

WISCONSIN CONSTRUCTION SPECIFICATION

300. CLAY LINER

1. SCOPE

The work shall consist of the construction of the clay liner as shown on the construction plans.

2. CLAY LINER MATERIAL

Clay liner material shall have a minimum plasticity index of 12 ($PI \geq 12$) and a minimum percentage passing the No. 200 sieve (P_{200}) as specified in the construction plans. The clay liner material shall be capable of providing a liner with a maximum hydraulic conductivity (permeability) of 1×10^{-7} centimeters per second.

Proposed liner material properties shall be determined in the lab prior to placement for each different borrow area and material, at the specified minimum frequency shown in Table 1. These tests are typically done in the design phase with additional tests required when unpredicted changes in borrow material are observed.

A standard or modified proctor test density curve, and optimum moisture, shall be developed from the borrow materials. A hydraulic conductivity (permeability) shall be determined on a re-compacted sample. The sample shall be re-compacted to the minimum density and moisture content specified in Section 6, Compaction.

Table 1 Borrow Material Testing	
Test Reference	Minimum Frequency
Standard Proctor (ASTM D 698) or Modified Proctor (ASTM D 1557)	1 per 5,000 cubic yards of estimated in-place liner quantity
Atterberg Limit (ASTM D 4318) and Percent Fines (ASTM D 1140)	1 per 5,000 cubic yards of estimated in-place liner quantity
Permeability (ASTM D 5084)	1 per 5,000 cubic yards of estimated in-place liner quantity

3. FOUNDATION PREPARATION

Foundation surfaces shall be graded to remove surface irregularities and shall be scarified or otherwise acceptably scored or loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the clay liner. The surface materials of the foundation shall be compacted and bonded with the first layer of the clay liner as specified for subsequent layers of clay liner.

4. PLACEMENT

The clay liner shall not be placed until the required foundation preparation has been completed and the foundation has been inspected and approved by the Technician or Engineer. The clay liner shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the clay liner.

Clay materials shall contain no sod, brush, roots, frozen soil, or other perishable materials. Rock particles larger than 3 inches shall be removed prior to compaction of the clay.

The clay liner shall be placed in lifts. The thickness of each lift before compaction shall not exceed the smaller of 6 inches or the length of the teeth of the footed compactor used.

The distribution of materials throughout the clay liner shall be essentially uniform, and the clay liner shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material.

If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified to a depth of not less than 2 inches before the next layer is placed.

5. CONTROL OF MOISTURE CONTENT

During placement and compaction of the clay liner, the moisture content of the clay being placed shall be maintained above optimum moisture as determined by the standard proctor test or modified proctor test.

The application of water to the clay shall be accomplished at the borrow areas in-so-far as practicable. Water may be applied by sprinkling the clay after placement and before compaction of the liner, if necessary. Uniform moisture distribution shall be obtained by disking.

6. COMPACTION

The clay liner shall be compacted to a minimum of 95% of standard proctor dry density or to a minimum of 90% of modified proctor dry density. The moisture content shall be above the optimum moisture.

The clay liner shall be compacted with a footed compactor weighing at least 25,000 pounds, operated continuously.

7. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE LINER

Clay liner placed at densities lower than the specified minimum density or at moisture contents lower than optimum moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the specifications or removed and replaced. The replacement clay material and the fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control, and compaction.

8. TESTING METHOD SPECIFICATIONS

- ASTM D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
- ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))
- ASTM D 4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D 1140 Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 µm) Sieve
- ASTM D 2922 Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
- ASTM D 2937 Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
- ASTM D 2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

- ASTM D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
- ASTM D 5084 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

9. TESTING FREQUENCY

Clay liner construction shall be tested and documented by a third party engineering or testing firm at the specified minimum frequency shown in Table 2.

Field density tests shall be completed on the compacted in-place clay liner, as the liner is being placed. Atterberg limit and percent fines shall be completed on samples obtained next to the field density test. After the completion of the liner, undisturbed samples shall be taken from the constructed clay liner for permeability verification.

Copies of the test locations and test results (documentation report) shall be provided to the owner to document compliance with this specification.

Table 2 Liner Testing

Test Reference	Minimum Frequency (Standard mathematical rounding rules apply)
Field Density (ASTM D 2922, or D 2937, or D 2167, or D 1556)	1 test per 500 cubic yards of in-place liner, distributed throughout the structure (Horizontally and Vertically)
Atterberg Limit (ASTM D 4318) and Percent Fines (ASTM D 1140)	1 test per 2000 cubic yards of in-place liner
Permeability (ASTM D 5084)	1 per 5,000 cubic yards of in-place liner (2 minimum per facility) ¹

1. At least one of these tests should be obtained from the side slope of the facility

All undisturbed sample test holes in the constructed clay liner shall be backfilled using powdered bentonite mixed with clay soil used in liner construction and compacted by hand tamping. The clay shall be broken down into clods less than ½ inch in diameter. A minimum of 25% of each backfilled test hole volume shall be occupied by powdered bentonite after backfilling.