The Vermont Standards and Specifications for Erosion Prevention & Sediment Control

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VERMONT
ENVIRONMENTAL CONSERVATION

Acknowledgements

The Vermont Standards and Specifications for Erosion Prevention and Sediment Control, adapted by: the New York State Standards and Specifications for Erosion and Sediment Control, prepared by: Donald W. Lake, Jr., P.E., CPESC, CPSWQ, Engineering Specialist, New York State Soil and Water Conservation Committee.

Information on Temporary and Permanent Critical Area Plantings, provided by: Sandra Primard, Agronomist, USDA-NRCS.

RECP Specifications, provided by: the Vermont Agency of Transportation.

Additional information provided by Illinois USDA-NRCS.

Soil Conservation Service, USDA, Oct. 1977.
National Handbook for Conservation Practices, U.S. Government Printing Office, Washington, D.C.

Soil Conservation Service, USDA, July 1984.
Engineering Field Manual of Conservation Practices, 4th Printing, U.S. Government Printing Office, Washington D.C.

Soil Conservation Service, USDA, June 1986.
Urban Hydrology for Small Watersheds, Technical Release 55, Second Edition, U.S. Government Printing Office, Washington, D.C.

Pitt, Robert; Clark, Shirley; and Donald Lake. 2006.
Construction Site Erosion and Sediment Control: Planning, Design and Performance. DESTech Publications, Lancaster, PA.

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Part 5 - Sediment Control Practices

Part 1 - Introduction

Purpose

These standards and specifications have been developed to assist designers in creating Erosion Prevention and Sediment Control Plans (EPSC Plans) that meet the requirements of the Vermont Construction General Permit. With proper implementation, a well-designed EPSC Plan will protect against water quality and impacts due to construction activity by limiting sediment discharge and will reduce costs associated with maintenance of road ditches, storm sewers, streams, lakes, and wetlands.

The standards and specifications provide criteria on minimizing erosion and sediment impacts from construction activity involving soil disturbance. They show how to use the soil, water, plans and products to protect the quality of our environment. These standards and specifications were based largely on the New York State Standards and Specifications for Erosion and Sediment Control, developed in cooperation with the USDA Natural Resources Conservation Service, New York State Soil and Water Conservation Committee (NYSSWCC), and NYS DEC. Additional information was provided by Illinois USDA-NRCS. Materials from New York and Illinois were adapted by Vermont DEC to suit conditions within the state of Vermont and for consistency with Vermont regulatory requirements.

Scope and Authority

The standards and specifications apply to projects that require a construction permit from Vermont DEC to discharge stormwater from construction sites and require the development of an EPSC plan. This includes projects on lands within Vermont where housing, industrial, institutional, recreational, road or highway construction and other land disturbances related to construction will occur. They are statewide in scope and, in some cases, are somewhat generalized due to variations in climate, topography, geology and soils.

How to Use This Manual

This manual is organized into five main parts.

Part 1 provides a general overview of the manual contents, purpose, and scope and authority.

Part 2 examines the causes of erosion, the factors that influence the susceptibility of soil to erosion, discusses sediment transport, and provides an overview of the EPSC Plan.

Part 3 describes the planning process for developing EPSC Plans for construction projects and outlines the minimum EPSC Plan requirements.

Parts 4 and 5 cover technical standards and specifications for erosion prevention practices and sediment control practices, respectively. These are the technical standards required of EPSC Plans for use in obtaining coverage under the Vermont Construction General Permit. Described in each specification are the appropriate applications, design considerations, accepted construction specifications, as well as requirements for plans and specifications submitted as part of an application for coverage under a construction stormwater discharge permit.

Part 2 - Erosion and Sediment Transport Overview

2.1 Introduction

Erosion on Construction Sites: Why is it a problem?

On many construction sites, relatively large areas of soil can be exposed to the erosive effects of wind and rain due to extensive earthwork. Eroded sediment may be easily transported by stormwater runoff to streams, lakes, and wetlands. Rates of erosion on an uncontrolled construction site can far exceed that of the same land under a natural vegetative cover, meaning that the sediment generated over many years from forest or pasture could be produced in a single season on a poorly managed construction site.

The water quality of streams, lakes, and wetlands can be negatively impacted by the input of eroded sediment. Sediment entering streams can directly cause a harmful alteration of destruction of habitats of fish and other aquatic organisms. In addition, sediment serves as a vehicle for the transport of stormwater pollutants that diminish water quality. Phosphorus, for example, which can contribute to excessive algae growth, is commonly transported by being bound to mobile sediment.

Excessive sediment loading can also contribute to stream channel instability and streambank erosion, accelerating sediment build-up in streams and loss of storage in lakes, ponds, and reservoirs. The physical, chemical and biological impacts of eroded sediment in turn decrease the recreational value and our enjoyment of Vermont's waters.

Responsible Construction: Implementing an EPSC Plan

An EPSC Plan is a set of documents which outlines the strategy for preventing erosion of disturbed soils by rain and runoff and for controlling movement off site of soil that does erode during construction. An EPSC Plan is developed based upon an analysis of the physical characteristics of the project area, the local climate, and the planned construction activities. The resulting documents serve as a blueprint showing the location of best management practices (e.g. silt fence, check dams, mulching) that are required on-site providing details for proper installation and maintenance, and listing requirements for the routine inspection and maintenance of best management practices to ensure they are functioning as designed and implemented.

This Part describes the required components of a plan submission for review under the Vermont Construction General Permit (CGP) EPSC Plan preparation requires knowledge of soils, hydrology and vegetation establishment. This knowledge is best complemented by experience with construction and erosion prevention and first hand knowledge of EPSC practices on construction sites. Before developing an EPSC Plan for permit applications, plan preparers should be familiar with the permit requirements, any local erosion prevention and sediment control regulations, and these standards and specifications.

An EPSC Plan for constructing a house on a single subdivision lot will generally not need to be as complete as an EPSC Plan for a large development. EPSC Plans for projects distant from water resources and on relatively flat terrain will be less complex than those for similar projects near streams or on steep, erodible soils. By applying the principles described here, following the suggested plan format, and using these standards and specifications, a plan preparer will be able to develop a suitable EPSC Plan that can be readily confirmed as consistent with the requirements of the Construction General Permit.

Before delving into the development of an EPSC Plan, however, a basic understanding of what erosion is, how sediment moves once it is eroded, and what factors affect these processes is necessary.

2.2 An Overview of Soil Erosion and Sediment Transport

The pollution of surface waters with sediment discharged from construction sites happens in two steps: the detachment of sediment from the soil (erosion) and its delivery to the water body (sediment transport). To be effective, an EPSC Plan must address both of these steps. Projects that rely heavily on the prevention of erosion, however, are generally less expensive to implement, require less maintenance, and are more effective than projects with a focus primarily on controlling sediment transport once soil has eroded.

Erosion is defined as the wearing away of the earth's surface by the action of wind, water, ice, and gravity. This occurs when the erosive force acting on the particle exceeds the strength of attachment between the particle and the soil. On construction sites, this erosive force comes primarily from raindrop impact and stormwater runoff on the soil. At the small scale, all erosion prevention practices are aimed at preventing these forces from detaching the particle from the soil.

Once detached from the soil, the main modes of sediment transport on construction sites are by stormwater runoff, by wind, and by attachment to equipment that moves on and off site. The majority of sediment control practices detailed in the standards and specs are focused on the movement of sediment by stormwater runoff, as it is the principal mode of sediment transport off of construction sites and into surface waters.

A number of factors directly influence erosion by runoff on a construction site. For a given area these include the cover on the soil, the velocity of runoff, and the physical properties of the soil that determine its resistance to erosion. Each of these affects the balance of forces that needs to be tipped for erosion of a sediment particle to occur.

Factors that Influence Erosion
-Flow Velocity-

The potential ability to cause erosion, or erosivity, of moving water is directly related to its velocity, and there are several corresponding types of erosion depending on the velocity of the water when it comes into contact with the soil (Figure 2.1). Splash erosion occurs when raindrops, which can reach the ground with a velocity of 25-35 feet per second, dislodges sediment particles on exposed soil. In the absence of preformed channels and at low velocities, water flows on the soil surface in a thin, broad layer or sheet, shearing off sediment particles at the surface of the soil interface. This is termed sheet erosion. As flow velocity increases, additional scour can occur, leafing to fine channels of higher velocity flow. When these channels are several inches deep, the process is referred to as rill erosion. Gully erosion is the scouring of still deeper channels with generally greater flow velocities, while in-stream scouring of soil is known as channel erosion.

Factors that Influence Erosion
-Soil Properties-

The nature of disturbed soils is another important factor influencing erosion on construction sites. Erodibility, the inherent susceptibility of a soil to erosion, is determined by several physical characteristics of the soil. The texture of a soil is the relative composition of sand, silt and clay particles. Coarse sandy soils have relatively large sediment grain size and tend to drain water quickly, making them less susceptible to erosion. Fine clay particles, while very small, have charges that make them cohesive and resistant to erosion. Once eroded, however, they can take a very long time to settle out of suspension. Soils with substantial clay content also drain poorly, increasing the risk of erosion. Fine sands and silts are the most vulnerable to erosion by water, having little cohesiveness, and being readily transported (Figure 2.2).

The soil structure is the arrangement of the soil particles within the soil. Additional structure imparts increased strength to a soil, and provides a network of spaces that promote drainage of soil water. Increased water drainage decreases erosion by reducing the amount and velocity of water on the surface. Compaction of soil by machinery destroys

Part 2 - Erosion and Sediment Transport Overview

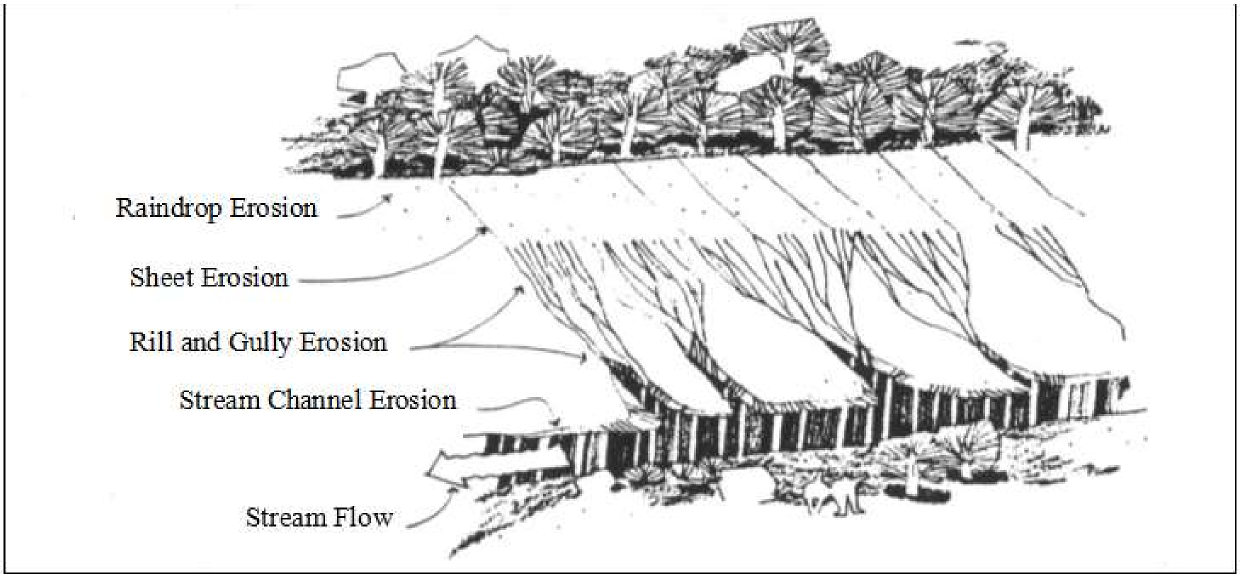

Figure 2.1 Four Types of Erosion by Water

Soil Type and Parameters	Slope%		
	0-5%	5-15%	>15%
Gravelly/Coarse Sand	Low	Low	Medium
Sandy (Fine)	Medium	High	High
Silty	Medium	High	Very High
Clay	Low	Medium	High
Dispersive Clay	High	Very High	Extreme

Figure 2.2 Erosion Risk Based on Soils and Slopes

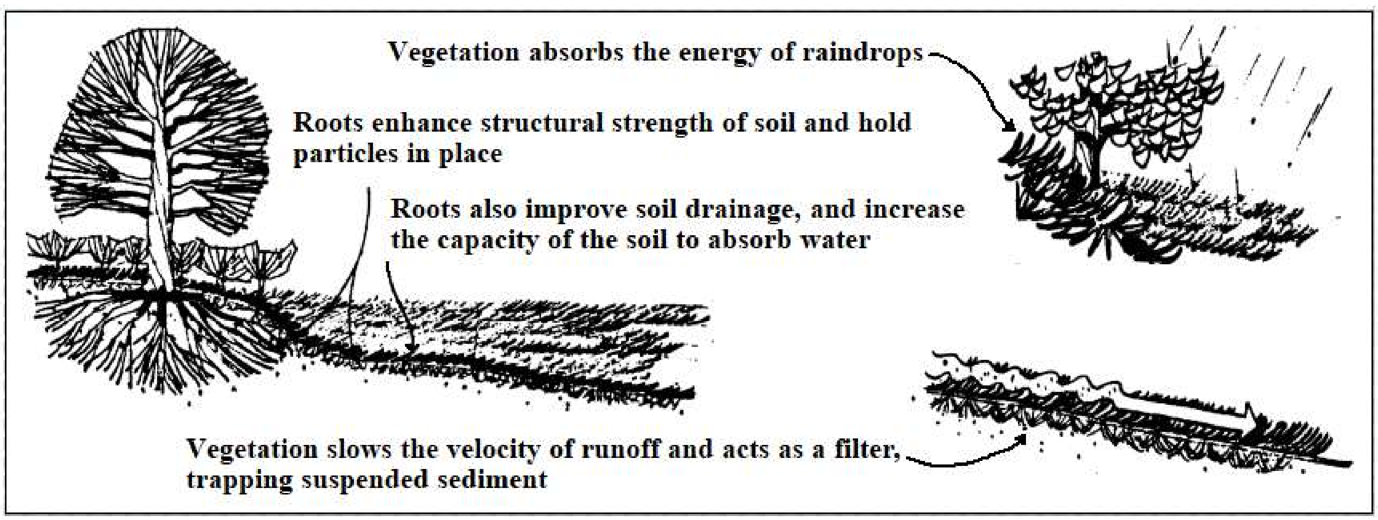

Figure 2.3 Protective Effects of Vegetation

soil structure and can seal soils, preventing drainage of water through the soil profile.

Organic matter reduces erodibility because, like clay particles, organic matter has charges which increase the cohesiveness of soil particles. Organic matter also contributes to soil structure.

Factors that Influence Erosion
-Topography-

The topographical character of the land influences erosion in several ways. First, it determines the size of the drainage area that will direct runoff to a construction site. Second, the steepness of the land contributes to the velocity of the runoff and greater erosion rates. Third, the increase in velocity associated with a longer flow path results in flows of greater erosivity.

Minor topographical variations that alter the flow paths of runoff can also influence erosion. Irregularities in the surface of exposed soil that are perpendicular to the direction of the flow (i.e. along the contour), serve as tiny diversions, slowing and dispersing flow. Those along the length of a slope, however, can serve to channel sheet flows and encourage rills and gullies by increasing flow velocity in a particular path. topographic features that direct a wide area of sheet flow to one or two discharge locations can lead to localized areas of intense scour.

Factors that Influence Erosion
-Vegetation-

Vegetative ground cover is a critical influence on the erosivity of overland flows and raindrop impact. It protects soil in two general ways: by improving on soil strength and by reducing the amount and velocity of water reaching the soil (Figure 2.3). Establishing and maintaining vegetative cover is often the simplest and most effective means of preventing erosion on a construction site.

Vegetation and duff protect against raindrop erosion by shielding the soil. Grasses and other dense vegetation near the ground also serve to slow the velocity of sheet flow, reducing erosivity of runoff and filtering out suspended sediment.

Plant root systems bolster soil strength by holding soil particles directly in place. Roots also promote soil structure and generally improve the infiltrative capacity of the soil. This resulting reduction in runoff volume and velocity reduces the risk of erosion.

Factors that Influence Erosion
-Climate-

Climate is also an important influence on erosion on construction sites. Rainfall characteristics for an area, including the intensity, duration, and frequency of storm events, help to determine the velocity of runoff that might be expected during a particular season. Such seasonal variations are particularly important in Vermont, as thunderstorms tend to cause large, short-duration amounts of runoff in the summer, whereas, in the spring, rain combined with melting snow can lead to long periods of flow on saturated, erodible, soils. The seasonal changes in vegetative cover are an indirect influence of climate on erosion.

Sediment Transport

Once sediment has been dislodged from the surface of the soil, it is available for transport by runoff or wind. The susceptibility of sediment to transport depends on the energy of the runoff (as indicated by the velocity) and on the mass of the particles. Heavier particles, such as sand and gravel fall quickly out of suspension when flows slow, and are therefore not readily transported. Silt and fine sand are more easily transported, while clay, though more difficult to erode, can stay in suspension for long periods of time. Because of this, EPSC Plans that rely heavily on sediment control by settling of particles out of stormwater flows, are often unsuccessful.

Sediment control measures described in this volume are generally designed with the goal of slowing the velocity of runoff and allowing sediment to fall out of suspension.

Part 3 - Preparing an EPSC Plan

3.1 Introduction

Preventing sediment pollution of surface waters from construction sites requires balancing the time and space constraints of a construction project with the risk of sediment leaving the site and reaching streams, lakes, or wetlands. A well-developed EPSC Plan is the key to having the right balance, ensuring timely construction, minimizing pollution, and keeping costs down. Part 3 presents the Minimum EPSC Plan Requirements, Winter Construction Considerations and Winter EPSC Plan Requirements, and the Recommended Approach to EPSC Plan Development.

3.2 Minimum EPSC Plan Requirements

Each EPSC Plan shall contain, at a minimum:

1. Project Description

   An overview of the proposed project. This may be in narrative or point form, may include tables or figures, and must include:

   a. The type of project (e.g., residential subdivision, town road, commercial building, etc.);

   b. A description of the major project components and the anticipated earth disturbance associated with each (e.g. roads, utilities, number of buildings, etc.);

   c. The total acreage of proposed earth disturbance;

   d. The intended sequence and timing of major project components that disturb soils at the site;

   e. The proposed pollution prevention strategies that will minimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste and other materials present on the site to precipitation and to stormwater. Minimization of exposure is not required in cases where the exposure to precipitation and to stormwater will not result in a discharge of pollutants, or where exposure of a specific material or product poses little risk of stormwater contamination (such as final products and materials intended for outdoor use); and

   f. The maximum concurrent earth disturbance used to score this project in Appendix A of Vermont's Construction General Permit or as otherwise proposed under an Individual Permit application;

   g. The use of vegetated buffers, if any, used to score this project in Appendix A of Vermont's Construction General Permit or as otherwise proposed under an Individual Permit application;

   h. The name of the receiving water(s), the number of discrete discharge points where collected stormwater flows are discharged from the construction site to the receiving water(s), the proximity of the proposed earth-disturbing activities to each of these discharge points, and a description of how stormwater flows from the construction site to the discharge point (e.g. vegetated swale, culvert, storm sewer). If no discrete discharge points, a description of the length, slope, and vegetative cover of the shortest overland flow path to receiving water from the limits of the proposed disturbance;

   i. The number of proposed stream crossings and whether a stream alteration permit is being obtained;

   j. The area of wetlands and wetland buffers that will be impacted by the proposed activities, their type, and whether a state wetlands permit or Army Corps of Engineers permit is being obtained for wetland impacts;

   k. A site-specific dewatering plan (if applicable) which shall include the minimum proposed distance to surface waters, a requirement that dewatering take place from the surface of any impoundments (unless infeasible), spoils disposal area (if applicable), detail/typical of dewatering structure, and any other aspect as so requested by the Secretary;

l. The need for off-site waste or borrow areas, if any, the anticipated amount of borrow or waste material to be transported, the nature of the material, and how these will be permitted (i.e. permitted as a part of the a current construction stormwater discharge permit application or under a separate application); and

m. A statement about whether earth disturbing activities are anticipated during the winter construction period (October 15-April 15), the nature of these activities, the area of disturbance associated with these activities, and whether the EPSC Plan incorporates BMPs according to the Standards applicable to the winter construction period.

n. A copy of the inspection form to be used by the On-Site Plan Coordinator (OSPC) in their weekly inspection (a copy of a form provided by the Secretary, if available, is sufficient if it will be utilized by the OSPC).

2. Location Map

A location map, in the form of a topographic map or aerial image, providing sufficient information to determine the location of the project and the receiving water;

3. Pre-Construction Plan / Existing Conditions

A map or maps of the proposed construction area and plan including the following information:

a. The limits of the construction site including the proposed limits of disturbance, and the methods for their demarcation in the field;

b. Existing contours based on site survey for the construction site and existing contours based on site survey or USGS topographical maps for the surrounding area 300 feet outside of the limits of disturbance;

c. Existing water and drainage features (e.g. streams, ponds, wetlands, channels, gullies, etc.).

d. Existing vegetation;

e. Location of soil types corresponding to NRCS Soil Maps;

f. All sediment control measures (e.g. silt fence, sediment or dewatering basins, etc.) to be installed ahead of primary earth disturbance activities;

g. Directions to complete installation of sediment control measures ahead of initiating the principal earthwork activities;

h. Directions to complete stabilization of operational stormwater treatment practices before directing runoff to them, unless utilized during construction as sediment control measures, in which case directions for ensuring these features are modified and stabilized as necessary prior to construction completion such that operational stormwater treatment practices will meet applicable design requirements for the treatment and control of post-construction stormwater runoff;

i. Identified buffers or setbacks from water bodies and conveyances to water bodies, with directions for avoiding impacts in these areas;

j. North arrow and scale;

k. A legend for all EPSC measures and all other features (e.g. wetlands, streams, property lines, etc.) included on the plan; and

l. Date of last plan revision, name of plan designer, and name of plan.

4. Construction Plan

The Construction Plan shall include all information related to erosion prevention as well as sediment control measures to be implemented during the construction activity. These must be consistent with limits specified on the Notice of Intent and completed Appendix A (e.g. vegetated buffer, limited concurrent disturbance, stabilization schedule) of Vermont's Construction General Permit, if applicable. It must include, where applicable:

a. Property lines of the project;

b. The proposed phase boundaries and sequencing of EPSC measures within each phase, the order of phases to be constructed, and the required items to complete before initiating the subsequent phase (e.g. complete stabilization of the prior phase);

c. The limits of disturbance;

d. Identified buffers or setbacks from water bodies and discrete conveyances to water bodies, with directions for avoiding impacts in these areas;

e. Specific directions for limiting concurrent earth disturbance;

f. Existing and proposed contours;

g. Location of all erosion prevention measures;

h. Location of all sediment control measures to be installed during the construction phase as well as sediment control measures implemented in the pre-construction phase;

i. Construction details for each practice proposed, which shall include all applicable notes regarding the installation and maintenance of said practice;

j. Consistent with the completed Appendix A, of Vermont Construction General Permit, as applicable, directions for stabilization of a given area within 14 days following initial disturbance: "All areas of earth disturbance must have temporary or final stabilization within 14 days of the initial disturbance. After this time, disturbed areas must be temporarily or permanently stabilized in advance of any runoff producing event.";

k. A plan for dewatering activities, if anticipated, including the location of dewatering discharges consistent with this permit;

l. Directions and location of practices employed for construction during the winter construction period (October 15-April 15), consistent with the Standards applicable to the winter construction period, if earthwork during this period is anticipated.

m. The location of all existing and proposed structures (roads, utilities, buildings, drainage inlets, etc.);

n. The location of all proposed stockpiles and directions for stabilizing and protecting stockpile areas consistent with the Standards;

o. The location of all proposed staging areas;

p. Directions for inspection frequency consistent with the permit;

q. North arrow and scale;

r. A legend for all EPSC measures and all other features (e.g. wetlands, streams, property lines, etc.) included on the plan; and

s. Date of last plan revision, name of plan designer, and name of plan.

5. Stabilization Plan

The Stabilization Plan shall convey to contractors all the information necessary to implement temporary and final stabilization for the entire construction site. It shall include the following, consistent with the Standards:

a. Property lines of the project;

b. Finish grade contours;

c. The location of all structures, existing and proposed;

d. Temporary stabilization measures required for all areas of disturbance consistent with the completed Appendix A of the Vermont's Construction General Permit, if applicable,

e. Final stabilization measures required for all areas of disturbance where structures are not installed, including areas requiring stone, rolled erosion control products, hydromulching, seeding and mulching, etc.;

f. Specifications for seed mixes, fertilization, and other soil amendments for areas to be stabilized with vegetation;

g. Directions for completing seeding after April 15 and before September 15 for areas where final stabilization is not scheduled to occur prior to the winter construction period;

h. Directions to remove all temporary erosion and sediment control practices within 30 days of achieving final stabilization;

i. Directions for inspection frequency consistent with the permit, including an indication of when inspections may be discontinued;

j. A legend for all EPSC measures included on the plan;

k. Date of last plan revision, name of plan designer, and name of plan; and

l. North arrow and scale.

Special Requirements for Linear Projects

Requirements 1-5 in section 3.2 above also apply to linear projects such as roads, pipelines, and utility installations, except that:

1. The Pre-Construction Plan, Construction Plan, and Stabilization Plan may be combined into one plan.

2. A Phasing Plan shall be developed in accordance with The Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

3. The location of all staging areas away from the project shall be shown with appropriate EPSC measures and accompanying location map.

3.3 Winter Construction Considerations

Managing construction sites to minimize erosion and prevent sediment discharges to waters is a year-round challenge. In Vermont, this challenge becomes even greater during the late fall, winter, and early spring months. 'Winter construction' as discussed here, describes the period between October 15 and April 15, where the erosion prevention and sediment control is significantly more difficult.

Rains in late fall, thaws throughout the winter, and spring melt and rains can produce significant flows over frozen and saturated ground, greatly increasing the potential for erosion. At the same time as the erosion risk increases, the "toolbox" available to the planner and on-site plan coordinator shrinks significantly over this period (Table 3.4). In particular, establishing vigorous vegetation during winter construction is not possible. How an EPSC Plan addresses winter conditions depends upon the nature of the construction site activities over this period.

EPSC Plan Requirements for
-Winter Shutdown-

There are specific requirements for sites that conduct earth disturbance during the defined winter construction period and for sites where disturbed areas have not reached final stabilization by October 15.

For projects or areas of a site that will have completed earth disturbance activities prior to the winter period (October 15), the following requirements must be adhered to:

1. For areas to be stabilized for the winter through the establishment of vegetation, seeding and mulching shall be completed no later than September 15 to ensure adequate growth and cover before the start of the winter period.

2. If seeding is not completed by September 15, additional non-vegetative protection must be used to stabilize the site or the winter period. Areas of disturbance not seeded and mulched by September 15 are required to temporarily stabilize by one of the following methods:

   a. Implement Rolled Erosion Control Products (e.g. Matting) over the areas of earth disturbance.

   b. Apply 2" mulch layer to areas of earth disturbance, equivalent to double the standard rate. Mulch should be tracked in open areas vulnerable to wind.

   c. Seeding with winter rye is recommended to allow for early germination during wet spring conditions.

EPSC Plan Requirements for -Winter Construction-

It is important that the EPSC Plan contain clear direction for the intended use and limitations of season-sensitive practices, even if no earth disturbance is initially planned for the winter period.

If construction activities involving earth disturbance will occur from October 15 throug April 15, the following requirements apply:

1. Enlarged access points, stabilized to provide for snow stockpiling.

2. Snow shall be managed with adequate storage and control of meltwater, requiring cleared snow to be stored down slope of all the areas of disturbance and out of stormwater treatment structures.

3. For areas of disturbance within 100 ft of a waterbody, the following must be installed across the slope, down gradient of the earth disturbance:

   a. A combination of one practice from group A placed in front of a practice from group B, or

   b. Two group B practices, or

   c. A single row of Reinforced Silt Fence

Group A	Group B
Filter Socks	Silt Fence
Straw Wattles	Erosion Control Berms

4. Drainage structures must be kept open and free of snow and ice dams.

5. Silt fence and other practices requiring earth disturbance must be installed ahead of frozen ground.

6. Mulch used for temporary stabilization must be applied at a minimum of 2 inches with an 80-90% cover.

7. To ensure cover of disturbed soil in advance of a precipitation or melt event, areas of disturbed soil must be stabilized prior to any runoff producing event.
   - Stabilization is not required if the work is occurring in a self-contained excavation (e.g. no outlet) with a depth of 2 feet or greater (e.g. house foundation excavation, utility trenches), provided any dewatering, if necessary, is conducted as required.

8. Prior to stabilization, snow or ice must be removed to the extent practicable.

9. Use stone to stabilize areas such as the perimeter of buildings under construction or where construction vehicle traffic is anticipated. Stone paths should be sufficient width to accommodate vehicle or equipment traffic.

3.4 Recommended Approach to EPSC Plan Development

Developing a strategy for preventing erosion and controlling sediment transport requires understanding the nature of the construction site and its surroundings. This involves identifying areas of increased erosion risk (e.g. areas with a well established vegetated buffer). With a thorough knowledge of the site and the proposed construction activities, the next step is to select erosion prevention practices that are most suitable (such as phased disturbance, rapid stabilization). Once an erosion prevention strategy is developed, sediment control practices are selected and located in areas where erosion might still be expected and at discharge points from the project.

This process of preparing a complete EPSC Plan can be broken down to four distinct steps:

Step 1
-Project Reconnaissance-

A thorough knowledge of the qualities of the construction site, its surroundings, and the climate are necessary to develop an EPSC Plan appropriate to the proposed construction activities. This requires field data collection and obtaining relevant documents.

1. Soil Survey

Review the soil survey maps for the site and determine the erodibility rating for the soils to be disturbed. County soil surveys and soil fact sheets are published by the Natural Resources Conservation Service (NRCS). These provide detailed information on the nature of the soils that may be expected on-site, including the NRCS index (K) which quantifies the susceptibility of soil to water erosion (erodibility).

2. Map Review

Review a topographic map, GIS map or aerial imagery and identify the project boundaries, property lines and all potential receiving waters, including wetlands.

3. On-Site Evaluation

Once basic resource information has been gathered, a thorough investigation of the site is needed. During the site visit, compare the information from the resource maps and any surveys with the actual conditions. Items to identify include:

1. Types and locations of existing vegetation.
2. Existing structures (roads, buildings, etc.).
3. Existing slopes for all areas of proposed disturbance
4. Drainage patterns, on-site drainage swales, ditches, and streams, discrete discharge points and areas of sheet flow.
5. Locations of unmapped wetlands.
6. Existing stormwater treatment and drainage facilities.
7. Location of diversions, drop inlets, and open or closed drainage conveyances.

Step 2
-Erosion Prevention Strategy-

Once areas of potential erosion problems have been identified, a suitable strategy for erosion prevention may be developed. Erosion prevention strategies may be divided into three basic areas, related to the factors that influence erosion: minimizing disturbance, managing runoff, and stabilizing promptly.

A variety of approaches may be suitable for a given site. For example; if there is a cut slope to be protected from erosion, the strategies may be to protect the ground surface, divert water from the slope, or shorten it. If no rainfall except that which falls on the slope has the potential to cause erosion, and if the slope is realatively short, protecting the soil surface is often all that is required to prevent problems.

Figures 3.1 through 3.3 provide planning flow charts for strategies and practices for particular erosion problems. These figures are not inclusive of all available strategies in the standards and specifications but may serve as guidance in the development of an EPSC Plan. For each area with potential erosion problems itentified, refer to these figures to identify the strategy that can be taken to solve the problem.

Part 3 - Preparing an EPSC Plan

The three categories of erosion prevention strategy are related to the factors that influence erosion:

1. Minimize Disturbance

By minimizing the area of erodible soil exposed to the erosive forces of rain, wind, and runoff, the potential for erosion is reduced considerably. Stripping and rough grading of many acres is not a suitable approach in most cases. Several management practices may be selected by a plan designer to minimize disturbance.

A. Maintain Existing Topography

Where feasible, making use of the existing lay of the land will minimize soil disturbance by avoiding the need for large cuts, fills, or grading operaions. Delineate and avoid disturbing wetlands and buffers, streams, and to the extent practicable, steep slopes and other environmentally sensitive areas. Minimize impacts by maintaining vegetative buffer strips between disturbed and nearby sensitive areas.

Planning of streets and lots should relate to site conditions. Streets laid out at right angles to contours often have excessive grades that increase erosion hazards and sediment pollution.

B. Phase Major Disturbance Activities

A phasing plan that requires EPSC practices to be installed and the soil stabilized as disturbance progresses should be developed. Ideally, this plan is devised in consultation with the construction site operator to ensure the feasibility of the approach.

Phasing plans should show the sequence and limits of each phase of consecutive disturbance, and provide clear direction as to the requirement for stabilization of one phase before another begins (e.g. "complete temporary stabilization of phase 1 must occur before earthwork on phase 2 can begin"). Note that in the standards, phasing refers to distinct project sections, done separately over time, while sequencing is providing a specific order for the installation and use of management practices relative to the progress of the earth disturbance work.

C. Maintain Existing Vegetation

As discussed in Part 2, existing vegetation shields soil from erosive rain and runoff, and extensive root systems help to hold soil in place. Where possible, existing vegetation should be maintained. Specify on plans areas of grass, trees, vegetated buffers on water bodies, etc. that should not be disturbed. Include a requirement for in-field demarcation of barriers (e.g. with orange construction fence) to prevent inadvertent intrusion on protected areas by vehicles and equipment.

2. Control Runoff

Where extensive disturbance cannot be avoided, stormwater run-on should be managed to preventerosion. This can be accomplished by diverting runoff around the disturbance, by providing a stable conveyance through the disturbance, or by dispersing concentrated flows through stable outlet structures. Dispersing concentrated flows through stable outlet structures. Diversion of surface water away from exposed soils provides the most economic and effective erosion control possible since it is more advantageous to control erosion at the source than to design controls to trap suspended sediment. Figure 3.1 provides a summary of the variety of runoff control practices that are included in the standards and specifications.

3. Stabilize Promptly

For those areas where soil disturbance is necessary, erosion can be minimized by ensuring that disturbance operations take place as quickly as possible, followed by prompt stabilization of the disturbed soils. Depending upon the size of the disturbed area, and the risk to water quality, this might require limiting concurrent disturbance to an area small enough to allow for quick stabilization of the site in advance of predicted rain events.

Another management option is placing a maximum duration for earthwork in any one area before temporary stabilization is required (e.g. “All areas must be at least temporarily stabilized within 14 days of initial disturbance”).Whatever approach is selected, it is important that directions be clear and specific. Avoid including statements such as “all areas to be stabilized within 48 hours” that are open to interpretation. The standards and specifications includes several soil stabilization practices. Figure 3.2 provides a summary of the variety of soil stabilization practices that are included in the standards and specifications.

Step 3
-Select Sediment Control Practices-

Once areas of erosion risk have been identified and an erosion prevention strategy specified, sediment control practices may be appropriately selected. The goal of their use is to capture sediment that escapes the construction area despite the use of erosion prevention practices. Sediment control practices typically do not offer complete capture of eroded sediment, and must not be used as a primary tool to prevent sediment pollution from the construction site. Instead, the aim should be to complement the selected erosion prevention strategy with thoughtful selection and placement of practices suited to the local risk of erosion.

Sediment control practices fall generally into two categories, those that retain eroded sediment on the construction site, and those that convey sediment to retaining practices.

Sediment retention practices most commonly rely upon slowing the velocity of runoff that contains sediment to a point where particles fall out of suspension. Silt fence, for example, when properly employed, serves to pond runoff upslope of the fence, slowing the flow and allowing for settling of sediment. On a larger scale, sediment basins provide the settling volume directly, and can retain water for a longer period of time.

Sediment control practices should be selected for all areas where there is an increased risk of erosion, and for all areas where there is the potential for a discharge (direct or indirect) to a water body.

In selecting sediment control practices, it is important to adhere to the design requirements found in the standards and specifications. Many small scale practices (e.g. silt fence) are appropriate for a drainage area or slope, whereas larger practices (e.g. Sediment basin) must be specifically sized to the on-site conditions. Figure 3.3 provides a summary of the variety of sediment control practices that are included in the standards and specifications.

Step 4
-Prepare EPSC Plans-

The last step in erosion and sediment control planning is completing final design. This involves applying any control measure within a group to solve the specific erosion and sediment control problem. From available erosion prevention and sediment control measure in the standards and specifications, the one measure which is most economical, practical, efficient and adaptable to the site should be chosen. While the standards and specifications are not intended to prescribe design for all projects, it is generally expected that practices from the subcategories or erosion prevention and sediment control standards (e.g. limit disturbance, small area sediment control) will be included for a given drainage area.

EPSC Plans should include all information necessary for the contractor to properly implement the chosen strategy. Multiple plan sheets may be required to reflect sequential phases, particularly if there are overlapping areas of disturbance between phases. Plan sheets should cover pre-construction, construction, and post-construction, these roughly corresponding to initial sediment control measures, erosion prevention during construction, and final stabilization.

Part 3 - Preparing an EPSC Plan

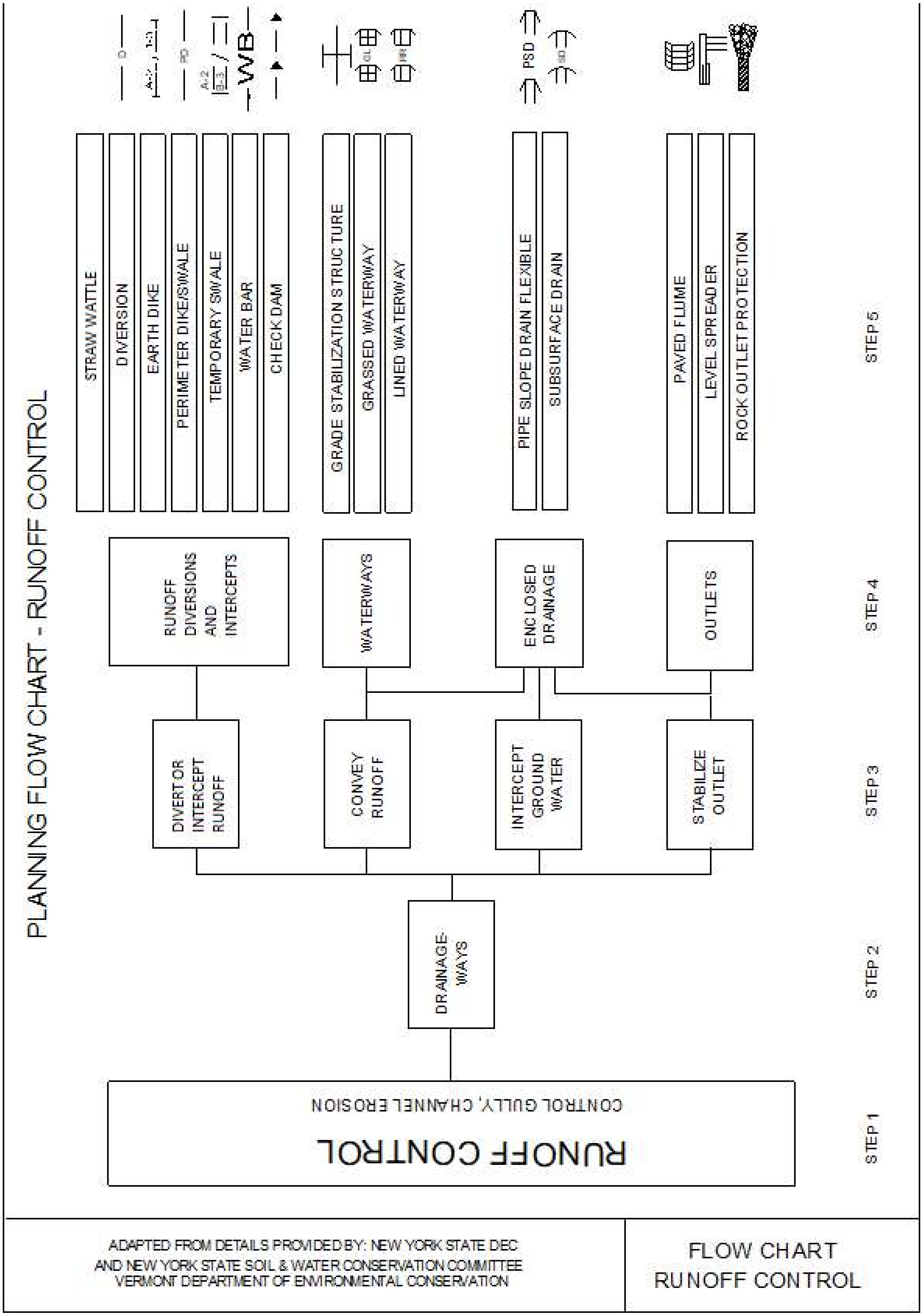

Figure 3.1 Planning Flow Chart - Runoff Control

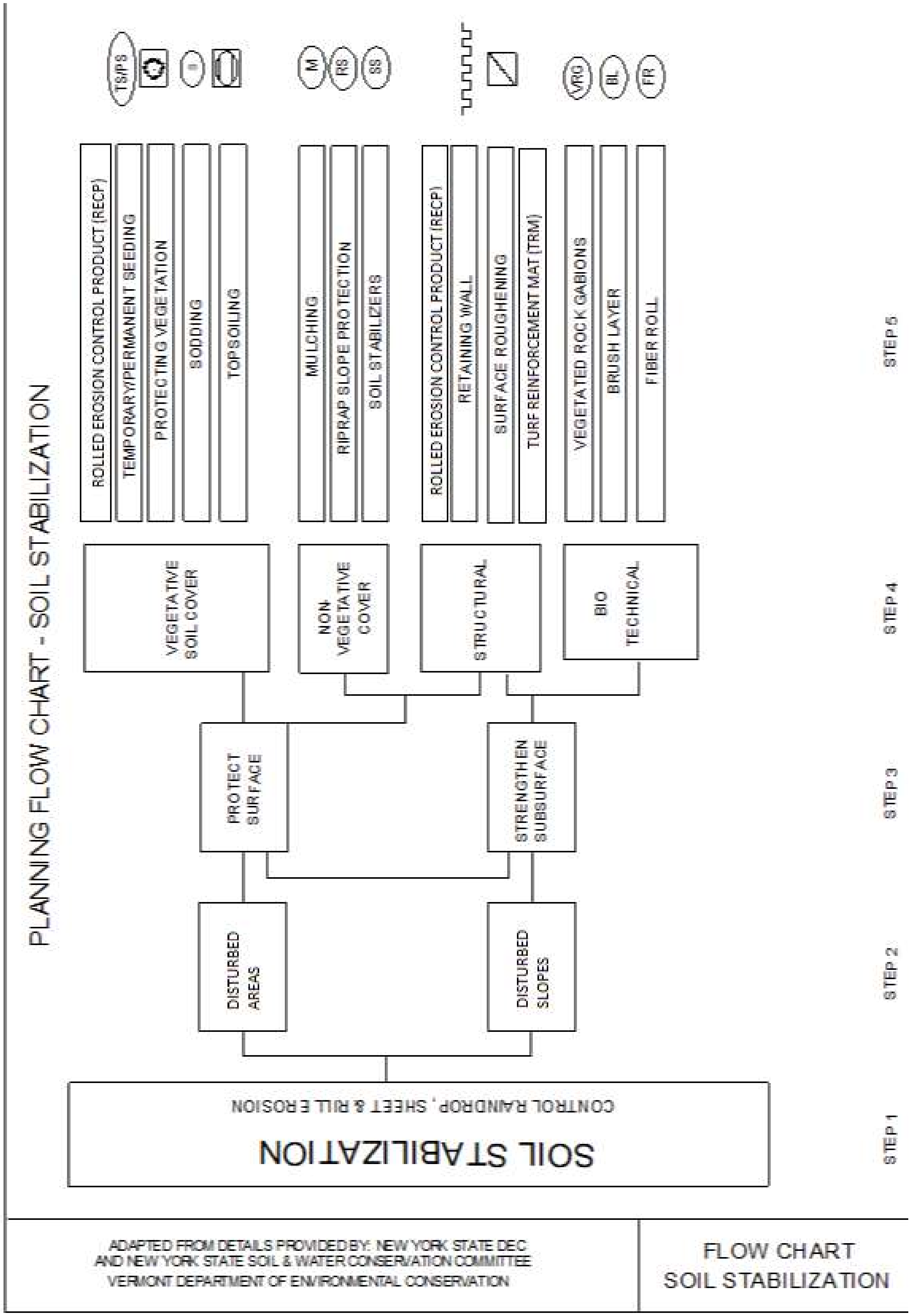

Figure 3.2 Planning Flow Chart - Soil Stabilization

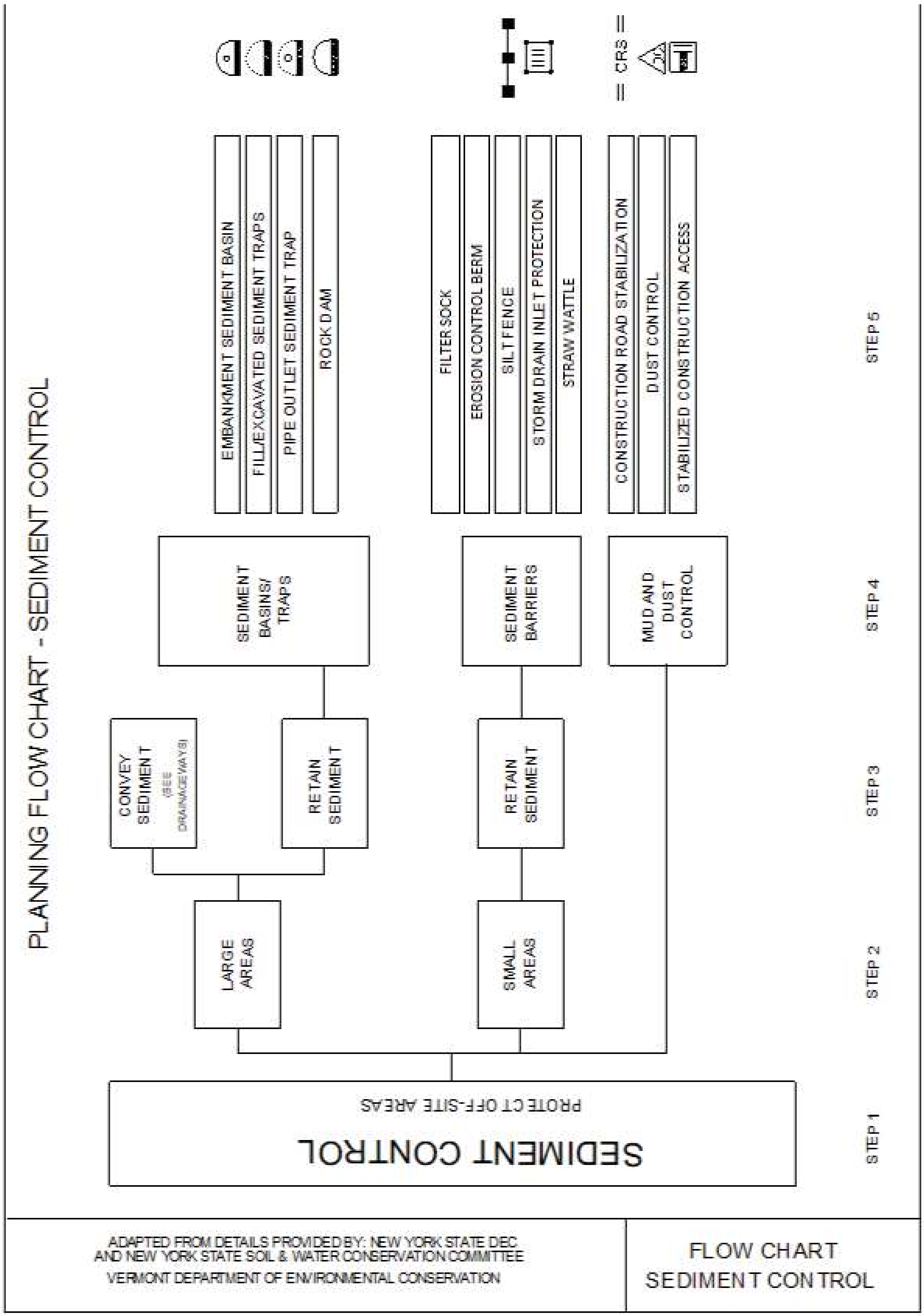

Figure 3.3 Planning Flow Chart - Sediment Control

Part 4 - Limits of Disturbance Demarcation

Definition

Defining and demarcating the boundaries of soil disturbance in the field.

Purpose

To limit the extent of disturbed soils by confining earth disturbing activities to the appropriate areas. To directly protect waters of the state and vegetated buffers surrounding them from unnecessary disturbance.

Condition Where Practice Applies

Where the boundary of authorized disturbance borders areas of existing vegetation or around the perimeter of the construction site within 100' of waters of the state.

Design Criteria

Limits of disturbance (LODs) should be the first construction item implemented on a construction site.

All disturbance areas should be demarcated with a barrier appropriate to the location.

Flagging Ribbon / Paint: For use where proposed disturbance borders established wooded areas where inadvertent disturbance by machinery is not possible. Mark trees along limit of clearing with flagging ribbon or paint corresponding to clearing limits on the authorized EPSC Plan.

Barrier Tape / Rope: For use where proposed disturbance borders non-wooded areas. Barrier tape is high visibility fiber-glass tape, minimum 3" in width. Barrier tape and rope should be attached to stakes, at a minimum height of 4' from the ground.

Construction Fence / Snow Fence / Boulders: Fence should be continuous and prevent access to buffer areas by machinery. Boulders must be spaced closely so as to prevent machinery access.

Considerations

Limits of disturbance are dynamic, changing with the progression of earth disturbing activities. They should reflect distinct phases and clearly indicate where disturbance is warranted. Limits of disturbance should be maintained until final stabilization in an area has been implemented.

Plans and Specifications

Plans and specifications for installing limits of disturbance shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items on EPSC Plans:

1. Location of all limits of disturbance.
2. Description of method of demarcation.
3. Legend showing various demarcation methods.
4. Construction detail for any method requiring specification.

Part 4 - Protecting Vegetation During Construction

Definition

The protection of trees, shrubs, ground cover and other vegetation from damage by construction equipment.

Purpose

To preserve existing vegetation determined to be important for soil erosion control, water quality protection, shade, screening, buffers, wildlife habitat, wetland protection, and other values.

Condition Where Practice Applies

On planned construction sites where valued vegetation exists and needs to be preserved.

Design Criteria

Planning Considerations:

1. Inventory:

   Vegetation that is desirable to preserve because of its value for screening, shade, critical erosion control, endangered species, aesthetics, etc., should be identified and marked on the pre-construction plan.

2. Planning:

   a. Areas to be seeded and planted should be identified on the post-construction plan. Remaining vegetation should blend with their surroundings and/or provide special function such as filter strip, buffer zone, or screen.

   b. Trees to be cut should be marked on the plans.

   c. The vigor of remaining trees may be improved by a selective thinning. A forester should be consulted for implementing this practice.

Measures to Protect Vegetation:

1. Limit soil placement over existing tree and shrub roots to a maximum of 3". Soils with loamy texture and good structure should be used.

2. Use retaining walls and terraces to protect roots of trees and shrubs when grades are lowered. Lowered grades should start no closer than the dripline of the tree. For narrow-canopied trees and shrubs, the stem diameter in inches is converted to feet and doubled, such that a 10" tree should be protected to 20'.

3. Trenching across tree root systems should be the same minimum distance from the trunk, as above "2". Tunnels under root systems for underground utilities should start 18" for deeper below the normal grounds surface. Tree root which must be severed should be cut clean. Backfill material that will be in contact with the roots should be topsoil or a prepared planting soil mixture.

4. Construct sturdy fences, or barriers, of wood, steel, or other protective material around valuable vegetation for protection from construction equipment. Place barriers far enough away from trees so that tall equipment such as backhoes and dump trucks do not contact tree branches.

5. Construction limits should be identified an clearly marked to exclude equipment.

6. Obstructive and broken branches should be pruned properly. The branch collar on all branches whether living or dead should not be damaged. The 3 or 4 cut method should be used on all branches larger than 2" at the cut. First cut about one-third the way through the underside of the limb (about 6-12" from the tree trunk). Then (approximately an inch further out) make a second cut through the limb from the upper side. When the branch is removed, there is not splintering of the main tree trunk. Remove the stub with the third cut. If the branch is larger than 5 or 6" in diameter, use the four cut system. Cuts 1 and 2 remain the same and cut 3

should be from the underside of the limb, on the outside of the branch collar. Cut 4 should be from the top and in alignment with th e 3rd cut. Cut 3 should be 1/4 to 1.3 the way through the limb. This will prevent the bark from peeling down the trunk. Do not paint the cut surface.

7. Penalties for damage to valuable trees, shrubs and herbaceous plants should be clearly spelled out in the contract.

Plans and Specifications

Plans and specifications for protecting existing vegetation shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Call out specific trees to be protected within the limits of disturbance.
2. Specify limits of disturbance and distance from trees to be protected.
3. Include narrative directions from this standard on plan details as appropriate.

Part 4 - Topsoiling

Definition

Spreading a specified quality and quantity of topsoil materials on graded or constructed subsoil areas.

Purpose

To provide acceptable plant cover growing conditions, thereby reducing erosion; to reduce irrigation water needs; and to reduce the need for nitrogen fertilizer application.

Ensuring soil depth and quality provides greater stormwater function in the post-development landscape, provides increased treatment of pollutants and sediments that result from the development, and minimizes the need for some landscaping chemicals, thus reducing pollution through prevention. When applicable, a project may be required to meet the 2017 Vermont Stormwater Management Manual Rule and Design Guidance Section 3.0 Post-Construction Soil Depth and Quality Standard when placing topsoil.

Conditions Where Practice Applies

Topsoil is applied to subsoils that are droughty (low available moisture for plants), stony, slowly permeable, salty or extremely acid. It is also used to backfill around shrub and tree transplants. This standard does not apply to wetland soils.

