Minnesota Pollution Control Agency

Solid Waste Program

Guidance for Soil Construction Standards and Testing Frequencies – Final Cover Construction

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Contents :

This guide has been developed to provide detailed information on recommended material quality and construction methods for soil components used in final cover construction. Long term problems can be avoided by taking care to specify clearly what the requirements are for material quality and construction methods during the construction bidding process.

The attached Soil Construction Standards and Testing Frequencies table provides detailed information on specifications for the clay, sand drainage, buffer layer, gravel, rooting zone and topsoil layers for constructing final cover systems at landfills. Please refer to this table for information that should be included in specifications for a project.

The guide has been developed with the foremost thought of final cover construction at mixed municipal solid waste (MSW) landfills; however, it may also be used for final cover construction at any landfill.

It is recommended that inspectors be at borrow sites and delivery sites during construction to ensure that the materials being used are properly tested and of the quality specified.

Inspectors should be aware that variability in materials delivered to sites during construction will occur. This is acceptable within reason and the variability which can be allowed and still have a well constructed final cover varies with specific site conditions. Adequate testing as recommended by the specification table will help reduce problems in the field. Unplanned variations in soil materials should be immediately reported to the MPCA review engineer. Any decision made during construction regarding the use of variable soils must also be documented in the construction certification report.

BUFFER LAYER

A minimum of 12 inches of soil material must be spread and compacted over the waste to create a smooth stable base for construction of the landfill cap.

Buffer layer at Onyx FCR Landfill

Waste should not protrude through the top of this layer. If a geomembrane is used for the barrier layer, the buffer layer must not contain sharp objects or materials larger than 3/8 inch in diameter. If a geomembrane will be used as the barrier layer, the buffer layer must be smooth rolled before its placement.

BARRIER LAYER

The purpose of the barrier layer is to prevent infiltration of water into the landfill. It is typically constructed using a 40 mil geomembrane, however, two feet of clay may be an acceptable alternative. You should check with your MPCA engineer to verify whether a clay barrier layer option is available for your site.

If clay is used it should be placed in lifts with a maximum lift being 9 inches of loose clay or less. Compaction of the clay is done with a sheepsfoot compactor to meet the 95 percent Standard Proctor maximum dry density as specified in the table. Lift thickness must be adjusted so that when compacted it is no greater than 6 inches thick and no deeper than the sheepsfoot can penetrate. The top lift should be smooth-rolled.

The moisture content of the clay during construction is very important. It should be maintained at a moisture that allows the sheepsfoot to "walk out" of the clay as it is worked.

SAND DRAINAGE LAYER

The purpose of the sand drainage layer is to allow water to pass freely through it to reduce the build up of moisture within the final cover. When this layer contains too many fines, the flow of water is impeded and can cause problems with the stability of the landfill cap.

Problems with the quality of sand used for the sand drainage layer has resulted in the MPCA recommending that washed sand be specified for the sand drainage layer. In the field, it is understood that gradation of materials can vary slightly, however, the standard of 5% fines should be used as the basis for determining if loads should be accepted or rejected.

The sand drainage layer should be installed in one lift. Equipment used for placement of the sand cannot be driven directly on the geomembrane. A minimum thickness of 1 foot of sand material must be in place between tracked equipment and the geomembrane. No rubber tired vehicles can be driven on the sand drainage layer during or after placement.

The layer should be constructed by pushing the sand up the landfill slope to prevent folding of the synthetic membrane (if one is used).
If crushed stone is used for the sand drainage layer and has sharp edges, the use of a heavy geotextile fabric on top of the geomembrane should be considered. This will protect the geomembrane from being damaged.

Sand drainage layer placement at Clay County Landfill.

A geonet may be an acceptable alternative for the sand drainage layer. In addition to transmissivity calculations, it is important to verify anticipated level on the barrier layer. Sand may still be need on top of the geonet to accommodate anticipated head levels and ensure proper slope stability. The recommended weight of the geonet should not be less than 10 oz/yd^2. The total soil thickness of two feet above the geonet is still required for adequate rooting zone.

ROOTING ZONE AND TOPSOIL

The rooting zone and topsoil used for the final cover should be selected to enhance plant growth. The purpose of these layers is to provide a media for vegetative growth. A good vegetative cover will prevent erosion from occurring. Soils that enhance plant growth are well aerated and have the ability to hold moisture and nutrients for plant uptake.

Rooting zone soils should be checked using the soil filter analysis described at the end of this fact sheet. The analysis will help predict whether fines contained in the rooting zone soil will move into the sand drainage layer and cause clogging problems. If the analysis shows that a clogging problem may occur, then it is recommended that a geotextile fabric be placed between the sand drainage layer and the rooting zone material.

