TRANSPORTATION CABINET
Frankfort, Kentucky 40622
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Steven L. Beshear
Governor

Joe Prather
Secretary

MEMORANDUM

Design Memo No. 02-09
Construction Memo No. 06-09

TO: **Chief District Engineers**
Design Engineers
Active Consultants

FROM: **Jeff D. Jasper, P.E.**
Director
Division of Highway Design

Steven Criswell, P.E.
Director
Division of Construction

DATE: **July 21, 2009**

SUBJECT: **Turf Reinforcing Mat Specification, Special Note and Standard Drawing Sepia**

This Design Memorandum discusses the use of Permanent Turf Reinforcement mats for use on KYTC projects. These can either be used in the protection of fill slopes or channel/ditch lining applications. They are also appropriate for use as a permanent BMP to increase infiltration and water quality. This memorandum applies to all projects let to construction on September 25, 2009 or thereafter.

Attached to this Design Memo is an updated version of Special Note 11F that supersedes the current Special Note 11F dated 3-28-2008. Also attached are two new Standard Drawing Sepia's "Turf Mat Channel Installation" and "Turf Mat Slope Installation." The List of Approved Materials has been updated to correspond with this memorandum.

Turf Reinforcing Mats are used in conjunction with vegetation to provide a long term composite lining system that is resistant to the shear stresses caused by flowing water. Turf Reinforcement Mats may be used in ditches and channels, fill slopes, stream banks, and shorelines where the erosive forces of flowing water would exceed the shear stress limits of unreinforced vegetation. They may also be used as an alternative rip rap due to economic or environmental considerations. Turf Reinforcing Mats may not be economically competitive on jobs with large quantities of rock available on the job for use as channel lining.

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Turf Reinforcing Mats provide water quality benefits over traditional aggregate linings. Vegetative linings act as a filtration system for the water flowing over their surfaces. By using Turf Reinforcing Mats, vegetated linings can be used over a larger range of flows than traditional unreinforced vegetation. Vegetated Turf Reinforcing Mats also encourage infiltration of surface runoff through the underlying soil. Turf Reinforcing Mats should be used in Karst areas or other areas where the environmental benefits are desirable.

The performance of Turf Reinforcing Mats is highly dependant on proper establishment of vegetation. Therefore, turf mats should not be used where frequent ponding would drown the vegetation before it can be established. In this instance, a possible solution is to install rip rap along the channel bottom to a depth that is equal to a smaller storm flow (2 yr storm flow depth) and use Turf Reinforcing Mat above this elevation. Turf Reinforcing mats may also experience problems in areas were establishment of vegetation may prove difficult because of other mechanisms. These areas include drainage channels carrying acidic runoff, rocky soils, shady areas or areas that presently exhibit sparse vegetation growth.

The design shear stress calculations should be based on the Turf Reinforcing Mats in their vegetated state. The Manning's n values used for channel lining design involving Turf Reinforcing Mats should be assumed to be the same as vegetation alone. The allowable shear stresses of the vegetated Turf Reinforcing Mats are listed in the attached Special Note 11F. As with other channel lining analyses, the 10 year storm should be used to calculate the applied shear stresses expected in the channel.

As a point of clarification, Turf Reinforcing Mats should not be confused with Erosion Control Blankets and/or Channel Change Erosion Control Blankets. Erosion Control Blankets are discussed in Section 212 of the Standard Specifications for Road and Bridge Construction. Erosion Control Blankets are used to temporarily stabilize soil areas until vegetation can be established. Channel Change erosion control blanket are based on the same principal as Erosion Control Blankets except that they are intended for use in stabilizing larger streams. Channel Change Erosion Control Blankets are discussed in Special Note 10L of the Standard Specifications for Road and Bridge Construction. Whereas Turf Reinforcing Mats are composed of non-degradable materials, Erosion Control Blankets and Channel Change Erosion Control Blankets are degradable.

JDJ/SC/WDM/RCA/JJF

Attachments

SPECIAL NOTE FOR TURF REINFORCING MAT

1.0 DESCRIPTION. Install turf reinforcement mat at locations specified in the Contract or as the Engineer directs. Section references herein are to the Department's 2008 Standard Specifications for Road and Bridge Construction.