Design Criteria

1. Preserve existing topsoil in place where possible, thereby reducing the need for added topsoil.
2. Conserve by stockpiling topsoil and friable fine textured subsoils that must be stripped from the excavated site and applied after final grading where vegetation will be established.
3. Refer to NRCS soil surveys or soil interpretation record sheets for further soil texture information for selecting appropriate design topsoil depths.

Site Preparation

1. As needed, install erosion control practices such as diversions, channels, sediment traps, and stabilizing measures, or maintain if already installed.
2. Complete rough grading and final grade, allowing for depth of topsoil to be added.
3. Scarify all compact, slowly permeable, medium and fine textured subsoil areas. Scarify at approximately right angles to the slope direction in soil areas that are steeper than 5%. Areas that have been overly compacted shall be decompacted to a minimum depth of 12" with a deep ripper or chisel plow prior to topsoiling.
4. Remove refuse, woody plant parts, stones over 3" in diameter, and other litter prior to topsoiling.

Topsoil Materials

1. Topsoil shall have at least 6% by weight of fine textured stable organic material, and no greater than 20%. Muck soil shall not be considered topsoil.
2. Topsoil shall have not less than 20% fine textured material (passing the NO. 200 sieve) and not more than 15% clay.
3. Topsoil treated with soil sterilants or herbicides shall be so identified to the purchaser.
4. Topsoil shall be relatively free of stones over 1.5" in diameter, trash, noxious weeds such as nut sedge and quackgrass, and shall have less than 10% gravel.
5. Topsoil containing soluble salts greater than 500 parts per million shall not be used.

Application and Grading

1. Apply topsoil in the following amounts:

Part 4 - Topsoiling

Site Conditions	Intended Use	Minimum Topsoil Depth
1. Deep Sand or Loamy Sand	Mowed Lawn. Tall Legumes, Unmowed. Tall Grass, Unmowed.	6" 2" 1"
2. Deep Sandy Loam	Mowed Lawn. Tall Legumes, Unmowed. Tall Grass, Unmowed.	5" 2" None
3. 6" or More: Silt Loam, Loam, or Silt	Mowed Lawn. Tall Legumes, Unmowed. Tall Grass, Unmowed.	4" 1" 1"

2. Topsoil shall be distributed to a uniform depth over the area.
3. Topsoil shall not be placed with it is partly frozen, muddy, or on frozen slopes or over ice, snow, or standing water puddles.
4. Topsoil shall be applied and graded as referenced in the 2017 Vermont Stormwater Management Manual Rule and Design Guidance section 3.0 Post-Construction Soil Depth and Quality Standard.

Considerations

1. Topsoil is the surface layer of the soil profile, generally characterized as darker than the subsoil due to the enrichment with organic matter. It is the major source of root development and biological activity. Microorganisms that enhance plant growth thrive in this layer. Topsoil can usually be differentiated from subsoil by texture as well as color. Clay content usually increases in the subsoil. Where subsoils are high in clay, the topsoil layer may be significantly coarser in texture. The depth of natural topsoil may be quite variable. On severely eroded sites it may be gone entirely.
2. Advantages of topsoil include its higher organic matter content, friable consistence (soil aggregates can be easily crushed with only moderate pressure), its available water holding capacity, and its nutrient content. Most often it is superior to subsoil in these characteristics. The texture and friability of topsoil are usually much more conducive to seedling germination, emergence, and root growth.
3. In addition to being a better growth medium, topsoil is often less erodible than subsoil, and the coarser texture of topsoil increases infiltration capacity and reduces runoff.
4. Although topsoil may provide in improved growth medium, there may be disadvantages to its use in certain situations. Stropping, stockpiling, hauling, and spreading topsoil or importing topsoil may not be cost-effective. Handling may be difficult if large amounts of branches or rocks are present or if the terrain is too rough. Most topsoil contains weed seeds, which compete with desirable species.
5. In site planning, compare the options of topsoiling with preparing a seedbed in the available subsoil. The clay content of many subsoils retains moisture. When properly limed and fertilized, subsoil may provide a satisfactory growth medium, which is generally free of weed seeds.
6. Topsoiling is normally recommended where ornamental plants or high-maintenance turf will be grown. It may also be required to establish vegetation on shallow soils, soils containing potentially toxic materials, stony soils, and soils of critically low pH (highly acid).

Plans and Specifications

The plans and specifications for installing topsoiling shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Stockpile location and method of stabilization prior to its use.
2. Site preparation plans and method of application, distribution and compaction.

Part 4 - Surface Roughening

Definition

Roughening a bare soil surface whether through creating horizontal grooves across a 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 trapping of sediment.

Conditions Where Practice Applies

All construction slopes require surface roughening to facilitate stabilization with vegetation, particularly slopes steeper than 3:1.

Design Criteria

There are many different methods to achieve a roughened soil surface on a slope. No specific design criteria is required. However, the selection of the appropriate method depends on the type of slope. Methods include tracking, grooving, and stair-stepping. Steepness, mowing requirements, and/or a cut or fill slope operation are all factors considered in choosing a roughening method. (See Figure 4.1).

Construction Specifications

1. Cut Slope, No Mowing.
    a. Stair-step guide or groove cut slopes with a gradient steeper than 3:1.
    b. Use stair-step grading on any erodible material soft enough to be ripped with a bulldozer. Slopes of soft rock with some soil are particularly suited to stair-step grading.
    c. Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" to the vertical wall.
    d. Do not make vertical cuts more than 2' in soft materials or 3' in rocky materials.
    e. Grooving uses machinery to create a series of ridges and depressions that run perpendicular to the slope following the contour. Groove using any appropriate implement that can be safely operated on the slope, such as disks, tillers, spring harrows, or the teeth of a front-end loader bucket. Do not make the grooves less than 3" deep or more than 15" apart.

2. Fill Slope, No Mowing.
    a. Place fill to create slopes with a gradient steeper than 3:1 in lifts 9" or less and properly compacted. Ensure the face of the slope consists of loose, uncompacted fill 4 to 6" deep. Use grooving as described above to roughen the slope, if necessary.
    b. Do not blade or scrape the final slope face.

3. Cuts/Fills, Mowed Maintenance.
    a. Make mowed slopes no steeper than 3:1.
    b. Roughen these areas to shallow grooves by normal tilling, disking, harrowing, or use of cultipacker-seeder. Make the final pass of such tillage equipment on the contour.
    c. Make grooves at least 1" deep and a maximum of 10" apart.
    d. Excessive roughness is undesirable where mowing is planned.
    e. Tracking should be used primarily in sandy soils to avoid undue compaction of the soil surface. Tracking is generally not as effective as the other roughening methods described, and is more suited as a method to anchor mulch. Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.

Part 4 - Surface Roughening

Considerations

Rough slope surfaces are preferred because they aid in the establishment of vegetation, improve water filtration, 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 promote cooler temperatures 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. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

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

Grooves may be made with any appropriate implement that can be safely operated on the slope and which will not cause significant compaction. Suggested implements include offset discs, tillers, spring harrows, chisel rippers, and the teeth on a front-end loader bucket.

For areas that will be mowed, surface roughening should consist of shallow grooves created by normal tilling, disking, harrowing, or use of a culti-packer seeder. The final pass of any such implement shall be on the contour.

Tracking is generally not as effective as other roughening methods described since the soil surface is more likely to be compacted which results in less infiltration runoff.

Plans and Specifications

Plans and specifications for surface roughening shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Directions on the plans to employ surface roughening, specific to site conditions.
2. Surface roughening detail.
3. Method and equipment needed.

Part 4 - Surface Roughening

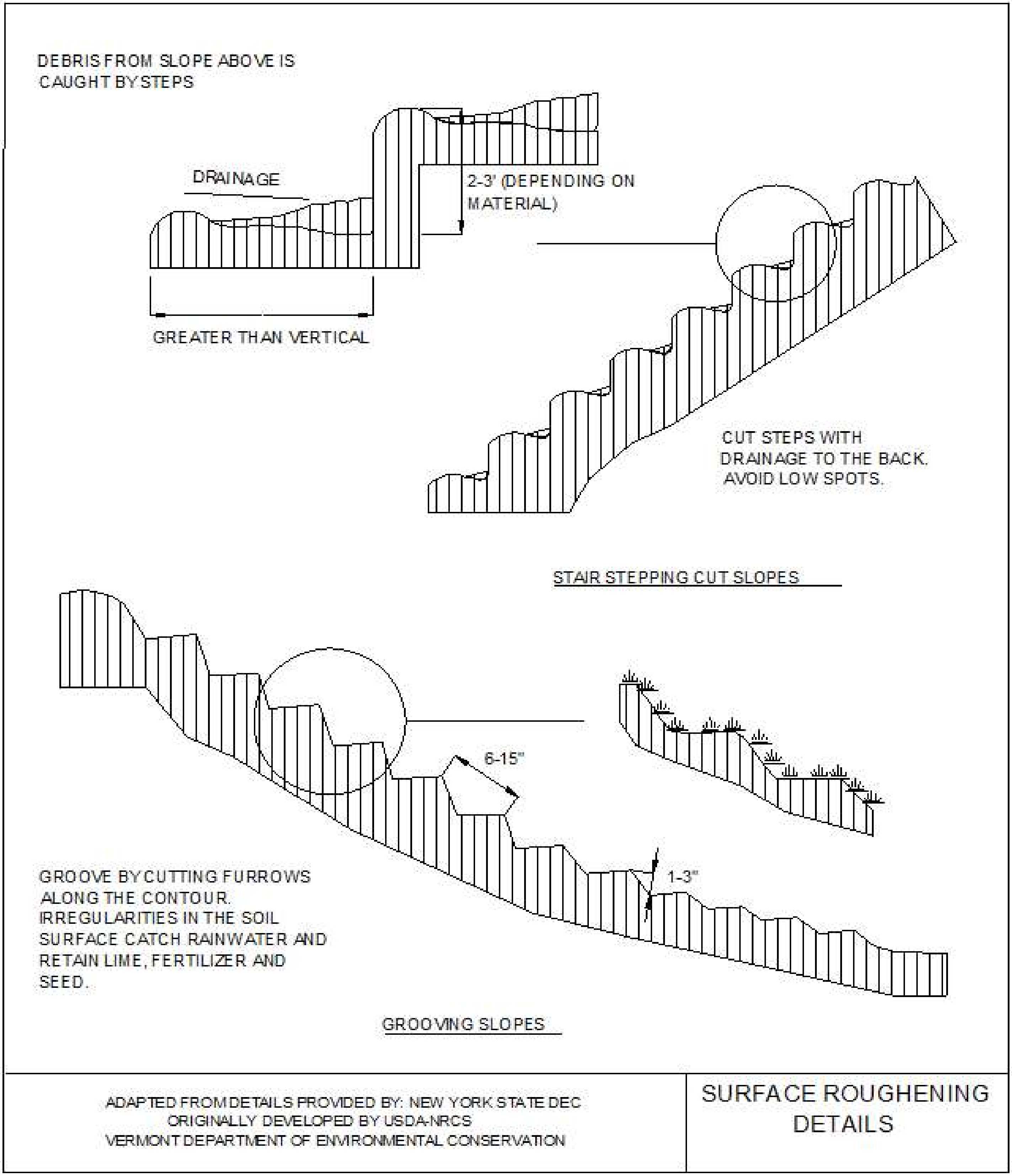

Figure 4.1 Surface Roughening

Part 4 - Surface Roughening

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Part 4 - Mulching

Definition

Applying coarse plant residue or chips, or other suitable materials, to cover the soil surface.

Purpose

The primary purpose is to provide initial erosion control while a seeding or shrub planting is establishing. Mulch will conserve moisture and modify the surface soil temperature and reduce fluctuation of both. Mulch will prevent soil surface crusting and aid in weed control. Mulch is also used alone for temporary stabilization in non-growing months.

Conditions Where Practice Applies

On disturbed soils to achieve temporary stabilization.

Design Criteria

Site preparation prior to mulching requires the installation of necessary erosion control or water management practices and drainage systems.

Slope, grade and smooth the site to fit the needs of selected mulch products.

Remove all undesirable stones and other debris to meet the needs of the anticipated land use and maintenance required.

Apply mulch in accordance with the requirements of the General Permit (see Figure 4.2 and 4.3) in reference to Vermont's Construction General Permit.

Select appropriate mulch material and application rate.

Select appropriate mulch anchoring material.

NOTE: The best combination for grass/legume establishment is straw (cereal grain) mulch applied at 2 ton/acre (90 lbs./1000sq.ft.) and anchored with wood fiber mulch (hydromulch) at 500-700 lbs./acre (11-17 lbs./1000 sq.ft.). The wood fiber mulch must be applied through a hydroseeder immediately after mulching.

Considerations

Organic mulches are the most effective mulch materials. Hydro fiber mulches are effective when used in combination with grass hay and cereal grain straw. Chemical soil binders are less effective than organic mulches.

Plans and Specifications

Plans and specifications for mulching shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Type(s) of mulch material used.
2. Thickness and percent cover and/or weight of mulch material required.
3. Timing of application (refer to Part 3).
4. Listing of netting, tackifiers, or method of anchoring.

Part 4 - Mulching

Mulch Material	Quality Standards	Per 1000 Sq.Ft.	Per Acre	Depth of Application	Remarks
Wood chips, shavings, or stump grindings	Air-dried. Free of objectionable coarse material.	500-900 lbs.	10-20 tons	2-7"	Used primarily around shrub and tree plantings and recreation trails to inhibit weed competition. Resistant to wind blowing. Decomposes slowly.
Wood fiber cellulose (partly digested wood fibers)	Made from natural wood usually with green dye and dispersing agent.	50 lbs.	2000 lbs.	___	Apply with hydromulcher. No tie down required. Less erosion control provided than 2 tons of hay or straw.
Gravel, or crushed stone	Washed; size 2B or 3A - 1.5".	9 cu.yds.	405 cu.yds.	3"	Excellent mulch for short slopes and around plants and ornaments. Use 2B where subject to traffic. (approximately 2,000 lbs./cu./yd.). Frequently used over filter fabric for better weed control.
Hay or straw	Air dried; free of undesirable seeds and coarse materials.	90-100 lbs. or 2-3 bales	2 tons or 100-120 bales	Cover about 90% surface	Use small grain straw where mulch is maintained for more than 3 months. Subject to wind blowing unless anchored. Most commonly used mulching material. Provides the best micro-environment for germinating seeds.
Compost	up to 3" pieces, moderately to highly stable.	3-9 cu.yds.	134-402 cu.yds.	1-3"	Coarser textured mulches may be more effective in reducing weed growth and wind erosion.

Figure 4.2 Guide to Mulch Materials, Rates, and Uses

Anchoring Method or Material	Kind of Mulch to be Anchored	How to Apply
1. Peg and twine	Hay or straw	After mulching divide areas into blocks approximately 1 sq.yd. in size. Drive 4-6 pegs per block to within 2" to 3" of soil surface. Secure mulch to surface by stretching twine between pegs in criss-cross pattern on each block. Secure twine around each peg with 2 or more tight turns. Drive pegs flush with soil. Driving states into ground tightens the twine.
2. Mulch netting	Hay or straw	Staple the light weight paper, jute, wood fiber, or plastic nettings to soil surface according to manufacturer's recommendations. Should be biodegradable. Most products are not suitable for foot traffic. To avoid wildlife entanglement, netting with fused joins is not approved. Refer to Figure 4.4 for RECP specifications.
3. Wood cellulose fiber	Hay or straw	Apply with hydroseeder immediately after mulching. Use 500 lbs. wood fiber per acre. Some products contain an adhesive material ("tackifier"), possibly advantageous.
4. Mulch anchoring tool	Hay or straw	Apply mulch and pull a mulch anchoring tool (blunt straight discs) over mulch as near to the contour as possible. Mulch material should be "tucked" into soil surface about 3".
5. Tackifier	Hay or straw	Mix and apply polymeric and gum tackifiers according to manufacturer's instructions. Avoid application during rain. A 24-hour curing period and a soil temperature higher than 45 degrees Fahrenheit are required.

Figure 4.3 Mulch Anchoring

Part 4 - Rolled Erosion Control Product (RECP)

Definition

A preformed protective blanket of straw or other plan residue, or plastic fibers formed into a mat, with a supporting mesh framework on one or both sides. Approved RECP applications include three sub-categories:

1. Mulch Control Netting:

   A temporary biodegradable RECP composed of planar woven natural fiber.

2. Erosion Control Blanket:

   A temporary biodegradable rolled erosion control product composed of processed natural fibers to form a continuous matrix.

3. Permanent Erosion Matting:

   Permanent erosion matting includes long-term non-degradable RECP composed of UV stabilized, non-degradable, synthetic fibers, filaments, nettings and/or wire mesh processed into three dimensional reinforcement matrices.

   Mulch Control Netting and Erosion Control Blanket are to be used where natural vegetation will be the final stabilization. Permanent Erosion Matting is to be used where vegetation alone will not provide sufficient long-term erosion protection (for example in drainage ditches with high design flow velocities).

Purpose

The purposes of this practice are to protect the soil surface from raindrop impacts and overland flow during the establishment of grass or other vegetation, and to reduce soil moisture loss due to evaporation.

Conditions Where Practice Applies

This practice applies where the protection of newly seeded areas is critical; on slopes greater than 3:1 (H:V) or where specified in the EPSC Plan. This is especially important where flowing water may occur before the grass is established. The most common application of RECP is on the bottom of small channels and on steep embankments.

Design Criteria

The RECP shall be in close contact with the soil. It shall be anchored per the manufacturer's recommendations with the proper number and spacing of wire staples. The staples shall be the proper width and length to meet the manufacturer's recommendations.

On slopes and in small drains the RECP shall be unrolled upstream to downstream parallel to the direction of flow. The upstream end of each RECP shall be anchored in a minimum 6-inch deep anchor trench. These RECPs, when laid side by side, shall overlap a minimum of 4 inches. When more than one RECP length is needed, the material shall be overlapped 12" over the downstream piece. All edges shall be stapled as per manufacturer's recommendation.

Temporary RECP materials shall conform to the specification and corresponding properties in Figure 4.4. Permanent RECP materials shall conform to the specifications and corresponding properties in Figure 4.5.

Considerations

RECP will be located as part of the site development plan. They protect the ground surface from raindrop impacts and flowing water. They also retain moisture on seeded areas thus increasing the potential for germination and survival of the vegetation. Mulch Control Netting and Erosion Control Blanket materials will break down over time. They should be chosen so that they last long enough for the grass or other vegetation to become established.

RECP product installations have the potential to ensnare animals, such as snakes and birds, which can lead to injury or fatality. This has been observed to be most problematic in products with welded joints in the supporting mesh, including products with plastic mesh, whether bio- or photo-degradable or not. Accordingly, only woven and interlinked products are approved for use in temporary RECP applications (see Figures 4.4 and 4.5 for full specifications for accepted RECP).

Plans and Specifications

Plans and specifications for installing erosion blankets shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Location of the RECP.
2. Type of RECP (must meet the criteria in Figures 4.4 and 4.5).
3. Location and cross section of anchor trenches.
4. Construction detail, with manufacturer's recommendations if available.

Part 4 - Rolled Erosion Control Product (RECP)

Product Description	Material Composition	Longevity *(months)*	Slope Applications*		Channel Applications*	Minimum Tensile Strength[1] *kN/m(lbs/ft)*
			Maximum Gradient *(h:v)*	C Factor [2,5]	Maximum Shear Stress[3,4,6] *Pg (lbs/ft2)*	
Mulch Control Nets	Mesh or woven biodegradable natural fiber netting.	3	5:1	≤ 0.10	12 (0.25)	0.073 (5)
		12	5:1	≤ 0.10	12 (0.25)	0.073 (5)
		24	5:1	≤ 0.10	12 (0.25)	0.36 (25)
Netless Rolled Erosion Control Blankets	Natural fibers mechanically interlocked together to form a RECP.	3	4:1	≤ 0.10	24 (0.5)	0.073 (5)
		12	4:1	≤ 0.10	24 (0.5)	0.073 (5)
Single-net Erosion Control Blankets	Processed biodegradable natural fibers mechanically bound together by a single, natural fiber netting of processed natural yarns or twines woven into a continuous matrix.	3	3:1	≤ 0.15	72 (1.5)	0.73 (50)
		12	3:1	≤ 0.15	72 (1.5)	0.73 (50)
Double-net Erosion Control Blankets	Processed biodegradable natural fibers mechanically bound together between two natural fiber nettings of processed natural yarns or twines woven into a continuous matrix.	3	2:1	≤ 0.20	84 (1.75)	1.09 (75)
		12	2:1	≤ 0.20	84 (1.75)	1.09 (75)
		24	1.5:1	≤ 0.25	96 (2.00)	1.45 (100)
		36	1:1	≤ 0.25	108 (2.25)	1.82(125)

* "C" factor and shear stress for mulch control nettings must be obtained with netting used in conjunction with pre-applied mulch material.
1 Minimum Average Roll Values, Machine direction using Erosion Control Technology Council (ECTC) Mod. ASTM D5035.
2 "C" factor calculated as ratio of soil loss from RECP protected slope (tested at specified or greater gradient, h:v) to ratio of soil loss from unprotected (control) plot in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions using ECTC Test Method # 2.
3 Required minimum shear stress RECP (unvegetated) can sustain without physical damage or excess erosion (> 12.7 mm (0.5 in) soil loss) during a 30-minute flow event in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using ECTC Test Method #3.
4 The permissible shear stress levels established for each performance category are based on historical experience with products characterized by Manning's roughness coefficients in the range of 0.01 - 0.05.
5 Acceptable large-scale test methods may include ASTM D 6459, ECTC Test Method #2, or other independent testing deemed acceptable by DEC.
6 Recommended acceptable large-scale testing protocol may include ASTM D6460, ECTC Test Method #3 or other independent testing deemed acceptable by the DEC.

Figure 4.4 Specifications for Temporary Rolled Erosion Control Products

Part 4 - Rolled Erosion Control Product (RECP)

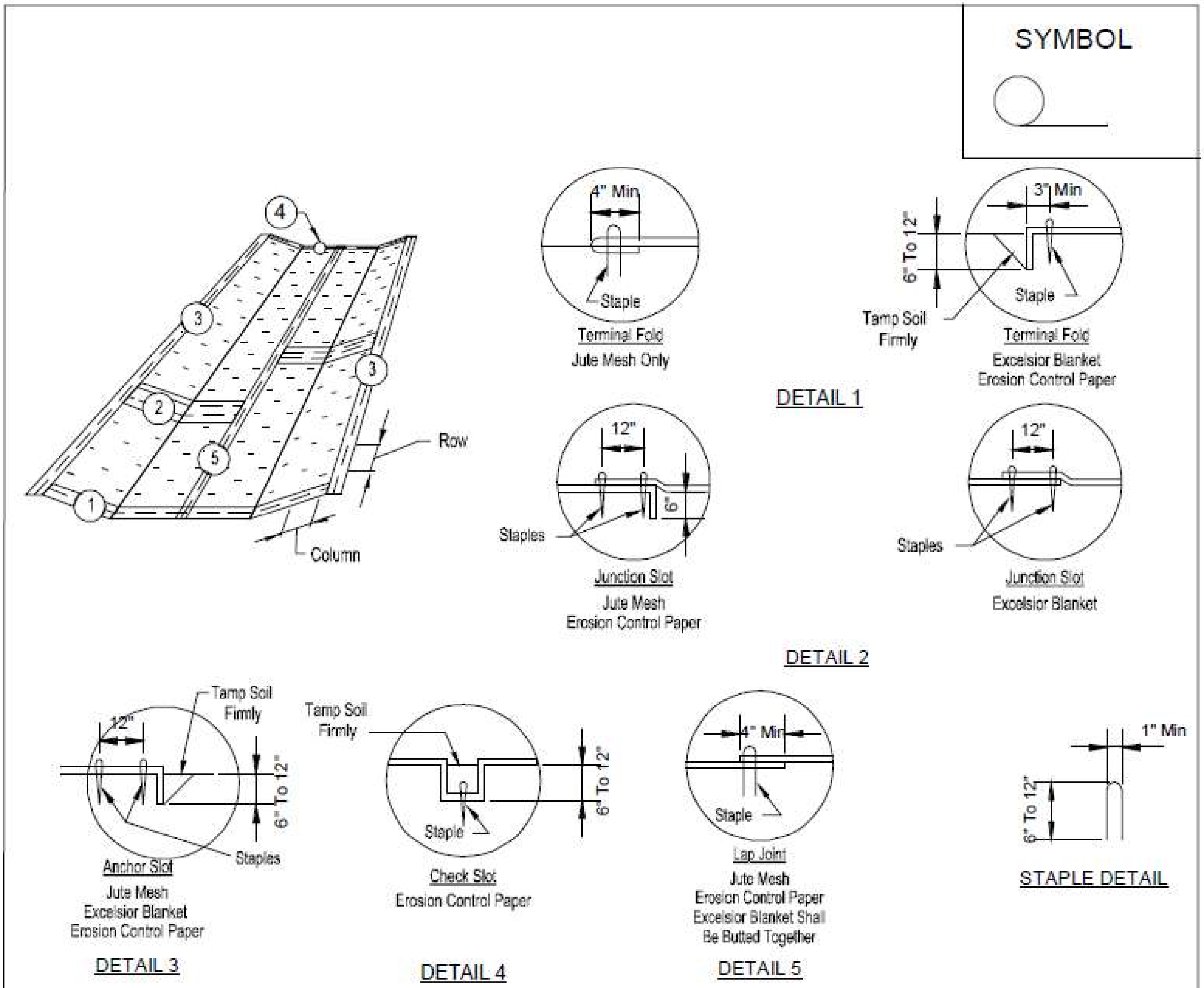
Type	Product Description	Material Composition	Slope Applications	Channel Applications	Minimum Tensile Strength[2,3] *kN/m(lbs/ft)*
			Maximum. Gradient *(h:v)*	Maximum Shear Stress[4,5] *Pa(lbs/ft2)*	
A	Turf Reinforcement Mat	Non-degradable synthetic fibers, filaments, nets, wire mesh and/or other elements, processed into a permanent, three-dimensional matrix of sufficient thickness. TRMs, which may be supplemented with degradable components, are designed to impart immediate erosion protection, enhance vegetation establishment and provide long-term functionality by permanently reinforcing vegetation during and after maturation. Note: TRMs are typically used in hydraulic applications, such as high flow ditches and channels, steep slopes, stream banks, and shorelines, where erosive forces may exceed the limits of natural, unreinforced vegetation or in areas where limited vegetation establishment is anticipated.	0.5:1	288(6.0)	1.82(125)
B	Turf Reinforcement Mat		0.5:1	384(8.0)	2.19(150)
C	Turf Reinforcement Mat		0.5:1	480(10.0)	2.55(175)

PERMANENT[1]-All categories of Turf Reinforcement Mat (TRM) must have a minimum thickness of 6.35 mm(0.25 inches) per ASTM D 6525 and U.V. stability of 80% per ASTM D 4355 (500 hours exposure).

1. For TRMs containing degradable components, all property values must be obtained on the non-degradable portion of the matting alone.
2. Minimum Average Roll Values, machine direction only for tensile strength determination using ASTM D 6818 (Supersedes Mod. ASTM D5035 for RECPs)
3. Field conditions with high loading and/or high survivability requirements may warrant the use of a TRM with a tensile strength of 44 kN/m (3,000 lb/ft) or greater.
4. Required minimum shear stress TRM (fully vegetated) can sustain without physical damage or excess erosion (>12.7 mm (0.5 in.) soil loss) during a 30-minute flow event in large scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using ECTC Test Method 43.
5. Acceptable large-scale testing protocol may include ASTM D6460, ECTC Test Method 43, or other independent testing deemed acceptable by DEC.

Figure 4.5 Specifications for Permanent Erosion Control Products

Part 4 - Rolled Erosion Control Product (RECP)



CONSTRUCTION SPECIFICATIONS

1. SPACIING: INSTALL RECP EVERY 50' ON SLOPES MORE THAN 4% AND LESS THAN 6%. ON SLOPES OF 6% OR MORE, THEY SHALL BE SPACED SO THAT ONE OCCURS WHITHIN EACH 25'.
2. STAPLES ARE TO BE PLACED ALTERNATELY, IN COLUMNS APPROXIMATELY 2' APART AND IN ROWS APPROXIMATELY 3' APART. APPROXIMATELY 175 STAPLES ARE REQUIRED PER 4' X 225' ROLL OF MATERIAL AND 125 STAPLES ARE REQUIRED PER 4' X 150' ROLL OF MATERIAL.
3. DISTURBED AREA SHALL BE SMOOTHLY GRADED TO ENSURE CLOSE CONTACT BETWEEN RECP AND GROUND.
4. EROSION CONTROL MATERIAL SHALL BE PLACED LOOSLEY OVER GROUND SURFACE. DO NOT STRETCH.
5. ALL TERMINAL ENDS ANDTRANSVERSELAPS SHALL BE STAPLED AT APPROXIMATELY 12" INTERVALS.

ADAPTED FROM DETAILS PROVIDED BY: ILLINOIS USDA-NRCS
ORIGINALLY DEVELOPED BY USDA-NRCS
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Rolled Erosion Control Product (RECP)

Figure 4.6 Rolled Erosion Control Product (RECP)

Part 4 - Temporary Stabilization Through Seeding

Definition

Providing erosion control protection to a disturbed area for an interim period.

Purpose

To provide temporary erosion and sediment control. Temporary control is achieved by covering all bare ground areas that exist as a result of construction or a natural event.

Conditions Where Practice Applies

Temporary seedings may be necessary on construction sites to protect an area, where final grading is complete, when preparing for winter work shutdown, or to provide cover when permanent seedings are likely to fail due to mid-summer heat and drought. The intent is to provide temporary protective cover during temporary shutdown of construction and/or while waiting for optimal planting time.

Design Criteria

Water management practices must be installed as appropriate for site conditions. The area must be rough graded and slopes physically stable. Large debris and rocks are usually removed. Seedbed must be seeded within 24 hours of disturbance or scarification of the soil surface will be necessary prior to seeding. Fertilizer or lime are not typically used for temporary plantings.

IF: Spring or summer or early fall, then seed the area with ryegrass (annual or perennial) at 20 lbs. per acre (approximately 0.5 lb./1000 sq. ft. or use 1 lb./1000 sq. ft.).

IF: Late fall or early winter, then seed Certified 'Aroostook' winter rye (cereal rye) at 90 lbs. per acre (2.0 lbs./1000 sq. ft.).

Any seeding method may be used that will provide uniform application of seed to the area and result in relatively good soil to seed contact.

Mulch the area with hay or straw at 2 tons/acre (approximately 90 lbs./1000 sq. ft. or 2 bales / 1000 sq. ft.). Quality of hay or straw mulch allowable will be determined based on long term use and visual concerns. Mulch anchoring will be required whee wind or areas of concentrated water are of concern. Wood fiber hydromulch or other sprayable products approved for erosion control may be used if applied according to manufacturers' specification. Caution is advised when using nylon or other synthetic products. They may be difficult to remove prior to final seeding.

Considerations

Native species or mixes that are adapted to the site and have multiple values should be considered. Avoid species that may harbor pests. Specie diversity should be considered to avoid loss of function due to species-specific pests.

Evaluate the need for structural practices to stabilize a critically eroding site or prevent off site movement of undesirable materials. Consider the long-term maintenance needs for the site.

Plans and Specifications

Plans and specifications for use of temporary critical area plantings shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Location of the temporary critical area plantings.
2. Specifications for appropriate seed type.
3. Directions for seeding and mulching trees.
4. Directions for irrigation if applicable.

Part 4 - Permanent Stabilization Through Seeding

Definition

Establishing grasses with other forbs and/or shrubs to provide perennial vegetative cover on disturbed areas.

Purpose

To reduce erosion and sediment transport.

Conditions Where Practice Applies

This practice applies to all disturbed areas that will be permanently stabilized with vegetation, cover to prevent erosion and sediment transport.

Design Criteria

All water control measures will be installed as needed prior to final grading and seedbed preparation. Any severely compacted sections will require chiseling or disking to provide an adequate rooting zone, to a minimum depth of 12". The seedbed must be prepared to allow good soil to seed contact, with the soil not too soft and not too compact. Adequate soil moisture must be present to accomplish this. If surface is powder dry or sticky wet, postpone operations until moisture changes to a favorable condition. If seeding is accomplished within 24 hours of final grading, additional scarification is generally not needed, especially on ditch or stream banks. Remove all stones and other debris from the surface that are greater than 4 inches, or that will interfere with future mowing or maintenance.

Soil amendments should be incorporated into the upper 2" of soil when feasible. The soil should be tested to determine the amounts of amendments needed. Apply ground agricultural limestone to attain a pH of 6.0 in the upper 2" of soil. If soil must be fertilized before the results of a soil test can be obtained to determine fertilizer needs, apply commercial fertilizer at 600 lbs. per acre of 5-10-10 or equivalent. If manure is used, apply a quantity to meet the nutrients of the above fertilizer. This requires an appropriate manure analysis prior to applying to the site. Do not use manure on sites to be planted with birdsfoot trefoil or in the path of concentrated water flow.

Seed mixtures may vary depending on location within the state and time of seeding. Generally, warm season grasses should only be seeded during early spring, April to May. These grasses are primarily used for vegetating excessively drained sands and gravels. Other grasses may be seeded any time of the year when the soil is not frozen and is workable. When legumes such as birdsfoot trefoil are included, spring seedings are preferred.

General Seed Mix:

	Variety	**lbs./acre**	**lbs.1000 sq. ft.**
Birdsfoot Trefoil[1] *OR*	Empire/ Pardee	5[2]	0.10
Common White Clover	Common	8	0.20
PLUS			
Tall Fescue	KY-31/ Rebel	10	0.25
PLUS			
Redtop *OR*	Common	2	0.05
Ryegrass (Perennial)	Pennfine/ Linn	5	0.10

[1] Add inoculant immediately prior to seeding
[2] Mix 2.5 lbs each of Empire and Pardee OR 2.5 lbs. of Birdsfoot and 2.5 lbs. white clover per acre.

Time of Seeding:
The optimum timing for the general seed mixture is early spring. Permanent seedings may be made any time of year if properly mulched and adequate moisture is provided. Late June through early August is not a good time to seed, but may facilitate covering the land without additional disturbance if construction is completed. Portions of the seeding fail due to drought and heat. These areas may need reseeding in late summer/fall or the following spring.

Part 4 - Permanent Stabilization Through Seeding

Method of Seeding:
Broadcasting, drilling, cultipack type seeding, or hydroseeding are acceptable methods. Proper soil to seed contact is key to successful seedings.

Mulching:
Mulching is essential to obtain a uniform stand of seeded plants. Optimum benefits of mulching new seedlings are obtained with the use of small grain straw applied at a rate of 2 tons per acre, and anchored with a netting or tackifier. See the mulch standard and specification for choices and requirements.

Irrigation:
Watering may be essential to establish a new seeding when a drought condition occurs shortly after a new seeding emerges. Irrigation is a specialized practice and care must be taken not to exceed the application rate for the soil or subsoil. When disconnecting irrigation pipe, be sure pipes are drained in a safe manner, not creating an erosion hazard.

Considerations

Native species or mixes that are adapted to the site and have multiple values should be considered. Avoid species that may harbor pests. Species diversity should be considered to avoid loss of function due to species-specific pests.

Evaluate the need for structural practices if needed to stabilize a critically eroding site or prevent off site movement of undesirable materials. Consider the long-term maintenance needs for the site.

Plans and Specifications

Plans and specifications for use of permanent critical area plantings shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Location of the permanent critical area plantings.
2. Specifications for appropriate seed type.
3. Directions for seeding and mulching rates.
4. Directions for irrigation if applicable.

Part 4 - Stabilization With Sod

Definition

Stabilizing disturbed areas by establishing long term stands of grass with sod.

Purpose

To stabilize the soil; reduce damage from sediment and runoff to downstream areas; enhance natural beauty.

Conditions Where Practice Applies

On exposed soils where a quick vegetative cover is desired. Moisture, either applied or natural, is essential to success.

Design Criteria

1. Sod shall be suitable to the location, bluegrass or a bluegrass/red fescue mixture or a perennial ryegrass for average sites. (CAUTION: Perennial ryegrass has limited cold tolerance and may winter kill.) Use turf type cultivars of tall fescue for shady, droughty, or otherwise more critical areas.
2. Sod shall be machine cut at uniform soil thickness of 3/4", plus or minus 1/4". Measurement for thickness shall exclude top growth and thatch.
3. Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) may adversely affect its survival.
4. Sod shall be harvested, delivered, and installed within a period of 36 hours. Sod not transplanted within this period shall be inspected and approved by their designated representative prior to its installation.

Site Preparation

Fertilizer and lime application rates shall be determined by soil tests. Under unusual circumstances where there is insufficient time for a complete soil test and the contracting officer agrees, fertilizer and lime materials may be applied in amounts shown in subsection 2 below. Slope land such as to provide good surface water drainage. Avoid depressions or pockets.

1. Prior to sodding, the surface shall be smoothed and cleared of all trash, debris, and all of roots, brush, wire, grade stakes and other objects that would interfere with planting, fertilizing or maintenance operations.
2. The soil should be tested to determine the amounts of amendments needed. Where the soil is acidic or composed of heavy clays, ground limestone shall be spread to raise the pH to 6.5. If the soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply commercial fertilizer at 20 lbs. of 5-10-10 (or equivalent) and mix into the top 3 inches of soil with the required lime for every 1000 sq. ft. Soil should be moist prior to sodding. Arrange for temporary storage of sod to keep it shaded and cool.

Sod Installation

1. For the operation of laying, tamping, and irrigating for any areas, sod shall be completed within 8 hours. During periods of excessively high temperature, the soil shall be lightly moistened immediately prior to laying the sod.
2. The first row of sod shall be laid in a straight line with subsequent rows placed parallel to, and tightly wedged against, each other. Lateral joints shall be staggered to promote more uniform growth and strength. Ensure that sod is not stretched or overlapped and that all joints are butted tight in order to prevent voids which would cause air drying of the roots. On sloping areas where erosion may be a problem, sod shall be laid with the long edges parallel to the contour and with staggered joints.
3. Secure the sod by tamping and pegging, or other approved methods. As sodding is completed in

any one section, the entire area shall be rolled or tamped to ensure solid contact of roots with the soil surface.

4. Sod shall be watered immediately after rolling or tamping until the underside of the new sod pad and soil surface below the sod are thoroughly wet. Keep sod moist for at least 2 weeks.

Sod Maintenance

1. In the absence of adequate rainfall, watering shall be performed daily, or as often as deemed necessary during the first week and in sufficient quantities to maintain moist soil to a depth of 4". Watering should be done in the morning. Avoid excessive watering during applications.
2. After the first week, sod shall be watered as necessary to maintain adequate moisture and ensure establishment.
3. If the soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply fertilizer three to four weeks after sodding, at a rate of 1 lb nitrogen/1000 sq. ft. Use a complete fertilizer with a 2-1-1 ratio.

Part 4 - Construction Road Stabilization

Definition

The stabilization of temporary construction access routes, on-site vehicle transportation routes, and construction parking areas.

Purpose

To control erosion on temporary construction routes and parking areas.

Conditions Where Practice Applies

All traffic routes and parking areas for temporary use by construction traffic.

Design Criteria

Construction roads should be located to reduce erosion potential, minimize impact on existing site resources, and maintain operations in a safe manner. Highly erosive soils, wet or rocky areas, and steep slopes should be avoided. Roads should be routed where seasonal water tables are deeper than 18". Surface runoff and control should be in accordance with other standards. A 4" layer of crushed gravel or dense graded crushed stone for sub-base (subsection 704.04-704.06 VT AOT Standards and Specifications for Construction).

Construction Specifications

1. Clear and strip roadbed and parking areas of all vegetation, roots, and other objectionable material.
2. Locate parking areas on naturally flat areas as available. Keep grades sufficient for drainage.
3. Provide surface drainage and divert excess runoff to stabilized areas.
4. Maintain cut and fill slopes to 2:1 or flatter and stabilize with vegetation as soon as grading is accomplished.
5. Spread a 4" layer of sub-base material evenly over the full width of the road and smooth it to avoid depressions.
6. Provide appropriate sediment control measures to prevent off-site sedimentation.

Maintenance

Inspect construction roads and parking areas periodically for condition of surface. Top dress with new gravel as needed. Check ditches for erosion and sedimentation after rainfall events. Maintain vegetation in a healthy, vigorous condition. Areas producing sediment should be treated immediately.

Considerations

Areas graded for construction vehicle transport and parking purposes are especially susceptible to erosion. The exposed soil is continually disturbed, eliminating the possibility of stabilization with vegetation. The prolonged exposure of the roads and parking areas to surface runoff can create severe rill erosion and/or sedimentation, requiring regrading before paving. The soil removed during this process may enter streams and other waters of the state, compromising water quality. Additionally, because unfinished roads become so unstable, erosion may limit access, and cause delays in construction.

Plans and Specifications

Plans and specifications for use of construction road stabilization shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Location of the construction road stabilization.
2. Specifications for preparation of road.
3. Directions for maintenance.

Part 4 - Riprap Slope Protection

Definition

A layer of stone designed to protect and stabilize areas subject to erosion.

Purpose

To protect the soil surface from erosive forces and/or improve the stability of soil slopes that are subject to seepage or have poor soil structure.

Conditions Where Practice Applies

Riprap is used for cut and fill slopes subject to seepage, erosion, or weathering, particularly where conditions prohibit the establishment of vegetation. Riprap is also used for channel side slopes and bottoms, streambanks, grade sills, on shorelines subject to erosion, and at inlets and outlets to culverts, bridges, slope drains, grade stabilization structures, and storm drains.

Design Criteria

Gradation - Riprap should be a well-graded mixture with 50% by weight larger than the specified design size. The diameter of the largest stone size in such a mixture should be 1.5 times the d_{50} size with smaller sizes grading down to 1". The designer should select the size or sizes that equal or exceed that minimum size based on riprap gradations commercially available in the area.

Thickness - The minimum layer thickness should be 1.5 times the maximum stone diameter, but in no case less than 6".

Quality - Stone for riprap should be hard, durable field or quarry materials. They should be angular and not subject to breaking down when exposed to water or weathering. The specific gravity should be at least 2.5.

Size - The sizes of stones used for riprap protection are determined by purpose and specific site conditions:

1. Slope Stabilization - Riprap stone for slope stabilization not subject to flowing water or wave action should be sized for the proposed grade. The gradient of the slope to be stabilized should be less than the natural angle of repose of the stone selected. Angles of repose of riprap stones may be estimated from Figure 4.7.

   Riprap used for surface stabilization of slopes does not add significant resistance to sliding or slope failure and should not be considered a retaining wall. Slopes approaching 1.5:1 may require special stability analysis. The inherent stability of the soil must be satisfactory before riprap is used for surface stabilization.

2. Outlet Protection - Design criteria for sizing stone and determining dimensions of riprap aprons are presented in the standards and specifications for Rock Outlet Protection.

Filter Blanket - A filter blanket is a layer of material placed between the riprap and the underlying soil to prevent soil movement into or through the riprap. A suitable filter may consist of a well-graded ravel or sand-gravel layer or a synthetic filter fabric manufactured for this purpose. The design of a gravel filter blanket is based on the ratio of particle size in accordance with th criteria below. Multiple layers may be designed to affect a proper filter if necessary.

A gravel filter blanket should have the following relationship for a stable design:

$$\frac{d_{15}\text{ filter}}{d_{85}\text{ base}} \leq 5$$

$$5 < \frac{d_{15}\text{ filter}}{d_{50}\text{ base}} \leq 40$$

and

$$\frac{d_{50}\text{ filter}}{d_{50}\text{ base}} \leq 40$$

Part 4 - Riprap Slope Protection

Filter refers to the overlying material while base refers to the underlying material. These relationships must hold between the base and filter and the filter riprap to prevent migration of material. In some cases, more than one filter may be needed. Each filter layer should be a minimum of 6 inches thick, unless acceptable filter fabric is used.

A synthetic filter fabric may be used with or in place of gravel filters. The following particle size relationships should exist:

1. Filter fabric covering a base containing 50% or less by weight of fine particles (#200 sieve size):
    a. d_{85} base (mm) EOS* filter fabric (mm) > 1
    b. Total open area of filter fabric should not exceed 36%

2. Filter fabric covering other soils:
    a. EOS is no larger than 0.21 mm (#70 sieve size)
    b. Total open area of filter fabric should not exceed 10%.

*EOS - Equivalent opening size compared to a U.S. standard sieve size.

No filter fabric should have less than 4% open area or an EOS less than U.S. Standard Sieve #100 (0.15 mm). The permeability of the fabric must be greater than that of the soil. The fabric may be made of woven or non-woven monofilament yarns and should meet the following minimum requirements:

1. Thickness 20-60 mils
2. Grab strength 90-120 lbs.
3. Conform to ASTM D-1682 or ASTM D-177

Filter blankets should always be provided where seepage is significant or where flow velocity and duration of flow or turbulence may cause underlying soil particles to move through the riprap.

Construction Specifications

Subgrade Preparation - Prepare the subgrade for riprap and filter to the required lines and grades shown on the plans. Compact any fill required in the subgrade to a density approximating that of the undisturbed material or overfill depressions with riprap. Remove brush, trees, stumps, and other objectionable material. Cut the subgrade sufficiently deep so that the finished grade of the riprap will be at the elevation of the surrounding area. Channels should be excavated sufficiently to allow placement of the riprap in a manner such that the finished inside dimensions and grade of the riprap meet design specifications.

Sand and Gravel Filter Blanket - Place the filter blanket immediately after the ground foundation is prepared. For gravel, spread filter stone in a uniform layer to the specified depth. Where more than one layer of filter material is used, spread the layers with minimal mixing.

Synthetic Filter Fabric - Place the cloth directly on the prepared foundation. Overlap the edges by at least 2', and space the anchor pins every 3' along the overlap. Bury the upper and lower ends of the cloth a minimum of 12" below ground. Take precautions not to damage the cloth by dropping the riprap. If damage occurs, remove the riprap and repair the sheet by adding another layer of filter fabric with a minimum overlap of 12" around the damaged area. Where large stones are to be placed, a 4" layer of fine sand or gravel is recommended to protect the filter cloth. Filter fabric is not recommended as a filter on slopes steeper than 2 horizontal to 1 vertical.

Stone Placement - Placement of the riprap should follow immediately after placement of the filter. Place riprap so that it forms dense, well-graded mass of stone with a minimum of voids. The desired distribution of stones throughout the mass may be obtained by selective loading at the quarry and controlled dumping during final placement. Place riprap to its full thickness in one operation. Do not place riprap by dumping through chutes or other methods that cause segregation of stone sizes. Be careful not to dislodge the underlying base or filter when placing the stones.

The toe of the riprap should be keyed into a stable foundation at its base as shown in Figure 4.7. Typical Riprap Slope Protection Detail. The toe should be excavated to a depth of 2'. The design thickness of the riprap should extend a minimum of 3' horizontally from the slope. The finished slope should be free of pockets of small stone or clusters of large stones. Hand placing may be necessary to achieve proper distribution of stone sizes to produce a relatively smooth, uniform surface. The finished grade of the riprap should blend with the surrounding area.

Maintenance

Riprap should be inspected periodically for scour or dislodged stones. Control weed and brush growth as needed.

Considerations

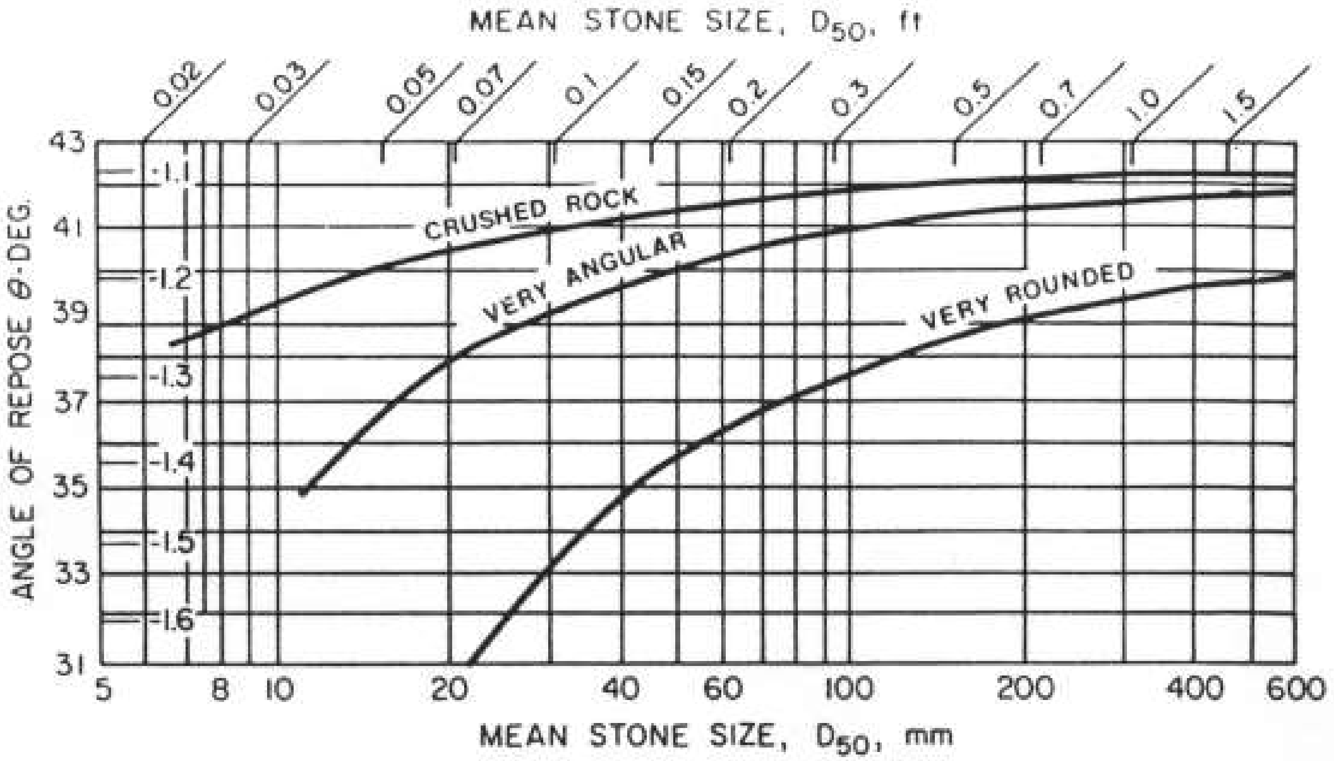
Since riprap is used where erosion potential is high, construction must be sequenced so that the riprap is put in place with the minimum delay. Disturbance of areas where riprap is to be placed should be undertaken only when final preparation and placement of the riprap can follow immediately behind the initial disturbance.

Plans and Specifications

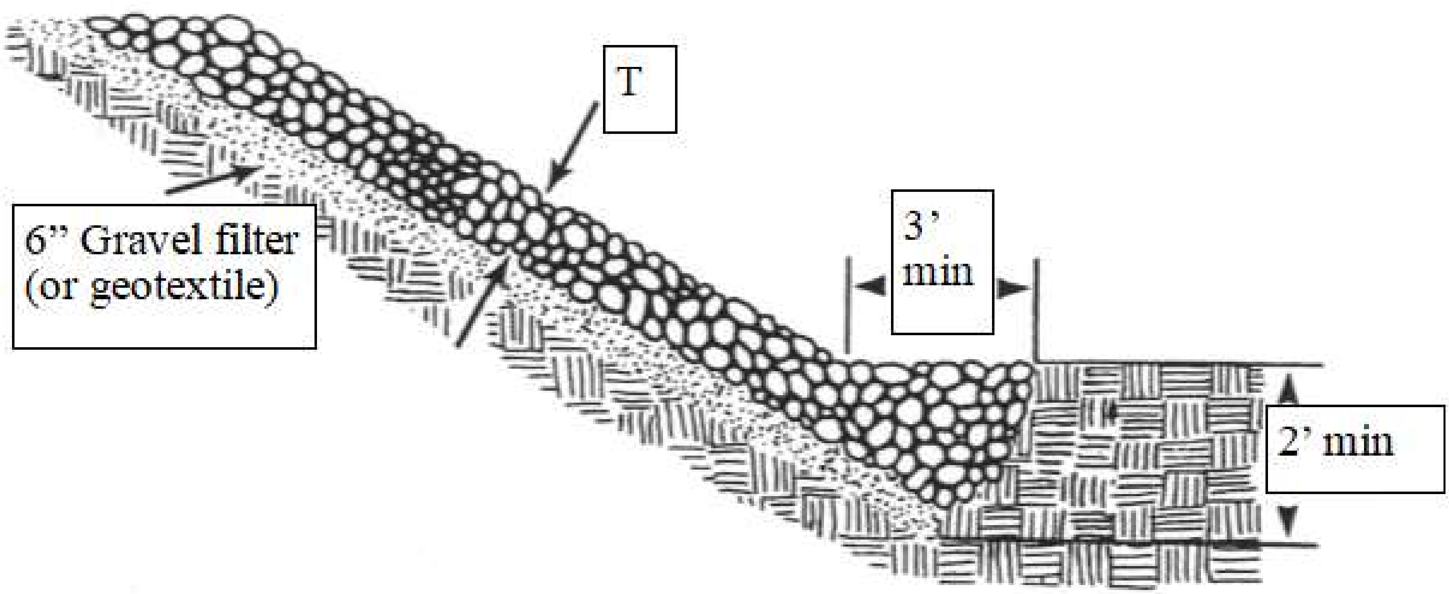
Plans and specifications for use of riprap slope protection shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Location of the riprap slope protection.
2. Riprap slope protection detail.
3. Specified angle of repose.
4. Construction specifications consistent with this standard.

Part 4 - Riprap Slope Protection



Angle of Repose for Riprap Stones (FHWA)



Typical Riprap Slope Protection Detail

Figure 4.7 Riprap Slope Protection

Part 4 - Retaining Walls

Definition

A structural wall constructed and located to prevent soil movement.

Purpose

To retain soil in place and prevent slope failures and movement of material down steep slopes.

