
USACE / NAVFAC / AFCEA / NASA UFGS-02 66 00 (April 2006)

Preparing Activity: USACE Replacing without change
UFGS-02140 (August 2003)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 9 October 2006

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SECTION 02 66 00

SELECT FILL AND TOPSOIL FOR LANDFILL COVER 04/06

NOTE: This guide specification covers the requirements for select fill and topsoil layers for landfill cover systems. Select fill is the term used by USACE to describe soil layers placed directly on geosynthetic materials.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically
be deleted from this section of the project
specification when you choose to reconcile
references in the publish print process.

The publications listed below form a part of this specification to the
extent referenced. The publications are referred to within the text by the
basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2216	(2005) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2487	(2000) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(2004) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2974	(2000) Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
ASTM D 3017	(2004) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 422	(1963; R 2002) Particle-Size Analysis of Soils
ASTM D 4318	(2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4972	(2001) pH of Soils
ASTM D 698	(2000ae1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

1.2 UNIT PRICES

NOTE: Delete this paragraph when work is covered by
a lump-sum contract price. Weight measurement may
be used to supplement volume measurement surveys if
significant subgrade settlement is anticipated.

Measurement and payment for "select fill" and "topsoil" shall be based on
the respective unit prices for each cubic meter yard of "select fill" and
"topsoil" in place. This unit price shall include the cost for development

of borrow sources, cost of materials, excavation, hauling, equipment, placement, testing, and other work required to construct the "select fill" or "topsoil" layers.

1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Materials Handling Plan

Materials Handling Plan describing placement and compaction procedures. The plan shall also describe equipment to be used (including ground pressures).

SD-04 Samples

Select Fill

A minimum of 23 kg 50 pounds of select fill from each proposed borrow source to the Government's designated laboratory at least [15] [_____] days prior to placement.

Topsoil

A minimum of 2 kg 5 pounds of topsoil from each proposed borrow source to the Government's designated laboratory at least [15] [_____] days prior to placement.

SD-06 Test Reports

Borrow Source Assessment[; G][; G, [_____]]

Select Fill and Topsoil Material Tests

Moisture Content and Density Tests of In-Place Select Fill

Borrow Source Assessment Report at least [15] [_____] days prior to select fill and topsoil placement. No select fill or topsoil shall be placed until the Borrow Source Assessment Report is approved. The report shall include the following: location of each borrow source; estimated quantity of borrow available; logs of subsurface explorations; and laboratory test results.

1.4 EQUIPMENT

Equipment used to place the select fill and topsoil layers shall be as described in the approved Materials Handling Plan. Equipment shall not accelerate or brake suddenly, turn sharply, or be operated at speeds exceeding 8 km 5.0 miles per hour.

PART 2 PRODUCTS

2.1 Select Fill

NOTE: The default maximum allowable particle size is 25 mm (1 inch). If the select fill layer will be placed directly on top of a geomembrane, this value may have to be reduced and restrictions regarding angularity may have to be included. Manufacturers should be consulted for recommendations on select fill based on the type and thickness of geomembrane being used.

Selection of suitable select fill should be based on the type and availability of soils at or close to the site. The designer must verify that these soils will not clog underlying drainage layers. The soil types listed in Table 1 are generally acceptable for use as select fill.

Sands must be analyzed to ensure they are internally stable. A soil is internally stable if it is self-filtering (i.e., the fine particles do not move through the pores of the coarser fraction). Federal Highway Administration Publication No. FHWA-HI-95-038 describes procedures for determining the clogging potential and internal stability of soil.

The designer must also ensure the select fill is compatible with the underlying filter. For landfill applications, the filter is typically a geotextile. Filter design is based on a comparison of the grain size distribution (ASTM D 422) of the select fill and the apparent opening size (AOS) of the underlying geotextile. Geotextile filter design procedures are outlined in Federal Highway Administration Publication No. FHWA-HI-95-038.

Criteria for Atterberg limits are sometimes included in Table 1 to control the properties of the select fill.

Hydraulic conductivity criteria may also need to be added to Table 1 for the select fill soil. The hydraulic conductivity of the select fill layer controls the rate at which precipitation infiltrates into the underlying drainage layer.

Select fill shall comply with the criteria listed in Table 1 and shall be free of debris, frozen materials, angular rocks, roots, and organics.

2.2 Topsoil

Topsoil shall consist of natural, friable soil that is representative of soils in the vicinity which produce heavy growths of crops, grass, or other vegetation and is reasonably free from underlying subsoil, clay lumps, objectionable weeds, litter, brush, matted roots, toxic substances, or any material that might be harmful to plant growth or be a hindrance to grading, planting, or maintenance operations. Topsoil shall also comply with the criteria listed in Table 1.