2.0 MATERIALS.

2.1 Turf Reinforcement Mat (TRM). Use a Turf Reinforcement Mat defined as permanent rolled erosion control product composed of non-degradable synthetic fibers, filaments, nets, wire mesh and/or other elements, processed into a three-dimensional matrix of sufficient thickness and from the Department's List of Approved Materials. Mats must be 100% UV stabilized materials. For TRMs containing degradable components, all physical property values must be obtained on the non-degradable portion of the matting exclusively. Ensure product labels clearly show the manufacturer or supplier name, style name, and roll number. Ensure labeling, shipment and storage follows ASTM D-4873. The Department will require manufacturer to provide TRMs that are machine constructed web of mechanically or melt bonded nondegradable fibers entangled to form a three dimensional matrix. The Department will require all long term performance property values in table below to be based on non degradable portion of the matting alone. Approved methods include polymer welding, thermal or polymer fusion, or placement of fibers between two high strength biaxially oriented nets mechanically bound by parallel stitching with polyolefin thread. Ensure that mats designated in the plans as Type 4 mats, are not to be manufactured from discontinuous or loosely held together by stitching or glued netting or composites. Type 4 mats shall be composed of geosynthetic matrix that exhibits a very high interlock and reinforcement capacities with both soil and root systems and with high tensile modulus. The Department will require manufacturer to use materials chemically and biologically inert to the natural soil environments conditions. Ensure the blanket is smolder resistant without the use of chemical additives. When stored, maintain the protective wrapping and elevate the mats off the ground to protect them from damage. The Department will not specify these materials for use in heavily acidic coal seam areas or other areas with soil problems that would severally limit vegetation growth.

A) Dimensions. Ensure TRMs are furnished in strips with a minimum width of 4 feet and length of 50 feet.
B) Weight. Ensure that all mat types have a minimum mass per unit area of 7 ounces per square yard according to ASTM D 6566.
C) Performance Testing: The Department will require AASHTO's NTPEP index testing. The Department will also require the manufacturer to perform internal MARV testing at a Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP) accredited laboratory for tensile strength, tensile elongation, mass per unit area, and thickness once every 24,000 yds. of production or whatever rate is required to ensure 97.7% confidence under ASTM D4439& 4354. The Department will require Full scale testing for slope and

channel applications shear stress shall be done under ASTM D 6459, ASTM D 6460-07 procedures.

2.2 Classifications

The basis for selection of the type of mat required will be based on the long term shear stress level of the mat of the channel in question or the degree of slope to protect and will be designated in the contract. The Type 4 mats are to be used at structural backfills protecting critical structures, utility cuts, areas where vehicles may be expected to traverse the mat, channels with large heavy drift, and where higher factors of safety, very steep slopes and/or durability concerns are needed as determined by project team and designer and will be specified in the plans by designer.

Turf Reinforcement Matting					
Properties[1]	Type 1	Type 2	Type 3	Type 4	Test Method
Minimum tensile Strength lbs/ft	125	150	175	3000 by 1500	ASTM D6818[2]
UV stability (minimum % tensile retention)	80	80	80	90	ASTM D4355[3] (1000-hr exposure)
Minimum thickness (inches)	0.25	0.25	0.25	0.40	ASTM D6525
Slopes applications	2H:1V or flatter	1.5H:1V or flatter	1H:1V or flatter	1 H: 1V or greater	
Shear stress lbs/ft^2 Channel applications	6.0[4]	8.0[4]	10.0[4]	12.0[4]	ASTM D6459 ASTM D6460-07

[1] For TRMs containing degradable components, all physical property values must be obtained on the non-degradable portion of the matting alone.

[2]Minimum Average Roll Values for tensile strength of sample material machine direction.

[3]Tensile Strength percentage retained after stated 1000 hr duration of exposure under ASTM D4355 testing. Based on nondegradable components exclusively.

[4]Maximum permissible shear design values based on short-term (0.5 hr) vegetated data obtained by full scale flume testing ASTM D6459, D6460-07. Based on nondegradable components exclusively. Testing will be done at Independent Hydraulics Facility such as Colorado State University hydraulics laboratory, Utah State University hydraulics laboratory, Texas Transportation Institute (TTI) hydraulics and erosion control laboratory.

2.3 Quality Assurance Sampling, Testing, and Acceptance

A) Provide TRM listed on the Department's List of Approved Materials. Prior to inclusion on the LAM, the manufacturer of TRM must meet the physical and performance criteria as outlined in the specification and submit a Letter

Certifying compliance of the product under the above ASTM testing procedures and including a copy of report from Full Scale Independent Hydraulics Facility that Fully Vegetated Shear Stress meets shear stress requirements tested under D6459 and D6460-07.