Conditions Where Practice Applies

A retaining wall may be used where site constraints will not allow slope shaping and seeding to stabilize an area. Slope areas that demonstrate seepage problems or experience erosive conditions at the toe can utilize retaining walls to help stabilize these areas. Retaining walls can be built from mortared block or stone, cast-in-place concrete, railroad ties, gabions, and more recently, precast concrete modular units and segmented walls that form a gravity retaining wall. See figure 4.8 and 4.9. These precast units allow for ease and quickness of installation while their granular backfill provides drainage. Selection of materials and type of wall should be based on hazard potential, load conditions, soil parameters, groundwater conditions, site constraints, and aesthetics.

Design Criteria

The design of any retaining wall structure must address the aspects of foundation bearing capacity, sliding, overturning, drainage and loading systems. These are complex systems and all but the smallest retaining walls should be designed by a licensed engineer.

Bearing Capacity - A minimum factor of safety of 1.5 should be maintained as the ratio of the ultimate bearing capacity to the designed unit loading. Spread footers and other methods may be used to meet factor requirements.

Sliding - A minimum factor of safety of 2.0 should be maintained against sliding. This factor can be reduced to 1.5 when passive pressures on the front of the wall are ignored.

Overturning - A minimum factor of safety of 1.5 should be used as the ratio of the resisting moment (that which tends to keep the wall in place) to the overturning moment.

Drainage - Unless adequate provisions are made to control both surface and groundwater behind the retaining wall, a substantial increase in active pressures tending to slide or overturn the wall will result. When backfill is sloped down to a retaining wall, surface drainage should be provided. Drainage systems with adequate outlets should be provided behind retaining walls that are placed in cohesive soils. Drains should be graded or protected by filters so soil material will not move through the drainfill.

Load Systems - Several different loads or combination of loads need to be considered when designing a retaining wall. The minimum load is the level backfill that the wall is being constructed to retain. Its unit weight will vary depending on its composition. Additional loads such as line loads, surcharge loads, or slope fills, will add to make the composite design load system for the wall.

Construction Specifications

Concrete Walls:

1. Foundation will be prepared by excavating to the lines and grades shown on the drawings and removing all objectionable material.
2. Subgrade will be compacted and kept moist at least 2 hours prior to placement of concrete.
3. Steel reinforcing will be in accordance with the schedule on the drawings and kept free of rust, scale, or dirt.
4. Exposed edges will be chamfered ¾ inches.
5. Drainfill will meet the gradations shown on the drawings.

6. Weep holes will be provided as drain outlets as shown on the drawings.
7. Concrete will be poured and cured in accordance with American Concrete Institute (ACI) specifications.

Precast Units:

1. Foundation will be prepared by excavating to the lines and grades shown on the drawings.
2. Subgrade will be compacted and trimmed to receive the leveling beam.
3. Precast units will be placed in accordance with the manufacturers recommendation.
4. Granular fill placed in the precast bins shall be placed in 3-foot lifts, leveled off and compacted with a plate vibrator.

Segmented Walls:

1. Foundation will be prepared by excavating to the lines and grades shown on the drawings.
2. Sub-grade will be compacted and screeded to form the base for the first course of wall units.
3. Units will be placed in accordance with the manufacturers recommendations, with each succeeding lift anchored and pinned as specified.
4. Granular fill will be placed behind the segmented wall to provide drainage. It shall be compacted with a plate vibrator. A drainage outlet will be provided as specified on the construction drawings.

Gabions

1. Foundation will be prepared by excavating to the lines and grades shown on the drawings.
2. Subgrade will be compacted and leveled to receive first layer of gabions. The first row will be keyed into the existing grade at the toe, a minimum of 1.5 feet.
3. Gabions will be placed according to the manufacturers recommendations.
4. Gabions will be filled with stone or crushed rock from 4 to 8 inches in diameter.
5. In corrosive environments, gabion wire should be coated with Poly Vinyl Chloride (PVC).

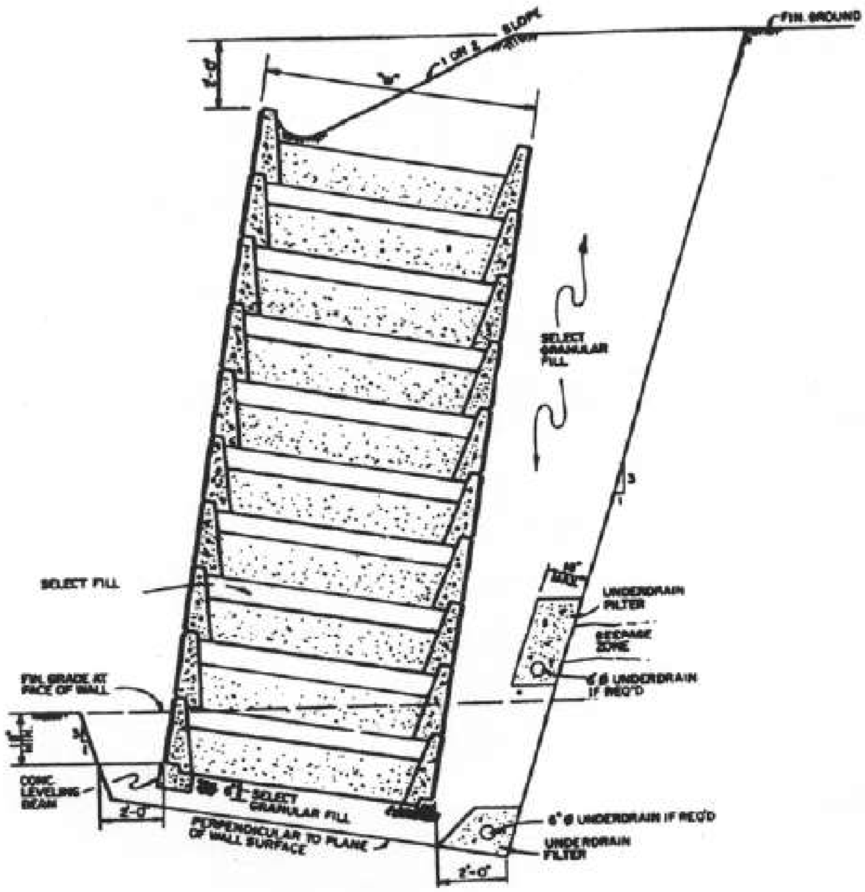
<u>Maintenance</u>

Once in place, a retaining wall should require little maintenance. They should be inspected annually for signs of tipping, clogged drains, or soil subsidence. If such conditions exist, they should be corrected immediately.

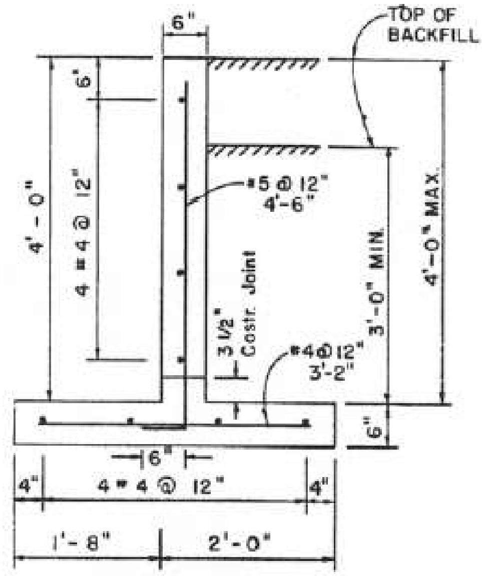
<u>Plans and Specifications</u>

Plans and specifications for use of retaining walls shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

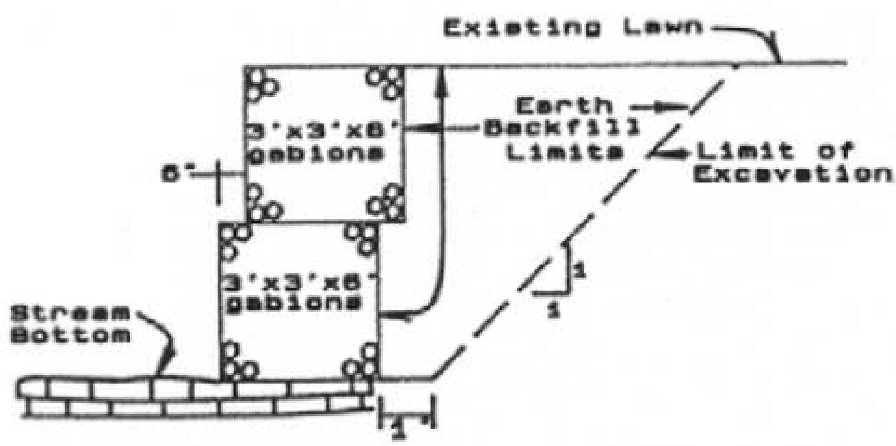
1. Location of the retaining wall.
2. Construction detail.



Precast Units



Cast In Place Concrete



Gabions

Figure 4.8 Retaining Wall Examples

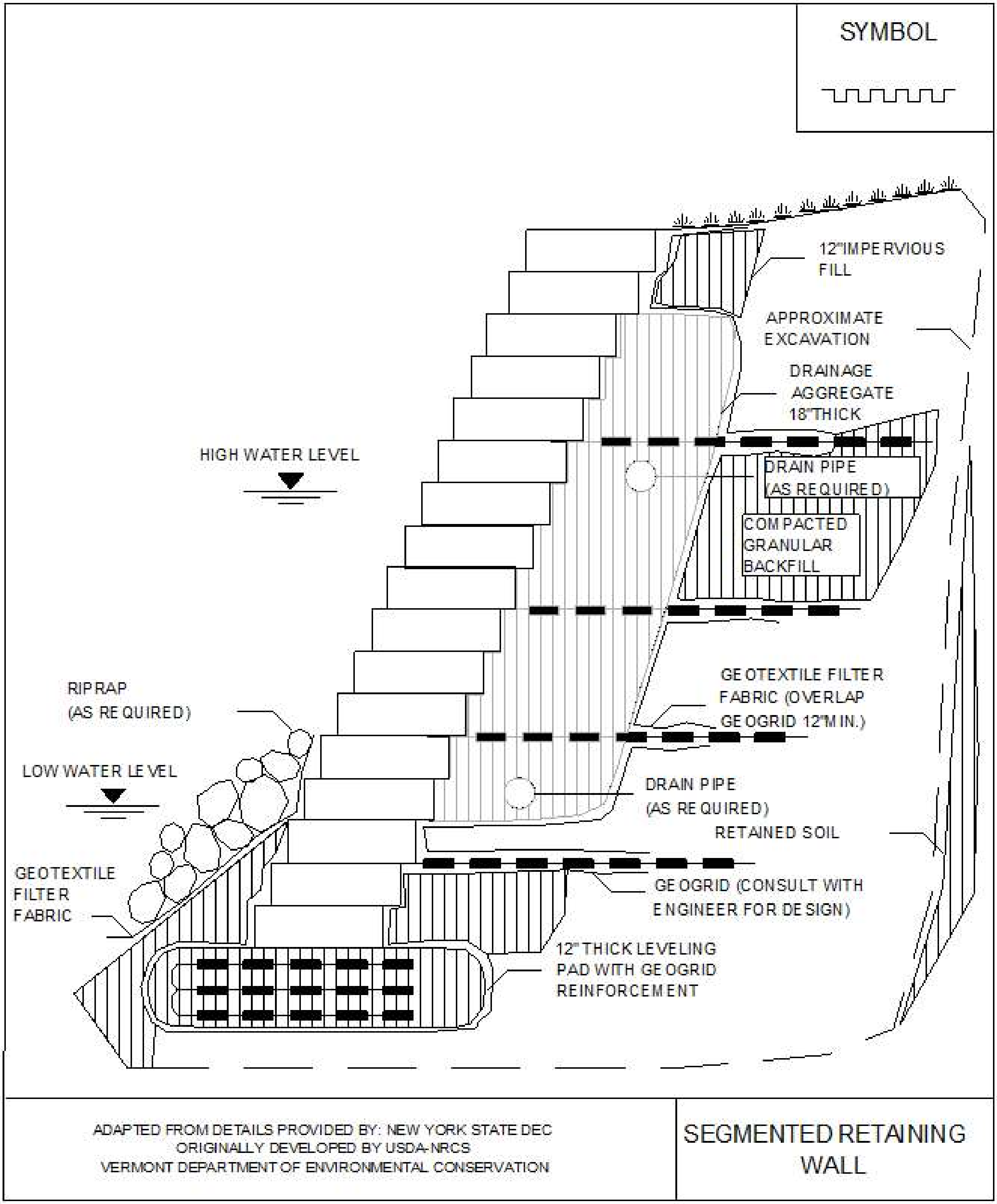


Figure 4.9 Segmented Retaining Wall

Part 4 - Biotechnical Slope Protection Measures for Erosion and Sediment Control

Introduction

Biotechnical slope protection is the specialized use of woody plant materials to stabilize soil. As noted in Part 2, one of the factors that affects erosion is vegetative cover. The more cover soil has, the more protected it is from the attacking forces of rainfall and runoff. Also working to hold the soil in place is the root mass that vegetation produces. Biotechnical measures generally combine basic engineering principles with plant science to create a system of stability for critical areas such as streambanks or roadside slopes. These systems may combine structural measures with woody plants and shrubs to effect a strengthening of the soil structure and improved vegetative cover to resist surface erosion.

There are many advantages to biotechnical slope protection measures:

1. They are often less expensive to install
2. They do not require specialized skills to install
3. Generally, heavy equipment is not required
4. They are environmentally compatible
5. They provide a natural aesthetic appearance
6. They provide wildlife habitat and cover
7. They can be self repairing during and after stress
8. They use natural/native materials

On the other hand, there are some disadvantages to these measures:

1. Higher risk due to less control with vegetation compared to structural practices
2. Require higher maintenance attention
3. Need an establishment period
4. More sensitive to seasonal changes

Biotechnical slope protection is actually an old technology. These techniques have been practiced for centuries in Europe. The Natural Resource Conservation Service used and promoted this technology in the 1940's in Vermont on the Winooski River and also in New York on Buffalo Creek, where plant materials (willows) were used in combination with rock riprap, concrete slabs, pinned rock, and cellular modules to halt streambank erosion.

Principles of Biotechnical Slope Protection

Generally a biotechnical slope protection system consists of both a structural or mechanical element and vegetative elements working together to stabilize a site-specific condition. Structural components are employed to allow establishment of vegetative elements, while at the same time providing a level of protection for stability. The vegetative components are not just landscaping plantings for a structural project; they also perform a functional role in preventing erosion by protecting the surface, while also stabilizing soil by preventing shallow mass movements.

Woody plant materials (usually dormant shrub willow branches) are placed into the soil in ways that provide an immediate degree of stability to the slope. As the branches take root and grow, the slope becomes more and more resistant to failure by shallow mass movements due to:

1. Mechanical reinforcement from the root system,
2. Soil moisture depletion through transpiration and interception, and
3. Buttressing and soil arching action from embedded stems.

Part 4 - Biotechnical Slope Protection Measures for Erosion and Sediment Control

The vegetation also tends to prevent surficial (surface or rainfall) erosion by:

1. Binding and restraining soil particles in place,
2. Filtering soil particles from runoff,
3. Intercepting raindrops,
4. Retarding velocity of runoff, and
5. Maintaining infiltration.

As the stability improves, native vegetation will volunteer, helping to blend the site into the surroundings.

There are many techniques used in biotechnical work. Some of the most common are:

Vegetated Rock Gabions - This is a combination of vegetation and rock gabions generally used for slope stabilization. Live branch cuttings are layered through the rock gabion structure to anchor in select earthfill. The cuttings protrude beyond the face of the gabion.

Live Fascines - This technique uses bundles of branches which are staked into shallow trenches, then filled with soil. They are oriented along the contour and are placed in multiple rows to help stabilize a slope. See Standard and Specifications for Live Fascines.

Brush Mattress - This method uses hardwood brush layered as a mattress and anchored in place with a grid of stakes and wire. The toe below the waterline is anchored by rock. This living blanket acts as a mulch for seedlings and plantings established in the bank. It also prevents erosion of sloped surfaces.

Live Staking - These are large stakes or poles sharpened at the bottom end and forced vertically into the soft earth along the waterline, usually about 1' apart. Depending on the size of the poles and the composition of the streambank, machinery may be required to force them into the ground or to prepare holes for planting. The poles will grow forming a very thick barrier to flow.

Brush Layering- This technique is generally used to stabilize slope areas on cut and fill slopes. It involves the use of long branches that are placed with cut ends into the slope on bulldozed terraces. The tops protrude outside the finished slope. A layer usually includes three layers of brush separated with a thin (3") layer of soil. On this layer a "lift" of 3-5' of soil is placed to form the next terrace and so forth.

Branchpacking - This technique alternates live branch cuttings with tamped backfill to repair small, localized slumps and holes in slopes. The alternating layers of branches and soil are placed between long posts driven in to the ground for support. This method is inappropriate for areas larger than 4' deep or 6' wide.

Fiber Roll - A fiber roll is a coconut fiber, straw, or excelsior woven roll encased in netting of jute, nylon, or burlap used to dissipate energy along bodies of water and provide a good medium for the introduction of herbaceous vegetation. This technique works best where water levels are relatively constant. The roll is anchored into the bank and, after suitable backfill is placed behind the roll, herbaceous or woody vegetation can be planted.

Properly designed structural measures may be necessary to help protect the toe or face of a slope against scour or erosion from moving water and against mass-moving of soil. These structures are generally capable of resisting much higher lateral earth pressures and higher shear values than vegetation. They can be natural, such as fieldstone, rock and timbers; or, they can be artificial like concrete and steel. Some structural measures can be a combination like gabions, which are wire baskets containing stone. Gabions can be used as retaining walls, grade stabilization structures and slope protection. Many of these types of structures can be planted or vegetated with materials to strengthen the system.

Part 4 - Biotechnical Slope Protection Measures for Erosion and Sediment Control

Planning Considerations

There are many facets that need to be considered when designing a biotechnical system for a site:

Method – What is the appropriate method for the particular problem encountered?

Materials – What type should be selected? How much is needed to do the job? Where can they be obtained?

Schedule – When is the best time to maximize the successful rooting or germination of materials?

Equipment – Since this process is somewhat labor intensive, it is necessary to make sure the proper type and amount of tools, such as shovels, pick axes, tile spades, hammers, etc. are available for proper installation of material.

Site Characteristics – The need for engineering structures will depend on potential hazards, management of site water, soil conditions, and site access. Aesthetics and follow-up maintenance are also important considerations. Protection from livestock is mandatory.

Plant Materials

Plant materials for biotechnical slope protection may be obtained in two basic ways. One method is to locate stands of appropriate species and obtain easements to harvest materials from these stands for incorporation into the project. Criteria for selecting native species are: easy rooting; long, straight, flexible whips; and plentiful supply near the site.

A second method is to grow and harvest materials from managed production beds that are maintained for commercial distribution. This allows selection of cultivars that have proven performance records and high survival rates.

The most popular materials in use today are the shrub willows. Willows have a tremendous ability to sprout roots and stems when in contact with moist soil. Willows are found growing in all parts of the world, so biotechnical slope protection techniques employ them more than any other group of plants. Two of the tested, proven willow cultivars in the Northeast are:

1. ‘Streamco’ purpleosier willow (Salix purpurea)
2. ‘Bankers’ dwarf willow (Salix cottetii – hybrid)

‘Streamco’ and ‘Bankers’ willow are both shrubs. ‘Streamco’ has an ultimate height of 15-20', while ‘Bankers’ is limited to 6-8'. Commercial and state nurseries in the Northeast are producing supplies of both species.

In addition to willows, red osier dogwood and poplars are other groups of plants effective for use in biotechnical systems. Species such as elderberry or forsythia can also be used to add biodiversity to a site.

All plant materials should be installed on site within 8 hours of cutting, unless provisions for proper storage are made. Materials should be fresh, dormant, and non-desiccated when installed.

Part 4 - Brush Layer

Definition

A brush layer is a horizontal row of live branch cuttings placed in soil with other similar rows, spaced a specific vertical distance apart.

Purpose

To stabilize cut and fill slope areas by reinforcing the soil with unrooted branch stems, trap debris on slope, dry excessively wet sites, and redirect adverse slope seepage by acting as horizontal drains.

Conditions Where Practice Applies

Generally applicable to stabilize slope areas on cut and fill slopes. Brush layers can be used on slopes up to 2:1 in steepness and 20' in height.

Design Criteria

The spacing requirements for brush layer rows is dependent on the slope steepness and moisture content. Spacing shall conform with the following table.

Slope Distance Between Layers (feet):

Slope H:V	Wet Slope	Dry Slope	Max Slope Length
2 to 2.5:1	3'	3'	15'
2.5 to 3.5:1	3'	4'	15'
3.5 to 4.0:1	4'	5'	25'

Brush layer cuttings shall be 1/2-2" in diameter and be from dormant plants. No leaf buds shall have initiated growth beyond 1/4" and the cambium layer shall be moist, green, and healthy. The cuttings shall be long enough to contact the back of the bench with the growing tips protruding out of the slope face.

Care shall be taken not to severely damage the live branch cuttings during installation. Damaged cuttings will be replaced prior to backfilling.

Starting at the toe of the slope, excavate benches along the contour of the slope. The benches shall range from 2-3' wide and the surface of the bench shall be angled so the front edge is higher than the back of the bench. See figure 4.10. The benches shall be spaced according to the previous table.

Live branch cuttings shall be placed on the bench in a crisscross or overlapping configuration in layers 3 - 4 inches thick. Backfill shall be placed on top of the live branch cuttings and tamped in 6 inch lifts. Small plate compactors may be used to settle the soil. Areas between the rows of brush layers shall be stabilized by seeding or other appropriate erosion control method.

Maintenance

Due to the susceptibility of plant materials to the physical constraints of the site, climate conditions, and animal populations, it is necessary to inspect installations frequently. This is especially important during the first year or two of establishment. Plant materials missing or damaged should be replaced as soon as possible. Sloughs or breaks in drainage pattern should be reestablished for the site as quickly as possible to maintain stability.

Plans and Specifications

Plans and specifications for installing a brush layer shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the brush layer will be installed.
2. Construction detail.

Part 4 - Brush Layer

SYMBOL

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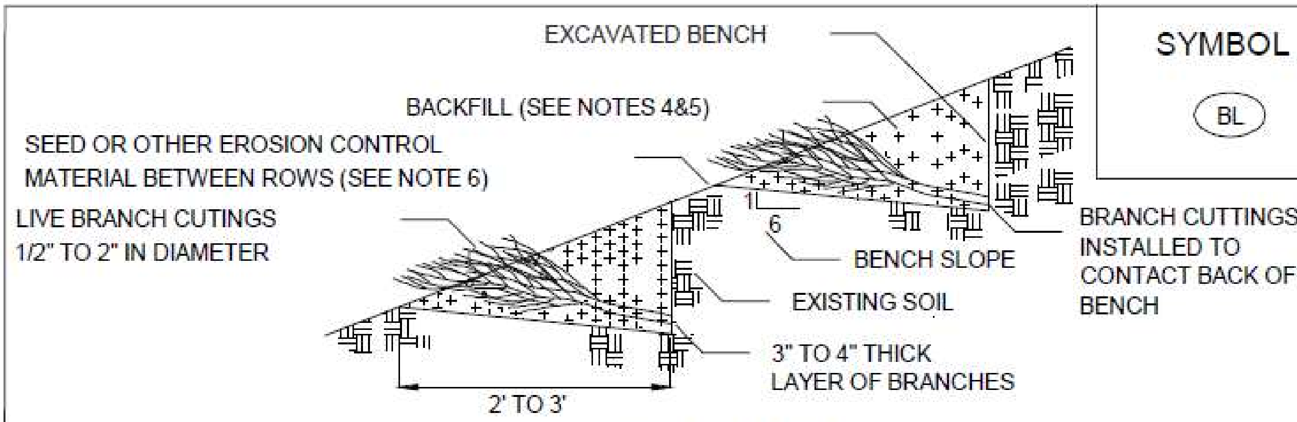
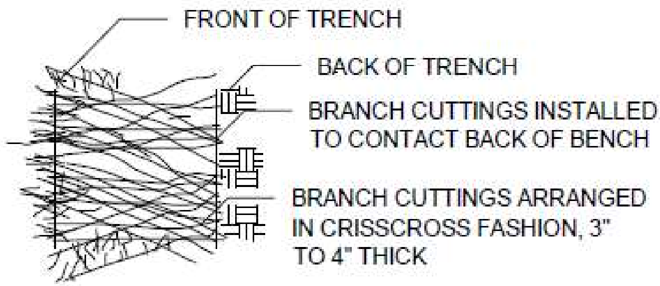


CROSS SECTION OF BRUSHLAYER ON CUT SLOPE
NOT TO SCALE



PLAN VIEW
NOT TO SCALE

CONSTRUCTION SPECIFICATIONS

1. BENCH SHALL BE ANGLED SO OUTSIDE EDGE IS HIGHER THAN BACK OF BENCH.
2. LIVE BRANCH CUTTINGS SHALL BE PLACED ON THE BENCH IN A CRISSCROSS OR OVERLAP CONFIGURATION, 3" TO 4" THICK.
3. GROWING TIPS SHALL BE ALIGNED OUT OF THE SLOPE FACE AND SHALL EXTEND SLIGHTLY BEYOND THE FILL AREA.
4. FILL EACH LOWER BENCH WITH SOIL EXCAVATED FROM THE BENCH ABOVE. TOP BENCH TO BE BACKFILLED WITH INITIAL EXCAVATION.
5. PLACE BACKFILL ON TOP OF BRANCHES AND HAND TAMP IN 6" LIFTS TO REDUCE AIR POCKETS.
6. SEED OR OTHER EROSION CONTROL MATERIAL SHALL BE USED BETWEEN THE ROWS AS STATED IN THE CONTRACT DOCUMENTS.
7. BRUSHLAYER BENCHES SHALL BE FROM 3' TO 5' VERTICAL APART, DEPENDING ON SLOPE, AS SHOWN ON THE PLANS MEASURED BETWEEN FRONT EDGE OF BENCHES.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	BRUSH LAYER

Figure 4.10 Brush Layer

Part 4 - Live Fascines

Definition

The placement of groups or bundles of twigs, whips, or branches in shallow trenches, on the contour, on either cut or fill slopes.

Purpose

To stabilize slopes by slowing water movement down the slope, increasing infiltration, trapping slope sediments, and increasing soil stability with root systems.

Conditions Where Practice Applies

On sloping areas such as road cuts, slumped areas, road fills, and gullies subject to erosion, seepage, or weathering, which have a low to medium hazard potential should slope failure occur. Slopes must be 1:1 or flatter.

Design Criteria

Vertical Spacing - The spacing of the contours for the fascines is dependent on the degree of erosion or potential erosion at the site. Factors include slope steepness, soil type, drainage, and existing ground cover. The following is a general guide to selecting contour interval:

Slope	Contour Interval
1:1	3'
1.5:1	3'
2:1	4'
2.5:1	4'
3:1	5'
3.5:1	5'
4:1	6'
6:1	8'

See Figure 4.12 for details.

Materials - Shall be a native or nursery grown cultivar that is capable of performing the intended function.

Fascines - Shall be made by forming the bundles 8-15' long, 4" minimum in diameter, from stems no more than 1" in diameter.

Overlap - Fascines should be overlapped at the tapered ends a minimum of 1'.

Construction Specifications

1. Fascines shall be 4" minimum in diameter.
2. Prior to placing the fascines, the slope shall be smoothed and graded with obstructions removed. Any structural measures for revetment, drainage, or surface water management will be installed first.
3. Working from the bottom of the slope to the top, excavate the fascine trench. Place fascines in trench and anchor with stakes spaced at 24". Cover fascines with soil leaving about 10% exposed to view. Fascines shall be overlapped 12" minimum in the trench.
4. Soil shall be worked into the fascine and compacted by walking on the fascine being covered.
5. All disturbed areas should be seeded upon completion of fascine placement.

Maintenance

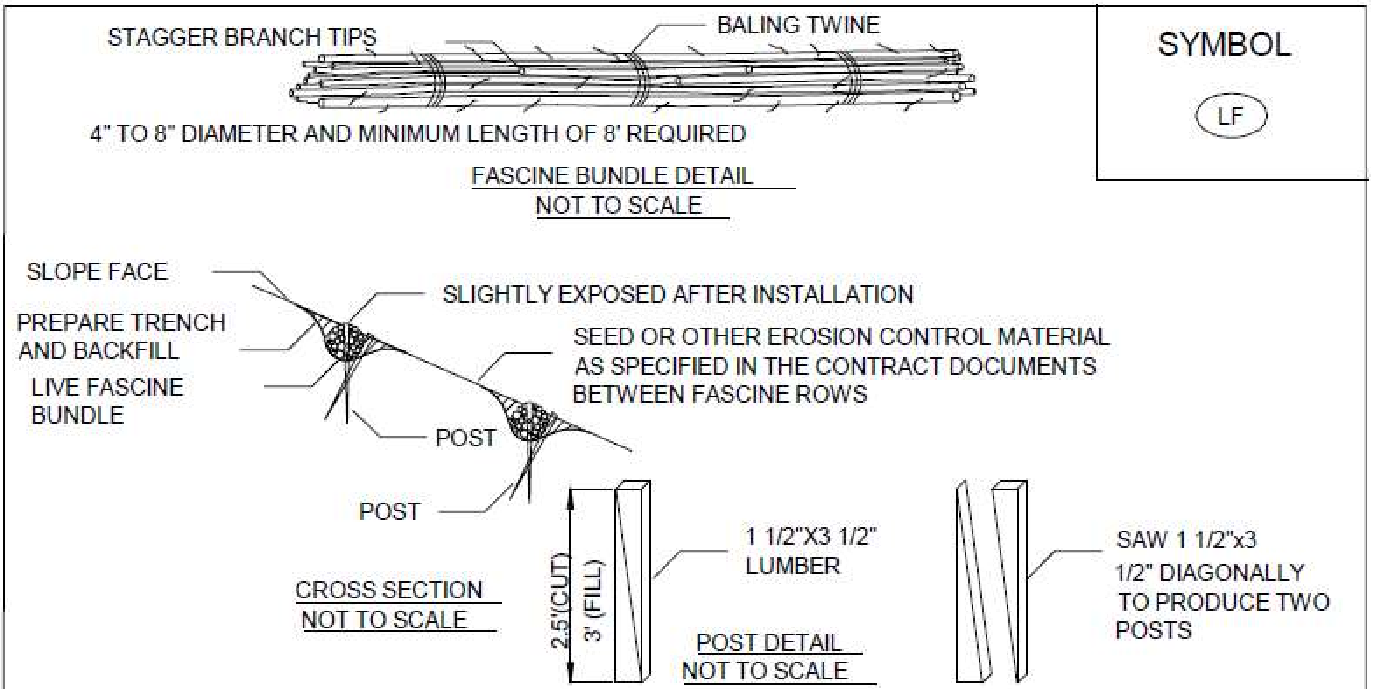
Regular inspection and maintenance of fascine installations should be conducted especially during the first year of establishment. Loose stakes should be reset and settled fill areas should be brought back to grade.

Plans and Specifications

Plans and specifications for installing fiber rolls shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.
At a minimum include the following:

1. Location where the live fascine will be installed.
2. Construction detail.

Part 4 - Live Fascines



CONSTRUCTION SPECIFICATIONS

1. LIVE FASCINES SHALL BE PREPARED FROM FRESHLY CUT DORMANT PLANTS AND INSTALLED WITHIN 8 HOURS OF THE TIME THE MATERIAL IS HARVESTED, UNLESS PROPERLY STORED.
2. LIVE FASCINE SHALL BE OBTAINED FROM SOURCES APPROVED BY THE ENGINEER.
3. LIVE FASCINES SHALL BE 4" TO 8" IN DIAMETER. LENGTHS MAY VARY TO SUIT CONDITIONS. A MINIMUM LENGTH OF 8' IS REQUIRED.
4. THE TIPS OF THE BRANCHES WITHIN THE LIVE FASCINE SHALL BE STAGGERED.
5. LIVE FASCINES SHALL BE PLACED AS INDICATED IN THE CONTRACT DOCUMENTS.
6. BEGINNING AT THE BASE OF THE SLOPE, A TRENCH SHALL BE DUG LARGE ENOUGH TO CONTAIN THE LIVE FASCINES. THE LIVE FASCINES SHALL BE PLACED IN THE TRENCH. WHERE ENDS MEET IN THE TRENCH, THE FASCINES SHALL OVERLAP BY 18".
7. WOOD POSTS SHALL BE INSTALLED FLUSH TO THE TOP OF THE FASCINE EVERY 18" ALONG THE LENGTH OF THE BUNDLES AS SHOWN ON THE CROSS SECTION. WHERE SPECIFIED LIVE STAKES MAY BE USED IN PLACE OF POSTS.
8. THE TRENCH SHALL BE BACKFILLED WITH MOIST SOIL AND HAND TAMPED. THE TOP OF THE FASCINE SHALL BE SLIGHTLY EXPOSED WHEN THE INSTALLATION IS COMPLETE AS SHOWN ON THE CROSS SECTION.
9. SEED OR OTHER EROSION CONTROL MATERIAL SHALL BE USED BETWEEN THE FASCINE ROWS, AS SPECIFIED IN THE CONTRACT DOCUMENTS.
10. LIVE FASCINE TRENCHES SHALL BE FROM 3' TO 8' APART, ACCORDING TO SLOPE AND/OR THE CONTRACT DOCUMENTS.

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Figure 4.11 Live Fascine

Part 4 - Live Stakes

Definition

A stake or pole fashioned from live woody material.

Purpose

To create a living root mat that stabilizes the soil by reinforcing and binding soil particles together and by contributing to the reduction of excess soil moisture.

Conditions Where Practice Applies

Live stakes are an appropriate technique for repair of small earth slips and slumps that are frequently wet. This technique is for relatively uncomplicated site conditions when construction time is limited and an inexpensive vegetative method for stabilization is derived. It is not intended where structural integrity is required nor to resist large, lateral earth pressures. See Figure 4.12.

Design Criteria

1. Live stakes shall be 1-2" in diameter and 2-6' long, depending on site application.
2. No leaf buds shall have initiated growth beyond 1/4" and the cambium layer shall be moist, green and healthy.
3. All material shall be maintained in a continuously cool, covered, and moist state prior to use and be in good condition when installed.
4. Materials harvested on site shall be installed the same day they are prepared. Nursery grown material shall be maintained in a moist condition until installed.
5. Installation Details
    a. The lengths of live cuttings/live stakes depends upon the application. If through riprap, the length shall extend through the surface of the stone fill. At least half the length shall be inserted into the soil, below the stone fill.
    b. A minimum of 2-4" and two live buds of the live stake shall be exposed above the stone filling.
    c. Live stakes shall be cut to a point on the basal end for insertion in the ground.
    d. Use a dead blow hammer to drive stakes into the ground. The hammer head should be filled with shot or sand. A dibble, iron bar, or similar tool shall be used to make a pilot hole to prevent damaging the material during installation.
    e. Live cuttings shall be inserted by hand into pilot holes.
    f. When possible, tamp soil around live stakes.
    g. Care shall be taken not to damage the live stakes during installation. Those damaged at the top during installation shall be trimmed back to undamaged condition.

Maintenance

Due to the susceptibility of plant materials to the physical constraints of the site, climate conditions, and animal populations, it is necessary to inspect installations frequently. This is especially important during the first year or two of establishment. Plant materials missing or damaged should be replaced as soon as possible. Sloughs or breaks in drainage pattern should be reestablished for the site as quickly as possible to maintain stability.

Plans and Specifications

Plans and specifications for installing live stakes shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

At a minimum include the following:

1. Location where the live stakes will be installed.
2. Construction detail.

Part 4 - Live Stakes

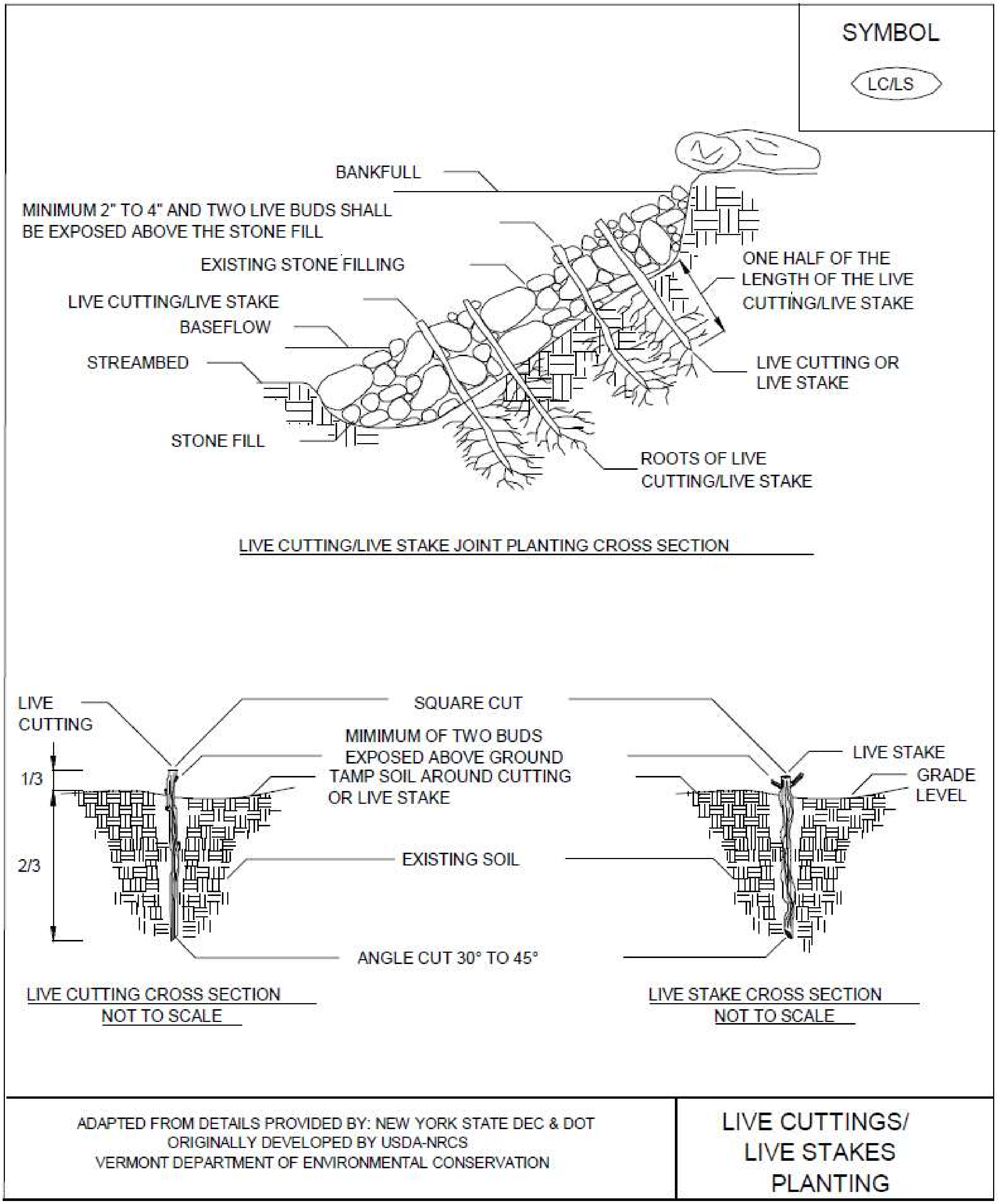


Figure 4.12 Cuttings / Live Stakes Planting

Part 4 - Branchpacking

Definition

Branchpacking consists of alternate layers of live branch cuttings and tamped backfill to repair small, localized slumps and holes in slopes.

Purpose

The purpose of branchpacking is to provide repair to existing slopes that have small slips or slumps by filling in the failed area with plant materials and soil.

Conditions Where Practice Applies

This is an appropriate technique for repairing slip areas that do not exceed 4' deep or 6' wide. It should not be used as a slope stability measure if structural embankment support is needed. See figure 4.13 Branchpacking.

Design Criteria

1. The live branch cuttings shall be 1/2-2" in diameter and long enough to touch the undisturbed soil at the back of the area to be repaired. They should extend 4-6" beyond the finished backfill grade.
2. Wooden posts should be used to secure the plant material in place. They should be 6-8' long and 3-4" in diameter. If lumber is used, it shall be a minimum standard two by four.
3. Wooden posts shall be driven vertically 3' deep and placed in a grid pattern 1-2' apart.
4. Beginning at the bottom of the slip area, 4-6" layers of live branch cuttings are placed in angled layers, 1.5-3' apart. Compacted moist soil is placed between the layers.

Maintenance

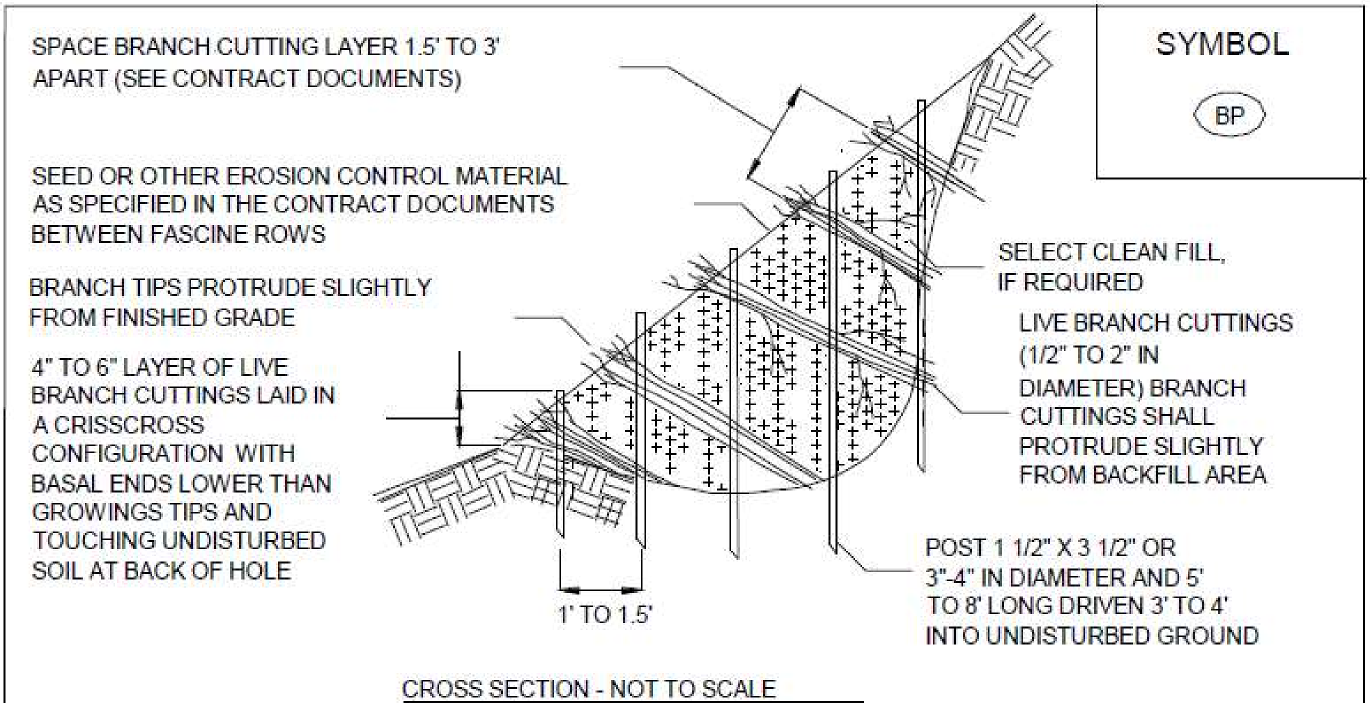
Due to the susceptibility of plant materials to the physical constraints of the site, climate conditions, and animal populations, it is necessary to inspect installations frequently. This is especially important during the first year or two of establishment. Plant materials missing or damaged should be replaced as soon as possible. Sloughs or breaks in drainage pattern should be reestablished for the site as quickly as possible to maintain stability.

Plans and Specifications

Plans and specifications for installing branchpacking shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the branchpacking will be used.
2. Construction detail.

Part 4 - Branchpacking



CONSTRUCTION SPECIFICATIONS

1. STARTING AT THE LOWEST POINT DRIVE THE WOODEN POSTS VERTICALLY 3' TO 4' INTO THE GROUND. SET THEM 1' TO 1.5' APART.
2. A LAYER OF LIVING BRANCHES 4" TO 6" THICK IS PLACED IN THE BOTTOM OF THE HOLE, BETWEEN THE VERTICAL POSTS. THEY SHALL BE PLACED IN A CRISSCROSS CONFIGURATION WITH THE GROWING TIPS GENERALLY ORIENTED TOWARD THE SLOPE FACE. SOME OF THE BASAL ENDS OF THE BRANCHES FROM EACH LAYER SHALL TOUCH THE BACK OF THE HOLE OR SLOPE.
3. EACH LAYER OF BRANCHES SHALL BE INSTALLED WITH THE BASAL ENDS LOWER THAN THE GROWING TIPS OF THE BRANCHES.
4. THE FINAL INSTALLATION SHALL MATCH THE EXISTING SLOPE. BRANCHES SHOULD PROTRUDE ONLY SLIGHTLY FROM THE FILLED FACE.
5. EACH LAYER OF BRANCHES SHALL BE FOLLOWED BY A 1' LAYER OF SOIL HAND TAMPED TO ENSURE CONTACT WITH THE BRANCH CUTTINGS.
6. THE SOIL SHALL BE MOIST OR MOISTENED TO ENSURE THAT LIVE BRANCHES DO NOT DRY OUT.
7. WHERE SPECIFIED, LIVE STAKES SHALL BE USED IN PLACE OF POSTS.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC & DOT ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	BRANCHPACKING

Figure 4.13 Branchpacking

Part 4 - Fiber Roll

Definition

A fiber roll is a coir (coconut fiber), straw, or excelsior woven roll encased in netting of jute, nylon, or burlap.

Purpose

To dissipate energy along channels and bodies of water and reduce sheet flow on slopes.

Conditions Where Practice Applies

Fiber rolls are used where the water surface levels are relatively constant. The rolls provide a good medium for the introduction of herbaceous vegetation. Planting in the fiber roll is appropriate where the roll will remain continuously wet.

Design Criteria

1. The roll is placed in a shallow trench dug below baseflow or in a 4" trench on the slope contour and anchored by 2” x 2”, 3' long posts driven on each side of the roll. See Figure 4.14.
2. The roll is contained by a 9-gauge non-galvanized wire placed over the roll from post to post. Braided nylon rope (1/8" thick) may be used.
3. The anchor posts shall be spaced laterally 4' on center on both sides of the roll, staggered, and driven down to the top of the roll.
4. Soil is placed behind the roll and planted with suitable herbaceous or woody vegetation. If the roll will be continuously saturated, wetland plants may be planted into voids created in the upper surface of the roll.
5. Where water levels may fall below the bottom edge of the roll, a brush layer of willow should be installed so as to lay across the top edge of the roll.

Maintenance

Due to the susceptibility of plant materials to the physical constraints of the site, climate conditions, and animal populations, it is necessary to inspect installations frequently. This is especially important during the first year or two of establishment. Plant materials missing or damaged should be replaced as soon as possible. Sloughs or breaks in drainage pattern should be reestablished for the site as quickly as possible to maintain stability.

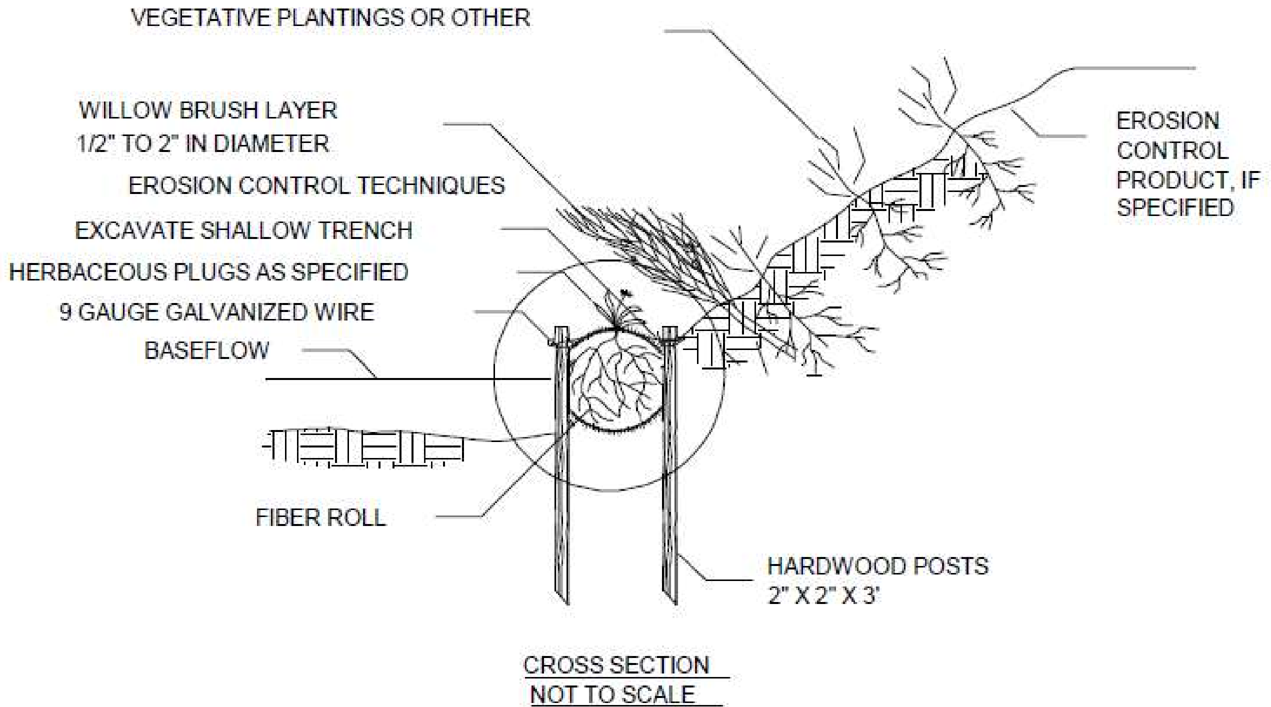
Plans and Specifications

Plans and specifications for installing fiber rolls shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the fiber rolls will be installed.
2. Construction detail.

SYMBOL

FR



CONSTRUCTION SPECIFICATIONS

1. EXCAVATE A SHALLOW TRENCH SLIGHTLY BELOW BASEFLOW OR A 4" TRENCH ON SLOPE CONTOURS.
2. PLACE THE ROLL IN THE TRENCH AND ANCHOR WITH 2" x 2" POSTS PLACED ON BOTH SIDES OF THE ROLL AND SPACED LATERALLY ON 2' TO 4' CENTERS. TRIM THE TOP OF THE POSTS EVEN WITH THE EDGE OF THE ROLL, IF NECESSARY.
3. NOTCH THE POSTS AND TIE TOGETHER, ACROSS THE ROLL, WITH 9 GAUGE GALVANIZED WIRE OR 1/8" DIAMETER BRAIDED NYLON ROPE..
4. PLACE SOIL EXCAVATED FROM THE TRENCH BEHIND THE ROLL AND HAND TAMP. PLANT WITH SUITABLE HERBACEOUS OR WOODY VEGETATION AS SPECIFIED ELSEWHERE IN THE CONTRACT DOCUMENTS. VEGETATION SHALL BE PLACED IMMEDIATELY ADJACENT TO THE ROLL TO PROMOTE ROOT GROWTH INTO THE FIBER. HERBACEOUS VEGETATION, IF SPECIFIED, SHALL BE PLANTED INTO THE FIBER ROLL.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	FIBER ROLL

Figure 4.14 Fiber Roll

Part 4 - Straw Wattle

Definition

Straw wattles are cylinders of compressed, weed free straw, generally 8 to 12 inches in diameter and 10 to 25 feet long. They are encased in a durable netting such as jute, nylon, or other photo degradable materials.

Purpose

Straw wattles are installed in a shallow trench forming a continuous barrier along the contour (across the slope) to intercept stormwater running down a slope and may serve as perimeter control beyond the limits of construction or for containment of soil stockpiles. Multiple rows of straw wattles may also be installed on slopes to break up slope lengths and reduce velocity of overland flow.

Conditions Where Practice Applies

Straw wattles may be used where perimeter control is required, provided contributing drainage area does not exceed capacity of the wattle installation. Straw wattles are also effective at breaking up slope lengths on long slopes where overland flow has the potential to collect and cause rill erosion before vegetation is established. Straw wattles are not appropriate for use on impervious surfaces such as asphalt, concrete or ledge.

Design Criteria

1. Begin at the location where the straw wattle is to be installed by excavating a 2-3" deep X 9" wide trench (or wider for larger wattles) along the contour of the slope for wattle placement. Excavated soil shall be placed up-slope from the trench.
2. Place the straw wattle in the trench so that it contours to the soil surface. Compact soil from the excavated trench against the wattle on the uphill side. Adjacent wattles shall overlap.
3. Secure the straw wattle with 18-24" stakes every 4' and with a stake on each end. Stakes shall be driven through the middle of the wattle leaving at least 2-3" of stake extending above the wattle. Stakes shall be driven perpendicular to the slope face.
4. For slope break installations: To maximize sediment containment, place the initial straw wattle at the top/crest of the slope if significant runoff is expected from above. If no runoff is expected to contribute from above the slope, the initial straw wattle can be installed at the appropriate distance downhill from the top/crest of the slope, per "Straw Wattle Spacing on Slope Gradient" table below. The final structure shall be installed at or just beyond the bottom/toe of the slope. Straw wattles shall be installed perpendicular to the primary direction of overland flow.

Straw Wattle Spacing on Slope Gradient

Slope Gradient (H:V)	Wattle Spacing (ft.)
< 6:1	50
4:1 - 6:1	10
> 4:1 - 2:1	20
> 2:1 - 1:1	10
> 1:1	5

Maintenance

Accumulated sediment behind straw wattles shall be removed when accumulation reaches half the height of the wattle. Removed material shall be placed in an upland location and stabilized as necessary.

