ORIGINATION FORM

Date: **6/5/2014**
Originator: Ben Watson
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Specification Title: **145**
Specification Section, Article, or Subarticle Number:

Why does the existing language need to be changed? **Quality Control requirements need to be clarified in Section 145**

Summary of the changes: **Required soils testing for geosynthetically reinforced backfill is clarified.**

Are these changes applicable to all Department jobs?
If not, what are the restrictions? **Yes**

Will these changes result in an increase or decrease in project costs? **No**
If yes, what is the estimated change in costs?

With who have you discussed these changes? **Construction, Geotechnical Design**

What other offices will be impacted by these changes?

Are changes needed to the PPM, Design Standards, SDG, CPAM or other manual? **No**

Are all references to external publications current?
If not, what references need to be updated (please include changes in the redline)?

Is a Design Bulletin, Construction Memo, or Estimates Bulletin needed? **No**

Contact the State Specifications Office for assistance in completing this form.
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ANANTH PRASAD, P.E.
SECRETARY

M E M O R A N D U M

DATE: June 20, 2014

TO: Specification Review Distribution List

FROM: Daniel Scheer, P.E., State Specifications Engineer

SUBJECT: Proposed Specification: **1450000 Geosynthetic Reinforcement.**

In accordance with Specification Development Procedures, we are sending you a copy of a proposed specification change.

This change was proposed by Ben Watson of the State Materials Office (SMO) to clarify soils testing quality control requirements for geosynthetically reinforced backfill.

Please share this proposal with others within your responsibility. Review comments are due within four weeks and should be sent to Mail Station 75 or online at http://www2.dot.state.fl.us/SpecificationsEstimates/Development/IndustryReview.aspx . Comments received after **July 18, 2014,** may not be considered. Your input is encouraged.

DS/dt
Attachment

GEOSYNTHETIC REINFORCEMENT.
(REV ~~6-6-14~~*6-13-14*)

SECTION 145 is deleted and replaced by the following:

SECTION 145
GEOSYNTHETIC REINFORCEMENT

145-1 Description.

This Section specifies the construction requirements for geosynthetics used in: (1) geosynthetic reinforced soil slopes, and (2) geosynthetic reinforced foundations constructed on soft in-situ soils. Furnish and place geosynthetics and any associated facing material or drainage blankets.

145-2 Responsibility.

Construct the geosynthetic reinforced feature, including materials, method, and installation based on information provided in the Contract Documents and the geosynthetic supplier's recommendations. Provide shop drawings depicting the details and distribution of the selected geosynthetics which are required to meet the design shown in the Plans and in accordance with the requirements contained in the Department's Plans Preparation Manual (PPM) and Design Standards, Index No. 501 for these items. Alternate designs optimizing the selected geosynthetic materials may be submitted.

For alternate designs, provide complete design calculations and details which include: plan view, elevation view, and details in accordance with the Contract Documents. These shall show the extent, number of layers of geosynthetic reinforcement, minimum properties of each geosynthetic reinforcement layer, vertical spacing of geosynthetic reinforcement, orientation of geosynthetic facing details, details at special structures or obstructions, typical construction sequence, and top and bottom elevations of the geosynthetic reinforcement. Calculations shall be submitted to substantiate the design meets the requirements of Chapter 31 of the PPM and in accordance with the Contract Plans. As a minimum these shall clearly show the derivation of reinforcement requirements (i.e., type, spacing, length, etc.) and determination of all design parameters and factors. All plans and calculations are to be signed and sealed by a Professional Engineer registered in the State of Florida.

145-3 Materials.

145-3.1 Geosynthetic Materials: Use primary and secondary reinforcing elements consisting of a regular array of tensile elements that have sufficient reinforcement strength to perform the prime functions of reinforcement and which are listed on Design Standards, Index No. 501.

Deliver geosynthetic materials (including facing and drainage elements) to the job site in unopened shipping packages labeled with the supplier's name and product name. During shipping and storage, protect the geosynthetic from physical damage, debris and from temperatures greater than 140°F. Follow the supplier's recommendations regarding protection from direct sunlight. At the time of installation, the Engineer will reject the material if it has defects, tears, punctures, flaws, deterioration, or other damage. However, if approved by the Engineer, the Contractor may repair torn or punctured sections by placing a patch over the

damaged area. Replace or repair any rejected geosynthetic at no additional expense to the Department.

