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Permit No.	Date	Document ID No.
28-03	February 23, 2010	9841

February 22, 2010

RECEIVED  
**February 22, 2010 via hand delivery**  
Solid Waste Section  
Raleigh Central Office

Mr. Ming-Tai Chao, P.E.  
Environmental Engineer II  
North Carolina Department of Environment and Natural Resources  
Division of Waste Management  
Permitting Branch, Solid Waste Section  
1646 Mail Service Center  
Raleigh, NC 27699-1646

Subject: Dare County  
Dare County Construction and Demolition Landfill (C&DLF)  
NCDENR LQS - Erosion and Sedimentation Control Plan and Permit

Dear Mr. Chao:

On behalf of Dare County, CDM is pleased to submit a CD with an electronic copy of the approved NCDENR Land Quality Section (LQS) Erosion and Sedimentation Control Plan and Permit along with the NCDENR LQS approval letter.

If you have any questions or need additional information, please do not hesitate to call me at (919) 787-5620.

Very truly yours,

W. Michael Brinchek, P.E.  
Project Manager  
Camp Dresser & McKee

cc: Ed Mussler, NCDENR DWM  
Edward Mann, Dare County  
Kevin Irby, CDM



North Carolina Department of Environment and Natural Resources  
Division of Land Resources  
Land Quality Section

James D. Simons, PG, PE  
Director and State Geologist

Beverly Eaves Perdue, Governor  
Dee Freeman, Secretary

February 18, 2010

**LETTER OF APPROVAL WITH MODIFICATIONS**

Dare County  
ATTN: Mr. Edward L Mann, Public Works Director  
Post Office Box 1000  
Manteo, North Carolina 27954

RE: Erosion and Sedimentation Control Plan No. DARE-2010-006  
Project Name: C&D Landfill Cell #4  
Location: US 264 County: Dare  
River Basin: Pasquotank  
Date Received by LQS: January 20, 2010  
Acres Approved: 18 Project Type: New  
Project Description: New Landfill cell, including access roads, as shown on the submitted plan dated January 11, 2010

Dear Sir:

This office has reviewed the subject erosion and sedimentation control plan. We find the plan to be acceptable and hereby issue this Letter of Approval with Modifications. The modifications required for approval are listed on the attached pages. This plan approval shall expire three (3) years following the date of approval, if no land-disturbing activity has been undertaken, as required by 15A NCAC 4B.0129, unless modified by other legislation.

Please be advised that 15A NCAC 4B.0118(a) requires that a copy of the approved erosion and sedimentation control plan be on file at the job site. Also, you should consider this letter as giving the Notice required by G.S. 113A-61.1(a) of our right of periodic inspection to ensure compliance with the approved plan.

North Carolina's Sedimentation Pollution Control Program is performance oriented, requiring protection of existing natural resources and adjoining properties. If, following the commencement of this project, it is determined that the erosion and sedimentation control plan is inadequate to meet the requirements of the Sedimentation Pollution Control Act of 1973 (G.S. 113A-51 through 66), this office may require revisions to the plan and implementation of the revisions to ensure compliance with the Act.

Acceptance and approval of this plan is conditioned upon your compliance with Federal and State water quality laws, regulations and rules. In addition, local city or county ordinances or rules may also apply to this land-disturbing activity. This approval does not supersede any other permit or approval.

Washington Regional Office

943 Washington Square Mall, Washington, North Carolina 27889 • Phone: 252-946-6481 / FAX: 252-975-3716

Internet: <http://www.dlr.enr.state.nc.us/pages/landqualitysection.html>

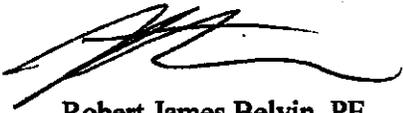
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Dare County  
ATTN: Mr. Edward L Mann, Public Works Director  
February 18, 2010  
Page 2

Please be aware that your project will be covered by the enclosed NPDES General Stormwater Permit NCG010000 (Construction Activities). You should first become familiar with all of the requirements for compliance with the enclosed permit.

Please note that this approval is based in part on the accuracy of the information provided in the Financial Responsibility/Ownership Form, which you have submitted. You are required to file an amended form if there is any change in the information included on the form. In addition, 15A NCAC 4B.0127(c) requires that you notify this office of the proposed starting date for this project (using the enclosed Project Information Sheet). Please notify us if you plan to have a preconstruction conference.

Sincerely,



Robert James Belvin, PE  
Assistant Regional Engineer

Enclosures

cc w/o enc: W. Michael Brinchek, PE, CDM  
Alton Hodge, Division of Water Quality  
1993 C&D Landfill file  
DARE-2002-009

1. **AS THE DECLARED RESPONSIBLE PARTY, YOUR LEGAL RESPONSIBILITY** is to understand the Act and comply with the following minimum requirements of the Act:
  - A. In the event of a conflict between the requirements of the Sedimentation Pollution Control Act, the submitted plan and/or the contract specifications, the more restrictive requirement shall prevail;
  - B. The land-disturbing activity shall be conducted in accordance with the approved erosion and sedimentation control plan;
  - C. The **LATEST APPROVED** erosion and sediment control plan will be used during periodic unannounced inspections to determine compliance and a copy of the plan must be on file at the job site. If it is determined that the implemented plan is inadequate, this office may require the installation of additional measures and/or that the plan be revised to comply with state law;
  - D. All revisions, including those required by other local, state or federal agencies, which affect site layout, drainage patterns, limits of disturbance and/or disturbed acreage must be submitted to this office for approval a minimum of 15 days prior to the start of construction;
  - E. Revisions exceeding the approved scope of this project without prior approval of the plan showing the changes can be considered a violation. Failure to comply with any part of the approved plan or with any requirements of this program could result in appropriate legal action (civil or criminal) against the financially responsible party. Legal actions include Stop Work Orders and the assessing of a civil penalty of up to \$5000 for the initial violation plus an additional penalty of up to \$5000 per day for each day the site is out of compliance;
  - F. The **CERTIFICATE OF PLAN APPROVAL** must be posted at the primary entrance to the job site and remain until the site is permanently stabilized;
  - G. In cases of natural disaster related changes to the proposed land disturbing activity, all appropriate actions and adequate measure installations may be performed to prevent sediment damage, prior to submitting and receiving approval of the revised plan. A revised plan must be submitted for approval as soon as possible, but no later than 15 days after all emergency actions have been performed;

Erosion and Sedimentation Control Plan No. DARE-2010-006

Project Name: C&D Landfill Cell #4

February 18, 2010

Modifications

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- H. Erosion and sediment control measures or devices are to be installed to safely withstand the runoff resulting from a 10 year storm event - 6.5 - 7 inches in 24 hours or at the rate of 6.5 - 7 inches in 1 hour;
  - I. Unless the off-site borrow and/or disposal sites are identified in the erosion control plan, no earthen material is to be brought on or removed from the project site;
  - J. Buffer zone, sufficient to restrain visible sedimentation within the 25% of the width closest to the land disturbance, must be provided and maintained between the land-disturbing activity and any adjacent property or watercourse;
  - K. In order to comply with the intent of the Act, the scheduling of the land-disturbing activities is to be such that both the area of exposure and the time between the land disturbance and the providing of a ground cover is minimized;
  - L. Unless a temporary, manufactured, lining material has been specified, a clean straw mulch must be applied, at the minimum rate of 2 tons/acre, to all seeded areas. The mulch must cover at least 75% of the seeded area after it is either tacked, with an acceptable tacking material, or crimped in place;
  - M. New or affected cut or filled slopes must be at an angle that can be retained by vegetative cover, **AND must be provided with a ground cover** sufficient to restrain erosion **within 21 calendar days of completion of any phase (rough or final) of grading (ANNUAL RYE GRASS IS NOT in the APPROVED seeding specifications NOR is it an ACCEPTABLE substitute for the providing of a temporary ground cover)**;
  - N. A **permanent ground cover**, sufficient restrain erosion, **must be provided** within the shorter of 15 working or 90 calendar days (if in a High Quality Zone, the shorter of 15 working or 60 calendar days) after completion of construction or development on any portion of the tract **(ANNUAL RYE GRASS IS NOT in the APPROVED seeding specifications NOR is it an ACCEPTABLE substitute for the providing of a nurse cover for the permanent grass cover)**;
2. Adequate and appropriate measures must be properly installed downstream, within the limits of disturbance, of any land disturbing activity to prevent sediment from leaving the limits of disturbance, entering existing drainage systems, impacting an on-site natural watercourse or adjoining property.

Erosion and Sedimentation Control Plan No. DARE-2010-006

Project Name: C&D Landfill Cell #4

February 18, 2010

Modifications

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3. Provide an overall site plan identifying the limits of disturbance associated with all existing SESC & mining permits and proposed permits.

**PROJECT INFORMATION SHEET**

APPROVAL DATE: February 18, 2010

RESPONSIBLE PARTY: Dare County

PROJECT NAME: C&D Landfill Cell #4

COUNTY: Dare NO.: DARE-2010-006

START-UP DATE: \_\_\_\_\_

CONTRACTOR: \_\_\_\_\_

ON-SITE CONTACT: \_\_\_\_\_

ON-SITE PHONE NO.: \_\_\_\_\_

OFFICE PHONE NO.: \_\_\_\_\_

**ADDITIONAL INFORMATION REQUIRED**

ADDITIONAL INFORMATION ENCLOSED                      YES                      NO  
(PLEASE CIRCLE)

**COMPLETE & RETURN THIS FORM  
PRIOR TO THE START OF CONSTRUCTION TO:**

**N.C.D.E.N.R.  
LAND QUALITY SECTION  
ATTN: *Robert Belvin, PE*  
943 WASHINGTON SQUARE MALL  
WASHINGTON, NORTH CAROLINA 27889**



5400 Glenwood Avenue, Suite 300  
Raleigh, North Carolina 27612  
tel: 919-325-3500  
fax: 919-781-5730

January 15, 2010

Mr. Pat McClain, P.E.  
North Carolina Department of Environment and Natural Resources  
Land Quality Section  
943 Washington Square Mall  
Washington, N.C. 27889

Subject: Dare County  
Dare County Construction and Demolition Debris Landfill Cell No. 4  
Erosion and Sedimentation Control Permit Application

Dear Mr. McClain:

Please find enclosed two (2) sets of the Erosion and Sedimentation Control Permit Application for the above referenced project located off U.S. Highway 264 in Dare County. Also included with the application are project drawings and a completed Financial Responsibility and Ownership Form. A check is attached for the normal review permitting fee.

The proposed Phase No. 4 Construction and Demolition Debris (C&D) Landfill will include construction of a 11.3-acre C&D landfill, including access roads, stormwater controls, and a canal crossing.

If you have any questions or need additional information, please do not hesitate to call me at (919) 787-5620.

Very truly yours,

A handwritten signature in blue ink, appearing to read 'W. Michael Brinckek'.

W. Michael Brinckek, P.E.  
Project Manager  
Camp Dresser & McKee

cc: Edward L. Mann, Dare County

Dare County, North Carolina

Dare County Construction and Demolition  
Debris Landfill

Phase No. 4 Expansion

Erosion and Sedimentation Control  
Permit Application

December 2009



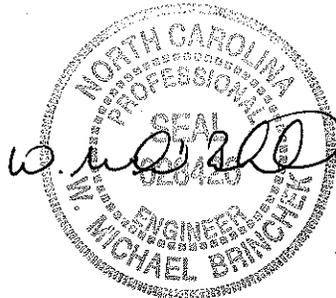
*Permit Application*

Dare County

Dare County Construction and Demolition Landfill Phase No. 4

**EROSION AND SEDIMENTATION**

**CONTROL PLAN**



12/31/2009

CDM PN: 17952-56960

Prepared by

**CDM**

5400 Glenwood Avenue, Suite 300

Raleigh, North Carolina 27612

Firm Licensure: F-0412

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# Section 1

## Narrative

### 1.1 Site Description

The Dare County Construction and Demolition Debris Landfill is located in Dare County, North Carolina, west of US Highway 264 between Link Road and Cub Road. The intent of this permit is to obtain a sedimentation and erosion control plan and permit for the proposed Cell 4 Construction and Demolition Debris Landfill (C&D) expansion. This expansion will consist of an 11.3 acre soil lined cell that will receive construction and demolition debris. The proposed expansion is identical to the previously approved cell number 3 expansion that is currently in operation.

The approximate site location is shown on the USGS map provided in **Appendix A**. A site map of the facility is also included on **Sheet C-1** (See **Appendix C**). Topography within the site boundaries is characterized by flat areas at or near mean sea level.

### 1.2 Soils

The Dare County Soil Survey was used to evaluate the upper subsurface soils within the proposed site boundaries. The information for the Dare County Soil Survey, North Carolina was obtained from the National Resource Conservation Service (NRCS) and is attached in **Appendix B**.

### 1.3 Project Description

The area of disturbance is 18 acres and includes access roads; canal crossings; filter basins for stormwater management; and silt fence around the perimeter of the proposed cell for added erosion and sedimentation control.

The proposed Erosion and Sedimentation Control Measures are identified on **C-3** and details are presented on **Sheets D-1 and D-2** (See **Appendix C**). Supporting calculations are provided in the attached **Appendix E**.

The Financial Responsibility/Ownership Form for the project, including a copy of the Property Deed is provided in **Appendix D**.

## **Section 2**

# **Planned Erosion and Sedimentation Control Practices**

The location of the erosion and sedimentation control features described below are shown on the design drawings and details contained in **Appendix C**. In addition, the North Carolina Erosion and Sediment Control Planning and Design Manual is referred to in the project specifications. Calculations supporting the design are in **Appendix D**. The contractor shall be responsible for installing all erosion control devices prior to beginning any land disturbing activities and shall maintain all control devices until construction is completed and all disturbed areas are stabilized.

### **2.1 Surface Roughening - Practice 6.03**

Any disturbed areas will be lightly roughened by disking just prior to vegetating. All construction slopes 3:1 or steeper will also be roughened. Surface stabilization will be accomplished with vegetation and mulch as specified in the vegetation plan.

### **2.2 Gravel Construction Entrance - Not Applicable**

A temporary gravel construction entrance/exit will not be required, because all construction and landfill operation traffic will enter/exit by the proposed entrance road located off Link Road (Gravel Road) or the haul road located off Cub Road (Gravel Road).

### **2.3 Temporary Seeding - Practice 6.10**

Temporary seeding will be provided as described in Section 5.1 of the Vegetative Plan.

### **2.4 Permanent Seeding - Practice 6.11**

Permanent seeding will be provided as described in Section 5.2 of the Vegetative Plan.

### **2.5 Mulching - Practice 6.14**

Mulching will accompany both permanent and temporary seeding at a minimum and will be completed immediately following seeding.

### **2.6 Silt Fence - Practice 6.62**

Silt fence will be installed as shown on **Sheet C-3**, until permanent vegetation is established. A silt fence detail has been provided on **Sheet D-1**.

### **2.7 Filter Basin**

Filter basins will be installed at the low points of each existing drainage channel located on the east and west sides of the proposed Cell no. 4. These filter basins will be the primary treatment device used to capture and treat sediment laden runoff.

## Section 3

# Construction Schedule

Erosion and sedimentation control will be completed to address the Dare County Construction and Demolition Debris Landfill Cell No. 4 Expansion construction.

1. Obtain erosion and sediment control permit approval and other applicable permits.
2. Hold preconstruction conference with NCDENR Land Quality Section at least one week prior to starting construction.
3. Notify permitting agency at (252)-946-6481 that approved the erosion and sediment control plan of the date that construction will begin.
4. Flag the limits of construction.
5. Clear the minimum amount of area necessary to install all silt fence as shown on the construction drawings.
6. Install erosion and sedimentation control measures as shown on the construction drawings.
8. Inspect all erosion and sediment control practices weekly and after each significant (1/2 inch or greater) rainfall event. Clean out sediment from silt fence when the depth of sediment reaches half of the allotted depth. Needed repairs will be made immediately.
9. Permanent ground cover shall be established within 15 working days or 90 calendar days after final grade is reached, whichever is shorter.
10. After site is stabilized, remove all temporary erosion control measures.

## Section 4

# Inspection and Maintenance Plan

Maintenance of the erosion and sedimentation control structures shall be performed throughout the final construction and during site stabilization. The maintenance activities will consist of the following:

1. All erosion and sediment control practices will be checked for stability and operation following every runoff-producing rainfall but at a minimum once per week and fill out NPDES form NCG010000 (**Appendix F**). Any needed repairs will be made immediately to maintain all practices as designed.
2. Sediment will be removed from behind the sediment fence when it reaches a height of 0.5 feet up the fence. The sediment fence will be repaired as necessary to provide adequate storage volume for the next rain event.
3. Sediment will be removed from filter basins and channels when it reaches  $\frac{1}{2}$  the design depth and upon completion of the work. Following cleaning activities all disturbed areas will be stabilized.
4. All seeded areas will be fertilized, re-seeded as necessary, and mulched according to specifications in the vegetative plan to maintain a vigorous, dense vegetative cover.

# Section 5

## Vegetative Plan

### 5.1 Temporary Seeding

Ground cover shall be established on exposed slopes within 21 calendar days following completion of any phase of grading. Temporary seeding shall be performed in accordance with the requirements of the North Carolina Erosion and Sediment Control Planning and Design Manual and as shown on the drawings.

### 5.2 Permanent Seeding

Areas to be stabilized with permanent vegetation must be seeded or planted within 15 working days or 90 calendar days after final grade is reached, unless temporary stabilization is applied. Permanent seeding shall be performed in accordance with the requirements of the North Carolina Erosion and Sediment Control Planning and Design Manual and as shown on the drawings.

Apply temporary erosion control matting over mulched areas on sloped surfaces greater than 4:1.

# Section 6

## Construction Specifications and Details

The erosion and sedimentation control measures will be constructed in accordance with the erosion and sedimentation control details in the Project Plans and Specifications and the *North Carolina Erosion and Sedimentation Control Planning and Design Manual*. These Specifications and Details are attached as follows:

### Details

6.03 - Surface Roughening

6.10 - Temporary Seeding

6.11 - Permanent Seeding

6.14 - Mulching

6.62 - Sediment Fence

6.03

## SURFACE ROUGHENING



**Definition** Roughening a bare soil surface with horizontal grooves running across the slope, stair stepping, or tracking with construction equipment.

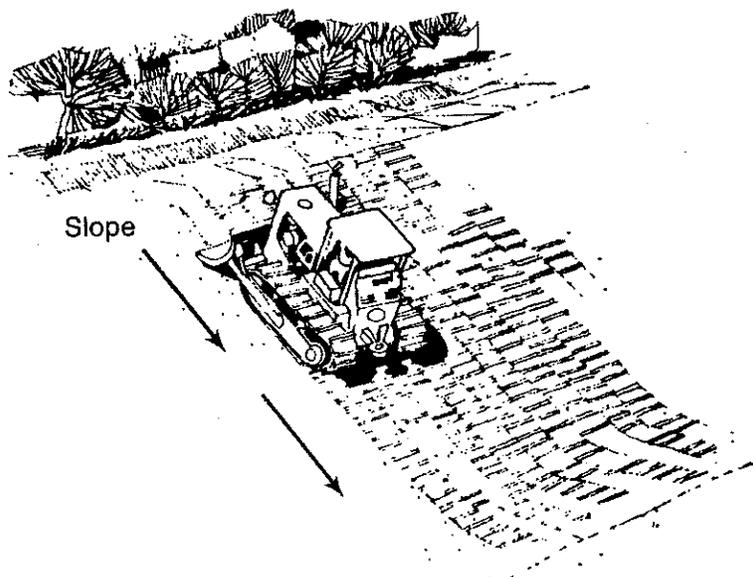
**Purpose** To aid the establishment of vegetative cover from seed, to reduce runoff velocity and increase infiltration, and to reduce erosion and provide for sediment trapping.

**Conditions Where Practice Applies** All construction slopes require surface roughening to facilitate stabilization with vegetation, particularly slopes steeper than 3:1.

**Planning Considerations** Rough slope surfaces are preferred because they aid the establishment of vegetation, improve water infiltration, and decrease runoff velocity. Graded areas with smooth, hard surfaces may be initially attractive, but such surfaces increase the potential for erosion. A rough, loose soil surface gives a mulching effect that protects lime, fertilizer, and seed. Nicks in the surface are cooler and provide more favorable moisture conditions than hard, smooth surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving (Figure 6.03a), and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

**Figure 6.03a** Bulldozer treads create grooves perpendicular to the slope. The slope face should not be back-bladed during the final grading operation (source: Va SWCC).



**Design Criteria** No formal design is required.

**Construction Specifications**

**CUT SLOPE ROUGHENING FOR AREAS NOT TO BE MOWED**

Stair-step grade or groove cut slopes with a gradient steeper than 3:1 (Figures 6.03b and 6.03c).

Use stair-step grading on any erodible material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.

Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" in toward the vertical wall.

Do not make individual vertical cuts more than 2 feet in soft materials or more than 3 feet in rocky materials.

**Grooving** uses machinery to create a series of ridges and depressions that run across the slope (on the contour).

Groove using any appropriate implement that can be safely operated on the slope, such as disks, tillers, spring harrows, or the teeth on a front-end loader bucket. Do not make such grooves less than 3 inches deep nor more than 15 inches apart.

**FILL SLOPE ROUGHENING FOR AREAS NOT TO BE MOWED**

Place fill slopes with a gradient steeper than 3:1 in lifts not to exceed 9 inches, and make sure each lift is properly compacted. Ensure that the face of the slope consists of loose, uncompacted fill 4 to 6 inches deep. Use grooving, as described above, to roughen the face of the slopes, if necessary.

Do not blade or scrape the final slope face.

**CUTS, FILLS, AND GRADED AREAS THAT WILL BE MOWED**

Make mowed slopes **no steeper than 3:1**.

Roughen these areas to shallow grooves by normal tilling, disking, harrowing, or use of cultipacker-seeder. Make the final pass of any such tillage implement on the contour.

Make grooves, formed by such implements, close together (less than 10 inches) and not less than 1 inch deep.

Excessive roughness is undesirable where mowing is planned.

**ROUGHENING WITH TRACKED MACHINERY**

Limit roughening with tracked machinery to sandy soils to avoid undue compaction of the soil surface. Tracking is generally not as effective as the other roughening methods described.

Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.

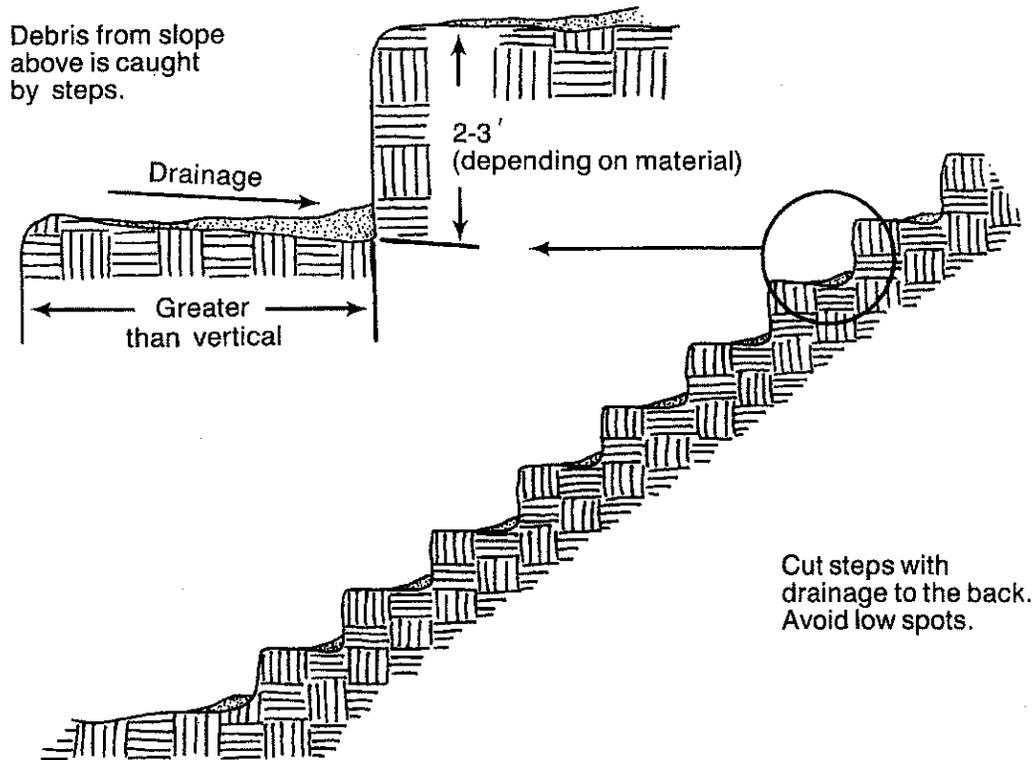


Figure 6.03b Stair stepping cut slopes (modified from Va SWCC).

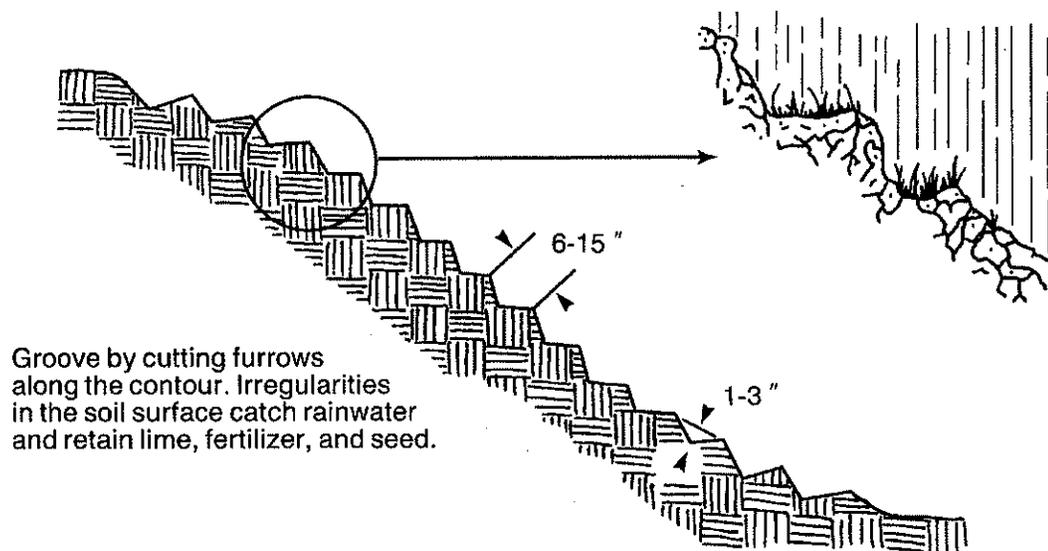


Figure 6.03c Grooving slopes (modified from Va SWCC).

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**Seeding**—Immediately seed and mulch roughened areas to obtain optimum seed germination and growth.

**Maintenance** Periodically check the seeded slopes for rills and washes. Fill these areas slightly above the original grade, then reseed and mulch as soon as possible.

**References** *Surface Stabilization*  
6.10, Temporary Seeding  
6.11, Permanent Seeding  
6.14, Mulching

*Chapter 3, Vegetative Considerations*

6.10

## TEMPORARY SEEDING

TS

**Definition** Planting rapid-growing annual grasses, small grains, or legumes to provide initial, temporary cover for erosion control on disturbed areas.

**Purpose** To temporarily stabilize denuded areas that will not be brought to final grade for a period of more than 21 calendar days.

Temporary seeding controls runoff and erosion until permanent vegetation or other erosion control measures can be established. In addition, it provides residue for soil protection and seedbed preparation, and reduces problems of mud and dust production from bare soil surfaces during construction.

**Conditions Where Practice Applies** On any cleared, unvegetated, or sparsely vegetated soil surface where vegetative cover is needed for less than 1 year. Applications of this practice include diversions, dams, temporary sediment basins, temporary road banks, and topsoil stockpiles.

**Planning Considerations** Annual plants, which sprout and grow rapidly and survive for only one season, are suitable for establishing initial or temporary vegetative cover. Temporary seeding preserves the integrity of earthen sediment control structures such as dikes, diversions, and the banks of dams and sediment basins. It can also reduce the amount of maintenance associated with these devices. For example, the frequency of sediment basin cleanouts will be reduced if watershed areas, outside the active construction zone, are stabilized.

Proper seedbed preparation, selection of appropriate species, and use of quality seed are as important in this Practice as in Practice 6.11, *Permanent Seeding*. Failure to follow established guidelines and recommendations carefully may result in an inadequate or short-lived stand of vegetation that will not control erosion.

Temporary seeding provides protection for no more than 1 year, during which time permanent stabilization should be initiated.

**Specifications** Complete grading before preparing seedbeds, and install all necessary erosion control practices such as, dikes, waterways, and basins. Minimize steep slopes because they make seedbed preparation difficult and increase the erosion hazard. If soils become compacted during grading, loosen them to a depth of 6-8 inches using a ripper, harrow, or chisel plow.

### SEEDBED PREPARATION

Good seedbed preparation is essential to successful plant establishment. A good seedbed is well-pulverized, loose, and uniform. Where hydroseeding methods are used, the surface may be left with a more irregular surface of large clods and stones.

**Liming**—Apply lime according to soil test recommendations. If the pH (acidity) of the soil is not known, an application of ground agricultural limestone at the

rate of 1 to 1 1/2 tons/acre on coarse-textured soils and 2-3 tons/acre on fine-textured soils is usually sufficient. Apply limestone uniformly and incorporate into the top 4-6 inches of soil. Soils with a pH of 6 or higher need not be limed.

**Fertilizer**—Base application rates on soil tests. When these are not possible, apply a 10-10-10 grade fertilizer at 700-1,000 lb/acre. Both fertilizer and lime should be incorporated into the top 4-6 inches of soil. If a hydraulic seeder is used, do not mix seed and fertilizer more than 30 minutes before application.

**Surface roughening**—If recent tillage operations have resulted in a loose surface, additional roughening may not be required, except to break up large clods. If rainfall causes the surface to become sealed or crusted, loosen it just prior to seeding by disking, raking, harrowing, or other suitable methods. Groove or furrow slopes steeper than 3:1 on the contour before seeding (Practice 6.03, *Surface Roughening*).

#### PLANT SELECTION

Select an appropriate species or species mixture from Table 6.10a for seeding in late winter and early spring, Table 6.10b for summer, and Table 6.10c for fall.

In the Mountains, December and January seedings have poor chances of success. When it is necessary to plant at these times, use recommendations for fall and a securely tacked mulch.

#### SEEDING

Evenly apply seed using a cyclone seeder (broadcast), drill, cultipacker seeder, or hydroseeder. Use seeding rates given in Tables 6.10a-6.10c. Broadcast seeding and hydroseeding are appropriate for steep slopes where equipment cannot be driven. Hand broadcasting is not recommended because of the difficulty in achieving a uniform distribution.

