RESPONSE 47

2.0 SOIL LINER EVALUATION

This section outlines generally acceptable construction practices and specifications and the minimum quality control testing requirements for soil liners.

2.1 Pre-construction Material Evaluation

The first step in constructing a soil liner is to pre-qualify the soil materials that are selected for liner construction. Soil liner material may be obtained from in situ soil strata that will be excavated as the liner is constructed or from a select borrow source. Representative samples from either source shall be subject to the minimum pre-construction testing program shown in Table III-3F-1.

TABLE III-3F-1: Soil Liner Materials Pre-Construction Testing Schedule

TEST	METHOD USED	FREQUENCY(1)
Soil Classification	ASTM D2487	1 per soil type
Particle-Size Analysis	ASTM D422 or D1140	1 per soil type
Atterberg Limits	ASTM D4318	1 per soil type
Hydraulic Conductivity(2)	ASTM D5084(3)	1 per soil type
Standard Proctor Test	ASTM D698	1 per soil type
Moisture Content	ASTM D2216	1 per soil type

Notes:
1. If either the liquid limit (LL) or plasticity index (PI) varies by more than 10 points from other samples, the soil is considered a different soil type.
2. Conduct this test on a remolded sample that is compacted at or less than 95% of the maximum dry density and at the optimum moisture content as determined from the standard Proctor test. If pre-construction samples are compacted at higher or lower densities and/or respective moisture contents, then these values will govern for field control. Pre-construction tests should represent the "worst-case" condition in the field concerning hydraulic conductivity results.
3. Testing procedures in Appendix VII of the US Army Corps of Engineers Manual EM 1110-2-1906, November 30, 1970, Laboratory Soils Testing, may be used as an alternative method. Permeability tests will be conducted using tap water or 0.05N calcium sulfate solution as the permeant fluid. Distilled or deionized water is not acceptable.

Where soil types vary substantially and are not segregated, representative blends of those soil types anticipated to be utilized for soil liner construction should also be sampled and tested. The material tested shall comply with the following minimum material specifications:

- Plasticity Index ≥ 15
- Liquid Limit ≥ 30
- Percent Passing No. 200 Sieve ≥ 30
- Particle Size ≤ 1 inch
- Hydraulic Conductivity ≤ 1×10^{-7} cm/sec

The Proctor moisture-density curves shall be developed for each type of soil determined suitable as liner material and shall be used during the construction phase as a performance reference for compaction and

moisture control. Rocks and stones in soil for liner construction shall be limited to no more than one inch in diameter and no more than 10% by weight.

The POR should consider the potential adverse effects on and/or inconsistencies of results due to laboratory drying procedures, as some materials may exhibit variation in results for Proctor and Atterberg limits tests. Samples should not be oven-dried nor dried back more than 2 to 3 percent below the lowest anticipated moisture content needed to develop the Proctor moisture-density relationship. The zero air voids line shall be computed and included along with the Proctor curves, indicating the specific gravity value used.

Pre-construction samples to be run for hydraulic conductivity testing shall be molded at or less than the optimum moisture content and at or less than 95 percent of the maximum dry density according to the standard Proctor test (ASTM D698). These points should represent reasonable worst-case conditions for hydraulic conductivity results on appropriately compacted soils. If higher moisture contents or dry densities are used for the hydraulic conductivity tests, then the higher values will be used for field control during placement. However, if lower moisture or density values are used and confirmed to achieve acceptable hydraulic conductivities, field control will still be based on the minimum compaction requirements in Section 2.2.

As a general rule, a minimum of one series of pre-construction tests should be performed for every 15,000 to 20,000 cubic yards of soil to be used in liner construction, unless soil types are limited and easily distinguished. As soil is usually made available subsequent to excavation during liner construction, additional pre-construction samples should be taken and tests performed when soils vary or as soon as the initial pre-construction test results appear inappropriate or questionable. If and when the same borrow source is utilized for the soil supply of more than one liner area, results from previous tests may be used to supplement the pre-construction data.

2.2 Soil Liner Construction Specifications and Practices

The soil liner shall be constructed in accordance with the requirements included in this section.. Also, certain construction practices shall be utilized as described herein when appropriate.

2.2.1 Liner Subgrade Preparation

Subgrade surfaces for both the bottom and the sideslope of waste disposal areas to receive constructed soil liners shall be prepared to ensure a stable foundation and to facilitate bonding of the soil liner to the subgrade material. Upon achieving the design subgrade level, zones of soft or unsuitable soils and deleterious material shall be excavated and removed and replaced with appropriate general fill or soil liner material. Free shallow groundwater or excess soil moisture shall be removed by providing drainage and/or aeration.