TABLE 1
REQUIRED PHYSICAL PROPERTIES OF SELECT FILL AND TOPSOIL

Property	Test Value	Test Method
Select Fill		
Soil classification	Lean clay (CL) Clayey sand (SC) Clayey gravel (GC) [_____]	ASTM D 2487
Max. particle size (mm)	25 [_____]	ASTM D 422
Topsoil		
Max. particle size (mm)	25	ASTM D 422
pH	5-7	ASTM D 4972
Organic content (%)	5-20	ASTM D 2974

TABLE 1
REQUIRED PHYSICAL PROPERTIES OF SELECT FILL AND TOPSOIL

Property	Test Value	Test Method
Select Fill		
Soil classification	Lean clay (CL) Clayey sand (SC) Clayey gravel (GC) [_____]	ASTM D 2487
Max. particle size (inches)	1.0 [_____]	ASTM D 422
Topsoil		
Max. particle size (inches)	1	ASTM D 422
pH	5-7	ASTM D 4972
Organic content (%)	5-20	ASTM D 2974

PART 3 EXECUTION

3.1 BORROW SOURCE ASSESSMENT

3.1.1 Select Fill

NOTE: A test fill should be required when needed to demonstrate placement technique or to determine cover or liner stability. Section 02 66 10 TEST FILL can be edited and included in the specification package if a test fill will need to be constructed.

Shear strength testing is often required for landfill covers and liners which contain geosynthetics. Criteria for shear strength testing are described in Section 02 56 13 WASTE CONTAINMENT GEOMEMBRANE or Section 02 56 15 GEOSYNTHETIC CLAY LINER (GCL).

3.1.1.1 Classification Testing

Borrow source assessment tests shall be performed on each principal type or combination of materials proposed for use in the select fill layer to ensure compliance with specified requirements. At least one set of borrow assessment tests shall be performed on each borrow source proposed for use.

A set of borrow source assessment tests shall consist of Atterberg limits (ASTM D 4318), particle size analysis (ASTM D 422), and moisture content (ASTM D 2216). Based on borrow source assessment testing, soils shall be classified in accordance with ASTM D 2487.

3.1.1.2 Moisture-Density (Compaction) Testing

NOTE: Delete this paragraph if compaction requirements will not be specified for the select

fill layer.

A representative sample from each principal type or combination of borrow materials shall be tested to establish compaction curves using **ASTM D 698**. At least one compaction test shall be performed on each borrow source proposed. A minimum of [5] [_____] points shall be used to develop each compaction curve. During construction, placement of select fill shall conform to the following requirements:

- a. The minimum allowable dry density shall be no less than [90] [_____] percent of maximum dry density.
- b. The allowable moisture content range shall be [+/- 3] [_____] percent of optimum.

3.1.2 Topsoil

Testing shall be performed on representative samples of each principal type or combination of topsoil materials. At least one set of tests shall be performed on each borrow source proposed. Testing shall consist of the determination of maximum particle size in accordance with **ASTM D 422**, pH in accordance with **ASTM D 4972**, and organic content in accordance with **ASTM D 2974**.

3.1.3 Chemical Contamination Testing

Borrow used for the select fill and topsoil layers shall be free of contamination. Each proposed borrow source shall be sampled and analyzed for chemical contamination in accordance with Section **01 35 45.00 10** CHEMICAL DATA QUALITY CONTROL.

3.2 INSTALLATION

3.2.1 Select Fill Placement

NOTE: Large landfills may require the construction of temporary haul roads to allow access for large construction equipment during select fill placement. The haul roads are typically a minimum of 1 meter (3 feet) in thickness and are constructed using select fill layer soil.

No equipment shall be operated directly on the top surface of geosynthetics without permission from the Contracting Officer. Select fill shall be pushed out over geosynthetics in an upward tumbling motion so that wrinkles in geosynthetics do not fold over. Soil shall not be dropped directly onto geosynthetics from a height greater than **915 mm 3 feet**. On slopes, select fill shall be placed from the bottom of the slope upward.

3.2.1.1 Initial Lift of Select Fill Placed Over Geosynthetics

The first lift of soil placed over geosynthetics shall be a minimum of **[305] [380] mm [12] [15] inches** in loose thickness. Equipment with ground pressures less than **49 kPa 7 psi** shall be used to place and traffic compact the first lift of select fill. Traffic compaction shall consist of a minimum of 2 passes over all areas.

3.2.1.2 Subsequent Lifts of Select Fill

NOTE: Maximum loose lift thickness should be no greater than 8 inches if a density criteria will be applied to the lift. The criteria for minimum number of passes can be omitted if the Contractor must meet a density criteria.

The loose lift thickness of each subsequent lift shall be no greater than [205] [305] mm [8] [12] inches. Full scale placement and compaction equipment shall be allowed on areas underlain by geosynthetics after the [first] [second] loose lift of soil has been placed. [Compaction shall consist of a minimum of 2 passes over all areas.]

3.2.2 Topsoil Placement

Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to proper grading. Topsoil shall be placed in one lift and shall be evenly spread to a final compacted thickness of [150] [] mm [6] [] inches. Topsoil shall be traffic compacted using approved placement equipment. On slopes, topsoil shall be placed from the bottom of the slope upward.