Small grains should be planted no more than 1 inch deep, and grasses and legumes no more than 1/2 inch. Broadcast seed must be covered by raking or chain dragging, and then lightly firmed with a roller or cultipacker. Hydroseeded mixtures should include a wood fiber (cellulose) mulch.

#### MULCHING

The use of an appropriate mulch will help ensure establishment under normal conditions, and is essential to seeding success under harsh site conditions (Practice 6.14, *Mulching*). Harsh site conditions include:

- seeding in fall for winter cover (wood fiber mulches are not considered adequate for this use),
- slopes steeper than 3:1,
- excessively hot or dry weather,
- adverse soils (shallow, rocky, or high in clay or sand), and
- areas receiving concentrated flow.

If the area to be mulched is subject to concentrated waterflow, as in channels, anchor mulch with netting (Practice 6.14, *Mulching*).

**Maintenance** Reseed and mulch areas where seedling emergence is poor, or where erosion occurs, as soon as possible. Do not mow. Protect from traffic as much as possible.

**References** *Site Preparation*  
6.03, Surface Roughening  
6.04, Topsoiling

*Surface Stabilization*  
6.11, Permanent Seeding  
6.14, Mulching

*Appendix*  
8.02, Vegetation Tables



**Table 6.10b  
Temporary Seeding  
Recommendations for  
Summer**

<b>Seeding mixture</b>	
<b>Species</b>	<b>Rate (lb/acre)</b>
German millet	40
<p>In the Piedmont and Mountains, a small-stemmed Sudangrass may be substituted at a rate of 50 lb/acre.</p>	
<b>Seeding dates</b>	
Mountains—May 15 - Aug. 15	
Piedmont—May 1 - Aug. 15	
Coastal Plain—Apr. 15 - Aug. 15	
<b>Soil amendments</b>	
Follow recommendations of soil tests or apply 2,000 lb/acre ground agricultural limestone and 750 lb/acre 10-10-10 fertilizer.	
<b>Mulch</b>	
Apply 4,000 lb/acre straw. Anchor straw by tacking with asphalt, netting, or a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulch anchoring tool.	
<b>Maintenance</b>	
Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.	

**Table 6.10c**  
**Temporary Seeding**  
**Recommendations for Fall**

<b>Seeding mixture</b>	
<b>Species</b>	<b>Rate (lb/acre)</b>
Rye (grain)	120
<b>Seeding dates</b>	
Mountains—Aug. 15 - Dec. 15	
Coastal Plain and Piedmont—Aug. 15 - Dec. 30	
<b>Soil amendments</b>	
Follow soil tests or apply 2,000 lb/acre ground agricultural limestone and 1,000 lb/acre 10-10-10 fertilizer.	
<b>Mulch</b>	
Apply 4,000 lb/acre straw. Anchor straw by tacking with asphalt, netting, or a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulch anchoring tool.	
<b>Maintenance</b>	
Repair and refertilize damaged areas immediately. Topdress with 50 lb/acre of nitrogen in March. If it is necessary to extend temporary cover beyond June 15, overseed with 50 lb/acre Kobe (Piedmont and Coastal Plain) or Korean (Mountains) lespedeza in late February or early March.	

6.11

**PERMANENT SEEDING**



**Definition** Controlling runoff and erosion on disturbed areas by establishing perennial vegetative cover with seed.

**Purpose** To reduce erosion and decrease sediment yield from disturbed areas, to permanently stabilize such areas in a manner that is economical, adapts to site conditions, and allows selection of the most appropriate plant materials.

**Conditions Where Practice Applies** Fine-graded areas on which permanent, long-lived vegetative cover is the most practical or most effective method of stabilizing the soil. Permanent seeding may also be used on rough-graded areas that will not be brought to final grade for a year or more.

Areas to be stabilized with permanent vegetation must be seeded or planted within 15 working days or 90 calendar days after final grade is reached, unless temporary stabilization is applied.

**Introduction** During the initial phase of all land disturbing projects, the protective layer, either natural or man-made, is removed from the earth's surface. As the protective layer is removed, the resulting bare areas are exposed to the natural forces of rainfall, freezing, thawing, and wind. The result is soil erosion that leads to sediment pollution of North Carolina streams, rivers, lakes, and estuaries.

This design manual presents many alternative strategies for preventing erosion and reducing sediment loss during the construction process. Establishment of protective vegetative cover during the construction project, however, is the crucial step in achieving soil stabilization, controlling soil erosion, and preventing sedimentation of waterways. Without a sufficient amount of root mat and leaf cover to protect and hold the soil in place, large volumes of soil will be lost and waterways will be degraded long after projects are considered complete.

Sections of this practice standard address many of these various situations and set forth selection criteria for the appropriate cover based on purpose and adaptability. Some sediment and erosion control practices recommended in earlier editions of the manual may no longer be applicable. For example, many popular and commonly used seed and plant varieties have been identified as invasive. Invasive plants are defined as species that aggressively compete with, and displace, locally adapted native plant communities. In select cases where no practical alternative is available, these plants may be considered on a limited basis for soil stabilization, understanding that the goal is to eliminate the use of all invasive plants in favor of non-invasive native and/or introduced species that will provide an equally acceptable vegetative cover. Where there is no alternative to the use of invasive species, measures need to be incorporated in the installation and maintenance of these plants to limit their impacts.

It is imperative that disturbed soils be totally protected from erosion and sediment loss during construction and before a project is considered complete and acceptable. Installing appropriate vegetation in an immediate and timely fashion is the optimal means of achieving this stabilization. Vegetative specifications for most exposed soil conditions across North Carolina are provided in this section of the manual. It should be noted however, that no two sites in the State are exactly alike; therefore the protective vegetative cover for individual sites should be carefully selected. Each requires its own investigation, analysis, design and vegetative prescription as set forth in this section of the manual.

This practice standard describes three stages of vegetative cover; immediate, primary and long term. Effective and acceptable stabilization can be provided only when the optimum combination of immediate, primary, and long term vegetative practices are applied.

The vegetative measures presented in this chapter include application of seed, sod and sprigs. Use of field and container grown plants are not addressed in this manual. Planting of these types of vegetation is typically at spacing and intervals that will not provide the required protective cover. However, the design professional is encouraged to utilize these larger plants to compliment the required protective cover, particularly where these types of plants will provide seed for continued long term cover and wildlife habitat.

## **PLANNING CONSIDERATIONS**

### **SOILS**

Test and analyze the type(s) and quality of the existing soils on a site, their pH ranges, and their nutrient levels. Taking soil samples from the different areas of the project site and having them tested at a state or independent lab will provide a baseline for determining the pH modifiers and additional nutrients required for the selected plant varieties.

Disturbed conditions on a site may produce a variety of soil communities. Nutrient and pH levels in deeply cut soils will be quite different from those soils found on the original surface. When sites are highly disturbed through mechanical means such as grading, the soils become mixed together in many different ratios. These areas should be identified and tested.

Results from soil tests will usually include recommended application rates of soil modifiers such as lime and fertilizer for the selected plant species in the particular soils. Application rates will be itemized in the report.

The texture of the soil on a site, which is the proportion of sand, silt, and clay in the soil, is an important physical indicator of the site's ability to support vegetation. In heavy clay soils amendments may be necessary to provide an adequately drained planting medium. Conversely, in extremely sandy soils, amendments may be required to provide for moisture and nutrient retention.

Soil tests will indicate the texture of the given soil but will not provide recommendations for amendments that will improve the soil texture. Generally, the addition of organic materials will improve the porosity of heavy clay soils and improve the water holding capacity of extremely sandy soils. On sites where these different soil conditions exist, it is recommended that a design professional with experience in soil modification be employed to recommend the proper amendments.

For more information visit the NCDA Agronomic Services Soil Testing web page <http://www.agr.state.nc.us/agronomic/sthome.htm>

#### **SOIL PREPARATION**

Proper soil preparation is necessary for successful seed germination and root establishment. It is also necessary for establishment of rooted sprigs, sod and woody plants. Heavily compacted soils prevent air, nutrients and moisture from reaching roots thereby retarding or preventing plant growth. The success of site stabilization and reduction of future maintenance are dependent on an adequately prepared soil bed. Following are the requirements for preparation of areas to be vegetated by grassing, sprigging, sodding, and/or planting of woody plants:

##### **General Requirements:**

- Preparation for primary/permanent stabilization shall not begin until all construction and utility work within the preparation area is complete. However, it may be necessary to prepare for nurse crops prior to completion of construction and installation of utilities.
- A North Carolina Department of Agriculture Soils Test (or equal) shall be obtained for all areas to be seeded, sprigged, sodded or planted. Recommended fertilizer and pH adjusting products shall be incorporated into the prepared areas and backfill material per the test.
- All areas to be seeded or planted shall be tilled or ripped to a depth specified on the approved plans, construction sequence and/or construction bid list. Ripping consists of creating fissures in a criss-cross pattern over the entire surface area, utilizing an implement that will not glaze the side walls of the fissures. Site preparation that does not comply with these documents shall not be acceptable. The depth of soil preparation may be established as a range based on the approval of the reviewing state or local agency. Once tilled or ripped according to the approved plan, all areas are to be returned to the approved final grade. pH modifiers and/or other soil amendments specified in the soil tests can be added during the soil preparation procedure or as described below.
- All stones larger than three (3) inches on any side, sticks, roots, and other extraneous materials that surface during the bed preparation shall be removed.

**Areas to be Seeded:**

- Till or disc the prepared areas to be seeded to a minimum depth of four (4) inches. Remove stones larger than three (3) inches on any side, sticks, roots and other extraneous materials that surface. If not incorporated during the soil preparation process, add pH modifier and fertilizers at the rate specified in the soil test report.
- Re-compact the area utilizing a cultipacker roller. The finished grade shall be a smooth even soil surface with a loose, uniformly fine texture. All ridges and depressions shall be removed and filled to provide the approved surface drainage. Seeding of graded areas is to be done immediately after finished grades are obtained and seedbed preparation is completed.

**Areas to be Sprigged, Sodded, and/or Planted:**

- At the time of planting till or disc the prepared areas to a depth of four (4) to six (6) inches below the approved finished grade. Remove all stones larger than three (3) inches on any side, sticks, roots and other extraneous materials that surface. If not incorporated in the ripping process, add pH modifier, fertilizer, and other recommended soil amendments.
- Re-compact the area utilizing a cultipacker roller and prepare final grades as described above. Install sprigs, sod and plants as directed immediately after fine grading is complete. Mulch, mat and/or tack as specified.

**VEGETATION**

Availability of seed and plant materials is an important consideration of any construction stabilization effort. Throughout North Carolina, climate, economics, construction schedule delays and accelerations, and other factors present difficult challenges in specifying the different vegetation needed for site stabilization. To help resolve this issue, vegetative stabilization requires consideration in three categories:

- Immediate Stabilization – nurse crop varieties (Note: temporary mulching may be utilized for immediate stabilization if outlined on the approved plans and construction sequence.)
- Primary Stabilization – plant varieties providing cover up to 3 years with a specified maintenance program
- Long Term Stabilization – plant varieties providing protective cover with maintenance levels selected by the owner

An adequate job in one of these areas does not guarantee success in the later phases. Horticultural maintenance must be included in the plans.

Immediate vegetative cover will always require additional fertilization, soil amendments, soil tests, overseeding and/or other horticultural maintenance until primary vegetative cover is established.

Where provisions are made for regular maintenance, primary vegetative cover may be the end result. An example of primary vegetative cover being acceptable as an end use would be lawns in residential and commercial developments that are established, monitored and complimented with regular and approved horticultural maintenance practices. (See Example 6.11.a.)

In projects where continual maintenance will not be provided or scheduled following the primary stabilization of a project, long-term stabilization will be necessary. Maintenance of initial and long-term stabilization can cease only after the long-term cover has established and hardened to local climatic conditions. Maintenance of long-term vegetation must be included in the project construction sequence and on the approved plans. Examples of areas suitable for long term vegetation include roadsides, reforestation areas, restored flood plains, restored riparian areas, phased closing of landfills, and mining reclamations.

Complete stabilization requires using at least two, and most times, all three vegetative phases. The design professional must clearly communicate this point in their specifications, construction sequence, and in direct communications to owners and installers. The charts in tables 6.11.a through 6.11.d provide information to assist the design professional in this task. The tables are not inclusive and are presented only as alternatives. The professional is expected and required to provide design and specifications that combine the information in the manual with knowledge of the particular sites and their constraints.

#### **pH AND NUTRIENT AMENDMENTS**

Determining the nutrients that enable seed and container plants to grow, flourish, and become established after planting are critical elements of the design and stabilization process. The soils tests previously described will provide a recipe for amendments based on particular plants and particular soils. The test results will recommend the amounts of base elements (nitrogen, phosphorous, potassium), pH modifiers and other trace elements that should be added to the soil for selected species of seeds and plants.

The acid/base characteristic of the soil is a primary component of soil fertility. If the soil acidity is not in the proper range, other nutrients will be ineffective, resulting in less productive plant growth. Most plants grow best in a pH range of 6.5 – 7.0 (slightly acidic to neutral). The soil tests will recommend the specific amendments and application rates required to achieve this range. These amendments must be incorporated into the soil (not applied on the surface) to be effective. (See the General Requirements for soil preparation specifications and timing for incorporation of soil amendments.)

The base elements are easily found in bulk quantities. Lime can also be obtained in large quantities. They all must be thoroughly incorporated into the soil through appropriate mechanical means. Ground surface applications without proper soil mixing will result in poor results.

In addition to the base fertilizers, other trace elements are needed to produce healthy and vigorous growth. These include but may not be limited to sulfur, manganese, zinc, boron, chlorine and molybdenum. If not already included with bulk mixes of the base elements, they can be obtained from commercial suppliers.

Provisions for soils test during and/or after initial grading is complete shall be included on the approved plan, in the approved construction sequence, and on the bid item list utilized for the project. *If you did not obtain a soil test:* Follow these recommendations for all grasses except centipedegrass.

1. Apply 75 pounds of ground limestone per 1,000 sq. ft.
2. Apply a starter type fertilizer (one that is high in phosphorus) based on the type of grass and planting method. Fertilizer bags have a three-number system indicating the primary nutrients, such as 8-8-8 or 5-10-10. These numbers denote the N-P-K ratio—the percentage of each nutrient in a fertilizer. The percentages are always noted in the following order:

N Nitrogen for green color and growth.

P<sub>2</sub>O<sub>5</sub> Phosphorus for good establishment and rooting.

K<sub>2</sub>O Potassium to enhance pest and environmental stress tolerance.

Some common examples of starter type fertilizers required for a 1,000 sq. ft. area include 40 pounds of 5-10-10, 20 pounds of 10-20-20, or 16 pounds of 18-24-6. For sandy soils, typical to coastal plain and sandhills of North Carolina, fertilizer rates should be increased by 20 percent.

Where available, it is recommended that the design professional specify organic compounds that meet the fertilization requirements, pH and other element requirements. Initial studies have indicated that these compounds have a more positive effect on the environment than some of the synthetic compounds used to manufacture inorganic fertilizers. These materials are readily available in the commercial trade as well as found in recycled yard waste debris, sewerage sludge, lime-stabilized sludge and animal manures. Materials proposed for use must be industry certified and/or privately tested and certified to be acceptable for proposed areas of use and application prior to approval.

#### **MULCHES AND TACKING AGENTS**

Mulches and tacking agents may be required or necessary to protect a seedbed's disturbed surface until the seed can germinate and provide the required protection from erosion. Selection of the materials used in this application should be based on their ability to hold moisture in the soil, as well as protect exposed soil from rainfall, storm water runoff, and wind. The availability of the selected material and the means to apply it are critical factors to consider when planning for the stabilization of any disturbed area. The mulch must cover a minimum of eighty (80) percent of the soil surface and must be secured by a tacking agent, crimping, or protective biodegradable netting. Netting that incorporates plastic mesh and/or plastic twine should not be used in wetlands, riparian buffers or floodplains due to the potential of small animal mortality. See Section 6.14 for detailed specifications and product applications.

#### **SOIL BLANKETS**

Soil blankets can be an acceptable and effective method of temporary sediment and erosion control in lieu of nurse crops. See Section 6.17 of the manual for descriptions of this product and how it can be used in conjunction with this section. In absence of mulches and tracking agents other means of protection may be necessary and required.

## **PROTECTIVE MATTING**

Protective matting consists of an impervious cover secured to the soil surface in lieu of vegetative cover. It is used to protect and stabilize the surface where the process of seeding or planting forms of vegetation may cause more erosion and off-site sedimentation than application of the mat. It is also used where a disturbed area is intended to lay fallow for a period of time before additional construction or land disturbance takes place. If a pervious matting is selected, a combination of vegetation and matting is required. Seeds can be applied prior to installation of the matting only after proper seedbed preparation has been provided. Also, live stakes, dormant sprigs, and other vegetation forms can be inserted in the pervious matting once it has been installed. Pre-seeded pervious matting may be used for quicker root establishment and stabilization only if certified dating and germination guarantees are provided. The reviewing agency must approve all pre-seeded matting on site prior to installation. Matting that incorporates plastic mesh and/or plastic twine should not be used in wetlands, riparian buffers or floodplains due to the potential of small animal mortality. See Section 6.17 for detailed specifications and recommended product applications.

## **STABILIZATION IN WETLANDS, RIPARIAN BUFFERS, AND FLOODPLAINS**

Land disturbing activity involving streams, wetlands or other waterbodies may also require permitting by the U.S. Army Corps of Engineers or the N.C. Division of Water Quality. Approval of an erosion and sedimentation control plan is conditioned upon the applicant's compliance with federal and State water quality laws, regulations, and rules. Additionally, a draft plan should be disapproved if implementation of the plan would result in a violation of rules adopted by the Environmental Management Commission to protect riparian buffers along surface waters. Care should be taken in selecting vegetative stabilization of wetlands and riparian buffers to comply with permitting requirements of other agencies, as well as provide adequate ground cover.

### **Planning Considerations for Land Disturbing Activities Within Wetland, Riparian, and Floodplain Areas**

Wetlands, riparian areas, floodplains, and/or terrestrial areas between streams and uplands, serve to buffer surface water and provide habitat for aquatic and terrestrial flora and fauna. When cleared and disturbed, these sensitive areas are difficult to protect. Because of their proximity to water courses, relatively high ground water tables, and flooding potential, detailed analysis and design is necessary to determine the appropriate erosion control measures during construction. Determining the appropriate and most expeditious means of permanent vegetative stabilization in these areas requires equally detailed analysis and design. The following considerations for erosion control and stabilization should be taken into account during the design phase of the land disturbing project where sensitive areas are involved:

- Obtain soil tests to determine the soil type, pH, texture and available nutrients.
- Based on the soil tests provide a schedule of nutrients and other soil amendments that will be required.

- Select a seeding mix of non-invasive species that will provide immediate stabilization (a short-term environment that will support and compliment permanent vegetative stabilization) and include a selective native species mix that will eventually provide a permanent cover (a long-term environment that, with minimal maintenance, will provide adequate root and leaf cover).
- Invasive species are to be avoided. If native species and introduced non-invasive seed sources are not available, protective matting that will hold and foster the development of native cover from adjacent seed sources should be used. Continuous maintenance must be employed until the selected species have matured and are no longer susceptible to competition from invasive plants. If no alternative to the use of invasive seeds and plants is available, invasives approved on the plans may be utilized only with strict containment measures outlined in detail on the plans, in the construction sequence and in the maintenance specifications.
- A quickly germinating nurse crop of non-invasive, non-competitive annual grass species can be used along with native seeding and/or matting. These temporary systems should be planted at minimal density so that they do not inhibit the growth and establishment of the permanent, native species. (See the plant chart in Table 6.11.a for recommended native and nurse crop species.)
- Seed bed preparation is key to successful establishment of seeds. Particular care should be taken, however, when working in wetlands, riparian areas, or floodplains due to their sensitive nature. Careful consideration should be given to the types and placement of large equipment working in these areas. This process must be outlined in detail on the plan's construction sequence.
- Installation techniques vary and should be planned for accordingly.
- A maintenance plan must be established for optimal plant establishment, submitted with the plans and included in the bid list for the project.

Like all construction sites, wetlands, riparian areas, and floodplains will vary widely in physical makeup across North Carolina. Different conditions will dictate specific treatment, design and plant selection within the Mountains, Piedmont, and Coastal Plain regions. Soil tests, seedbed preparation, mulching, matting, and maintenance will be critical for successful vegetative establishment and long-term protection of these environmentally sensitive areas. Unavoidable impacts to these areas during land disturbing activities need to be addressed in detail on the plan sheets and construction sequence.

**Native Seed and Plant Selection for Stabilization of Wetlands, Riparian Areas, and Floodplains**

Upon the completion of the land disturbing activity, vegetative cover must be established on all areas not stabilized by other means. If work in these areas stops for more than 15 working days, temporary vegetative cover and/or matting must be applied to all disturbed areas. The goal is to protect these areas from erosion and to prevent sedimentation of adjacent streams, wetlands, lakes, and other water bodies.

Planning considerations for wetlands, riparian areas and floodplains will require additional research, detail and specifications. Native grasses are usually required as a condition of a 401 Water Quality Certification or a trout buffer variance.

Native vegetative species are plant species that naturally occur in the region in which they evolved. These plants are adapted to local soil types and climatic variations. Because most native species do not germinate and establish as readily as some introduced species, it is necessary to provide a non-native nurse crop or matting to stabilize the soil until the native crop can become established as the dominant cover. Once established, the native plants will produce an extensive root structure that, if properly maintained, will stabilize soils and reduce erosive forces of rainfall and overland stormwater flow. Many of these plants also possess characteristics that, when established, allow them not only to survive, but also to thrive under local conditions.

Seeding a mixture of perennial native grasses, rushes, and sedges is a way to establish permanent ground cover within wetlands, riparian areas and floodplains. The use of propagated plants is another method of reestablishing natives in these environments. Selecting a seed mixture and/or propagated plants of different species with complimentary characteristics will provide vegetation to fill select niches on sites with varying physical conditions. The design professional should note that because most native species do not germinate and establish as readily as some introduced species, it is necessary to provide a non-native nurse crop or matting to stabilize the soil until the native crop can become established as the dominant cover. For additional information about acceptable nurse crop varieties, consult the planting list in Appendix 8.02, local seed and plant suppliers, the North Carolina Cooperative Extension Service or a qualified design professional to assure the proper selection and plant mix.

Permanent native seed species within the seed mixture should be selected based on natural occurrence of each species in the project site area. Climate, soils, topography, and aspect are major factors affecting the suitability of plants for a particular site and these factors vary widely across North Carolina, with the most significant contrasts occurring among the three major physiographic regions of the state – Mountains, Piedmont, and Coastal Plain. Sub-regions of the state should also be considered. For example, the Triassic Basin in the Piedmont region may have characteristics that call for special soil treatment, limited plant selection, and special maintenance. Even within the riparian area, there may be need for different species depending on site conditions (i.e., dry sandy alluvial floodplains with wet pockets). Therefore, thoughtful planning is required when selecting species for individual sites in order to maximize successful vegetation establishment.

Native seed and plant species are included on the plant list in Appendix 8.02 of this manual.

The design professional should note that regardless of the benefits and advantages of native seeds and plants, there are potential issues if proper planning, installation and maintenance do not occur. These may include:

- Potential for erosion or washout during the establishment stage;
- Seasonal limitation on suitable seeding dates and availability of seed and plants;
- Adaptability of species at specific sites;
- Availability of water and appropriate temperatures during germination and early growth; and
- Lack of maintenance to control invasive plants and undesirable competition.

#### PLANTING

- **Seed** – Prepare the seed bed as described above in soil preparation. Apply seed at rates specified on the plans, and/or as recommended in Tables 6.11a-c of this manual, with a cyclone seeder, prop type spreader, drill, or hydroseeder on and/or into the prepared bed. Incorporate the seed into the seed bed as specified. Provide finished grades as specified on the approved plan and carefully culti-pack the seedbed as terrain allows. If terrain does not allow for the use of a cultipacker, the approved plans and construction sequence must provide an alternative method of lightly compacting the soil. Mulch immediately.
- **Sprigs and Sod** – Install onto the prepared seed bed per the most current guidance in Carolina Lawns, NCSU Extension Bulletin AG-69, or Practice 6.12 *Sodding*.

- **Woody plants (liners, container, B&B)** – These materials are typically used to complement an herbaceous protective cover. They eventually are major components of long-term, permanent stabilization and should be chosen and planned in conjunction with immediate and long-term maintenance. The plants should be selected and specified by the design professional for each individual project. See Practice 6.13 *Trees, Shrubs, Vines, and Ground Covers*.

#### **MAINTENANCE**

The absence of or an incomplete landscape management specification and/or complete maintenance schedule shall constitute grounds for disapproval of the plans. Proper maintenance is critical for the continued stabilization once vegetative cover is established. Although maintenance strategies for different sites may be similar, no two construction sites in North Carolina have been or will be able to be controlled or protected in identical ways. Variations in climate, topography, soils, available moisture, size and many other conditions will dictate the maintenance methodology to be used. A detailed schedule of maintenance will be required on the plans. This schedule will illustrate how the initial planting will be maintained to assure immediate, short term and permanent protection. The schedule will address topics such as appropriate irrigation of plants during the early establishment phase, drought conditions, excessive rainfall, mulch replacement, supplemental seeding, supplemental soils tests, application of nutrients and amendments, control of competitive and invasive species, disease and insect control, and corrective maintenance, measures to address failure of vegetation to become established. Contractual responsibility for maintenance after initial establishment of vegetative cover will be provided on the plans, in the construction sequence and on the bid list for the project. Maintenance bonds and/or warranty guarantee may be required of the responsible party, especially for areas in or adjacent to environmentally sensitive sites such as wetlands, riparian buffers, floodplains, and waters of the State. See Example 6.11a for a sample maintenance specification and a minimum maintenance check list that shall be provided on all plans.

#### **RECOMMENDED BID LIST**

(These items should be itemized on documents utilized to obtain pricing for planting pertaining to vegetative stabilization of land disturbing projects in North Carolina.)

- Soil test prior to grading (price per each test).
- Soil test during grading operations (price per each test).
- Soil test at completion of grading and/or prior to seeding, sprigging, sodding and application of fertilizer, lime, and other soil amendments (price per each test).
- Ripping/subsoiling to a depth of six (6) inches. (Provide an alternate for ripping to a depth greater than six (6) inches.) (price per acre)
- Tilling/discing ripped area to a depth of four (4) inches and re-compacting with a cultipacker roller (include in seeding price).

- 
- Seeding (price per square foot).
  - Mulching (price per square foot).
  - Repair seeding (price per square foot).
  - Repair mulching (price per square foot).
  - Matting (price per square yard).
  - Watering (price per thousand gallons).
  - Mowing (price per square foot).

### SEEDING RECOMMENDATIONS

The following tables list herbaceous plants recommended for use as nurse crops for immediate stabilization and primary crops for initial and long-term stabilization. Nurse crops are expected to develop in two to five weeks and, with adequate maintenance, be an effective method of soil stabilization for a period of six months to one year. Nurse crops are not effective as primary long-term cover, however if properly maintained they can be an adequate cover and protection for the development of primary crops.

The goal for a primary crop is for it to develop over a three-week to one-year period and be effective up to three years with a well-defined maintenance program. The long-term goal for a primary crop is the initial step toward a sustainable protective cover without the need of maintenance. Where the primary crop is intended for a managed lawn and landscape aesthetics, the effective period can be extended by a more intense maintenance program. Where native species are utilized and become established during the planned maintenance program, a permanent cover that will support future succession species should exist and require little or no additional maintenance or management.

In uses of both nurse and primary crops, the development periods listed on the tables are optimal based on normal climatic conditions for the planting dates listed. The sediment and erosion control maintenance program must recognize that optimum temperatures and rainfall are the exception rather than the rule. The design professional needs to provide flexibility in the stabilization plan to address the potential ranges of temperature and moisture conditions we experience in North Carolina.

Information is provided for seeding rates, optimum planting dates in the state's three regions, sun and shade tolerance, invasive characteristics, compatibility in wetlands and riparian buffers, and installation maintenance considerations. By going through the lists the design professional can select the nurse and primary seed varieties and maintenance characteristics they feel are best suited for their site conditions, vegetation management expertise and maintenance capabilities.

To use the information in the seeding charts the plan preparer must:

- Determine what nurse crop best fits their site, soil conditions, and permanent seed mix.
- Obtain soil tests for all areas to be seeded.
- Know the site's region: mountains, piedmont, or coastal plain.
- Know if the areas to be seeded are sunny, part shade, or full shade.
- Know if the areas are well or poorly drained.
- Know if wetlands or riparian buffers are included in the areas to be seeded.
- Know if a chosen crop is invasive and if so, what potential impacts it will have on the site and adjacent properties.

With this knowledge the plan preparation may proceed utilizing the charts provided to provide the several seed mixes that will be applicable to the different areas requiring stabilization.

Table 6.11.a

HERBACEOUS PLANTS--Seeding recommendations for immediate stabilization/nurse crops  
(2 to 5 weeks for development; effectiveness goal: 6 months to 1 year stabilization)  
NURSE CROP SPECIES

Common Name	Botanical Name	Native / Introduced	Seeding Rates lbs/acre	Fertilization/ limestone lbs/acre	Optimal Planting Dates			Sun/Shade tolerant	Wetlands	Riparian Buffers	Invasive Yes or No	Installation / Maintenance Considerations	Other information, commentary
					Mountains	Piedmont	Coastal Plains						
Rye Grain	<i>Secale cereale</i>	I	40 lbs	By soil test	11/1 - 4/30	8/15 - 4/15	8/15 - 4/15	Sun	Yes	Yes	No	Must be mown to reduce competitiveness with permanent or long term vegetation	
Wheat	<i>Triticum aestivum</i>	I	30 lbs	By soil test	11/1 - 4/30	8/15 - 5/15	8/15 - 4/15	Sun	Yes	Yes	No	Must be mown to reduce competitiveness with permanent or long term vegetation	Not water tolerant. May be used in wetlands that are not continuously saturated.
German Millet	<i>Setaria italica</i>	I	10 lbs	By soil test	5/11 - 9/30	5/15 - 8/15	4/15 - 8/15	Sun	Yes	Yes	No	Crop should be cut / disc prior to planting primary or long term vegetation	Not water tolerant. May be used in wetlands that are not continuously saturated.
Browntop Millet	<i>Urochloa ramosa</i>	I	10 lbs	By soil test	5/11 - 9/30	5/15 - 8/15	4/15 - 8/15	Sun	Yes	Yes	No	Crop should be cut / disc prior to planting primary or long term vegetation	Not water tolerant. May be used in wetlands that are not continuously saturated.
Sudangrass (hybrids)	<i>Sorghum saccharatum</i> <i>S. bicolor</i> ssp. <i>Drummondii</i>	I	15 lbs	By soil test		NR	NR	Sun	No	No	Yes	Crop should be cut / disc prior to planting primary or long term vegetation	Use only where plants and seed can be contained and controlled.
Kobe Lespedeza	<i>Kummerowia striata</i> v. <i>Kobe</i>	I	10 lbs	By soil test	5/1 - 9/1	5/1 - 9/1	5/1 - 9/1	Sun	No	No	No	Consult qualified horticulturalist or extension agent for over-seeding with primary cover	Use in Coastal Plain
Korean Lespedeza	<i>Kummerowia stipulacea</i>	I	10 lbs	By soil test	5/1 - 9/1	5/1 - 9/1	5/1 - 9/1	Sun	No	No	No	Consult qualified horticulturalist or extension agent for over-seeding with primary cover	Use in Piedmont and Mountains. May become invasive

NOTES:

1. Seeding rates are for hulled seed unless otherwise noted.
2. Fertilizer & Limestone - rates to be applied in absence of soils tests. Recommended application rate assumes significantly disturbed site soils with little or no residual value.
3. NR means Species not recommended for this region or application area.
4. Invasive designation as determined by the N.C. Exotic Pest Plant Council and N.C. Native Plant Society .
5. Sprigging is not recommended for immediate stabilization unless terrain is flat heavy mulch is applied and no other immediate stabilization method is practical.