2.0 COHESIVE SOIL COVER EVALUATION (INFILTRATION LAYER)

This section outlines generally acceptable construction practices and specifications and the minimum quality control testing requirements for cohesive soil covers, serving as the infiltration layer in the final cover system.

2.1 Pre-construction Material Evaluation

The first step in constructing a cohesive soil cover is to pre-qualify the soil materials that are selected for final cover construction. Cohesive soil cover material may be obtained from in situ soil strata that will be excavated as the final cover is constructed or from a select borrow source. Representative samples from either source shall be subject to the minimum pre-construction testing program shown in Table III-7A-1.

Table III-7A-1: Cohesive Soil Cover Materials Pre-construction Testing Schedule

TEST	METHOD USED	FREQUENCY(1)
Soil Classification	ASTM D2487	1 per soil type
Particle-Size Analysis	ASTM D422 or D1140	1 per soil type
Atterberg Limits	ASTM D4318	1 per soil type
Hydraulic Conductivity(2)	ASTM D5084(3)	1 per soil type
Standard Proctor Test	ASTM D698	1 per soil type
Moisture Content	ASTM D2216	1 per soil type

NOTES:

(1) If either the liquid limit (LL) or plastic limit (PI) varies by more than 10 points from other samples, the soil is considered a different soil type.

(2) Conduct this test on a remolded sample that is compacted at or less than 95% of the maximum dry density and at the optimum moisture content as determined from the standard Proctor test or compacted at or less than 90% for modified Proctor test at one percent dry of the optimum. If pre-construction samples are compacted at higher or lower densities and/or respective moisture contents, then these values will govern for field control. Pre-construction tests should represent the "worst-case" condition in the field concerning hydraulic conductivity results.

(3) Testing procedures in Appendix VII of the US Army Corps of Engineers Manual EM 1110-2-1906, November 30, 1970, Laboratory Soils Testing, may be used as an alternative method. Permeability tests will be conducted using tap water or 0.05N calcium sulfate solution as the permeant fluid. Distilled or deionized water is not acceptable.

Where soil types vary substantially and are not segregated, representative blends of those soil types anticipated to be utilized for cohesive soil cover construction should also be sampled and tested. The material tested shall comply with the following minimum material specifications:

- Plasticity Index ≥ 15
- Liquid Limit ≥ 30
- Percent Passing No. 200 Sieve ≥ 30
- Particle Size ≤ 1 inch
- Hydraulic Conductivity ≤ 1×10^{-5} cm/sec

The Proctor moisture-density curves shall be developed for each type of soil determined suitable as cohesive soil cover material and shall be used during the construction phase as a performance reference

for compaction and moisture control. Rocks and stones in soil for liner construction shall be limited to no more than one inch in diameter and no more than 10% by weight.

The POR should consider the potential adverse effects on and/or inconsistencies of results due to laboratory drying procedures, as some materials may exhibit variation in results for Proctor and Atterberg limits tests. Samples should not be oven-dried nor dried back more than 2 to 3 percent below the lowest anticipated moisture content needed to develop the Proctor moisture-density relationship. The zero air voids line shall be computed and included along with the Proctor curves, indicating the specific gravity value used.

Pre-construction samples to be run for hydraulic conductivity testing shall be molded at or less than the optimum moisture content and at or less than 95 percent of the maximum dry density according to the standard Proctor test (ASTM D698). These points should represent reasonable worst-case conditions for hydraulic conductivity results on appropriately compacted soils. If higher moisture contents or dry densities are used for the hydraulic conductivity tests, then the higher values will be used for field control during placement. However, if lower moisture or density values are used and confirmed to achieve acceptable hydraulic conductivities, field control will still be based on the minimum compaction requirements in Section 2.2.

As a general rule, a minimum of one series of pre-construction tests should be performed for every 15,000 to 20,000 cubic yards (CY) of soil to be used in cohesive soil cover construction, unless soil types are limited and easily distinguished. As soil is usually made available subsequent to excavation during final cover construction, additional pre-construction samples should be taken and tests performed when soils vary or as soon as the initial pre-construction test results appear inappropriate or questionable. If and when the same borrow source is utilized for the soil supply of more than one final cover area, results from previous tests may be used to supplement the pre-construction data.

2.2 Soil Cover Construction Specifications and Practices

The cohesive soil cover shall be constructed in accordance with the requirements included in this section. Also, certain construction practices shall be utilized as described herein when appropriate.

2.2.1 Working Surface Preparation

Subgrade preparation prior to receiving final cover will include compacting the near surface waste or intermediate cover to prepare the working surface. Depressions in the surface where ponded water is observed will be prepared by removing the water and filling the depression to maintain an adequate slope.

Stability of the working surface prior to placement of the final cover shall be determined by the POR by visual inspection to confirm that deflection and pumping characteristics are minimized and the strength of