B) Contractors will provide a Letter of Certification from Manufacturer stating the product name, manufacturer, and that the product MARV product unit testing results meets Department criteria. Provide Letters once per project and for each product.

C) Acceptance shall be in accordance with ASTM D-4759 based on testing performed by a Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP) accredited laboratory using Procedure A of ASTM D-4354.

Current mats meeting the above criteria are shown on the Department's List of Approved Materials.

2.4 Fasteners. When the mat manufacturer does not specify a specific fastener, use steel wire U-shaped staples with a minimum diameter of 0.09 inches (11 gauge), a minimum width of one inch and a minimum length of 12 inches. Use a heavier gauge when working in rocky or clay soils and longer lengths in sandy soils as directed by Engineer or Manufacturer's Representative. Provide staples with colored tops when requested by the Engineer.

3.0 CONSTRUCTION. When requested by the Engineer, provide a Manufacturer's Representative on-site to oversee and approve the initial installation of the mat. When requested by the Engineer, provide a letter from the Manufacturer approving the installation. When there is a conflict between the Department's criteria and the Manufacturer's criteria, construct using the more restrictive. The Engineer and Manufacturer's Representative must approve all alternate installation methods prior to execution. Construct according to the Manufacturer's recommendations and the following as minimum installation technique:

3.1 Site Preparation. Grade areas to be treated with matting and compact. Remove large rocks, soil clods, vegetation, roots, and other sharp objects that could keep the mat from intimate contact with subgrade. Prepare seedbed by loosening the top 2 to 3 inch of soil.

3.2 Installation. Install mats according to Standard Drawing Sepias "Turf Mat Channel Installation" and "Turf Mat Slope Installation." Install mats at the specified elevation and alignment. Anchor the mats with staples with a minimum length of 12 inches. Use longer anchors for installations in sandy, loose, or wet soils as directed by the Engineer or Manufacturer's Representative. The mat should be in direct contact with the soil surface.

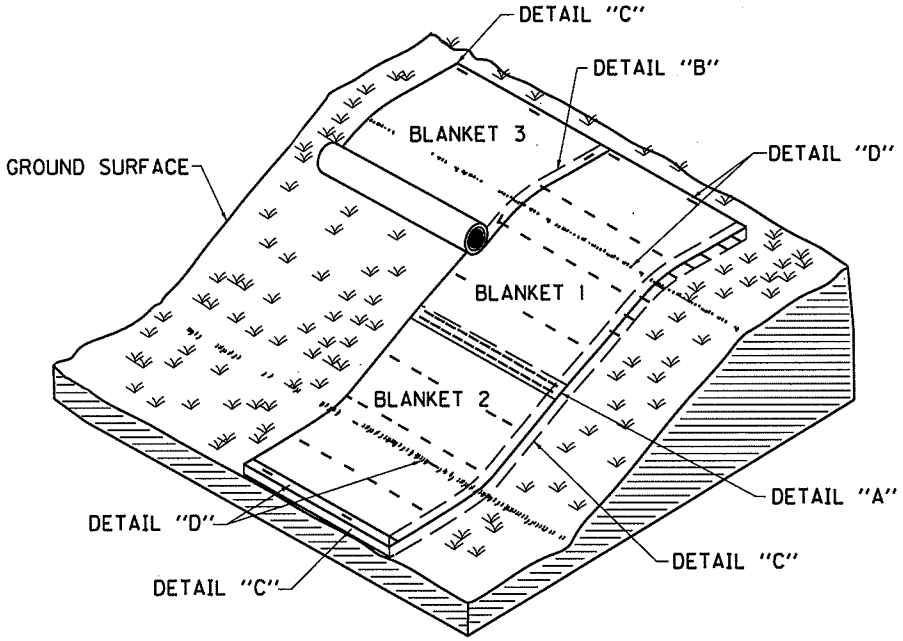
4.0 MEASUREMENT. The Department will measure the quantity of Turf Reinforcement Mat by the square yard of surface covered. The Department will not measure preparation of the bed, providing a Manufacturer's Representative, topsoil, or seeding for payment and will consider them incidental to the Turf Reinforcement Mat. The Department will not measure any reworking of slopes or channels for payment as it is considered corrective work and incidental to the Turf Reinforcement Mat. Seeding and protection will be an incidental item.

