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USACE / NAVFAC / AFCESA / NASA **UFGS-02 56 14 (April 2006)**

Preparing Activity: USACE **Replacing without change UFGS-02377 (August 2004)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 18 July 2006

Revised throughout - changes not indicated by CHG tags
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04/06

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SECTION 02 56 14

CLAY BARRIER LAYER
04/06

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NOTE: This guide specification covers the requirements for construction of a clay barrier layer to isolate contaminated material from the environment.

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 1140	(2000) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2002e1) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1587	(2000) Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
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 2488	(2000) Description and Identification of Soils (Visual-Manual Procedure)
ASTM D 2922	(2004) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(2004) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3740	(2004) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 422	(1963; R 2002) Particle-Size Analysis of Soils
ASTM D 4220	(1995; R 2000) Preserving and Transporting Soil Samples
ASTM D 4318	(2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 5084	(2003) Measurement of Hydraulic Conductivity of Saturated Porous Materials

	Using a Flexible Wall Permeameter
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 (landfill cover applications) is anticipated.
****

Measurement and payment for the clay barrier layer shall be based on the unit price schedule for each cubic meter cubic yard of clay in place. This unit price shall include the cost for development of the clay borrow source, cost of clay, excavation, hauling, equipment, placement, testing, and other incidental work required to construct the clay barrier layer.

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

Protection
Equipment

Materials Handling Plan describing the following: processing and placement of the clay; type, model number, weight and critical dimensions of equipment to be used for soil processing, compaction, scarification, and smooth rolling; method of protecting clay from changes in moisture content and freezing after placement.

Commercial Testing Laboratory

Name and qualifications of the proposed commercial testing laboratory.

SD-04 Samples

Clay
Quality Assurance Samples

A minimum of 46 kg 100 pounds of each principal type of material or combination of materials to the Government's designated laboratory at least [30] [_____] days prior to placement.

SD-06 Test Reports

Borrow Source Assessment[; G][; G, [_____]]
Assessment Tests[; G][; G, [_____]]
Moisture Content and Density Tests of In-Place Clay[; G][; G, [_____]]
Hydraulic Conductivity Tests of In-Place Clay[; G][; G, [_____]]

Borrow Source Assessment Report at least [15] [_____] days prior to clay placement. No clay shall be placed until the Borrow Source Assessment Report is approved. The report shall include the following: location of each borrow source; plan view and estimated available quantity of clay; locations and logs of subsurface explorations; laboratory test results; moisture-density curves showing the "Acceptable Zone" of moisture contents and densities which achieve the required hydraulic conductivity for each principal type of material or combination of materials.

1.4 EQUIPMENT

****
NOTE: A soil stabilizer or road regrader is often specified for use on soils that have clods or particles which are difficult to reduce to an acceptable size.
****

Equipment used to place the clay barrier layer shall not brake suddenly, turn sharply, or be operated at speeds exceeding 8 km 5.0 miles per hour.

1.4.1 Compaction Equipment

Compaction equipment shall consist of tamping foot rollers which have a minimum weight of 18,140 kg 40,000 pounds. At least one tamping foot shall be provided for each 71,000 square mm 110 square inches of drum surface. The length of each tamping foot, from the outside surface of the drum, shall be equal to or greater than the loose lift thickness. During compaction operations, the spaces between the tamping feet shall be maintained clear of materials which would impair the effectiveness of the tamping foot rollers.

1.4.2 Scarification Equipment

****
NOTE: Tamping foot rollers create a roughened surface on each lift of clay. The designer must determine if scarification is required to further roughen the surface of the clay layer prior to placement of additional lifts of clay. If additional scarification is not required, omit this paragraph and other references to scarification throughout this section.
****

Disks, rotor tillers, or other approved means shall be provided to scarify the surface of each lift of clay prior to placement of the next lift. The scarification equipment shall be capable of uniformly disturbing the upper 25 mm 1 inch of the clay surface to provide good bonding between lifts.

1.4.3 Steel Wheeled Rollers

****
NOTE: The upper surface of the clay layer must be smooth rolled if a geosynthetic will be placed on top of the clay layer. Remove this paragraph and all other references to smooth rolling if a geosynthetic will not be placed on top of the clay layer.
****

A smooth, non-vibratory steel wheeled roller shall be used to produce a smooth compacted surface on the clay barrier layer. Steel wheeled rollers shall weigh a minimum of 9,070 kg 20,000 pounds.

