



## Liners for stormwater management



Liners are designed to limit infiltration of water from a stormwater Best Management Practice (BMP) into underlying and adjacent soil.

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Example of an impermeable liner for a stormwater best management practice.

Source: Philadelphia Water (PWD) Stormwater Management Guidance Manual (<https://www.pwdplanreview.org/manual/cha-pter-4/4.12-outlet-controls>).

### Conditions where liners are required

Under the Construction Stormwater General Permit:

- The Permittee(s) must ensure filtration systems ([http://stormwater.pca.state.mn.us/index.php/Stormwater\\_filtration\\_Best\\_Management\\_Practices](http://stormwater.pca.state.mn.us/index.php/Stormwater_filtration_Best_Management_Practices)) with less than three (3) feet of separation from seasonally saturated soils or from bedrock are constructed with an impermeable liner;
- Permittees must design basins using an impermeable liner if located within active karst terrain.

The following sectors covered under an Industrial Stormwater Permit ([http://stormwater.pca.state.mn.us/index.php/Industrial\\_stormwater\\_program](http://stormwater.pca.state.mn.us/index.php/Industrial_stormwater_program)) are required to have liners for ponds constructed after April 5, 2010.

- Automobile salvage yards ([http://stormwater.pca.state.mn.us/index.php/Sector\\_M\\_-\\_Automobile\\_Salvage\\_Yards](http://stormwater.pca.state.mn.us/index.php/Sector_M_-_Automobile_Salvage_Yards)) (Sector M)
- Air transportation facilities that conduct deicing activities ([http://stormwater.pca.state.mn.us/index.php/Sector\\_S\\_-\\_Air\\_Transportation](http://stormwater.pca.state.mn.us/index.php/Sector_S_-_Air_Transportation)) (Sector S)
- Hazardous waste treatment, storage, or disposal facilities operating as a Solid Waste Management Unit ([http://stormwater.pca.state.mn.us/index.php/Sector\\_K\\_-\\_Hazardous\\_Waste\\_Treatment,\\_Storage,\\_or\\_Disposal\\_Facilities](http://stormwater.pca.state.mn.us/index.php/Sector_K_-_Hazardous_Waste_Treatment,_Storage,_or_Disposal_Facilities)) (Sector K)

- Timber product facilities operating under an SIC code of 2491 ([http://stormwater.pca.state.mn.us/index.php/Sector\\_A\\_-\\_Timber\\_Products](http://stormwater.pca.state.mn.us/index.php/Sector_A_-_Timber_Products)) (Sector A - wood preserving)
- Scrap recycling and waste recycling facilities ([http://stormwater.pca.state.mn.us/index.php/Sector\\_N\\_-\\_Scrap\\_Recycling\\_and\\_Waste\\_Recycling\\_Facilities](http://stormwater.pca.state.mn.us/index.php/Sector_N_-_Scrap_Recycling_and_Waste_Recycling_Facilities)) (Sector N)

## Conditions where liners are recommended

Liners are recommended for the following conditions.

- Circumstances where a permanent pool is needed but difficult to maintain due to site conditions. Examples include constructed wet detention ponds or constructed wetlands requiring a permanent pool and underlain by areas with Hydrologic Soil Group A soils, gravel, or fractured bedrock
- Permeable pavement designs in compacted fill soils.
- Areas where seepage from a BMP into the groundwater would otherwise occur but should be avoided due to risk of groundwater contamination. These include
  - Confirmed stormwater hotspots ([http://stormwater.pca.state.mn.us/index.php/Potential\\_stormwater\\_hotspots#Determining\\_if\\_a\\_PSH\\_is\\_a\\_hotspot](http://stormwater.pca.state.mn.us/index.php/Potential_stormwater_hotspots#Determining_if_a_PSH_is_a_hotspot)) in areas where the potential for groundwater pollution is high. Groundwater pollution potential is determined based on hydrogeologic conditions, which are used to estimate the time of travel for water and conservative chemicals to pass through the soil and vadose zone and into groundwater. The potential for groundwater pollution can be determined using existing pollution sensitivity maps developed by the Minnesota Department of Natural Resources ([http://www.dnr.state.mn.us/waters/groundwater\\_section/mapping/atlas.html](http://www.dnr.state.mn.us/waters/groundwater_section/mapping/atlas.html)). Note these maps cover large geographic areas and should be used for initial screening at a site.
  - Areas where infiltrating water will mobilize contaminants in soil or groundwater
- Locations where recommended horizontal or vertical separation distances ([http://stormwater.pca.state.mn.us/index.php/Stormwater\\_infiltration\\_and\\_setback\\_%28separation%29\\_distances](http://stormwater.pca.state.mn.us/index.php/Stormwater_infiltration_and_setback_%28separation%29_distances)) cannot be achieved
- Use impermeable liner as needed to separate tree BMPs ([http://stormwater.pca.state.mn.us/index.php/Fact\\_sheet\\_for\\_tree\\_trenches\\_and\\_tree\\_boxes](http://stormwater.pca.state.mn.us/index.php/Fact_sheet_for_tree_trenches_and_tree_boxes)) from road, parking lot, sidewalk or adjacent walls or building foundation