5.0 PAYMENT. The Department will make payment for the completed and accepted quantities
under the following:

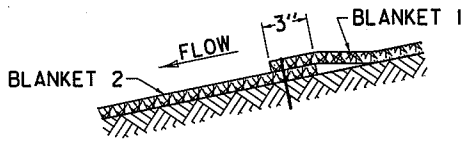
Code	Pay Item	Pay Unit
23274EN11F	Turf Reinforcement Mat 1	Square Yard
23275EN11F	Turf Reinforcement Mat 2	Square Yard
23276EN11F	Turf Reinforcement Mat 3	Square Yard
23277EN11F	Turf Reinforcement Mat 4	Square Yard

April 18, 2009

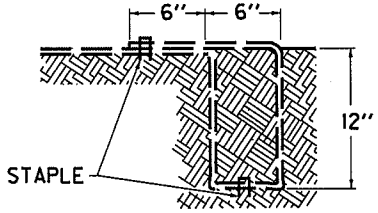
COUNTY OF	ITEM NO.	SHEET NO.



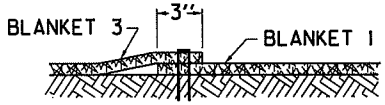
TURF MAT
SLOPE INSTALLATION



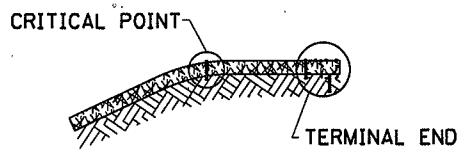
PROFILE VIEW
DETAIL "A"

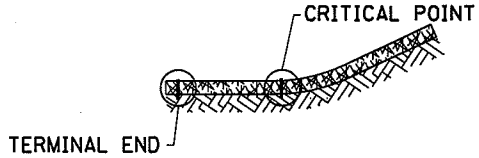


PROFILE VIEW
DETAIL "C"



CROSS SECTION VIEW
DETAIL "B"





CRITICAL POINTS
DETAIL "D"

NOTES

1. CONSTRUCT A 6" X 12" ANCHOR TRENCH AT THE BEGINNING OF THE SLOPE. LINE THE ANCHOR TRENCH WITH TURF REINFORCING MAT LEAVING 12" EXTENDING PAST THE ANCHOR TRENCH. FASTEN THE MAT MATERIAL INTO THE ANCHOR TRENCH ON 12" CENTERS BACKFILL THE TRENCH WITH TOPSOIL AND COMPACT. COVER THE AREA WITH THE REMAINING 12" OF THE MAT'S TERMINAL END LEAVING 6" TO OVERLAP THE TURF REINFORCING MAT. SECURE THE 6" OVERLAP WITH STAPLES ON 12" CENTERS.
2. UNROLL THE MAT PARALLEL TO THE PRIMARY DIRECTION OF WATER FLOW AND PLACE IN DIRECT CONTACT WITH THE SOIL SURFACE. DO NOT STRETCH OR ALLOW THE MATERIAL TO BRIDGE OVER SURFACE INCONSISTENCIES.
3. SECURELY FASTEN THE MAT TO THE SOIL BY INSTALLING STAPLES AT A MINIMUM RATE OF 1.5 PER SQ. YD. ANCHORS SHALL BE SELECTED SO THAT THEY HAVE SUFFICIENT GROUND PENETRATION TO RESIST PULLOUT. INCREASE ANCHORING FREQUENCY FOR SITE CONDITIONS (LOOSE, SANDY, OR WET SOILS) AS DIRECTED BY THE ENGINEER AND MANUFACTURER'S REPRESENTATIVE.
4. OVERLAP EDGES OF PARALLEL AND PERPENDICULAR BLANKETS ALONG THE SLOPE A MINIMUM OF 3" AND SECURE WITH STAPLES AT A MAXIMUM SPACING OF 1'.
5. CONSTRUCT A 6"X 12" ANCHOR TRENCH AT THE TOE OF THE SLOPE FOLLOWING SIMILAR PROCEDURE DENOTED FOR THE TOP OF THE SLOPE ANCHOR TRENCH.
6. ENSURE THAT THE MAT IS IN DIRECT CONTACT WITH THE SOIL SURFACE WITH NO PROJECTIONS OR PROTRUSIONS.
7. APPLY SEEDING AND PROTECTION ACCORDING TO SECTION 212.03.03 USING SEED MIX TYPE I. DIRECTLY AFTER APPLYING SEEDING AND TREATMENTS IN 212.03.03, BUT BEFORE APPLYING MULCHING OR HYDROMULCHING: INFILL THE VOID SPACES IN THE MAT WITH 1/2" OF TOPSOIL. TOPSOIL IS THE SOIL PROFILE DEFINED TECHNICALLY AS "A" HORIZON BY THE SOIL SCIENCE SOCIETY OF AMERICA. USE LOOSE, FRIABLE TOPSOIL THAT IS FREE OF STONES 1" OR GREATER IN OVERALL DIMENSIONS, ADMIXTURE OF SUBSOIL, REFUSE, STUMPS, ROOTS, BRUSH, WEEDS AND OTHER MATERIALS THAT PREVENT THE FORMATION OF A SUITABLE SEED BED. DO NOT USE TOPSOIL FROM SITES HAVING JOHNSON GRASS, CANADA THISTLE, QUACK GRASS, NODDING THISTLE OR EXCESSIVE AMOUNTS OF WEEDS OR THEIR RHIZOMES.