145-3.2 Backfill Materials: Use only free draining backfill material in the reinforced fill volume as shown in the Plans meeting the following gradation limits as determined in accordance with AASHTO T27 and FM 1 T-011:

Sieve Size	Percent Passing
3-1/2 inches	100
3/4 inch	70 to 100
No. 4	30 to 100
No. 40	15 to 100
No. 100	5 to 65
No. 200	0 to 15

Do not use backfill material containing more than *an average of* 2.0% by weight of organic material, as determined by FM 1-T 267 and by averaging the test results for three randomly selected, representative samples from each stratum or stockpile of a particular material. Consider the stratum or stockpile unsuitable for construction of the reinforced fill volume if an individual test value exceeds 3.0%.

Use backfill with a maximum plasticity index of six as determined by AASHTO T90, and a maximum liquid limit of 15 as determined by AASHTO T89. Use backfill materials with a pH between 4.5 and 10.0 *as determined by FM 5-550*. When metal pipes or other metal items are embedded in the backfill, use backfill with a pH between 6.0 and 10.0. Do not use soil cement or lime stabilized backfill unless approved by the Engineer.

Have the backfill material tested for every soil type for pH by a Department approved independent testing laboratory prior to placement. Provide certification to the Engineer that the results have met the requirements of this Section and are signed and sealed by a Professional Engineer, registered in the State of Florida.

145-4 Construction.

145-4.1 General: Obtain from the geosynthetic supplier, technical instructions, guidance in preconstruction activities, and on-site technical assistance during construction. Submit a copy of any instructions provided by the supplier to the Engineer prior to beginning installation.

145-4.2 Reinforced Soil Slopes:

145-4.2.1 Preparation: Remove all existing vegetation and all unsuitable foundation materials. Prepare the foundation in accordance with Section 110, except as noted herein.

Proof roll the graded area with a vibratory roller weighing a minimum of 8 tons or a sheepsfoot roller, where appropriate, exerting a compression of at least 250 pounds psi on the tamper foot for at least five passes in the presence of the Engineer or as directed by the Engineer. Remove and replace any soft or loose foundation subsoils that are, in the opinion of the Engineer, incapable of sustaining the required proof rolling, in accordance with Section 125.

Provide proof rolled ground surfaces which are uniform, smooth, and free of abrupt changes in slope, debris, and irregularities that might damage the reinforcement. Promptly repair and restore to their original condition any areas outside the limits of disturbance

shown in the Plans which are damaged as part of this work at no expense to the Department. Make every possible effort to avoid such damage.

145-4.2.2 Geosynthetic Placement: Place the geosynthetics at the proper elevation, location and orientation as shown in the Plans. In general, place the geosynthetics used for slope stabilization such that its primary direction of tensile strength is perpendicular to the plan face of the slope. Pull the geosynthetic material tight, and secure it as necessary to lay flat against the soil prior to fill placement.

Place adjacent rolls of geosynthetic to maintain 100% horizontal coverage at the face of the slope. When placing geosynthetic for curved embankments, do not allow less than 50% horizontal coverage or an unreinforced horizontal spacing greater than 3 feet at the end of the reinforcement farthest from the face of the slope. Do not allow vertical spacing of the geosynthetic layers to exceed the spacing shown on the shop drawings.

Do not make any splices or seams in the primary direction of tensile strength in the geosynthetic without approval of the Engineer. When splices in the primary direction are approved, make splices full width of the geosynthetic strip by using a similar material with similar strength. Use a splice mechanism that allows a minimum of 95% load transfer from piece to piece of geosynthetic. Make only one splice per length of geosynthetic. Do not place splices within 6 feet of the slope face, within 6 feet below top of slope, or horizontally adjacent to another splice.

Place only that amount of geosynthetic material, including facing and drainage material, which will be covered in a single days' production.

Do not operate equipment directly on the geosynthetics. Operate equipment such that no turning movements occur on the areas where geosynthetic is in place with less than 12 inches of fill cover. Fill and compact ruts of more than 3 inches in depth as they develop.

145-4.2.3 Backfill Placement: *Perform work in accordance with an approved QC Plan meeting the requirements of 105-3. A LOT is defined as a single lift of finished embankment not to exceed 500 feet in length.* Maintain uniform moisture content of the backfill material prior to and during compaction throughout each layer of material. Use backfill material having a placement moisture content within 2% on the dry side of optimum. Do not place wet backfill with moisture content greater than optimum in the fill. Spread backfill material over the geosynthetic in the direction of geosynthetic overlaps. Do not stockpile backfill materials on the installed geosynthetics. Avoid construction procedures or equipment which, in the opinion of the Engineer, will cause excessive mudwaving.