**Table 6.11.b**  
**HERBACEOUS PLANTS-Seedling recommendations for primary stabilization**  
 Successful development depends on planting date (effectiveness goal: 6 mo. - 3 yrs. without an ongoing maintenance program)  
**NON-NATIVE SPECIES**

Common Name	Botanical Name / Cultivar	Native / Introduced	Broadcast Seeding Rates lbs/acre	Fertilization/ Limestone lbs/acre	Optimal Planting Dates					Sun/Shade tolerant	Wetlands	Riparian Buffers	Invasive Yes or No	Installation / Maintenance Considerations	Other information, commentary
					Mountains 9/1 - 6/1	Piedmont 9/1 - 5/1	Coastal Plains 10/1 - 4/1	9/1 - 5/1	8/15 - 5/1						
Lespedeza	<i>Lespedeza cuneata</i> <i>Dumont</i>	I	15 lbs	By soil test						Sun	NR	NR	Yes	Responds well to controlled burns	Severe Threat Invasive species
Crown Vetch	<i>Securigera varia</i> <i>(Coronilla varia)</i>	I	15 lbs	By soil test	3/15-4/30	NR	NR	NR	Sun	NR	NR	Yes	Highly competitive, not recommended unless an acceptable alternative is not available.	Prefers neutral soils	
Centipede Grass	<i>Eremochloa ophiuroid</i>	I	5 lbs 10 lbs. for road shoulders	By soil test	NR	Eastern only	9/1 - 5/1		Sun	NR	NR	No	Significant maintenance may be required to obtain desired cover	Does not tolerate high traffic. Acceptable for sodding	
KY 31 Tall Fescue	<i>Schedonorus schoenii</i> <i>(Festuca arundinacea)</i>	I	100 lbs	By soil test	8/15-5/1	9/1 - 4/15	9/30 - 3/15		Sun / mod. Shade	NR	NR	Yes	If utilized, it is imperative that maintenance includes a containment plan	Acceptable for sodding	
KY Blue Grass	<i>Poa pratensis</i>	I	15 lbs	By soil test	8/15-5/1	NR	NR		Sun	NR	NR	Yes	If utilized, it is imperative that maintenance includes a containment plan	Prefers neutral soils, highly competitive, not recommended unless an acceptable alternative is not available. Acceptable for sodding	
Hard Fescue	<i>Festuca brevipila</i> <i>(Festuca longifolia)</i>	I	15 lbs	By soil test	8/1 - 6/1	NR	NR		Shade	NR	NR	No	Not recommended for slopes greater than 6%	Low growing, bunch grass	
Bermuda Grass	<i>Cynodon dactylon</i>	I	25 lbs	By soil test	NR	4/15-6/30	4/15-6/30		Sun	NR	NR	Yes	If utilized, it is imperative that maintenance includes a containment plan	Extremely aggressive, not recommended and should be avoided unless an acceptable alternative is not available. May be sodded or sprigged	

Table 6.11.c

HERBACEOUS PLANTS-Seeding recommendations for primary stabilization  
 Successful development depends on planting date (effectiveness goal: 6 mo. - 3 yrs. without an ongoing maintenance program)

NATIVE SPECIES

Common Name	Botanical Name / Cultivar	Native / Introduced	See Table 6.11.d for varieties/ seeding rates	Fertilization/ limestone lbs/acre	Optimal Planting Dates				Sun/Shade tolerant	Wetlands	Riparian Buffers	Invasive Yes or No	Installation / Maintenance Considerations	Other information, commentary
					Moisture	Piedmont	Coastal Plains	NR						
Switchgrass	<i>Panicum virgatum</i> / Cave-In-Rock	N	A	By soil test	12/1-4/15	NR	NR	Sun	NR	Well drained only	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.		
Switchgrass	<i>Panicum virgatum</i> / Blackwell	N	A	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	NR	Well drained only	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.		
Switchgrass	<i>Panicum virgatum</i> / Sheller	N	A	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	NR	Well drained only	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.		
Switchgrass	<i>Panicum virgatum</i> / Carnegie	N	A	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	Yes	Yes	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.		
Switchgrass	<i>Panicum virgatum</i> / Kaolow	N	A	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	No	Poorly drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.		
Switchgrass	<i>Panicum virgatum</i> / Alamo	N	A	By soil test	NR	12/1 - 5/1	1/1 - 5/1	Sun	No	Poorly drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.		
Indiangrass	<i>Sorghastrum nutans</i> / Rumsey	N	B	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Western coastal plain only	
Indiangrass	<i>Sorghastrum nutans</i> / Osage	N	B	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Western coastal plain only	

Table 6.11.c (cont)

HERBACEOUS PLANTS-Seeding recommendations for primary stabilization  
 Successful development depends on planting date (effectiveness goal: 6 mo. - 3 yrs. without an ongoing maintenance program)

NATIVE SPECIES		Optimal Planting Dates										Invasive Yes or No	Riparian Buffers	Installation / Maintenance Considerations	Other information, commentary
Common Name	Botanical Name / Cultivar	Native / Introduced	See Table 6.11.d for variety seeding rates	Fertilization/ lime/acid lbs/acre	Mountains 12/1-4/15	Piedmont 12/1 - 4/1	Coastal Plains 12/1-4/1	Sun/Shade tolerant	Wetlands	Well drained					
Indiangrass	<i>Sorghastrum nutans</i> / <i>Chelyone</i>	N	B	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Western coastal plain only		
Indiangrass	<i>Sorghastrum nutans</i> / <i>Lomenta</i>	N	B	By soil test	NR	12/1 - 5/1	1/1 - 5/1	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Only Indiangrass adaptable to Eastern coastal plain (Zone 5)		
Deertongue	<i>Dichanthium ciliolatum</i> / <i>Tioga</i>	N	C	By soil test	5/1-4/15	5/1 - 4/1	NR	Sun & Shade	Yes	Poorly drained to drought	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.			
Big Bluestem	<i>Andropogon gerardii</i> / <i>Roultree</i>	N	D	By soil test	12/1-4/15	12/1 - 4/1	NR	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass		
Big Bluestem	<i>Andropogon gerardii</i> / <i>Raw</i>	N	D	By soil test	12/1-4/15	12/1 - 4/1	NR	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass		
Big Bluestem	<i>Andropogon gerardii</i> / <i>Fair</i>	N	D	By soil test	12/1-4/15	12/1 - 4/1	12/1-5/1	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass		
Little Bluestem	<i>Schizachyrium scoparium</i> / <i>Albus</i>	N	E	By soil test	12/1-4/15	NR	NR	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass		
Little Bluestem	<i>Schizachyrium scoparium</i> / <i>Cimmaron</i>	N	E	By soil test	12/1-4/15	12/1 - 4/1	NR	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass		

Table 6.11.c (cont)

HERBACEOUS PLANTS-Seeding recommendations for primary stabilization  
 Successful development depends on planting date (effectiveness goal: 6 mo. - 3 yrs. without an ongoing maintenance program)

NATIVE SPECIES

Common Name	Botanical Name / Cultivar	Native / Introduced	See Table 6.11.d for variety seedling rates	Fertilization/ Limestone/ Insecticide rates	Optimal Planting Dates				Wetlands	Riparian Buffers	Invasive Yes or No	Installation / Maintenance Considerations	Other information, commentary
					Mountains	Piedmont	Coastal Plains	Sun/Shade tolerant					
Little Bluestem	Schizachyrium scoparium / Common	N	E	By soil test	NR	NR	12/1 - 4/1	Sun	NR	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass	
Sweet Woodreed	Circa arundinacea	N	F	By soil test	12/1 - 4/1	12/1 - 4/1	12/1 - 4/1	Sun & mod. Shade	Yes	No	Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass	
Rice Cutgrass	Leersia oryzoides	N	G	By soil test	12/1 - 4/1	12/1 - 4/1	12/1 - 4/1	Sun	Yes	No	Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass	
Indian Woodoats	Chasmanthium latifolium	N	H	By soil test	3/1 - 5/15 7/15 - 8/15	2/15 - 4/1 8/15 - 10/15	2/15 - 3/20 9/1 - 11/1	Sun & mod. Shade	NR	No	Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Cool season grass	
Virginia Wild Rye	Elymus virginicus	N	I	By soil test	3/1 - 5/15 7/15 - 8/15	2/15 - 4/1 8/15 - 10/15	2/15 - 3/20 9/1 - 11/1	Sun & mod. Shade	NR	No	Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Cool season grass	
Eastern Bottlebrush Grass	Elymus hystrix	N	J	By soil test	3/1 - 5/15 7/15 - 8/15	2/15 - 4/1 8/15 - 10/15	NR	Sun & mod. Shade	NR	No	Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Cool season grass	
Soft Rush	Juncus effusus	N	K	By soil test	12/1 - 5/15 8/15 - 10/15	12/1 - 5/1 9/1 - 11/1	12/1 - 4/15	Sun	Yes	No	Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Cool season grass	
Shallow Sedge	Carex lurida	N	L	By soil test	12/1 - 5/15 8/15 - 10/15	12/1 - 5/1 9/1 - 11/1	12/1 - 4/15	Sun	Yes	No	Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Cool season grass	
Fox Sedge	Carex vulpinoidea	N	L	By soil test	12/1 - 5/15 8/15 - 10/15	12/1 - 5/1 9/1 - 11/1	12/1 - 4/15	Sun	Yes	No	Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Cool season grass	

NOTE:

1. Seeding rates are for hulled seed unless otherwise noted.
2. Fertilizer & Limestone - rates to be applied in absence of soils tests. Recommended application rate assumes significantly disturbed site soils with little or no residual value.
3. NR means Species not recommended for this region or application area.
4. Native, warm season grasses require six or more months to germinate under optimum conditions. If they are planted in the summer, then a whole year will have to pass before they germinate.
5. Invasive designation as determined by the N.C. Exotic Pest Plant Council and N.C. Native Plant Society.
6. Sprigging is not recommended for immediate stabilization unless terrain is flat, heavy mulch is applied and no other immediate stabilization method is practical.
7. Sodding for immediate stabilization - see primary stabilization charts (other information column) and Section 6.12.
8. Long term stabilization can only be accomplished with an adequate, immediate, and primary stabilization program. To achieve long term protective cover with the species listed in

Table 6.11.d

**Seed Mixes for Native Species (lbs/ac)**  
**When Mixed with 3, 4, or 5 Other Native Species**  
 (See Table 6.11.a for nurse crop species to be added to these mixes)

	3 Other (total 4 species)	4 Other (total 5 species)	5 Other (total 6 species)
Switch Grasses (A)	3.5 lbs.	3.0 lbs.	2.5 lbs.
Indian Grasses (B)	7.0 lbs.	6.0 lbs.	5.0 lbs.
Deertongue (C)	6.0 lbs.	5.0 lbs.	4.0 lbs.
Big Bluestem (D)	7.0 lbs.	6.0 lbs.	5.0 lbs.
Little Bluestem (E)	7.0 lbs.	6.0 lbs.	5.0 lbs.
Sweet Woodreed (F)	2.5 lbs.	2.0 lbs.	1.5 lbs.
Rice Cutgrass (G)	6.0 lbs.	5.0 lbs.	4.0 lbs.
Indian Woodoats (H)	2.5 lbs.	2.0 lbs.	1.5 lbs.
Virginia Wild Rye (I)	6.0 lbs.	5.0 lbs.	4.0 lbs.
Eastern Bottlebrush Grass (J)	2.5 lbs.	2.0 lbs.	1.5 lbs.
Soft Rush (K)	2.5 lbs.	2.0 lbs.	1.5 lbs.
Sedges (L)	2.5 lbs.	2.0 lbs.	1.5 lbs.

**NOTE:**

With the native varieties, the seed mix should be in the range of 15 pounds per acre. Depending on availability of native seeds adaptable to North Carolina, the percentage of a particular variety used may be reduced or increased accordingly. Although diversity is desirable, it is imperative that the primary crop develop and become an effective protective cover. In addition to the native species mix, additional nurse crop species must be included to provide immediate stabilization and an adequate ground cover.

## Example 6.11.a GUIDELINES FOR WRITING MINIMUM LANDSCAPE MANAGEMENT SPECIFICATIONS

Following is an outline that demonstrates what should be included in specifications that will insure the long term stabilization of disturbed sites in North Carolina. As noted before in this manual, each construction site in the state is unique and has features that will require special provisions for revegetation and stabilization. The outline provided below cannot address these individual sites. It is the responsibility of the design professional and the financially responsible party to see that the specifications are edited to fit their site and to assure that permanent stabilization is achieved.

**General Provisions****A. Intent:**

1. These specifications are prepared with the intent of promoting outstanding performance in long-term stabilization. They are to be used as guidelines in establishing sediment control and vegetative standards for the sites. Final technical decisions such as herbicides, fertilizer ratios, times of application and schedules are to be determined by the Contractor, who has the responsibility to obtain soil test and to manage the vegetation to achieve the desired results. The maintenance specifications must address maintenance for sediment and erosion control vegetation during construction and for permanent/long-term stabilization.

**B. Description of Work:**

1. Perform all work necessary and required for the (insert period of contract) maintenance of the project as indicated on the drawings, in the project manual, and specified herein.

**2. Licensing:**

a) Contractor shall provide verification of current, applicable pesticide applicator licensing for each applicator that will handle pesticides on the contracted sites.

**3. Contract Administration**

a) **Staffing:** The Contractor shall provide adequate staffing, with the appropriate expertise, to perform all required work.

b) **Monthly Site Review meetings** will be held. Attendees will include the Contractor's Project Manager and Site Foreman and the property manager or other representative designated by the financially responsible party. Result of site reviews will be documented and circulated to the attendees and the owner by the contractor.

c) The Contractor will communicate with the proper person on a monthly basis to summarize work performed and immediately notify the project manager of any failure of the site to remain stabilized.

**II. Materials**

**A. Soil Additives:** Additives are to be applied per soils test taken prior to, during and after construction. **(Use this section to provide the types and quantities of fertilizers, lime, and other soil amendments called for in the soils report. Include all soils test reports in the specifications document. This narrative or list should include quantities, rates, mixes, organic information, manufacturer, sources, and other information suggested in the soils test.)**

A. Pesticides:

1. Establish an Integrated Pest Management (IPM) program for the site that relies on targeted insect and disease control coupled with sound stabilization management and water management practices.
2. These specifications do not include pesticide treatments for infestations of Southern Pine Beetle, Gypsy Moth, or Fire Ants. The contractor shall notify the Owner if these pests are observed on site.
3. All pesticides shall be applied by a North Carolina licensed applicator in accordance with all State and Federal regulations and per manufacturer's recommendations.

B. Mulches: Mulch for areas not subject to erosion and over wash by storm water should be called out in this section addressing its maintenance, replacement, removal and conversion to other uses. Those subject to erosion and over wash by storm water must be addressed on the plans and in the calculations.

III. Execution

A. General:

1. Good long term stabilization is based on the proper maintenance, management and balance of nutrients, soil moisture and general cultural practices. It is recognized that fewer fungicide and pesticide treatments as well as lower fertility rates are required with a well managed, balanced landscape. The following section is meant to promote this balance and therefore do not highlight specific quantitative standards. **(Quantitative standards should be addressed as site specific by the design professional in conjunction with the owner and contractor.)** Calendar references are general and are to be used only as a guide. Weather and soil conditions that are most appropriate for a given process, procedure and/or area of the state shall be the determining factor in scheduling work.

B. Soil Tests:

1. After the soil test prior to stabilization, tests shall be made yearly in the fall to determine the required soil additives for all stabilized areas. If known nitrogen requirements are not specified by previous test, they need to be determined by the subsequent soils test and the proper applications made. Fertilizer ratios may be determined through analysis of the soil tests coupled with the contractor's experience and knowledge of the site.

C. Mowing

1. Mowing for maintained turf/lawns

- a. Mow areas intended for "groomed appearance" on a schedule during the growing season and as required throughout the year to provide the desired appearance. **(Establish a mowing frequency here that addresses the specific plant species used and their growing habits.)** This frequency will be a minimum standard. Particular properties and their peculiar characteristics as well as individual plant species may require mowing more often than the stated minimum may be required. This should be noted in this section.
- b. The range of turf species suggested for lawns in the three growing regions of North Carolina vary as to optimum maintained height. The selected species should be maintained at a height recommended by the seed producer. Do not cut too short and do not allow the turf to attain a height that will cause the crop to decline or die. Consult individual seed producers and/or packaging for recommended mowing heights.
- c. Mow with a mulching mower to limit the amount of clippings removed, or mow and blow in such a manner that clippings are not evident and not to adversely effect the growing capacity

and/or health of the existing vegetation turf. It is important clippings are allowed to remain spread throughout the lawn area, to the extent possible, so that they might aid in building a more productive soil profile and root zone.

2. Mowing other stabilized areas to promote continued growth. Include mowing specification here for other stabilized areas which require maintenance but not a "groomed" appearance. Also include specifications for mowing areas where it is desirable for woody native volunteer vegetation to become established. This should include attention to mowing stakes or other way of protecting the desired woody natives from the mowing operation.

#### D. Watering

1. Irrigation System Maintenance and Monitoring: If stabilized areas are to be irrigated the design professional should include specifications for the system, its maintenance and its operation in this section.

2. In the absence of an automatic or manual irrigation system, provisions for providing adequate water to stabilized areas should be addressed in this section.

3. **(Provisions should be made in this section for adjustments to application rates of water during times of regulated droughts and/or periods of excessive rainfall.)**

**E. CONTROL OF INVASIVES:** Competition from invasive species can be detrimental to the establishment of the permanent vegetative cover. Left unchecked, these invasives can undermine a revegetation process in a short period of time and eventually lead to unprotected soil and sediment damage. Make site observations monthly to check for the presence of such species and, if found, treat them immediately with the appropriate cultural practices and/or by the use of seasonally-appropriate and site appropriate herbicides.

F. Maintenance items including fertilization, mowing, continued soils testing, repair, mulching, matting and soil preparation are to be addressed in the approved construction sequence and on the project bid list.

6.14

**MULCHING**

**Definition** Application of a protective blanket of straw or other plant residue, gravel, or synthetic material to the soil surface.

**Purpose** To protect the soil surface from the forces of raindrop impact and overland flow. Mulch fosters the growth of vegetation, reduces evaporation, insulates the soil, and suppresses weed growth. Mulch is frequently used to accent landscape plantings.

**Conditions Where Practice Applies** Mulch temporary or permanent seedings immediately. Areas that cannot be seeded because of the season should be mulched to provide temporary protection of the soil surface. Use an organic mulch in this case (but not wood fiber), and seed the area as soon as possible. Mulch around plantings of trees, shrubs, or ground covers to stabilize the soil between plants.

**Planning Considerations** A surface mulch is the most effective, practical means of controlling runoff and erosion on disturbed land prior to vegetation establishment. Mulch reduces soil moisture loss by evaporation, prevents crusting and sealing of the soil surface, moderates soil temperatures, provides a suitable microclimate for seed germination, and may increase the infiltration rate of the soil.

Organic mulches such as straw, wood chips, and shredded bark have been found to be the most effective. Do not use materials which may be sources of competing weed and grass seeds. Decomposition of some wood products can tie up significant amounts of soil nitrogen, making it necessary to modify fertilization rates, or add fertilizer with the mulch (Table 6.14a).

A variety of mats and fabrics have been developed in recent years for use as mulch, particularly in critical areas such as waterways and channels. Various types of netting materials are also available to anchor organic mulches.

Chemical soil stabilizers or soil binders, when used alone, are less effective than other types of mulches. These products are primarily useful for tacking wood fiber mulches.

The choice of materials for mulching should be based on soil conditions, season, type of vegetation, and size of the area. A properly applied and tacked mulch is always beneficial. It is especially important when conditions for germination are not optimum, such as midsummer and early winter, and on difficult areas such as cut slopes and slopes with southern exposures.

**ORGANIC MULCHES**

**Straw** is the mulch most commonly used in conjunction with seeding. The straw should come from wheat or oats ("small grains"), and may be spread by hand or with a mulch blower. Straw may be lost to wind, and must be tacked down.

**Wood chips** are suitable for areas that will not be closely mowed, and around ornamental plantings. Chips do not require tacking. Because they decompose slowly, they must be treated with 12 pounds of nitrogen per ton to prevent

**Table 6.14a**  
**Mulching Materials and Application Rates**

<b>Material</b>	<b>Rate Per Acre</b>	<b>Quality</b>	<b>Notes</b>
<b>Organic Mulches</b>			
Straw	1-2 tons	Dry, unchopped, unweathered; avoid weeds.	Should come from wheat or oats; spread by hand or machine; must be tacked down.
Wood chips	5-6 tons	Air dry	Treat with 12 lbs nitrogen/ton. Apply with mulch blower, chip handler, or by hand. Not for use in fine turf.
Wood fiber	0.5-1 tons		Also referred to as wood cellulose. May be hydroseeded. Do not use in hot, dry weather.
Bark	35 cubic yards	Air dry, shredded or hammer-milled, or chips.	Apply with mulch blower, chip handler, or by hand. Do not use asphalt tack.
Corn stalks	4-6 tons	Cut or shredded in 4-6 in. lengths.	Apply with mulch blower or by hand. Not for use in fine turf.
Sericea lespedeza seed-bearing stems	1-3 tons	Green or dry; should contain mature seed.	
<b>Nets and Mats<sup>1</sup></b>			
Jute net	Cover area	Heavy, uniform; woven of single jute yarn.	Withstands waterflow. Best when used with organic mulch.
Fiberglass net	Cover area		Withstands waterflow. Best when used with organic mulch.
Excelsior (wood fiber) mat	Cover area		Withstands waterflow.
Fiberglass roving	0.5-1 tons	Continuous fibers of drawn glass bound together with a non-toxic agent.	Apply with a compressed air ejector. Tack with emulsified asphalt at a rate of 25-35 gal/1,000 sq ft.
<b>Chemical Stabilizers<sup>2</sup></b>			
Aquatain Aerospray Curasol AK Petroset SB Terra Tack Crust 500 Genaqua 743 M-145	follow manufacturer's specifications		Not beneficial to plant growth.

<sup>1</sup>Refer to Practice No. 6.30, *Grass Lined Channels*.

<sup>2</sup>Use of trade names does not imply endorsement of product.

nutrient deficiency in plants. This can be an inexpensive mulch if chips are obtained from trees cleared on the site.

**Bark chips and shredded bark** are by-products of timber processing often used in landscape plantings. Bark is also a suitable mulch for areas planted to grasses and not closely mowed. It may be applied by hand or with a mulch blower. Unlike wood chips, the use of bark does not require additional nitrogen fertilizer.

**Wood fiber** refers to short cellulose fibers applied as a slurry in hydroseeding operations. Wood fiber does not require tacking, although tacking agents or soil binders can easily be added to the slurry. Wood fiber hydroseeder slurries may be used to tack straw mulch on steep slopes, critical areas, and where harsh climatic conditions exist. **Wood fiber mulch does not provide sufficient erosion protection to be used alone.**

There are other organic materials that make excellent mulches, but may only be available locally or seasonally, for example: dried sewage sludge, corn stalks, animal manure, pine boughs, cotton burs, peanut hulls, and hay. Creative use of these materials can reduce costs.

#### **CHEMICAL MULCHES AND SOIL BINDERS**

A wide range of synthetic mulching compounds is available to stabilize and protect the soil surface. These include emulsions or dispersions of vinyl compounds, asphalt, or rubber mixed with water. They may be used alone, or may be used to tack wood fiber hydromulches.

When used alone, chemical mulches do not insulate the soil or retain moisture, and therefore do little to aid seedling establishment. They are easily damaged by traffic, are usually more expensive than organic mulches, and they decompose in 60-90 days.

**Check labels on chemical mulches and binders for environmental concerns. Take precautions to avoid damage to fish, wildlife, and water resources.**

#### **NETS, MATS, AND ROVING**

**Netting** is very effective in holding mulch in place on waterways and slopes before grasses become established.

**Mats** promote seedling growth in the same way as organic mulches. They are very useful in establishing grass in channels and waterways. A wide variety of synthetic and organic materials are available. "Excelsior" is a wood fiber mat, and should not be confused with wood fiber slurry.

When installing nets and mats, it is critical to obtain a firm, continuous contact between the material and the soil. Without such contact, the material is useless, and erosion will occur underneath.

**Fiberglass roving** consists of continuous strands of fiberglass which, when blown onto the soil surface from a special compressed air ejector, form a mat of glass fibers. This mat must then be tacked down with asphalt.

## Construction Specifications

Select a material based on site and practice requirements, availability of material, labor, and equipment. Table 6.14a lists commonly used mulches and some alternatives.

**Before mulching**, complete the required grading, install sediment control practices, and prepare the seedbed. Apply seed before mulching **except** in the following cases:

- Seed is applied as part of a hydroseeder slurry containing wood fiber mulch.
- A hydroseeder slurry is applied over straw.

### APPLICATION OF ORGANIC MULCH

Organic mulches are effective where they can be tacked securely to the surface. Material and specifications are given in Table 6.14a.

Spread mulch uniformly by hand, or with a mulch blower. When spreading straw mulch by hand, divide the area to be mulched into sections of approximately 1,000 ft<sup>2</sup>, and place 70-90 lb of straw ( 1 1/2 to 2 bales) in each section to facilitate uniform distribution. After spreading mulch, no more than 25% of the ground surface should be visible. In hydroseeding operations a green dye, added to the slurry, assures a uniform application.

### ANCHORING ORGANIC MULCH

**Straw mulch must be anchored immediately after spreading.** The following methods of anchoring mulch may be used:

**Mulch anchoring tool**—A tractor-drawn implement designed to punch mulch into the soil, a mulch anchoring tool provides maximum erosion control with straw. A regular farm disk, weighted and set nearly straight, may substitute, but will not do a job comparable to the mulch anchoring tool. The disk should not be sharp enough to cut the straw. These methods are limited to slopes no steeper than 3:1, where equipment can operate safely. Operate machinery on the contour.

**Liquid mulch binders**—Application of liquid mulch binders and tackifiers should be heaviest at the edges of areas and at crests of ridges and banks, to resist wind. Binder should be applied uniformly to the rest of the area. Binders may be applied after mulch is spread, or may be sprayed into the mulch as it is being blown onto the soil. Applying straw and binder together is the most effective method. Liquid binders include asphalt and an array of commercially available synthetic binders.

Emulsified asphalt is the most commonly used mulch binder. Any type thin enough to be blown from spray equipment is satisfactory. Asphalt is classified according to the time it takes to cure. Rapid setting (RS or CRS designation) is formulated for curing in less than 24 hours, even during periods of high humidity; it is best used in spring and fall. Medium setting (MS or CMS) is formulated for curing within 24 to 48 hours, and slow setting (SS or CSS) is formulated for use during hot, dry weather, requiring 48 hours or more curing time.

Apply asphalt at 0.10 gallons per square yard (10 gal/1,000 ft<sup>2</sup>). Heavier applications cause straw to “perch” over rills.

In traffic areas, uncured asphalt can be picked up on shoes and cause damage to rugs, clothing etc. Use types RS or CRS to minimize such problems.

Synthetic binders such as Petroset, Terratack, and Aerospray may be used, as recommended by the manufacturer, to anchor mulch. These are expensive, and therefore usually used in small areas or in residential areas where asphalt may be a problem (Use of trade names does not constitute an endorsement).

**Mulch nettings**—Lightweight plastic, cotton, jute, wire, or paper nets may be stapled over the mulch according to the manufacturer’s recommendations (see “Nets and Mats” below).

**Peg and twine**—Because it is labor-intensive, this method is feasible only in small areas where other methods cannot be used. Drive 8-10 inch wooden pegs to within 3 inches of the soil surface, every 4 feet in all directions. Stakes may be driven before or after straw is spread. Secure mulch by stretching twine between pegs in a criss-cross-within-a-square pattern. Turn twine two or more times around each peg. Twine may be tightened over the mulch by driving pegs further into the ground.

**Vegetation**—Rye (grain) may be used to anchor mulch in fall plantings, and German millet in spring. Broadcast at 15 lb/acre before applying mulch.

#### **CHEMICAL MULCHES**

Chemical mulches may be effective for soil stabilization if used between May 1 and June 15, or Sept. 15 and Oct. 15, provided that they are used on slopes **no steeper** than 4:1, and that proper seedbed preparation has been accomplished, including surface roughening where required.

Chemical mulches may be used to bind other mulches, or with wood fiber in a hydroseeded slurry at any time. Follow the manufacturer’s recommendations for application.

#### **FIBERGLASS ROVING**

Fiberglass roving (“roving”) is wound into a cylindrical package so that it can be continuously withdrawn from the center using a compressed air ejector. Roving expands into a mat of glass fibers as it contacts the soil surface. It is often used over a straw mulch, but must still be tacked with asphalt.

Spread roving uniformly over the area at a rate of 0.25 to 0.35 lb/yd<sup>2</sup>. Anchor with asphalt immediately after application, at a rate of 0.25 to 0.35 gal/yd<sup>2</sup>.

As a channel lining, and at other sites of concentrated flow, the roving mat must be further anchored to prevent undermining. It may be secured with stakes placed at intervals no greater than 10 feet along the drainageway, and randomly throughout its width, but not more than 10 feet apart. As an option to staking, the roving can be buried to a depth of 5 inches at the upgrade end and at intervals of 50 feet along the length of the channel.