GRAVEL

Gravel may be used in construction of the gas collection and venting system or in the construction of the surface water drainage system. If it is used for gas collection and venting, the gravel cannot contain limestone, because of the reaction that occurs between limestone and the gas condensate (limestone dissolves).

Riprap drainageway off final cover into perimeter sedimentation pond at Clay County Landfill.

HAUL ROADS

A three foot layer of calcareous sand or other soil should be used on haul roads during final cover construction to prevent damage to the final cover system. This depth can be reduced if tracked equipment is used. Haul roads should not impede proper surface water drainage at the site.

CONTACT INFORMATION

For more information on soils used for the construction of landfills, contact 651-296-6300 and ask for the solid waste engineer assigned to your facility.

SOIL CONSTRUCTION STANDARDS AND TESTING FREQUENCIES

	CLAY	SAND DRAINAGE	BUFFER LAYER	GRAVEL$_{\Psi}$	ROOTING ZONE	TOPSOIL$_{\Phi}$
PARTICLE SIZE (soil construction standard)	Min. 50% by weight passing through #200 sieve, Max.% gravel = 5% Max. rock size = 1" diameter, Max. clod size =3"	Max. 2% by weight passing through #200 sieve 100% by weight passing through the 3/8" sieve Sand must be washed.	Max. Rock size = 2" diameter Max. clod size =3"	Max. 5% by weight passing through #4 sieve 100% passing 1" (max. size = 1" diameter)	Max Rock size = 3" diameter To determine if a geotextile or filter fabric is needed between the rooting zone and the sand drainage layer use the soil filter analysis.	Min. 90% by weight passing through #10 sieve AWC tested by ASTM D2980-71 (1996)
Frequency of borrow source evaluation testing (1)	1/3000 cu.yd. ASTM D422	Tests from conveyor 1/5000 cu.yd. ASTM D422	1/acre ASTM D422	1/source ASTM D422	1/source ASTM D422	1/source ASTM D422
ATTERBERG LIMITS (soil construction standard)	liquid limit $\geq$25% plasticity index $\geq$12%	N.A.	N.A.	N.A.	N.A.	N.A.
frequency of borrow source evaluation testing (1)	1/3000 cu. yd. ASTM D4318	N.A.	N.A.	N.A.	N.A.	N.A.

SOIL CONSTRUCTION STANDARDS AND TESTING FREQUENCIES (cont.)

	CLAY	SAND DRAINAGE	BUFFER LAYER	GRAVEL$_{\Psi}$	ROOTING ZONE	TOPSOIL$_{\Phi}$
PERMEABILITY (soil construction standard)	Cover: max $2x10^{-6}$ cm/sec* *note:* Combustor ash cover max. $1x10^{-6}$	ASTM 2434 min. $1x10^{-3}$ cm/s 1 test per 10,000 yd^3 *note:* min. $1x10^{-2}$ cm/s for the cover at combustor ash facilities.	N.A.	Min. $1x10^{-2}$ cm/sec	N.A.	N.A.
frequency of soil testing for borrow source evaluation (1)	1/5000 cu.yd. ASTM D5084 EPA 9100	1/2000 cu.yd. ASTM D2434	N.A.	N.A.	N.A.	N.A.
frequency of in-place soil testing (3)	1/acre/foot ASTM D5084 EPA 9100	1 per acre for particle size 1 per acre for permeability	N.A.	N.A.	N.A.	N.A.

SOIL CONSTRUCTION STANDARDS AND TESTING FREQUENCIES (cont.)

	CLAY	SAND DRAINAGE	BUFFER LAYER	GRAVEL$_{\Psi}$	ROOTING ZONE	TOPSOIL$_{\Phi}$
COMPACTION / NUCLEAR DENSITY (Construction Standard) **using a minimum 4000 lb sheepsfoot compactor to penetrate full depth of loose lift with a recommended minimum of 5 passes**	95% standard proctor*	N.A. Note: MPCA does not recommend compacting the sand drainage layers placed over synthetic membrane	95% standard proctor	N.A.	90% - 95% standard proctor	leave loose*
frequency of soil testing for borrow source evaluation (1) (determines maximum density)	1/3000 cu. yd. ASTM D698 or ASTM D1557	N.A.	N.A.	N.A.	1/5000 cu. Yd ASTM D698 or ASTM D1557	N.A.
frequency of in-place soil testing (3)	100 foot grid/lift off set each lift ASTM D2922 ASTM D1556	N.A.	100 foot grid	N.A.	200 foot grid/lift off set each lift ASTM D2922	N.A.