Compact the backfill using either smooth wheel or rubber tire rollers. Do not use sheepsfoot, grid rollers, or other types of equipment employing a foot. At the end of each day's operation, slope the backfill surface in order to permit runoff of rainwater away from the slope face, or provide some other positive drainage. *Do not exceed the maximum allowable lift thickness in Section 120.*

145.4.2.4 Repairs: Replace geosynthetic reinforcement damaged during or after installation at no expense to the Department. Repair geosynthetics damaged during or after installation only after the supplier establishes that the interior and exterior stability is not affected and after obtaining the Engineer's approval. Make such repairs as follows:

Remove all backfill material from the damaged area of the reinforcement geosynthetic plus an additional 4 feet in all directions beyond the limits of damage. Place a patch consisting of the same material as the reinforcement geosynthetic over the damaged area.

Overlap the undamaged reinforcement geosynthetic with the patch a minimum of 3 feet in all directions. Then replace and compact backfill material in accordance with 145-4.2.3.

145-4.3 Reinforced Foundations Constructed on Soft In-Situ Soils:

145-4.3.1 Preparation: For some applications involving reinforcement of soft insitu soils, the Engineer may require that some vegetation be left in place. If directed in the Plans or by the Engineer, cut trees to within 6 inches of the ground line, and leave the stumps in place. Remove fallen trunks, limbs, etc. greater than 3 inches in diameter.

145-4.3.2 Backfill Placement: Meet the requirements of 145-4.2.3.

145-4.3.3 Geosynthetic Placement: Position and orient the geosynthetics over prepared surfaces. Place a geotextile filter of a type recommended by the designer of the geosynthetic system under the reinforcement geosynthetic. Cut and overlap geosynthetics as necessary to accommodate curves. Overlap or join ends and sides of adjacent geosynthetic courses as shown in the Plans and in accordance with 145-4.2.2. Make any overlaps in geosynthetics in the same direction that covering embankment will be spread. Take care to ensure that the geosynthetic sections do not separate at overlaps during construction. Pull the geosynthetic material tight by hand to a tension that removes all slack.

145-4.3.4 Repairs: Meet the requirements of 145-4.2.4.

145-5 Certification.

Furnish certification from the supplier, at least ten days prior to placement, that the products used are the same products listed on Design Standards, Index No. 501, are in accordance with the project design requirements and is recommended by the supplier for use at this location.

Acceptance of furnished material will be based on the supplier's certification and visual inspection by the Engineer.

145-6 Acceptance Program.

145-6.1 General Requirements: *Meet the requirements of 120-10 except delete the requirements of 120-10.1.4.1, 120-10.1.6, and 120-10.2 and 120-10.3.*

145-6.2 Maximum Density Determination: *Determine the maximum QC density in accordance with FM 1 T-180. Determine the maximum density in accordance with AASHTO T99, Method C. Perform gradation tests on the sample collected in accordance with AASHTO T27 and FM 1-T 011.*

145-6.3 Density Testing Requirements: *Ensure compliance with the requirements of nuclear density testing in accordance with FM 1-T238. Determine the in-place moisture content for each density test. Use FM 5-507 (Determination of Moisture Content by Means of a Calcium Carbide Gas Pressure Moisture Tester), or FM 5-535 (Laboratory Determination of Moisture Content by Granular Soils by Use of a Microwave Oven) for moisture determination.*

145-6.3.1 Acceptance Criteria: *For select backfill, obtain a density in each LOT of at least 95% of the maximum density as determined by AASHTO T180.*

145-6.3.1.1 Optional Acceptance Criteria for A-3 and A-2-4 Materials*: Obtain a minimum density of 100 of the maximum dry density as determined by AASHTO T99. The combined width from both reinforced fill volume and retained fill material may be considered the same LOT if both volumes comprise the same material and both are compacted with the same procedure, lift thickness, equipment and compacting effort.*

145-6.4 Frequency: *Conduct sampling and testing at a minimum frequency listed in the table below. The Engineer will perform verification sampling and tests at a minimum frequency listed in the table below.*

Test Name	*Quality Control (QC)*	*Verification*
Maximum Density	*One per soil type*	*One per soil type*
Density	*One per LOT*	*One per four LOTs*
Soil Classification, Gradation, LL & PI	*One per Maximum Density*	*One per Maximum Density*
Organic Content	*One per soil type*	*One per soil type*

In addition, test for pH at a minimum frequency of one test per soil type at point of placement according to 145-3. The Engineer will collect enough material to split and create two separate samples and retain one for resolution at point of placement until LOTs represented by the samples are accepted.

145-6.5 Test Selection and Reporting: *Determine test locations including Stations and offsets, using the random number generator approved by the Engineer. Do not use note pads or work sheets to record data for later transfer to the Density Log Book. Notify the Engineer upon successful completion of Quality Control testing on each LOT.*

145-7 Verification Comparison Criteria and Resolution Procedures.