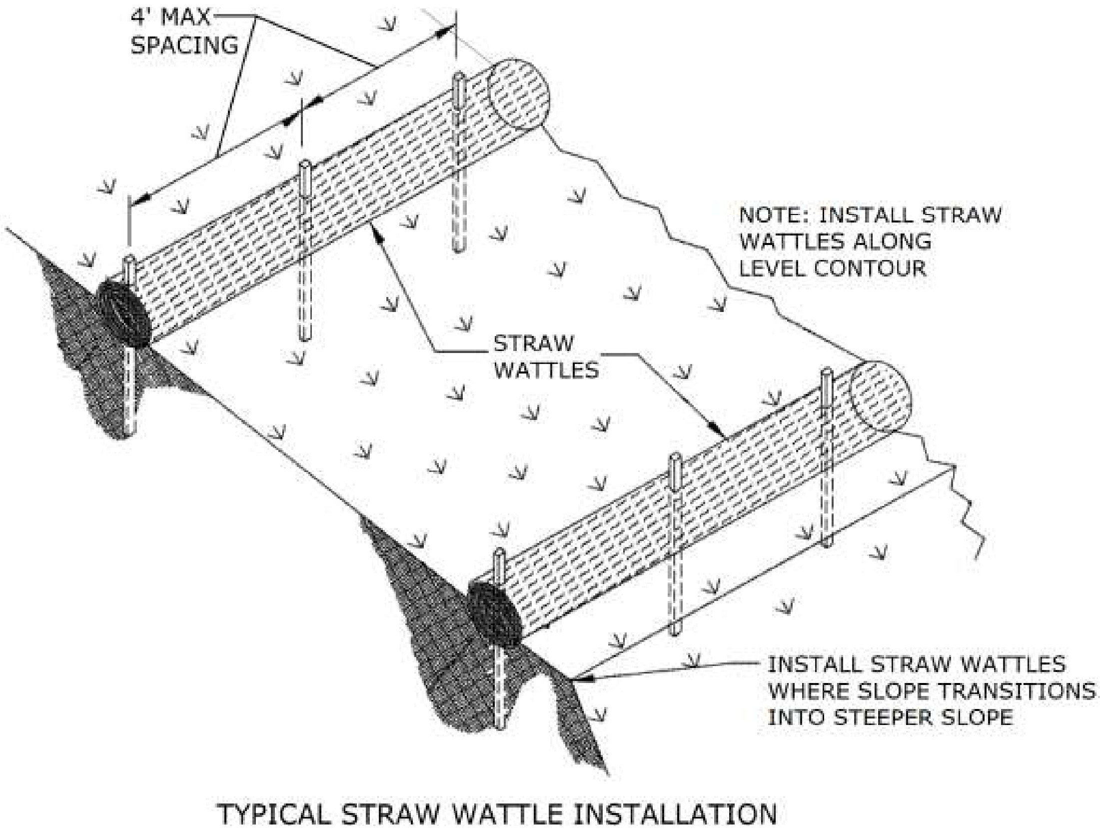
Straw wattles shall be reshaped or replace if they become flattened, cakes with sediment, or otherwise are no longer effective for runoff or sediment control.

Plans and Specifications

Plans and specifications for installing straw wattles shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimim include the following:

1. Location where the straw wattles will be installed.
2. Construction detail.

Part 4 - Straw Wattle



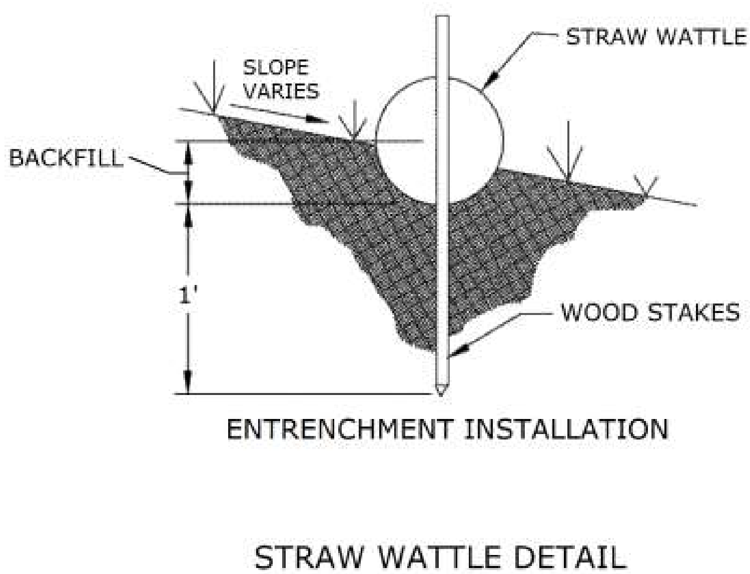


Figure 4.15 Straw Wattle

Part 4 - Water Bar

Definition

A ridge or ridge and channel constructed diagonally across a sloping road or utility right-of-way that is subject to erosion.

Purpose

To limit the erosive velocity of water by diverting surface runoff at pre-designed intervals.

Conditions Where Practice Applies

Where runoff protection is needed to prevent erosion on sloping access right-of-ways or long, narrow sloping areas generally less than 100' in width.

Design Criteria

1. The design height shall be minimum of 12" measured from channel bottom to ridge top.
2. The side slopes shall be 2:1 or flatter, and no steeper than 4:1 where vehicles cross.
3. The spacing of the water bars shall be as follows:

Slope (%)	Spacing (ft)
<5	125
5-10	100
10-20	75
20-35	50
>35	25

4. The grade of the water bar shall not exceed 2%. A crossing angle of approximately 60 degrees is preferred.
5. Once diverted, water must be conveyed to a stable system (i.e. vegetated swale or storm sewer system). Water bars should have stable outlets, either natural or constructed.

Plans and Specifications

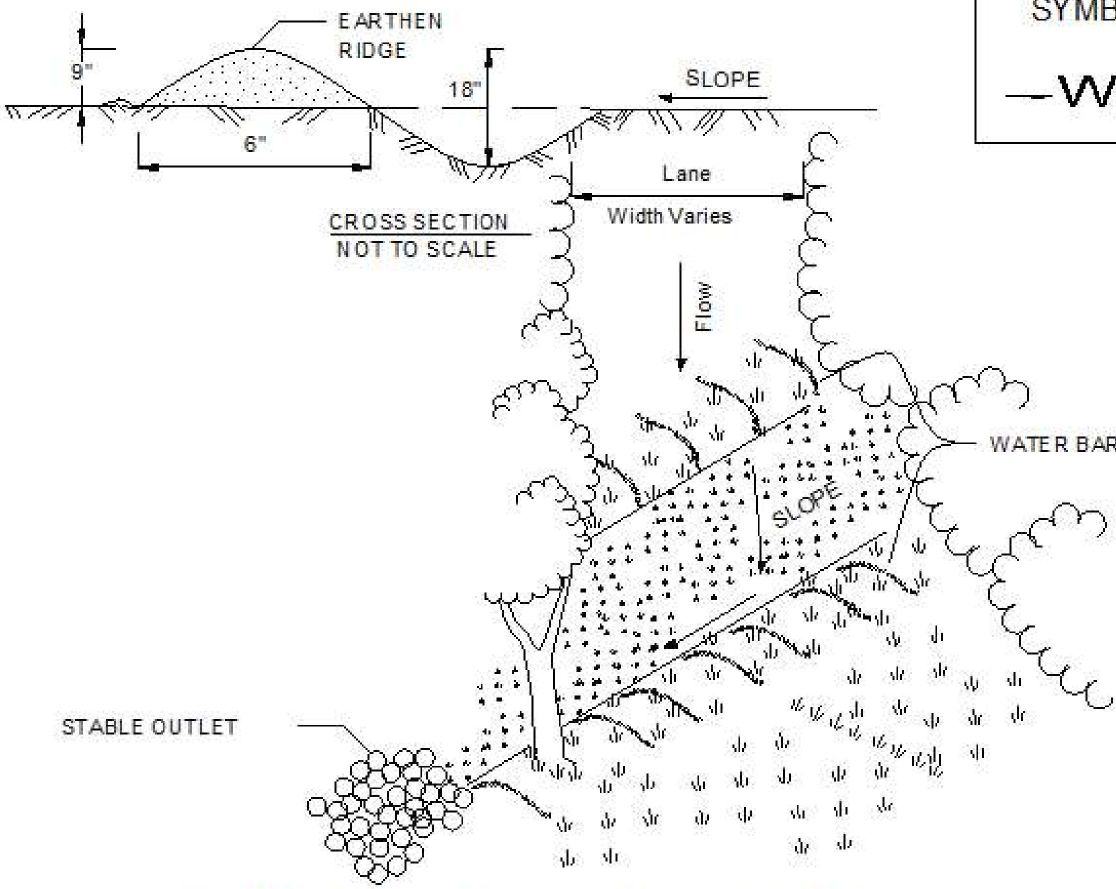
Plans and specifications for installing water bars shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the water bars will be installed.
2. Dimensions of the water bars.
3. Type and location of stable outlet.
4. Construction detail.

Part 4 - Water Bar

SYMBOL

—WB—



CONSTRUCTION SPECIFICATIONS

1. INSTALL THE WATER BAR AS SOON AS THE RIGHT OF WAY IS CLEARED AND GRADED.
2. DISK OR STRIP THE SOD FROM THE BASE FOR THE CONSTRUCTED RIDGE BEFOREPLACING FILL.
3. TRACK THE RIDGE TO COMPACT IT TO THE DESIGN CROSS SECTION.
4. THE OUTLET SHALL BE LOCATED ON AN UNDISTURBED AREA. FIELD SPACING WILL BE ADJUSTED TO USE THE MOST STABLE OUTLET AREAS. OUTLET PROTECTION WILL BE PROVIDED WHEN NATURAL AREAS ARE NOT ADEQUATE.
5. VEHICLE CROSSING SHALL BE STABILIZED WITH GRAVEL. EXPOSED AREAS SHALL BE IMMEDIATELY SEEDED AND MULCHED.
6. INSPECT WATER BARS FOR EROSION DAMAGE AND SEDIMENT. CHECK OUTLET AREAS AND MAKE REPAIRS AS NEEDED TO RESTORE OPERATION.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	WATER BARS

Figure 4.16 Water Bars

Part 4 - Check Dam

Definition

Small barriers or dams constructed of stone, or other durable material across a drainage way.

Purpose

To reduce erosion in a drainage channel by creating pools that slow the velocity of flow in the channel and trap sediment.

Conditions Where Practice Applies

This practice is used as a temporary measure to limit erosion by reducing velocities in small open channels that are degrading or subject to erosion.

Design Criteria

Height: Not greater than 2'. Center shall be maintained 9" lower than abutments at natural ground elevation.

Side Slopes: Shall be 2:1 or flatter.

Spacing: The check dams shall be spaced as necessary in the channel so that the crest of the downstream dam is at the elevation of the toe of the upstream dam. This spacing is equal to the height of the check dam divided by the channel slope.

Therefore:

S = h / s

Where:

S = spacing interval (ft.)
h = height of check dam (ft.)
S = channel slope (ft./ft)

Example:

For a channel with a 4% slope and 2' high stone check dams, they are spaced as follows:

$$S = \frac{2 \text{ ft.}}{.04 \text{ ft/ft.}} = 50 \text{ ft.}$$

Stone Size: Use a well graded stone matrix 2-9" in size.

The overflow of the check dams will be stabilized to resist erosion that might be caused by the check dam.

Check dams may be anchored in the channel by a cutoff trench 18" wide and 6" deep and lined with filter fabric to prevent soil migration.

Maintenance

The check dams should be inspected after each runoff event. Correct all damage immediately. If significant erosion has occurred between structures, a liner of stone or other suitable material should be installed in that portion of the channel.

Remove sediment accumulated behind the dam as needed to allow channel to drain through the stone check dam and prevent large flows from carrying sediment over the dam. Replace stones as needed to maintain the design cross section of the structures.

Considerations

For added stability, the base of the check dam should be keyed into the soil to a depth of 6". Filter fabric may be used under the rock to provide a stable foundation and to facilitate removal of the rock. Check dams are effective in reducing flow velocity and thereby the potential for channel erosion. It is usually better to establish a protective vegetative lining before flow is confined or to install a structural channel lining than to install rock check dams. Field experience has shown rock check dams to perform much more effectively than silt fences or straw bales in the effort to stabilize "wet-weather" ditches. Accordingly, silt fences dams and hay bale check dams are not accepted practices in Vermont.

Rock check dams installed in grass-lined channels may kill the vegetative lining if submergence after rains is too long and/or siltation is excessive.

Part 4 - Check Dam

If temporary rock check dams are used in grass-lined channels that will be mowed, care should be taken to remove all the rock when the rock check dam is removed. This should include any rocks that have washed downstream.

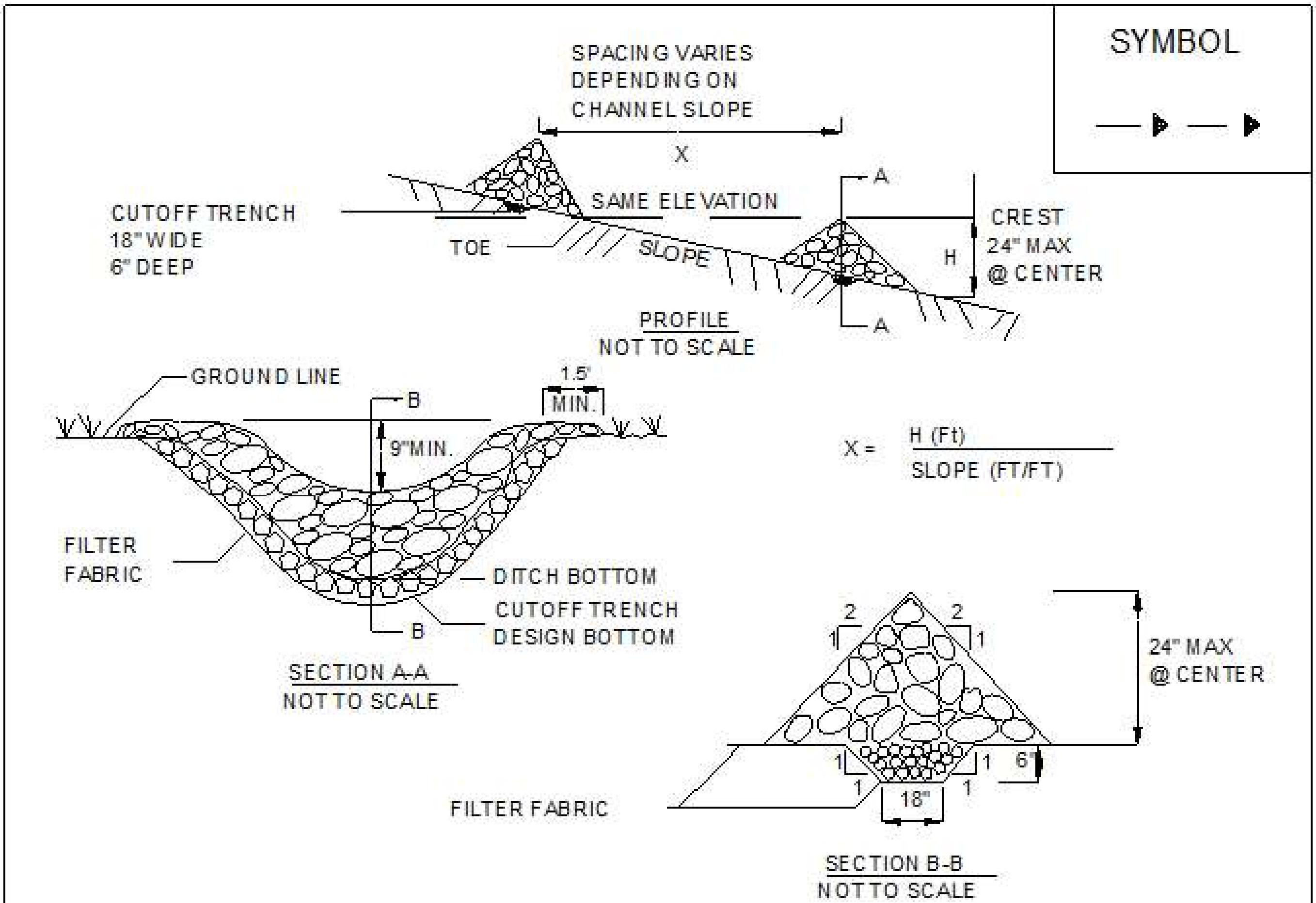
Field experience has shown that many rock check dams are not constructed with the center lower than the sides forming a weir. Stormwater flows are then forced to the rock-soil interface, thereby promoting scour at that point and subsequent failure of the structure to perform its intended function.

Plans and Specifications

Plans and specifications for installing check dams shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the practice will be installed.
2. Dimensions, elevations, and spacing between the dams.
3. Rock gradation and quality.
4. Fabric specification if used.
5. Construction detail.

Part 4 - Check Dam



CONSTRUCTION SPECIFICATIONS

1. STONE WILL BE PLACED ON A FILTER FABRIC FOUNDATION TO THE LINES, GRADES AND LOCATIONS SHOWN IN THE PLAN.
2. SET SPACING OF CHECK DAMS TO ASSUME THAT THE ELEVATIONS OF THE CREST OF THE DOWNSTREAM DAM IS AT THE SAME ELEVATION OF THE TOE OF THE UPSTREAM DAM.
3. EXTEND THE STONE A MINIMUM OF 1.5 FEET BEYOND THE DITCH BANKS TO PREVENT CUTTING AROUND THE DAM.
4. PROTECT THE CHANNEL DOWNSTREAM OF THE LOWEST CHECK DAM FROM SCOUR AND EROSION WITH STONE OR LINER AS APPROPRIATE.
5. ENSURE THAT CHANNEL APPURTENANCES SUCH AS CULVERT ENTRANCES BELOW CHECK DAMS ARE NOT SUBJECT TO DAMAGE OR BLOCKAGE FROM DISPLACED STONE.

MAXIMUM DRAINAGE AREA 2 ACRES.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	CHECK DAM

Figure 4.17 Check Dam

Part 4 - Diversion

Definition

A drainage way of parabolic or trapezoidal cross-section with a supporting ridge on the lower side that is constructed across the slope.

Purpose

The purpose of a diversion is to intercept and convey runoff to stable outlets at non-erosive velocities.

Conditions Where Practice Applies

Diversions are used where:

1. Runoff from higher areas has potential for damaging properties, causing erosion, or interfering with, or preventing the establishment of, vegetation on lower areas.
2. Surface and/or shallow subsurface flow is damaging sloping upland.
3. The length of slopes needs to be reduced so that soil loss will be kept to a minimum.

Diversions are only applicable below stabilized or protected areas. Avoid establishment on slopes greater than fifteen percent. Diversions should be used with caution on soils subject to slippage.

Design Criteria

Location - Diversion location shall be determined by considering outlet conditions, topography, land use, soil type, length of slope, seep planes (when seepage is a problem), and the development layout.

Capacity - Peak rates of runoff values used in determining the capacity requirements shall be computed by TR-55, Urban Hydrology for Small Watersheds, or other appropriate methods.

Cross Section - The diversion channel shall be parabolic or trapezoidal in shape. Parabolic Diversion design charts are provided in Figures 4.19a-f. The diversion shall be designed to have stable side slopes. The side slopes shall not be steeper than 2:1 and shall be flat enough to ensure ease of maintenance of the diversion and its protective vegetative cover.

The ridge shall have a minimum width of four feet at the design water elevation; a minimum of 4 inches freeboard and a reasonable settlement factor shall be provided.

Velocity and Grade - The permissible velocity for the specified method of stabilization will determine the maximum grade. Maximum permissible velocities of flow for the stated conditions of stabilization shall be considered.

Diversions are not usually applicable below high sediment producing areas unless land treatment practices or structural measures, designed to prevent damaging accumulations of sediment in the channels, are installed with, or before, the diversions.

Outlets - Each diversion must have an adequate outlet. The outlet may be a grassed waterway, vegetated or paved area, grade stabilization structure, stable watercourse, or subsurface drain outlet. In all cases, the outlet must convey runoff to a point where outflow will not cause damage. Vegetated outlets shall be installed before diversion construction, if needed, to ensure establishment of vegetative cover in the outlet channel.

The design elevation of the water surface in the diversion shall not be lower than the design elevation of the water surface in the outlet at their junction when both are operating at design flow.

Stabilization - Diversions shall be stabilized in accordance with the approved EPSC Plans.

Considerations

Diversions should be planned as a part of initial site development. They are principally runoff control measures that subdivide the site into specific drainage areas. Permanent diversions can be installed as temporary diversions until the site is stabilized, then completed as a permanent measure, or they can be installed in final form during the initial construction operation. The amount of sediment anticipated and the maintenance required as a result of construction operations will determine which approach should be used. Stabilize permanent diversions with vegetation or materials such as riprap, paving stone, or concrete as soon as possible after installation. Base the location, type of stabilization, and diversion configuration on final site conditions. Evaluate function, need, velocity control, outlet stability, and site aesthetics. When properly located, landforms such as landscape islands, swales or ridges can be used effectively as permanent diversions. Base the capacity of a diversion on the runoff characteristics of the site and the potential damage after development. Consider designing an emergency overflow section or bypass area to limit damage from storms that exceed the design storm. The overflow section may be designed as a weir with riprap protection.

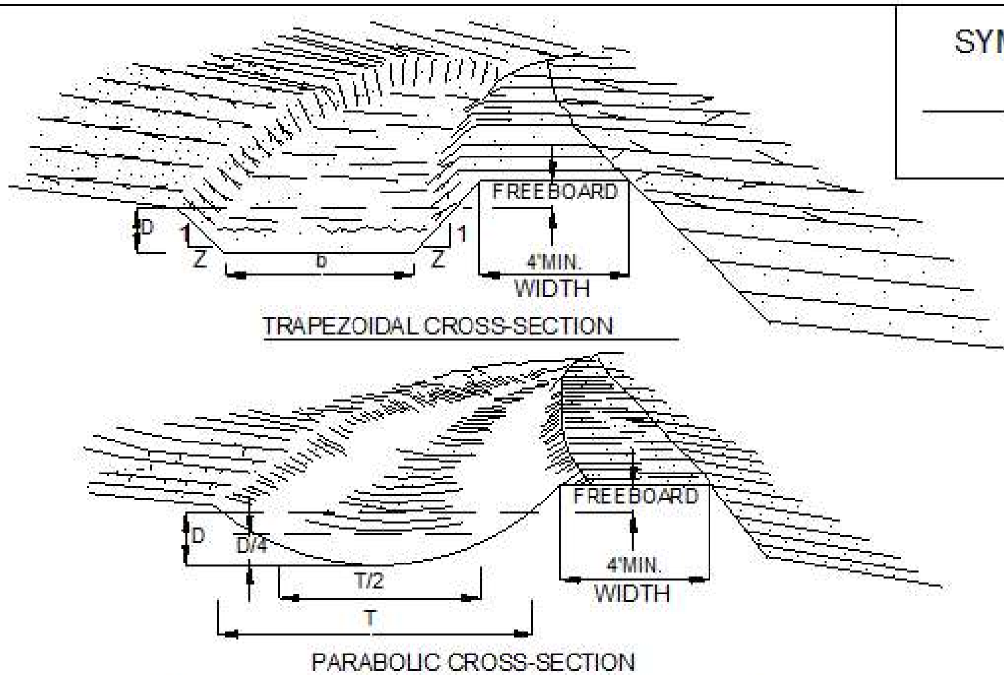
<u>Plans and Specifications</u>

Plans and specifications for installing diversions shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended function. At a minimum include the following items:

1. Diversion location.
2. Channel grade.
3. Diversion cross-sections.
4. Directions for stabilization.
5. Design calculations.
6. Construction detail.

SYMBOL

——— D ———



CONSTRUCTION SPECIFICATIONS

1. ALL TREES, BRUSH, STUMPS, OBSTRUCTIONS, AND OTHER OBJECTIONABLE MATERIAL SHALL BE REMOVED AND DISPOSED OF SO AS NOT TO INTERFERE WITH THE PROPER FUNCTIONING OF THE DIVERSION.
2. THE DIVERSION SHALL BE EXCAVATED OR SHAPED TO LINE, GRADE, AND CROSS SECTION AS REQUIRED TO MEET THE CRITERIA SPECIFIED HEREIN, AND BE FREE OF BANK PROJECTIONS OR OTHER IRREGULARITIES WHICH WILL IMPEDE NORMAL FLOW.
3. FILLS SHALL BE COMPACTED AS NEEDED TO PREVENT UNEQUAL SETTLEMENT THAT WOULD CAUSE DAMAGE IN THE COMPLETE DIVERSION.
4. ALL EARTH REMOVED AND NOT NEEDED IN CONSTRUCTION SHALL BE SPREAD OR DISPOSED OF SO THAT IT WILL NOT INTERFERE WITH THE FUNCTIONING OF THE DIVERSION.
5. STABILIZATION SHALL BE DONE ACCORDING TO THE APPROPRIATE STANDARD AND SPECIFICATIONS FOR VEGETATIVE STABILIZATION.
   A. FOR DESIGN VELOCITIES OF LESS THAN 3.5 FT. PER. SEC., SEEDING AND MULCHING MAY BE USED FOR THE ESTABLISHMENT OF THE VEGETATION. IT IS RECOMMENDED THAT, WHEN CONDITIONS PERMIT, TEMPORARY DIVERSIONS OR OTHER MEANS SHOULD BE USED TO PREVENT WATER FROM ENTERING THE DIVERSION DURING THE ESTABLISHMENT OF THE VEGETATION.
   B. FOR DESIGN VELOCITIES OF MORE THAN 3.5 FT. PER. SEC., THE DIVERSION SHALL BE STABILIZED WITH SOD, WITH SEEDING PROTECTED BY JUTE OR MATTING OR WITH SEEDING AND MULCHING INCLUDING TEMPORARY DIVERSION OF THE WATER UNTIL THE VEGETATION IS ESTABLISHED.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC
ORIGINALLY DEVELOPED BY USDA-NRCS
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVERSION

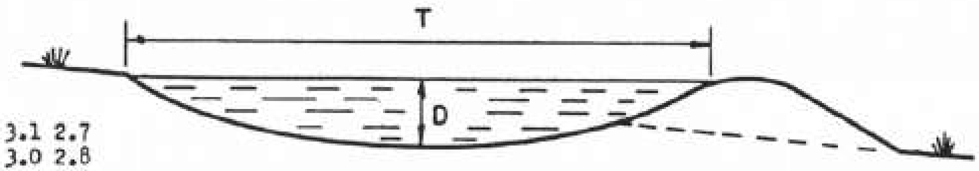
Figure 4.18 Diversion

PARABOLIC DIVERSION DESIGN, WITHOUT FREEBOARD

RETARDANCE - D & C
GRADE, % - 0.25

V_1 Based on Permissible Velocity of the Soil With Retardance "D"
Top Width, Depth & V_2 Based on Retardance "C"

Q	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
cfs	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15																											
20																											
25	10	2.4	1.6																								
30	11	2.3	1.7																								
35	13	2.3	1.7																								
40	15	2.3	1.8	10	2.7	2.1																					
45	17	2.2	1.8	12	2.6	2.2																					
50	19	2.2	1.8	13	2.6	2.2																					
55	20	2.2	1.8	14	2.6	2.3																					
60	22	2.2	1.8	15	2.5	2.3																					
65	24	2.2	1.8	17	2.5	2.3																					
70	26	2.2	1.9	18	2.5	2.3	13	3.1	2.7																		
75	28	2.2	1.9	19	2.5	2.4	13	3.0	2.8																		
80	29	2.2	1.9	20	2.5	2.4	14	3.0	2.8																		
90	33	2.2	1.9	23	2.5	2.4	16	3.0	2.8																		
100	37	2.2	1.9	25	2.5	2.4	18	3.0	2.9																		
110	40	2.2	1.9	28	2.5	2.4	19	2.9	2.9																		
120	44	2.2	1.9	30	2.5	2.4	21	2.9	2.9	15	3.6	3.3															
130	48	2.2	1.9	33	2.5	2.4	23	2.9	2.9	16	3.6	3.3															
140	51	2.2	1.9	35	2.5	2.4	25	2.9	2.9	18	3.5	3.4															
150	55	2.2	1.9	37	2.5	2.4	26	2.9	2.9	19	3.5	3.4															
160	58	2.2	1.9	40	2.5	2.4	28	2.9	3.0	20	3.5	3.4															
170	62	2.2	1.9	42	2.5	2.4	30	2.9	3.0	21	3.5	3.4	17	4.0	3.8												
180	66	2.2	1.9	45	2.5	2.4	31	2.9	3.0	22	3.5	3.5	18	4.0	3.8												
190	69	2.2	1.9	47	2.5	2.4	33	2.9	3.0	24	3.5	3.5	19	4.0	3.9												
200	73	2.2	1.9	50	2.5	2.4	35	2.9	3.0	25	3.4	3.5	19	3.9	3.9												
220	80	2.2	1.9	55	2.5	2.4	38	2.9	3.0	27	3.4	3.5	21	3.9	3.9												
240	87	2.2	1.9	60	2.5	2.5	42	2.9	3.0	30	3.4	3.6	23	3.9	4.0												
260	95	2.2	1.9	65	2.5	2.4	45	2.9	3.0	32	3.4	3.5	25	3.9	4.0	20	4.6	4.3									
280				69	2.5	2.5	49	2.9	3.0	35	3.4	3.6	27	3.9	4.0	21	4.6	4.3									
300				74	2.5	2.5	52	2.9	3.0	37	3.4	3.6	29	3.8	4.1	22	4.5	4.4									



T = Top width, Retardance "C"
D = Flow depth, Retardance "C"
V_1 = Permissible velocity, Retardance "D"
V_2 = Velocity, Retardance "C"

T and D are the dimensions required to carry the design flow. Add freeboard and allowance for settlement as necessary.

Figure 4.19a Parabolic Diversion Design, Without Freeboard 1 (USDA-NRCS)

PARABOLIC DIVERSION DESIGN, WITHOUT FREEBOARD

RETARDANCE - D & C
GRADE, % - 0.50

V_1 Based on Permissible Velocity of the Soil With Retardance "D"
Top Width, Depth & V_2 Based on Retardance "C"

Q	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
cfs	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	9	1.6	1.6																								
20	11	1.6	1.7																								
25	14	1.6	1.7	9	1.9	2.1																					
30	17	1.6	1.7	11	1.9	2.2	8	2.2	2.5																		
35	20	1.6	1.7	12	1.9	2.3	9	2.1	2.6																		
40	22	1.6	1.7	14	1.8	2.3	11	2.1	2.7																		
45	25	1.5	1.7	16	1.8	2.3	12	2.0	2.8																		
50	28	1.5	1.7	18	1.8	2.4	13	2.0	2.8	10	2.4	3.2															
55	31	1.5	1.7	19	1.8	2.4	15	2.0	2.8	11	2.4	3.3															
60	33	1.5	1.7	21	1.8	2.4	16	2.0	2.8	11	2.4	3.3															
65	36	1.5	1.8	23	1.8	2.4	17	2.0	2.9	12	2.4	3.3															
70	39	1.5	1.7	24	1.8	2.4	18	2.0	2.9	13	2.3	3.4															
75	42	1.5	1.8	26	1.8	2.4	19	2.0	2.9	14	2.3	3.4	11	2.7	3.7												
80	44	1.5	1.8	28	1.8	2.4	21	2.0	2.9	15	2.3	3.4	12	2.7	3.8												
90	50	1.5	1.8	31	1.8	2.4	24	2.0	2.9	17	2.3	3.4	13	2.7	3.8												
100	55	1.5	1.8	35	1.8	2.4	26	2.0	2.9	19	2.3	3.5	15	2.6	3.9	12	3.0	4.1									
110	61	1.5	1.8	38	1.8	2.4	29	2.0	2.9	21	2.3	3.5	16	2.6	3.9	13	3.0	4.2									
120	66	1.5	1.8	42	1.8	2.4	31	2.0	2.9	22	2.3	3.5	18	2.6	3.9	14	2.9	4.3									
130	72	1.5	1.8	45	1.8	2.4	34	2.0	2.9	24	2.3	3.5	19	2.6	4.0	15	2.9	4.4									
140	77	1.5	1.8	48	1.8	2.4	36	2.0	2.9	26	2.3	3.5	20	2.6	4.0	16	2.9	4.3									
150	83	1.5	1.8	52	1.8	2.4	39	2.0	2.9	28	2.3	3.5	22	2.6	4.0	18	2.9	4.4	14	3.3	4.8						
160	88	1.5	1.8	55	1.8	2.4	41	2.0	2.9	30	2.3	3.5	23	2.6	4.0	19	2.9	4.4	15	3.3	4.8						
170	93	1.5	1.8	59	1.8	2.4	44	2.0	2.9	32	2.3	3.6	25	2.6	4.0	20	2.9	4.4	16	3.3	4.9						
180	99	1.5	1.8	62	1.8	2.4	47	2.0	2.9	33	2.3	3.6	26	2.6	4.0	21	2.9	4.5	17	3.3	4.9						
190				55	1.8	2.4	49	2.0	2.9	35	2.3	3.6	28	2.6	4.0	22	2.9	4.5	18	3.3	5.0						
200				69	1.8	2.4	52	2.0	2.9	37	2.3	3.6	29	2.6	4.0	23	2.9	4.5	18	3.3	5.0	15	3.7	5.2			
220				76	1.8	2.4	57	2.0	2.9	41	2.3	3.6	32	2.6	4.0	25	2.9	4.5	20	3.2	5.0	17	3.7	5.4			
240				82	1.8	2.5	62	2.0	2.9	44	2.3	3.6	45	2.5	4.1	28	2.9	4.5	22	3.2	5.0	18	3.7	5.4			
260				89	1.8	2.5	67	2.0	2.9	48	2.3	3.6	38	2.6	4.1	30	2.9	4.5	24	3.2	5.1	20	3.5	5.4			
280				96	1.8	2.5	72	2.0	3.0	52	2.3	3.6	40	2.5	4.1	32	2.8	4.6	26	3.2	5.1	21	3.6	5.5	18	4.1	5.8
300							77	2.0	3.0	55	2.3	3.6	43	2.5	4.1	35	2.8	4.6	27	3.2	5.2	23	3.6	5.5	19	4.1	5.8

Figure 4.19b Parabolic Diversion Design, Without Freeboard 2 (USDA-NRCS)

PARABOLIC DIVERSION DESIGN, WITHOUT FREEBOARD

RETARDANCE - D & C
GRADE, % - 0.75

V_1 Based on Permissible Velocity of the Soil With Retardance "D"
Top Width, Depth & V_2 Based on Retardance "C"

Q	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
cfs	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	12	1.3	1.5	7	1.6	2.0																					
20	16	1.3	1.5	9	1.5	2.2																					
25	19	1.3	1.5	11	1.5	2.2	8	1.7	2.6																		
30	23	1.3	1.5	13	1.5	2.2	10	1.7	2.7	8	1.9	3.0															
35	27	1.3	1.5	15	1.5	2.3	11	1.7	2.7	9	1.9	3.1															
40	31	1.3	1.5	18	1.5	2.3	13	1.7	2.8	10	1.9	3.2															
45	35	1.3	1.6	20	1.5	2.3	14	1.7	2.8	11	1.8	3.2															
50	38	1.3	1.6	22	1.5	2.3	16	1.6	2.9	13	1.8	3.3	9	2.2	3.7												
55	42	1.3	1.6	24	1.5	2.3	18	1.6	2.9	14	1.8	3.3	10	2.1	3.8												
60	46	1.3	1.6	26	1.5	2.3	19	1.6	2.8	15	1.8	3.3	11	2.1	3.9												
65	50	1.3	1.6	28	1.5	2.3	21	1.6	2.9	16	1.8	3.3	12	2.1	3.8	10	2.4	4.1									
70	53	1.3	1.6	30	1.5	2.3	22	1.6	2.9	17	1.8	3.3	13	2.1	3.8	11	2.4	4.2									
75	57	1.3	1.6	33	1.5	2.3	24	1.5	2.9	19	1.8	3.3	14	2.1	4.0	11	2.3	4.2									
80	61	1.3	1.6	35	1.5	2.3	25	1.6	2.9	20	1.8	3.4	15	2.1	4.0	12	2.3	4.3									
90	68	1.3	1.6	39	1.5	2.3	28	1.6	2.9	22	1.8	3.4	16	2.1	4.0	13	2.3	4.4	11	2.6	4.6						
100	76	1.3	1.6	43	1.5	2.3	32	1.6	2.9	25	1.8	3.4	18	2.1	4.0	15	2.3	4.4	12	2.6	4.8						
110	83	1.3	1.6	48	1.5	2.3	35	1.6	2.9	27	1.8	3.4	20	2.0	4.0	16	2.3	4.5	13	2.6	4.8						
120	91	1.3	1.6	52	1.5	2.3	38	1.6	2.9	30	1.8	3.4	22	2.1	4.0	18	2.3	4.4	15	2.5	4.9	12	2.9	5.2			
130	98	1.3	1.6	56	1.5	2.4	41	1.6	2.9	32	1.8	3.4	23	2.1	4.0	19	2.2	4.5	16	2.5	4.9	13	2.8	5.3			
140				60	1.5	2.4	44	1.6	2.9	34	1.8	3.4	25	2.0	4.1	21	2.3	4.5	17	2.5	4.9	14	2.8	5.3			
150				65	1.5	2.4	47	1.6	2.9	37	1.8	3.4	27	2.0	4.1	22	2.2	4.5	18	2.5	4.9	15	2.8	5.3			
160				69	1.5	2.4	50	1.6	2.9	39	1.8	3.4	29	2.0	4.1	24	2.2	4.5	19	2.5	4.9	16	2.8	5.4	13	3.1	5.8
170				73	1.5	2.4	53	1.6	2.9	42	1.8	3.4	30	2.0	4.1	25	2.2	4.5	20	2.5	5.0	17	2.8	5.4	14	3.1	5.8
180				77	1.5	2.4	56	1.6	2.9	44	1.8	3.4	32	2.0	4.1	27	2.2	4.5	22	2.5	5.0	18	2.8	5.5	15	3.1	5.9
190				82	1.5	2.4	60	1.6	2.9	47	1.8	3.4	34	2.0	4.1	28	2.2	4.6	23	2.5	5.0	19	2.8	5.5	16	3.1	5.9
200				86	1.5	2.4	63	1.6	3.0	49	1.8	3.4	36	2.0	4.1	29	2.2	4.5	24	2.5	5.0	20	2.7	5.5	16	3.1	5.9
220				94	1.5	2.4	69	1.6	3.0	54	1.8	3.4	39	2.0	4.1	32	2.2	4.6	26	2.5	5.1	22	2.7	5.5	18	3.1	5.9
240							75	1.6	3.0	59	1.8	3.4	43	2.0	4.1	35	2.2	4.6	29	2.5	5.0	24	2.7	5.6	19	3.1	6.0
260							81	1.6	3.0	64	1.8	3.4	46	2.0	4.1	38	2.2	4.6	31	2.5	5.1	26	2.7	5.6	21	3.1	6.1
280							87	1.6	3.0	68	1.8	3.4	50	2.0	4.1	41	2.2	4.6	33	2.5	5.1	27	2.7	5.7	23	3.0	6.1
300							93	1.6	3.0	73	1.8	3.5	53	2.0	4.1	44	2.2	4.6	35	2.5	5.1	29	2.7	5.6	24	3.0	6.1

Figure 4.19c Parabolic Diversion Design, Without Freeboard 3 (USDA-NRCS)

PARABOLIC DIVERSION DESIGN, WITHOUT FREEBOARD

RETARDANCE - D & C
GRADE, % - 1.0

V_1 based on Permissible Velocity of the Soil With Retardance "D"
Top Width, Depth & V_2 Based on Retardance "C"

Q	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
cfs	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	13	1.1	1.5	8	1.3	2.0																					
20	18	1.1	1.5	11	1.3	2.1	8	1.5	2.6																		
25	22	1.1	1.5	14	1.3	2.1	9	1.5	2.6	8	1.6	3.0															
30	27	1.1	1.5	17	1.3	2.1	11	1.5	2.7	9	1.6	3.0															
35	31	1.1	1.5	19	1.3	2.2	13	1.5	2.8	11	1.6	3.1	8	1.8	3.6												
40	35	1.1	1.5	22	1.3	2.1	15	1.4	2.8	12	1.5	3.1	9	1.8	3.7												
45	40	1.1	1.5	25	1.3	2.2	17	1.5	2.8	13	1.6	3.2	10	1.8	3.7												
50	44	1.1	1.5	28	1.3	2.2	19	1.4	2.8	15	1.6	3.2	11	1.8	3.7	9	2.0	4.2									
55	46	1.1	1.5	30	1.3	2.2	20	1.4	2.8	16	1.5	3.3	12	1.8	3.8	10	2.0	4.3									
60	53	1.1	1.5	33	1.3	2.2	22	1.4	2.8	18	1.5	3.3	14	1.7	3.8	10	2.0	4.3									
65	57	1.1	1.5	36	1.3	2.2	24	1.4	2.8	19	1.5	3.3	15	1.7	3.8	11	2.0	4.3	9	2.2	4.7						
70	61	1.1	1.5	38	1.3	2.2	26	1.4	2.8	21	1.5	3.3	16	1.7	3.9	12	2.0	4.4	10	2.2	4.7						
75	66	1.1	1.5	41	1.3	2.2	28	1.4	2.9	22	1.5	3.3	17	1.7	3.9	13	2.0	4.5	11	2.2	4.7						
80	70	1.1	1.5	44	1.3	2.2	29	1.4	2.9	24	1.5	3.3	18	1.7	3.9	14	2.0	4.4	11	2.2	4.9						
90	79	1.1	1.5	49	1.3	2.2	33	1.4	2.9	27	1.5	3.3	20	1.7	3.9	15	1.9	4.5	13	2.2	4.9	11	2.4	5.2			
100	87	1.1	1.5	55	1.3	2.2	37	1.4	2.9	29	1.5	3.3	22	1.7	3.9	17	1.9	4.5	14	2.2	4.9	12	2.4	5.3			
110	96	1.1	1.5	60	1.3	2.2	40	1.4	2.9	32	1.5	3.3	24	1.7	3.9	19	1.9	4.5	15	2.1	5.0	13	2.4	5.3	11	2.6	5.7
120				65	1.3	2.2	44	1.4	2.9	35	1.5	3.3	27	1.7	4.0	20	1.9	4.6	17	2.1	5.0	14	2.4	5.4	12	2.6	5.7
130				71	1.3	2.2	47	1.4	2.9	38	1.5	3.3	29	1.7	4.0	22	1.9	4.6	18	2.1	5.0	15	2.4	5.4	13	2.6	5.8
140				76	1.3	2.2	51	1.4	2.9	41	1.5	3.3	31	1.7	4.0	24	1.9	4.6	20	2.1	5.0	16	2.3	5.5	14	2.6	5.8
150				81	1.3	2.2	55	1.4	2.9	44	1.5	3.3	33	1.7	4.0	25	1.9	4.6	21	2.1	5.1	17	2.4	5.5	15	2.6	5.8
160				87	1.3	2.2	58	1.4	2.9	47	1.5	3.3	35	1.7	4.0	27	1.9	4.6	22	2.1	5.1	19	2.3	5.5	16	2.5	6.0
170				92	1.3	2.2	62	1.4	2.9	50	1.5	3.3	38	1.7	4.0	29	1.9	4.6	24	2.1	5.1	20	2.3	5.7	17	2.5	5.9
180				97	1.3	2.2	65	1.4	2.9	53	1.5	3.4	40	1.7	4.0	30	1.9	4.6	25	2.1	5.1	21	2.3	5.6	18	2.5	5.9
190							69	1.4	2.9	55	1.5	3.4	42	1.7	4.0	32	1.9	4.6	26	2.1	5.1	22	2.3	5.6	19	2.5	6.0
200							72	1.4	2.9	58	1.5	3.4	44	1.7	4.0	34	1.9	4.7	28	2.1	5.1	23	2.3	5.6	20	2.5	6.0
220							80	1.4	2.9	64	1.5	3.4	48	1.7	4.0	37	1.9	4.6	31	2.1	5.1	25	2.3	5.6	22	2.5	6.1
240							87	1.4	2.9	70	1.5	3.4	53	1.7	4.0	40	1.9	4.7	33	2.1	5.1	28	2.3	5.7	24	2.5	6.1
260							94	1.4	2.9	76	1.5	3.4	57	1.7	4.0	44	1.9	4.7	36	2.1	5.1	30	2.3	5.4	26	2.5	6.1
280										81	1.5	3.4	61	1.7	4.0	47	1.9	4.7	39	2.1	5.1	32	2.3	5.6	28	2.5	6.2
300										87	1.5	3.4	66	1.7	4.0	50	1.9	4.7	42	2.1	5.1	34	2.3	5.7	30	2.5	6.1

Figure 4.19d Parabolic Diversion Design, Without Freeboard 4 (USDA-NRCS)

PARABOLIC DIVERSION DESIGN, WITHOUT FREEBOARD

RETARDANCE - D & C
GRADE, % - 1.5

V_1 Based on Permissible Velocity of the Soil With Retardance "D"
Top Width, Depth & V_2 Based on Retardance "C"

Q	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0		
cfs	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	17	0.9	1.4	11	1.1	1.9	8	1.2	2.4						
20	23	0.9	1.4	15	1.0	1.9	10	1.2	2.5	7	1.4	3.0	5	1.5	3.4
25	28	0.9	1.4	19	1.0	1.9	12	1.2	2.6	8	1.4	3.2	7	1.5	3.6
30	34	0.9	1.4	22	1.0	1.9	15	1.2	2.6	10	1.3	3.2	8	1.5	3.6
35	40	0.9	1.4	26	1.0	2.0	17	1.1	2.6	12	1.3	3.3	10	1.4	3.7
40	45	0.9	1.4	30	1.0	1.9	20	1.2	2.6	14	1.3	3.3	11	1.4	3.7
45	51	0.9	1.4	33	1.0	2.0	22	1.1	2.6	15	1.3	3.4	12	1.4	3.8
50	56	0.9	1.4	37	1.0	2.0	25	1.1	2.7	17	1.3	3.4	14	1.4	3.9
55	62	0.9	1.5	41	1.0	2.0	27	1.1	2.6	19	1.3	3.4	15	1.4	3.9
60	67	0.9	1.5	44	1.0	2.0	30	1.1	2.7	20	1.3	3.4	16	1.4	3.9
65	73	0.9	1.5	48	1.0	2.0	32	1.1	2.7	22	1.3	3.4	18	1.4	3.9
70	78	0.9	1.5	51	1.0	2.0	34	1.1	2.7	24	1.3	3.4	19	1.4	3.9
75	83	0.9	1.5	55	1.0	2.0	37	1.1	2.7	25	1.3	3.4	21	1.4	3.9
80	89	0.9	1.5	59	1.0	2.0	39	1.1	2.7	27	1.3	3.4	22	1.4	3.9
90	100	0.9	1.5	66	1.0	2.0	44	1.1	2.7	30	1.3	3.5	25	1.4	3.9
100				73	1.0	2.0	49	1.1	2.7	33	1.3	3.5	27	1.4	3.9
110				80	1.0	2.0	54	1.1	2.7	37	1.3	3.5	30	1.4	3.9
120				87	1.0	2.0	58	1.1	2.7	40	1.3	3.5	33	1.4	4.0
130				95	1.0	2.0	63	1.1	2.7	43	1.3	3.5	35	1.4	3.9
140							68	1.1	2.7	47	1.3	3.5	38	1.4	4.0
150							73	1.1	2.7	50	1.3	3.5	41	1.4	4.0
160							78	1.1	2.7	53	1.3	3.5	43	1.4	4.0
170							82	1.1	2.7	56	1.3	3.5	46	1.4	4.0
180							87	1.1	2.7	60	1.3	3.5	49	1.4	4.0
190							92	1.1	2.7	63	1.3	3.5	51	1.4	4.0
200							97	1.1	2.7	66	1.3	3.5	54	1.4	4.0
220										73	1.3	3.5	59	1.4	4.0
240										79	1.3	3.5	65	1.4	4.0
260										86	1.3	3.5	70	1.4	4.0
280										92	1.3	3.5	75	1.4	4.0
300										99	1.3	3.5	81	1.4	4.0

Q	V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
cfs	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15												
20												
25												
30	7	1.6	4.0									
35	8	1.6	4.1									
40	9	1.6	4.2	7	1.8	4.6						
45	10	1.5	4.3	8	1.8	4.6						
50	11	1.5	4.3	9	1.8	4.8						
55	12	1.5	4.3	10	1.7	4.9	8	1.9	5.1			
60	14	1.5	4.4	11	1.7	4.9	9	1.9	5.2			
65	15	1.5	4.4	11	1.7	5.0	10	1.9	5.3			
70	16	1.5	4.4	12	1.7	4.9	10	1.9	5.4	9	2.1	5.6
75	17	1.5	4.4	13	1.7	5.0	11	1.9	5.4	9	2.1	5.6
80	18	1.5	4.4	14	1.7	5.0	12	1.9	5.5	10	2.1	5.8
90	20	1.5	4.4	15	1.7	5.0	13	1.9	5.4	11	2.0	5.9
100	22	1.5	4.5	17	1.7	5.1	15	1.9	5.5	12	2.0	6.0
110	25	1.5	4.5	19	1.7	5.1	16	1.8	5.6	14	2.0	6.0
120	27	1.5	4.5	21	1.7	5.1	18	1.9	5.5	15	2.0	6.0
130	29	1.5	4.5	22	1.7	5.1	19	1.8	5.5	15	2.0	6.1
140	31	1.5	4.5	24	1.7	5.2	20	1.8	5.5	17	2.0	6.1
150	33	1.5	4.5	26	1.7	5.2	22	1.8	5.6	19	2.0	6.1
160	36	1.5	4.5	27	1.7	5.2	23	1.8	5.6	20	2.0	6.1
170	38	1.5	4.5	29	1.7	5.2	25	1.8	5.5	21	2.0	6.1
180	40	1.5	4.5	31	1.7	5.2	26	1.8	5.7	22	2.0	6.1
190	42	1.5	4.5	33	1.7	5.2	27	1.8	5.7	23	2.0	6.2
200	44	1.5	4.5	34	1.7	5.2	29	1.8	5.6	24	2.0	6.2
220	49	1.5	4.5	38	1.7	5.2	32	1.8	5.7	27	2.0	6.2
240	53	1.5	4.5	41	1.7	5.2	35	1.8	5.7	29	2.0	6.2
260	57	1.5	4.5	44	1.7	5.2	37	1.8	5.7	32	2.0	6.2
280	62	1.5	4.5	48	1.7	5.2	40	1.8	5.7	34	2.0	6.2
300	66	1.5	4.5	51	1.7	5.2	43	1.8	5.7	36	2.0	6.2

Figure 4.19e Parabolic Diversion Design, Without Freeboard 5 (USDA-NRCS)

PARABOLIC DIVERSION DESIGN, WITHOUT FREEBOARD

RETARDANCE - D & C
GRADE, % - 2.0

V_1 Based on Permissible Velocity of the Soil With Retardance "D"
Top Width, Depth & V_2 based on Retardance "C"

Q	V_1 = 2.0			V_1 = 2.5			V_1 = 3.0			V_1 = 3.5			V_1 = 4.0			V_1 = 4.5			V_1 = 5.0			V_1 = 5.5			V_1 = 6.0		
cfs	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2	T	D	V_2
15	21	0.8	1.3	13	0.9	1.9	9	1.0	2.4	7	1.2	2.9															
20	28	0.8	1.3	17	0.9	1.9	12	1.0	2.4	9	1.1	3.0	7	1.3	3.5	5	1.4	3.8									
25	35	0.8	1.3	21	0.9	1.9	15	1.0	2.4	11	1.1	3.0	8	1.3	3.7	7	1.4	4.0									
30	41	0.8	1.3	26	0.9	1.9	18	1.0	2.5	13	1.1	3.0	10	1.2	3.7	8	1.3	4.2	7	1.5	4.5						
35	48	0.8	1.4	30	0.9	1.9	22	1.0	2.4	15	1.1	3.1	11	1.2	3.8	9	1.3	4.2	8	1.5	4.7						
40	55	0.8	1.3	34	0.9	1.9	25	1.0	2.5	18	1.1	3.1	13	1.2	3.8	11	1.3	4.3	9	1.5	4.7	7	1.7	5.0			
45	62	0.8	1.4	38	0.9	1.9	28	1.0	2.5	20	1.1	3.1	14	1.2	3.8	12	1.3	4.3	10	1.4	4.8	8	1.6	5.2			
50	68	0.8	1.4	42	0.9	1.9	31	1.0	2.5	22	1.1	3.1	16	1.2	3.9	13	1.3	4.3	11	1.4	4.8	9	1.6	5.3	8	1.7	5.6
55	75	0.8	1.4	46	0.9	1.9	34	1.0	2.5	24	1.1	3.1	17	1.2	3.8	14	1.3	4.3	12	1.4	4.9	10	1.6	5.3	8	1.7	5.8
60	82	0.8	1.4	51	0.9	1.9	37	1.0	2.5	26	1.1	3.1	19	1.2	3.9	16	1.3	4.4	13	1.4	4.8	11	1.6	5.3	9	1.7	5.7
65	88	0.8	1.4	55	0.9	1.9	40	1.0	2.5	28	1.1	3.1	21	1.2	3.9	17	1.3	4.4	14	1.4	4.9	11	1.6	5.4	10	1.7	5.7
70	95	0.8	1.4	59	0.9	1.9	43	1.0	2.5	30	1.1	3.1	22	1.2	3.9	18	1.3	4.4	15	1.4	4.9	12	1.6	5.4	10	1.7	5.8
75				63	0.9	1.9	46	1.0	2.5	32	1.1	3.2	24	1.2	3.9	20	1.3	4.4	16	1.4	5.0	13	1.6	5.5	11	1.7	5.9
80				67	0.9	2.0	48	1.0	2.5	35	1.1	3.1	25	1.2	3.9	21	1.3	4.4	17	1.4	4.9	14	1.6	5.4	12	1.7	6.0
90				75	0.9	2.0	54	1.0	2.5	39	1.1	3.2	28	1.2	3.9	23	1.3	4.4	19	1.4	4.9	16	1.6	5.5	13	1.7	5.9
100				83	0.9	2.0	60	1.0	2.5	43	1.1	3.2	31	1.2	3.9	26	1.3	4.4	21	1.4	5.0	17	1.6	5.5	15	1.7	6.0
110				92	0.9	2.0	66	1.0	2.5	47	1.1	3.2	34	1.2	3.9	28	1.3	4.4	23	1.4	5.0	19	1.5	5.6	16	1.7	6.0
120				100	0.9	2.0	72	1.0	2.5	52	1.1	3.2	38	1.2	3.9	31	1.3	4.4	26	1.4	5.0	21	1.5	5.6	18	1.7	6.1
130							78	1.0	2.5	56	1.1	3.2	41	1.2	3.9	34	1.3	4.5	28	1.4	5.0	23	1.5	5.6	19	1.7	6.0
140							84	1.0	2.5	60	1.1	3.2	44	1.2	4.0	36	1.3	4.5	30	1.4	5.0	24	1.5	5.6	21	1.7	6.1
150							90	1.0	2.5	64	1.1	3.2	47	1.2	4.0	39	1.3	4.5	32	1.4	5.0	26	1.5	5.6	22	1.7	6.1
160							96	1.0	2.5	69	1.1	3.2	50	1.2	4.0	41	1.3	4.5	34	1.4	5.1	28	1.5	5.6	23	1.7	6.1
170										73	1.1	3.2	53	1.2	4.0	44	1.3	4.5	36	1.4	5.1	29	1.5	5.7	25	1.7	6.1
180										77	1.1	3.2	56	1.2	4.0	46	1.3	4.5	38	1.4	5.0	31	1.5	5.7	26	1.7	6.1
190										81	1.1	3.2	59	1.2	4.0	49	1.3	4.5	40	1.4	5.0	33	1.5	5.7	28	1.7	6.1
200										85	1.1	3.2	62	1.2	4.0	51	1.3	4.5	42	1.4	5.0	34	1.5	5.7	29	1.7	6.2
220										94	1.1	3.2	68	1.2	4.0	56	1.3	4.5	46	1.4	5.1	38	1.5	5.7	32	1.7	6.2
240													74	1.2	4.0	61	1.3	4.5	51	1.4	5.1	41	1.5	5.7	35	1.7	6.2
260													80	1.2	4.0	66	1.3	4.5	55	1.4	5.1	45	1.5	5.7	38	1.7	6.2
280													86	1.2	4.0	71	1.3	4.5	59	1.4	5.1	48	1.5	5.7	41	1.7	6.2
300													92	1.2	4.0	76	1.3	4.5	63	1.4	5.1	51	1.5	5.7	44	1.7	6.2

Figure 4.19f Parabolic Diversion Design, Without Freeboard 6 (USDA-NRCS)

Part 4 - Earth Dike

Definition

A temporary berm or ridge of compacted soil, located in such a manner as to channel water to a desired location.