3.3 CONSTRUCTION TOLERANCES

NOTE: The U.S. Environmental Protection Agency document, EPA/600/R-93/182 Quality Assurance and Quality Control for Waste Containment Facilities discourages the use of grade stakes which penetrate the select fill layer to control lift thickness. Grade stakes can potentially damage underlying geosynthetic materials.

Finished surfaces shall be uniformly graded and shall be free from depressions, mounds, or windrows. The top surface of the select fill layer and topsoil layer shall be no greater than [76] [] mm [3] [] inches above the lines and grades shown on the drawings. No minus tolerance will be permitted. Rigid grade stakes shall not be driven into the select fill layer to control placement.

3.4 CONSTRUCTION TESTS

3.4.1 Select Fill and Topsoil Material Tests

During construction of the select fill layer, representative samples shall be taken for testing at the frequencies listed in Table 2 from the borrow source prior to placement. Test results must comply with the requirements listed in Part 2 Products or the material will be rejected for use.

TABLE 2
SELECT FILL AND TOPSOIL MATERIAL TESTING FREQUENCIES

Property	Frequency	Test Method
Select Fill		
Grain size analysis	1,500 cubic meters	ASTM D 422
Atterberg limits	1,500 cubic meters	ASTM D 4318
Compaction (Note 1)	4,000 cubic meters	ASTM D 698
Topsoil		
Grain size analysis for maximum particle size	1,500 cubic meters	ASTM D 422
pH	1,500 cubic meters	ASTM D 4972
Organic content	1,500 cubic meters	ASTM D 2974

TABLE 2
SELECT FILL AND TOPSOIL MATERIAL TESTING FREQUENCIES

Property	Frequency	Test Method
Select Fill		
Grain size analysis	2,000 cubic yards	ASTM D 422
Atterberg limits	2,000 cubic yards	ASTM D 4318
Compaction (Note 1)	5,200 cubic yards	ASTM D 698
Topsoil		
Grain size analysis for maximum particle size	2,000 cubic yards	ASTM D 422
pH	2,000 cubic yards	ASTM D 4972
Organic content	2,000 cubic yards	ASTM D 2974

Note 1: Compaction test results shall be compared with the results obtained during the borrow source assessment. When there are significant differences, adjustments to the acceptable moisture content or density ranges shall be proposed by the Contractor for approval.

3.4.2 Moisture Content and Density Tests of In-Place Select Fill

NOTE: Density testing requirements are usually waived for the first 305 to 460 mm (12 to 18 inches) of select fill placed over geosynthetics to prevent damage to the underlying geosynthetics. Remove this paragraph if moisture content and density testing will not be performed on any of the select fill lifts.

Moisture content and density tests shall be performed in accordance with Table 3. Density requirements will not be enforced for the first lift of the select fill layer.

TABLE 3
MOISTURE CONTENT AND DENSITY TESTS OF IN-PLACE SELECT FILL

Property	Frequency per Lift	Test Method
Nuclear moisture content	925 square meters	ASTM D 3017
Standard moisture content	1 for every 20 nuclear tests	ASTM D 2216
Nuclear density	925 square meters	ASTM D 2922
Standard density	1 for every 20 nuclear tests	ASTM D 1556 or ASTM D 2167

TABLE 3
MOISTURE CONTENT AND DENSITY TESTS OF IN-PLACE SELECT FILL

Property	Frequency per Lift	Test Method
Nuclear moisture content	10,000 square feet	ASTM D 3017
Standard moisture content	1 for every 20 nuclear tests	ASTM D 2216
Nuclear density	10,000 square feet	ASTM D 2922
Standard density	1 for every 20 nuclear tests	ASTM D 1556 or ASTM D 2167

3.4.2.1 Test Frequencies and Locations

Each day that select fill is placed, a minimum of one set of standard moisture content and density tests shall be performed. Nuclear density and moisture content tests shall be checked at the frequencies shown in Table 3. Standard tests shall be performed at locations which are as close as possible to the locations of the nuclear tests being checked.

3.4.2.2 Nuclear Density and Moisture Content Tests

Nuclear density readings shall be taken in the direct transmission mode. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using only the sand cone method as described in ASTM D 1556. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017; the calibration checks of both the density and moisture gauges shall be

made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer.

3.4.2.3 Test Results

Field moisture content and density test results shall be compared to the compaction curve for the appropriate material type being tested. If test results are not within the acceptable range for moisture content or density, as described in subparagraph Moisture-Density (Compaction) Testing, [3] [] additional tests shall be performed near the location of the failed parameter. If all retests pass, no additional action shall be taken. If any of the retests fail, the lift of soil shall be repaired out to the limits defined by passing tests for that parameter. The area shall then be retested as directed.

3.5 PROTECTION

3.5.1 Damage

Erosion rills or other damage that occurs shall be repaired and grades re-established. Repairs to the select fill layer or topsoil layer shall be documented including location and volume of soil affected, corrective action taken, and results of retests.

3.5.2 Stockpiles

Storage or stockpiling of material on the completed surface of the select fill or topsoil layers will not be permitted.

-- End of Section --