1.4.4 Hand Operated Tampers

Hand operated tampers shall consist of rammers or other impact type equipment. Vibratory type equipment will not be allowed.

PART 2 PRODUCTS

2.1 CLAY

****
NOTE: The physical criteria listed in Table 1 are

minimum requirements. More restrictive criteria may be appropriate depending on local soils. For composite geomembrane/clay covers and liners, the maximum particle size should be reduced to 12.5 mm (0.5 inches) in the upper lift of clay layer to prevent puncturing of the geomembrane.

Bentonite is often added to soils that do not contain enough clay to achieve the desired hydraulic conductivity. Refer to EPA/600/R-93/182 - Quality Assurance and Quality Control for Waste Containment Facilities if bentonite will be used as an additive to the available soils.

****

Clay shall be free of roots, debris, organic or frozen material, and shall have a maximum clod size of 50 mm 2 inches at the time of compaction. Clay material shall comply with the criteria listed in Table 1.

TABLE 1
REQUIRED PHYSICAL PROPERTIES OF CLAY

Property	Test Value	Test Method
Max. particle size (mm)	25	ASTM D 422
Min. percent passing 4.75 mm sieve	80	ASTM D 422
Min. percent passing 0.075 mm sieve	50	ASTM D 1140
Min. liquid limit	35	ASTM D 4318
Min. plasticity index	10	ASTM D 4318
Max. plasticity index	40	ASTM D 4318

TABLE 1
REQUIRED PHYSICAL PROPERTIES OF CLAY

Property	Test Value	Test Method
Max. particle size (inches)	1	ASTM D 422
Min. percent passing No. 4 sieve	80	ASTM D 422
Min. percent passing No. 200 sieve	50	ASTM D 1140
Min. liquid limit	35	ASTM D 4318
Min. plasticity index	10	ASTM D 4318
Max. plasticity index	40	ASTM D 4318

PART 3 EXECUTION

3.1 BORROW SOURCE ASSESSMENT

****

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

****

Borrow source assessment tests shall be performed on each principal type or combination of materials proposed for use in the clay barrier layer to assure compliance with specified requirements and to develop compaction requirements for placement. A minimum of one set of borrow assessment tests shall be performed for each borrow source proposed. A set of borrow source assessment tests shall consist of classification testing, moisture-density (compaction) testing, and hydraulic conductivity testing.

3.1.1 Classification Testing

****
NOTE: Test pits should be used, if possible, because they provide a better method of characterizing borrow sources than borings.
****

[Test pits] [Borings] placed in a grid pattern shall be used to characterize each proposed borrow source. The [test pits] [borings] shall extend to the full depth of the proposed borrow source. Visual classification as described in ASTM D 2488 shall be performed over the full depth of each [test pit] [boring] by a [qualified] [registered] geologist or geotechnical engineer. Soils shall be grouped into "principal types" based on visual classification. Classification testing shall be performed on representative samples of each principal type or combination of materials. At a minimum, one set of classification tests shall be performed per 5000 cubic meters 6500 cubic yards of proposed borrow. Classification testing shall consist of liquid and plastic limits in accordance with ASTM D 4318 and particle size analysis in accordance with ASTM D 422. Moisture content testing of proposed borrow shall be performed at a frequency of once per 2000 cubic meters 2600 cubic yards in accordance with ASTM D 2216.

3.1.2 Compaction Testing

****
NOTE: A minimum of two compaction efforts are recommended to adequately define the relationship between moisture-density and hydraulic conductivity. A reduced compaction procedure may also be used. The reduced compaction procedure is the same as ASTM D 698 except 15 drops of the hammer per lift are used instead of 25. The reduced compactive effort is expected to correspond to a reasonable minimum level of compactive energy for a typical soil liner or cover.
****

A representative sample from each principal type or combination of borrow materials shall be tested to establish compaction curves using [_____], ASTM D 698 and ASTM D 1557. A minimum of one set of compaction curves shall be developed per 5,000 cubic meters 6,500 cubic yards of each proposed borrow material. A minimum of [5] [_____] points shall be used to develop each compaction curve. The compaction curves for each principal type or combination of borrow materials shall be plotted on a single graph of dry density versus moisture content.