Purpose

The purpose of an earth dike is to direct runoff to a sediment trapping device, thereby reducing the potential for erosion and off site sedimentation. Earth dikes can also be used for diverting clean water away from disturbed areas.

Conditions Where Practice Applies

Earth dikes are often constructed across disturbed areas and around construction sites such as graded parking lots and subdivisions. The dikes shall remain in place until the disturbed areas are permanently stabilized.

Design Criteria

	Dike A	**Dike B**
Drainage Area	<5 acres	5-10 acres
Dike Height	18 inches	36 inches
Dike Width	24 inches	36 inches
Flow Width	4 feet	6 feet
Flow Depth in Channel	8 inches	15 inches
Side Slopes	2:1 or flatter	2:1 or flatter
Grade	0.5% min. 20% max.	0.5% min. 20% max.

For drainage areas larger than 10 acres, refer to the standards and specifications for Diversion.

Outlet - Earth dikes shall have an outlet that functions with a minimum of erosion.

Runoff shall be conveyed to a sediment trapping device until the drainage area above the dike is adequately stabilized.

The on-site location may need to be adjusted to meet field conditions in order to utilize the most suitable outlet.

Stabilization - Stabilization of the dike shall be completed within 48 hours of installation in accordance with the standard and specifications for seed and straw mulch or straw mulch only if not in seeding season and flow channel shall be stabilized as per the following criteria:

Type of treatment	**Channel Grade[1]**	**Flow Channel A (<5 acres)**	**Flow Channel B (5-10 acres)**
1	0.5-3.0%	Seed and Straw Mulch	Seed and Straw Mulch
2	3.1-5.0%	Seed and Straw Mulch	Seed and cover with RECP, Sod, or Line with Plastic or 2' Stone
3	5.1-8.0%	Seed and cover with RECP, Sod, or Line with Plastic or 2" Stone	Line with 4-8" Stone or Recycled Concrete Equivalent or Geotextile
4	8.1-20%	Line with 4-8" Stone or Recycled Concrete Equivalent[2] or Geotextile	Site Specific Engineering Design

1 In highly erodible soils, as defined by the local approving agency, refer to the next higher slope grade for type of stabilization.

2 Recycled Concrete Equivalent shall be concrete broken into the required size, and shall contain no steel reinforcement.

Part 4 - Earth Dike

Considerations

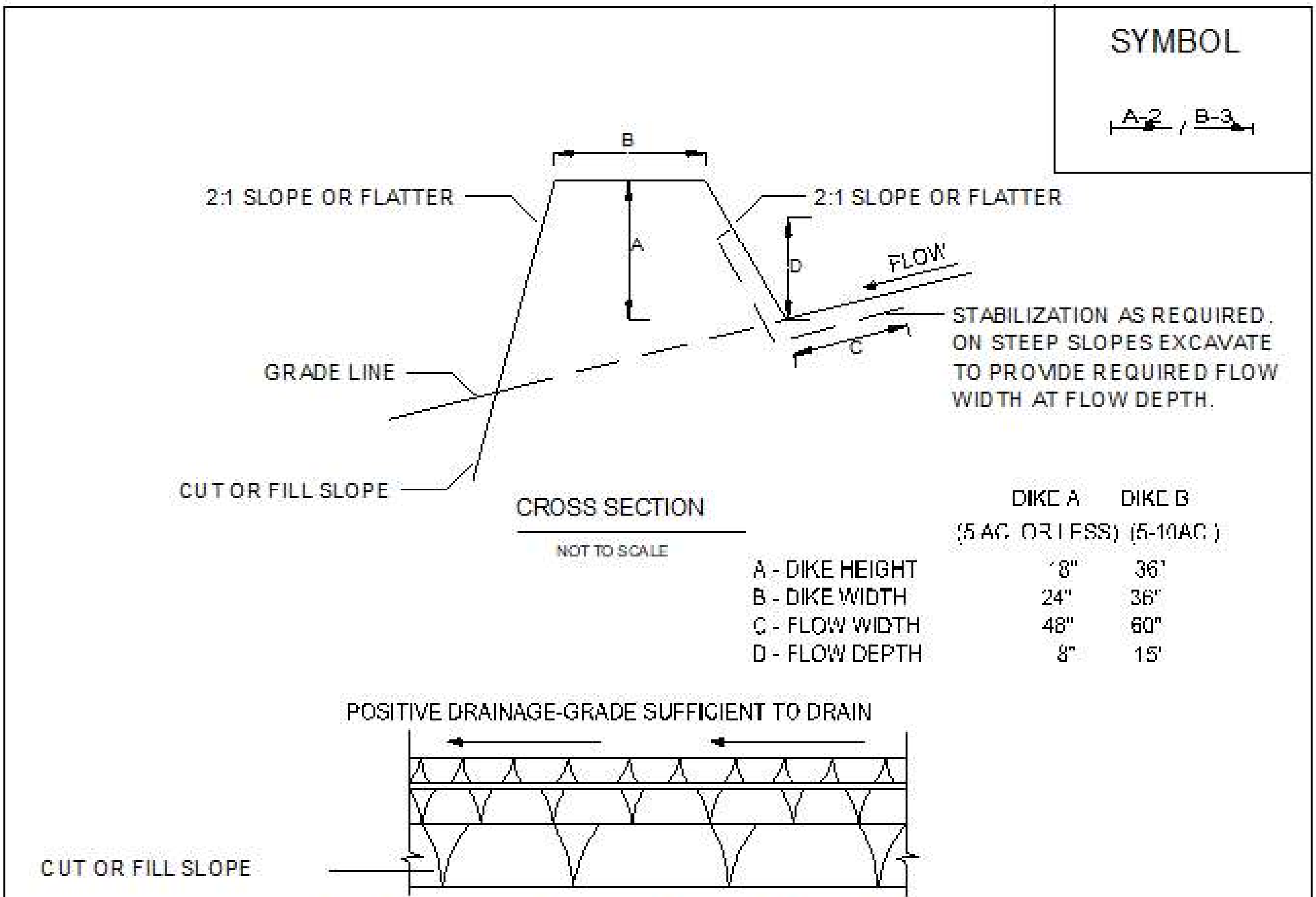
An earth dike is a special application of a temporary or permanent diversion. It differs from other diversions in that the location and grade are usually fixed, and the cross section and stabilization requirements are based on the existing grade of the work boundary. Hence, the design cross section may vary significantly throughout the length. Give special care to avoid erosive velocities in steep areas. Identify areas where sedimentation will occur since they are often subject to overtopping. Earth dikes should be protected from damage from ongoing construction activities.

Immediately vegetate diversion dikes after construction, but make sure channel flow area is stabilized during the initial phase of construction. Exercise caution in diverting flow to be certain that the diverted water is released through a stable outlet and that the flow will not cause flood damage. Sediment laden water should first be directed through an approved sediment-trapping device before entering receiving surface waters.

Plans and Specifications

The plans and specifications for installing earth dikes shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Diversion dike location.
2. Minimum cross-sections.
3. Channel grade.
4. Seeding requirements.
5. Construction detail.



CONSTRUCTION SPECIFICATIONS

1. ALL DIKES SHALL BE COMPACTED BY EARTH-MOVING EQUIPMENT.
2. ALL DIKES SHALL HAVE POSITIVE DRAINAGE TO AN OUTLET.
3. TOP WIDTH MAY BE WIDER AND SIDE SLOPES BE FLATTER IF DESIRED TO FACILITATE CONSTRUCTION TRAFFIC.
4. FIELD LOCATION SHOULD BE ADJUSTED AS NEEDED TO UTILIZE A STABILIZED SAFE OUTLET.
5. EARTH DIKES SHALL HAVE AN OUTLET THAT FUNCTIONS WITH A MINIMUM OF EROSION. RUNOFF SHALL BE CONVEYED TO A SEDIMENT TRAPPING DEVICE SUCH AS A SEDIMENT TRAP OR SEDIMENT BASIN WHERE EITHER THE DIKE CHANNEL OR THE DRAINAGE AREA ABOVE THE DIKE ARE NOT ADEQUATELY STABILIZED.
6. STABILIZATION SHALL BE: (A) IN ACCORDANCE WITH STANDARD SPECIFICATIONS FOR MULCH IF NOT IN SEEDING SEASON OR (B) PER THE FOLLOWING CHART:

TYPE OF TREATMENT	CHANNEL GRADE	A(5 AC. OR LESS)	B(5 AC -10AC)
1	0.5-3.0%	SEED AND STRAW MULCH	SEED AND STRAW MULCH
2	3.1-5.0%	SEED AND STRAW MULCH	SEED AND COVER USING RECP
3	5.1-8.0%	SEED AND COVER WITH RECP	LINED WITH 4-8" RIP-RAP OR
4	8.1-20.%	LINED WITH 4-8" RIP-RAP	ENGINEERED DESIGN

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VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

EARTH DIKE

Figure 4.20 Earth Dike

Part 4 - Temporary Swale

Definition

A temporary excavated drainage way.

Purpose

The purpose of a temporary swale is to prevent runoff from entering disturbed areas by intercepting and diverting it to a stabilized outlet or to intercept sediment laden water and divert it to a sediment trapping device.

Conditions Where Practice Applies

Temporary swales are constructed:

1. To divert flows from entering a disturbed area.
2. Intermittently across disturbed areas to shorten overland flow distances.
3. To direct sediment laden water along the base of slopes to a trapping device.
4. To transport off-site flows across disturbed areas such as rights-of-way.

Swales collecting runoff from disturbed areas shall remain in place until the disturbed areas are permanently stabilized.

Stabilization - Stabilization of the swale shall be completed within 7 days of installation in accordance with the appropriate standard and specifications for vegetative stabilization or stabilization with mulch as determined by the time of year. The flow channel shall be stabilized as per the following criteria:

Type of Treatment	Channel Grade[1]	Flow Channel A (<5 acres)	Flow Channel B (5-10 acres)
1	0.5-3.0%	Seed and Straw Mulch	Seed and Straw Mulch
2	3.1-5.0%	Seed and Straw Mulch	Seed and cover with RECP, Sod, or Line with Plastic or 2' Stone
3	5.1-8.0%	Seed and cover with RECP, Sod, or Line with Plastic or 2" Stone	Line with 4-8" Stone or Recycled Concrete Equivalent or Geotextile
4	8.1-20%	Line with 4-8" Stone or Recycled Concrete Equivalent[2] or Geotextile	Site Specific Engineering Design

1 In highly erodible soils, as defined by the local approving agency, refer to the next higher slope grade for type of stabilization.
2 Recycled Concrete Equivalent shall be concrete broken into the required size, and shall contain no steel reinforcement.

Outlet - Swale shall have an outlet that functions with a minimum of erosion, and dissipates runoff velocity prior to discharge off the site.

Runoff shall be conveyed to a sediment trapping device such as a sediment trap or sediment basin until the drainage area above the swale is adequately stabilized.

The on-site location may need to be adjusted to meet field conditions in order to utilize the most suitable outlet condition.

If a swale is used to divert clean water flows from entering a disturbed area, a sediment trapping device may not be needed.

Design Criteria

	Swale A	Swale B
Drainage Area	<5 acres	5-10 acres
Bottom Width of Flow Channel	4 feet	6 feet
Depth of Flow Channel	1 foot	1 foot
Side Slopes	2:1 or flatter	2:1 or flatter
Grade	0.5% min. 20% max.	0.5% min. 20% max.

Considerations

It is important that temporary swales are properly designed, constructed and maintained since they concentrate water flow and increase erosion potential. Particular care must be taken in planning temporary swale grades. Too much slope can result in erosion in the channel or at the outlet. A change of slope from steeper grade to flatter may cause deposition to occur. The deposition reduces carrying capacity and may cause overtopping and failure. Frequent inspection and timely maintenance are essential to the proper functioning of temporary swales. Sufficient area must be available to construct and properly maintain temporary swales.

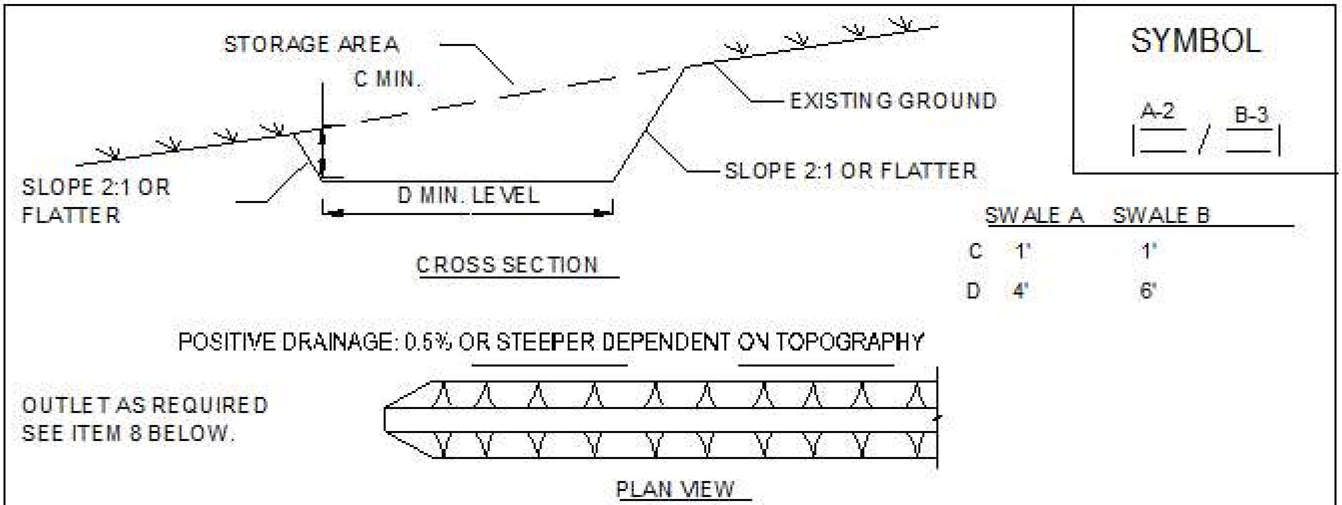
Temporary swales may serve as in-place sediment traps if over excavated 1 to 2' and placed on a nearly flat grade. The dike serves to divert water as the stage increases. Wherever feasible, build and stabilize temporary swales and outlets before initiating other land-disturbing activities.

Plans and Specifications

Plans and specifications for installing temporary swales shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Temporary swale location.
2. Channel grade.
3. Swale cross-sections.
4. Stabilization directions.
5. Appropriate outlet protection.
6. Construction detail.

Part 4 - Temporary Swale



CONSTRUCTION SPECIFICATIONS

1. ALL TEMPORARY SWALES SHALL HAVE UNINTERUPTED POSITIVE GRADE TO AN OUTLET.
2. DIVERTED RUNOFF FROM A DISTURBED AREA SHALL BE CONVEYED TO A SEDIMENT TRAPPING DEVICE.
3. DIVERTED RUNOFF FROM AN UNDISTURBED AREA SHALL OUTLET DIRECTLY INTO AN UNDISTURBED STABILIZED AREA AT NON-EROSIVE VELOCITY.
4. ALL TREES, BRUSH, STUMPS, OBSTRUCTIONS, AND OTHER OBJECTIONABLE MATERIAL SHALL BE REMOVED AND DISPOSED OF SO AS NOT TO INTERFERE WITH THE PROPER FUNCTIONING OF THE SWALE.
5. THE SWALE SHALL BE EXCAVATED OR SHAPED TO LINE, GRADE, AND CROSS SECTION AS REQUIRED TO MEET THE CRITERIA SPECIFIED HEREIN AND BE FREE OF BANK PROJECTIONS OR OTHER IRREGULARITIES WHICH WILL IMPEDE NORMAL FLOW.
6. FILLS SHALL BE COMPACTED BY EARTH MOVING EQUIPMENT.
7. ALL EARTH REMOVED AND NOT NEEDED FOR CONSTRUCTION SHALL BE PLACED SO THAT IT WILL NOT INTERFERE WITH THE FUNCTIONING OF THE SWALE.
8. STABILIZATION SHALL BE AS PER THE FLOW CHANNEL STABILIZATION CHART BELOW:

TYPE OF TREATMENT	CHANNEL GRADE	A(5 AC. OR LESS)	B(5 AC -10AC)
1	0.5-3.0%	SEED AND STRAW MULCH	SEED AND STRAW MULCH
2	3.1-5.0%	SEED AND STRAW MULCH	SEED AND COVER USING RECP
3	5.1-8.0%	SEED AND COVER WITH RECP	LINED WITH 4-8" RIP-RAP OR GEOTEXTILE
4	8.1-20.%	LINED WITH 4-8" RIP-RAP OR GEOTEXTILE	ENGINEERED DESIGN

9. PERIODIC INSPECTION AND REQUIRED MAINTENANCE MUST BE PROVIDED AFTER EACH RAIN EVENT AND AS REQUIRED BY THE PERMIT.

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TEMPORARY SWALE

Figure 4.21 Temporary Swale

Part 4 - Perimeter Dike/Swale

Definition

A temporary ridge of soil excavated from an adjoining swale located along the perimeter of the site or disturbed area.

Purpose

The purpose of a perimeter dike/swale is to prevent off site storm runoff from entering a disturbed area and to prevent sediment laden storm runoff from leaving the construction site or disturbed area.

Conditions Where Practice Applies

Perimeter dike/swale is constructed to divert flows from entering a disturbed area, or along tops of slopes to prevent flows from eroding the slope, or along base of slopes to direct sediment laden flows to a trapping device.

The perimeter dike/swale shall remain in place until the disturbed areas are permanently stabilized.

Design Criteria

A design is not required for perimeter dike/swale. The following criteria shall be used:

Drainage area – Less than 2 acres (for drain age areas larger than 2 acres but less than 10 acres, see earth dike or temporary swale; for drainage areas larger than 10 acres, see standard and specifications for diversion).

Height – 18 inches minimum from bottom of swale to top of dike evenly divided between dike height and swale depth.

Bottom Width of Dike– 24 inches minimum.

Width of Swale – 24 inches minimum.

Grade – Dependent upon topography, but shall have positive drainage (sufficient grade to drain) to an adequate outlet. Maximum allowable grade not to exceed 8 percent.

Stabilization – The disturbed area of the dike and swale shall be stabilized within 7 days of installation, in accordance with the standard and specifications for temporary swales.

Outlet

1. Perimeter dike/swale shall have a stabilized outlet.
2. Diverted runoff from a protected or stabilized upland area shall outlet directly onto an undisturbed stabilized area.
3. Diverted runoff from a disturbed or exposed upland area shall be conveyed to a sediment trapping device such as a sediment trap, sediment basin, or to an area protected by any of these practices.
4. The on-site location may need to be adjusted to meet field conditions in order to utilize the most suitable outlet.

Considerations

It is important that perimeter dikes are properly designed, constructed and maintained since they concentrate water flow and increase erosion potential. Particular care must be taken in planning perimeter dike grades. Too much slope can result in erosion in the channel or at the outlet. A change of slope from steeper grade to flatter may cause deposition to occur. The deposition reduces carrying capacity and may cause overtopping and failure. Frequent inspection and timely maintenance are essential to the proper functioning of perimeter dikes.

Perimeter dikes may serve as in-place sediment traps if over excavated 1 to 2 feet and placed on a nearly flat grade. The dike serves to divert water as the stage increases. Wherever feasible, build and stabilize temporary swales and outlets before initiating other land-disturbing activities.

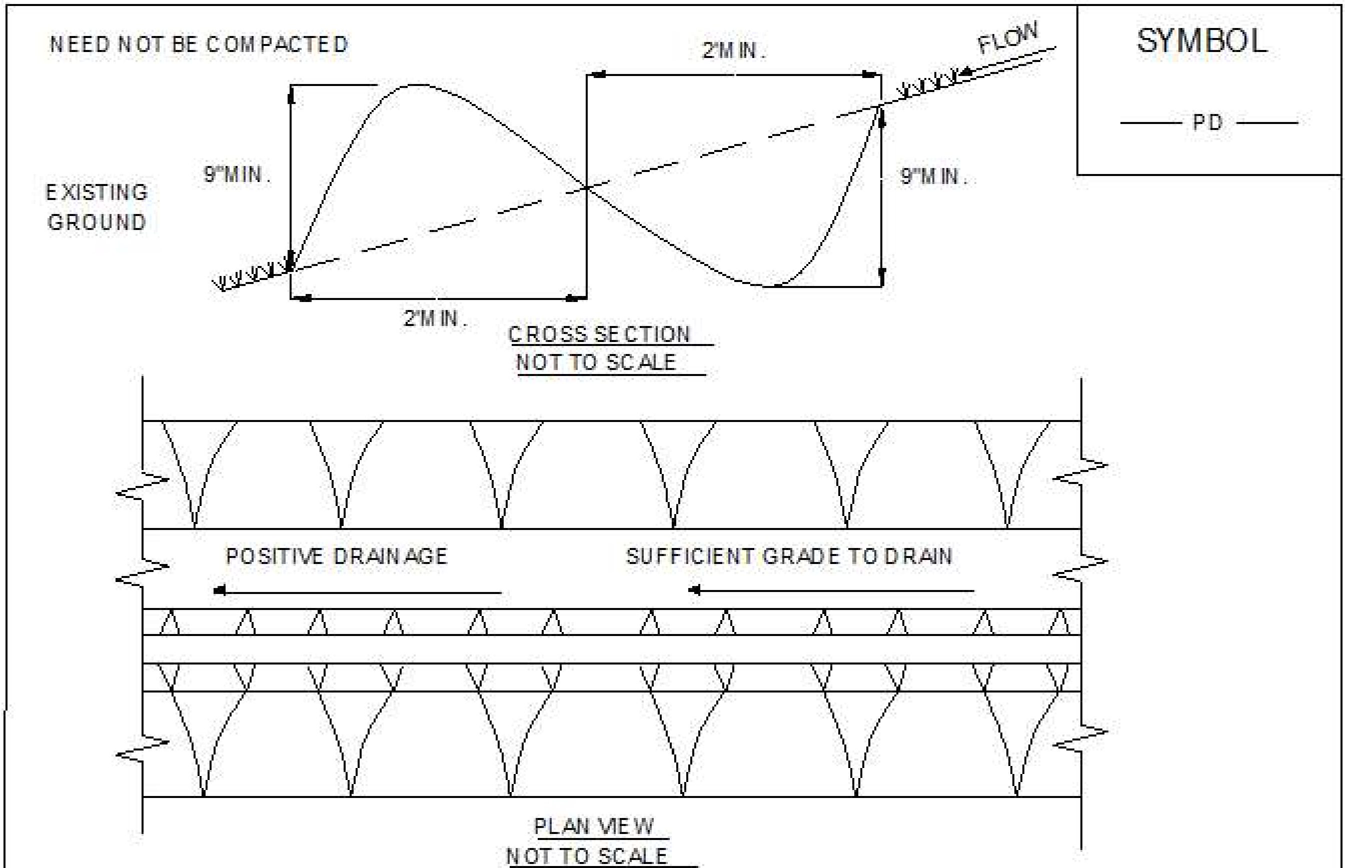
Part 4 - Perimeter Dike/Swale

Plans and Specifications

Plans and specifications for installing perimeter dikes shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Perimeter dike location.
2. Channel grade.
3. Dike/swale cross-sections.
4. Stabilization directions.
5. Appropriate outlet protection
6. Construction detail.

Part 4 - Perimeter Dike/Swale



CONSTRUCTION SPECIFICATIONS

1. ALL PERIMETER DIKE/SWALE SHALL HAVE UNINTERRUPTED POSITIVE GRADE TO AN OUTLET.
2. DIVERTED RUNOFF FROM A DISTURBED AREA SHALL BE CONVEYED TO A SEDIMENT TRAPPING DEVICE.
3. DIVERTED RUNOFF FROM AN UNDISTURBED AREA SHALL OUTLET INTO AN UNDISTURBED STABILIZED AREA AT NON-EROSION VELOCITY.
4. THE SWALE SHALL BE EXCAVATED OR SHAPED TO LINE GRADE, AND CROSS SECTION AS REQUIRED TO MEET THE CRITERIA SPECIFIED IN THE STANDARD.
5. STABILIZATION OF THE AREA DISTURBED BY THE DIKE AND SWALE SHALL BE DONE IN ACCORDANCE WITH THE STANDARD AND SPECIFICATIONS FOR TEMPORARY SEEDING AND MULCHING, AND SHALL BE DONE WITHIN 7 DAYS.
6. PERIODIC INSPECTION AND REQUIRED MAINTENANCE MUST BE PROVIDED AFTER EACH RAIN EVENT AND AS REQUIRED BY PERMIT.

MAX. DRAINAGE AREA LIMIT: 2 ACRES

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VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PERIMETER DIKE OR SWALE

Figure 4.22 Perimeter Dike/Swale

Part 4 - Pipe Slope Drain

Definition

A temporary structure placed from the top of a slope to the bottom of a slope.

Purpose

The purpose of the structure is to convey surface runoff down slopes without causing erosion.

Conditions Where Practice Applies

Pipe slope drains are used where concentrated flow of surface runoff must be conveyed down a slope in order to prevent erosion. The maximum allowable drainage area shall be 3.5 acres.

Design Criteria

General

Maximum Size	Pipe Diameter (in.)	Drainage Area (Ac)
PSD-12	12	0.5
PSD-18	18	1.5
PSD-21	21	2.5
PSD-24	24	3.5

Inlet

The minimum height of the earth dike at the entrance to the pipe slope drain shall be the diameter of the pipe (D) plus 12 inches.

Outlet

The pipe slope drain shall outlet into a sediment trapping device when the drainage area is disturbed. A riprap apron shall be installed below the pipe outlet where water is being discharged into a stabilized area.

Construction Specifications

1. The pipe slope drain shall have a slope of 3 percent or steeper.
2. The top of the earth dike over the inlet pipe, and those dikes carrying water to the pipe, shall be at least one (1) foot higher at all points than the top of the inlet pipe.
3. Corrugated plastic pipe or equivalent shall be used with watertight connecting bands.
4. A flared end section shall be attached to the inlet end of pipe with a watertight connection.
5. The soil around and under the pipe and end section shall be hand tamped in 4 in. lifts to the top of the earth dike.
6. Where flexible tubing is used, it shall be the same diameter as the inlet pipe and shall be constructed of a durable material with hold down grommets spaced 10 ft. on centers.
7. The flexible tubing shall be securely fastened to the corrugated plastic pipe with metal strapping or watertight connecting collars.
8. The flexible tubing shall be securely anchored to the slope by staking at the grommets provided.
9. Where a pipe slope drain outlets into a sediment trapping device, it shall discharge at the riser crest or weir elevation.
10. A riprap apron shall be used below the pipe outlet where clean water is being discharged into a stabilized area.
11. Inspection and any needed maintenance shall be performed after each storm.

Part 4 - Pipe Slope Drain

Considerations

There is often a significant lag between the time a cut or fill is graded and the time it is permanently stabilized. During this period, the slope is very vulnerable to erosion, and temporary slope drains together with temporary diversions can provide valuable protection.

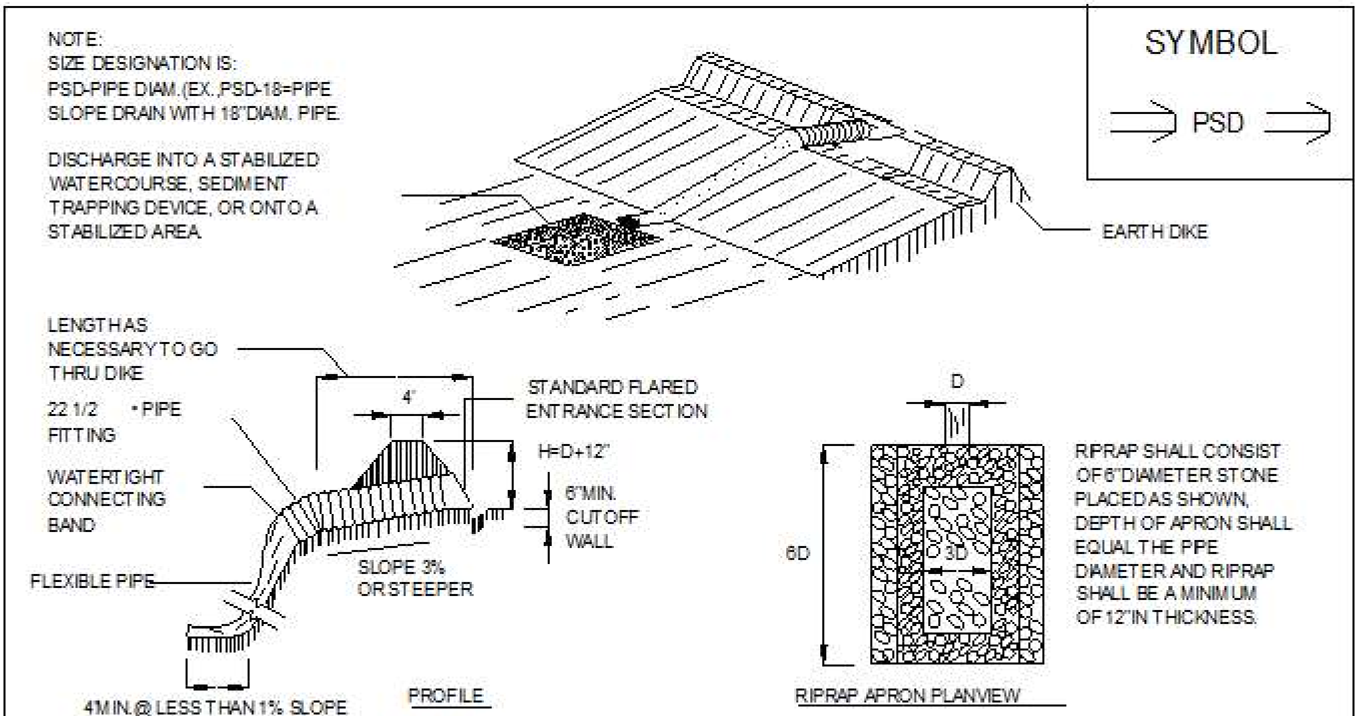
Slope drains must be sized, installed, and maintained properly, because failure will usually result in severe erosion of the slope. The entrance section to the drain should be well entrenched and stable so that surface water can enter freely. The drain should extend downslope beyond the toe of the slope to a stable area or outlet.

Other points of concern are failure from overtopping from inadequate pipe inlet capacity or blockage and lack of maintenance of diversion channel capacity and ridge height.

Plans and Specifications

Plans and specifications for installing pipe slope drains shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Drain location.
2. Inlet type.
3. Conduit size and material.
4. Construction detail.



CONSTRUCTION SPECIFICATIONS

1. THE INLET PIPE SHALL HAVE A SLOPE OF 3% OR STEEPER.

2. THE TOP OF THE EARTH DIKE OVER THE INLET PIPE AND THOSE DIKES CARRYING WATER TO THE PIPE SHALL BE AT LEAST 1' HIGHER AT ALL POINTS THAN THE TOP OF THE INLET PIPE.

3. THE INLET PIPE SHALL BE CORRUGATED METAL PIPE WITH WATERTIGHT CONNECTING BANDS.

4. THE FLEXIBLE TUBING SHALL BE THE SAME DIAMETER AS THE INLET PIPE AND SHALL BE CONSTRUCTED OF A DURABLE MATERIAL WITH HOLD-DOWN GROMMETS SPACED AT 10' ON CENTER.

5. THE FLEXIBLE TUBING SHALL BE SECURELY FASTENEND TO THE CORRUGATED METAL PIPE WITH METAL STRAPPING OR WATERTIGHT CONNECTING COLLARS.

6. THE FLEXIBLE TUBING SHALL BE SECURELY ANCHORED TO THE SLOPE BY STAKING AT THE GROMMETS PROVIDED.

7. A RIPRAP APRON SHALL BE PROVIDED AT THE OUTLET. THIS SHALL CONSIST OF 6"DIAMETER STONE PLACED AS SHOWN.

8. THE SOIL AROUND AND UNDER INLET PIPE AND ENTRANCE SECTION SHALL BE HAND TAMPED IN 4"LIFTS TO THE TOP OF EARTH DIKE.

9. FOLLOW-UP INSPECTION AND ANY NEEDED MAINTENANCE SHALL BE PERFORMED AFTER EACH STORM AND AS REQUIRED BY PERMIT.

* DRAINAGE AREA MUST NOT EXCEED 3.5 ACRES.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	PIPE SLOPE DRAIN FLEXIBLE

Figure 4.23 Pipe Slope Drain

Part 4 - Grass Waterways

Definition

Waterways are a natural or constructed outlet, shaped or graded. They are vegetated as needed for safe transport of runoff water.

Purpose

To provide for the safe transport of excess surface water from construction sites and urban areas without damage from erosion.

Conditions Where Practice Applies

This standard applies to vegetating waterways and similar water carrying structures.

Supplemental measures may be required with this practice. These may include: subsurface drainage to permit the growth of suitable vegetation and to eliminate wet spots; a section stabilized with asphalt, stone, or other suitable means; or additional storm drains to handle snowmelt or storm runoff.

Retardance factors for determining waterway dimensions are shown in Figure 4.26 and "Maximum Permissible Velocities for the selected seed mix and/or RECP for stabilization shall be considered.

Design Criteria

Waterways or outlets shall be protected against erosion by vegetative means as soon after construction as practical. Vegetation must be well established before diversions or other channels are outletted into them. Consideration should be given to the use of synthetic products, jute or excelsior matting, other rolled erosion control products, or sodding of channels to provide erosion protection as soon after construction as possible. It is strongly recommended that the center line of the waterway be protected with one of the above materials to avoid center gullies.

1. Liming, fertilizing, and seedbed preparation.
   a. Lime to pH 6.5.
   b. The soil should be tested to determine the amounts of amendments needed. If the soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply commercial fertilizer at 1.0 lbs/1,000 sq. ft. of N, P2O5, and K2O.
   c. Lime and fertilizer shall be mixed thoroughly into the seedbed during preparation.
   d. Channels, except for paved section, shall have at least 4 inches of topsoil.
   e. Remove stones and other obstructions that will hinder maintenance.

2. Timing of Seeding.
   a. Early spring and late August are best.
   b. Temporary cover to protect from erosion is recommended during periods when seedings may fail.

3. Seed Mixtures:

Mixtures	Rate per Acre (lbs)	Rate per 1,000 sq. ft. (lbs)
A. Birdsfoot trefoil or ladino clover[1]	8	0.20
Tall fescue or smooth bromegrass	20	0.45
Redtop[2]	2	0.05
	30	0.70
OR		
B. Kentucky bluegrass[3]	25	0.60
Creeping red fescue	20	0.50
Perennial ryegrass	10	0.20
	55	1.30

1 Inoculate with appropriate inoculum immediately prior to seeding. Ladino or common white clover may be substituted for birdsfoot trefoil and seeded at the same rate.

2 Perennial ryegrass may be substituted for the redtop but increase seeding rate to 5 lbs/acre (0.1 lb/1,000 sq. ft).

3 Use this mixture in areas which are mowed frequently. Common white clover may be added if desired and seeded at 8 lbs/acre (0.2 lb/1,000 sq. ft.)

4. Seeding

   Select the appropriate seed mixture and apply uniformly over the area. Rolling or cultipacking across the waterway is desirable.

   Waterway centers or crucial areas may be sodded. Refer to the standard and specification for Stabilization with Sod. Be sure sod is securely anchored using staples or stakes.

5. Mulching.

   All seeded areas will be mulched. Channels more than 300 feet long, and/or where the slope is 5 percent or more, must have the mulch securely anchored. Refer to the standard and specifications for Mulching for details.

6. Maintenance

   Fertilize, lime, and mow as needed to maintain dense protective vegetative cover.

   Waterways shall not be used for roadways.

   If rills develop in the centerline of a waterway, prompt attention is required to avoid the formation of gullies. Either stone and/or compacted soil fill with excelsior or filter fabric as necessary may be used during the establishment phase. Spacing between rill maintenance barriers shall not exceed 100 feet.

<u>Considerations</u>

Generally, grassed waterways should be located to conform with and use the natural drainage system. Waterways may also be needed along development boundaries, roadways, and back lot lines. In all situations channels should be located so that they do not make sharp, unnatural changes in direction or grade of flow. Avoid crossing watershed boundaries or ridges.

Major reconfiguration of the drainage system often entails increased maintenance and risk of failure. Establishment of a dense, erosion resistant vegetation is essential. Construct and vegetate grassed waterways early in the construction schedule before grading and paving increase the rate of runoff.

All grassed waterways should be designed to permit easy crossing of equipment during construction and maintenance.

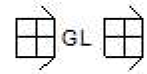
Geotextile fabrics or special mulch protection such as fiberglass roving or straw and netting provide stability until the vegetation is fully established. It may also be necessary to divert water from the waterway until vegetation is established or to line the channel with sod. Rock checks or filter fabric checks may also be needed to protect the channel before vegetation is established. Sediment traps may be needed at waterway inlets and outlets.

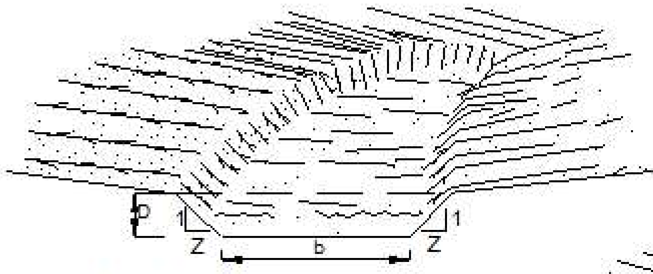
Plans and Specifications

Plans and specifications for installing grass-lined channels shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

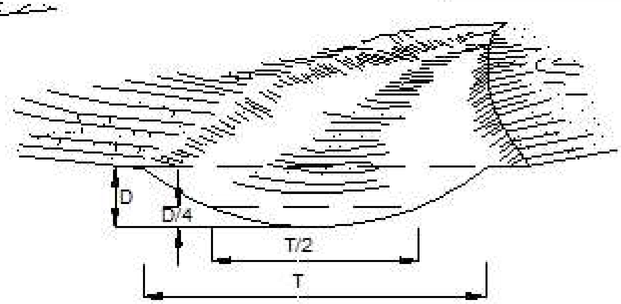
1. Waterway location and alignment.
2. Grade, depth and width.
3. Channel cross section type.
4. Stabilization directions.
5. Construction detail.

SYMBOL





TRAPEZIODAL CROSS SECTION



PARABOLIC CROSS SECTION

CONSTRUCTION SPECIFICATIONS

1. ALL TREES, BRUSH, STUMPS, OBSTRUCTIONS, AND OTHER OBJECTIONABLE MATERIAL SHALL BE REMOVED AND DISPOSED OF SO AS NOT TO INTERFERE WITH THE PROPER FUNCTIONING OF THE WATERWAY.

2. THE WATERWAY SHALL BE EXCAVATED OR SHAPED TO LINE, GRADE, AND CROSS SECTION AS REQUIRED TO MEET THE CRITERIA SPECIFIED HEREIN, AND BE FREE OF BANK PROJECTIONS OR OTHER IRREGULARITIES WHICH WILL IMPEDE NORMAL FLOW.

3. FILLS SHALL BE COMPACTED AS NEEDED TO PREVENT UNEQUAL SETTLEMENT THAT WOULD CAUSE DAMAGE IN THE COMPLETE WATERWAY.

4. ALL EARTH REMOVED AND NOT NEEDED IN CONSTRUCTION SHALL BE SPREAD OR DISPOSED OF SO THAT IT WILL NOT INTERFERE WITH THE FUNCTIONING OF THE WATERWAY.

5. STABILIZATION SHALL BE DONE ACCORDING TO THE APPROPRIATE STANDARD AND SPECIFICATIONS FOR VEGETATIVE PRACTICES.

A. FOR DESIGN VELOCITIES OF LESS THAN 3.5 FT. PER. SEC., SEEDING AND MULCHING MAY BE USED FOR THE ESTABLISHMENT OF THE VEGETATION. IT IS RECOMMENDED THAT, WHEN CONDITIONS PERMIT, TEMPORARY WATERWAYS OR OTHER MEANS SHOULD BE USED TO PREVENT WATER FROM ENTERING THE WATERWAY DURING THE ESTABLISHMENT OF THE VEGETATION.

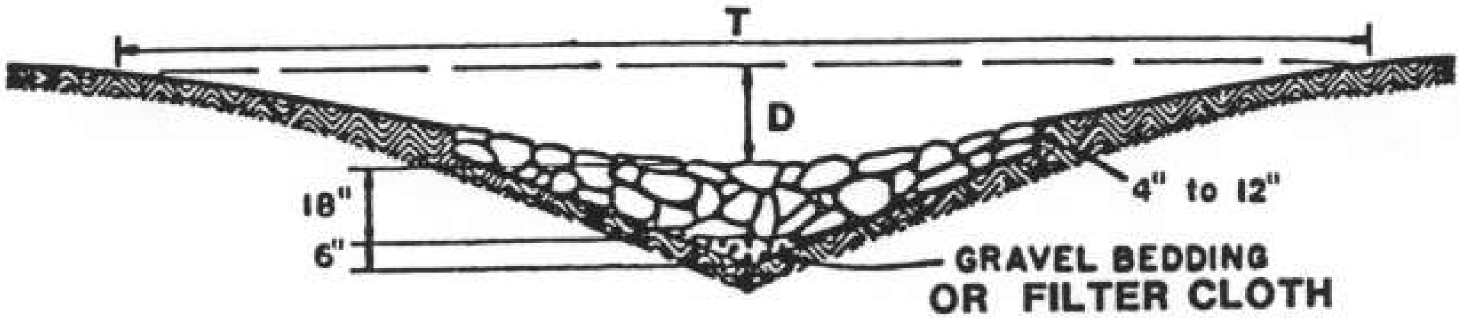
B. FOR DESIGN VELOCITIES OF MORE THAN 3.5 FT. PER. SEC., THE WATERWAY SHALL BE STABILIZED WITH SOD, WITH SEEDING PROTECTED BY JUTE OR OTHER MATTING OR WITH SEEDING AND MULCHING INCLUDING TEMPORARY DIVERSION OF THE WATER UNTIL THE VEGETATION IS ESTABLISHED.

C. STRUCTURAL - VEGETATIVE PROTECTION
SUBSURFACE DRAIN FOR BASE FLOW SHALL BE CONSTRUCTED AS SHOWN ON THE STANDARD DRAWING AND AS SPECIFIED IN THE STANDARD AND SPECIFICATIONS FOR SUBSURFACE DRAIN.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC
ORIGINALLY DEVELOPED BY USDA-NRCS
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

GRASSED WATERWAY

Figure 4.24 Grassed Waterways



Waterway with stone center drain. "V"
section shaped by motor grader.

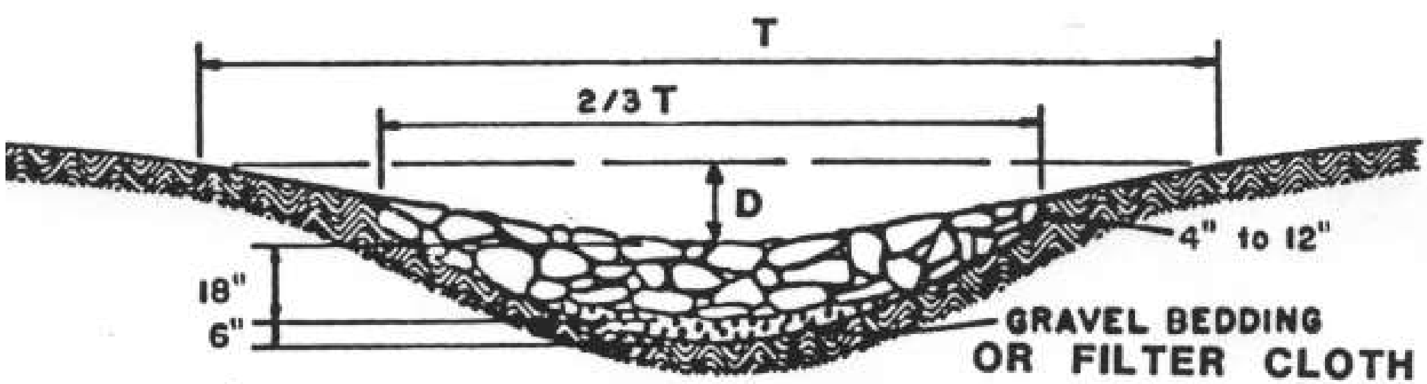


Figure 4.25 Typical Waterway Cross Section

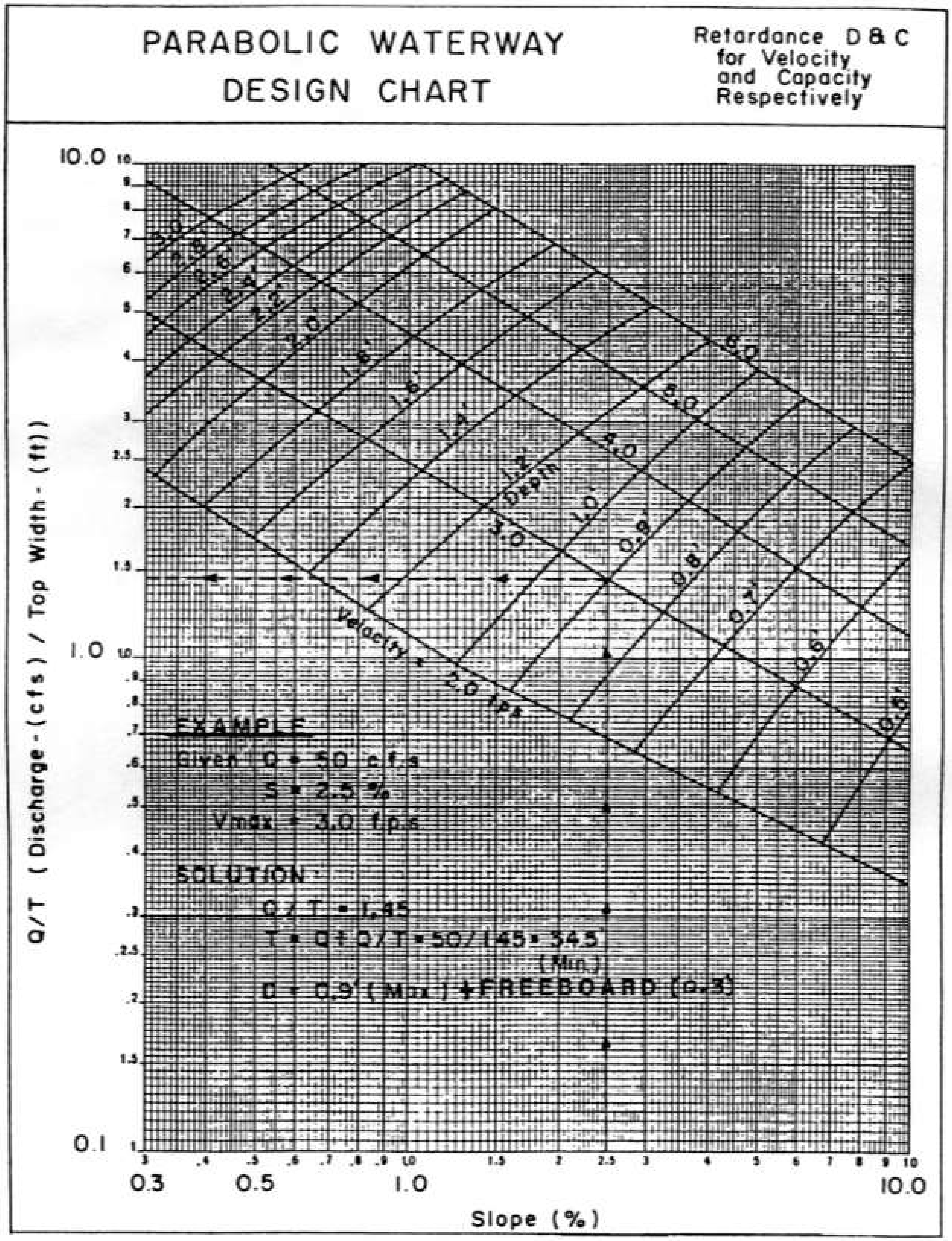


Figure 4.26 Parabolic Waterway Design Chart

Part 4 - Lined Waterway or Outlet

Definition

A waterway or outlet with a lining of concrete, stone, or other permanent material. The lined section extends up the side slopes to the designed depth. The earth above the permanent lining may be vegetated or otherwise protected.

Purpose

To provide for the disposal of concentrated runoff without damage from erosion or flooding, where grassed waterways would be inadequate due to high velocities.

Scope

This standard applies to waterways or outlets with linings of cast-in-place concrete, flagstone mortared in place, rock riprap, gabions, or similar permanent linings. It does not apply to irrigation ditch or canal linings, grassed waterways with stone centers or small lined sections that carry prolonged low flows, or to reinforced concrete channels. The maximum capacity of the waterway flowing at design depth shall not exceed 100 cubic feet per second.

Conditions Where Practice Applies

This practice applies where the following or similar conditions exist:

1. Concentrated runoff is such that a lining is required to control erosion.
2. Steep grades, wetness, prolonged base flow, seepage, or piping that would cause erosion.
3. The location is such that damage from use by people or animals precludes use of vegetated waterways or outlets.
4. Soils are highly erosive or other soil and climate conditions preclude using vegetation.
5. High value property or adjacent facilities warrant the extra cost to contain design runoff in a limited space.

Design Criteria

Capacity

1. The minimum capacity shall be adequate to carry the peak rate of runoff from a 10-year, 24-hour storm. Velocity shall be computed using Manning's equation with a coefficient of roughness "n" as follows:

Lined Material	"n"
Concrete (Type):	
Trowel Finish	0.015
Float Finish	0.019
Gunite	0.019
Flagstone	0.022
Riprap	Determine from Figure 4.27
Gabion	0.030

2. Riprap gradation and filter (bedding) are generally designed in accordance with criteria set forth in the National Cooperative Highway Research Program Report 108, available from the University Microfilm International, 300 N. Ree Road, Ann Arbor, Michigan 48016, Publication No. PB-00839; or the Hydraulic Engineering Circular No. 11, prepared by the U.S. Bureau of Public Roads, available from Federal Highway Administration, 400 7th Street, S.W., Washington, D.C. 20590, HNG-31, or the procedure in the USDA-NRCS's Engineering Field Manual, Chapter 16.

Velocity

1. Maximum design velocity shall be as shown below. Except for short transition sections, flow with a channel gradient within the range of 0.7 to 1.3 of this flow's critical slope must be avoided unless the channel is straight. Velocities exceeding critical willbe restricted to straight reaches.

Part 4 - Lined Waterway or Outlet

Design Flow Depth (ft.)	Maximum Velocity (ft./sec.)
0.0 – 0.5	25
0.5 – 1.0	15
Greater than 1.0	10

2. Waterways or outlets with velocities exceeding critical shall discharge into an energy dissipater to reduce velocity to less than critical, or to a velocity the downstream soil and vegetative conditions will allow.

Cross Section

The cross section shall be triangular, parabolic, or trapezoidal. Monolithic concrete or gabions may be rectangular.

Freeboard

The minimum freeboard for lined waterways or outlets shall be 0.25 feet above design high water in areas where erosion resistant vegetation cannot be grown adjacent to the paved side slopes. No freeboard is required where good vegetation can be grown and is maintained.

Side Slope

Steepest permissible side slopes, horizontal to vertical will be as follows:

1. Non-Reinforced Concrete
   a. Hand-placed, formed concrete:

      Height of lining, 18 inches or less…. Vertical
   b. Hand placed screened concrete or mortared in-place flagstone:

      Height of lining, less than 2 ft……… 1:1

      Height of lining, more than 2 ft………2:1
2. Slip form concrete:

   Height of lining, less than 3 ft…………..1:1
3. Rock Riprap……… …………………. 2:1
4. Gabions………………………… …….. Vertical
5. Pre-cast Concrete Sections………… ….Vertical

Lining Thickness

Minimum lining thickness shall be as follows:

1. Concrete………………..4 in.

   (In most problem areas, shall be 5 in. with welded wire fabric reinforcing.)
2. Rock Riprap……1.5 x maximum stone size plus thickness of filter or bedding.
3. Flagstone…………..4 in. including mortar bed.