SOIL CONSTRUCTION STANDARDS AND TESTING FREQUENCIES (cont.)

	CLAY	SAND DRAINAGE	BUFFER LAYER	GRAVEL$_{\Psi}$	ROOTING ZONE	TOPSOIL$_{\Phi}$
SOIL CLASSIFICATION and SOIL DESCRIPTION (Construction Standard)	CL,CH, possibly SC if soil meets permeability and other criteria No organic matter	SC, SM, SW-SM, SW-SC, SP-SM, SP-SC Uniformity Coefficient < 6 No organic matter		GW, GP Uniformity Coefficient < 4 No organic matter		USDA Classifications: sandy loam, sandy clay loam, loam, clay loam, silt loam
frequency of borrow source evaluation testing (1)	1/3000 cu. yd ASTM D2487	1/2000 cu. yd. ASTM D2487	1/source	1/Source ASTM D2487	1/source ASTM D2487	1/Source ASTM D2487
frequency of preconstruction testing for verification at borrow source (2)	1/3000 cu. yd. (3 minimum) ASTM D2488	1/2000 cu. yd. (3 minimum) ASTM D2488	N.A.	1/2000 cu. yd. (3 minimum) ASTM D2488	1/2000 cu. yd. (3 minimum) ASTM D2488	1/2000 cu. yd. (3 minimum) ASTM D2488

SOIL CONSTRUCTION STANDARDS AND TESTING FREQUENCIES (cont.)

	CLAY	SAND DRAINAGE	BUFFER LAYER	GRAVEL$_{\Psi}$	ROOTING ZONE	TOPSOIL$_{\Phi}$
NUTRIENT CONTENT	N.A.	N.A.	N.A.	N.A.	N.A.	pH:6.1-7.5 Nitrogen: min. 30lbs/acre Phosphorus: min 30lbs/acre Potassium: min. 150 lbs/acre **Note**: Compost Materials that meet MnDOT 3890 or MN RULES Chapter 7035.2836 are acceptable for use as a soil amendment
Frequency of soil testing for borrow source evaluation (1)	N.A.	N.A.	N.A.	N.A.	N.A.	1/1500 cu. yd. (3 minimum)

SOIL CONSTRUCTION STANDARDS AND TESTING FREQUENCIES (cont.)

	CLAY	SAND DRAINAGE	BUFFER LAYER	GRAVEL$_{\Psi}$	ROOTING ZONE	TOPSOIL$_{\Phi}$
WATER CONTENT (soil construction standards)	Maintain at 0%-5% above optimum*	N.A.	N.A.	N.A.	N.A. Check available water holding capacity to enhance vegetative growth	N.A. Check available water holding capacity to enhance vegetative growth
frequency of soil testing for borrow source evaluation (1) (determines optimum moisture content)	1/3000 cu. yd. ASTM D2216	N.A.	N.A.	N.A.	N.A.	N.A.
frequency of soil testing for preconstruction verification at borrow source (2)	1/3000 cu.yd. ASTM D2216 or ASTM D3017	N.A.	N.A.	N.A.	N.A.	N.A.
frequency of in-place soil testing (3)	100 foot grid/lift off set each lift ASTM D2216	N.A.	N.A.	N.A.	N.A.	N.A.

* - Standards followed by an asterisk are requirements of the Minnesota Solid Waste Rules.

Ψ - Gravel or Pipe Bedding and Course Filter Aggregate.

Φ - Compost Used as part of the topsoil make-up shall meet the requirements of Minnesota Department of Transportation Specification 3890.

(1) - Frequency of soil testing for borrow source evaluation - refers to all testing requirements to determine the suitability of the properties of specified a borrow source for its desired use (e.g. checking the properties of a clay borrow source for suitability as a liner material)

(2) - Frequency of soil testing for preconstruction verification at borrow source refers to testing performed during the construction event to ensure that borrow source material is homogeneous and at the proper water content.

(3) - Frequency of in-place soil testing refers to all testing after soil has been placed during a construction event to ensure that the soil has been installed properly.

Soil Filter Analysis

This analysis is used to determine whether fine soil layers will wash through coarser layers. The analysis is based upon the grain size distribution for each layer. The criteria used to determine if the soils will not wash through each other are:

$$D_{15\ (\textbf{lower})}/D_{85\ (\textbf{upper})} < 5 \quad \text{and} \quad D_{50\ (\textbf{lower})}/D_{50\ (\textbf{upper})} < 25$$

Where D refers to the particle size at which the specified percent of particles are smaller.

If both relationships are true, the soil layers are compatible and the upper zone will not clog the lower zone. If either is not true, a geotextile or filter fabric is required to separate the two layers and prevent clogging.