#### **NETS AND MATS**

**Nets** alone generally provide little moisture conservation benefits and only

limited erosion protection. Therefore, they are usually used in conjunction with an organic mulch such as straw.

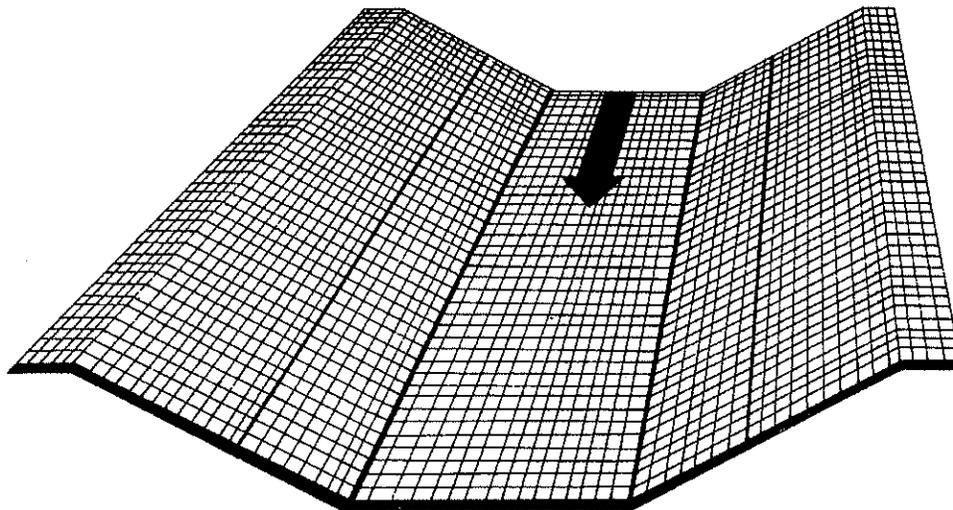
Except when wood fiber slurry is used, netting should always be installed **over** the mulch. Wood fiber may be sprayed on top of an installed net.

**Mats**, including “excelsior” (wood fiber) blankets, are considered protective mulches and may be used alone, on erodible soils, and during all times of the year. Place the matting in firm contact with the soil, and staple securely.

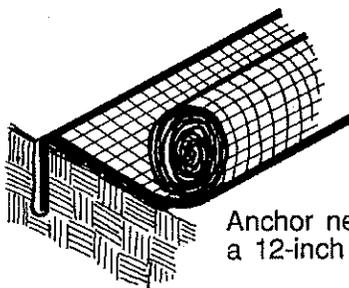
**INSTALLATION OF NETTING AND MATTING**

Products designed to control erosion should be installed in accordance with manufacturer’s instructions. Any mat or blanket-type product used as a protective mulch should provide cover of at least 30% of the surface where it is applied. Installation is illustrated in Figure 6.14a.

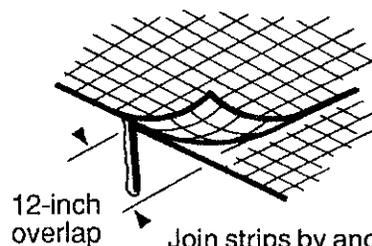
- 1. Apply lime, fertilizer, and seed **before** laying the net or mat.



In channels, roll out strips of netting parallel to the direction of flow and over the protective mulch.



Anchor netting in a 12-inch trench



12-inch overlap

Join strips by anchoring and overlapping.

Figure 6.14a Installation of netting and matting (modified from Va. Div. of Forestry).

2. Start laying the net from the top of the channel or slope, and unroll it down the grade. **Allow netting to lay loosely on the soil or mulch cover but without wrinkles—do not stretch.**

3. To secure the net, bury the upslope end in a slot or trench no less than 6 inches deep, cover with soil, and tamp firmly as shown in Figure 6.14a. Staple the net every 12 inches across the top end and every 3 ft around the edges and bottom. Where 2 strips of net are laid side by side, the adjacent edges should be overlapped 3 inches and stapled together. Each strip of netting should also be stapled down the center, every 3 ft. **Do not stretch the net when applying staples.**

4. To join two strips, cut a trench to anchor the end of the new net. Overlap the end of the previous roll 18 inches, as shown in Figure 6.14a, and staple every 12 inches just below the anchor slot.

**Maintenance** Inspect all mulches periodically, and after rainstorms to check for rill erosion, dislocation or failure. Where erosion is observed, apply additional mulch. If washout occurs, repair the slope grade, reseed and reinstall mulch. Continue inspections until vegetation is firmly established.

**References** *Surface Stabilization*  
6.11, Permanent Seeding  
*Appendix*  
8.02, Vegetation Tables



6.62



## SEDIMENT FENCE

**Definition** A temporary sediment control measure consisting of fabric buried at the bottom, stretched, and supported by posts.

**Purpose** To retain sediment from small disturbed areas by reducing the velocity of sheet flows to allow sediment deposition.

**Conditions Where** Below small-disturbed areas that are less than ¼ acre per 100 feet of fence.

**Practice Applies** Where runoff can be stored behind the sediment fence without damaging the fence or the submerged area behind the fence.

**Do not install sediment fences across streams, ditches, or waterways, or other areas of concentrated flow.**

Sediment fence should be placed along topographic elevation contours, where it can intercept stormwater runoff that is in dispersed sheet flow. Sediment fence should not be used alone below graded slopes greater than 10 feet in height.

**Planning Considerations** A sediment fence is a system to retain sediment on the construction site. The fence retains sediment primarily by retarding flow and promoting deposition. In operation, generally the fence becomes clogged with fine particles, which reduce the flow rate. This causes a pond to develop behind the fence. The designer should anticipate ponding and provide sufficient storage areas and overflow outlets to prevent flows from overtopping the fence. Since sediment fences are not designed to withstand high water levels, locate them so that only shallow pools can form. Tie the ends of a sediment fence into higher ground to prevent flow around the end of the fence before the pool reaches design level. Curling each end of the fence uphill in a “J” pattern may be appropriate to prevent end flow. Provide stabilized outlets to protect the fence system and release storm flows that exceed the design storm.

Deposition occurs as the storage pool forms behind the fence. The designer can direct flows to specified deposition areas through appropriate positioning of the fence or by providing an excavated area behind the fence. Plan deposition areas at accessible points to promote routine cleanout and maintenance. Show deposition areas in the erosion and sedimentation control plan. A sediment fence acts as a diversion if placed slightly off the contour. A maximum slope of 2 percent is recommended. This technique may be used to control shallow, uniform flows from small disturbed areas and to deliver sediment-laden water to deposition areas. The anchoring of the toe of the fence should be reinforced with 12 inches of NC DOT #5 or #57 washed stone when flow will run parallel to the toe of the fence.

Sediment fences serve no function along ridges or near drainage divides where there is little movement of water. Confining or diverting runoff unnecessarily with a sediment fence may create erosion and sedimentation problems that would not otherwise occur.

Straw barriers have only a 0-20% trapping efficiency and are inadequate. Straw bales may not be used in place of sediment fence. Prefabricated sediment fence with the fabric already stapled to thin wooden posts does not meet minimum standards specified later in this section.

Anchoring of sediment fence is critical. The toe of the fabric must be anchored in a trench backfilled with compacted earth. Mechanical compaction must be provided in order for the fence to effectively pond runoff.

**Design Criteria**

Ensure that drainage area is no greater than ¼ acre per 100 feet of fence. This is the maximum drainage area when the slope is less than 2 percent. Where all runoff is to be stored behind the fence, ensure that the maximum slope length behind a sediment fence does not exceed the specifications shown in Table 6.62a. The shorter slope length allowed for steeper slopes will greatly reduce the maximum drainage area. For example, a 10-20 % slope may have a maximum slope length of 25 feet. For a 100-foot length of sediment fence, the drainage area would be 25ft X 100ft = 2500sq.ft., or 0.06 acres.

**Table 6.62a Maximum Slope Length and Slope for which Sediment Fence is Applicable**

Slope	Slope Length (ft)	Maximum Area (ft <sup>2</sup> )
<2%	100	10,000
2 to 5%	75	7,500
5 to 10%	50	5,000
10 to 20%	25	2,500
>20%	15	1,500

Make the fence stable for the 10-year peak storm runoff.

Ensure that the depth of impounded water does not exceed 1.5 feet at any point along the fence.

If non-erosive outlets are provided, slope length may be increased beyond that shown in Table 6.62a, but runoff from the area should be determined and bypass capacity and erosion potential along the fence must be checked. The velocity of the flow at the outlet or along the fence should be in keeping with Table 8.05d, Appendix 8.05.

Provide a riprap splash pad or other outlet protection device for any point where flow may overtop the sediment fence, such as natural depressions or swales. Ensure that the maximum height of the fence at a protected, reinforced outlet does not exceed 2 feet and that support post spacing does not exceed 4 feet.

The design life of a synthetic sediment fence should be 6 months.

**Construction Specifications**

**MATERIALS**

1. Use a synthetic filter fabric of at least 95% by weight of polyolefins or polyester, which is certified by the manufacturer or supplier as conforming to the requirements in ASTM D 6461, which is shown in part in Table 6.62b.

Synthetic filter fabric should contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 to 120° F.

2. Ensure that posts for sediment fences are 1.33 lb/linear ft steel with a minimum length of 5 feet. Make sure that steel posts have projections to facilitate fastening the fabric.

3. For reinforcement of standard strength filter fabric, use wire fence with a minimum 14 gauge and a maximum mesh spacing of 6 inches.

**Table 6.62b Specifications For Sediment Fence Fabric**

Temporary Silt Fence Material Property Requirements					
	Test Material	Units	Supported <sup>1</sup> Silt Fence	Un-Supported <sup>1</sup> Silt Fence	Type of Value
Grab Strength	ASTM D 4632	N (lbs)			
Machine Direction			400	550	MARV
			(90)	(90)	
X-Machine Direction			400	450	MARV
			(90)	(90)	
Permittivity <sup>2</sup>	ASTM D 4491	sec-1	0.05	0.05	MARV
Apparent Opening Size <sup>2</sup>	ASTM D 4751	mm	0.60	0.60	Max. ARV <sup>3</sup>
		(US Sieve #)	(30)	(30)	
Ultraviolet Stability	ASTM D 4355	% Retained Strength	70% after 500h of exposure	70% after 500h of exposure	Typical
<sup>1</sup> Silt Fence support shall consist of 14 gage steel wire with a mesh spacing of 150 mm (6 inches), or prefabricated polymer mesh of equivalent strength. <sup>2</sup> These default values are based on empirical evidence with a variety of sediment. For environmentally sensitive areas, a review of previous experience and/or site or regionally specific geotextile tests in accordance with Test Method D 5141 should be performed by the agency to confirm suitability of these requirements. <sup>3</sup> As measured in accordance with Test Method D 4632.					

**CONSTRUCTION**

1. Construct the sediment barrier of standard strength or extra strength synthetic filter fabrics.

2. Ensure that the height of the sediment fence does not exceed 24 inches above the ground surface. (Higher fences may impound volumes of water sufficient to cause failure of the structure.)

3. Construct the filter fabric from a continuous roll cut to the length of the barrier to avoid joints. When joints are necessary, securely fasten the filter cloth only at a support post with 4 feet minimum overlap to the next post.

4. Support standard strength filter fabric by wire mesh fastened securely to the **upslope** side of the posts. Extend the wire mesh support to the bottom of the trench. Fasten the wire reinforcement, then fabric on the upslope side of the fence post. Wire or plastic zip ties should have minimum 50 pound tensile strength.

5. When a wire mesh support fence is used, space posts a maximum of 8 feet apart. Support posts should be driven securely into the ground a minimum of 24 inches.

6. Extra strength filter fabric with 6 feet post spacing does not require wire mesh support fence. Securely fasten the filter fabric directly to posts. Wire or plastic zip ties should have minimum 50 pound tensile strength.

7. Excavate a trench approximately 4 inches wide and 8 inches deep along the proposed line of posts and upslope from the barrier (Figure 6.62a).
8. Place 12 inches of the fabric along the bottom and side of the trench.
9. Backfill the trench with soil placed over the filter fabric and compact. Thorough compaction of the backfill is critical to silt fence performance.
10. Do not attach filter fabric to existing trees.

#### **SEDIMENT FENCE INSTALLATION USING THE SLICING METHOD**

Instead of excavating a trench, placing fabric and then backfilling trench, sediment fence may be installed using specially designed equipment that inserts the fabric into a cut sliced in the ground with a disc (Figure 6.62b).

### **Installation Specifications**

1. The base of both end posts should be at least one foot higher than the middle of the fence. Check with a level if necessary.
2. Install posts 4 feet apart in critical areas and 6 feet apart on standard applications.
3. Install posts 2 feet deep on the downstream side of the silt fence, and as close as possible to the fabric, enabling posts to support the fabric from upstream water pressure.
4. Install posts with the nipples facing away from the silt fabric.
5. Attach the fabric to each post with three ties, all spaced within the top 8 inches of the fabric. Attach each tie diagonally 45 degrees through the fabric, with each puncture at least 1 inch vertically apart. Also, each tie should be positioned to hang on a post nipple when tightened to prevent sagging.
6. Wrap approximately 6 inches of fabric around the end posts and secure with 3 ties.
7. No more than 24 inches of a 36 inch fabric is allowed above ground level.
8. The installation should be checked and corrected for any deviations before compaction.
9. Compaction is vitally important for effective results. Compact the soil immediately next to the silt fence fabric with the front wheel of the tractor, skid steer, or roller exerting at least 60 pounds per square inch. Compact the upstream side first, and then each side twice for a total of 4 trips.

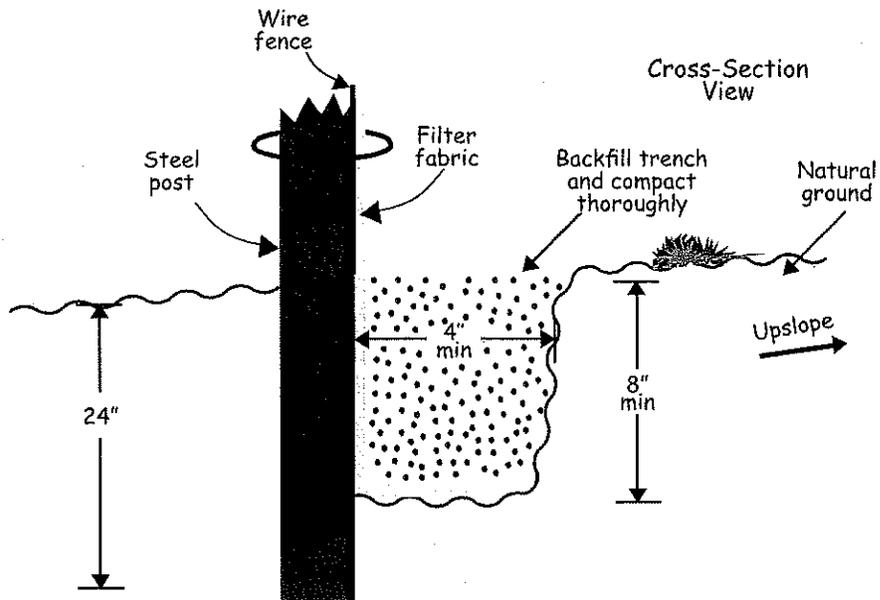
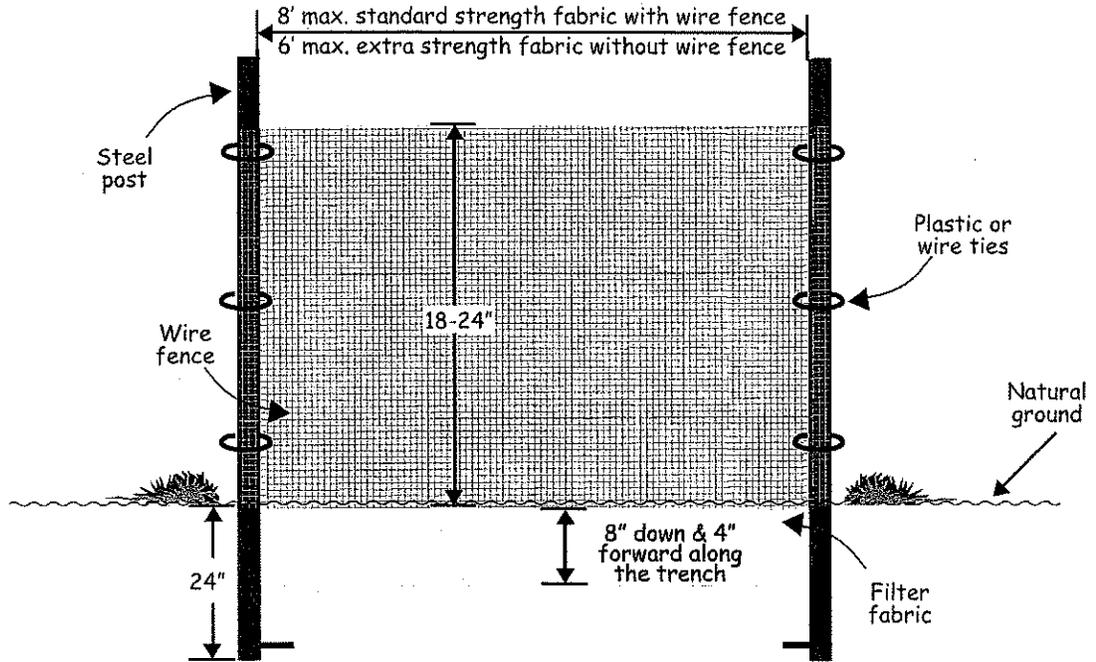
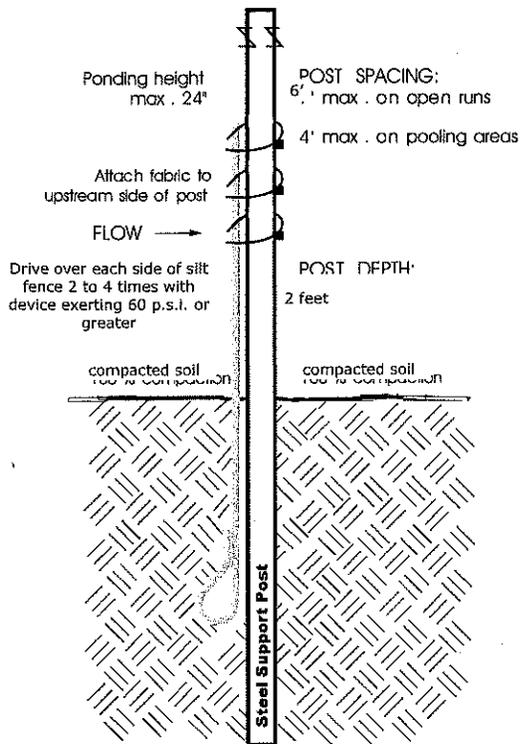
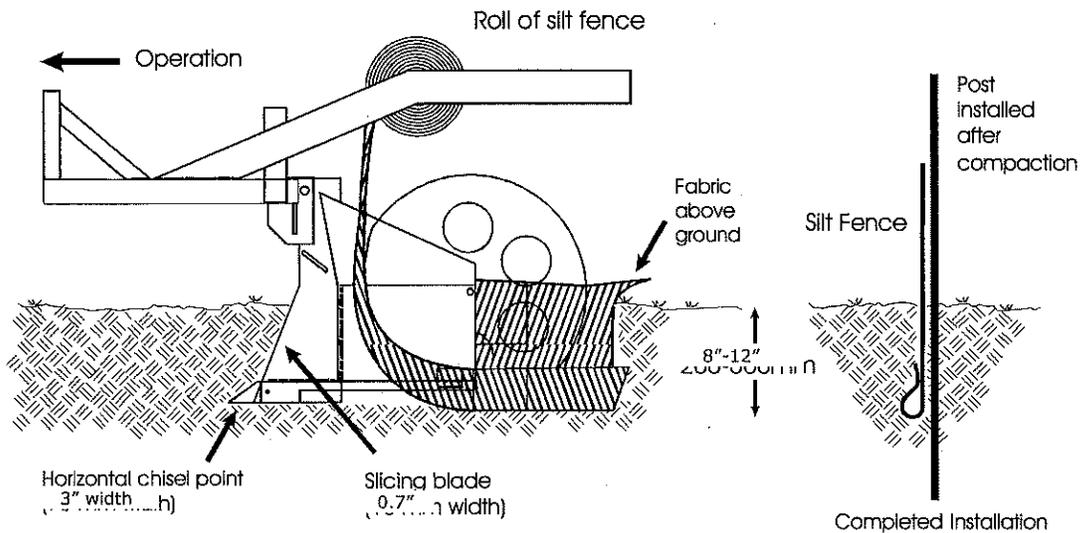
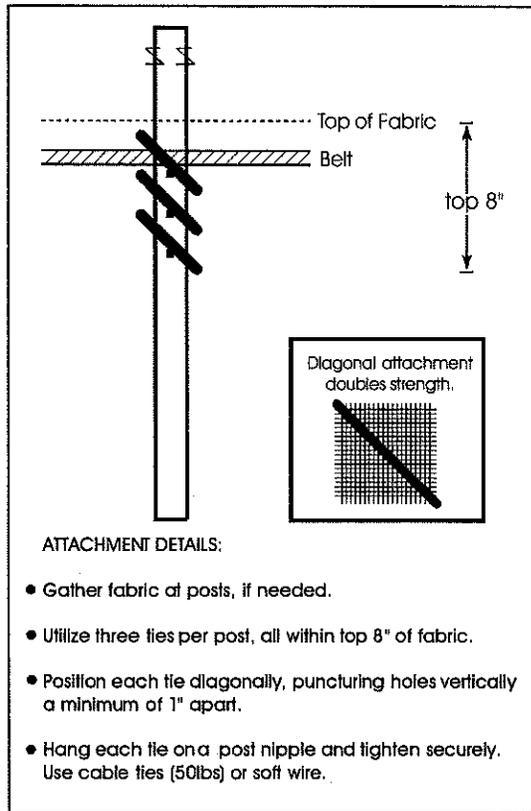


Figure 6.62a Installation detail of a sediment fence.

# The Slicing Method



No more than 24" of a 36" fabric is allowed above ground.



Vibratory plow is not acceptable because of horizontal compaction

Figure 6.62b Schematics for using the slicing method to install a sediment fence. Adapted from *Silt Fence that Works*

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**Maintenance** Inspect sediment fences at least once a week and after each rainfall. Make any required repairs immediately.

Should the fabric of a sediment fence collapse, tear, decompose or become ineffective, replace it promptly.

Remove sediment deposits as necessary to provide adequate storage volume for the next rain and to reduce pressure on the fence. Take care to avoid undermining the fence during cleanout.

Remove all fencing materials and unstable sediment deposits and bring the area to grade and stabilize it after the contributing drainage area has been properly stabilized.

**References** ASTM D 6461 – 99. “Standard Specification for Silt Fence Materials” ASTM International. For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For Annual Book of ASTM Standards volume information, refer to the standard’s Document Summary page on the ASTM website.

ASTM D 6462 – 03. “Standard Practice for Silt Fence Installation” ASTM International. For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For Annual Book of ASTM Standards volume information, refer to the standard’s Document Summary page on the ASTM website.

C. Joel Sprague, PE, Silt Fence Performance Limits and Installation Requirements. Sprague and Sprague Consulting Engineers and TRI/Environmental, Inc.

Carpenter Erosion Control. <http://www.tommy-sfm.com/>

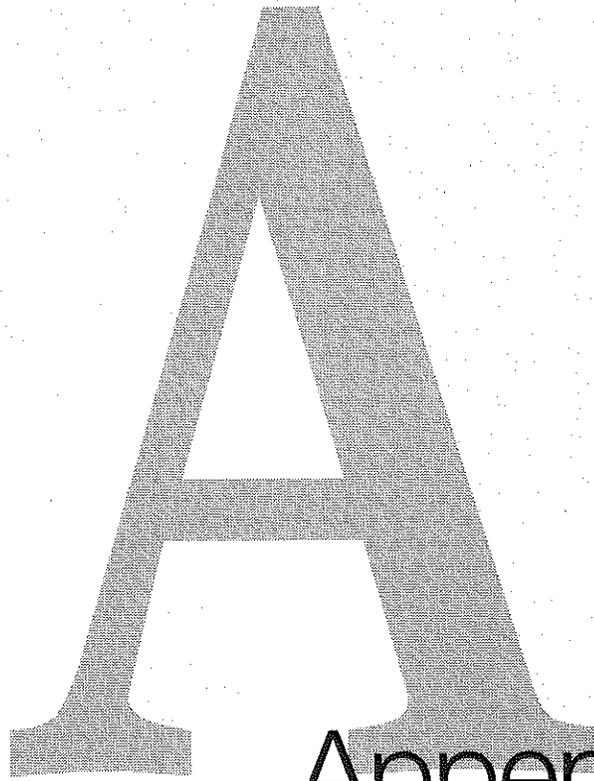
Kentucky Erosion Prevention and Sediment Control Field Manual, 2004.

*Runoff Control Measures*  
6.20, Temporary Diversions

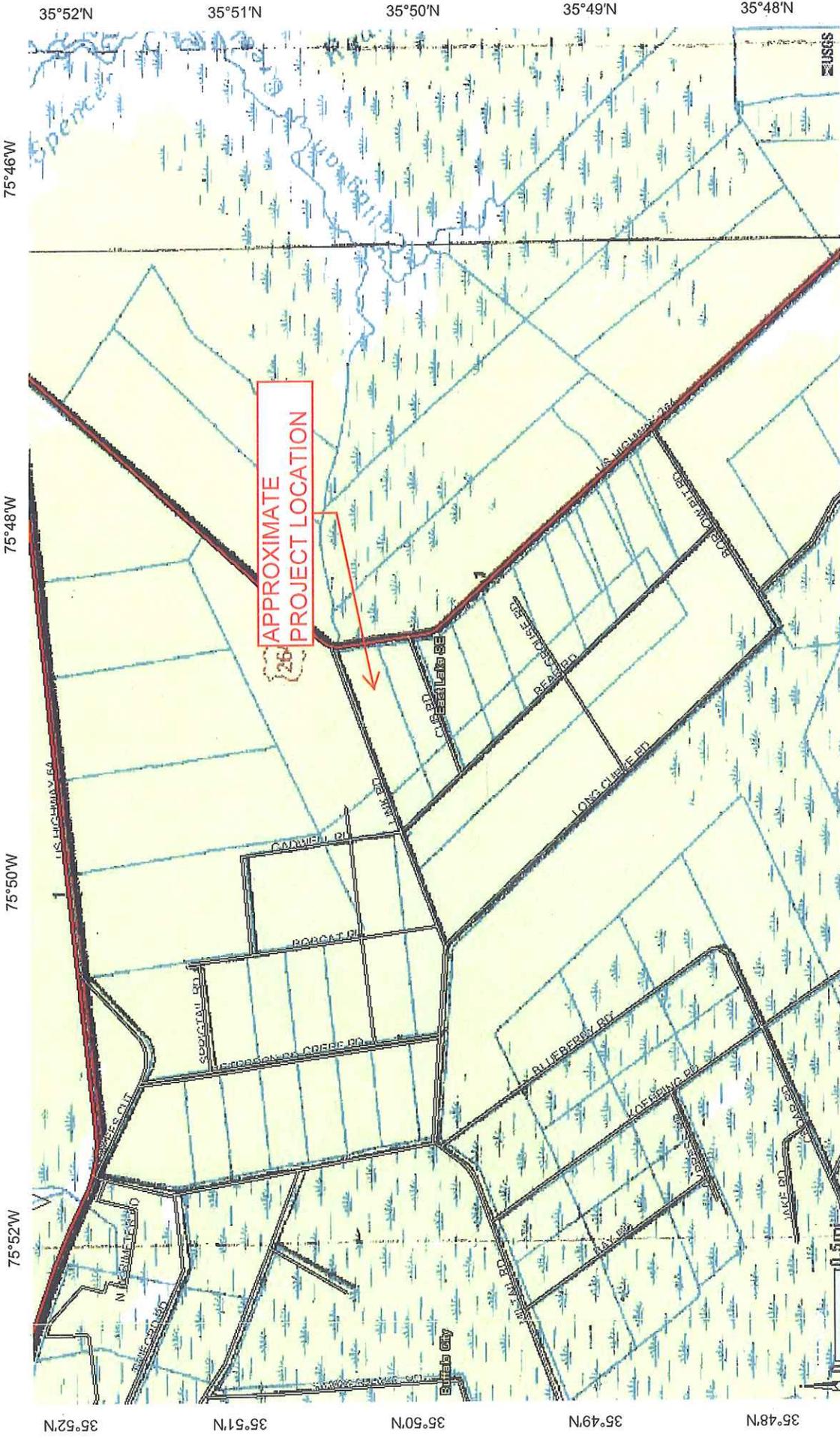
*Outlet Protection*  
6.41, Outlet Stabilization Structure

*Appendix*  
8.03, Estimating Runoff





Appendix  
A



35°52'N 35°51'N 35°50'N 35°49'N 35°48'N

75°50'W 75°48'W 75°46'W

75°52'W 75°50'W 75°48'W

35°52'N 35°51'N 35°50'N 35°49'N 35°48'N



<http://nationalmap.gov/>  
Geographic Coordinate System (WGS84)

35°52'11"N  
75°52'56"W  
Map Extent  
75°45'14"W  
35°47'36"N



0.5 mi

## TOPOGRAPHIC MAPS

1:100,000 Index

 Quad Index - 100K

1:250,000 Index

 Quad Index - 250 K

7.5 Minute Index

 Quad Index - 7.5min

USGS Raster Graphics (Topo Maps)  
*No legend available*

## BOUNDARIES

## TRANSPORTATION

Roads

*No legend available*

US Interstate Labels (BTS)

*No legend available*

## ELEVATION

1/3 ArcSecond NED CONUS



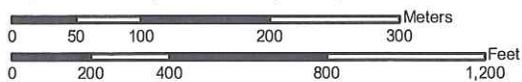
B

Appendix  
B

Soil Map—Dare County, North Carolina  
(Dare County C&D NRCS Soil Survey)



Map Scale: 1:5,560 if printed on A size (8.5" x 11") sheet.