3.1.3 Hydraulic Conductivity Testing

****

NOTE: When performing hydraulic conductivity testing, the average effective confining pressure should be representative of post construction conditions. The minimum effective confining pressure should be equal to or greater than 21 kpa (3 psi) to avoid side wall leakage.

If the clay layer will be placed beneath hazardous waste, chemical compatibility testing may be appropriate. Chemical compatibility testing consists of performing hydraulic conductivity tests on the clay liner material using a representative leachate sample as the permeant.

****

A set of hydraulic conductivity tests shall be performed on representative samples of each principal type or combination of borrow materials. A minimum of one set of tests shall be performed per 5,000 cubic meters 6,500 cubic yards of proposed borrow material. A set of tests shall consist of one hydraulic conductivity test run on a representative sample corresponding to each point from each compaction curve at or above ASTM D 1557 optimum moisture content. Hydraulic conductivity testing referenced in this section shall be conducted in accordance with ASTM D 5084. In addition, the following procedures shall be adhered to when performing the hydraulic conductivity testing:

a. Saturation of test specimens shall be verified by determination of the B coefficient. The B coefficient must be at least 0.95. The B coefficient is defined as the change in pore water pressure divided by the change in confining pressure.

b. During consolidation of the test specimens, outflow volumes versus time shall be recorded on a semi-log graph to confirm primary consolidation has been completed prior to permeation of the specimens.

c. The permeant used for back pressure saturation and permeation shall be 0.01 molar calcium chloride solution created from deaired, distilled water as specified in ASTM D 5084.

d. The average effective confining pressure shall be [_____] kPa psi.

3.1.4 Acceptable Zone Development

****

NOTE: Additional testing may be required to determine the "Acceptable Zone" based on shear strength considerations.

****

An "Acceptable Zone" of moisture contents and densities shall be developed and displayed with the compaction curve graphs for each principal type of borrow material or combination of borrow materials. The "Acceptable Zone" shall consist of moisture-density values that meet the following requirements:

a. Maximum Allowable Hydraulic Conductivity = [1 x 10 to the -7 cm per second] [_____].

b. The minimum allowable moisture content shall be no less than [optimum moisture content] [_____] based on ASTM D 1557.

c. The minimum allowable density shall be no less than [90] [_____] percent of maximum dry density based on ASTM D 698.

3.1.5 Chemical Contamination Testing

Borrow used for the clay barrier layer 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.

3.1.6 Commercial Testing Laboratory

Tests for the clay barrier layer shall be performed by an approved testing laboratory furnished by the Contractor. No testing will be permitted until the facilities have been inspected and approved. The inspection will be performed to determine if the laboratory has a quality system in place for personnel, equipment, reporting procedures, record keeping, and equipment calibration that ensures the laboratory is capable of accurately performing the specified testing. The quality system shall be in accordance with ASTM D 3740 or as approved by the Government Inspector. The first inspection will be at the Government's expense. Cost incurred for subsequent inspections required because of deficiencies found during the first inspection will be charged to the Contractor.

3.2 INSTALLATION

3.2.1 Clay Placement

****

NOTE: Verify subgrade requirements are covered in another section of the specification package. The subgrade must provide adequate support for compaction of the clay barrier layer.

For clay barrier layers placed above geosynthetics, require the placement and compaction equipment work from the base of the slope up to prevent damage to underlying geosynthetics.

Clay is generally placed parallel to the direction of maximum slope. Clay placement parallel to the slope becomes difficult on slopes steeper than 3 horizontal on 1 vertical. Horizontal lifts should be considered for clay placement on slopes steeper than 3 horizontal on 1 vertical.

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 clay layer to control lift thickness.

****

Clay shall be placed to the lines and grades shown on the drawings. The clay shall be placed in loose lifts not to exceed 200 mm 8 inches in thickness. In areas where hand operated tampers must be used, the loose lift thickness shall not exceed 100 mm 4 inches. [Grade stakes shall not be driven into the clay layer.] [If grade stakes are driven into the clay layer to control lift thickness, they shall be numbered and accounted for at the end of each shift. When removing grade stakes, no broken portion of the grade stakes shall be left in the clay layer. Holes left by grade stakes shall be backfilled and compacted.]

3.2.2 Moisture Control

Clay shall be placed and compacted within the "Acceptable Zone" moisture content range in the approved Borrow Source Assessment Report. The moisture content shall be maintained uniform throughout each lift. Water added shall be thoroughly incorporated into the clay to ensure uniformity of moisture content prior to compaction.