Related Structures

Side inlets, drop structures, and energy dissipaters shall meet the hydraulic and structural requirements of the site.

Filters or Bedding

Filters or bedding to prevent piping, reduce uplift pressure, and collect water will be used as required and will be designed in accordance with sound engineering principles. Weep holes and drains should be provided as needed.

Concrete

Concrete used for lining shall be so proportioned that it is plastic enough for thorough consolidation and stiff enough to stay in place on side slopes. A dense product will be required. A mix that can be certified as suitable to produce a minimum strength of at least 3,000 pounds per square inch will be required. Cement used shall be Portland Cement, Type I, II, IV, or V. Aggregate used shall have a maximum diameter of 1 ½ inches.

Weep holes should be provided in concrete footings and retaining walls to allow free drainage of water. Pipe used for weep holes shall be non-corrosive.

Mortar

Mortar used for mortared in-place flagstone shall consist of a mix of cement, sand, and water. Follow directions on the bag of mortar for proper mixing of mortar and water.

Contraction Joints

Contraction joints in concrete linings, where required, shall be formed transversely to a depth of about one third the thickness of the lining at a uniform spacing in the range of 10 to 15 feet.

Rock Riprap or Flagstone

Stone used for riprap or gabions shall be dense and hard enough to withstand exposure to air, water, freezing, and thawing. Flagstone shall be flat for ease of placement and have the strength to resist exposure and breaking. Rock riprap maximum size shall be as follows:

Velocity, f.p.s.	dmax, inches
5.0	6
8.5	12
10	18
12	24
15	36

Cutoff Walls

Cutoff walls shall be used at the beginning and ending of concrete lining. For rock riprap lining, cutoff walls shall be keyed into the channel bottom and at both ends of the lining.

<u>Construction Specifications</u>

1. The foundation area shall be cleared of trees, stumps, roots, sod, loose rock, or other objectionable material.
2. The cross-section shall be excavated to the neat lines and grades as shown on the plans. Over-excavated areas shall be backfilled with moist soil compacted to the density of the surrounding material.
3. No abrupt deviations from design grade or horizontal alignment shall be permitted.
4. Concrete linings shall be placed to the thickness shown on the plans and finished in a workmanlike manner. Adequate precautions shall be taken to protect freshly placed concrete from extreme (hot or cold) temperatures, to ensure proper curing.
5. Filter bedding and rock riprap shall be placed to line and grade in the manner specified.
6. Construction operation shall be done in such a manner that erosion, air pollution, and water pollution will be minimized and held within legal limits. The completed job shall present a workmanlike appearance. All disturbed areas shall be vegetated or otherwise protected against soil erosion.

<u>Maintenance</u>

Pavement or lining should be maintained as built to prevent undermining and deterioration. Existing trees next to pavements should be removed, as roots can cause uplift damage.

Vegetation next to pavement should be maintained in good condition to prevent scouring if the pavement is overtopped. See Standard and Specifications for Permanent Critical Area Seeding.

Part 4 - Lined Waterway or Outlet

Considerations

The outlets of channels, conduits and other structures are points of high erosion potential, because they frequently carry flows at velocities that exceed the allowable limit for the area downstream. To prevent scour and undermining, an outlet stabilization structure is needed to absorb the impact of the flow and reduce the velocity to non-erosive levels. A riprap-lined apron is the most commonly used practice for this purpose because of its relatively low cost and ease of installation. The riprap apron should be extended downstream until stable conditions are reached even though this may exceed the length calculated for
design velocity control.

Riprap-stilling basins or plunge pools reduce flow velocity rapidly. They should be considered in lieu of aprons where overfalls exit at the ends of pipes or where high flows would require excessive apron length. Consider other energy dissipaters such as concrete impact basins or paved outlet structures when conduits are flowing more than 10 fps.

Plans and Specifications

Plans and specification for installing a lined waterway or outlet shall be in keeping with this standard and will describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the practice will be installed.
2. Dimensions of the practice.
3. Construction detail.
4. Design calculations.

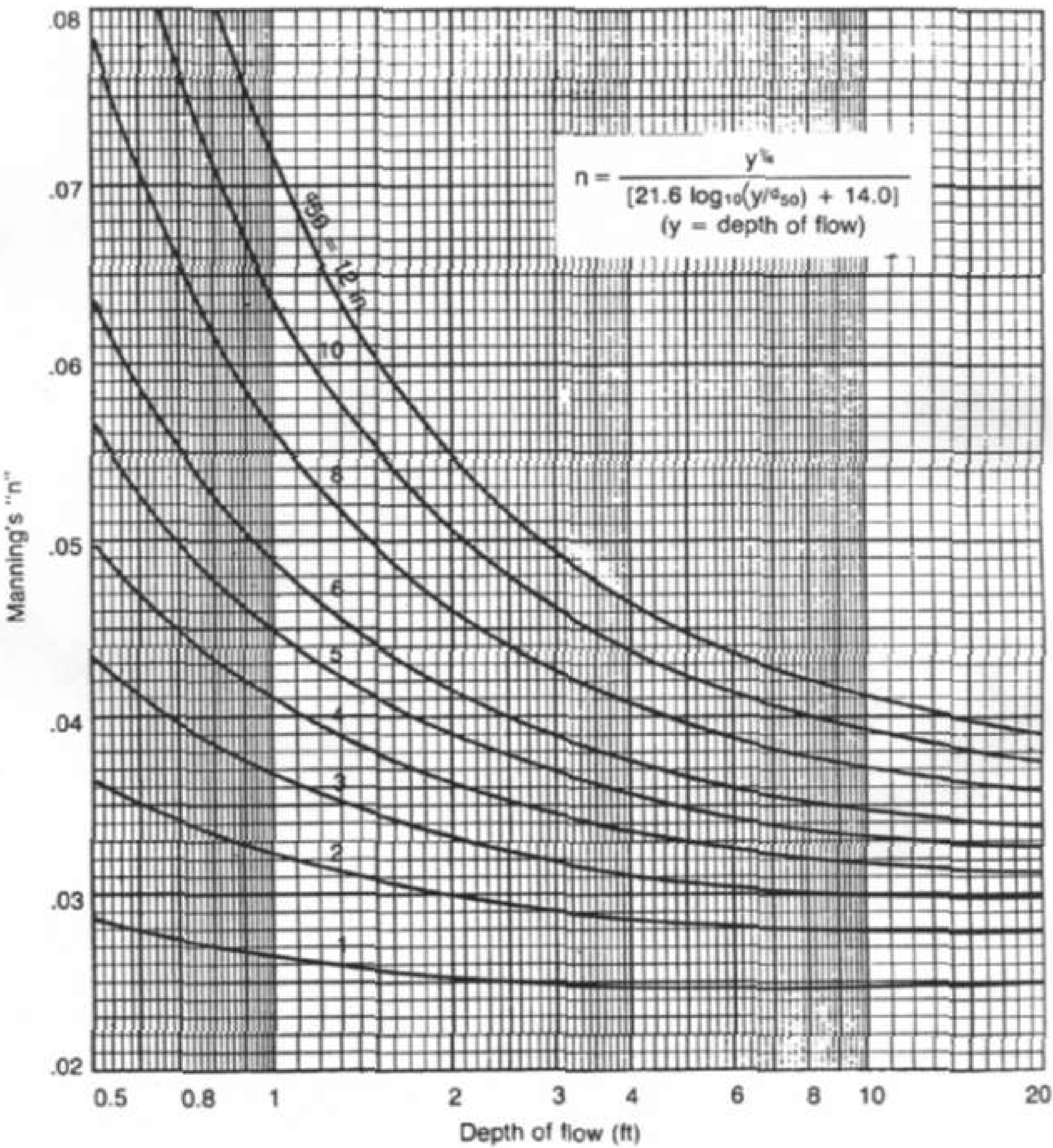


Figure 4.27 Determining "n" for Riprap Lined Channel using Depth of Flow **(UDSA-NRCS)**

Part 4 - Rock Outlet Protection

Definition

A section of rock protection placed at the outlet end of the culverts, conduits, or channels.

Purpose

The purpose of the rock outlet protection is to reduce the depth, velocity, and energy of water, such that the flow will not erode the receiving downstream reach.

Scope

This standard applies to the planning, design, and construction of rock riprap and gabions for protection of downstream areas. It does not apply to rock lining of channels or streams.

Conditions Where Practice Applies

This practice applies where discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach. This applies to:

1. Culvert outlets of all types.
2. Pipe conduits from all sediment basins, dry storm water ponds, and permanent type ponds.
3. New channels constructed as outlets for culverts and conduits.

Design Criteria

The design of rock outlet protection depends entirely on the location. Pipe outlet at the top of cuts or on slopes steeper than 10 percent cannot be protected by rock aprons or riprap sections due to re-concentration of flows and high velocities encountered after the flow leaves the apron.

Tailwater Depth

The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. If the tailwater depth is less than half the diameter of the outlet pipe, and the receiving stream is wide enough to accept divergence of the flow, it shall be classified as a Minimum Tailwater Condition. If the tailwater depth is greater than half the pipe diameter and the receiving stream will continue to confine the flow, it shall be classified as a Maximum Tailwater Condition. Pipes which outlet onto flat areas with no defined channel may be assumed to have a Minimum Tailwater Condition.

Apron Size

The apron length and width shall be determined from the curves according to the tailwater conditions:

Minimum Tailwater – Use Figure 4.28
Maximum Tailwater – Use Figure 4.29

If the pipe discharges directly into a well defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tailwater depth or to the top of the bank, whichever is less.

The upstream end of the apron, adjacent to the pipe, shall have a width two (2) times the diameter of the outlet pipe, or conform to pipe end section if used.

Bottom Grade

The outlet protection apron shall be constructed with no slope along its length. There shall be no overfall at the end of the apron. The elevation of the downstream end of the apron shall be equal to the elevation of the receiving channel or adjacent ground.

Alignment

The outlet protection apron shall be located so that there are no bends in the horizontal alignment.

Part 4 - Rock Outlet Protection

Materials

The outlet protection may be done using rock riprap, grouted riprap, or gabions.

Riprap shall be composed of a well-graded mixture of stone size so that 50 percent of the pieces, by weight, shall be larger than the d_{50} size determined by using the charts. A well-graded mixture, as used herein, is defined as a mixture composed primarily of larger stone sizes, but with a sufficient mixture of other sizes to fill the smaller voids between the stones. The diameter of the largest stone size in such a mixture shall be 1.5 times the d_{50} size.

Thickness

The minimum thickness of the riprap layer shall be 1.5 times the maximum stone diameter for d_{50} of 15 inches or less; and 1.2 times the maximum stone size for d_{50} greater than 15 inches. The following chart lists some examples:

Stone Quality

Stone for riprap shall consist of field stone or rough unhewn quarry stone. The stone shall be hard and angular and of a quality that will not disintegrate on exposure to water or weathering. The specific gravity of the individual stones shall be at least 2.5.

D_{50} (inches)	d_{max} (inches)	Minimum Blanket Thickness (inches)
4	6	9
6	9	14
9	14	20
12	18	27
15	22	32
18	27	32
21	32	38
24	36	43

Recycled concrete equivalent may be used provided it has a density of at least 150 pounds per cubic foot, and does not have any exposed steel or reinforcing bars.

Filter

A filter is a layer of material placed between the riprap and the underlying soil surface to prevent soil movement into and through the riprap. Riprap shall have a filter placed under it in all cases.

A filter can be of two general forms: a gravel layer or a plastic filter cloth. The plastic filter cloth can be woven or non-woven monofilament yarns, and shall meet these base requirements: thickness 20-60 mils, grab strength 90-120 lbs; and shall conform to ASTM D-1777 and ASTM D-1682.

Gravel filter blanket, when used, shall be designed by comparing particle sizes of the overlying material and the base material. Design criteria are available in Standard and Specification for Riprap Slope Protection.

Gabions

Gabions shall be made of hexagonal triple twist mesh with heavily galvanized steel wire. The maximum linear dimension of the mesh opening shall not exceed 4 ½ inches and the area of the mesh opening shall not exceed 10 square inches.

Gabions shall be fabricated in such a manner that the sides, ends, and lid can be assembled at the construction site into a rectangular basket of the specified sizes. Gabions shall be of single unit construction and shall be installed according to manufacturers recommendations.

The area on which the gabion is to be installed shall be graded as shown on the drawings. Foundation conditions shall be the same as for placing rock riprap, and filter cloth shall be placed under all gabions. Where necessary, key, or tie, the structure into the bank to prevent undermining of the main gabion structure.

Part 4 - Rock Outlet Protection

Maintenance

Once a riprap outlet has been installed, the maintenance needs are very low. It should be inspected after high flows for evidence of scour beneath the riprap or for dislodged stones. Repairs should be made immediately.

Design Procedure

1. Investigate the downstream channel to assure that nonerosive velocities can be maintained.
2. Determine the tailwater condition at the outlet to establish which curve to use.
3. Enter the appropriate chart with the design discharge to determine the riprap size and apron length required. Note that references to pipe diameters in the charts are based on full flow. For other than full pipe flow, the parameters of depth of flow and velocity must be used to adjust the design discharges.
4. Calculate apron width at the downstream end if a flare section is to be employed.

Examples

Example 1: Pipe Flow (full) with discharge to unconfined section.

Given: A circular conduit flowing full.

Q = 280 cfs, diam. = 66 in., tailwater (surface) is 2 ft. above pipe invert (minimum tailwater condition).

Find: Read d_{50} = 1.2 and apron length (La) = 38 ft.
Apron width = diam. + La = 5.5 + 38 = 43.5 ft.

Dmax = $1.5(d_{50})$ = 1.5 (15”) = 22.5”
Use: d_{50} = 15”, dmax = 22”

$D_{50} \leq$ 15”, blanket thickness = 1.5 (max d)
= 1.5 (22”)
= 33”
Use blanket thickness = 32”.

Example 2: Box Flow (partial) with high tailwater

Given: A box conduit discharging under partial flow conditions. A concrete box 5.5 ft. x 10 ft. flowing 5.0 ft. deep,

Q = 600 cfs and tailwater surface is 5 ft. above invert (max. tailwater condition).

Since this is not full pipe and does not directly fit the nomograph assumptions of Figure 4.24 substitute depth as the diameter, to find a discharge equal to full pipe flow for that diameter, in this case 60 inches.

Since, Q = AV and $A = \frac{\pi D^2}{4}$

First, compute velocity:

V = (Q/A) = (600/(5) (10)) = 12 fps

Then substituting:

$Q = \frac{\pi D^2}{4} \times V = \frac{3.14 (5\ ft)^2}{4} \times 12\ fps = 236\ cfs$

At the intersection of the curve d = 60 in. and Q = 236 cfs, read d50 = 0.4 ft.

Then reading the d = 60 in. curve, read apron length (La) = 40 ft.

Apron width, W = conduit width + (6.4)(La) = 10 + (0.4)(40) = 26 ft.

Example 3: Open Channel Flow with Discharge to unconfined section

Given: A trapezoidal concrete channel 5 ft. wide with 2:1 side slopes is flowing 2 ft. deep, Q = 180 cfs (velocity = 10 fps) and the tailwater surface downstream is 0.8 ft. (minimum tailwater condition).

Find: Using similar principles as Example 2, compute equivalent discharge for a 2 foot, using depth as a diameter, circular pipe flowing full at 10 feet per second.

Velocity:

$$Q = \frac{\pi\,(2ft)^2}{4} \times 10 \text{ fps} = 31.4 \text{ cfs}$$

At intersection of the curve, d = 24 in. and Q = 31.4 cfs, read d_{50} = 0.6 ft.

Then reading the d = 24 in. curve, read apron length (L_a) = 20 ft.

Apron width, W = bottom width of channel + L_a = 5 + 20 = 25 ft.

Example 4: Pipe flow (partial) with discharge to a confined section

Given: A 48 in. pipe is discharging with a depth of 3 ft. Q = 100 cfs, and discharge velocity of 10 fps (established from partial flow analysis) to a confined trapezoidal channel with a 2 ft. bottom, 2:1 side slopes, n = 0.04, and grade of 0.6%.

Calculation of the downstream channel (by Manning's Equation) indicates a normal depth of 3.1 ft. and normal velocity of 3.9 fps.

Since the receiving channel is confined, the maximum tailwater condition controls.

Find: discharge using previous principles:

$$Q = \frac{\pi\,(3ft)^2}{4} \times 10 \text{ fps} = 71 \text{ cfs}$$

At the intersection of d = 36 in. and Q = 71 cfs, read d_{50} = 0.3 ft.

Reading the d = 36" curve, read apron length (L_a) = 30 ft.

Since the maximum flow depth in this reach is 3.1 ft., that is the minimum depth of riprap to be maintained for the entire length.

Construction Specifications

1. The subgrade for the filter, riprap, or gabion shall be prepared to the required lines and grades. Any fill required in the subgrade shall be compacted to a density of approximately that of the surrounding undisturbed material.
2. The rock or gravel shall conform to the specified grading limits when installed respectively in the riprap or filter.
3. Filter cloth shall be protected from punching, cutting, or tearing. Any damage other than an occasional small hole shall be repaired by placing another piece of cloth over the damaged part or by completely replacing the cloth. All overlaps, whether for repairs or for joining two pieces of cloth, shall be a minimum of one foot.

Stone for the riprap or gabion outlets may be placed by equipment. Both shall each be constructed to the full course thickness in one operation and in such a manner as to avoid displacement of underlying materials. The stone for riprap or gabion outlets shall be delivered and placed in a manner that will ensure that it is reasonably homogenous with the smaller stones filling the voids between the larger stones. Riprap shall be placed in a manner to prevent damage to the filter blanket or filter cloth. Hand placement will be required to the extent necessary to prevent damage to the permanent works.

Part 4 - Rock Outlet Protection

Plans and Specifications

Plans and specifications for installing rock outlet protection shall be in keeping with this standard and will describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the practice will be installed.
2. Dimensions of the practice.
3. Construction detail.
4. Design calculations.

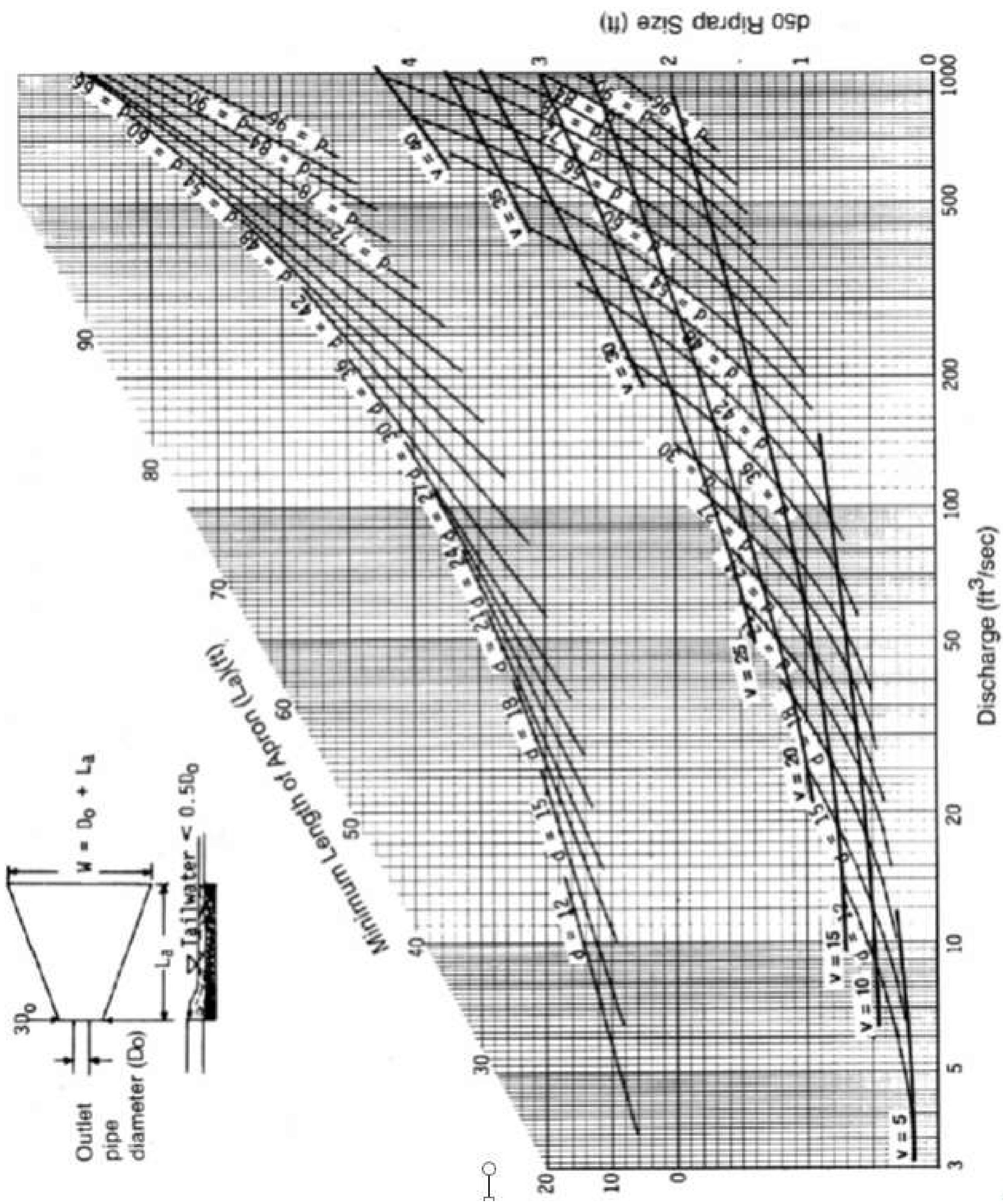


Figure 4.28 Outlet Protection Design—Minimum Tailwater Condition (Design of Outlet Protection from a Round Pipe Flowing Full, Minimum Tailwater Condition: Tw <0.5 D0) (USDA-NRCS)

Part 4 - Rock Outlet Protection

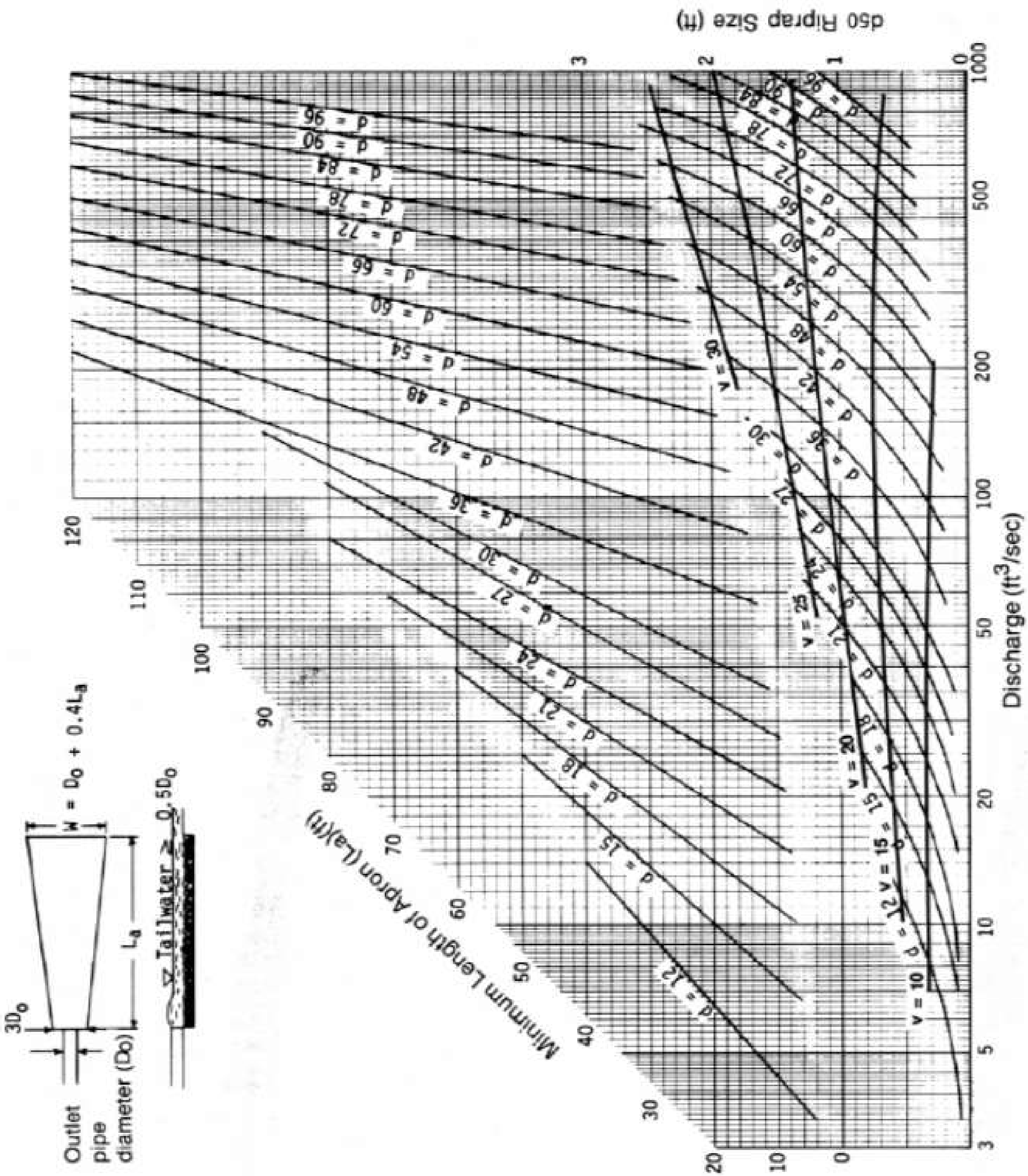


Figure 4.29 Outlet Protection Design—Maximum Tailwater Condition (Design of Outlet Protection from a Round Pipe Flowing Full, MaximumTailwater Condition: Tw >0.5 D0) (USDA-NRCS)

Part 4 - Rock Outlet Protection

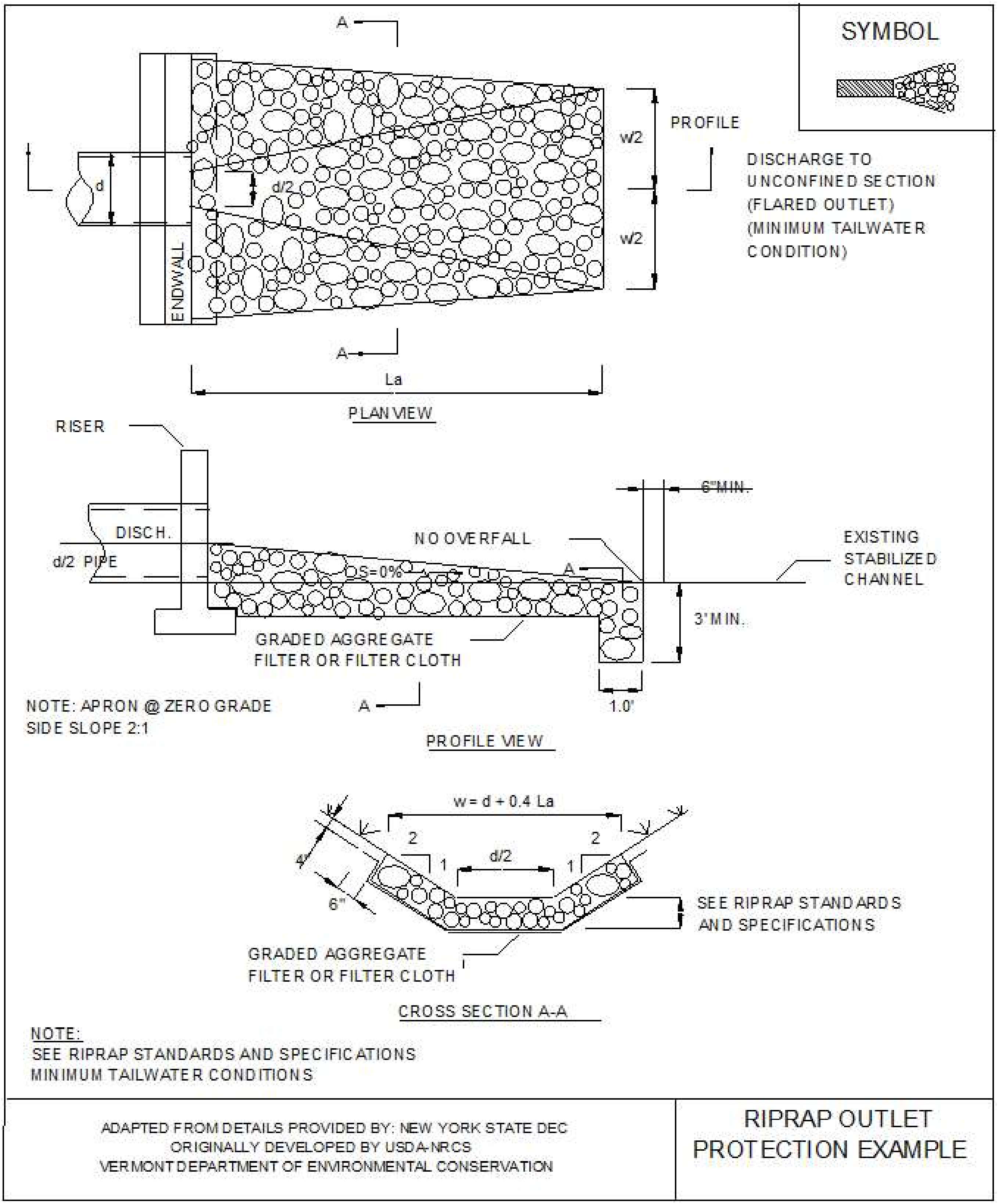


Figure 4.30 Riprap Outlet Protection Detail (1)

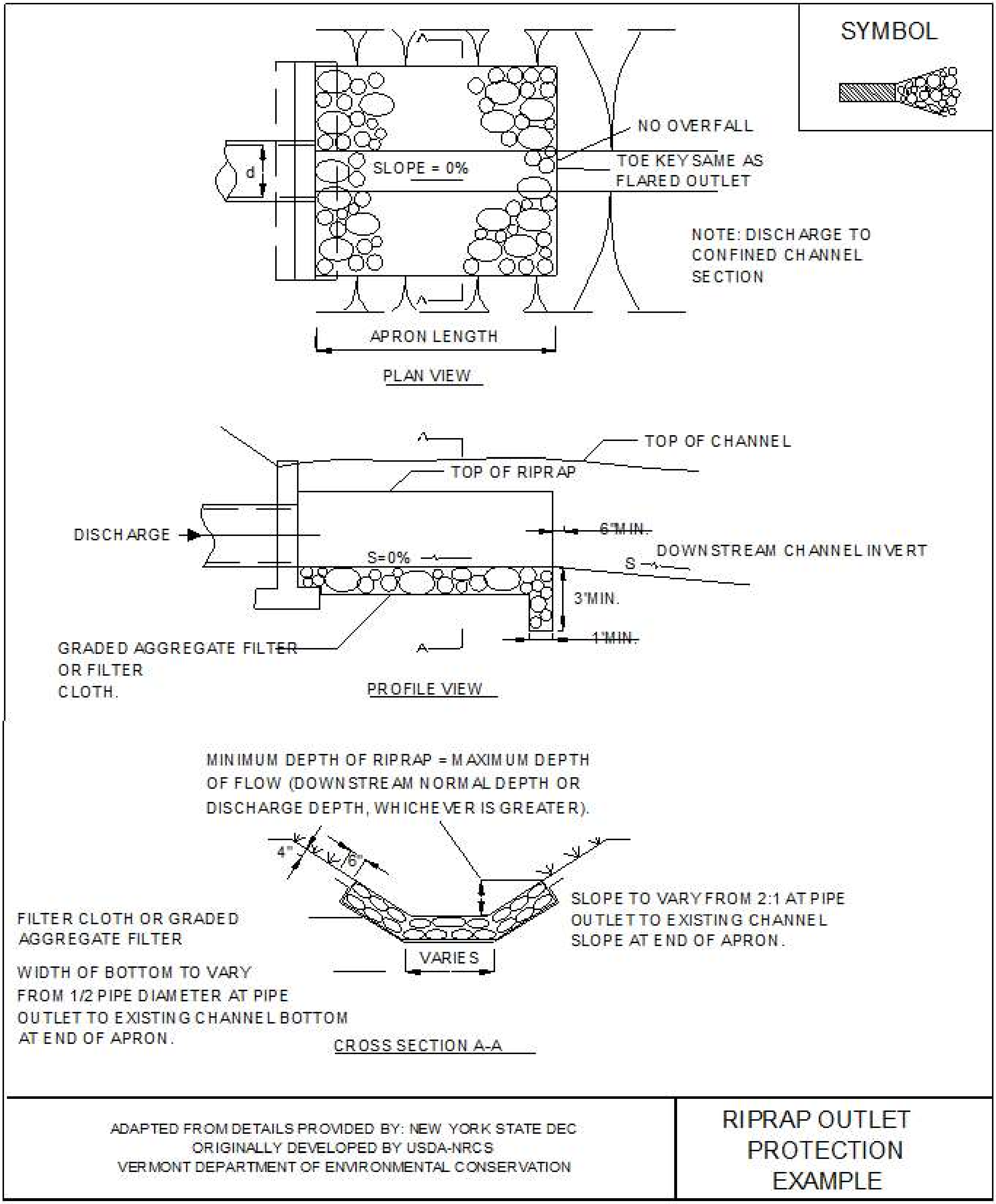


Figure 4.31 Riprap Outlet Protection

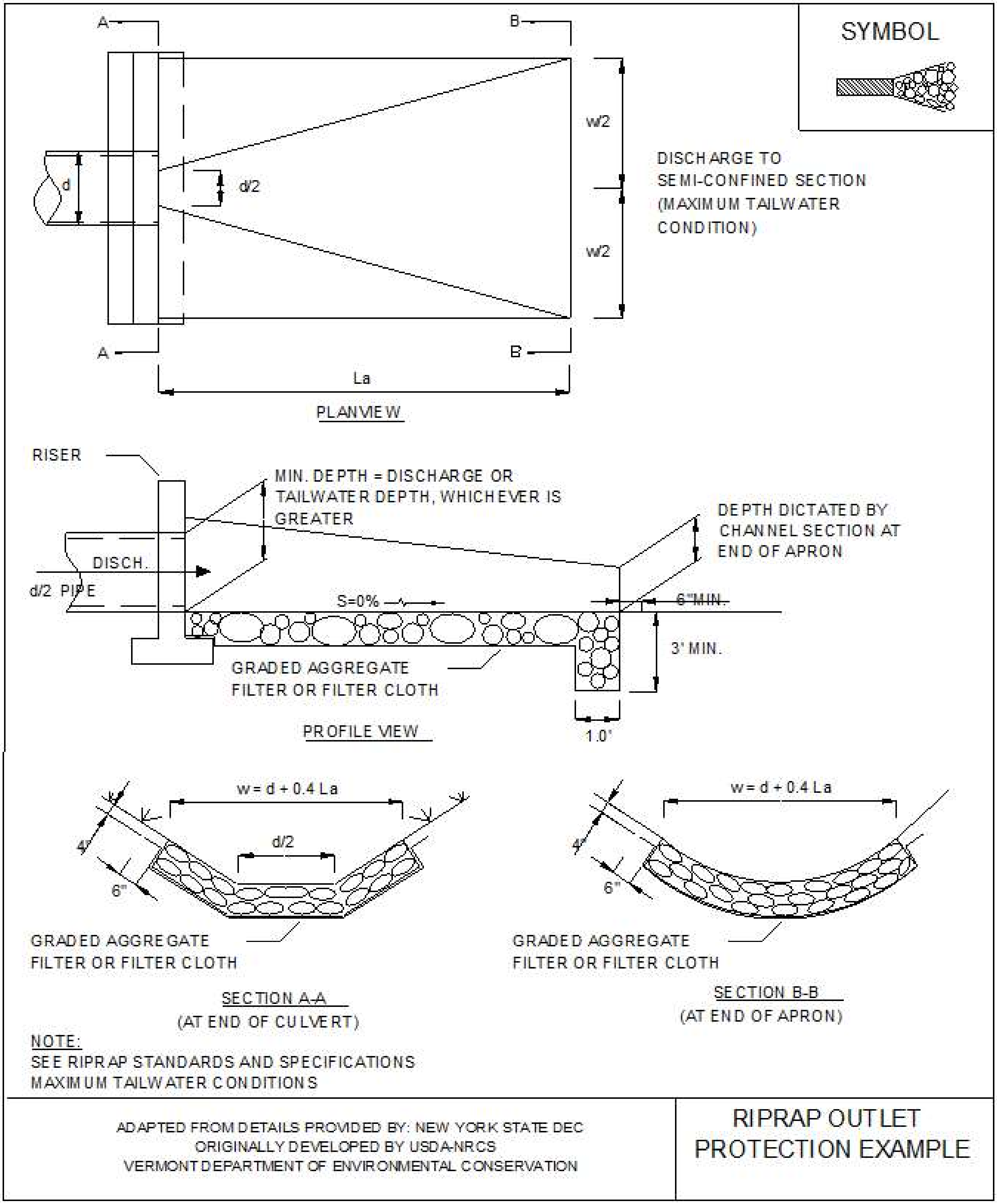


Figure 4.32a Riprap Outlet Protection

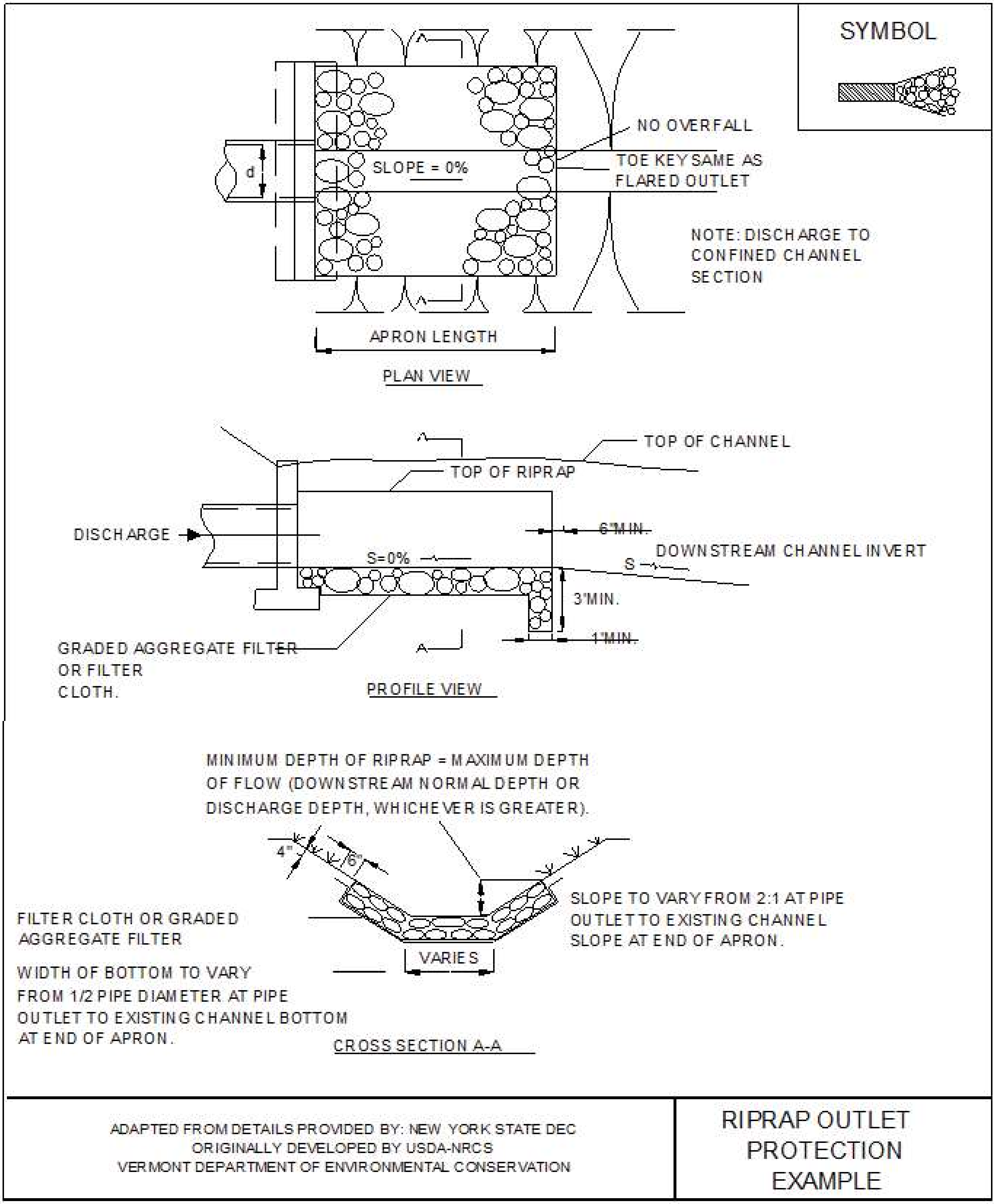


Figure 4.32b Riprap Outlet Protection

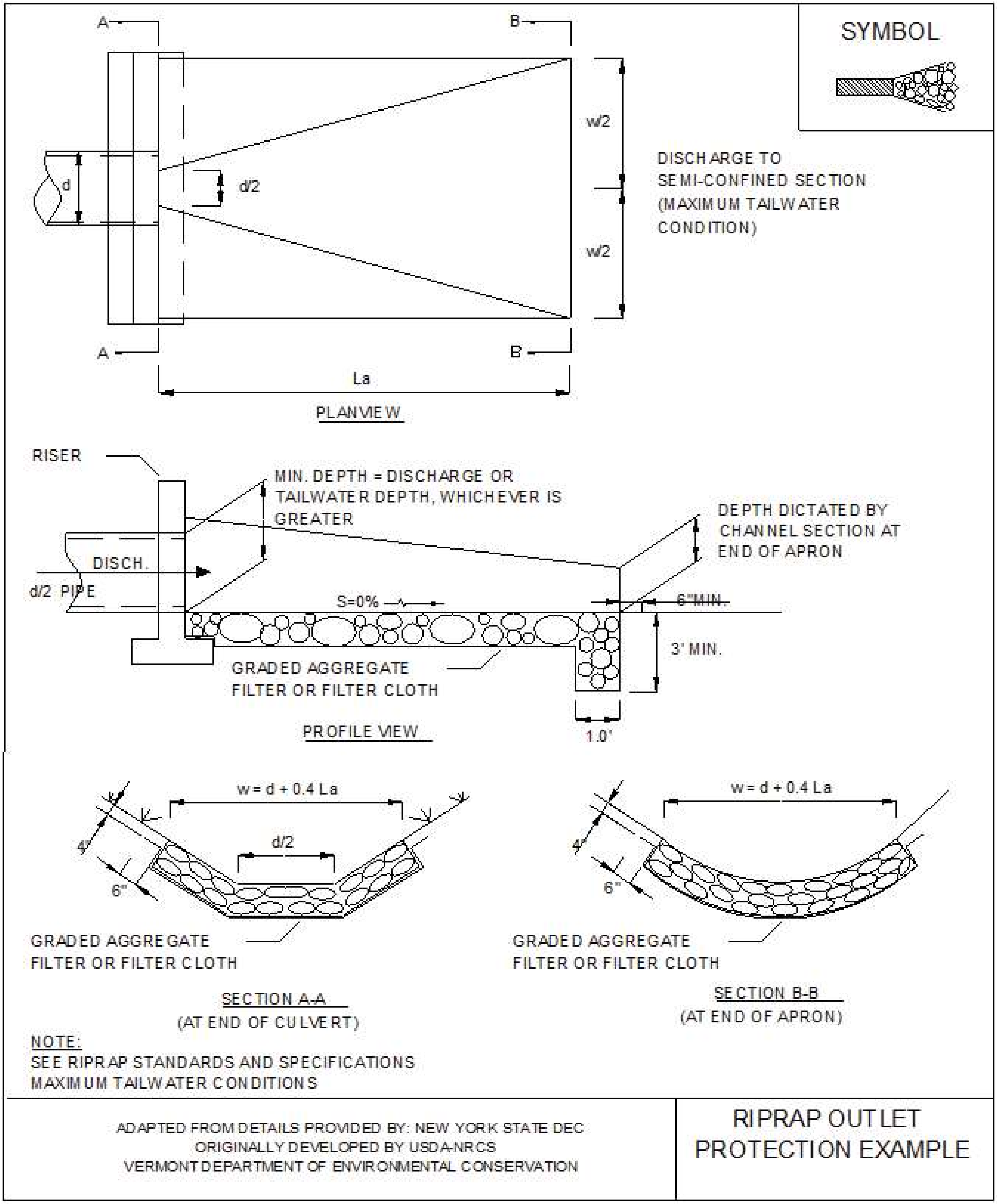

A
B
SYMBOL
w/2
d
d/2
DISCHARGE TO SEMI-CONFINED SECTION (MAXIMUM TAILWATER CONDITION)
w/2
A
B
La
PLANVIEW
RISER
MIN. DEPTH = DISCHARGE OR TAILWATER DEPTH, WHICHEVER IS GREATER
DEPTH DICTATED BY CHANNEL SECTION AT END OF APRON
DISCH.
d/2 PIPE
S=0%
6"MIN.
3' MIN.
GRADED AGGREGATE FILTER OR FILTER CLOTH
PROFILE VIEW
1.0'
w = d + 0.4 La
d/2
4'
6"
GRADED AGGREGATE FILTER OR FILTER CLOTH
SECTION A-A
(AT END OF CULVERT)
w = d + 0.4 La
4'
6"
GRADED AGGREGATE FILTER OR FILTER CLOTH
SECTION B-B
(AT END OF APRON)
NOTE:
SEE RIPRAP STANDARDS AND SPECIFICATIONS
MAXIMUM TAILWATER CONDITIONS
ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC
ORIGINALLY DEVELOPED BY USDA-NRCS
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
RIPRAP OUTLET PROTECTION EXAMPLE

Figure 4.32c

Part 4 - Grade Stabilization Structure

Definition

A structure to stabilize the grade or to control head cutting in natural or artificial channels.

Purpose

Grade stabilization structures are used to reduce or prevent excessive erosion by reduction of velocities and grade in the watercourse or by providing channel linings or structures that can withstand the higher velocities.

Scope

This standard applies to all types of grade stabilization structures. It does not apply to storm sewers or their component parts.

Conditions Where Practice Applies

This practice applies to sites where the capability of earth and vegetative measures is exceeded in the safe handling of water at permissible velocities, where excessive grades or overfall conditions are encountered, or where water is to be lowered structurally from one elevation to another. These structures should generally be planned and installed along with, or as a part of, other conservation practices in an overall surface water disposal system.

Design Criteria

General

Designs and specifications shall be prepared for each structure on an individual job basis depending on its purpose, site conditions, and the basic criteria of the conservation practice with which the structure is planned. Typical structures are as follows:

1. Channel linings of concrete, asphalt, half round metal pipe or other suitable lining materials. These linings should generally be used where channel velocities exceed safe velocities for vegetated channels due to increased grade or a change in channel cross section or where durability of vegetative lining is adversely affected by seasonal changes. Adequate protection will be provided to prevent erosion or scour of both ends of the channel lining.
2. Overfall structures of concrete, metal, rock riprap, or other suitable material are used to lower water from one elevation to another. These structures are applicable where it is desirable to drop the watercourse elevation over a very short horizontal distance. Adequate protection will be provided to prevent erosion or scour upstream, downstream and along sides of overfall structures. Structures should be located on straight sections of channel with a minimum of 100 feet of straight channel each way.
3. Pipe drops of metal pipe with suitable inlet and outlet structures. The inlet structure may consist of a vertical section of pipe or similar material, an embankment, or a combination of both. The outlet structure will provide adequate protection against erosion or scour at the pipe outlet.

Capacity

Structures that are designed to operate in conjunction with other erosion control practices shall have, at a minimum, a capacity equal to the bankfull capacity of the channel delivering water to the structures. The minimum design capacity for structures that are not designed to perform in conjunction with other practices shall be that required to handle the peak rate of flow from a 10-year, 24-hour frequency storm or bankfull, whichever is greater. Peak rates of runoff used in determining the capacity requirements shall be determined by TR-55, Urban Hydrology for Small Watersheds, or other appropriate method.

Set the rest of the structure at an elevation that will stabilize the grade of the upstream channel. The outlet should be set at an elevation to assure stability. Outlet velocities should be kept within the allowable limits for the receiving stream. Structural drop spillways need to include a foundation drainage system to reduce hydrostatic loads.

Construction Specifications

Structures shall be installed according to lines and grades shown on the plan. The foundation for structures shall be cleared of all undesirable materials prior to the installation of the structure. Materials used in construction shall be in conformance with the design frequency and life expectancy of the practice.

Earth fill, when used as a part of the structure, shall be placed in 4-inch lifts and hand compacted within 2 feet of the structure.

Locate emergency bypass areas so that floods in excess of structural capacity enter the channel far enough downstream so as not to cause damage to the structure.

Maintenance

Once properly installed, the maintenance for the grade stabilization structure should be minimal. Inspect the structure periodically and after major storm events. Check fill for piping or extreme settlement. Ensure a good vegetative cover. Check the channel for scour or debris and loss of rock from aprons. Repair or replace failing structures immediately.

Plans and Specifications

Plans and specification for installing grade stabilization structures shall be in keeping with this standard and will describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the practice will be installed.
2. Dimensions of the practice.
3. Design calculations.

Part 4 - Paved Flume

Definition

A small concrete-lined channel to convey water on a relatively steep slope.

Purpose

To convey concentrated runoff safely down the face of a cut or fill slope without causing erosion.

Conditions Where Practice Applies

Where concentrated storm runoff must be conveyed down a cut or fill slope as part of a permanent erosion control system. Paved flumes serve as stable outlets for diversions, drainage channels, or natural drainageways, that are located above relatively steep slopes. Paved flumes should be used on slopes of 1.5:1 or flatter.

Design Criteria

Capacity – Minimum capacity should be the 10-year frequency storm. Freeboard or enough bypass capacity should be provided to safeguard the structure from peak flows expected for the life of the structure.

Slope – The slope should not be steeper than 1.5:1 (67%).

Cutoff Walls – Install cutoff walls at the beginning and end of paved flumes. The cutoff should extend a minimum of 18 inches into the soil and across the full width of the flume and be 6 inches thick. Cutoff walls should be reinforced with #3 reinforcing bars (3/8") placed on a 6-inch grid in the center of the wall.

Anchor Lugs – Space anchor lugs a minimum of 10 feet on center for the length of the flume. They will extend the width of the flume, extend 1 foot into subsoil, be a minimum of 6 inches thick, and be reinforced with #3 reinforcing bars placed on a 6-inch grid.

Concrete – Minimum strength of design mix shall be 3000 psi. Concrete thickness shall be a minimum of 6 inches reinforced with #3 reinforcing bars. Mix shall be dense, durable, stiff enough to stay in place on steep slopes, and sufficiently plastic for consolidation. Concrete mix should include an air-entraining admixture to resist freeze-thaw cycles.

Cross Section – Flumes shall have minimum depth of 1 foot with 1.5:1 side slopes. Bottom widths shall be based on maximum flow capacity. Chutes will be maintained in a straight alignment because of supercritical flow velocities.

Drainage filters – Use a drainage filter with all paved flumes to prevent piping and reduce uplift pressures. Size of the filter material will be dependent on the soil material the flume is located in.

Inlet Section – Design the inlet to the following minimum dimensions: side walls 2 feet high, length 6 feet, width equal to the flume channel bottom, and side slopes the same as the flume channel side slopes.

Outlet Section – Outlets must be protected from erosion. Usually an energy dissipater is used to reduce the high chute velocities to lower non-erosive velocities. Rock riprap should be placed at the end of the dissipater to spread flow evenly to the receiving channel.

Invert – Precast concrete sections may be used in lieu of cast in place concrete. The sections should be designed at the joint to be overlapped to prevent displacement between sections. Joint sealing compound should be used to prevent migration of soil through a joint. Cutoff walls and anchor lugs should be cast in the appropriate sections to accommodate the design criteria.

Small Flumes – Where the drainage area is 10 acres or less, the design dimensions for concrete flumes may be selected from those shown in the following table:

Part 4 - Paved Flume

	5	10
Min Bottom Width	4	8
Min Inlet Depth (ft)	2	2
Min Channel Depth (ft)	1.3	1.3
Max Channel Slope	1.5:1	1.5:1
Max Side Slope	1.5:1	1.5:1

Construction Specifications

1. The subgrade shall be constructed to the lines and grades shown on the plans. Remove all unsuitable material and replace them if necessary with compacted stable fill materials. Shape subgrade to uniform surface. Where concrete is poured directly on subsoil, maintain it in a moist condition.
2. On fill slopes, the soil adjacent to the chute must be well compacted for a minimum of 5 feet.
3. Where drainage filters are placed under the structure, the concrete will not be poured on the filter. A plastic liner, a minimum of 4 mils thick, shall be placed to prevent contamination of filter layer.
4. Place concrete for the flume to the thickness shown on the plans and finish according to details. Protect freshly poured concrete from extreme temperatures (hot or cold) and ensure proper curing.
5. Form, reinforce, and pour together cutoff walls, anchor lugs and channel linings. Provide traverse joints to control cracking at 20-foot intervals. Joints can be formed by using a 1/8 inch thick removable template or by sawing to a minimum depth of 1 inch. Flumes longer than 50 feet shall have preformed expansion joints installed.
6. Immediately after construction, all disturbed areas shall be final graded and seeded.

Maintenance

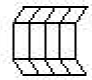
Inspect flumes after each rainfall until all areas adjoining the flume are permanently stabilized. Repair all damage immediately. Inspect outlet and rock riprap to assure presence and stability. Any missing components should be immediately replaced.