## MAP LEGEND

 Area of Interest (AOI)	 Very Stony Spot
 Soils	 Wet Spot
 Soil Map Units	 Other
 Special Point Features	<b>Special Line Features</b>
 Blowout	 Gully
 Borrow Pit	 Short Steep Slope
 Clay Spot	 Other
 Closed Depression	<b>Political Features</b>
 Gravel Pit	 Cities
 Gravelly Spot	<b>Water Features</b>
 Landfill	 Oceans
 Lava Flow	 Streams and Canals
 Marsh or swamp	<b>Transportation</b>
 Mine or Quarry	 Rails
 Miscellaneous Water	 Interstate Highways
 Perennial Water	 US Routes
 Rock Outcrop	 Major Roads
 Saline Spot	 Local Roads
 Sandy Spot	
 Severely Eroded Spot	
 Sinkhole	
 Slide or Slip	
 Sodic Spot	
 Spoil Area	
 Stony Spot	

## MAP INFORMATION

Map Scale: 1:5,560 if printed on A size (8.5" x 11") sheet.  
 The soil surveys that comprise your AOI were mapped at 1:24,000.  
 Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service  
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>  
 Coordinate System: UTM Zone 18N NAD83

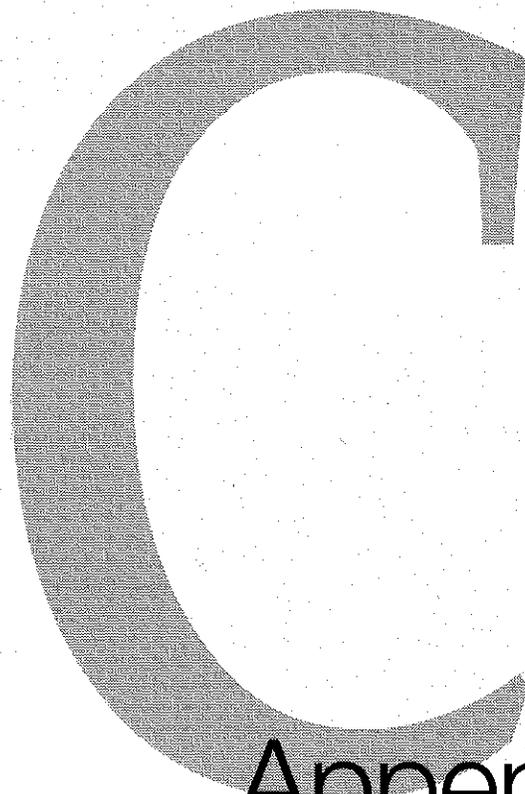
This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Dare County, North Carolina  
 Survey Area Data: Version 11, Mar 27, 2009  
 Date(s) aerial images were photographed: 8/26/2006

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

## Map Unit Legend

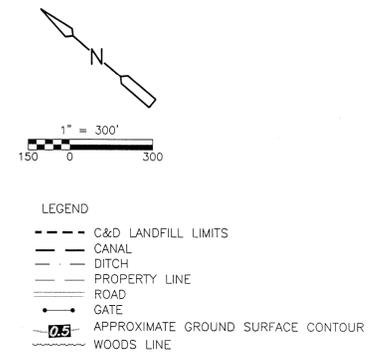
Dare County, North Carolina (NC055)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
HyA	Hyde loam, 0 to 2 percent slopes, rarely flooded	96.4	89.2%
PoA	Ponzer muck, 0 to 2 percent slopes, rarely flooded	3.8	3.5%
RpA	Roper muck, 0 to 2 percent slopes, rarely flooded	7.8	7.2%
<b>Totals for Area of Interest</b>		<b>108.0</b>	<b>100.0%</b>



Appendix  
C

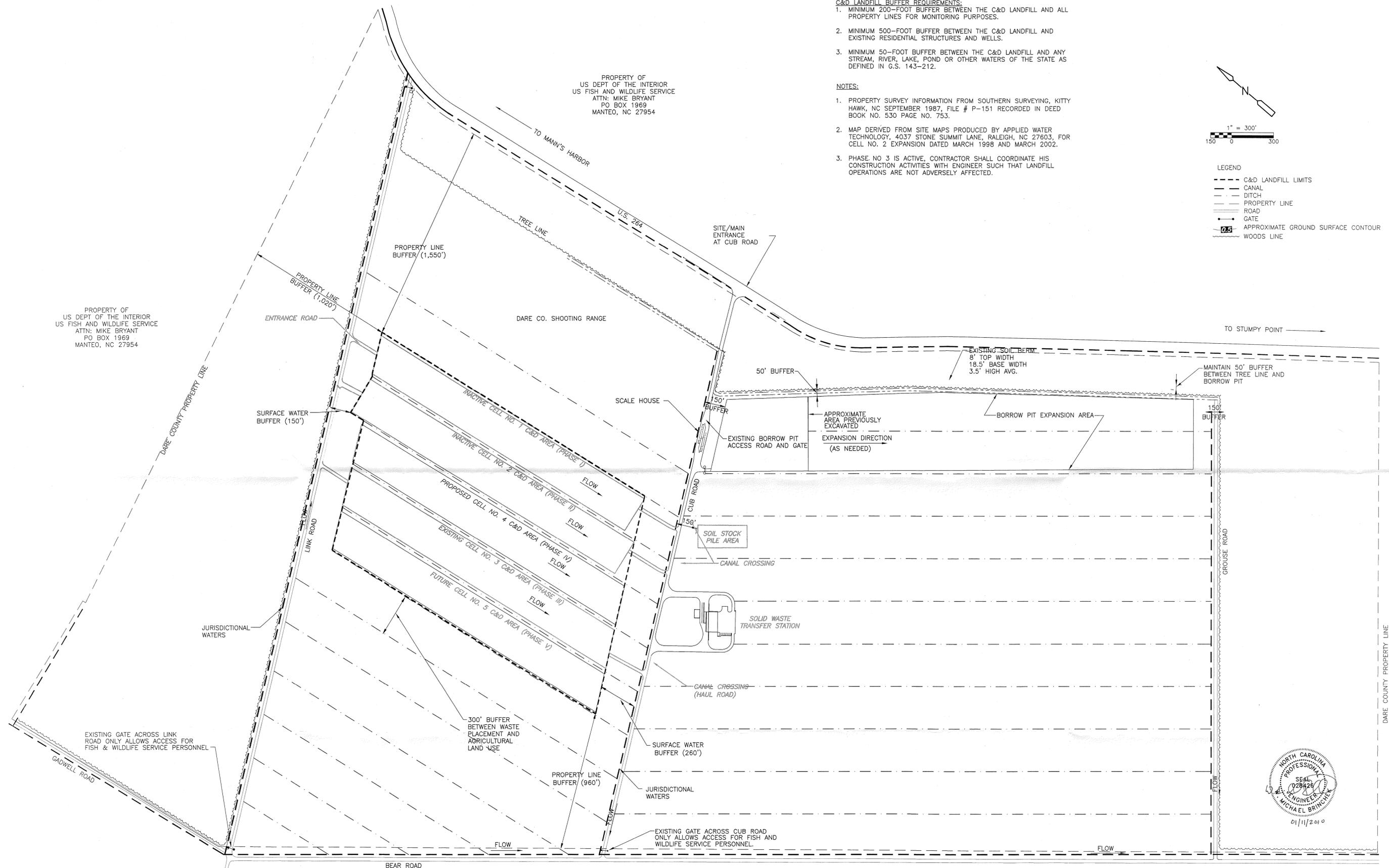
- C&D LANDFILL BUFFER REQUIREMENTS:**
1. MINIMUM 200-FOOT BUFFER BETWEEN THE C&D LANDFILL AND ALL PROPERTY LINES FOR MONITORING PURPOSES.
  2. MINIMUM 500-FOOT BUFFER BETWEEN THE C&D LANDFILL AND EXISTING RESIDENTIAL STRUCTURES AND WELLS.
  3. MINIMUM 50-FOOT BUFFER BETWEEN THE C&D LANDFILL AND ANY STREAM, RIVER, LAKE, POND OR OTHER WATERS OF THE STATE AS DEFINED IN G.S. 143-212.

- NOTES:**
1. PROPERTY SURVEY INFORMATION FROM SOUTHERN SURVEYING, KITTY HAWK, NC SEPTEMBER 1987, FILE # P-151 RECORDED IN DEED BOOK NO. 530 PAGE NO. 753.
  2. MAP DERIVED FROM SITE MAPS PRODUCED BY APPLIED WATER TECHNOLOGY, 4037 STONE SUMMIT LANE, RALEIGH, NC 27603, FOR CELL NO. 2 EXPANSION DATED MARCH 1998 AND MARCH 2002.
  3. PHASE NO 3 IS ACTIVE, CONTRACTOR SHALL COORDINATE HIS CONSTRUCTION ACTIVITIES WITH ENGINEER SUCH THAT LANDFILL OPERATIONS ARE NOT ADVERSELY AFFECTED.



PROPERTY OF  
US DEPT OF THE INTERIOR  
US FISH AND WILDLIFE SERVICE  
ATTN: MIKE BRYANT  
PO BOX 1969  
MANTEO, NC 27954

PROPERTY OF  
US DEPT OF THE INTERIOR  
US FISH AND WILDLIFE SERVICE  
ATTN: MIKE BRYANT  
PO BOX 1969  
MANTEO, NC 27954



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REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: P. STOUT  
 DRAWN BY: P. STOUT  
 SHEET CHK'D BY: K. YANC  
 CROSS CHK'D BY: M. BRINCHEK  
 APPROVED BY: \_\_\_\_\_  
 DATE: JANUARY 2010

**CDM**  
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 North Carolina Firm License: F-0412  
 consulting • engineering • construction • operations

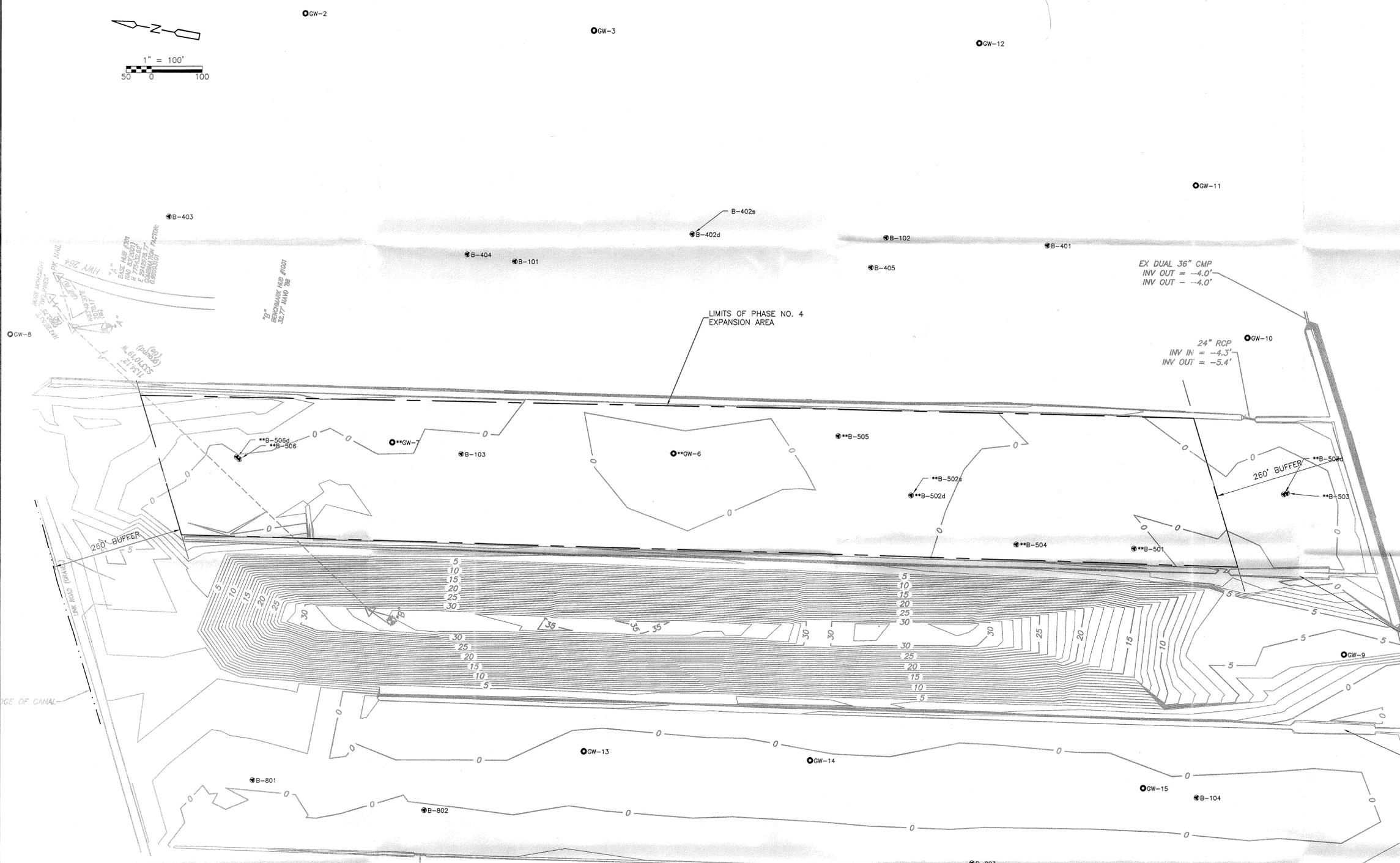
DARE COUNTY  
NORTH CAROLINA  
**CONSTRUCTION & DEMOLITION DEBRIS LANDFILL**  
PHASE IV CONSTRUCTION DRAWINGS

**SITE DEVELOPMENT PLAN**

PROJECT NO. 17952 56960  
 FILE NAME: COO1LFPL.DWG  
 SHEET NO.  
**C-1**



PIEZOMETER AND MONITORING WELL SCHEDULE				
POINT #	PIEZOMETER/GW WELL	BOREHOLE DEPTH (FEET BGS)	NORTHING	EASTING
1	GW-1	10	775459.46	2943423.17
2	GW-2	20	774812.63	2943476.21
3	GW-3	20	774246.50	2943544.29
4	**GW-6	20	773947.90	2942765.94
5	**GW-7	20	774497.80	2942689.46
6	GW-8	20	775276.96	2942765.21
7	GW-9	20	772578.01	2942615.36
8	GW-10	20	772873.78	2943188.48
9	GW-11	20	773027.15	2943464.85
10	GW-12	20	773495.49	2943656.65
11	GW-13	20	774019.56	2942163.28
12	GW-14	20	773577.80	2942224.90
13	GW-15	20	772922.37	2942289.76
14	B-401	15	773293.90	2943295.50
15	B-402d	31	773986.50	2943192.70
16	B-403	15	775008.80	2943046.40
17	B-404	15	774415.90	2943075.50
18	B-405	15	773628.50	2943191.10
19	**B-501	15	773021.90	2942745.50
20	**B-502d	31	773472.30	2942768.70
21	B-801	15	774653.40	2941992.70
22	B-802	15	774309.30	2941994.10
23	B-803	15	773228.10	2942083.90
24	B-101	100	774321.40	2943078.80
25	B-102	99	773609.40	2943254.10
26	B-103	100	774359.70	2942690.90
27	B-104	100	772815.20	2942290.30
28	**B-503	20	772744.09	2942905.36
29	**B-503d	50	772749.74	2942902.33
30	**B-504	25	773251.27	2942711.61
31	**B-505	25	773633.82	2942856.46
32	**B-506	20	774789.35	2942603.78
33	**B-506d	50	774795.08	2942607.09
34	B-402s	15	773986.50	2943192.70
35	**B-502s	15	773472.30	2942768.70



- LEGEND**
- GW-1 EXISTING MONITORING WELL
  - B-101 EXISTING PIEZOMETER
  - EXISTING INTERMEDIATE CONTOUR
  - 2- EXISTING INDEX CONTOUR

- NOTES:**
- TOPOGRAPHIC SURVEY DATE 04/12-05/11-09 BY QUIBLE & ASSOCIATES, P.C.
  - REFERENCE DB 530, PG 733 & PL C, SL 32B.
  - DRAWING VERTICAL DATUM BASED ON GPS RAPID STATIC SESSIONS, OPUS REPORT NUMBERS 000023442, 000023441, 000023439 & 000031628 DATUM NAVD '88, FEET.
  - HORIZONTAL DATUM NAD 83(2007) AND VERTICAL DATUM VERIFICATION BASED UPON RAPID STATIC GPS SESSIONS 000381637, 000381747, 000180456, 000177169, 000147860, 000242228 AND 000237065.
  - CONDITIONS WITHIN SURVEY AREA MAY HAVE CHANGED SINCE DATE OF SURVEY.

**GROUNDWATER MONITORING WELL AND PIEZOMETER ABANDONMENT NOTES:**

PIEZOMETERS AND GROUNDWATER MONITORING WELLS WITH DUAL ASTRICS (\*\*) REPRESENT WELLS TO BE ABANDONED.

CONTRACTOR SHALL ADHERE TO THE FOLLOWING CONDITIONS WHEN ABANDONING GROUNDWATER MONITORING WELLS, PIEZOMETERS AND LOCATED IN THE PROPOSED PHASE NO. 4 EXPANSION AREA:

PRIOR TO CONSTRUCTION OF THE PHASE OR CELL(S) WITHIN THE PHASE, ALL PIEZOMETERS, GROUNDWATER MONITORING WELLS AND LOCATED WITHIN THE FOOTPRINT MUST BE PROPERLY ABANDONED BY OVERDRILLING FIRST (EXCEPTION OF NON-CASED BORINGS) AND SEALED WITH GROUT IN ACCORDANCE WITH 15A NCAC 2C.0113(b)(1) ENTITLED "ABANDONMENT OF WELLS",

- IN AREAS WHERE SOIL IS TO BE UNDERCUT, ABANDONED PIEZOMETERS, MONITORING WELLS AND BORINGS MUST NOT BE GROUTED TO PRE-GRADE LAND SURFACE, BUT TO THE PROPOSED BASE GRADE SURFACE TO PREVENT HAVING TO CUT EXCESS GROUT AND POTENTIALLY DAMAGING THE WELLS.
- WELL ABANDONMENT RECORDS (GW-30 FORM) FOR EACH DECOMMISSIONED PIEZOMETER, BORING AND GROUNDWATER MONITORING WELL MUST BE CERTIFIED BY A LICENSED GEOLOGIST IN ACCORDANCE WITH RULE .1623(b)(2)(1) AND SUBMITTED TO THE SOLID WASTE SECTION IN ACCORDANCE WITH 15A NCAC 02C.0114(b).

EX DUAL 36" CMP  
NORTH CMP: INV IN = -4.3'  
NORTH CMP: INV OUT = -3.3'  
SOUTH CMP: INV IN = -4.6'  
SOUTH CMP: INV OUT = -4.3'

EXISTING FILTER BASIN

EXISTING FILTER BASIN

A PORTION OF PIV 8747-00-32-3320  
1531 LINK ROAD  
HARRIS HARBOR, NORTH CAROLINA



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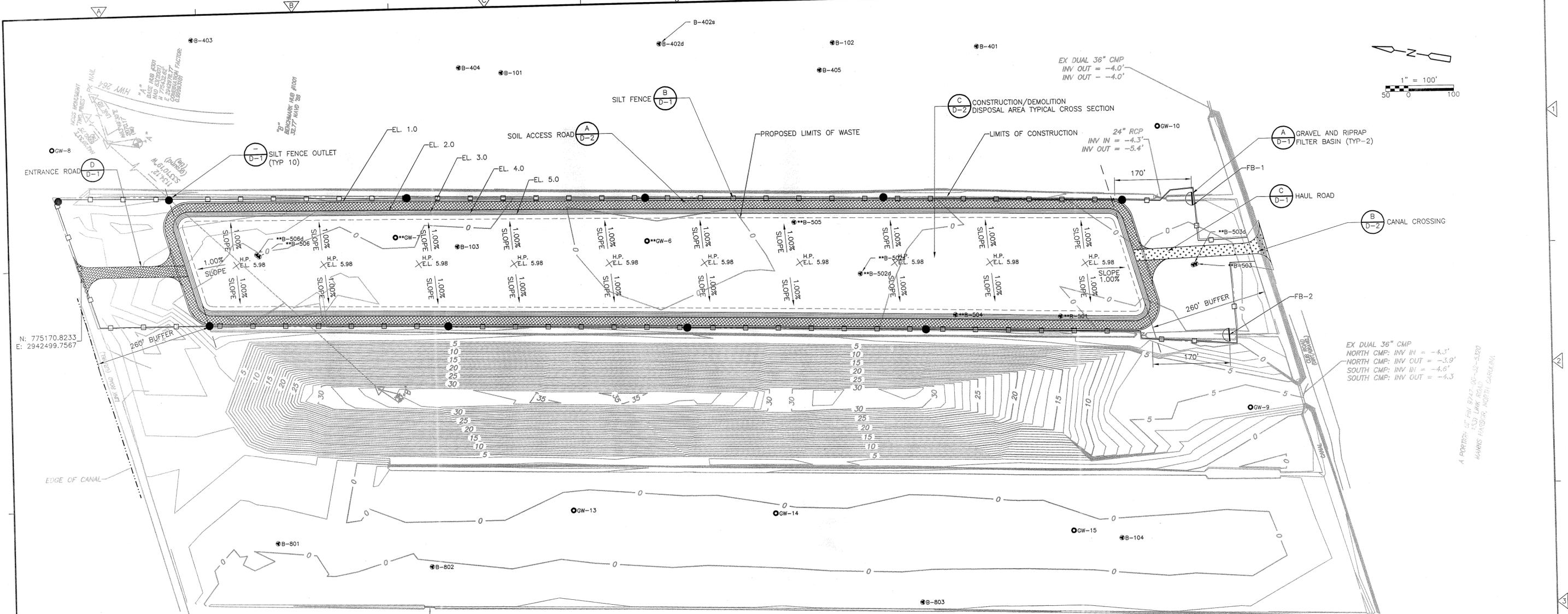
REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: P. STOUT	<p>Camp Dresser &amp; McKee 5400 Glenwood Avenue, Suite 300 Raleigh, NC 27612 Tel: (919) 787-5620 Fax: (919) 781-5730 North Carolina Firm Licensure: F-0412 consulting • engineering • construction • operations</p>
DRAWN BY: P. STOUT	
SHEET CHK'D BY: K. YANG	
CROSS CHK'D BY: M. BRINCKEK	
APPROVED BY: M. BRINCKEK	
DATE: JANUARY 2010	

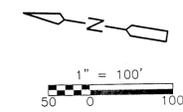
**DARE COUNTY  
NORTH CAROLINA  
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL  
PHASE IV CONSTRUCTION DRAWINGS**

**EXISTING CONDITIONS**

PROJECT NO. 17952 56960
FILE NAME: C002LFPL.DWG
SHEET NO. C-2



N: 775170.8233  
E: 2942499.7567



**LEGEND**

- GW-9 EXISTING MONITORING WELL
- P-1 EXISTING PIEZOMETER
- EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- H.P. H.P. E.L. 0.00 HIGH POINT
- FB-1 FILTER BASIN
- SILT FENCE
- HAUL ROAD
- PROPOSED SOIL ACCESS ROAD
- ENTRANCE ROAD
- LIMITS OF CONSTRUCTION
- SILT FENCE OUTLET

**GENERAL CONSTRUCTION NOTES:**

1. CONTRACTOR SHALL LOCATE AND/OR RELOCATE ALL EXISTING UTILITIES, DRAINAGE STRUCTURES, MONITORING WELLS, ETC. IN COORDINATION WITH THE APPROPRIATE UTILITIES, AGENCY, OR COMPANY WITHIN 72 HOURS PRIOR TO CONSTRUCTION. CONTRACTOR IS RESPONSIBLE FOR LOCATING, PROTECTING, MAINTAINING, AND RESTORING ALL SITE UTILITIES AND BUILDING SERVICES.
2. NO HAUL ROUTE SHALL BE USED FOR MATERIAL TRANSPORT UNTIL NO THE ROUTE HAS BEEN COORDINATED WITH THE OWNER.
3. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRING OR REPLACING, AT NO ADDITIONAL COST TO THE OWNER, ANY EXISTING MONITORING WELLS, DRAINAGE STRUCTURES, ETC. DAMAGED DURING CONSTRUCTION.
4. CONTRACTOR'S TRAILER SHALL BE LOCATED WITHIN STAGING AREAS AS DESIGNATED BY THE OWNER ON THIS SHEET. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ALL NECESSARY UTILITY CONNECTIONS, A POTABLE WATER SUPPLY, AND TEMPORARY SANITARY SERVICE FOR TRAILER.
5. LOCATIONS, ELEVATIONS, AND DIMENSIONS OF EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES ARE SHOWN ACCORDING TO THE BEST INFORMATION AVAILABLE AT THE TIME OF THESE PLANS BUT DO NOT PURPORT TO BE ABSOLUTELY CORRECT. PRIOR TO CONSTRUCTION THE CONTRACTOR SHALL VERIFY AND AGREE TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL EXISTING UTILITIES, STRUCTURES, OR PRESERVATION AREAS AND OTHER FEATURES AFFECTING HIS WORK.
6. THE CONTRACTOR SHALL REPLACE ALL PAVING (ASPHALT, STONE, OR CONCRETE), STABILIZED EARTH, CURBS, DRIVEWAYS, SIDEWALKS, MAILBOXES, DRAINAGE CULVERTS, FENCES, ETC. WITH THE SAME TYPE OF MATERIAL THAT WAS REMOVED OR DAMAGED DURING CONSTRUCTION.
7. STORM DRAINAGE PIPE LENGTHS SHOWN ARE APPROXIMATE AND MAY BE ADJUSTED AS REQUIRED IN THE FIELD, UPON APPROVAL BY ENGINEER.
8. EXISTING DRAINAGE DITCHES SHALL HAVE SEDIMENT AND DEBRIS REMOVED AND SHALL BE REPAIRED AND ALL NEW EROSION CONTROL AND SEDIMENTATION CONTROL DEVICES SHALL BE IN PLACE PRIOR TO ANY CLEARING AND GRUBBING. THEY SHALL BE INSTALLED TO THE LIMITS OF CONSTRUCTION SHOWN ON THE DRAWINGS, REQUIRED IN THE SPECIFICATIONS AND IN ACCORDANCE WITH ALL REGULATORY AGENCY REQUIREMENTS.

9. THE LIMITS OF DISTURBANCE SHOWN ON THE PLANS SHALL BE STRICTLY OBSERVED BY THE CONTRACTOR. ALL INGRESS AND EGRESS AND TRAFFIC PATTERNS ON THE SITE SHALL BE WITHIN THE LIMITS OF DISTURBANCE.
10. CONTRACTOR SHALL VERIFY THE EXISTENCE AND ACCURACY OF BENCHMARK AND CONTROL DATA PRIOR TO INITIATING CONSTRUCTION. CONTRACTOR SHALL NOTIFY ENGINEER IF DISCREPANCIES ARE FOUND.
11. CONTRACTOR SHALL STAKE OUT LIMITS OF WORK (INCLUDING CUT/FILL SLOPES) PRIOR TO INITIATING EXCAVATION AND BACKFILL ACTIVITIES. SURVEY DATA SHALL BE SUBMITTED TO ENGINEER FOR REVIEW. CONTRACTOR SHALL SEED AND MULCH ALL DISTURBED AREAS PER SPECIFICATIONS EXCEPT FOR ROAD SURFACES AND AREA WITHIN PROPOSED EDGE OF WASTE.
12. CONTROL POINTS PROVIDED ARE BASED ON A LOCAL COORDINATE SYSTEM. COORDINATE WITH QUILBE & ASSOC., PC (PHONE NO. 252-261-3300) PRIOR TO LAYING OUT WORK.

**SURVEY NOTES:**

1. TOPOGRAPHIC SURVEY DATE 04/12-05/11-09 BY MCKIM AND CREED, PA.
2. REFERENCE DB 530, PG 733 & PL C, SL 32B.
3. DRAWING VERTICAL DATUM BASED ON GPS RAPID STATIC SESSIONS, OPUS REPORT NUMBERS 000023442, 000023441, 000023439 & 000031628 DATUM NAVD '88, FEET.
4. HORIZONTAL DATUM NAD 83(2007) AND VERTICAL DATUM VERIFICATION BASED UPON RAPID STATIC GPS SESSIONS 000381637, 000381747, 000180456, 000177169, 000147860, 000242228 AND 000237065.
5. CONDITIONS WITHIN SURVEY AREA MAY HAVE CHANGE SINCE DATE OF SURVEY.



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REV. NO.	DATE	DRWN	CHKD	REMARKS

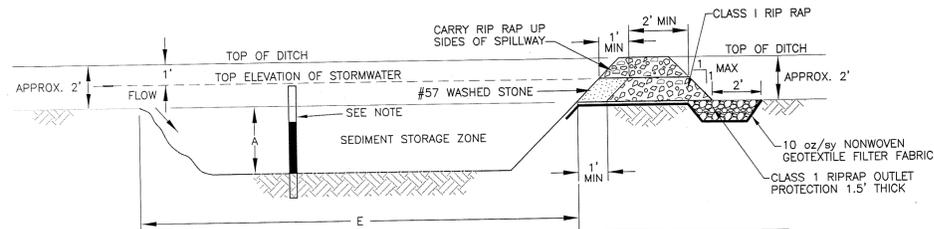
DESIGNED BY: P. STOUT  
 DRAWN BY: P. STOUT  
 SHEET CHK'D BY: K. YANG  
 CROSS CHK'D BY: M. BRINCHEK  
 APPROVED BY: M. BRINCHEK  
 DATE: JANUARY 2010

**CDM**  
 Camp Dresser & McKee  
 5400 Glenwood Avenue, Suite 300  
 Raleigh, NC 27612  
 Tel: (919) 787-5620 Fax: (919) 781-5730  
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DARE COUNTY  
NORTH CAROLINA  
**CONSTRUCTION & DEMOLITION DEBRIS LANDFILL**  
PHASE IV CONSTRUCTION DRAWINGS

**GRADING PLAN**  
C-3

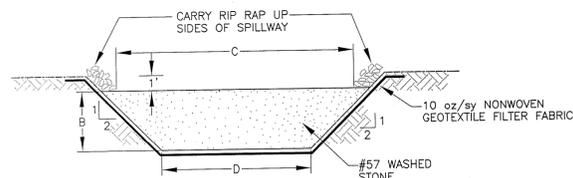
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 SHEET NO.  
**C-3**  
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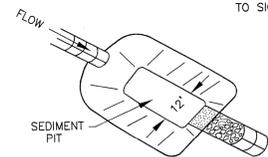
SECTION THRU BASIN & FILTER

BASIN	A	B	C	D	E
1	3'	1'	25'	19'	170'
2	3'	1'	25'	19'	170'

NOTE:  
PROVIDE TREATED 6x6 POST PLACED 50'  
FROM FILTER BERM. MARK POST WITH  
WHITE STRIPE 2' FROM BOTTOM OF BASIN  
TO SIGNIFY CLEANOUT DEPTH.