## Liner specifications

**Information:** Mil Thickness: What Does It Mean, and How Do I Measure It? (<http://www.deeprout.com/blog/blog-entries/mil-thickness-what-does-it-mean-and-how-do-i-measure-it>)

Specifications are provided for different levels of liners. Although specifications for clay liners are included with Levels 1 and 2, clay liners are generally not recommended. Links to information on design and installation is recommended. For additional information see additional information.

- Level 1 liner - for sites with high potential for groundwater contamination
  - HDPE (high density polyethylene) liner criteria:
    - Minimum thickness shall be 60 mils.
    - Design according to the criteria in Table 3 of the NRCS 313, Waste Storage Facility technical standard ([http://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcs143\\_026465.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026465.pdf)).
    - Install according to NRCS Wisconsin Construction Specification 202 ([https://efotg.sc.egov.usda.gov/api/CPSFile/5425/000\\_WI\\_CS-202\\_Polyethylene\\_Geomembrane\\_Lining\\_MAR-2019](https://efotg.sc.egov.usda.gov/api/CPSFile/5425/000_WI_CS-202_Polyethylene_Geomembrane_Lining_MAR-2019)), Polyethylene Geomembrane Lining (You can also access the specification here - File:000 WI CS-202 Polyethylene Geomembrane Lining MAR-2019.pdf).
  - PVC (Polyvinyl chloride) - follow specifications in MPCA's PVC liner guidance (<http://www.pca.state.mn.us/index.php/view-document.html?gid=16187>). **NOTE: 30 mil smooth polyvinyl chloride geomembrane is functionally equivalent to 60 mil textured high density polyethylene.**
  - GCL (geosynthetic clay liner) liner criteria:

- Design according to the criteria in Table 4 of NRCS 313, Waste Storage Facility technical standard ([http://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcs143\\_026465.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026465.pdf)).
- Install according to NRCS Wisconsin Construction Specification 203 ([https://efotg.sc.egov.usda.gov/api/CPSFile/5426/000\\_WI\\_CS-203\\_Geosynthetic\\_Clay\\_Liner\\_OCT-2019](https://efotg.sc.egov.usda.gov/api/CPSFile/5426/000_WI_CS-203_Geosynthetic_Clay_Liner_OCT-2019)), Geosynthetic Clay Liner. (You can download the document here - File:000 WI CS-203 Geosynthetic Clay Liner OCT-2019.pdf)
- Clay liner criteria (essentially the same as the clay below landfills but not as thick):
  - 50 percent fines (200 sieve) or more
  - An in-place hydraulic conductivity of  $1 \times 10^{-7}$  centimeters per second (cm/s) or less
  - Average liquid limit of 25 or greater, with no value less than 20
  - Average PI of 12 or more, with no values less than 10
  - Clay installed wet of optimum if using standard Proctor, and 2 percent wet of optimum if using modified Proctor
  - Clay compaction and documentation as specified in NRCS Wisconsin Construction Specification 300 ([https://efotg.sc.egov.usda.gov/references/public/WI/WCS-300-\(2018-04\).pdf](https://efotg.sc.egov.usda.gov/references/public/WI/WCS-300-(2018-04).pdf)), Clay Liners (or download here - File:WCS-300-(2018-04).pdf)
  - Minimum thickness of two feet
  - Specify method for keeping the pool full or use of composite soils below liner
- Level 2 liner - for sites with low groundwater pollution potential
  - HDPE liner criteria:
    - Minimum thickness shall be 40 mils or greater
    - Design according to the criteria in Table 3 of the NRCS 313, Waste Storage Facility technical standard ([http://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcs143\\_026465.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026465.pdf))
    - Install according to NRCS Wisconsin Construction Specification 202 ([https://efotg.sc.egov.usda.gov/api/CPSFile/5425/000\\_WI\\_CS-202\\_Polyethylene\\_Geomembrane\\_Lining\\_MAR-2019](https://efotg.sc.egov.usda.gov/api/CPSFile/5425/000_WI_CS-202_Polyethylene_Geomembrane_Lining_MAR-2019)), Polyethylene Geomembrane Lining (You can download the document here - File:000 WI CS-202 Polyethylene Geomembrane Lining MAR-2019.pdf)
  - Silt/Clay liner criteria:
    - 50 percent fines (200 sieve), or 20 percent fines and a PI of 7
    - An in-place hydraulic conductivity of  $1 \times 10^{-5}$  centimeters per second or less
    - Soil compaction and documentation as specified in NRCS Wisconsin Construction Specification 204 ([https://efotg.sc.egov.usda.gov/api/CPSFile/5454/000\\_WI\\_CS-204\\_-Earthfill\\_for\\_Waste\\_Storage\\_Facilities\\_SEP-2018](https://efotg.sc.egov.usda.gov/api/CPSFile/5454/000_WI_CS-204_-Earthfill_for_Waste_Storage_Facilities_SEP-2018)), Earthfill for Waste Storage Facilities (You can download the document here - File:000 WI CS-204 -Earthfill for Waste Storage Facilities SEP-2018.pdf)
    - Minimum thickness of two feet
    - Specify method for keeping the pool full or use of composite soils below liner
- Liners for facilities covered by an Industrial Stormwater Permit and where ponds are allowed with a constructed liner
  - The industrial stormwater pond must be lined with a synthetic liner that is chemically compatible with materials expected to enter the pond, must be Ultra Violet (UV) stable, and must be designed to restrict infiltration to less than 500 gallons per acre per day ( $5.41 \times 10^{-7}$  centimeters per second).
  - The industrial stormwater pond must be designed in accordance with accepted engineering practices. (See MPCA Recommended Pond Design Criteria (<http://www.pca.state.mn.us/index.php/view-document.html?gid=11503>), Polyvinyl Chloride Liner guidelines (<http://www.pca.state.mn.us/index.php/view-document.html?gid=16187>), and High Density Polyethylene Liner Guidance (<http://www.pca.state.mn.us/index.php/view-document.html?gid=16186>))

## Decision process for selecting liner level

The following table summarizes the process for selecting a liner.