3.2.3 Compaction

****

NOTE: Special compaction procedures are required if geosynthetic layers are located immediately beneath the clay layer. The minimum initial lift thickness over geosynthetic layers is typically 300 mm (12 inches). This lift of soil is typically placed with low ground pressure track mounted equipment with a track pressure of 21 to 41 kPa (3 to 6 psi). No compaction requirements are generally specified for this first lift of clay.

For clay barrier layers placed on soft subgrades, lighter equipment and the relaxation or elimination of compaction criteria is often specified for the first lift of clay.

****

Clay shall be compacted to meet the density requirements in the approved Borrow Source Assessment Report and by at least [5] [_____] passes of the approved compaction equipment over all areas of each lift. For self-propelled compactors, one pass is defined as one pass of the entire vehicle. For towed rollers, one pass of the drum constitutes a pass. Hand operated tampers shall be used in areas where standard compaction equipment cannot be operated.

3.2.4 Scarification

****

NOTE: For geomembrane/clay composites, the final lift of clay is generally smooth rolled instead of being scarified to allow intimate contact between the clay surface and the overlying geomembrane. Smooth rolling also helps to prevent desiccation during delays in construction.

****

Scarification shall be performed on all areas of the upper surface of each clay lift prior to placement of the next lift. Scarification shall be accomplished with approved equipment. The final lift of clay shall not be

scarified. The final lift shall be smooth rolled with at least [3] [_____] passes of the approved smooth steel wheeled roller to provide a smooth surface with no ridges or depressions.

3.2.5 Repair of Voids

Voids created in the clay barrier layer during construction (including, but not limited to, penetrations for test samples, grade stakes, and other penetrations necessary for construction) shall be repaired by removing sand or other non-clay material, placing clay backfill in lifts no thicker than 76 mm 3 inches and tamping each lift with a steel rod. Each lift shall be tamped a minimum of 25 times altering the location of the rod within the void for each blow. Other ruts and depressions in the surface of the lifts shall be scarified, filled, and then compacted to grade.

3.3 CONSTRUCTION TOLERANCES

The top surface of the clay barrier 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.

3.4 CONSTRUCTION TESTS

3.4.1 Clay Material Tests

****
NOTE: The definition of unclassified materials must be determined on a site specific basis. Unclassified materials are typically defined using Atterberg limits, grain size distribution, or compaction testing.
****

During construction of the clay barrier layer, representative samples shall be taken for testing at the frequencies listed in Table 2 [from the borrow source] [from onsite stockpiles] [after a loose lift of clay has been placed] [_____]. Test results shall meet the requirements listed in Table 1. Unclassified material shall be defined as follows: [_____]. Where test results indicate an unclassified material type, additional testing shall be performed as described in paragraph BORROW SOURCE ASSESSMENT.

TABLE 2
CLAY MATERIAL PROPERTIES

Property	Frequency	Test Method
Particle size analysis (Note 1)	800 cubic meters	ASTM D 422
Atterberg limits (Note 1)	800 cubic meters	ASTM D 4318
Compaction (Note 2)	5,000 cubic meters	ASTM D 698

Note 1: At least one test shall be performed each day that soil is placed.
Note 2: Compaction test results shall be compared to previous results on the same material type to verify the compaction characteristics have

remained the same.

TABLE 2
CLAY MATERIAL PROPERTIES

Property	Frequency	Test Method
Particle size analysis (Note 1)	1,000 cubic yards	ASTM D 422
Atterberg limits (Note 1)	1,000 cubic yards	ASTM D 4318
Compaction (Note 2)	6,500 cubic yards	ASTM D 698

Note 1: At least one test shall be performed each day that soil is placed.
Note 2: Compaction test results shall be compared to previous results on the same material type to verify the compaction characteristics have remained the same.

3.4.2 Moisture Content and Density Tests of In-Place Clay

****
Note: Test results using ASTM D 3017 may show a significant amount of scatter in some situations. ASTM D 4643 (microwave method) can be used as an alternative to ASTM D 3017 for quick determinations of moisture content.

Density and hydraulic conductivity testing requirements are often waived for the first lift of clay placed on a soft subgrade or above a geosynthetic layer which could be damaged by compaction equipment.
****

Moisture content and density tests shall be performed in a grid pattern. The grid pattern shall be staggered for successive lifts so that sampling points are not at the same location in each lift. Moisture content and density tests shall be performed in accordance with Table 3.