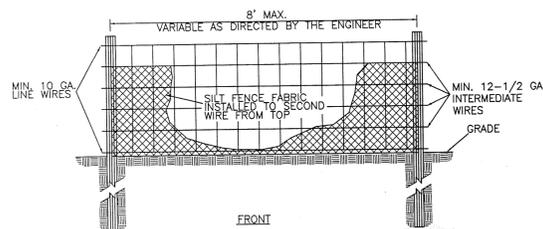
SECTION THRU FILTER



PERSPECTIVE VIEW

GRAVEL & RIPRAP FILTER BASIN

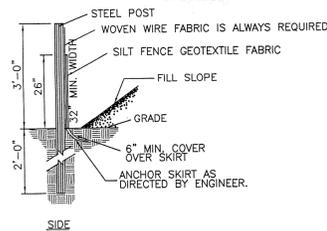
DETAIL A  
NOT TO SCALE  
C-3



FRONT

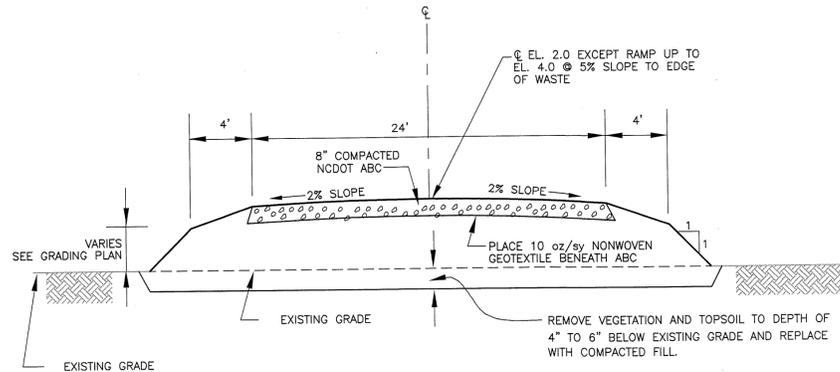
NOTES:

1. END OF SILT FENCE SHOULD BE TURNED UPHILL. SEE NCDENR PRACTICE STANDARDS & SPECIFICATIONS SEDIMENT FENCE SET FOR CONDITIONS WHERE PRACTICE APPLIES; PLANNING CONSIDERATIONS & DESIGN CRITERIA. (HOWEVER FLOW SHALL NOT RUN PARALLEL WITH THE TOE OF THE FENCE).
2. FOR REPAIR OF SILT FENCE FAILURES, USE No. 57 WASHED STONE. IN EACH CASE THE SILT FENCE IS TO BE PROPERLY ENTRENCHED & THE STONE SHALL BE AT A MINIMUM OF 16" ABOVE GRADE AT THE DIRECTION OF FLOW & BETWEEN 60 - 45 DEGREES.



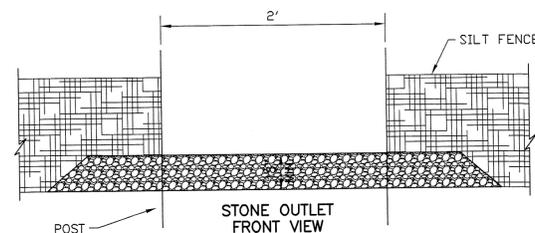
SILT FENCE

DETAIL B  
NOT TO SCALE  
C-3

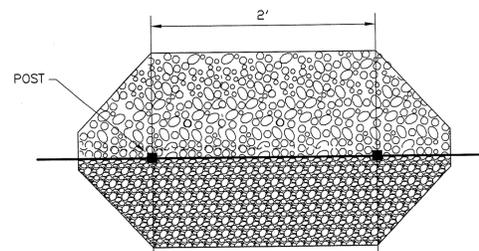


ENTRANCE ROAD

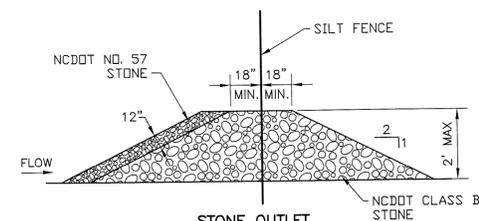
DETAIL D  
NOT TO SCALE  
C-3



STONE OUTLET FRONT VIEW

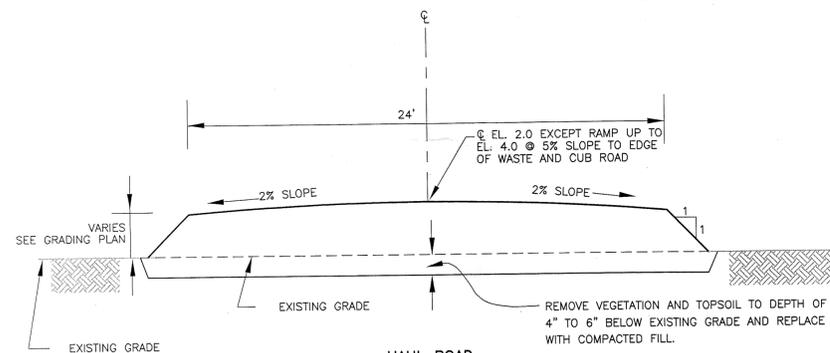


STONE OUTLET PLAN VIEW



STONE OUTLET CROSS SECTION

SILT FENCE OUTLET  
DETAIL E  
NTS  
C-3



HAUL ROAD

DETAIL C  
NOT TO SCALE  
C-3



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REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY:	P. STOUT
DRAWN BY:	P. STOUT
SHEET CHK'D BY:	K. YANG
CROSS CHK'D BY:	M. BRINCKEY
APPROVED BY:	
DATE:	JANUARY 2010

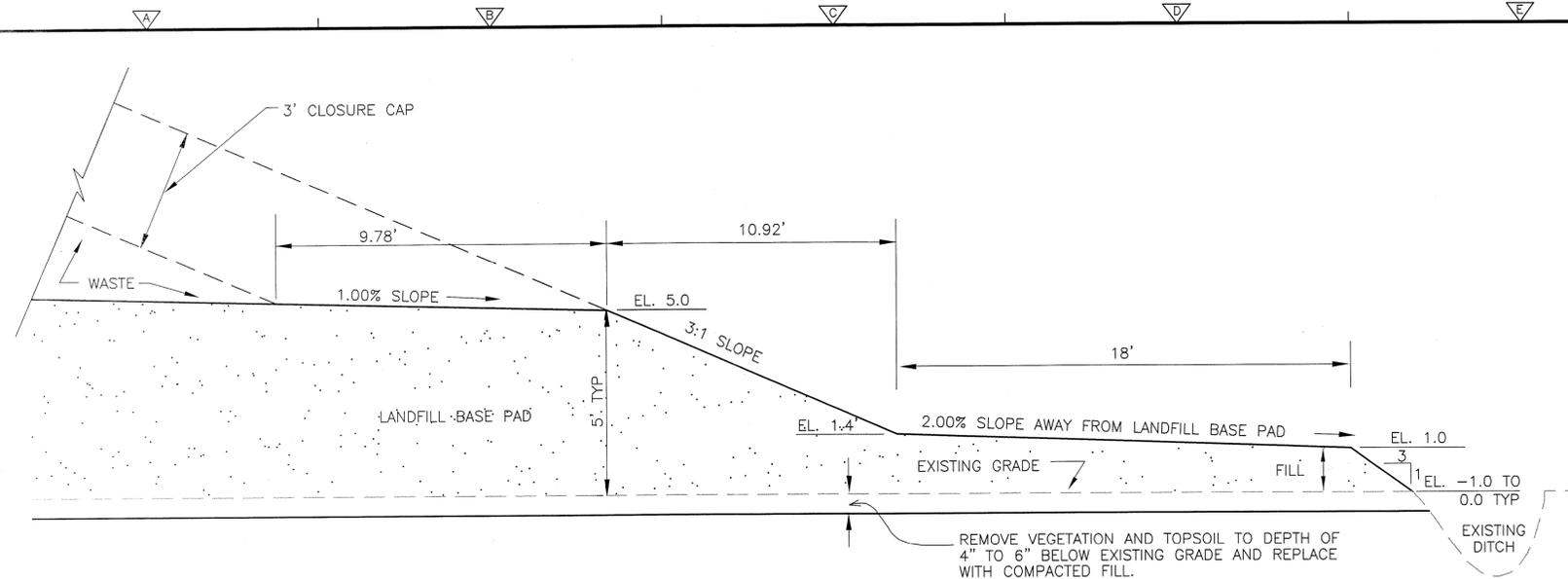
**CDM**  
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DARE COUNTY  
NORTH CAROLINA  
**CONSTRUCTION & DEMOLITION DEBRIS LANDFILL**  
PHASE IV CONSTRUCTION DRAWINGS

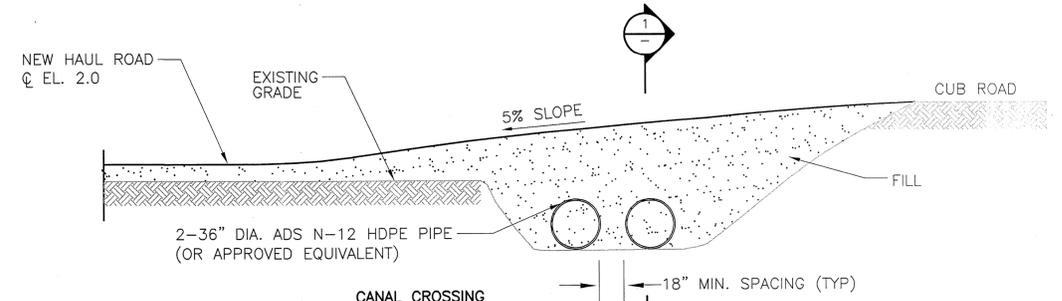
DETAILS

SHEET NO.  
**D-1**

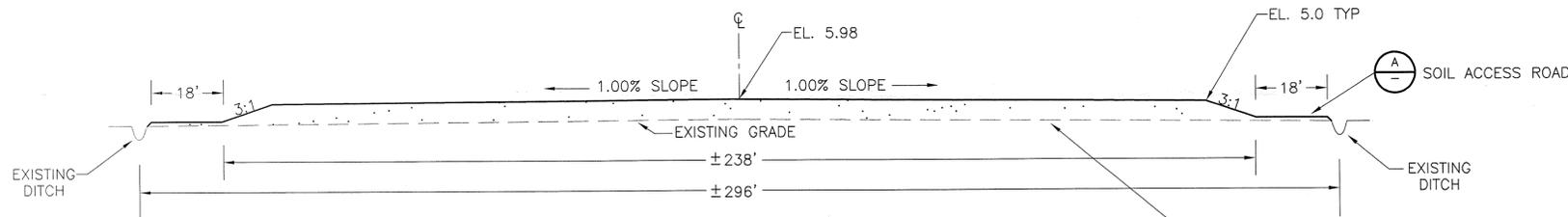
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SHEET NO.  
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PERMIT SET



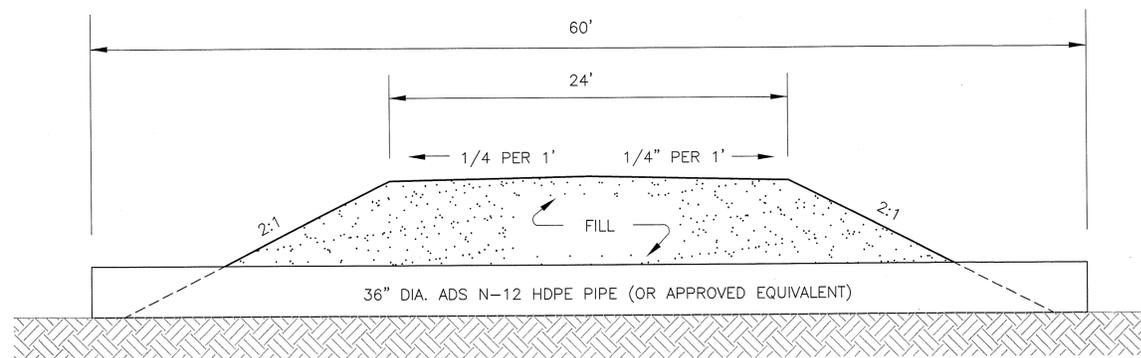
SOIL ACCESS ROAD  
**DETAIL A**  
 NOT TO SCALE  
 C-3



CANAL CROSSING  
**DETAIL B**  
 NOT TO SCALE  
 C-3



CONSTRUCTION/DEMOLITION DISPOSAL AREA TYPICAL CROSS SECTION  
**DETAIL C**  
 NOT TO SCALE  
 C-3



CANAL CROSSING  
**SECTION 1**  
 NOT TO SCALE



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REV. NO.	DATE	DRWN	CHKD	REMARKS

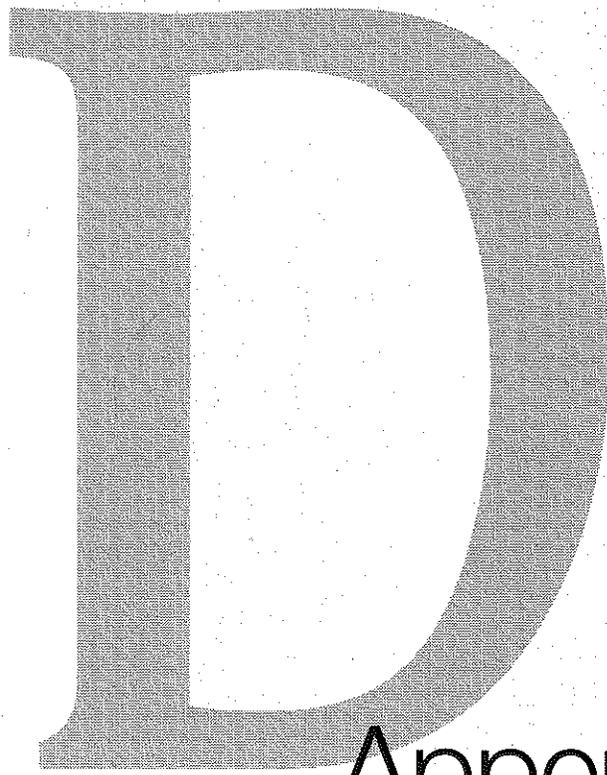
DESIGNED BY: P. STOUT  
 DRAWN BY: P. STOUT  
 SHEET CHK'D BY: K. YANG  
 CROSS CHK'D BY: M. BRINCKEY  
 APPROVED BY: \_\_\_\_\_  
 DATE: JANUARY 2010

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DARE COUNTY  
 NORTH CAROLINA  
**CONSTRUCTION & DEMOLITION DEBRIS LANDFILL  
 PHASE IV CONSTRUCTION DRAWINGS**

DETAILS

PROJECT NO. 17952	56960
FILE NAME:	D-2
SHEET NO.	D-2



Appendix  
D

**FINANCIAL RESPONSIBILITY/OWNERSHIP FORM  
SEDIMENTATION POLLUTION CONTROL ACT**

No person may initiate any land-disturbing activity on one or more acres as covered by the Act before this form and an acceptable erosion and sedimentation control plan have been completed and approved by the Land Quality Section, N.C. Department of Environment and Natural Resources. (Please type or print and, if the question is not applicable or the e-mail and/or fax information unavailable, place N/A in the blank.)

**Part A.**

1. Project Name Dare County Construction and Demolition Debris Landfill Cell No. 4 Expansion
2. Location of land-disturbing activity: County Dare City or Township Manns Harbor  
Highway/Street 1531 Link Road Latitude 35.8402 Longitude 75.8136
3. Approximate date land-disturbing activity will commence: March 2010
4. Purpose of development (residential, commercial, industrial, institutional, etc.): Municipal
5. Total acreage disturbed or uncovered (including off-site borrow and waste areas): 18 Acres
6. Amount of fee enclosed: \$ 1,170.00. The application fee of \$65.00 per acre (rounded up to the next acre) is assessed without a ceiling amount (Example: a 9-acre application fee is \$585).
7. Has an erosion and sediment control plan been filed? Yes \_\_\_\_\_ No \_\_\_\_\_ Enclosed X
8. Person to contact should erosion and sediment control issues arise during land-disturbing activity:  
Name W. Michael Brinchek E-mail Address brinchekwm@cdm.com  
Telephone 919-787-5620 Cell # 919-280-7705 Fax # 919-781-5730
9. Landowner(s) of Record (attach accompanied page to list additional owners):  

<u>Dare County</u>	<u>252-475-5880</u>	<u>(252) 473-5218</u>
Name	Telephone	Fax Number
<u>P.O. Box 1000</u>	<u>1018 Driftwood Drive</u>	
Current Mailing Address	Current Street Address	
<u>Manteo NC 27954</u>	<u>Manteo NC 27954</u>	
City State Zip	City State Zip	
10. Deed Book No. 530 Page No. 733 Provide a copy of the most current deed.

**Part B.**

1. Person(s) or firm(s) who are financially responsible for the land-disturbing activity (Provide a comprehensive list of all responsible parties on an attached sheet):

<u>Dare County</u>	<u>edwardlee@co.dare.nc.us</u>
Name	E-mail Address
<u>P.O. Box 1000</u>	<u>1018 Driftwood Drive</u>
Current Mailing Address	Current Street Address
<u>Manteo NC 27954</u>	<u>Manteo NC 27954</u>
City State Zip	City State Zip
Telephone <u>252-475-5888</u>	Fax Number _____

2. (a) If the Financially Responsible Party is not a resident of North Carolina, give name and street address of the designated North Carolina Agent:

Name _____			E-mail Address _____		
Current Mailing Address _____			Current Street Address _____		
City _____	State _____	Zip _____	City _____	State _____	Zip _____
Telephone _____			Fax Number _____		

(b) If the Financially Responsible Party is a Partnership or other person engaging in business under an assumed name, **attach a copy of the Certificate of Assumed Name**. If the Financially Responsible Party is a Corporation, give name and street address of the Registered Agent:

Name of Registered Agent _____			E-mail Address _____		
Current Mailing Address _____			Current Street Address _____		
City _____	State _____	Zip _____	City _____	State _____	Zip _____
Telephone _____			Fax Number _____		

The above information is true and correct to the best of my knowledge and belief and was provided by me under oath (This form must be signed by the Financially Responsible Person if an individual or his attorney-in-fact, or if not an individual, by an officer, director, partner, or registered agent with the authority to execute instruments for the Financially Responsible Person). I agree to provide corrected information should there be any change in the information provided herein.

<u>Edward L Mann</u> Type or print name	<u>Dare County Public Works Director</u> Title or Authority
<u>Edward L. Mann</u> Signature	<u>01/04/10</u> Date

I, Shanna T. Fullmer, a Notary Public of the County of Dare

State of North Carolina, hereby certify that Edward L Mann appeared personally before me this day and being duly sworn acknowledged that the above form was executed by him.

Witness my hand and notarial seal, this 4th day of January, 2010

Shanna T. Fullmer  
Notary

Seal

My commission expires January 5, 2013

STATE OF NORTH CAROLINA  
DARE COUNTY  
SEP 21 '87  
Real Estate  
EXCISE TAX  
500.00

BK 53020783  
FILED  
'87 SEP 21 PM 4 48  
DORRIS A. FRY  
REGISTER OF DEEDS  
DARE COUNTY, N.C.

APPROVED

DARE COUNTY TAX COLLECTOR

NO. 5057-87

Transfer Tax \$5,000.00

Excise Tax \$500.00

Tax Lot No. DARE COUNTY  
Verified by COUNTY  
by 5057-87  
Parcel Identifier No.  
County on the 19 day of  
5000.00

Mail after recording to GRANTEE c/o Dwight R. Whelless, Attorney at Law, P. O. Box 500, Manteo, NC 27954.

This instrument was prepared by Ralph S. Wheatly, Regional Counsel, The Prudential Insurance Co. of America, Suite 300, 855 Ridge Lake Blvd., Memphis, TN 38119.

NORTH CAROLINA SPECIAL WARRANTY DEED

THIS DEED made this 15th day of September, 1987, by and between

GRANTOR  
THE PRUDENTIAL INSURANCE COMPANY OF AMERICA  
Suite 300, 855 Ridge Lake Boulevard  
Memphis, Tennessee 38119

GRANTEE  
COUNTY OF DARE, a body politic and corporate  
under the laws of the state of North Carolina  
P. O. Box 1000  
Manteo, North Carolina 27954

Enter in appropriate block for each party: name, address, and, if appropriate, character of entity, e.g. corporation or partnership.

The designation Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine or neuter as required by context.

WITNESSETH, that the Grantor, for a valuable consideration paid by the Grantee, the receipt of which is hereby acknowledged, has and by these presents does grant, bargain, sell and convey unto the Grantee in fee simple, all that certain lot or parcel of land situated in the City of Croatan, Township, Dare County, North Carolina and more particularly described as follows:

SEE EXHIBIT "A" ANNEXED HERETO AND BY REFERENCE INCORPORATE HEREIN WHICH EXHIBIT IS SIGNED AT THE BOTTOM FOR IDENTIFICATION BY ABNER M. BECK, VICE PRESIDENT OF GRANTOR.

The property hereinabove described was acquired by Grantor by instrument recorded in \_\_\_\_\_

A map showing the above described property is recorded in Plat Book \_\_\_\_\_ page \_\_\_\_\_  
TO HAVE AND TO HOLD the aforesaid lot or parcel of land and all privileges and appurtenances thereto belonging to the  
Grantee in fee simple.

And the Grantor covenants with the Grantee, that Grantor has done nothing to impair such title as Grantor received, and  
Grantor will warrant and defend the title against the lawful claims of all persons claiming by, under or through Grantor,  
except for the exceptions hereinafter stated.

Title to the property hereinabove described is subject to the following exceptions:  
All matters of public record without reimposing the same.

IN WITNESS WHEREOF, the Grantor has hereunto set his hand and seal, or if corporate, has caused this instrument to be signed in its  
corporate name by its duly authorized officers and its seal to be hereunto affixed by authority of its Board of Directors, the day and year first  
above written.

THE PRUDENTIAL INSURANCE COMPANY OF AMERICA  
(Corporate Name)

By: Abner M. Beck  
Abner M. Beck  
Vice President

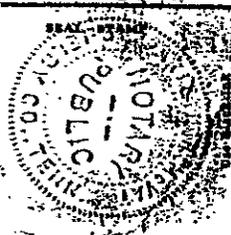
ATTEST:  
Ralph S. Wheatly  
Ralph S. Wheatly  
Assistant Secretary (Corporate Seal)

USE BLACK INK ONLY

SEAL - STAMP

USE BLACK INK ONLY

NORTH CAROLINA, \_\_\_\_\_ County.  
I, a Notary Public of the County and State aforesaid, certify that \_\_\_\_\_  
Grantor,  
personally appeared before me this day and acknowledged the execution of the foregoing instrument, Witness my  
hand and official stamp or seal, this \_\_\_\_\_ day of \_\_\_\_\_, 19\_\_\_\_  
My commission expires: \_\_\_\_\_ Notary Public



TENNESSEE, Shelby County.  
I, a Notary Public of the County and State aforesaid, certify that Ralph S. Wheatly  
personally came before me this day and acknowledged that he is Assistant Secretary of  
THE PRUDENTIAL INSURANCE COMPANY OF AMERICA, a New Jersey  
corporation, and that by authority duly  
given and in the act of the corporation, the foregoing instrument was signed in his name by its Vice  
President, sealed with its corporate seal and attested by Ralph S. Wheatly Assistant Secretary.  
Witness my hand and official stamp or seal, this 15th day of September, 1987  
My commission expires: July 3, 1990 Marilyn R. Melby Notary Public

The foregoing Certificate(s) of Marilyn R. Melby a Notary Public of  
Shelby Co. Tenn

is/are certified to be correct. This instrument and this certificate are duly registered at the date and time and in the Book and Page shown on the  
next page hereof.

Dorrie A. Fry  
by Mary B. Scarborough REGISTER OF DEEDS FOR Dare COUNTY  
Deputy/Assistant-Register of Deeds.

EXHIBIT 5  
BK 530

All that certain piece or parcel of land lying and being in Croatan Township, Dare County, North Carolina, and described as follows:

BEGINNING at a stake or other marker lying in and on the West line of the right of way of U. S. Highway 264 and at a point thereon which lies North 34 deg. 40 min. 27 sec. East 102.95 feet from another concrete marker, said point of beginning also lying and being North 24 deg. 45 min. 56 sec. East 577.39 feet from a concrete marker identified as "Bridge 1974" (said marker lying at the following grid coordinates based on the North Carolina Grid System: North 776227.158, East 2944678.124), said point of beginning also lying South 76 deg. 38 min. 10 sec. West 60.55 feet from an existing concrete monument which itself lies on the same course and 44.14 feet from an existing P. K. nail in the centerline of the pavement of U. S. Highway 264 which said nail lies North 32 deg. 4 min. 29 sec. East 647.29 feet from the concrete marker identified as "Bridge 1974", proceeding thence from the point of beginning South 76 deg. 38 min. 10 sec. West along the South line of lands belonging to the United States Department of the Interior (U. S. Fish and Wildlife Service) 4,686.48 feet to an existing concrete monument, then cornering and running North 9 deg. 0 min. 23 sec. West 23.87 feet to a concrete monument, thence South 81 deg. 24 min. 20 sec. West 975.66 feet to a concrete monument, thence South 8 deg. 38 min. 54 sec. East 1,731.72 feet to a concrete monument, thence South 39 deg. 44 min. 25 sec. East 8,291.60 feet to a concrete monument, thence North 50 deg. 10 min. 9 sec. East 3,468.62 feet to a concrete monument, which concrete monument lies on the same course 40 feet to another existing concrete monument and 30 feet beyond that to an existing P. K. nail on the centerline of the pavement of U. S. Highway 264, thence from the concrete monument on the edge of the right of way in a general Northwesterly, Northerly and Northeasterly direction following the curvature of the right of way U. S. Highway 264 to the point or place of beginning.

The aforesaid tract is identified on a plat prepared by Southern Surveying recorded in Plat Cabinet C at Slide 32B in the office of the Register of Deeds of Dare County, North Carolina.

All courses in this description are coordinated with the North Carolina Grid System as further shown on the aforesaid plat.

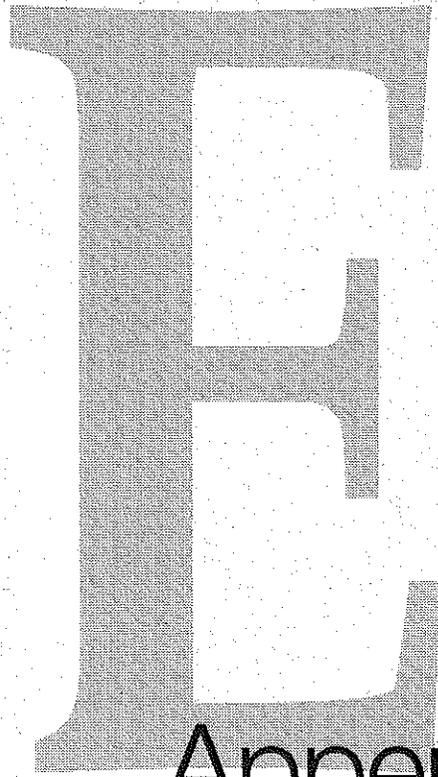
There is also conveyed hereby a right of access over and upon portions of the road shown on the aforesaid plat as "Bear Road".

Portions of the described properties are subject to existing land leases which terminate no later than December 31, 1987.

MARKED FOR IDENTIFICATION THIS 15th DAY OF September, 1987.

THE PRUDENTIAL INSURANCE COMPANY OF AMERICA  
By: Abner M. Beck  
Abner M. Beck, Vice President





Appendix

E



CLIENT	Dare County
PROJECT	Dare County Cell 4 C&D LF
DETAIL	Filter Basin #'s 1 & 2
PROJECT NO.	17952-56960

COMPUTED BY / DATE	WPS	01/21/09
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REVISION NO. / DATE	-	-
REVIEWED BY / DATE	-	-

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**Calculation Brief Title:** Filter Basin #'s 1 & 2

---

## 1.0 Objective

Design Gravel & Riprap Filter Basins for Dare County Cell No. 4 expansion.

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## 2.0 Procedure

1. Determine total area draining to each filter basin.
  2. Determine Disturbed area draining to each filter basin.
  3. Determine required pond volume.
  4. Determine required surface area for pond behind berm.
  5. Determine time of concentration.
  6. Determine dimensions of pond.
  7. Determine length of spillway.
- 

## 3.0 References / Data Sources

1. Dare County C&D Landfill Cell # 4 Expansion
  2. North Carolina Erosion and Sediment Control Planning and Design Manual
- 

## 4.0 Assumptions / Limitations

1. Assume base design on 25-yr Storm
- 

## 5.0 Calculations

Filter berms will be placed in the existing drainage ditches located east and west of Cell No. 4, downstream of cell construction, as shown in Sheet C-3, Grading Plan, of the permit application. FB-1 and FB-2 will serve same total and disturbed areas, so design will be the same.

### 1.) Total Area Draining to Each Filter Basin:

$$= 2,500 \text{ ft} \times 300 \text{ ft} = 750,000 \text{ ft}^2 = 17.22 \text{ AC}$$

### 2.) Disturbed Area Draining to Each Filter Basin (including cell & roads):

$$= 1/2 * (2,300 \text{ ft} \times 300 \text{ ft}) = 345,000 \text{ ft}^2 = 7.9 \text{ AC}$$

### 3.) Determine reqd. pond volume behind berm:

$$V = 3,600 \text{ ft}^3 / \text{disturbed acre}$$

$$V = 3,600 * (7.9) = 14,220 \text{ ft}^3$$



CLIENT Dare County  
PROJECT Dare County Cell 4 C&D LF  
DETAIL Filter Basin #'s 1 & 2  
PROJECT NO. 17952-56960

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**4.) Determine reqd. surface area for pond behind berm:**

Use Area (A) = 0.01 acres per cfs based on 25 yr storm (disturbed area only)

$Q_{25D} = C_D I_{25} A_D$  where:

$Q_{25D}$  = 25yr peak runoff from disturbed area (cfs)

$I_{25}$  = 25yr rainfall intensity (in/hr)

$A_D$  = Disturbed Area (AC)

$C_D$  = Runoff Coefficient for disturbed area, dimensionless

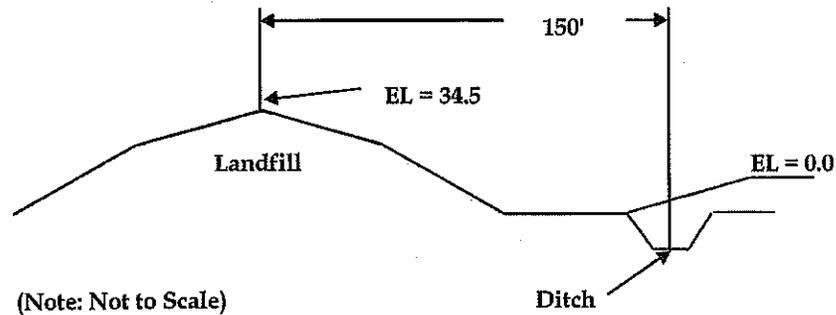
From Attachment A, use  $C_D = 0.45$  for bare packed smooth soil

**5.) Determine Time of Concentration:**

Assume two components

- 1.) Overland flow from top of landfill to ditch.
- 2.) Ditch flow to filter basin.