### Design process for selecting the appropriate liner level.

Link to this table

Condition	Design level	Note
Filtration BMP ( <a href="http://stormwater.pca.state.mn.us/index.php/Stormwater_filtration_Best_Management_Practices">http://stormwater.pca.state.mn.us/index.php/Stormwater_filtration_Best_Management_Practices</a> ) with less than 3 feet of separation to seasonal saturated soil or bedrock	1	Required under the Construction Stormwater permit ( <a href="http://stormwater.pca.state.mn.us/index.php/III._STORMWATER_DISCHARGE_DESIGN_REQUIREMENTS#III.D._PERMANENT_STORMWATER_MANAGEMENT_SYSTEM">http://stormwater.pca.state.mn.us/index.php/III._STORMWATER_DISCHARGE_DESIGN_REQUIREMENTS#III.D._PERMANENT_STORMWATER_MANAGEMENT_SYSTEM</a> )  Applies to all post-construction BMPs ( <a href="http://stormwater.pca.state.mn.us/index.php/Post-construction_stormwater_Best_Management_Practices">http://stormwater.pca.state.mn.us/index.php/Post-construction_stormwater_Best_Management_Practices</a> ). See section on Potential stormwater hotspots ( <a href="http://stormwater.pca.state.mn.us/index.php/Potential_stormwater_hotspots">http://stormwater.pca.state.mn.us/index.php/Potential_stormwater_hotspots</a> ) for more information
BMP in confirmed potential stormwater hotspot with high or very high groundwater pollution potential or areas where infiltrating water will mobilize contaminants in soil or groundwater	1	
Constructed ponds with less than 3 feet separation from seasonally high water table in a potential hotspot ( <a href="http://stormwater.pca.state.mn.us/index.php/Potential_stormwater_hotspots">http://stormwater.pca.state.mn.us/index.php/Potential_stormwater_hotspots</a> )	1	
Constructed wet ponds underlain by soils with an infiltration rate of 0.3 inches per hour or greater (HSG A or B soils)(see [1] ( <a href="http://tnpermanentsstormwater.org/manual/10%20Chapter%205.4.2%20Wet%20Ponds.pdf">http://tnpermanentsstormwater.org/manual/10%20Chapter%205.4.2%20Wet%20Ponds.pdf</a> ) or [2] ( <a href="http://dnr.wi.gov/topic/stormwater/documents/wetpondstd1001.pdf">http://dnr.wi.gov/topic/stormwater/documents/wetpondstd1001.pdf</a> ))	1	To maintain a permanent pool
Karst terrain with high or very high groundwater pollution potential <sup>1</sup>	1	See section on karst ( <a href="http://stormwater.pca.state.mn.us/index.php/Karst">http://stormwater.pca.state.mn.us/index.php/Karst</a> ) for more information
Prevent groundwater intrusion into a BMP requiring aerobic conditions, such as iron-enhanced media	1	
Maintain permanent pool in constructed ponds or constructed wetlands in areas underlain by geologic material that is fractured or has a high infiltration rate Separation distance ( <a href="http://stormwater.pca.state.mn.us/index.php/Summary_of_horizontal_and_vertical_setback_distances">http://stormwater.pca.state.mn.us/index.php/Summary_of_horizontal_and_vertical_setback_distances</a> ) from a BMP cannot be achieved	2	To prevent tree root intrusion. See link ( <a href="http://stormwater.pca.state.mn.us/index.php/Fact_sheet_for_tree_trenches_and_tree_boxes#Summary_of_design_criteria">http://stormwater.pca.state.mn.us/index.php/Fact_sheet_for_tree_trenches_and_tree_boxes#Summary_of_design_criteria</a> )
Separate tree BMP from road, parking lot, sidewalk or adjacent walls or building foundation	2	

<sup>1</sup> Groundwater pollution potential is determined based on hydrogeologic conditions, which are used to estimate the time of travel for water and conservative chemicals to pass through the soil and vadose zone and into groundwater.

## Additional information

- Wisconsin guidance (<http://dnr.wi.gov/topic/stormwater/documents/wetpondstd1001.pdf>) for wet detention pond
- Washington D.C. guidance ([http://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Ch3.9\\_StormwaterPonds\\_0.pdf](http://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Ch3.9_StormwaterPonds_0.pdf)) for ponds
- State of Washington (<https://fortress.wa.gov/ecy/publications/parts/1210030part6.pdf>) guidance. See section 4.4.

- Virginia guidance ([http://www.vwrrc.vt.edu/swc/NonPBMPSpecsMarch11/DCR%20BMP%20Spec%20No%202014\\_WET%20PONDS\\_Final%20Draft\\_v1-9\\_03012011.pdf](http://www.vwrrc.vt.edu/swc/NonPBMPSpecsMarch11/DCR%20BMP%20Spec%20No%202014_WET%20PONDS_Final%20Draft_v1-9_03012011.pdf)) for wet ponds. See section 6.8.
- Texas guidance ([http://www.tceq.state.tx.us/publications/rg/rg-348/chapter3.html/at\\_download/file](http://www.tceq.state.tx.us/publications/rg/rg-348/chapter3.html/at_download/file)). See section 3.4.2.
- Seattle guidance ([http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web\\_informational/p2145421.pdf](http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2145421.pdf)). See section E-7, page E-18.
- Minnesota Pollution Control Agency
  - HPDE liner guidance (<http://www.pca.state.mn.us/index.php/view-document.html?gid=16186>)
  - PVC liner guidance (<http://www.pca.state.mn.us/index.php/view-document.html?gid=16187>)

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This page was last edited on 8 June 2021, at 17:21.

Template:Footer

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