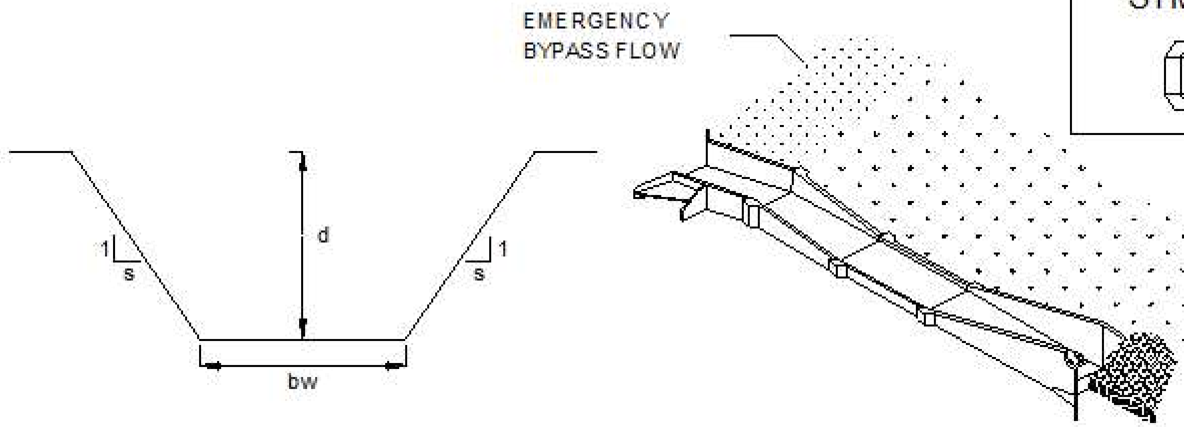
Plans and Specifications

Plans and specification for installing a paved flume shall be in keeping with this standard and will describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the practice will be installed.
2. Dimensions of the practice.
3. Construction detail.
4. Design calculations

SYMBOL





DRAINAGE AREA (AC)	MIN BOTTOM WIDTH (FT)	MIN CHANNEL DEPTH (FT)	MAX SIDE SLOPE (FT/FT)	MIN INLET DEPTH (FT)	MAX CHANNEL SLOPE (FT/FT)
5	4	1.3	1.5:1	2	1.5:1
10	8	1.3	1.5:1	2	1.5:1

CONSTRUCTION SPECIFICATIONS

1. SUBGRADE SHALL BE CONSTRUCTED TO THE LINES AND GRADES SHOWN ON THE PLANS. REMOVE ALL UNSUITABLE MATERIAL AND REPLACE THEM IF NECESSARY WITH COMPACTED STABLE FILL MATERIALS. SHAPE SUBGRADE TO UNIFORM SURFACE. WHERE CONCRETE IS POURED DIRECTLY ON SUBSOIL MAINTAIN IT IN A MOIST CONDITION.

2. ON FILL SLOPES THE SOIL ADJACENT TO THE CHUTE FOR A MINIMUM OF 5 FEET SHALL BE WELL COMPACTED.

3. WHERE DRAINAGE FILTERS ARE PLACED UNDER THE STRUCTURE THE CONCRETE WILL NOT BE POURED ON THE FILTER. A PLASTIC LINER, MINIMUM 4 MILS THICK, WILL BE PLACED TO PREVENT CONTAMINATION OF THE FILTER LAYER.

4. PLACE CONCRETE FOR THE FLUME TO THE THICKNESS SHOWN ON THE PLANS AND FINISH ACCORDING TO DETAILS. PROTECT FRESHLY POURED CONCRETE FROM EXTREME TEMPERATURES (HOT OR COLD) AND ENSURE PROPER CURING.

5. FORM, REINFORCE, AND POUR TOGETHER CUTOFF WALLS, ANCHOR LUGS AND CHANNEL LININGS. PROVIDE TRAVERSE JOINTS TO CONTROL CRACKING AT 20 FOOT INTERVALS. JOINTS CAN BE FORMED BY USING A 1/8 INCH THICK REMOVABLE TEMPLATE OR BY SAWING TO A MINIMUM DEPTH OF 1 INCH. FLUMES LONGER THAN 50 FEET SHALL HAVE PERFORMED EXPANSION JOINTS INSTALLED.

6. IMMEDIATELY AFTER CONSTRUCTION, ALL DISTURBED AREAS WILL BE FINAL GRADED AND SEEDED.

7. MAINTENANCE - INSPECT FLUMES AFTER EACH RAINFALL UNTIL ALL AREAS ADJOINING THE FLUME ARE PERMANENTLY STABILIZED. REPAIR ALL DAMAGE IMMEDIATELY. INSPECT OUTLET AND ROCK RIPRAP TO ASSURE PRESENCE AND STABILITY. ANY MISSING COMPONENTS SHOULD BE IMMEDIATELY REPLACED.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC
ORIGINALLY DEVELOPED BY USDA-NRCS
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PAVED FLUME

Figure 4.33 Paved Flume

Part 4 - Paved Flume

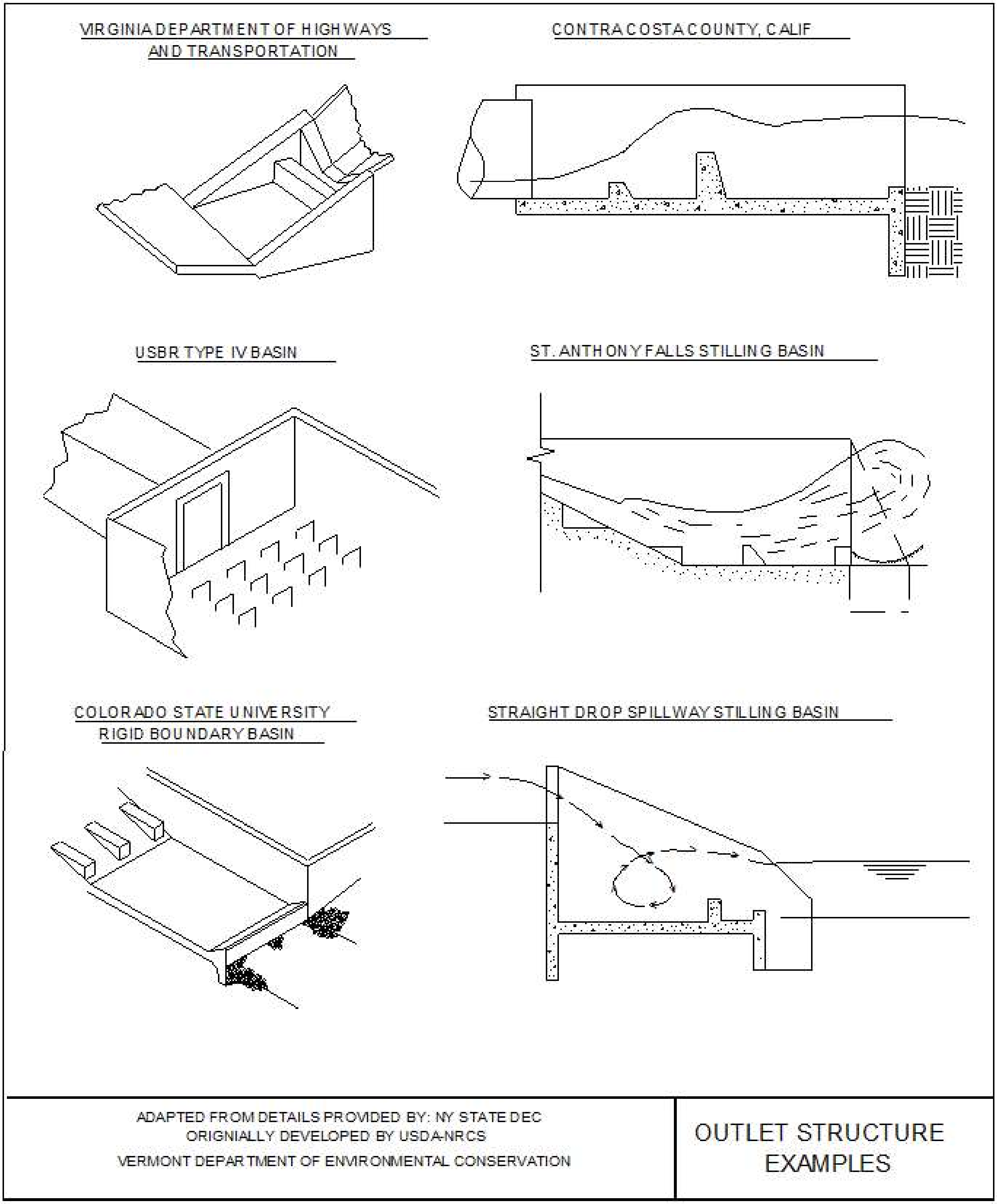


Figure 4.34 Paved Flume Outlet Structures Example

Part 5 - Silt Fence

Definition

A temporary barrier of geotextile fabric installed on the contours across a slope used to intercept sediment laden runoff from small drainage areas of disturbed soil and to provide perimeter control to the site.

Purpose

The purpose of a silt fence is to reduce runoff velocity in order to promote deposition of transported sediment load. Limits imposed by ultraviolet stability of the fabric will dictate the maximum period the silt fence may be used (approximately one year).

Conditions Where Practice Applies

Downslope of areas of earth disturbance.

A silt fence may be used subject to the following conditions:

1. Maximum allowable slope lengths contributing runoff to a silt fence placed on a slope are:

Slope Steepness	Maximum Length (ft.)
2:1	25
3:1	50
4:1	75
5:1 or flatter	100

2. Maximum drainage area for overland flow to a silt fence shall not exceed ¼ acre per 100 feet of fence, with maximum ponding depth of 1.5 feet behind the fence; and
3. Erosion would occur in the form of sheet or rill erosion; and
4. There is no concentration of water flowing to the barrier (i.e. silt fence is not to be used in areas of concentrated water flow).

Design Criteria

All silt fence shall be placed as close to the disturbed areas as possible, but at least 10 feet from the toe of a slope to allow for maintenance and energy dissipation. The area beyond the fence must be undisturbed or stabilized. Silt fence is required to be reinforced during the winter construction period (October 15-April 15) by using heavy wire fencing for added support or pairing with an additional practice, such as filter socks. See Part 3 for EPSC Plan Requirements for Winter Construction. Where ends of filter cloth come together, they shall be overlapped, and rolled together to prevent sediment bypass. A detail of the silt fence shall be shown on the plan.

Criteria for Silt Fence Materials

1. Silt Fence Fabric: The fabric shall meet the following specifications unless otherwise approved by the VT DEC.

Fabric Properties	Minimum Acceptable Value	Test Method
Grab Tensile Strength (lbs)	90	ASTM D1682
Elongation at Failure (%)	50	ASTM D1682
Mullen Burst Strength (PSI)	190	ASTM D3786
Puncture Strength (lbs)	40	ASTM D751 (modified)
Slurry Flow Rate (gal/min/sf)	0.3	
Equivalent Opening Size	40-80	US Std Sieve CW-02215
Ultraviolet Radiation Stability (%)	90	ASTM G-26

2. Fence Posts (for fabricated units): The length shall be a minimum of 36 inches long. Wood posts will be of sound quality hardwood with a minimum cross sectional area of 3.0 square inches. Steel posts will be standard T and U section weighing not less than 1.00 pound per linear foot.

3. Wire Fence (for fabricated units): Wire fencing shall be a minimum 14 gage with a maximum 6 in. mesh opening, or as approved.

Considerations

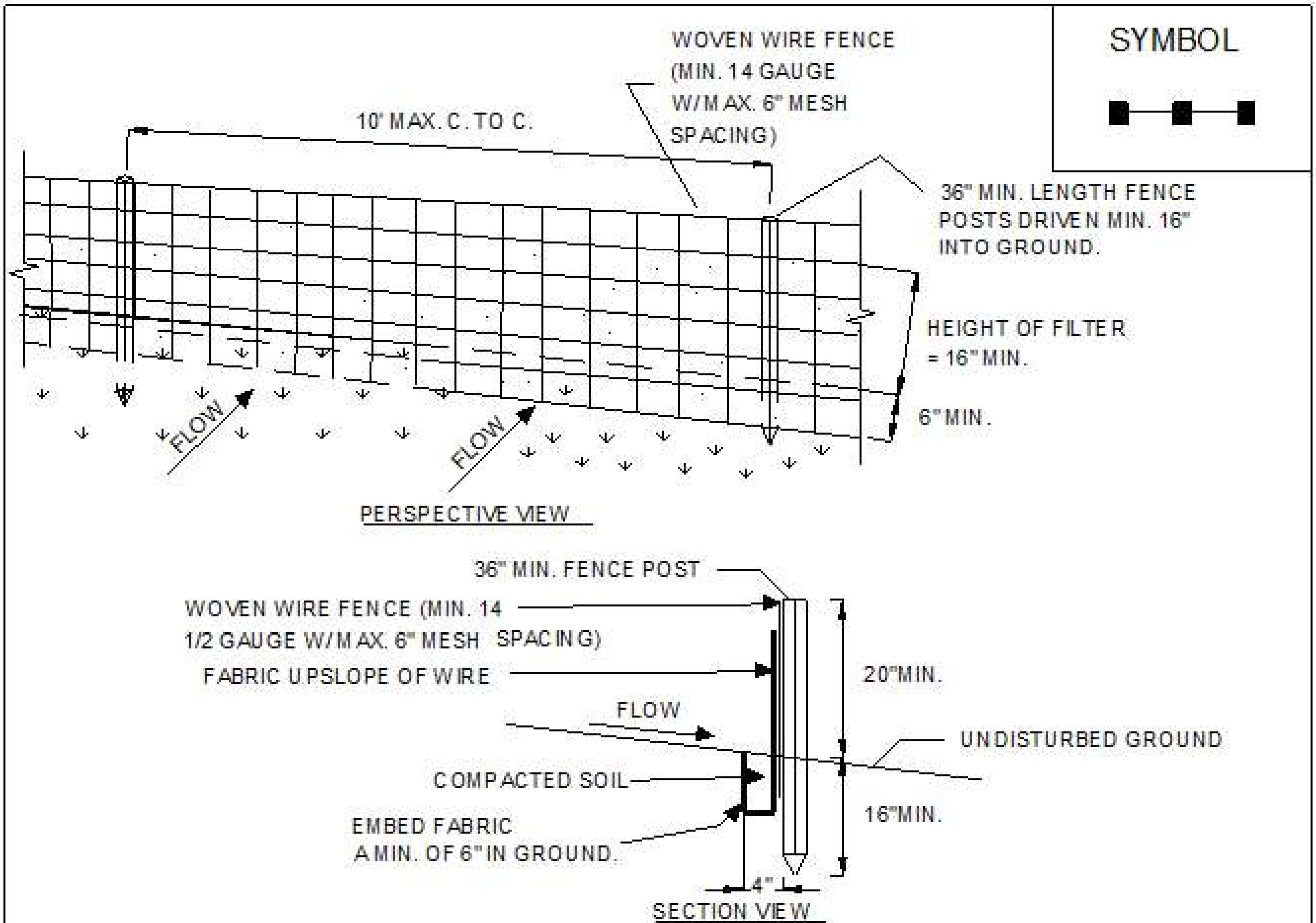
Silt fences should be considered for trapping sediment where sheet and rill erosion may be expected to occur in small drainage areas. Silt fences should not be placed in areas of concentrated flows.

Plans and Specifications

Plans and specifications for installing silt fences shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the silt fence is to be installed.
2. The type, size, and spacing of fence posts.
3. The type and size of wire or other approved support mesh backing, if used.
4. The type of filter fabric used.
5. The method of anchoring the filter fabric.
6. The method of fastening the filter fabric to the fencing support.
7. Construction detail.

Part 5 - Silt Fence



CONSTRUCTION SPECIFICATIONS

1. WOVEN WIRE FENCE TO BE FASTENED SECURELY TO FENCE POSTS WITH WIRE TIES
   WIRE FENCE REINFORMCEMENT REQUIRED WITHIN 100 FT UPSLOPE OF RECEIVING WATERS
2. FILTER CLOTH TO BE TO BE FASTENED SECURELY TO WOVEN WIRE FENCE WITH TIES SPACED EVERY 24" AT TOP AND MID SECTION. FENCE SHALL BE WOVEN WIRE, 6" MAXIMUM MESH OPENING.
3. WHEN TWO SECTIONS OF FILTER CLOTH ADJOIN EACH OTHER THEY SHALL BE OVER-LAPPED BY SIX INCHES AND FOLDED. FILTER CLOTH SHALL BE EITHER FILTER X, MIRAFI 100X, STABILINKA T140N, OR APPROVED EQUIVALENT.
4. PREFABRICATED UNITS SHALL BE GEOFAB, ENVIROFENCE, OR APPROVED EQUIVALENT.
5. MAINTENANCE SHALL BE PERFORMED AS NEEDED AND MATERIAL REMOVED WHEN SEDIMENT REACHES HALF OF FABRIC HEIGHT.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	SILT FENCE

Figure 5.1 Silt Fence

Part 5 - Erosion Control Berm

Definition

A berm comprised of a dense, processed mixture of intertwining wood fragments and grit that form a stable, long lasting mulch used to reduce flow velocity and filter construction site runoff. Common sources include stump grindings and aged wood waste and may also contain shredded bark as part of the mix.

Purpose

Erosion control berms are a perimeter control that act to slow and filter overland flow from construction sites before leaving the site.

Conditions Where Practice Applies

Erosion control berms are an appropriate perimeter control on most construction sites and can be applied on ledge, frozen ground, and wooded areas where root damage is a concern. They are to be installed downslope of earth disturbance between the disturbed area and the construction site boundary.

Light vegetative clearing may be required in the area of berm placement to insure direct contact with the ground.

The maximum drainage area for overland flow to an erosion control berm shall not exceed 1/4 acre per 100' of berm,.

Maximum allowable slope lengths contributing runoff to an erosion control berm placed on a slope are:

Slope Steepness	Maximum Length (ft.)
2:1	25
3:1	50
4:1	75
5:1 or flatter	100

Design Criteria

1. Erosion Control Berms shall be placed along the contour and constructed of stump grindings and may also contain partially aged wood material and shredded bark.
2. At a minimum the berm should be 1' tall and 2' at the base. Larger berms may be needed in steeper drainage areas with higher velocity flows.
3. Erosion control berms should be made of a mix that is 50-100% organic material, with the mineral component coming from the root ball the mineral component should not include rocks >4" or large amounts of silts and clays.
4. The mix should contain no unsuitable material including refuse, construction debris or reprocessed wood products.
5. The intertwining matrix of shredded wood and grit is essential to this practice working properly and therefore use of wood chips as the primary component will not meet the specifications and is not an acceptable primary source material.
6. Erosion control berms should not be used in areas of concentrated flows (i.e. these should only receive runoff as sheet flow).

Considerations

This practice is best implemented on sites where clearing is required, and source material is readily available.

Maintenance

Erosion control berms can be reshaped as needed. Sediment build-up should be removed and placed in a stable upslope location once it reaches halfway up the berm or before if needed.

Part 5 - Erosion Control Berm

<u>Plans and Specifications</u>

Plans and specifications for installing erosion control berms shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the erosion control berm is going to be installed.
2. Source material and approximate composition of the berm.
3. Construction detail.

Part 5 - Erosion Control Berm

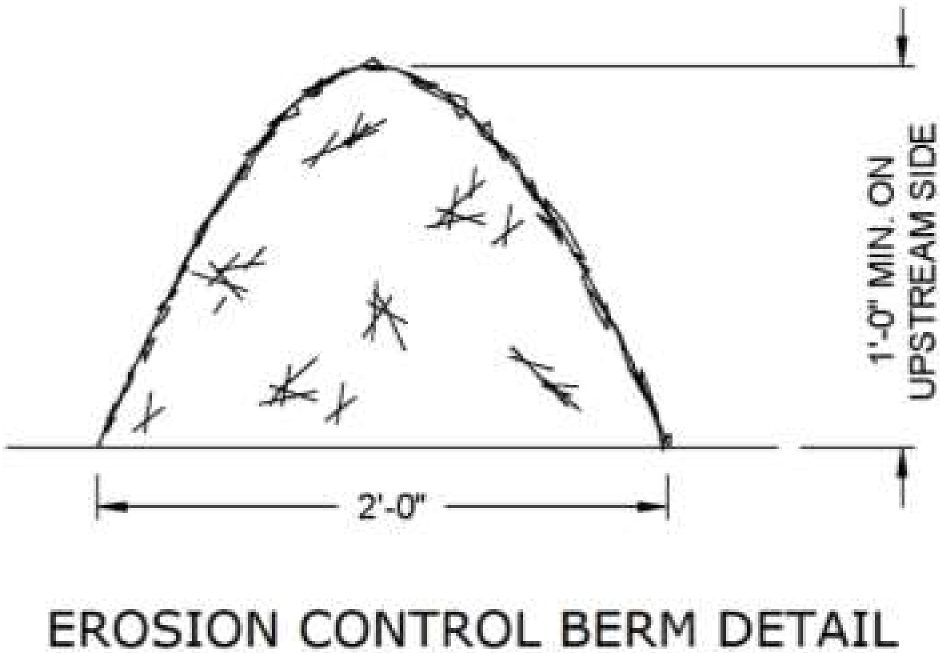


Figure 5.2 Erosion Control Berm

Part 5 - Filter Socks

Definition

An organic filter media encased in a mesh tube used as a temporary perimeter control that filters stormwater before discharging from the construction site.

Purpose

Filter socks are a perimeter control that act to slow and filter overland flow from construction sites before leaving the site.

Conditions Where Practice Applies

Filter socks are an appropriate perimeter control on most construction sites and can applied on ledge, frozen ground, concrete, asphalt, and other impervious surfaces, as well as on pervious surfaces. They are to be installed downslope of earth disturbance between the disturbed area and the construction site boundary.

Filter sock performance is dictated by contributing slope, slope length, and filter sock diameter. Typical filter sock lifespan is one year.

Design Criteria

1. Filter socks shall be placed on the contour, with the ends of socks turned uphill at a 45 degree angle to prevent bypass of flow.
2. Anchoring shall be in the form of driven wooden stakes spaced at 10' intervals on pervious ground applications and by sandbags or other anchors placed over the filter sock at 10' intervals on impervious ground applications, including ledge, frozen ground, asphalt, concrete, and gravel to ensure continuous contact with the ground surface.
3. No vehicle traffic shall be directed over the filter sock.
4. Maintenance shall be performed when sediment accumulation reaches half of the effective height of the filter sock and shall include removal of accumulated sediment.
5. Removal of filter sock upon final stabilization shall include removal of the stakes and mesh and spreading of the contents of the filter sock in a stabilized location. Plastic mesh may not be left in place, even if considered to be photo- or biodegradable.

Media Specifications

Filter media shall be composed of well-decomposed organic media that meets the conditions below:

1. pH between 6-8.
2. Particle size: 100% passing a 2 in (50mm) sieve and a maximum of 40% passing a 3/8 in (9.5mm) sieve.
3. Moisture content of less than 60%. Material shall be relatively free (<1% by dry weight) of inert or foreign man made materials.
4. Free of weeds.

Mesh Specifications

1. Mesh opening shall not exceed 3/8"
2. Mesh shall be comprised on knitted cotton or polypropylene

Criteria for Filter Sock Spacing

1. The maximum area contributing to filter socks shall not exceed 1/4 per 100 ft. of filter sock.
2. The maximum slope length contributing to any one filter sock is as follows:

Part 5 - Filter Socks

Maximum slope length (in feet) above a filter sock:

Slope (%)	Sock Diameter (in)			
	12"	18"	24"	32"
<5	225	250	275	325
5-10	125	150	200	275
10-20	65	70	130	150
20-25	50	55	100	120
25-33	40	45	60	75
>33	25	30	35	50

Plans and Specifications

Plans and specifications for installing filter socks shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following:

1. Location where the filter sock is going to be installed.
2. Media specification.
3. Construction detail.

Part 5 - Filter Socks

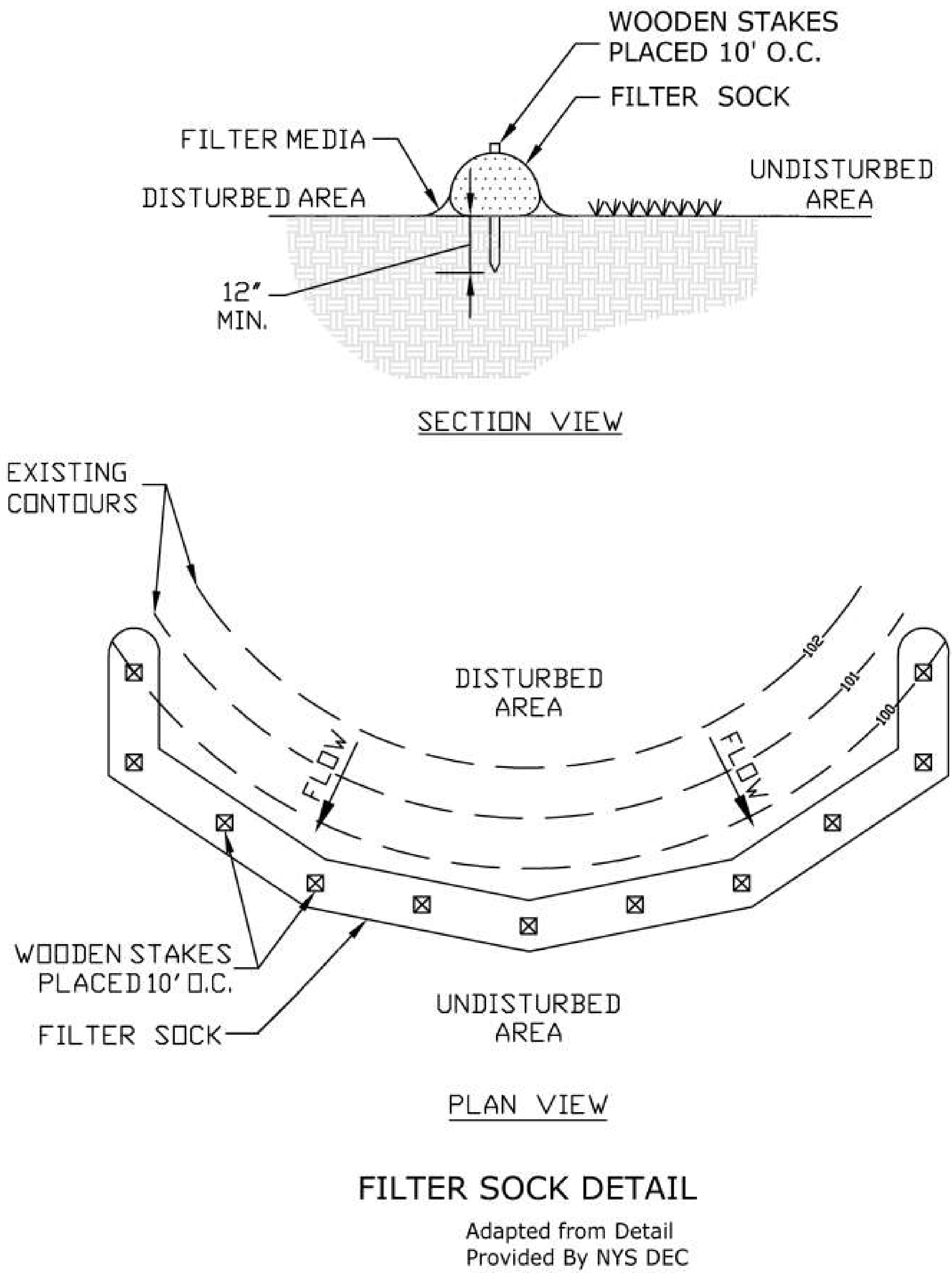


Figure 5.3 Filter Sock

Part 5 - Stabilized Construction Access

Definition

A stabilized pad of aggregate underlain with geotextile located at any point where traffic will be entering or leaving a construction site to or from a public right-of-way, street, alley, sidewalk, or parking area.

Purpose

The purpose of stabilized construction access is to reduce or eliminate the tracking of sediment onto public rights-of-way or streets.

Conditions Where Practice Applies

A stabilized construction access shall be used at all points of construction ingress and egress.

Design Criteria

Aggregate Size: Use a matrix of 1-4 inch stone, or reclaimed or recycled concrete equivalent.

Thickness: Not less than eight (8) inches.

Width: 12-feet minimum but not less than the full width of points where ingress or egress occurs. Access shall be flared at road for vehicle turning.

Length: 40 feet minimum (or length of driveway for residential projects, if shorter).

Geotextile: To be placed over the entire area to be covered with aggregate. Piping for stormwater under construction access shall be provided as required.

Criteria for Geotextile

The geotextile shall be woven or non-woven fabric consisting only of continuous chain polymeric filaments or yarns of polyester. The fabric shall be inert to commonly encountered chemicals, hydro-carbons, mildew, rot resistant, and conform to the fabric properties as shown:

Fabric Properties[3]	Light Duty[1] Roads Grade Subgrade	Heavy Duty[2] Haul Roads Rough Graded	Test Method
Grab Tensile Strength (lbs)	200	220	ASTM D1682
Elongation at Failure (%)	50	60	ASTM D1682
Mullen Brust Strength (lbs)	190	430	ASTM D3786
Puncture Strength (lbs)	40	125	ASTM D751 modified
Equivalent Opening Size	40-80	40-80	US Std Sieve CW-02215
Aggregate Depth	6	10	--

[1]Light Duty Road: Area sites that have been graded to subgrade and where most travel would be single axle vehicles and an occasional multi-axle truck. Acceptable materials are Trevira Spunbond 1115, Mirafi 100X, Typar 3401, or equivalent.

[2]Heavy Duty Road: Area sites with only rough grading, and where most travel would be multi-axle vehicles. Acceptable materials are Trevira Spunbond 1135, Mirafi 600X, or equivalent.

[3]Fabrics not meeting these specifications may be used only when design procedure and supporting documentation are supplied to determine aggregate depth and fabric strength.

Maintenance

1. The access shall be maintained in a condition which will prevent tracking of sediment onto public rights-of-way or streets. Redress with clean stone or scarify to open voids as required to keep sediment from tracking onto street.

2. Where sediment has been tracked-out from the construction site onto paved roads, sidewalks, or other paved areas outside of the site, remove the deposited sediment by the end of the same day in which the track-out occurs. When necessary, wheels must be cleaned to remove sediment prior to entrance onto public rights-of-way.

3. Remove the track-out by sweeping, shoveling, or vacuuming these surfaces, or by using other similarly effective means of sediment removal.

4. Hosing or sweeping tracked-out sediment into any stormwater conveyance, storm drain inlet, or water of the State is prohibited.

Considerations

Improperly planned and maintained construction accesses can become a continual erosion problem. The tracking of mud from active construction sites onto roads by construction vehicles can be greatly reduced, and in some cases eliminated, by the use of a stabilized construction access. These accesses provide an area where mud can be removed from construction vehicle tires before they enter a public road.

If the action of the vehicle tires traveling over the stone is not sufficient to remove the majority of the mud, then the tires must be washed before the vehicle enters a public road. When washing is required it shall be done on an area stabilized with aggregate, or using a wash rack underlain with gravel. Provisions shall be made to intercept the wash water and trap the sediment before it is carried off-site. Construction accesses should be used in conjunction with the stabilization of construction roads, and other exposed areas, to reduce the amount of mud picked up by construction vehicles and equipment.

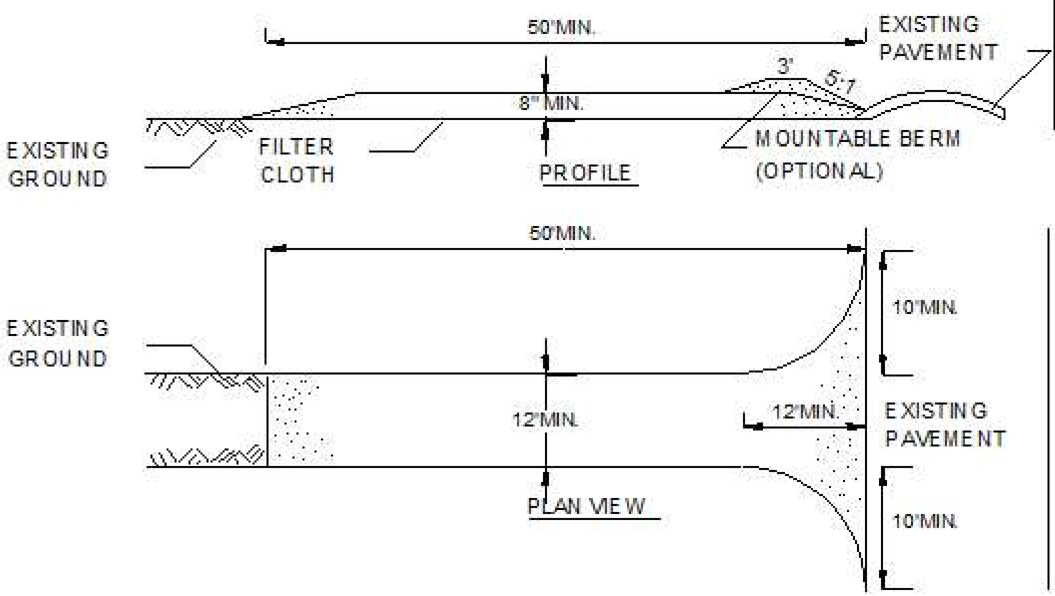
Plans and Specifications

Plans and specifications for installing stabilized construction accesses shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. Location of stabilized construction accesses.

2. Construction detail.

Part 5 - Stabilized Construction Access



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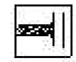


CONSTRUCTION SPECIFICATIONS

1. STONE SIZE - USE 1-4 INCH STONE, OR RECLAIMED OR RECYCLED CONCRETE EQUIVALENT.

2. LENGTH - NOT LESS THAN 50 FEET (EXCEPT ON A SINGLE RESIDENCE LOT WHERE A 30 FOOT MINIMUM LENGTH APPLIES).

3. THICKNESS - NOT LESS THAN EIGHT (8) INCHES.

4. WIDTH - TWELVE (12) FOOT MINIMUM, BUT NOT LESS THAN THE FULL WIDTH AT POINTS WHERE INGRESS OR EGRESS OCCURS. TWENTY-FOUR (24) FOOT IF SINGLE ENTRANCE TO SITE.

5. GEOTEXTILE MUST BE PLACED OVER THE ENTIRE AREA PRIOR TO PLACING OF STONE.

6. SURFACE WATER - ALL SURFACE WATER FLOWING OR DIVERTED TOWARD CONSTRUCTION ENTRANCES SHALL BE PIPED BENEATH THE ENTRANCE. IF PIPING IS IMPRACTICAL, A MOUNTABLE BERM WITH 5:1 SLOPES WILL BE PERMITTED.

7. MAINTENANCE - THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHTS-OF-WAY, ALL SEDIMENT SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC RIGHTS-OF-WAY MUST BE REMOVED IMMEDIATELY.

8. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON A AREA STABILIZED WITH STONE AND WHICH DRAINS INTO AN APPROVED SEDIMENT TRAPPING DEVICE.

9. PERIODIC INSPECTION AND NEEDED MAINTENANCE SHALL BE PROVIDED ACCORDING TO PERMIT REQUIREMENTS.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	STABILIZED CONSTRUCTION ENTRANCE

Figure 5.4 Stabilized Construction Access

Part 5 - Storm Drain Inlet Protection

Definition

A temporary, somewhat permeable barrier, installed around inlets in the form of a fence, berm or excavation around an opening, trapping water and thereby reducing the sediment content of stormwater by settling.

Purpose

To prevent heavily sediment laden water from entering a storm drain system through inlets.

Conditions Where Practice Applies

This practice shall be used where the drainage area to an inlet is disturbed, but where it is not possible to temporarily divert the storm drain outfall into a trapping device, and watertight blocking of inlets is not advisable. It is not to be used in place of sediment trapping devices. This may be used in conjunction with storm drain diversion to help prevent siltation of pipes installed with low slope angles.

Types of Storm Drain Inlet Practices

There are five (5) specific types of storm drain inlet protection practices that vary according to their function, location, drainage area, and availability of materials:

I. Excavated Drop Inlet Protection
II. Fabric Drop Inlet Protection
III. Stone & Block Drop Inlet Protection
IV. Curb Drop Inlet Protection
V. Proprietary Inlet Protection

Design Criteria

Drainage Area – The drainage area for storm drain inlets shall not exceed one acre. The crest elevations of these practices shall provide storage and minimize bypass flow.

Type I – Excavated Drop Inlet Protection

Limit the drainage area to the inlet device to 1 acre. Excavated side slopes shall be no steeper than 2:1. The minimum depth shall be 1 foot and the maximum depth 2 feet as measured from the crest of the inlet structure. Shape the excavated basin to fit conditions with the longest dimension oriented toward the longest inflow area to provide maximum trap efficiency. The capacity of the excavated basin should be established to contain 900 cubic feet per acre of disturbed area. Weep holes, protected by fabric and stone, should be provided for draining the temporary pool.

Inspect and clean the excavated basin after every storm. Sediment should be removed when 50 percent of the storage volume is achieved This material should be incorporated into the site in a stabilized manner.

Type II – Fabric Drop Inlet Protection

Limit the drainage area to 1 acre per inlet device. Land area slope immediately surrounding this device should not exceed 1 percent. The maximum height of the fabric above the inlet crest shall not exceed 1.5 feet unless reinforced.

The top of the barrier should be maintained to allow overflow to drop into the drop inlet and not bypass the inlet to unprotected lower areas. Support stakes for fabric shall be a minimum of 3 feet long, spaced a maximum 3 feet apart. They should be driven close to the inlet so any overflow drops into the inlet and not on the unprotected soil. Improved performance and sediment storage volume can be obtained by excavating the area.

Inspect the fabric barrier after each rain event and make repairs as needed. Remove sediment from the pool area as necessary with care not to undercut or damage the filter fabric. Upon stabilization of the drainage area, remove all materials and unstable sediment and dispose of properly. Bring the adjacent area of the drop inlet to grade, smooth and compact and stabilize in the appropriate manner to the site.

Part 5 - Storm Drain Inlet Protection

Type III – Stone and Block Drop Inlet Protection

Limit the drainage area to 1 acre at the drop inlet. The stone barrier should have a minimum height of 1 foot and a maximum height of 2 feet. Do not use mortar. The height should be limited to prevent excess ponding and bypass flow.

Recess the first course of blocks at least 2 inches below the crest opening of the storm drain for lateral support. Subsequent courses can be supported laterally if needed by placing a 2x4 inch wood stud through the block openings perpendicular to the course. The bottom row should have a few blocks oriented so flow can drain through the block to dewater the basin area.

The stone should be placed just below the top of the blocks on slopes of 2:1 or flatter. Place hardware cloth of wire mesh with ½ inch openings over all block openings to hold stone in place.

As an optional design, the concrete blocks may be omitted and the entire structure constructed of stone, ringing the outlet ("doughnut"). The stone should be kept at a 3:1 slope toward the inlet to keep it from being washed into the inlet. A level area 1-foot wide and four inches below the crest will further prevent wash. Stone on the slope toward the inlet should be at least 3 inches in size for stability and 1 inch or smaller away from the inlet to control flow rate.
The elevation of the top of the stone crest must be maintained 6 inches lower than the ground elevation down slope from the inlet to ensure that all storm flows pass over the stone into the storm drain and not past the structure. Temporary diking should be used as necessary to prevent bypass flow.

The barrier should be inspected after each rain event and repairs made where needed. Remove sediment as necessary to provide for accurate storage volume for subsequent rains. Upon stabilization of contributing drainage area, remove all materials and any unstable soil and dispose of properly.

Bring the disturbed area to proper grade, smooth, compact and stabilized in a manner appropriate to the site.

Type IV – Curb Drop Inlet Protection

The drainage area should be limited to 1 acre at the drop inlet. The wire mesh must be of sufficient strength to support the filter fabric and stone with the water fully impounded against it. Stone is to be 2 inches in size and clean. The filter fabric must be of a type approved for this purpose with an equivalent opening size (EOS) of 40-85. The protective structure will be constructed to extend beyond the inlet 2 feet in both directions. Assure that storm flow does not bypass the inlet by installing temporary dikes (such as sand bags) directing flow into the inlet. Make sure that the overflow weir is stable. Traffic safety shall be integrated with the use of this practice. The structure should be inspected after every storm event. Any sediment should be removed and disposed of on the site. Any stone missing should be replaced. Check materials for proper anchorage and secure as necessary.

Type V - Proprietary Inlet Protection

Proprietary storm drain inlet protection practices are acceptable for protecting inlets from sediment laden runoff when selected in consideration of the specific design and site conditions.

Proprietary inlet protection shall provide for storage and removal of sediment and shall be sized appropriately for the drainage area, while allowing stormwater to filter through. These may be used when installed and maintained in accordance with the manufacturer's specficications.

<u>Considerations</u>

In developing areas, installation of streets and storm sewer networks usually occur before the construction of homes, businesses or other developments.
During this and subsequent phases of construction,

unprotected soil is susceptible to erosion. Storm sewers that are operational before their drainage areas are stabilized often carry large amounts of sediment to lakes, detention ponds, streams, or other natural or constructed drainageways. As a result, the water quality of the receiving body of water is detrimentally affected. In cases of extreme sediment loading, the storm sewer may clog completely or lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

Storm drain inlet protection consists of several types of inlet filters and traps. Each type differs in application dependant upon site conditions and type of inlet. Not all designs are appropriate in all cases. The user must carefully select a design suitable for the needs and site conditions. Field experience has shown that inlet protection that causes excessive ponding in an area of high construction activity may become so inconvenient that it is removed or bypassed, thus transmitting sediment-laden flows unchecked. In such situations, a structure with an adequate overflow mechanism must be utilized.

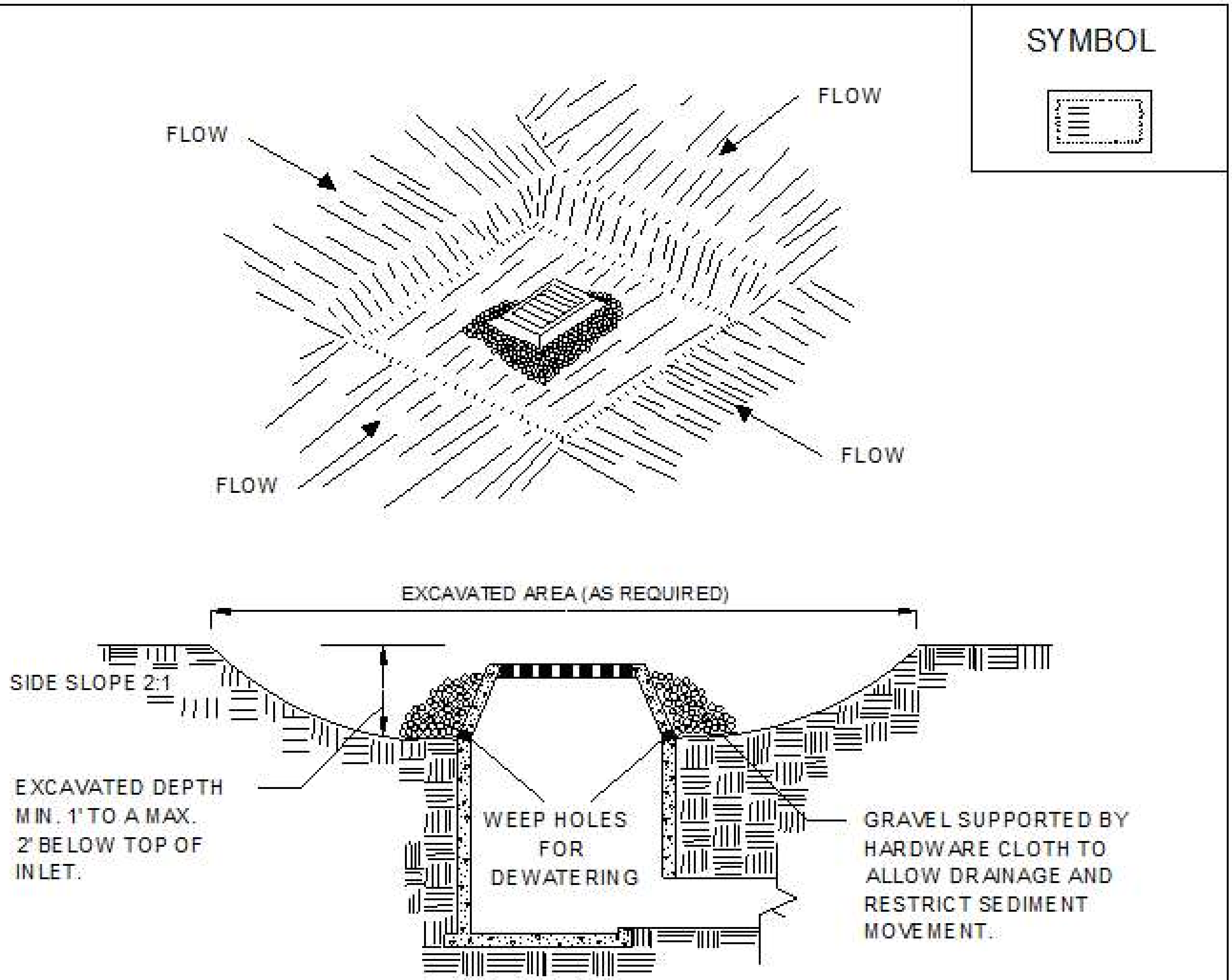
Stone is utilized as the chief ponding/filtering agent in many types of inlet protection. The various types of "coarse aggregates" which are shown are able to filter out sediment mainly through slowing down flows directed to the inlet by creating an increased flow path for the stormwater (through void space in the respective stone). The stone filtering medium by no means slows stormwater flow rate as does filter cloth and therefore cannot provide the same degree of filter efficiency when smaller silt and clay particles are introduced into stormwater flows. However, as mentioned earlier, excessive ponding in busy areas adjacent to stormwater inlets is in many cases unacceptable.

In most instances, inlet protection utilizing stone should not be the sole control measure. At the time that storm sewer inlet and associated appurtenances become operational, areas adjacent to the structures are most likely at final grade or will not be altered for extended periods. This is the time when temporary or final stabilization should be in place and other appropriate controls should be implemented to enhance sediment-loss reductions. In addition, by varying stone sizes used in the construction of inlet protection, a greater degree of sediment removal can be obtained. As an option, filter cloth can be used with the stone in these devices to further enhance sediment removal. Notably, the potential inconvenience of excessive ponding must be examined with these choices, especially the latter. In all designs that utilize stone with a wire-mesh support as a filtering mechanism, the stone can be completely wrapped with the wire mesh to improve stability and provide easier cleaning.

<u>Plans and Specifications</u>

Plans and specifications for installing storm drain inlet protection shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum include the following items:

1. All locations where inlet protection is designated.
2. Type of inlet protection for each location.
3. Construction detail for each type of inlet protection designated.



CONSTRUCTION SPECIFICATIONS

1. CLEAR THE AREA OF ALL DEBRIS THAT WILL HINDER EXCAVATION.
2. GRADE APPROACH TO THE INLET UNIFORMLY AROUND THE BASIN.
3. WEEP HOLES SHALL BE PROTECTED BY GRAVEL.
4. UPON STABILIZATION OF CONTRIBUTING DRAINAGE AREA, SEAL WEEP HOLES, FILL EXCAVATION WITH STABLE SOIL TO FINAL GRADE, COMPACT IT PROPERLY AND STABILIZE WITH PERMANENT SEEDING.

MAXIMUM DRAINAGE AREA 1 ACRE

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC
ORIGINALLY DEVELOPED BY USDA-NRCS
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

EXCAVATED DROP INLET PROTECTION

Figure 5.5a Storm Drain Inlet Protection: Excavated

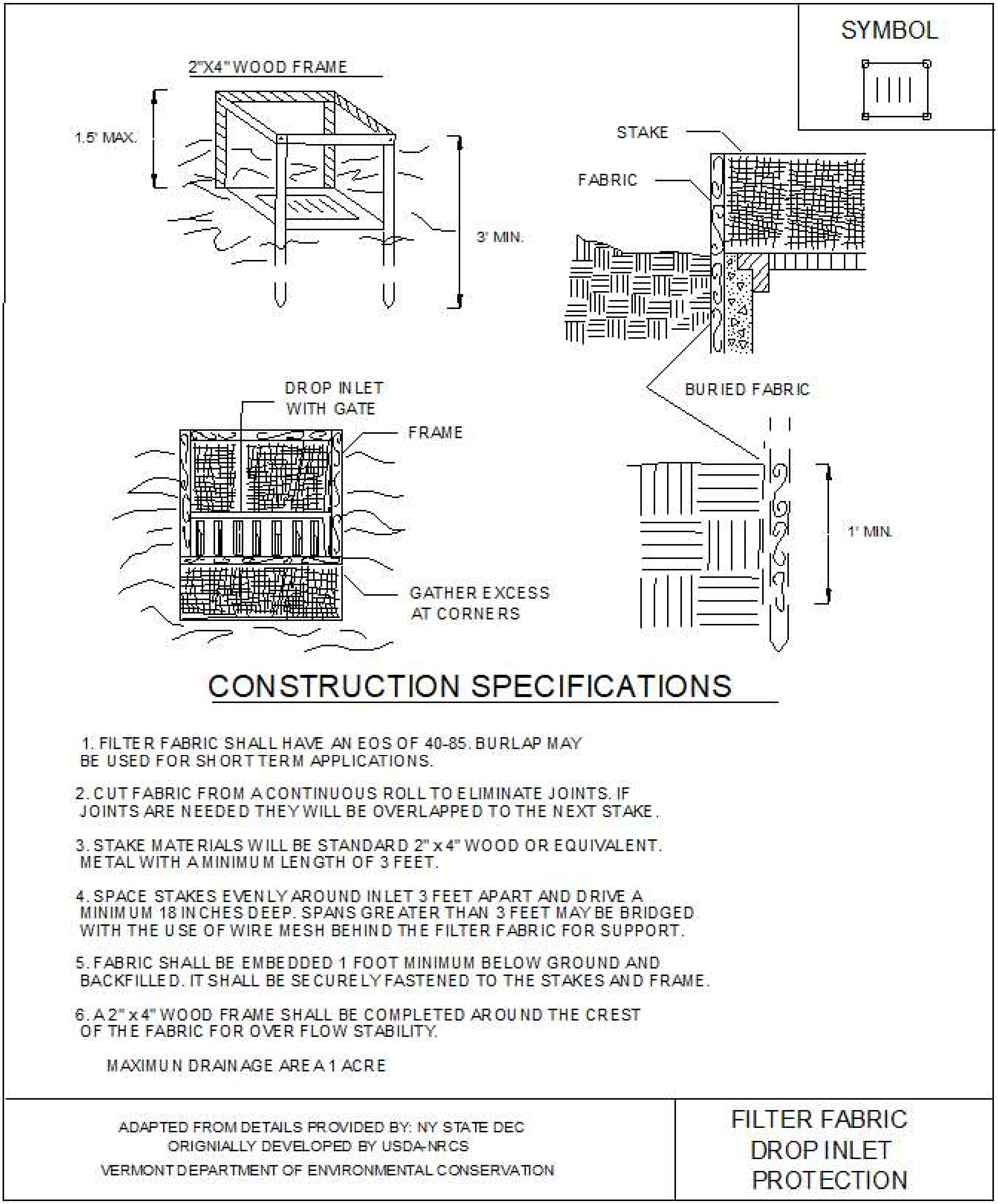
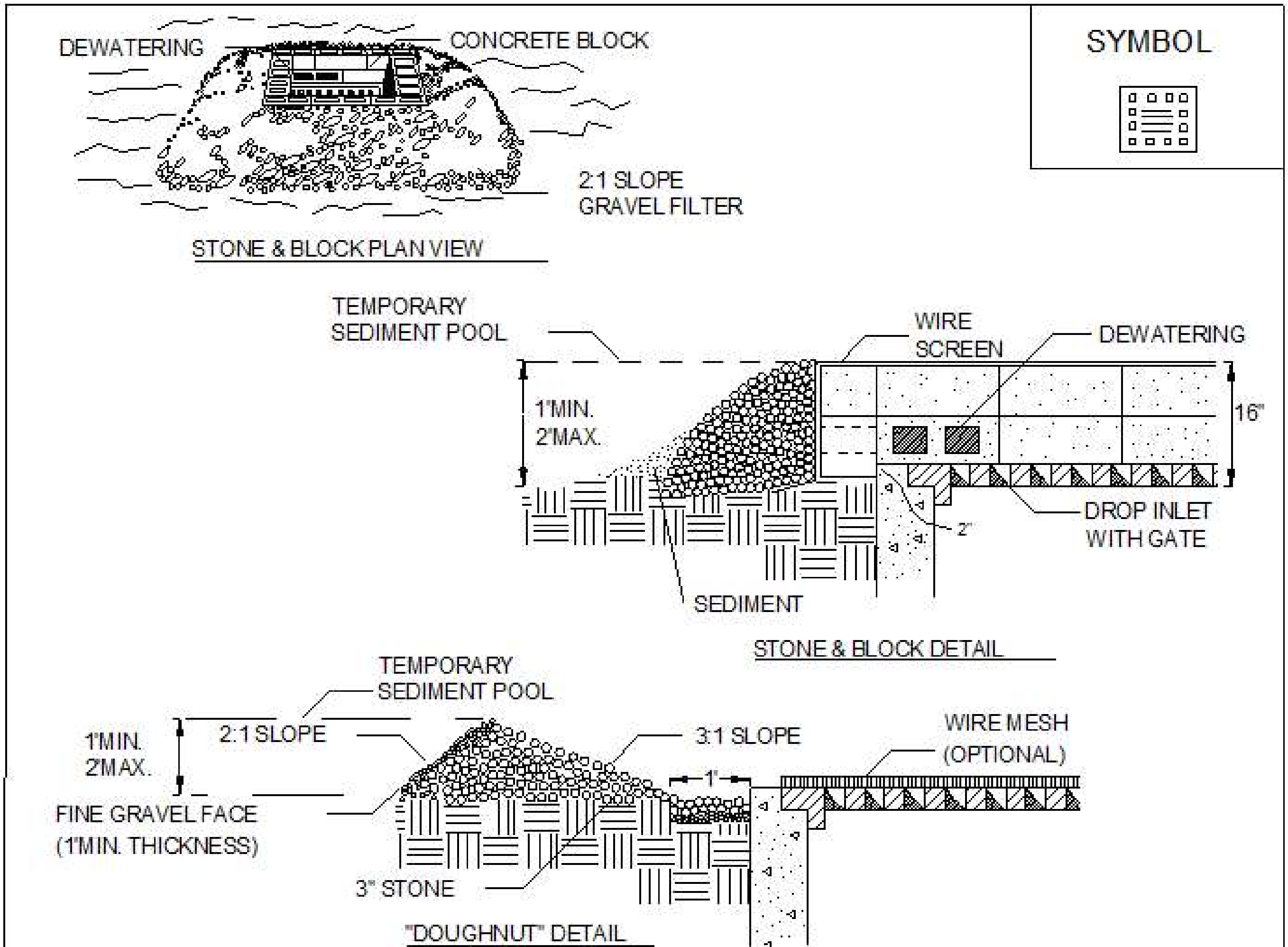


Figure 5.5b Storm Drain Inlet Protection: Filter Fabric



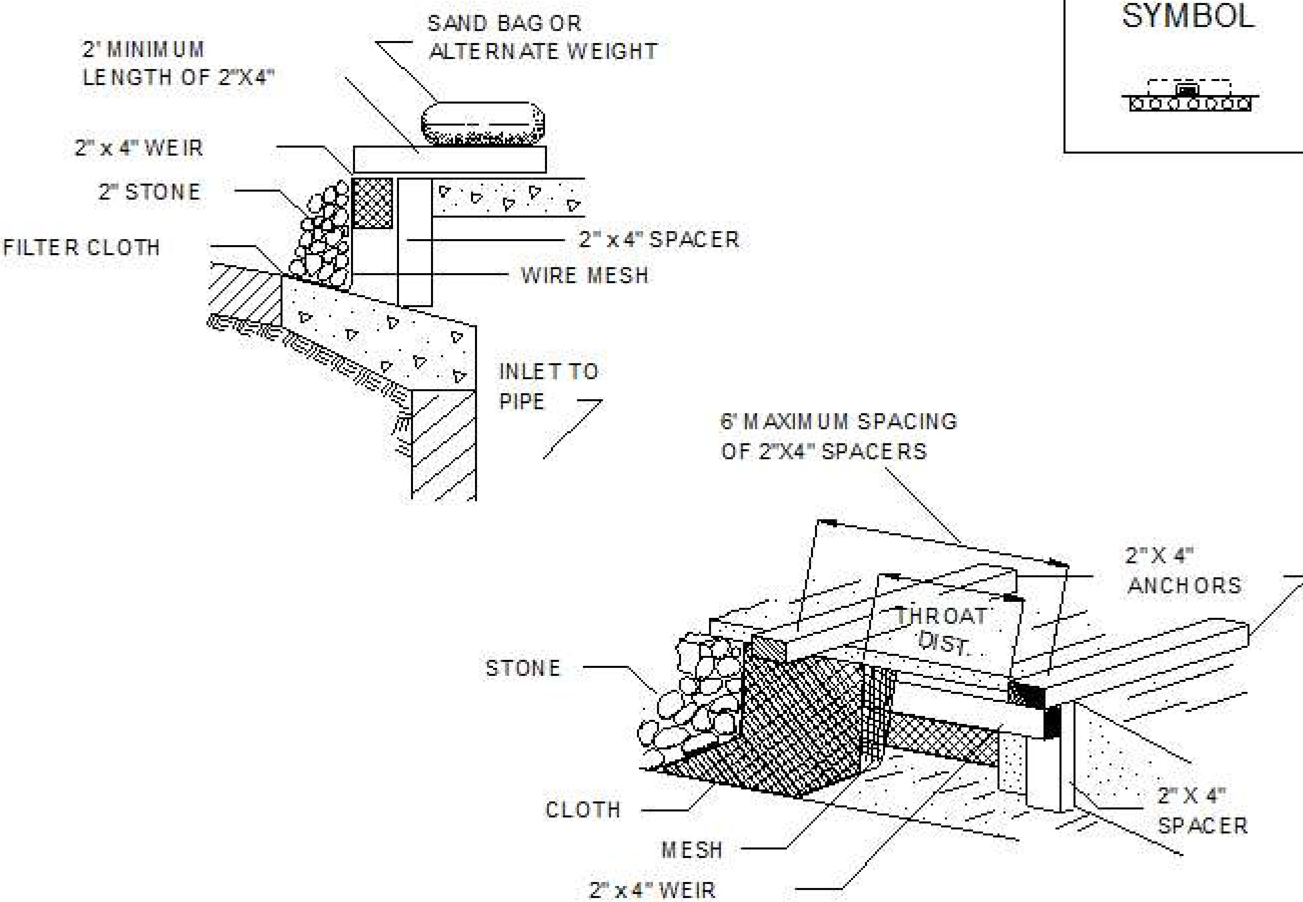
CONSTRUCTION SPECIFICATIONS

1. LAY ONE BLOCK ON EACH SIDE OF THE STRUCTURE ON ITS SIDE FOR DEWATERING. FOUNDATION SHALL BE 2 INCHES MINIMUM BELOW REST OF INLET AND BLOCKS SHALL BE PLACED AGAINST INLET FOR SUPPORT.
2. HARDWARE CLOTH OR 1/2" WIRE MESH SHALL BE PLACED OVER BLOCK OPENINGS TO SUPPORT STONE.
3. USE CLEAN STONE OR GRAVEL 1/2-3/4 INCH IN DIAMETER PLACED 2 INCHES BELOW TOP OF THE BLOCK ON A 2:1 SLOPE OR FLATTER.
4. FOR STONE STRUCTURES ONLY, A 1 FOOT THICK LAYER OF THE FILTER STONE WILL BE PLACED AGAINST THE 3 INCH STONE AS SHOWN ON THE DRAWINGS.