KENTUCKY
DEPARTMENT OF HIGHWAYS

TURF MAT
SLOPE
INSTALLATION

SUBMITTED _____ 05-20-09
DIRECTOR, DIVISION OF HIGHWAY DESIGN — DATE

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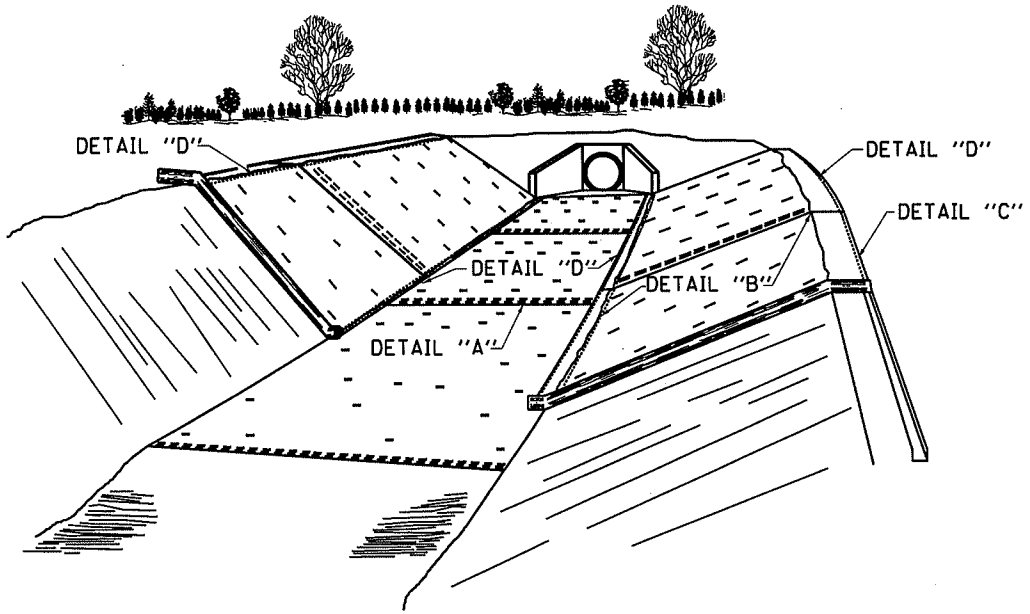
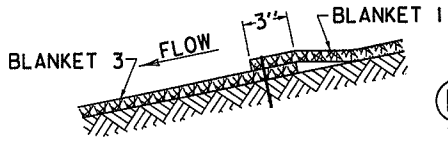
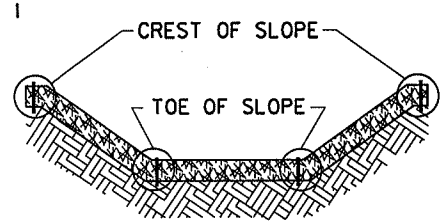
COUNTY OF	ITEM NO.	SHEET NO.



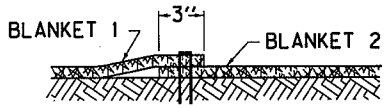
TURF MAT
CHANNEL INSTALLATION



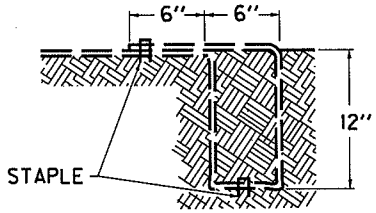
PROFILE VIEW
DETAIL "A"



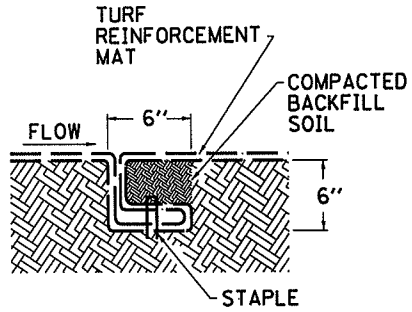
CRITICAL POINTS
DETAIL "D"