1.) Use Attachment B for Overland Flow:



Conclusion:

H = 34.5 ft

L = 150 ft

From Attachment B,  $T_{Cl} = 0.5$  min

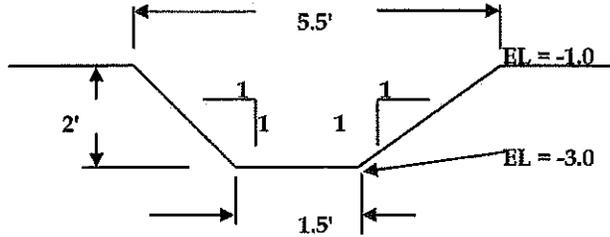


CLIENT Dare County  
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1.) Length of flow in ditch = 2100 ft

Typical Dimensions of ditch:



(Note: Not to Scale)

Avg. Slope along ditch:

$$\text{Slope (S)} = 1' / 2100' = 0.0005 = 0.05\%$$

Determine Velocity in ditch using Manning's Eqn.

$$V = \frac{1.49 r^{2/3} s^{1/2}}{n_{\text{Total}}}$$

Where: r = hydraulic radius  
 s = Slope  
 n = Manning's Coeff.

	n = 0.02	for channels in earth (basic)
	0.010	
+	0.005	Low vegetative effect
<hr/>	<hr/>	
$n_{\text{Total}}$	0.035	

$$V = 0.94 \text{ ft/s}$$

Conclusion:

$$T_{C2} = 2100' / 0.94 \text{ ft/s} = 2,234 \text{ sec} = 37.2 \text{ min}$$

$$T_{C\text{Total}} = T_{C1} + T_{C2} = 0.5 \text{ min} + 37.2 \text{ min} = 37.7 \text{ min}$$

From Attachment C, for  $T_C = 37.7 \text{ min}$ .

$$25\text{yr intensity} = 5.31 \text{ in/hr (Hatteras)}$$



CLIENT	Dare County
PROJECT	Dare County Cell 4 C&D LF
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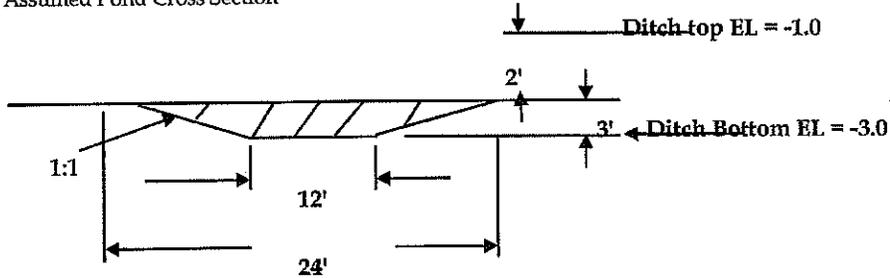
Conclusion:

$$Q_{25D} = C_D I_{25} A_D = 0.45 * (5.31) * (7.9) = 18.9 \text{ cfs}$$

$$\text{Reqd. Surface Area of Pond} = 0.01 * (18.9 \text{ cfs}) = 0.19 \text{ AC}$$

### 6.) Determine Dimensions of Pond:

Assumed Pond Cross Section



(Note: Not to Scale)

Sediment Storage Volume per foot of cross-section

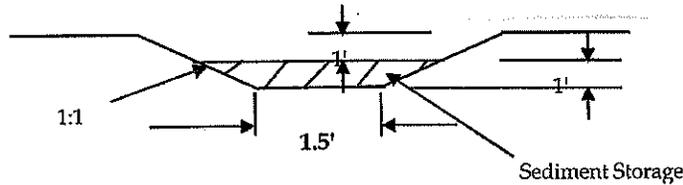
$$V = (12' + 24') * (3') = 54 \text{ ft}^3/\text{ft}$$

$$\text{Reqd. Volume} = 14,220 \text{ ft}^3$$

$$\text{Reqd. Length of Pond} = \frac{14,220 \text{ ft}^3}{54 \text{ ft}^2} = 263 \text{ ft (Too Long)}$$

Account for sediment storage capacity of existing ditch or 1.0' between spillway and ditch bottom:

Typical Dimensions of ditch



Sediment storage volume per ft of ditch

$$= (1.5' + 1') * (1') = 2.5 \text{ ft}^3/\text{ft}$$

$$\text{Length of ditch} = 2,100 \text{ ft}$$



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Conclusion:

Sediment storage capacity per ditch

$$V = 2.5 \text{ ft}^3 / \text{ft} (2,100 \text{ ft}) = 5,250 \text{ ft}^3$$

Reqd. length of pond after accounting for sediment storage within ditch:

$$\frac{14,220 \text{ ft}^3 - 5,250 \text{ ft}^3}{54} = 166' \quad (\text{Use } 170')$$

Check surface Area Requirement:

Reqd. Surface Area = 0.19 AC

Surface Area of Pond at ditch bottom elev.

$$A_1 = 24'(170') = 4,080 \text{ ft}^2$$

Surface area of ditch w/ 1' of ponded water:

$$A_2 = 2.5'(2,100') = 5,250 \text{ ft}^2$$

$$\text{Total Surface Area} = A_1 + A_2 = 9,350 \text{ ft}^2 = 0.21 \text{ AC}$$

**0.21 AC > 0.19 AC OK!**

**7.) Determine Length of Spillway:**

Total Area draining to each basin = 17.22 AC of which 7.9 AC is disturbed:

$$\text{Undisturbed area} = 17.22 \text{ AC} - 7.9 \text{ AC} = 9.32 \text{ AC}$$

Use C = 0.30 (Pasture heavy soil) (See Attachment A)



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Disturbed Area = 7.9 AC

Use C = 0.45 (Base Packed Soil, Smooth)

$$\text{Composite } C_c = \frac{9.32*(0.30)+7.9*(0.45)}{17.22} = 0.37$$

Flow through spillway:  $Q_{25} = C_c I_{25} A_T$

$$Q_{25} = CLH^{1.5}$$

Where: Q = discharge (cfs)  
 C = Coefficient = 2.6  
 L = Length of weir (ft)  
 H = Depth of flow over weir = 0.5

Try L = 10':

$$Q = 2.6*(10)*(0.5)^{1.5} = 9.19 \text{ cfs} < 23 \text{ cfs (No Good!)}$$

Solve for L:

$$L_{\text{reqd}} = \frac{Q}{CH^{1.5}} = \frac{23}{2.6(0.5)^{1.5}} = 25'$$

## 6.0 Conclusion

Based on the above calculations filter basin # 1 & 2 need to be built at a minimum to the above highlighted dimensions to treat the 25-yr storm and meet the requirements of the NC Erosion and Sediment Control Planning and Design Manual.

**Table 8.03a**  
**Value of Runoff Coefficient**  
**(C) for Rational Formula**

Land Use	C	Land Use	C
<b>Business:</b>		<b>Lawns:</b>	
Downtown areas	0.70-0.95	Sandy soil, flat, 2%	0.05-0.10
Neighborhood areas	0.50-0.70	Sandy soil, ave., 2-7%	0.10-0.15
<b>Residential:</b>		Sandy soil, steep, 7%	0.15-0.20
Single-family areas	0.30-0.50	Heavy soil, flat, 2%	0.13-0.17
Multi units, detached	0.40-0.60	Heavy soil, ave., 2-7%	0.18-0.22
Multi units, attached	0.60-0.75	Heavy soil, steep, 7%	0.25-0.35
Suburban	0.25-0.40	<b>Agricultural land:</b>	
<b>Industrial:</b>		Bare packed soil	
Light areas	0.50-0.80	Smooth	0.30-0.60
Heavy areas	0.60-0.90	Rough	0.20-0.50
Parks, cemeteries	0.10-0.25	Cultivated rows	
Playgrounds	0.20-0.35	Heavy soil no crop	0.30-0.60
Railroad yard areas	0.20-0.40	Heavy soil with crop	0.20-0.50
Unimproved areas	0.10-0.30	Sandy soil no crop	0.20-0.40
<b>Streets:</b>		Sandy soil with crop	0.10-0.25
Asphalt	0.70-0.95	Pasture	
Concrete	0.80-0.95	Heavy soil	0.15-0.45
Brick	0.70-0.85	Sandy soil	0.05-0.25
Drives and walks	0.75-0.85	Woodlands	0.05-0.25
Roofs	0.75-0.85		

Avg. = 0.45

Avg. = 0.30

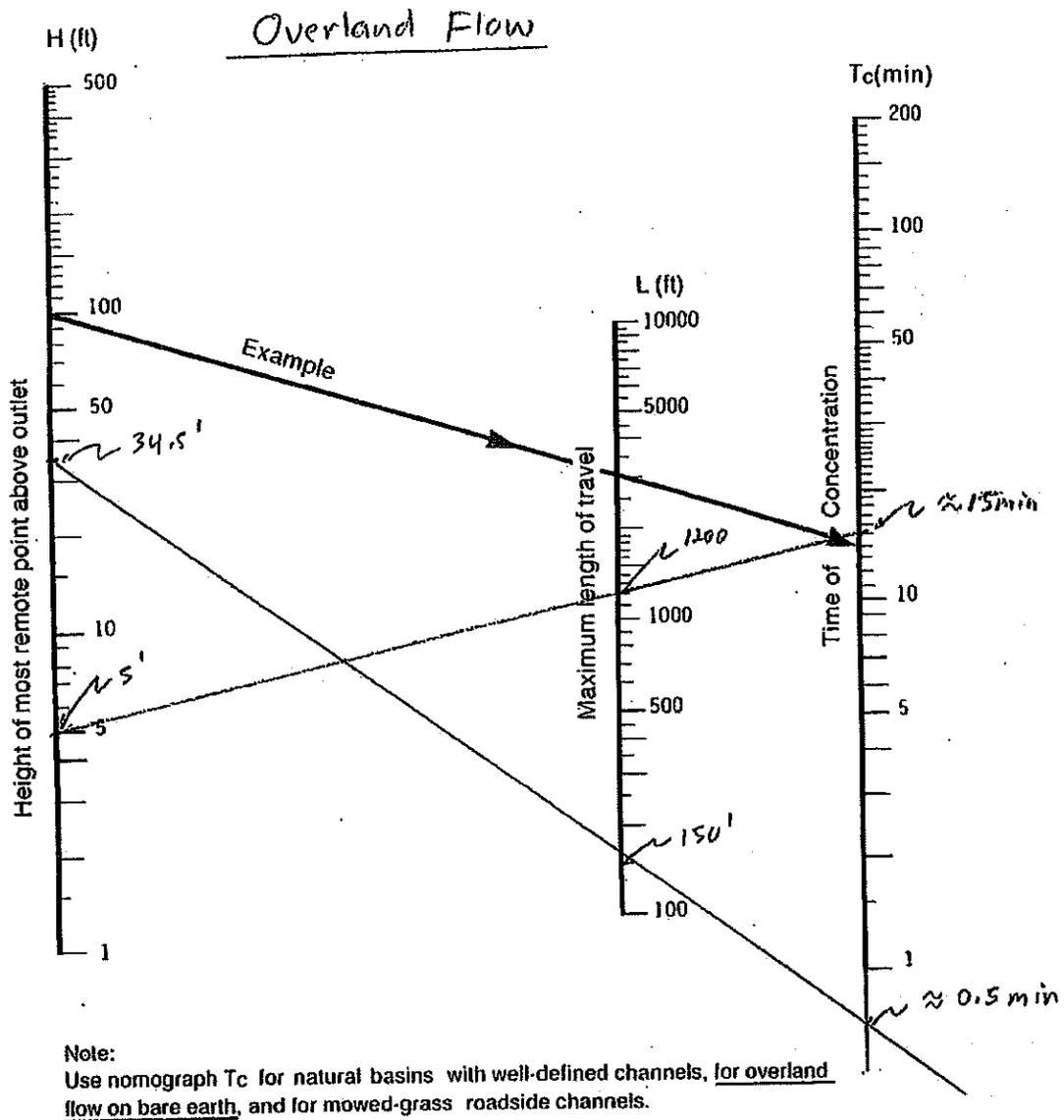
**NOTE:** The designer must use judgment to select the appropriate C value within the range for the appropriate land use. Generally, larger areas with permeable soils, flat slopes, and dense vegetation should have lowest C values. Smaller areas with slowly permeable soils, steep slopes, and sparse vegetation should be assigned highest C values.

Source: American Society of Civil Engineers

The overland flow portion of flow time may be determined from Figure 8.03a. The flow time (in minutes) in the channel can be estimated by calculating the average velocity in feet per minute and dividing the length (in feet) by the average velocity.

**Step 4.** Determine the rainfall intensity, frequency, and duration (Figures 8.03b through 8.03g—source: North Carolina State Highway Commission; Jan. 1973). Select the chart for the locality closest to your location. Enter the "duration" axis of the chart with the calculated time of concentration,  $T_c$ . Move vertically until you intersect the curve of the appropriate design storm, then move horizontally to read the rainfall intensity factor,  $i$ , in inches per hour.

**Step 5.** Determine peak discharge,  $Q$  ( $\text{ft}^3/\text{sec}$ ), by multiplying the previously determined factors using the rational formula (Sample Problem 8.03a).



For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

**Raleigh, North Carolina 35.8706N, 78.7864W**

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	5.58	4.46	3.74	2.58	1.62	0.94	0.66	0.40	0.24	0.14
10	7.08	5.66	4.78	3.46	2.25	1.33	0.95	0.58	0.34	0.021
25	7.78	6.19	5.24	3.88	2.58	1.54	1.11	0.68	0.41	0.24
100	8.64	6.86	5.78	4.43	3.05	1.85	1.36	0.84	0.51	0.30

**Fayetteville, North Carolina 35.0583N, 78.8583W**

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.11	4.88	4.09	2.83	1.77	1.04	0.74	0.44	0.26	0.15
10	7.96	6.36	5.36	3.88	2.53	1.54	1.10	0.66	0.39	0.23
25	8.94	7.13	6.02	4.46	2.97	1.83	1.32	0.80	0.47	0.28
100	10.44	8.29	6.99	5.35	3.69	2.29	1.69	1.03	0.62	0.36

**Wilmington, North Carolina 34.2683N, 77.9061W**

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	7.39	5.92	4.96	3.42	2.15	1.28	0.91	0.56	0.33	0.19
10	9.70	7.75	6.54	4.74	3.08	1.94	1.39	0.87	0.51	0.30
25	10.98	8.75	7.40	5.48	3.65	2.38	1.73	1.08	0.64	0.38
100	12.92	10.27	8.65	6.63	4.56	3.18	2.37	1.49	0.89	0.53

**Washington, North Carolina 35.5333N, 77.0167W**

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.41	5.12	4.29	2.96	1.86	1.10	0.78	0.47	0.27	0.16
10	8.38	6.70	5.65	4.09	2.66	1.64	1.19	0.72	0.42	0.25
25	9.48	7.55	6.38	4.73	3.15	1.99	1.46	0.88	0.52	0.31
100	11.16	8.87	7.47	5.72	3.94	2.58	1.93	1.18	0.70	0.42

**Manteo Airport, North Carolina 35.9167N, 75.7000W**

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.46	5.16	4.32	2.99	1.87	1.08	0.79	0.48	0.29	0.17
10	8.47	6.77	5.71	4.14	2.69	1.62	1.20	0.74	0.44	0.27
25	9.56	7.62	6.44	4.77	3.17	1.96	1.47	0.91	0.54	0.33
100	11.26	8.95	7.54	5.77	3.98	2.54	1.95	1.21	0.73	0.44

**Cape Hatteras, North Carolina, 35.2322N, 75.6225W**

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	7.20	5.75	4.82	3.33	2.09	1.29	0.94	0.58	0.34	0.20
10	9.41	7.52	6.35	4.60	2.99	1.93	1.43	0.89	0.53	0.31
25	10.66	8.49	7.18	5.31	3.54	2.33	1.75	1.09	0.65	0.38
100	12.53	9.95	8.39	6.42	4.42	3.03	2.32	1.45	0.88	0.51



CLIENT Dare County  
 PROJECT Dare County Cell 4 C&D LF  
 DETAIL Cell # 4 Canal Crossing  
 PROJECT NO. 17952-56960

COMPUTED BY / DATE WPS 01/22/09  
 CHECKED BY / DATE WMB -  
 REVISION NO. / DATE - -  
 REVIEWED BY / DATE - -

**Calculation Brief Title: Cell # 4 Canal Crossing**

**1.0 Objective**

Design a Canal Crossing for Cell # 4

**2.0 Procedure**

1. Estimate flow passing through culvert.
2. Estimate time of concentration.
3. Determine flow capacity of single 36" dia. CMP pipe.

**3.0 References / Data Sources**

1. Dare County C&D Landfill Cell # 4 Expansion
2. North Carolina Erosion and Sediment Control Planning and Design Manual

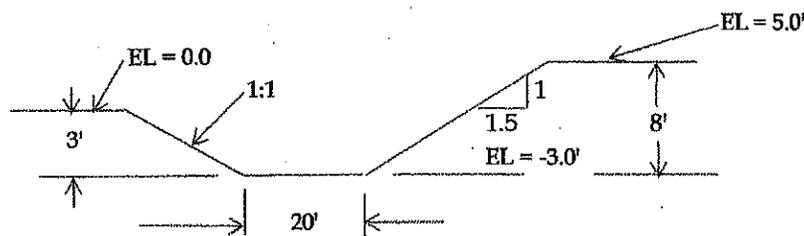
**4.0 Assumptions / Limitations**

1. Assume base design on 25-yr Storm

**5.0 Calculations**

Canal crossing will occur on the south side of Cell # 4 at Cub Road. The crossing will be designed in accordance with the North Carolina Erosion and Sedimentation Control Planning and Design Manual for stream crossings.

Cross - Section of Canal @ proposed crossing @ Cub Rd.



**1.) Estimate flow passing through culvert:**

$$A = 2,700' \times 2,700' = 7,290,00 \text{ ft}^2 = 167 \text{ AC}$$

Assume maximum disturbed area for any given time

$$= 15 \text{ AC } c = 0.45 \text{ (Bare packed soil, smooth) - See Attachment A}$$

$$\text{Undisturbed Area} = 167 \text{ AC} - 15 \text{ AC} = 152 \text{ AC}$$

$$C = 0.30 \text{ (Pasture, Heavy Soil)}$$

$$\text{Composite } C_c = \frac{15*(0.45) + 152*(0.30)}{167} = 0.31$$



CLIENT Dare County  
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COMPUTED BY / DATE WPS 01/22/09  
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## 2.) Estimate Time of Concentration:

Assume two components:

- 1.) Overland flow from most remote point.
- 2.) Ditch/canal flow.

Use Attachment B, Assume  $H = 5'$ ,  $L = 1,200'$

$$T_{c1} = 15 \text{ min}$$

Length of flow in ditches/canal =  $4,100'$

Assume  $V = 1 \text{ ft/s}$  in ditches/canal (see filter basin calcs.)

$$T_{c2} = 68 \text{ min}$$

$$T_{CT} = 15 \text{ min} + 68 \text{ min} = 83 \text{ min}$$

From Attachment C, for  $T_C = 37.7 \text{ min}$ .

25yr intensity =  $3.54 \text{ in/hr}$  (Hatteras - 60 min)

$$Q_{p25} = C_c I_{10} A_T = 0.31(3.54)(167) = 184 \text{ cfs}$$

## 2.) Determine flow capacity of 36" Dia. CMP pipe.

- 1.) Use chart on Attachment D.
- 2.) Assume submerged outlet.

Length of culvert,  $L = 60'$

Use  $K_e = 0.9$  for cmp projecting from fill (no headwall)

Assume  $H = 1'$

From Attachment D,  $Q = 24 \text{ cfs}$  per 36" pipe.

## 6.0 Conclusion

Upstream existing canal crossing, has three 36" CMP culverts, which will limit flow entering new canal crossing. Thus three culverts were chosen on the basis that the flow will not overflow the crossing because sufficient head will be generated to drive the flow through the three 36" CMP culverts.

**Table 8.03a**  
**Value of Runoff Coefficient**  
**(C) for Rational Formula**

Land Use	C	Land Use	C
<b>Business:</b>		<b>Lawns:</b>	
Downtown areas	0.70-0.95	Sandy soil, flat, 2%	0.05-0.10
Neighborhood areas	0.50-0.70	Sandy soil, ave., 2-7%	0.10-0.15
		Sandy soil, steep, 7%	0.15-0.20
<b>Residential:</b>		Heavy soil, flat, 2%	0.13-0.17
Single-family areas	0.30-0.50	Heavy soil, ave., 2-7%	0.18-0.22
Multi units, detached	0.40-0.60	Heavy soil, steep, 7%	0.25-0.35
Multi units, attached	0.60-0.75		
Suburban	0.25-0.40	<b>Agricultural land:</b>	
		Bare packed soil	
<b>Industrial:</b>		Smooth	0.30-0.60
Light areas	0.50-0.80	Rough	0.20-0.50
Heavy areas	0.60-0.90	Cultivated rows	
		Heavy soil no crop	0.30-0.60
<b>Parks, cemeteries</b>	0.10-0.25	Heavy soil with crop	0.20-0.50
		Sandy soil no crop	0.20-0.40
<b>Playgrounds</b>	0.20-0.35	Sandy soil with crop	0.10-0.25
		Pasture	
<b>Railroad yard areas</b>	0.20-0.40	Heavy soil	0.15-0.45
		Sandy soil	0.05-0.25
<b>Unimproved areas</b>	0.10-0.30	Woodlands	0.05-0.25
<b>Streets:</b>			
Asphalt	0.70-0.95		
Concrete	0.80-0.95		
Brick	0.70-0.85		
<b>Drives and walks</b>	0.75-0.85		
<b>Roofs</b>	0.75-0.85		

Avg. = 0.45

Avg. = 0.30

NOTE: The designer must use judgment to select the appropriate C value within the range for the appropriate land use. Generally, larger areas with permeable soils, flat slopes, and dense vegetation should have lowest C values. Smaller areas with slowly permeable soils, steep slopes, and sparse vegetation should be assigned highest C values.

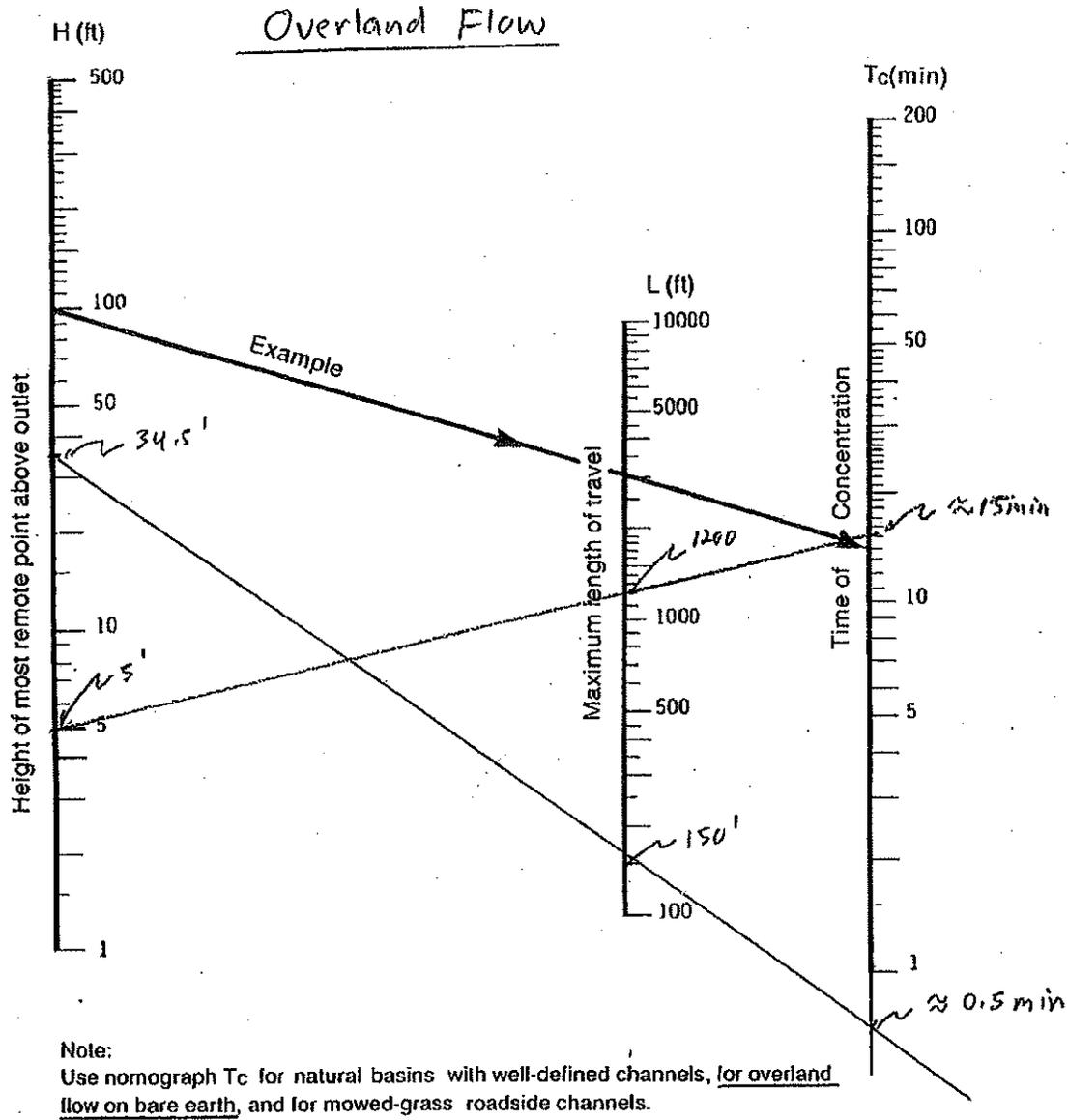
Source: American Society of Civil Engineers

The overland flow portion of flow time may be determined from Figure 8.03a. The flow time (in minutes) in the channel can be estimated by calculating the average velocity in feet per minute and dividing the length (in feet) by the average velocity.

Step 4. Determine the rainfall intensity, frequency, and duration (Figures 8.03b through 8.03g—source: North Carolina State Highway Commission; Jan. 1973). Select the chart for the locality closest to your location. Enter the "duration" axis of the chart with the calculated time of concentration, T<sub>c</sub>. Move vertically until you intersect the curve of the appropriate design storm, then move horizontally to read the rainfall intensity factor, i, in inches per hour.

Step 5. Determine peak discharge, Q (ft<sup>3</sup>/sec), by multiplying the previously determined factors using the rational formula (Sample Problem 8.03a).

8



For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

# ATTACHMENT C

Appendices

<b>Raleigh, North Carolina 35.8706N. 78.7864W</b>										
ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	5.58	4.46	3.74	2.58	1.62	0.94	0.66	0.40	0.24	0.14
10	7.08	5.66	4.78	3.46	2.25	1.33	0.95	0.58	0.34	0.21
25	7.78	6.19	5.24	3.88	2.58	1.54	1.11	0.68	0.41	0.24
100	8.64	6.86	5.78	4.43	3.05	1.85	1.36	0.84	0.51	0.30

<b>Fayetteville, North Carolina 35.0583N. 78.8583W</b>										
ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.11	4.88	4.09	2.83	1.77	1.04	0.74	0.44	0.26	0.15
10	7.96	6.36	5.36	3.88	2.53	1.54	1.10	0.66	0.39	0.23
25	8.94	7.13	6.02	4.46	2.97	1.83	1.32	0.80	0.47	0.28
100	10.44	8.29	6.99	5.35	3.69	2.29	1.69	1.03	0.62	0.36

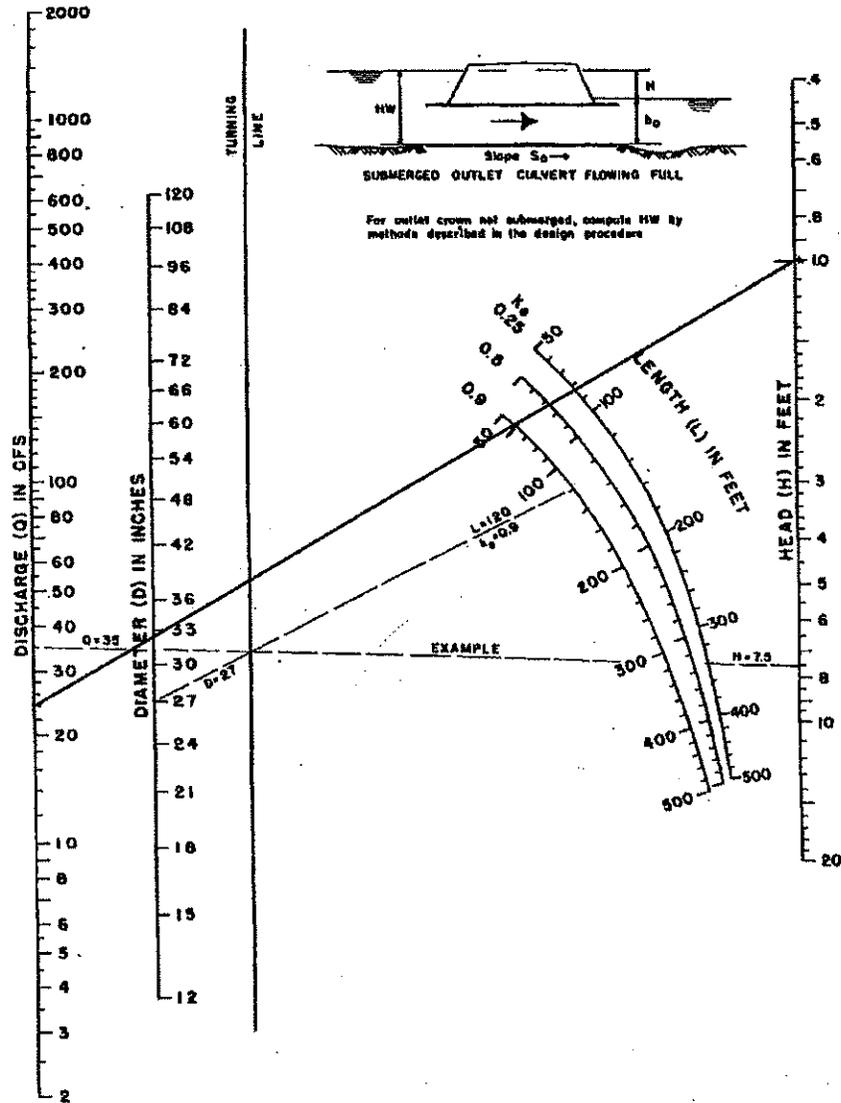
<b>Wilmington, North Carolina 34.2683N. 77.9061W</b>										
ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	7.39	5.92	4.96	3.42	2.15	1.28	0.91	0.56	0.33	0.19
10	9.70	7.75	6.54	4.74	3.08	1.94	1.39	0.87	0.51	0.30
25	10.98	8.75	7.40	5.48	3.65	2.38	1.73	1.08	0.64	0.38
100	12.92	10.27	8.65	6.63	4.56	3.18	2.37	1.49	0.89	0.53

<b>Washington, North Carolina 35.5333N. 77.0167W</b>										
ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.41	5.12	4.29	2.96	1.86	1.10	0.78	0.47	0.27	0.16
10	8.38	6.70	5.65	4.09	2.66	1.64	1.19	0.72	0.42	0.25
25	9.48	7.55	6.38	4.73	3.15	1.99	1.46	0.88	0.52	0.31
100	11.16	8.87	7.47	5.72	3.94	2.58	1.93	1.18	0.70	0.42

<b>Manteo Airport, North Carolina 35.9167N. 75.7000W</b>										
ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.46	5.16	4.32	2.99	1.87	1.08	0.79	0.48	0.29	0.17
10	8.47	6.77	5.71	4.14	2.69	1.62	1.20	0.74	0.44	0.27
25	9.56	7.62	6.44	4.77	3.17	1.96	1.47	0.91	0.54	0.33
100	11.26	8.95	7.54	5.77	3.98	2.54	1.95	1.21	0.73	0.44

<b>Cape Hatteras, North Carolina 35.2322N. 75.6225W</b>										
ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	7.20	5.75	4.82	3.33	2.09	1.29	0.94	0.58	0.34	0.20
10	9.41	7.52	6.35	4.60	2.99	1.93	1.43	0.89	0.53	0.31
25	10.66	8.49	7.18	5.31	3.54	2.33	1.75	1.09	0.65	0.38
100	12.53	9.95	8.39	6.42	4.42	3.03	2.32	1.45	0.88	0.51

**Exhibit 20**  
**Culvert capacity under outlet control**  
**Standard circular CMP**



**HEAD FOR  
 STANDARD  
 C. M. PIPE CULVERTS  
 FLOWING FULL  
 $n = 0.024$**

BUREAU OF PUBLIC ROADS JAN. 1965



CLIENT Dare County Cell No. 4  
PROJECT Cell No. 4 PTC  
DETAIL Soil Loss Calculation

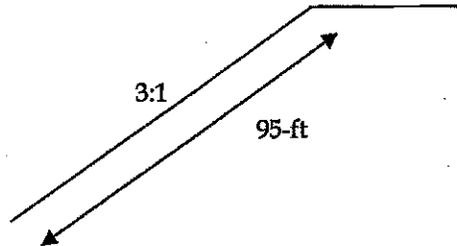
JOB NO. 17952-56960  
DATE CHECKED 7/16/2009  
CHECKED BY WMB

COMPUTED BY WPS  
DATE 7/16/2009  
PAGE NO. 1 of 11

Task: 1 Design permanent/temporary stabilization for the Cell No. 4 closure slopes.