145-7.1 Maximum Density Determination: *The Engineer will collect enough material to split and create two separate samples and retain one for resolution until LOTs represented by the samples are accepted. The Engineer will meet the requirements of 120-10.4.1 except replace AASHTO T99, Method C with FM 1-T 180, Method D. If the Contractor selects the Optional Acceptance Criteria, the Engineer will verify the QC results of AASHTO T99, Method C in accordance with 120-10.4.1.*

145-7.2 Density Testing: *Meet the requirements of 120-10.4.2.*

145-7.3 Gradation: *The Engineer will verify the QC results if the verification result meets the gradation limits set forth in the gradation table of 145-3.2. Otherwise, the Engineer will test the sample retained in 145-6.1. The State Materials Office (SMO) or an AASHTO accredited laboratory designated by the SMO will perform resolution testing. The material will be sampled and tested in accordance with AASHTO T27 and FM 1-T 011.*

If the resolution test result satisfies the required gradation limits, the LOTs will be verified. If the resolution test results do not meet the required gradation limits, reconstruct the LOTs with acceptable material. The Engineer will perform new verification testing.

145-7.4 Liquid Limit and Plasticity Index (LL&PI): *The Engineer will verify the QC results if the verification result satisfies the plasticity index and liquid limit criteria set forth in 548-2.6. Otherwise, the Engineer will test the sample retained in 145-6.1. The SMO or an AASHTO accredited laboratory designated by the SMO will perform resolution testing. The material will be sampled and tested in accordance with AASHTO T90 & AASHTO T89, respectively.*

If the resolution test result satisfies the required criteria, LOTs of that soil type will be verified. If the resolution test results do not meet the required criteria, reconstruct the corresponding LOTs with acceptable material. The Engineer will perform new verification testing.

145-7.5 Soil Classification: *The Engineer will meet the requirements of 120-10.4.3 except test the sample retained in 145-6.1 instead of taking the additional one.*

145-7.6 Organic Content: *The Engineer will verify the QC results if the verification result satisfies the organic content test criteria set forth in 145-3.2. Otherwise, the Engineer will collect three additional samples. The material will be sampled and tested in accordance with FM 1-T 267 and by averaging the test results for three randomly selected samples from at least one lift per soil type. The SMO or an AASHTO accredited laboratory designated by the SMO will perform resolution testing. If the resolution test result satisfies the required criteria, material of that soil type will be verified and accepted. If the resolution test results do not meet the required criteria, reject the material and reconstruct with acceptable material.*

145-7.7 pH: *The Engineer will verify the QC results if the verification result satisfies the pH test criteria set forth in 145-3.2. Otherwise the Engineer will collect an additional sample. The SMO or an AASHTO accredited laboratory designated by the SMO will perform resolution testing. The material will be sampled and tested in accordance with FM 5-550. If the resolution test result satisfies the required criteria, material of that soil type will be verified and accepted. If the resolution test results do not meet the required criteria, reject the material and reconstruct with acceptable material.*

145-~~6~~ *8* Method of Measurement.

145-~~6~~*8*.1 Geosynthetic Reinforced Soil Slopes: The quantity to be paid for will be the plan area, in square feet, of the projected vertical height of the slope face, measured from the top of slope to the proposed final ground line at the toe of slope and from the beginning to end limits as shown in the Plans, regardless of the length or number of layers of geosynthetic within the reinforced volume and including any reinforcement required below the toe of slope elevation.

145-~~6~~*8*.2 Geosynthetic Reinforced Foundations over Soft Soils: The quantity to be paid for will be the plan area, in square yards, of the embankment to be reinforced as shown in the Plans, regardless of the length or number of layers of geosynthetic within the reinforced soil volume, and including any reinforcement required below the original ground elevation.

145-~~7~~ *9* Basis of Payment.

145-~~7~~*9*.1 Geosynthetic Reinforced Soil Slopes: Price and payment will be full compensation for all work, materials, and services specified in this Section, including design and shop drawings, geosynthetic materials, facing materials and/or treatment, installation, testing, and required submittals. The cost and placement of all backfill material will be included in the pay quantity for embankment or borrow excavation, as applicable.

145-~~7~~*9*.2 Geosynthetic Reinforced Foundations over Soft Soils: Price and payment will be full compensation for all work, materials, and services specified in this Section, including geosynthetic materials, geotextile filter materials, facing materials, drainage materials, installation, testing, and required submittals. The cost and placement of all backfill will be included in the pay quantity for embankment or borrow excavation, as applicable.

145-~~7~~*9*.3 Payment Items: Payment will be made under:

Item No. 145- 1- Geosynthetic Reinforced Soil Slopes - per square foot.

Item No. 145- 2- Geosynthetic Reinforced Foundations over Soft Soils - per square yard.