CROSS SECTION VIEW
DETAIL "B"



PROFILE VIEW
DETAIL "C"



CHANNEL CHECK SLOT ③

NOTES

1. CONSTRUCT A 6" X 12" ANCHOR TRENCH AT THE BEGINNING OF THE CHANNEL. LINE THE ANCHOR TRENCH WITH TURF REINFORCING MAT LEAVING 12" EXTENDING PAST THE ANCHOR TRENCH. FASTEN THE MAT MATERIAL INTO THE ANCHOR TRENCH ON 12" CENTERS BACKFILL THE TRENCH WITH TOPSOIL AND COMPACT. COVER THE AREA WITH THE REMAINING 12" OF THE MAT'S TERMINAL END LEAVING 6" TO OVERLAP THE TURF REINFORCING MAT. SECURE THE 6" OVERLAP WITH STAPLES ON 12" CENTERS.
2. UNROLL THE MAT PARALLEL TO THE PRIMARY DIRECTION OF WATER FLOW AND PLACE IN DIRECT CONTACT WITH THE SOIL SURFACE. DO NOT STRETCH OR ALLOW THE MATERIAL TO BRIDGE OVER SURFACE INCONSISTENCIES.
③ EXCAVATE 6" X 6" CHECK SLOTS EVERY 25' ALONG THE LENGTH OF THE CHANNEL. LINE THE SIDE AND BOTTOM OF THE SLOT WITH THE MAT AND THEN PULL BACK OVER. FASTEN WITH STAPLES ON 12" CENTERS. FILL THE CHECK SLOT WITH TOPSOIL, COMPACT, AND CONTINUE UNROLLING MAT DOWN THE CHANNEL.
4. CONTINUE UNROLLING THE MAT DOWNSTREAM OVER THE COMPACTED SLOT TO NEXT CHECK SLOT OR TERMINAL ANCHOR TRENCH. IF MORE THAN ONE SECTION OF MAT IS USED OVERLAP UPSTREAM MATS OVER TOP OF THE DOWNSTREAM MAT 3" AND SECURE STAPLES ON 12" CENTERS.
5. SECURE MATS WHILE UNROLLING ON SIDESLOPES AND CHANNEL BOTTOMS WITH STAPLES AT A FREQUENCY THE TABLE INDICATES. USE STAPLES HAVING SUFFICIENT GROUND PENETRATION TO RESIST PULLOUT. INCREASE ANCHORING FREQUENCY AS DIRECTED BY THE ENGINEER AND MANUFACTURER'S REPRESENTATIVE.
6. APPLY SEEDING AND PROTECTION ACCORDING TO SECTION 212.03.03 USING SEED MIX TYPE I. DIRECTLY AFTER APPLYING SEEDING AND TREATMENTS IN 212.03.03, BUT BEFORE APPLYING MULCHING OR HYDROMULCHING: INFILL THE VOID SPACES IN THE MAT WITH 1/2" OF TOPSOIL. TOPSOIL IS THE SOIL PROFILE DEFINED TECHNICALLY AS "A" HORIZON BY THE SOIL SCIENCE SOCIETY OF AMERICA. USE LOOSE, FRIABLE TOPSOIL THAT IS FREE OF STONES 1" OR GREATER IN OVERALL DIMENSIONS, ADMIXTURE OF SUBSOIL, REFUSE, STUMPS, ROOTS, BRUSH, WEEDS AND OTHER MATERIALS THAT PREVENT THE FORMATION OF A SUITABLE SEED BED. DO NOT USE TOPSOIL FROM SITES HAVING JOHNSON GRASS, CANADA THISTLE, QUACK GRASS, NODDING THISTLE OR EXCESSIVE AMOUNTS OF WEEDS OR THEIR RHIZOMES.

SLOPE GRADE	ANCHORING FREQUENCY
UP TO 2H:1V	1.5 ANCHORS/SQUARD YARD
2H:1V TO 1H:1V	2.0 ANCHORS/SQUARE YARD
STEEPER THAN 1H:1V AND CHANNEL BOTTOMS	3.0 ANCHORS/SQUARE YARD

KENTUCKY
DEPARTMENT OF HIGHWAYS

TURF MAT
CHANNEL
INSTALLATION

SUBMITTED J. J. Jagger 05-20-09
DIRECTOR DIVISION OF HIGHWAY DESIGN — DATE

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