Reference North American Green ECMDS® version 4.3- slope protection design

Given Slope length: 95 ft  
Side slope: 3:1  
Vegetation coverage: Fair condition  
Project location: Dare County NC, US  
Soil Type: sand



1- Permanent slope stability

The following assumptions were made for the permanent slope stability analysis

- Reinforcement material SC250
- Bunch-type vegetatic
- Fairly dense vegetation
- Project Location - Norfolk Virginia (Closest City)

The analysis performed using North American Green ECMDS® shows that the slope is stable with a safety factor of 4.9 (See Attachment 1)

2- Temporary slope stability

The following assumptions were made for the temporary slope stability analysis

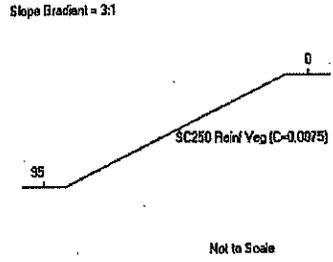
- Reinforcement material SC250
- Bunch-type vegetation
- Fairly dense vegetation
- Duration 12 months
- Beginning month is December
- Project Location - Norfolk Virginia (Closest City)

The analysis performed using North American Green ECMDS® shows that the slope is stable with a safety factor of 3.5 (See Attachment 2)

Conclusion: SC250 reinforcement material is capable of providing both temporary and permanent stabilization for the Dare County Cell No. 4 closure slope.

**Attachment 1**  
**North American Green Permanent Slope**  
**Protection Analysis**

Country: United States  
 State/Region: Virginia  
 City: Norfolk  
 Annual R Factor: 250  
 Total Slope Length (ft): 95  
 Protection Type: Permanent  
 Protection Period (months):  
 Beginning Month:  
 Adjusted R Value: 250  
 Slope Gradient (H:1): 3  
 Soil Type: Sand  
 K Factor: 0.1  
 Soil Loss Tolerance (in): 0.03



Reach	Cum. Dist. Begin (ft)	Cum. Dist. End (ft)	Material	Vegetation Type Growth Habit	Density	ASL bare (in)	ASL mat (in)	SLT (in)	SF	Remarks
1	0	95	SC250 Rein.	Bunch Type	50-75%	0.630	0.006	0.03	4.813	STABLE
2										
3										
	0	95		Composite		0.630	0.006			

Vegetation Density=Percentage of soil coverage provided by vegetation  
 ASL bare=Average Soil Loss potential of unprotected soil (uniform inches)  
 ASL mat=Average Soil Loss potential w/material (uniform inches)  
 MSL bare=Maximum Soil Loss potential on unprotected soil (uniform inches)  
 MSL mat=Maximum Soil Loss potential w/material (uniform inches)  
 SLT=Soil Loss Tolerance for slope segment (uniform inches)  
 SF=Safety Factor  
 Composite=Average soil loss from total slope length (uniform inches)  
 C=Cover material performance factor (fraction of soil loss of unprotected)

\*\*\*\*\*  
 NORTH AMERICAN GREEN EROSION CONTROL MATERIALS DESIGN SOFTWARE VERSION 4.3  
 NORTH AMERICAN GREEN SLOPE PROTECTION - ENGLISH/S.I.  
 USER SPECIFIED - PERMANENT BACK-UP COMPUTATIONS  
 \*\*\*\*\*

PROJECT NAME: Dare County Cell No 4 Expansion PROJECT NO.: 17952-56960  
 COMPUTED BY: Patrick Stout DATE: 7/16/2009  
 SLOPE DESCRIPTION: Landfill Closure Sideslopes

-----  
 \*\*\*\*\* INPUT PARAMETERS \*\*\*\*\*  
 -----

Slope Gradient: 3:1  
 Slope Degrees =  $\tan^{-1}(1/3) = 18.43$  degrees  
 Slope Length: 95 feet (29.0 meters)  
 Soil Type: Sand  
 K Factor:  $K = 0.10 \text{ t}^* \text{ac}^* \text{h} / 100^* \text{ac}^* \text{ft}^* \text{tonf}^* \text{in}$  ( $K = 0.01 \text{ t}^* \text{ha}^* \text{h} / \text{ha}^* \text{MJ}^* \text{mm}$ )  
 Annual R Factor:  $260 \text{ 100ft}^* \text{t}^* \text{in} / \text{ac}^* \text{hr}^* \text{yr}$  ( $4425 \text{ MJ}^* \text{mm} / \text{ha}^* \text{h}^* \text{y}$ )  
 for United States, Virginia, Norfolk  
 PRECIPDIST = 100

REACH NO.	CUMULATIVE DISTANCE TO END OF REACH	MATERIAL TYPE	Density	C FACTOR
1	95 feet/29.0 meters	SC250 Reinf. Ve Bunch Type		0.008

SLT = 0.03 inches (0.08 centimeters)  
 ADJR =  $260 * 100.0 / 100 = 260.0 \text{ 100ft}^* \text{tonf}^* \text{in} / \text{ac}^* \text{hr}^* \text{yr}$  ( $4425.2 \text{ MJ}^* \text{mm} / \text{ha}^* \text{h}^* \text{yr}$ )  
 Soil Loss Factor (SLF) = 1.46 inches (3.72 cm)

-----  
 \*\*\*\*\* CALCULATIONS \*\*\*\*\*  
 -----

REACH NUMBER: \*\*\*1\*\*\*  
 CUMHORZL1 =  $95 * \cos(18.4) = 90.1$  feet (27.5 meters)  
 LS 1 Factor = 5.36  
 Cumulative LS 1 Factor = 5.36  
 ASLBARE 1 =  $.00595 * 260 * 0.10 * 5.36 = 0.830$  in (2.108 cm)  
 MSLBARE 1 =  $.00595 * 260 * 0.10 * 1.46 * 5.36 = 1.215$  in (3.085 cm)  
 ASLMAT 1 =  $0.0075 * 0.830 = 0.006$  in (0.016 cm)  
 MSLMAT 1 =  $0.0075 * 1.215 = 0.009$  in (0.023 cm)  
 SF 1 =  $0.030 / 0.006 = 4.819$   
 COMPASLBARE 1 =  $0.830 * [(95 - 0) / 95] = 0.830$  in (2.108 cm)

TOTCOMPASLBARE = 0.830 in (2.108 cm)

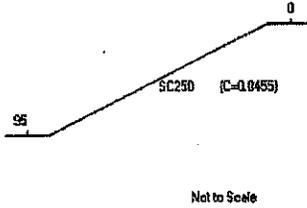
$$\begin{aligned} \text{COMPASLMAT 1} &= 0.006 * [(95 - 0) / 95] = 0.006 \text{ in (0.016 cm)} \\ \text{TOTCOMPASLMAT} &= 0.006 \text{ in (0.016 cm)} \end{aligned}$$

For additional computation details, see the North American Green Users Manual and the Natural Resource Conservation Service RUSLE Documentation.

**Attachment 2**  
**North American Green Temporary Slope  
Protection Analysis**

Country: United States  
 State/Region: Virginia  
 City: Norfolk  
 Annual R Factor: 260  
 Total Slope Length (ft): 95  
 Protection Type: Temporary  
 Protection Period (months): 12  
 Beginning Month: December  
 Adjusted R Value: 260  
 Slope Gradient (H:1): 3  
 Soil Type: Sand  
 K Factor: 0.1  
 Soil Loss Tolerance (in): 0.25

Slope Gradient = 3:1



Reach	Cum. Dist. Begin (ft)	Cum. Dist. End (ft)	Material	Vegetation Type Growth Habit	Density	ASL bare (in)	ASL mat (in)	MSL bare (in)	MSL mat (in)	SLT (in)	SF	Remarks	Stability
1	0	95	SC250			0.886	0.040	1.531	0.070	0.26	3.590	STABLE	D
2													
3													
	0	95		Composite		0.886	0.040						

Vegetation Density-Percentage of soil coverage provided by vegetation  
 ASL bare-Average Soil Loss potential of unprotected soil (uniform inches)  
 MSL bare-Maximum Soil Loss potential on unprotected soil (uniform inches)  
 SLT=Soil Loss Tolerance for slope segment (uniform inches)  
 Composite-Average soil loss from total slope length (uniform inches)  
 C-Cover material performance factor (Fraction of soil loss of unprotected)  
 ASL mat-Average Soil Loss potential w/material (uniform inches)  
 MSL mat-Maximum Soil Loss potential w/material (uniform inches)  
 SF-Safety Factor

\*\*\*\*\*  
 NORTH AMERICAN GREEN EROSION CONTROL MATERIALS DESIGN SOFTWARE VERSION 4.3  
 NORTH AMERICAN GREEN SLOPE PROTECTION - ENGLISH/S.I.  
 USER SPECIFIED - TEMPORARY BACK-UP COMPUTATIONS  
 \*\*\*\*\*

PROJECT NAME: Dare County Cell No 4 Expansion PROJECT NO.: 17952-56960  
 COMPUTED BY: Patrick Stout DATE: 7/16/2009  
 SLOPE DESCRIPTION: Landfill Closure Sideslopes

-----  
 \*\*\*\*\* INPUT PARAMETERS \*\*\*\*\*  
 -----

Slope Gradient: 3:1  
 Slope Degrees =  $\tan^{-1}(1/3) = 18.43$  degrees  
 Slope Length: 95 feet (29.0 meters)  
 Soil Type: Sand  
 K Factor:  $K = 0.10 \text{ t}^* \text{ac}^* \text{h} / 100^* \text{ac}^* \text{ft}^* \text{tonf}^* \text{in}$  ( $K = 0.01 \text{ t}^* \text{ha}^* \text{h} / \text{ha}^* \text{MJ}^* \text{mm}$ )  
 Annual R Factor:  $260 \text{ 100ft}^* \text{t}^* \text{in} / \text{ac}^* \text{hr}^* \text{yr}$  ( $4425 \text{ MJ}^* \text{mm} / \text{ha}^* \text{h}^* \text{y}$ )  
 for United States, Virginia, Norfolk  
 Protection Period: 12 months from December to December, over 1 whole year(s)  
 Cumulative Annual R Factor For The Beginning Month: 97.0 %  
 Cumulative Annual R Factor For The End Month: 97.0 %

$\text{PRECIPDIST} = 97.0 - 97.0 + (100 * 1) = 100.0$

REACH NO.	CUMULATIVE DISTANCE TO END OF REACH	MATERIAL	MATERIAL FACTOR	C
1	95 feet/29.0 meters	SC250	0.046	

SLT = 0.25 inches (0.64 centimeters)  
 $\text{ADJR} = 260 * 100.0 / 100 = 260. \text{ 100ft}^* \text{tonf}^* \text{in} / \text{ac}^* \text{hr}^* \text{yr}$  ( $4425.2 \text{ MJ}^* \text{mm} / \text{ha}^* \text{h}^* \text{yr}$ )  
 Soil Loss Factor (SLF) = 1.73 inches (4.39 cm)

-----  
 \*\*\*\*\* CALCULATIONS \*\*\*\*\*  
 -----

REACH NUMBER: \*\*\*1\*\*\*  
 $\text{CUMHORZL1} = 95 * \cos(18.4) = 90.1$  feet (27.5 meters)  
 LS 1 Factor = 5.72  
 Cumulative LS 1 Factor = 5.72  
 $\text{ASLBARE 1} = .00595 * 260 * 0.10 * 5.72 = 0.886$  in (2.250 cm)  
 $\text{MSLBARE 1} = .00595 * 260 * 0.10 * 1.73 * 5.72 = 1.531$  in (3.888 cm)  
 $\text{ASLMAT 1} = 0.0455 * 0.886 = 0.040$  in (0.102 cm)

MSLMAT 1 = 0.0455 \* 1.531  
SF 1 = 0.250 / 0.070 = 3.590

=0.070 in (0.177 cm)

$$\begin{aligned} \text{COMPASLBARE 1} &= 0.886 * [(95 - 0) / 95] = 0.886 \text{ in (2.250 cm)} \\ \text{TOTCOMPASLBARE} &= 0.886 \text{ in (2.250 cm)} \end{aligned}$$

$$\begin{aligned} \text{COMPASLMAT 1} &= 0.040 * [(95 - 0) / 95] = 0.040 \text{ in (0.102 cm)} \\ \text{TOTCOMPASLMAT} &= 0.040 \text{ in (0.102 cm)} \end{aligned}$$

For additional computation details, see the North American Green Users Manual and the Natural Resource Conservation Service RUSLE Documentation.

"



CLIENT Dare County  
 PROJECT Dare County Cell No. 4 C&D Landfill  
 DETAIL Cell No. 4 Sediment Fence  
 PROJECT NO. 17952-56960

COMPUTED BY / DATE WPS 03/30/09  
 CHECKED BY / DATE WMB -  
 REVISION NO. / DATE - -  
 REVIEWED BY / DATE - -

**Calculation Brief Title:** Phase No. 4 Sediment Fence

**1.0 Objective**

Ensure that the drainage area is no greater than 1/4 acre per 100 feet of sediment fence and that the sediment fence meets the North Carolina Department of Environment and Natural Resources (NCDENR) Sedimentation and Erosion Control Planning and Design Manual.

**2.0 Procedure**

1. Determine the drainage area for each sediment fence using AutoCAD.
2. Using the parameters provided in the NCDENR ESC Planning and Design Manual, design the sediment fence.

**3.0 References / Data Sources**

1. Refer to attached Dare County Cell ESC Permit drawings.
2. Refer to NCDENR ESC Planning and Design Manual.

**4.0 Assumptions / Limitations**

1. Sediment Fence corresponding to drainage area DA-1, DA-2 and DA-3 are the only drainage areas acting as the primary treatment device and the remaining drainage areas will be used as an treatment device to capture as much sediment as possible prior to entering the filter basins.

**5.0 Calculations**

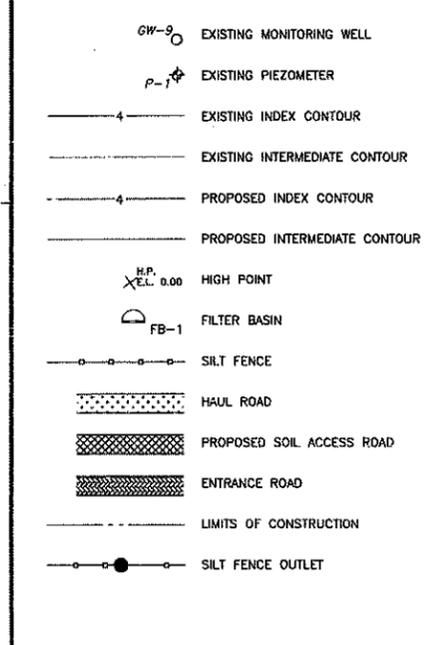
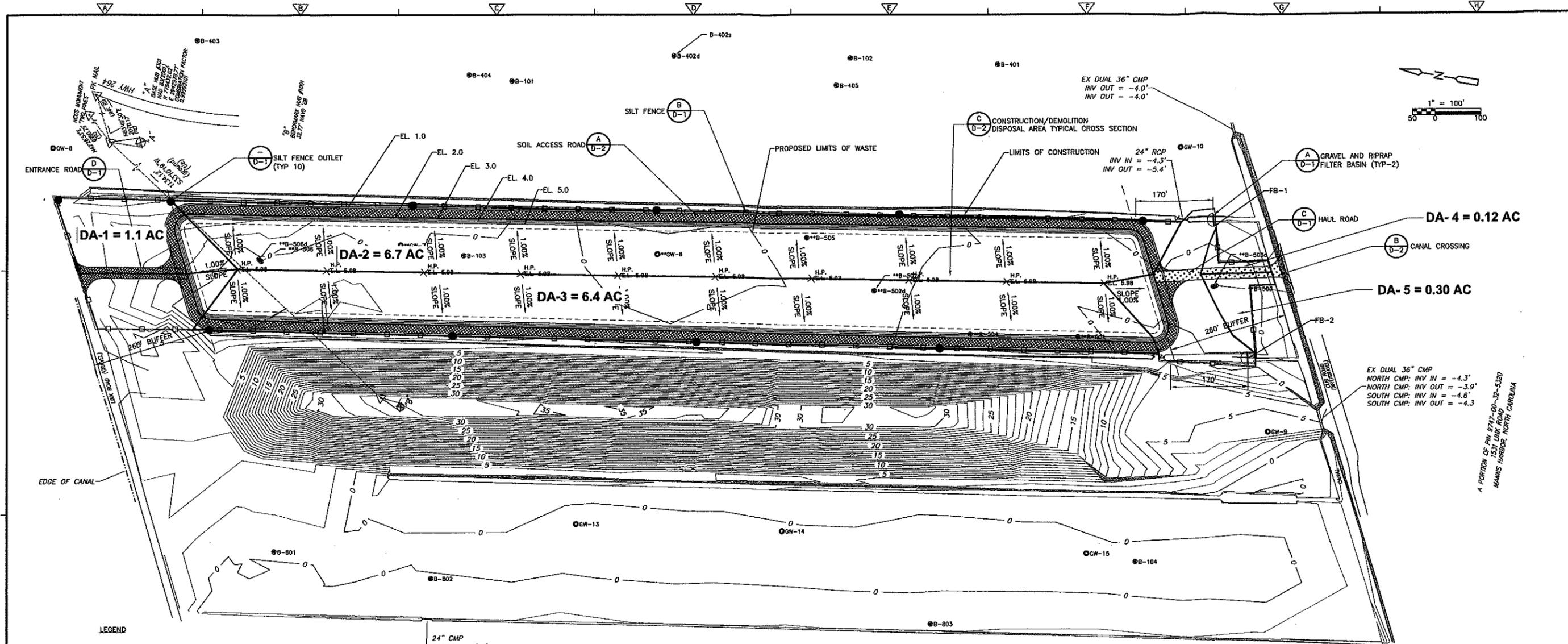
**5.1 Calculations:**

Location	Slope	Slope Length (ft)	Drainage Area (ft <sup>2</sup> )	Drainage Area (Acres)	Length of Silt Fence (FT)	Area (ft <sup>2</sup> ) per 100 ft Length	Area (Acres) per 100 ft Length	CHECK
DA-1	<2%	100	43560	1.00	424	10274	0.24	<0.25
DA-2	<2%	100	291852	6.70	2187	13345	0.31	<0.25
DA-3	<2%	100	278784	6.40	2088	13352	0.31	<0.25
DA-4	<2%	100	5100	0.12	182	2802	0.06	<0.25
DA-5	<2%	100	12900	0.30	199	6482	0.15	<0.25

(Refer to Sheet C-3A for drainage areas)

**5.0 Calculations**

Based on the NCDENR ESC Planning and Design Manual Guidelines, drainage areas 2 & 3 do not meet the requirements. However the sediment fence in these areas are a preliminary treatment device and are not the primary treatment device (filter basins 1 & 2). Therefore these segments of sediment fence do not have to meet the requirements. Sediment fence along drainage areas 1, 4 and 5 do meet the requirements.



- GENERAL CONSTRUCTION NOTES:**
- CONTRACTOR SHALL LOCATE AND/OR RELOCATE ALL EXISTING UTILITIES, DRAINAGE STRUCTURES, MONITORING WELLS, ETC. IN COORDINATION WITH THE APPROPRIATE UTILITIES, AGENCY, OR COMPANY WITHIN 72 HOURS PRIOR TO CONSTRUCTION. CONTRACTOR IS RESPONSIBLE FOR LOCATING, PROTECTING, MAINTAINING, AND RESTORING ALL SITE UTILITIES AND BUILDING SERVICES.
  - NO HAUL ROUTE SHALL BE USED FOR MATERIAL TRANSPORT UNTIL NO THE ROUTE HAS BEEN COORDINATED WITH THE OWNER.
  - CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRING OR REPLACING, AT NO ADDITIONAL COST TO THE OWNER, ANY EXISTING MONITORING WELLS, DRAINAGE STRUCTURES, ETC. DAMAGED DURING CONSTRUCTION.
  - CONTRACTOR'S TRAILER SHALL BE LOCATED WITHIN STAGING AREAS AS DESIGNATED BY THE OWNER ON THIS SHEET. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ALL NECESSARY UTILITY CONNECTIONS, A POTABLE WATER SUPPLY, AND TEMPORARY SANITARY SERVICE FOR TRAILER.
  - LOCATIONS, ELEVATIONS, AND DIMENSIONS OF EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES ARE SHOWN ACCORDING TO THE BEST INFORMATION AVAILABLE AT THE TIME OF THESE PLANS BUT DO NOT PURPORT TO BE ABSOLUTELY CORRECT. PRIOR TO CONSTRUCTION THE CONTRACTOR SHALL VERIFY AND AGREE TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL EXISTING UTILITIES, STRUCTURES, OR PRESERVATION AREAS AND OTHER FEATURES AFFECTING HIS WORK.
  - THE CONTRACTOR SHALL REPLACE ALL PAVING (ASPHALT, STONE, OR CONCRETE), STABILIZED EARTH, CURBS, DRIVEWAYS, SIDEWALKS, MAILBOXES, DRAINAGE CULVERTS, FENCES, ETC. WITH THE SAME TYPE OF MATERIAL THAT WAS REMOVED OR DAMAGED DURING CONSTRUCTION.
  - STORM DRAINAGE PIPE LENGTHS SHOWN ARE APPROXIMATE AND MAY BE ADJUSTED AS REQUIRED IN THE FIELD, UPON APPROVAL BY ENGINEER.
  - EXISTING DRAINAGE DITCHES SHALL HAVE SEDIMENT AND DEBRIS REMOVED AND SHALL BE REPAIRED AND ALL NEW EROSION CONTROL AND SEDIMENTATION CONTROL DEVICES SHALL BE IN PLACE PRIOR TO ANY CLEARING AND GRUBBING. THEY SHALL BE INSTALLED TO THE LIMITS OF CONSTRUCTION SHOWN ON THE DRAWINGS, REQUIRED IN THE SPECIFICATIONS AND IN ACCORDANCE WITH ALL REGULATORY AGENCY REQUIREMENTS.
  - THE LIMITS OF DISTURBANCE SHOWN ON THE PLANS SHALL BE STRICTLY OBSERVED BY THE CONTRACTOR. ALL INGRESS AND EGRESS AND TRAFFIC PATTERNS ON THE SITE SHALL BE WITHIN THE LIMITS OF DISTURBANCE.
  - CONTRACTOR SHALL VERIFY THE EXISTENCE AND ACCURACY OF BENCHMARK AND CONTROL DATA PRIOR TO INITIATING CONSTRUCTION. CONTRACTOR SHALL NOTIFY ENGINEER IF DISCREPANCIES ARE FOUND.
  - CONTRACTOR SHALL STAKE OUT LIMITS OF WORK (INCLUDING CUT/FILL SLOPES) PRIOR TO INITIATING EXCAVATION AND BACKFILL ACTIVITIES. SURVEY DATA SHALL BE SUBMITTED TO ENGINEER FOR REVIEW. CONTRACTOR SHALL SEED AND MULCH ALL DISTURBED AREAS PER SPECIFICATIONS EXCEPT FOR ROAD SURFACES AND AREA WITHIN PROPOSED EDGE OF WASTE.
  - CONTROL POINTS PROVIDED ARE BASED ON A LOCAL COORDINATE SYSTEM. COORDINATE WITH QUIBLE & ASSOC., PC (PHONE NO. 252-261-3300) PRIOR TO LAYING OUT WORK.

- SURVEY NOTES:**
- TOPOGRAPHIC SURVEY DATE 04/12-05/11-09 BY MCKIM AND CREED, PA.
  - REFERENCE DB 530, PG 733 & PL C, SL 32B.
  - DRAWING VERTICAL DATUM BASED ON GPS RAPID STATIC SESSIONS, OPUS REPORT NUMBERS 000023442, 000023441, 000023439 & 000031628 DATUM NAVD '88, FEET.
  - HORIZONTAL DATUM NAD 83(2007) AND VERTICAL DATUM VERIFICATION BASED UPON RAPID STATIC GPS SESSIONS 000381637, 000381747, 000180458, 000177189, 000147860, 000242228 AND 000237065.
  - CONDITIONS WITHIN SURVEY AREA MAY HAVE CHANGE SINCE DATE OF SURVEY.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: P. STOUT  
 DRAWN BY: P. STOUT  
 SHEET CHK'D BY: K. YANG  
 CROSS CHK'D BY: M. BRINCHER  
 APPROVED BY: \_\_\_\_\_  
 DATE: DECEMBER 2009

**CDM**  
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 consulting • engineering • construction • operations

DARE COUNTY  
 NORTH CAROLINA  
**CONSTRUCTION & DEMOLITION DEBRIS LANDFILL  
 PHASE IV CONSTRUCTION DRAWINGS**

**DRAINAGE AREA MAP**

PROJECT NO. 17952 56960  
 FILE NAME: C003ALFPL.DWG  
 SHEET NO.  
**C-3A**

PERMIT SET

12/30/09 9:32:38 AM L:\17952-56960\CONFORMED DRAWINGS\1000\C003ALFPL\_DRAINAGE\_AREAS.DWG

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Appendix

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STORMWATER INSPECTIONS FOR GENERAL PERMIT NCG010000 – LAND DISTURBING ACTIVITIES

PROJECT: \_\_\_\_\_ MONITORING FOR THE WEEK BEGINNING: \_\_\_\_\_

All erosion and sedimentation control facilities and stormwater discharge outfalls must be inspected at least once (twice, if on 303(d) listed stream for construction related parameters\*) per seven calendar days and within 24 hours of a rainfall of 0.5 inches per 24 hours. Permittee must keep a record of inspections.

RAINFALL: Gauge must be maintained on site

Date Of Rain	Amount (inches)	Name

By this signature, I certify (in accordance with Part II Section B, 10 of the NCG010000 permit) that this report is accurate and complete to the best of my knowledge:

\_\_\_\_\_ (Signature of Permittee or Designee)

EROSION AND SEDIMENTATION CONTROL FACILITIES INSPECTED: Identification of all facilities may require additional pages.

Facility Identification (all measures)	Date of inspection	Time of inspection	Name of inspector	Operating Property (Y/N)	Describe corrective actions taken (may need to attach additional information)

OBSERVATIONS OF RUNOFF AT STORMWATER DISCHARGE OUTFALLS: Take immediate corrective action to control the discharge of sediments outside the disturbed limits of the site. May require additional pages.

Stormwater Discharge Outfall Identification	Date of inspection	Time of inspection	Name of inspector	Clarity (1-10)	Floating solids (1-10)	Suspended Solids (1-10)	Oil sheen (Y/N)	Other obvious indicators of stormwater pollution (list & describe)	Visible sediment leaving the site? (Y/N)	If yes, describe actions taken to prevent future releases (may need to attach additional information)	Describe measures taken to clean up sediment outside of the disturbed limits (may need to attach additional information)

Clarity: Choose the number which best describes the clarity of the discharge where 1 is clear and 10 is very cloudy

Floating Solids: Choose the number which best describes the amount of floating solids in the discharge where 1 is no solids and 10 the surface is covered in floating solids

Suspended Solids: Choose the number which best describes the amount of suspended solids in the discharge where 1 is no solids and 10 is extremely muddy

Has all land disturbing construction been completed? \_\_\_\_\_ (Y/N) Has the final permanent ground cover been completed & established? \_\_\_\_\_ (Y/N)

\* 303(d) listed streams for construction related parameters – The latest approved list may be obtained from the Division of Water Quality, or from the following website location: <http://h2o.enr.state.nc.us/sw/construction303d>