TABLE 3
MOISTURE CONTENT AND DENSITY TESTS OF IN-PLACE CLAY

Property	Frequency Per Lift	Test Method
Rapid Moisture Content	800 square meters	ASTM D 3017
Standard Moisture Content	1 for every 10 rapid tests	ASTM D 2216
Rapid Density	800 square meters	ASTM D 2922
Standard Density	1 for every 20 rapid tests	ASTM D 1556 or ASTM D 2167

TABLE 3
MOISTURE CONTENT AND DENSITY TESTS OF IN-PLACE CLAY

Property	Frequency Per Lift	Test Method
Rapid Moisture Content	8,500 square feet	ASTM D 3017
Standard Moisture Content	1 for every 10 rapid tests	ASTM D 2216
Rapid Density	8,500 square feet	ASTM D 2922
Standard Density	1 for every 20 rapid tests	ASTM D 1556 or ASTM D 2167

3.4.2.1 Rapid Tests

Each day that clay is compacted, a minimum of one set of moisture content and density tests shall be performed using standard procedures. Rapid 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 location of the rapid 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

The field moisture content and density test results shall be plotted on the "Acceptable Zone" plot that corresponds to the appropriate material type being tested. If test results are not within the "Acceptable Zone" for moisture content or density, [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. Repairs to the clay layer shall be documented including location and volume of soil affected, corrective action taken, and results of retests.

3.4.3 Hydraulic Conductivity Tests of In-Place Clay

****

NOTE: Laboratory hydraulic conductivity tests constitute a major inconvenience because the tests usually take several days to perform. For this

reason, the use of laboratory hydraulic conductivity tests should be minimized or eliminated if possible.
****

Undisturbed samples shall be taken for hydraulic conductivity testing at a frequency of once per 3,720 square meters 40,000 square feet for each lift of clay placed. Samples shall be cut from the lift in accordance with ASTM D 1587 and transported in the vertical position in accordance with ASTM D 4220, Group C. Each undisturbed sample shall be tested for hydraulic conductivity in accordance with ASTM D 5084, [moisture content in accordance with ASTM D 2216], [particle size analysis in accordance with ASTM D 422], and [liquid and plastic limits in accordance with ASTM D 4318]. Hydraulic conductivity testing shall be conducted in accordance with the requirements in paragraph Hydraulic Conductivity Testing. If any test result is greater than the "Maximum Allowable Hydraulic Conductivity", modifications shall be proposed and approved for future placement of clay of that type. If the hydraulic conductivity of any test is more than one-half of one order of magnitude greater than the "Maximum Allowable Hydraulic Conductivity",[3] [_____] additional tests shall be performed near the location of the original failed test. If all retests pass, no additional action shall be taken. If any of the retests fail, the area shall be repaired out to the limits defined by passing hydraulic conductivity tests. The area shall then be retested as directed. Repairs to the clay layer shall be documented including location and volume of soil affected, corrective action taken, and results of retests.

3.4.4 Quality Assurance Samples

****
NOTE: Remove or modify this paragraph if the quality assurance laboratory will not perform hydraulic conductivity testing. On some projects, the Contractor is also tasked to periodically provide samples of borrow soil to the quality assurance laboratory for classification testing.
****

Quality assurance samples shall be taken at locations as directed. Samples shall be taken at a frequency of once per [_____] square meters square feet for each lift of clay placed. Samples shall be cut from the lift in accordance with ASTM D 1587 and shipped in the vertical position in accordance with ASTM D 4220, Group C.

3.5 PROTECTION

3.5.1 Moisture Content

****
NOTE: Smooth rolling or other measures may be necessary to limit moisture loss and/or promote run-off of surface water.
****

After placement, moisture content shall be maintained or adjusted to meet the acceptable zone criteria.

3.5.2 Erosion

Erosion that occurs in the clay layer shall be repaired and grades

re-established.

3.5.3 Freezing and Desiccation

Freezing and desiccation of the clay layer shall be prevented. If freezing or desiccation occurs, the affected soil shall be removed or reconditioned as directed.

3.5.4 Retests

Areas that have been repaired shall be retested as directed. Repairs to the clay layer shall be documented including location and volume of soil affected, corrective action taken, and results of retests.

-- End of Section --