
Dimensional Stability (each direction % change max.)	2	ASTM-D1204 212F, 1 hr.
Resistance to Soil Burial (percent change maximum in original values)		ASTM-D-751 Method A
1. Membrane Fabric Breaking Strength	25	
Hydrostatic Resistance (lb. /sq. in., min.)	500	ASTM-D-751 Method A, Procedure 1
Ozone Resistance	No Cracks	ASTM-D-1149 (7 day, 100 pphm 104°F, 1/8 in. bent loop)
Ply Adhesion (each direction lb./in. width min.)	Film Tear Bond or 8 lb. per in.	ASTM-D-413 Machine Method Type A

3. FENCING

The area covered by a flexible membrane shall be fenced if livestock may be present to protect the membrane from possible puncture.

4. VEGETATION

The finished area shall be shaped and smoothed and all disturbed areas vegetated to protect against erosion. Mowing and maintenance activities shall be careful to avoid cutting or damaging the flexible membrane.

5. CONSTRUCTION DETAILS

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