MAXIMUM DRAINAGE AREA 1 ACRE

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	STONE & BLOCK DROP INLET PROTECTION

Figure 5.5c Storm Drain Inlet Protection: Stone & Block



CONSTRUCTION SPECIFICATIONS

1. FILTER FABRIC SHALL HAVE AN AOS OF 40-85.
2. WOODEN FRAME SHALL BE CONSTRUCTED OF 2" x 4" CONSTRUCTION GRADE LUMBER.
3. WIRE MESH ACROSS THROAT SHALL BE A CONTINUOUS PIECE 30 INCH MINIMUM WIDTH WITH A LENGTH 4 FEET LONGER THAN THE THROAT. IT SHALL BE SHAPED AND SECURELY NAILED TO A 2" x 4" WEIR.
4. THE WEIR SHALL BE SECURELY NAILED TO 2" x 4" SPACERS 9 INCHES LONG SPACED NO MORE THAN 6 FEET APART.
5. THE ASSEMBLY SHALL BE PLACED AGAINST THE INLET AND SECURED BY 2" x 4" ANCHORS 2 FEET LONG EXTENDING ACROSS THE TOP OF THE INLET AND HELD IN PLACE BY SAND BAGS OR ALTERNATE WEIGHTS.

MAXIMUM DRAINAGE AREA 1 ACRE

ADAPTED FROM DETAILS PROVIDED BY: NY STATE DEC
ORIGNIALLY DEVELOPED BY USDA-NRCS
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

CURB DROP INLET
PROTECTION

Figure 5.5d Storm Drain Inlet Protection: Curb Drop Inlet

Part 5 - Sediment Trap

Definition

A temporary sediment control device formed by excavation and/or embankment to intercept sediment laden runoff and retain the sediment.

Purpose

The purpose of the structure is to intercept sediment-laden runoff and trap the sediment in order to protect drainage ways, properties, and rights-of-way below the sediment trap from sedimentation.

Conditions Where Practice Applies

A sediment trap is usually installed in a drainage way, at a storm drain inlet, or other points of collection from a disturbed area. Sediment traps should be used to artificially break up the natural drainage area into smaller sections where a larger device (sediment basin) would be less effective.

Design Criteria

If any of the design criteria presented here cannot be met, see the Standard and Specification for Sediment Basin.

Drainage Area

The drainage area for sediment traps shall be in accordance with the specific type of sediment trap used (Type I through V).

Location

Sediment traps shall be located so that they can be installed prior to grading or filling in the drainage area they are to protect. Traps must not be located any closer than 20 feet from a proposed building foundation if the trap is to function during building construction. Locate traps to obtain maximum storage benefit from the terrain and for ease of cleanout and disposal of the trapped sediment.

Trap Size

The volume of a sediment trap as measured at the elevation of the crest of the outlet shall be at least 3,600 cubic feet per acre of drainage area. The volume of a constructed trap shall be calculated using standard mathematical procedures. The volume of a natural sediment trap may be approximated by the equation:
Volume (cu.ft.) = 0.4 x surface area (sq.ft.) x maximum depth (ft.).

Trap Cleanout

Sediment shall be removed and the trap restored to the original dimensions when the sediment has accumulated to ½ of the design depth of the trap. Sediment removed from the trap shall be deposited in a protected area and in such a manner that it will not erode.

Embankment

All embankments for sediment traps shall not exceed five (5) feet in height as measured at the low point of the original ground along the centerline of the embankment. Embankments shall have a minimum four (4) foot wide top and side slopes of 2:1 or flatter. The embankment shall be compacted by traversing with equipment while it is being constructed. The embankment shall be stabilized with seed and mulch as soon as it is completed.

The elevation of the top of any dike directing water to any sediment trap will equal or exceed the maximum height of the outlet structure along the entire length of the trap.

Excavation

All excavation operations shall be carried out in such a manner that erosion and water pollution shall be minimal. Excavated portions of sediment traps shall have 1:1 or flatter slopes.

Part 5 - Sediment Trap

Outlet

The outlet shall be designed, constructed, and maintained in such a manner that sediment does not leave the trap and that erosion at or below the outlet does not occur.

Sediment traps must outlet onto stabilized (preferable undisturbed) ground, into a watercourse, stabilized channel, or into a storm drain system. Distance between inlet and outlet should be maximized to the longest length practicable.

Type of Sediment Traps

There are five (5) specific types of sediment traps which vary according to their function, location, or drainage area.

I. Pipe Outlet Sediment Trap
II. Grass Outlet Sediment Trap
III. Catch Basin Sediment Trap
IV. Stone Outlet Sediment Trap
V. Riprap Outlet Sediment Trap

I. Pipe Outlet Sediment Trap

A Pipe Outlet Sediment Trap consists of a trap formed by embankment or excavation. The outlet for the trap is through a perforated riser and a pipe through the embankment. The outlet pipe and riser shall be made of steel, corrugated metal or other suitable material. The top of the embankment shall be at least 1 ½ feet above the crest of the riser. The top 2/3 of the riser shall be perforated with one (1) inch nominal diameter holes or slits spaced six (6) inches vertically and horizontally placed in the concave portion of the corrugated pipe.

No holes or slits will be allowed within six (6) inches of the top of the horizontal barrel. All pipe connections shall be watertight. The riser shall be wrapped with ½ to ¼ inch hardware cloth wire then wrapped with filter cloth with a sieve size between #40-80 and secured with strapping or connecting band at the top and bottom of the cloth. The cloth shall cover an area at least six (6) inches above the highest hole and six (6) inches below the lowest hole. The top of the riser pipe shall not be covered with filter cloth. The riser shall have a base with sufficient weight to
prevent flotation of the riser. Two approved bases are:

1. A concrete base 12 in. thick with the riser embedded 9 in. into the concrete base, or

2. One quarter inch, minimum, thick steel plate attached to the riser by a continuous weld around the circumference of the riser to form a watertight connection. The plate shall have 2.5 feet of stone, gravel, or earth placed on it to prevent flotation. In either case, each side of the square base measurement shall be the riser diameter plus 24 inches.

Select mimimum pipe diameter size from the following table:

Barrel Diameter[1] (in.)	Riser Diameter[1] (in.)	Maximum Drainage Area (ac.)
12	15	1
15	18	2
18	21	3
21	24	4
21	27	5

[1]Barrel diameter may be same size as riser diameter.

Pipe outlet sediment traps shall be limited to a five (5) acre maximum drainage area with a required storage of 3600 cubic feet per acre of drainage area.

Pipe outlet sediment traps may be interchangeable in the field with stone outlet or riprap sediment traps provided that these sediment traps are constructed in accordance with the detail and specifications for that trap.

Part 5 - Sediment Trap

II. Grass Outlet Sediment Trap

A Grass Outlet Sediment Trap consists of a trap formed by excavating the earth to create a holding area. The trap has a discharge point over natural existing grass. The outlet crest width (feet) shall be equal to four (4) times the drainage area (acres) with a minimum width of four (4) feet. The outlet shall be free of any restrictions to flow. The outlet lip must remain undisturbed and level. The volume of this trap shall be computed at the elevation of the crest of the outlet. Grass outlet sediment traps shall be limited to a five (5) acre maximum drainage area with a required storage of 3600 cubic feet per acre of drainage area.

III. Catch Basin Sediment Trap

A Catch Basin Sediment Trap consists of a basin formed by excavation on natural ground that discharges through an opening in a storm drain inlet structure. This opening can either be the inlet opening or a temporary opening made by omitting bricks or blocks in the inlet.

A yard drain inlet or an inlet in the median strip of a dual highway could use the inlet opening for the type outlet. The trap should be out of the roadway so as not to interfere with future compaction or construction. Placing the trap on the opposite side of the opening and diverting water from the roadway to the trap is one means of doing this. Catch basin sediment traps shall be limited to a three (3) acre maximum drainage area. The volume of this trap is measured at the elevation of the crest of the outlet (invert of the inlet opening).

IV. Stone Outlet Sediment Trap

A Stone Outlet Sediment Trap consists of a trap formed by an embankment or excavation. The outlet of this trap is over a stone section placed on level ground. The minimum length (feet) of the outlet shall be equal to four (4) times the drainage area (acres) with a required storage 3,600 cubic feet per acre of drainage area.

The outlet crest (top of stone in weir section) shall be level, at least one (1) foot below top of embankment and no more than one (1) foot above ground beneath the outlet. Stone used in the outlet shall be small riprap (4 in. x 8 in.). To provide more efficient trapping effect, a layer of filter cloth should be embedded one (1) foot back into the upstream face of the outlet stone or a one (1) foot thick layer of two (2) inch or finer aggregate shall be placed on the upstream face of the outlet.

Stone Outlet Sediment Traps may be interchangeable in the field with pipe or riprap outlet sediment traps provided they are constructed in accordance with the detail and specifications for those traps. Stone outlet sediment traps shall be limited to a five (5) acre maximum drainage area.

V. Riprap Outlet Sediment Trap

A Riprap Outlet Sediment Trap consists of a trap formed by an excavation and embankment. The outlet for this trap shall be through a partially excavated channel lined with riprap. This outlet channel shall discharge onto a stabilized area or to a stable watercourse. The riprap outlet sediment trap may be used for drainage areas of up to a maximum of 15 acres.

Design Criteria for Riprap Outlet Sediment Trap

1. The total contributing drainage area (disturbed or undisturbed either on or off the developing property) shall not exceed 15 acres.
2. The storage needs for this trap shall be computed using 3600 cubic feet of required storage for each acre of drainage area. The storage volume provided can be figured by computing the volume of storage area available behind the outlet structure up to an elevation of one (1) foot below the level weir crest.
3. The maximum height of embankment shall not exceed five (5) feet.
4. The elevation of the top of any dike directing water

to a riprap outlet sediment trap will equal or exceed the minimum elevation of the embankment along the entire length of this trap.

Optional Dewatering Methods

Optional dewatering devices may be designed for use with sediment traps. Included in the details within this standard are two methods, which may be used.

Riprap Outlet Sediment Trap ST-V
(for Stone Lined Channel)

Contributing Drainage Area (ac.)	Depth of Channel (a) (ft.)	Length of Weir (b) (ft.)
1	1.5	4.0
2	1.5	5.0
3	1.5	6.0
4	1.5	10.0
5	1.5	12.0
6	1.5	14.0
7	1.5	16.0
8	2.0	10.0
9	2.0	10.0
10	2.0	12.0
11	2.0	14.0
12	2.0	14.0
13	2.0	16.0
14	2.0	16.0
15	2.0	18.0

Considerations

Select locations for sediment traps during site evaluation. Note natural drainage divides and select trap sites so that runoff from potential sediment-producing areas can easily be diverted into the traps. Make traps readily accessible for periodic sediment removal and other necessary maintenance. Plan locations for sediment disposal as part of trap site selection. Clearly designate all disposal areas on the plans.

Sediment trapping is achieved primarily by settling within a permanent pool formed by excavation, or by a combination of excavation and embankment. Sediment-trapping efficiency is a function of surface area and inflow rate. Installations that provide pools with large length to width ratios reduce short-circuiting and allow more of the pool surface area for settling. This optimizes efficiency.

The minimum length of flow through the trap should be 10 feet and the minimum length to width ratio should be 2:1. If site conditions permit a greater travel distance through the basin and greater length to width ratio the water quality benefit provided by the sediment trap will be enhanced. The average trap permanent pool depth should be a minimum of 3 feet to prevent resuspension of sediments.

Because well-planned sediment traps are key measures to preventing off-site sedimentation, they should be installed in the first stages of project development.

Plans and Specifications

Plans and specifications for installing sediment traps shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Each trap shall be delineated on the plans in such a manner that it will not be confused with any other features. Each trap on a plan shall indicate all the information necessary to properly construct and maintain the structure. If the drawings are such that this information cannot be delineated on the drawings, then a table shall be developed. If a table is developed, then each trap on a plan shall have a number and the numbers shall be consecutive.

Part 5 - Sediment Trap

The following information shall be shown for each trap in a summary table format on the plans.

1. Trap number.
2. Type of trap.
3. Drainage area.
4. Storage required.
5. Storage provided (if applicable).
6. Outlet length or pipe sizes.
7. Storage depth below outlet or cleanout elevation.
8. Embankment height and elevation (if applicable).
9. The construction detail for each type of sediment trap designated.

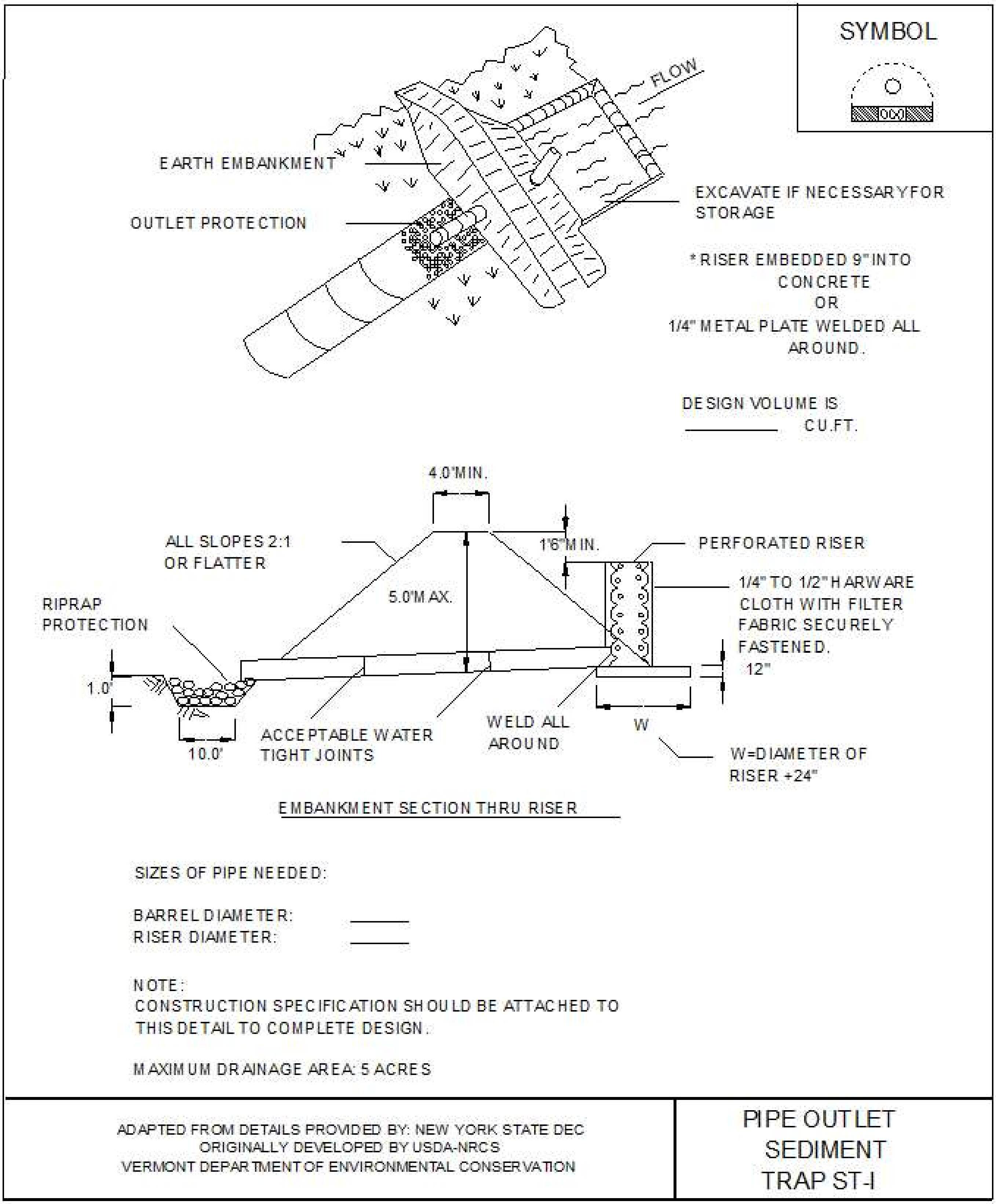
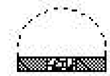


Figure 5.6a Pipe Outlet Sediment Trap ST-1

SYMBOL



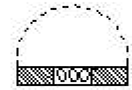
CONSTRUCTION SPECIFICATIONS

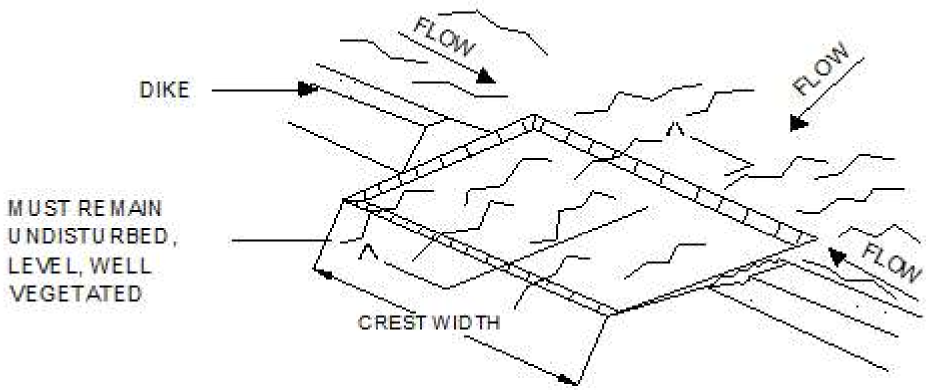
1. AREA UNDER EMBANKMENT SHALL BE CLEARED, GRUBBED AND STRIPPED OF ANY VEGETATION AND ROOT MAT. THE POOL AREA SHALL BE CLEARED.
2. THE FILL MATERIAL FOR THE EMBANKMENT SHALL BE FREE OF ROOTS OR OTHER WOODY VEGETATION AS WELL AS OVER-SIZED STONES, ROCKS, ORGANIC MATERIAL, OR OTHER OBJECTIONABLE MATERIAL. THE EMBANKMENT SHALL BE COMPACTED BY TRAVERSING WITH EQUIPMENT WHILE IT IS BEING CONSTRUCTED.
3. VOLUME OF SEDIMENT STORAGE SHALL BE 3600 CUBIC FEET PER ACRE OF CONTRIBUTORY DRAINAGE.
4. SEDIMENT SHALL BE REMOVED AND TRAP RESTORED TO ITS ORIGINAL DIMENSIONS WHEN THE SEDIMENT HAS ACCUMULATED TO 1/2 THE DESIGN DEPTH OF THE TRAP. REMOVED SEDIMENT SHALL BE DEPOSITED IN A SUITABLE AREA AND STABILIZED.
5. THE STRUCTURE SHALL BE INSPECTED AFTER EACH RAIN AND REPAIRS MADE AS NEEDED.
6. CONSTRUCTION OPERATIONS SHALL BE CARRIED OUT IN SUCH A MANNER THAT EROSION AND SEDIMENT ARE CONTROLLED.
7. THE STRUCTURE SHALL BE REMOVED AND AREA STABILIZED WHEN THE DRAINAGE AREA HAS BEEN PROPERLY STABILIZED.
8. ALL FILL SLOPES SHALL BE 2:1 OR FLATTER; CUT SLOPES 1:1 OR FLATTER.
9. ALL PIPE CONNECTIONS SHALL BE WATERTIGHT.
10. THE TOP 2/3 OF THE RISER SHALL BE PERFORATED WITH ONE (1) INCH DIAMETER HOLES OR SLITS SPACED SIX (6) INCHES VERTICALLY AND HORIZONTALLY AND PLACED IN THE CONCAVE PORTION OF PIPE. NO HOLES WILL BE ALLOWED WITHIN SIX (6) INCHES OF THE HORIZONTAL BARREL.
11. THE RISER SHALL BE WRAPPED WITH 1/4 TO 1/2 INCH HARDWARE CLOTH WIRE THEN WRAPPED WITH FILTER CLOTH (HAVING AN EQUIVALENT SIEVE SIZE OF 40-80). THE FILTER CLOTH SHALL EXTEND SIX (6) INCHES ABOVE THE HIGHEST HOLE AND SIX (6) INCHES BELOW THE LOWEST HOLE. WHERE ENDS OF THE FILTER CLOTH COME TOGETHER, THEY SHALL BE OVER-LAPPED, FOLDED AND STAPLED TO PREVENT BYPASS.
12. STRAPS OR CONNECTING BANDS SHALL BE USED TO HOLD THE FILTER CLOTH AND WIRE FABRIC IN PLACE. THEY SHALL BE PLACED AT THE TOP AND BOTTOM OF THE CLOTH.
13. FILL MATERIAL AROUND THE PIPE SPILLWAY SHALL BE HAND COMPACTED IN FOUR (4) INCH LAYERS. A MINIMUM OF TWO (2) FEET OF HAND COMPACTED BACKFILL SHALL BE PLACED OVER THE PIPE SPILLWAY BEFORE CROSSING IT WITH CONSTRUCTION EQUIPMENT.
14. THE RISER SHALL BE ANCHORED WITH EITHER A CONCRETE BASE OR STEEL PLATE BASE TO PREVENT FLOTATION. FOR CONCRETE BASED THE DEPTH SHALL BE TWELVE (12) INCHES WITH THE RISER EMBEDDED NINE (9) INCHES. A 1/4 INCH MINIMUM THICKNESS STEEL PLATE SHALL BE ATTACHED TO THE RISER BY A CONTINUOUS WELD AROUND THE BOTTOM TO FORM A WATERTIGHT CONNECTION AND THEN PLACE TWO (2) FEET OF STONE, GRAVEL, OR TAMPED EARTH ON THE PLATE.

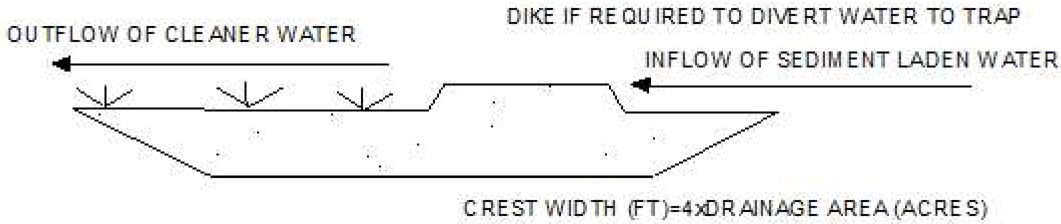
ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	PIPE OUTLET SEDIMENT TRAP ST-I

Figure 5.6b Pipe Outlet Sediment Trap ST-1 Specifications

SYMBOL







SECTION A - A
EXCAVATED GRASS OUTLET SEDIMENT TRAP

CONSTRUCTION SPECIFICATIONS

1. VOLUME OF SEDIMENT STORAGE SHALL BE 3600 CUBIC FEET PER ACRE OF CONTRIBUTORY DRAINAGE AREA.
2. MINIMUM CREST WIDTH (FEET) SHALL BE 4 x DRAINAGE AREA (ACRES)
3. SEDIMENT SHALL BE REMOVED AND TRAP RESTORED TO ITS ORIGINAL DIMENSIONS WHEN THE SEDIMENT HAS ACCUMULATED TO 1/2 THE DESIGN DEPTH OF THE TRAP. REMOVED SEDIMENT SHALL BE DEPOSITED IN A SUITABLE AREA AND STABILIZED.
4. THE STRUCTURE SHALL BE INSPECTED AFTER EACH RAIN AND REPAIRS MADE AS NEEDED.
5. CONSTRUCTION OPERATIONS SHALL BE CARRIED OUT IN SUCH A MANNER THAT EROSION AND SEDIMENT ARE CONTROLLED.
6. THE SEDIMENT TRAP SHALL BE REMOVED AND AREA STABILIZED WHEN THE REMAINING DRAINAGE AREA HAS BEEN PROPERLY STABILIZED.
7. ALL CUT SLOPES SHALL BE 1:1 OR FLATTER.

MAXIMUM DRAINAGE AREA: 5 ACRES

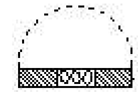
ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC
ORIGINALLY DEVELOPED BY USDA-NRCS
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

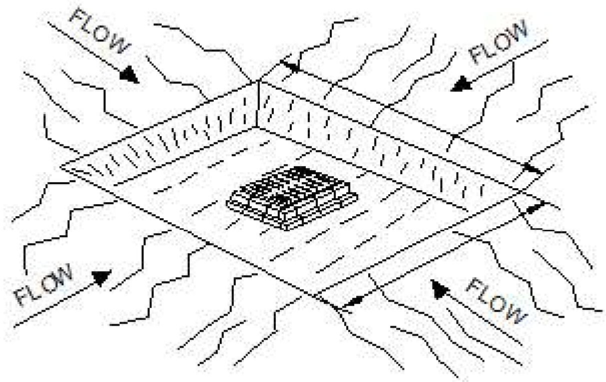
GRASS OUTLET
SEDIMENT TRAP
ST-II

Figure 5.7 Grass Outlet Sediment Trap ST-II

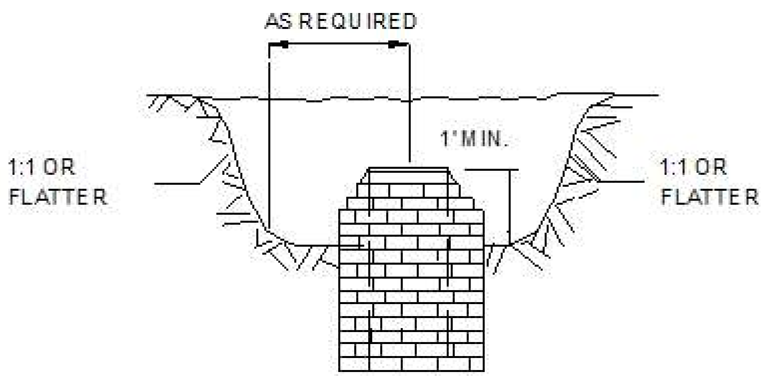
Part 5 - Sediment Trap

SYMBOL





YARD DRAIN



CROSS SECTION

CONSTRUCTION SPECIFICATIONS

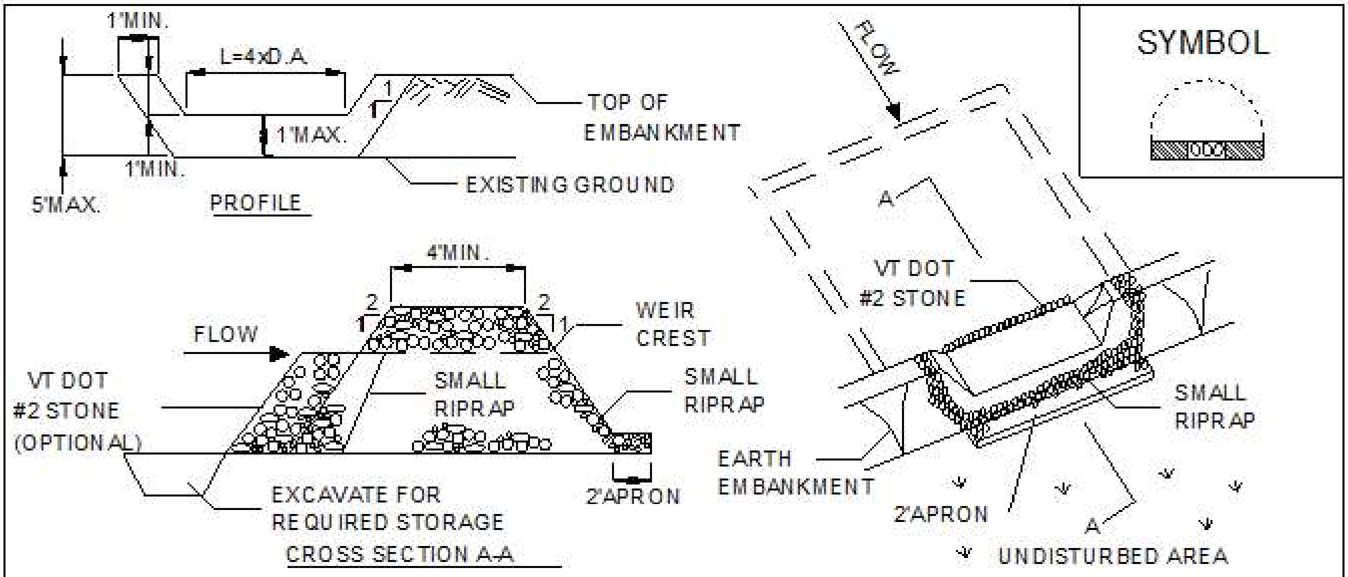
1. SEDIMENT SHALL BE REMOVED AND THE TRAP RESTORED TO ITS ORIGINAL DIMENSIONS WHEN THE SEDIMENT HAS ACCUMULATED TO 1/2 THE DESIGN DEPTH OF THE TRAP. REMOVED SEDIMENT SHALL BE DEPOSITED IN A SUITABLE AREA AND STABILIZED.
2. THE VOLUME OF SEDIMENT STORAGE SHALL BE 3600 CUBIC FEET PER ACRE OF CONTRIBUTORY DRAINAGE.
3. THE STRUCTURE SHALL BE INSPECTED AFTER EACH RAIN AND REPAIRS MADE AS NEEDED.
4. CONSTRUCTION OPERATIONS SHALL BE CARRIED OUT IN SUCH A MANNER THAT EROSION AND SEDIMENT ARE CONTROLLED.
5. THE SEDIMENT TRAP SHALL BE REMOVED AND THE AREA STABILIZED WHEN THE CONSTRUCTED DRAINAGE AREA HAS BEEN PROPERLY STABILIZED.
6. ALL CUT SLOPES SHALL BE 1:1 OR FLATTER.

MAXIMUM DRAINAGE AREA: 3 ACRES

ADAPTED FROM DETAILS PROVIDED BY: NY STATE DEC ORIGNIALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	CATCH BASIN SEDIMENT TRAP ST-III

Figure 5.8 Catch Basin Sediment Trap ST-III

Part 5 - Sediment Trap



CONSTRUCTION SPECIFICATIONS

1. AREA UNDER EMBANKMENT SHALL BE CLEARED, GRUBBED AND STRIPPED OF ANY VEGETATION AND ROOT MAT. THE POOL AREA SHALL BE CLEARED.

2. THE FILL MATERIAL FOR THE EMBANKMENT SHALL BE FREE OF ROOTS AND OTHER WOODY VEGETATION AS WELL AS OVER-SIZED STONES, ROCKS, ORGANIC MATERIAL OR OTHER OBJECTIONABLE MATERIAL. THE EMBANKMENT SHALL BE COMPACTED BY TRAVERSING WITH EQUIPMENT WHILE IT IS BEING CONSTRUCTED.

3. ALL CUT AND FILL SLOPES SHALL BE 2:1 OR FLATTER.

4. THE STONE USED IN THE OUTLET SHALL BE SMALL RIPRAP 4"-8" ALONG WITH A 1' THICKNESS OF 2" AGGREGATE PLACED ON THE UP-GRADE SIDE ON THE SMALL RIPRAP OR EMBEDDED FILTER CLOTH IN THE RIPRAP.

5. SEDIMENT SHALL BE REMOVED AND TRAP RESTORED TO ITS ORIGINAL DIMENSIONS WHEN THE SEDIMENT HAS ACCUMULATED TO 1/2 THE DESIGN DEPTH OF THE TRAP. IT SHALL BE PLACED ON SITE AND STABILIZED.

6. THE STRUCTURE SHALL BE INSPECTED AFTER EACH RAIN AND AS REQUIRED BY THE PERMIT.

7. CONSTRUCTION OPERATIONS SHALL BE CARRIED OUT IN SUCH A MANNER THAT EROSION AND SEDIMENT ARE CONTROLLED.

8. THE STRUCTURE SHALL BE REMOVED AND THE AREA STABILIZED WHEN THE DRAINAGE AREA HAS BEEN PROPERLY STABILIZED.

MAXIMUM DRAINAGE AREA 5 ACRES

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	STONE OUTLET SEDIMENT TRAP ST-IV

Figure 5.9 Stone Outlet Sediment Trap ST-IV

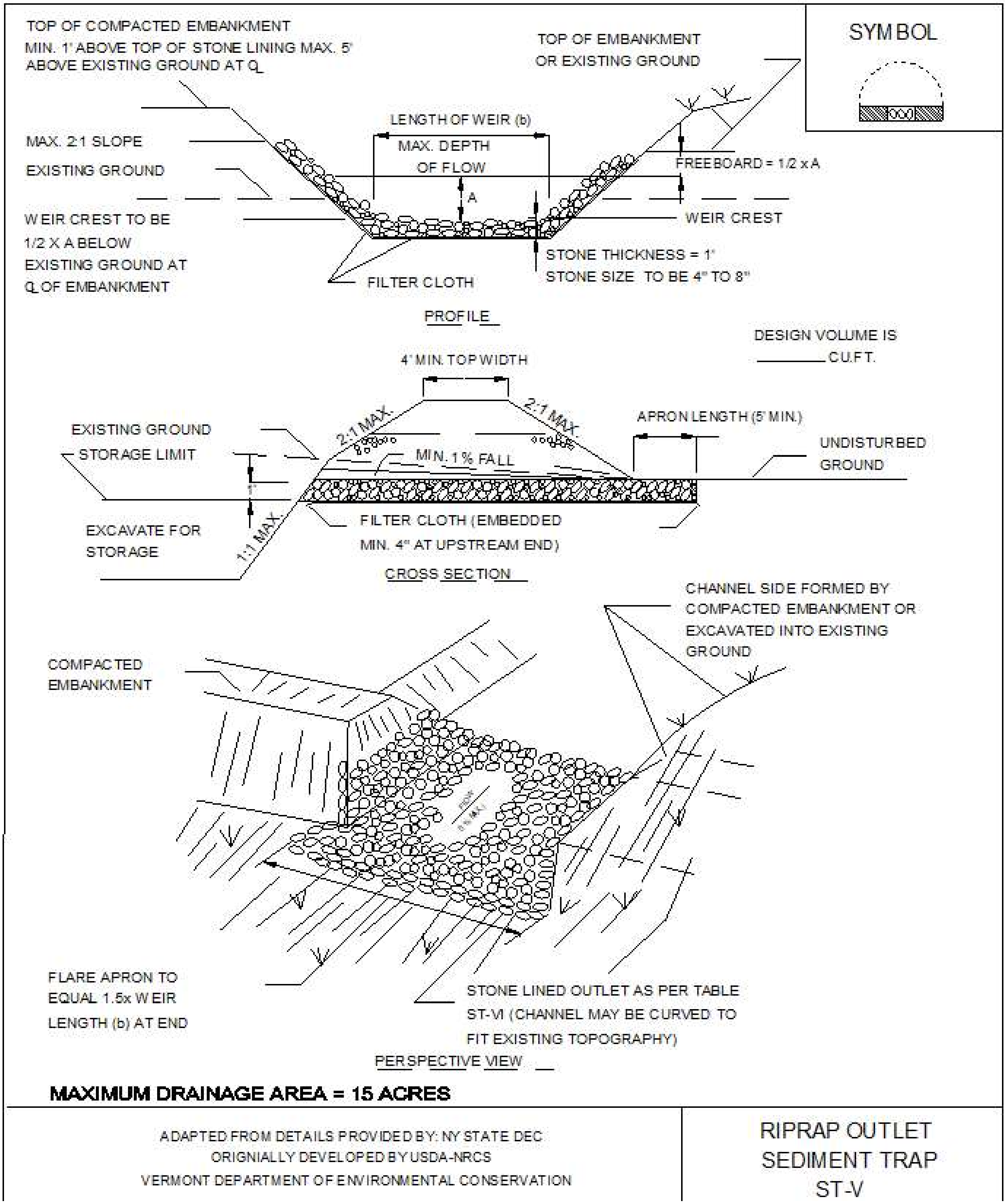
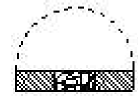


Figure 5.10a Rip Rap Outlet Sediment Trap ST-V

SYMBOL



CONSTRUCTION SPECIFICATIONS

1. THE AREA UNDER EMBANKMENT SHALL BE CLEARED, GRUBBED AND STRIPPED OF ANY VEGETATION AND ROOT MAT. THE POOL AREA SHALL BE CLEARED.

2. THE FILL MATERIAL FOR THE EMBANKMENT SHALL BE FREE OF ROOTS OR OTHER WOODY VEGETATION AS WELL AS OVER-SIZED STONES, ROCKS, ORGANIC MATERIAL OR OTHER OBJECTIONABLE MATERIAL. THE EMBANKMENT SHALL BE COMPACTED BY TRAVERSING WITH EQUIPMENT WHILE IT IS BEING CONSTRUCTED. MAXIMUM HEIGHT OF OF EMBANKMENT SHALL BE FIVE (5) FEET, MEASURED AT CENTERLINE OF EMBANKMENT.

3. ALL FILL SLOPES SHALL BE 2:1 OR FLATTER, CUT SLOPES 1:1 OR FLATTER.

4. ELEVATION OF THE TOP OF ANY DIKE DIRECTING WATER INTO TRAP MUST EQUAL OR EXCEED THE HEIGHT OF EMBANKMENT.

5. STORAGE AREA PROVIDED SHALL BE FIGURED BY COMPUTING THE VOLUME AVAILABLE BEHIND THE OUTLET CHANNEL UP TO AN ELEVATION OF ONE (1) FOOT BELOW THE LEVEL WEIR CREST.

6. FILTER CLOTH SHALL BE PLACED OVER THE BOTTOM AND SIDES OF THE OUTLET CHANNEL PRIOR TO PLACEMENT OF STONE. SECTIONS OF FABRIC MUST OVERLAP AT LEAST ONE (1) FOOT WITH SECTION NEAREST THE ENTRANCE PLACED ON TOP. FABRIC SHALL BE EMBEDDED AT LEAST SIX (6) INCHES INTO EXISTING GROUND AT ENTRANCE OUTLET CHANNEL.

7. STONE USED IN THE OUTLET CHANNEL SHALL BE FOUR (4) TO EIGHT (8) INCH RIPRAP. TO PROVIDE A FILTERING EFFECT, A LAYER OF FILTER CLOTH SHALL BE EMBEDDED ONE (1) FOOT WITH SECTION NEAREST ENTRANCE PLACED ON TOP. FABRIC SHALL BE EMBEDDED AT LEAST SIX (6) INCHES INTO EXISTING GROUND AT ENTRANCE OF OUTLET CHANNEL.

8. SEDIMENT SHALL BE REMOVED AND TRAP RESTORED TO ITS ORIGINAL DIMENSIONS WHEN SEDIMENT HAS ACCUMULATED TO 1/2 THE DESIGN DEPTH OF THE TRAP. REMOVED SEDIMENT SHALL BE DEPOSITED IN A SUITABLE AREA AND STABILIZED.

9. THE STRUCTURE SHALL BE INSPECTED AFTER EACH RAIN AND REPAIRED AS NEEDED.

10. CONSTRUCTION OPERATIONS SHALL BE CARRIED OUT IN SUCH A MANNER THAT EROSION AND SEDIMENT ARE CONTROLLED.

11. THE STRUCTURE SHALL BE REMOVED AND THE AREA STABILIZED WHEN DRAINAGE AREA HAS BEEN PROPERLY STABILIZED.

12. DRAINAGE AREA FOR THIS PRACTICE IS LIMITED TO 15 ACRES OR LESS.

ADAPTED FROM DETAILS PROVIDED BY: NY STATE DEC
ORIGNIALLY DEVELOPED BY USDA-NRCS
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

RIPRAP OUTLET
SEDIMENT TRAP ST-V

Figure 5.10b Rip Rap Sediment Trap ST-V Specifications

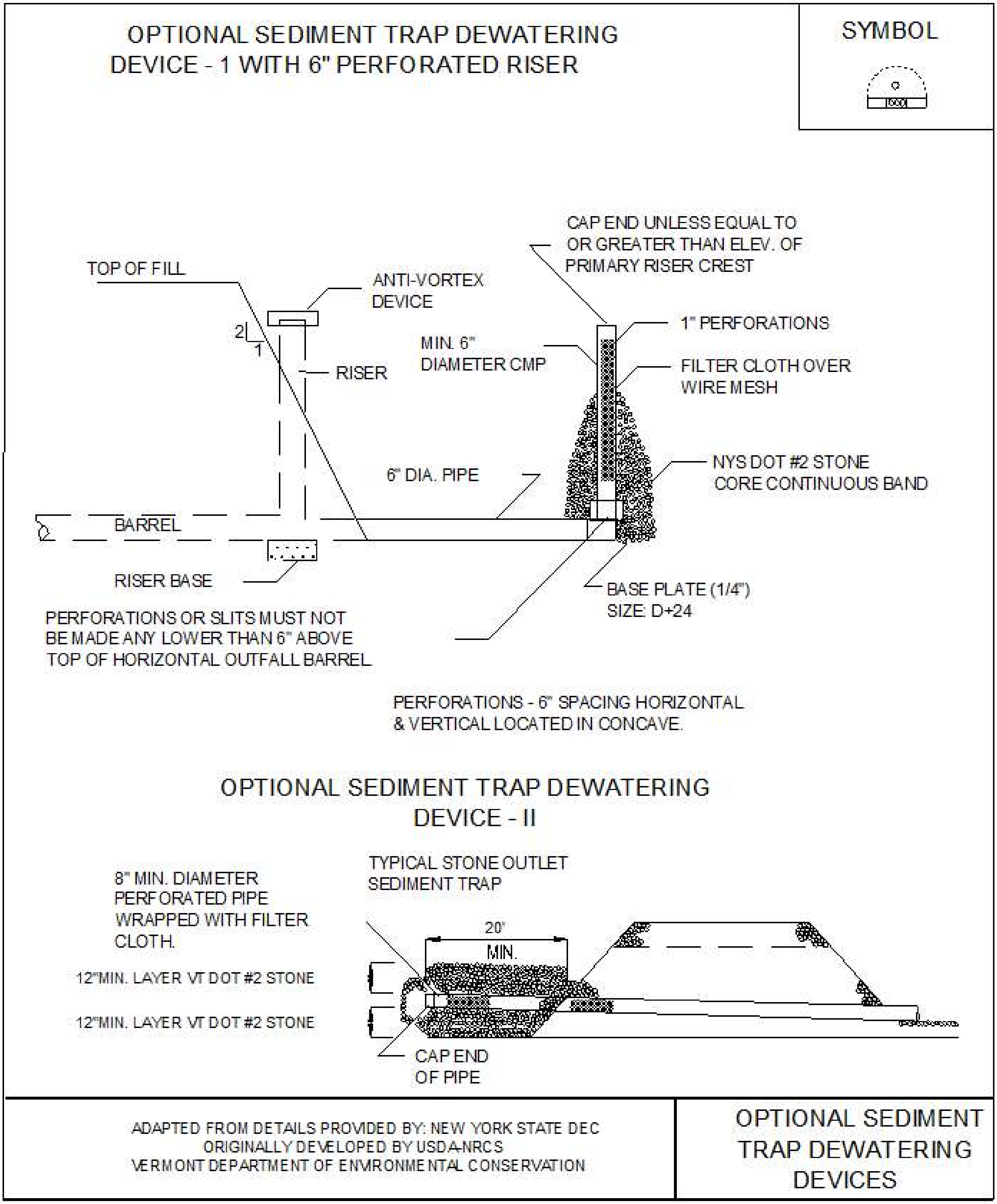


Figure 5.11 Optional Sediment Trap Dewatering Devices

Part 5 - Dust Control

Definition

The control of dust resulting from land-disturbing activities.

Purpose

To prevent surface and air movement of dust from disturbed soil surfaces that may cause off-site damage, health hazards, and traffic safety problems.

Conditions Where Practice Applies

On construction roads, access points, and other disturbed areas subject to surface dust movement and dust blowing where off-site damage may occur if dust is not controlled.

Design Criteria

Buffer areas of vegetation should be left where practical. Temporary or permanent stabilization measures shall be installed. No specific design criteria is given; see construction specifications below for common methods of dust control.

Water quality must be considered when materials are selected for dust control.

Chemical applications, including the use of chloride, shall not be applied without written approval from the VT DEC.

Construction Specifications

A. Non-driving Areas – These areas use products and materials applied or placed on soil surfaces to prevent airborne migration of soil particles.

Vegetative Cover – For disturbed areas not subject to traffic, vegetation provides the most practical method of dust control.

Mulch – Mulch offers a fast effective means of controlling dust. This can also include rolled erosion control blankets.

Spray adhesives – These are products generally composed of polymers in a liquid or solid form that are mixed with water to form an emulsion that is sprayed on the soil surface with typical hydroseeding equipment. The mixing ratios and application rates will be in accordance with the manufacturer's recommendations for the specific soils on the site. In no case should the application of these adhesives be made on wet soils or if there is a probability of precipitation within 48 hours of its proposed use. Material Safety Data Sheets will be provided to all applicators and others working with the material.

B. Driving Areas – These areas utilize water, polymer emulsions, and barriers to prevent dust movement from the traffic surface into the air.

Sprinkling – The site may be sprayed with water until the surface is wet. This is especially effective on haul roads and access routes.

Polymer Additives – These polymers are mixed with water and applied to the driving surface by a water truck with a gravity feed drip bar, spray bar or automated distributor truck. The mixing ratios and application rates will be in accordance with the manufacturer's recommendations. Incorporation of the emulsion into the soil will be done to the appropriate depth based on expected traffic. Compaction after incorporation will be by vibratory roller to a minimum of 95%. The prepared surface shall be moist and no application of the polymer will be made if there is a probability of precipitation within 48 hours of its proposed use. Material Safety Data Sheets will be provided to all applicators working with the material.

Barriers – Woven geotextiles can be placed on the driving surface to effectively reduce dust throw and particle migration on haul roads. Stone can also be used for construction roads for effective dust control.

Windbreak – A silt fence or similar barrier can control air currents at intervals equal to ten times the barrier height. Preserve existing wind barrier vegetation as much as practical.

Part 5 - Dust Control

Maintenance

Maintain dust control measures through dry weather periods until all disturbed areas are stabilized.

Considerations

The easiest way to control dust is to avoid exposed soil surfaces. This is not possible on most construction sites, but the area exposed can usually be reduced by careful planning of controlled traffic patterns and by the phasing of clearing and grading operations. Consider the use of undisturbed vegetative buffers (min. 50 ft.) between graded areas and protected areas.

Plans and Specifications

Plans and specifications for dust control shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum the following items should be included:

1. The area to be treated.
2. The methods that are acceptable to use.

Part 5 - Rock Dam

Definition

A rock embankment located to capture sediment.

Purpose

To retain sediment on the construction site and prevent sedimentation in off site water bodies.

Conditions Where Practice Applies

The rock dam may be used instead of the standard sediment basin with barrel and riser. The rock dam is preferred when it is difficult to construct a stable, earthen embankment and rock materials are readily available. The site should be accessible for periodic sediment removal. This rock dam should not be located in a perennial stream. The top of the dam will serve as the overflow outlet. The inside of the dam will be faced with smaller stone to reduce the rate of seepage so a sediment pool forms during runoff events.

Design Criteria

Drainage Area: The drainage area for this structure is limited to 50 acres.

Location: The location of the dam should:

1. Provide a large area to trap sediment.
2. Intercept runoff from disturbed areas.
3. Be accessible to remove sediment.
4. Not interfere with construction activities.

Storage Volume: The storage volume behind the dam shall be at least 3,600 cubic feet per acre of drainage area to the dam. This volume is measured one foot below the crest of the dam.

Dam Section:

Top Width	5 feet minimum @ crest
Side Slopes	2:1 upstream slope 3:1 downstream slope
Height	6' max to spillway crest

Length of Crest: The crest length should be designed to carry the 10 yr. peak runoff with a flow depth of 1 foot and 1 foot of freeboard.

Rock at the abutments should extend at least 2 feet above the spillway and be at least 2 feet thick. These rock abutments should extend at least one foot above the downstream slope to prevent abutment scour. A rock apron at least 1.5 feet thick should extend downstream from the toe of the dam a distance equal to the height of the dam to protect the outlet area from scour.

Rock Fill: The rock fill should be well graded, hard, erosion resistant stone with a minimum d_{50} size of 9 inches. A "key trench" lined with geotextile filter fabric should be installed in the soil foundation under the rock fill. The filter fabric must extend from the key trench to the downstream edge of the apron and abutments to prevent soil movement and piping under the dam.

The upstream face of the dam should be covered with fine gravel a minimum of 3 feet thick to reduce the drainage rate.

Trapping Efficiency: To obtain maximum trapping efficiency, design for a long detention period. Usually a minimum of eight (8) hours before the basin is completely drained. Maximize the length of travel of sediment laden water from the inlet to the drain. Achieve a surface area equal to 0.01 acres per cfs (inflow) based on the 10-year storm.

Part 5 - Rock Dam

Maintenance

Check the basin area after each rainfall event. Remove sediment and restore original volume when sediment accumulates to one-half the design volume. Check the structure for erosion, piping, and rock displacement after each significant event and replace immediately.

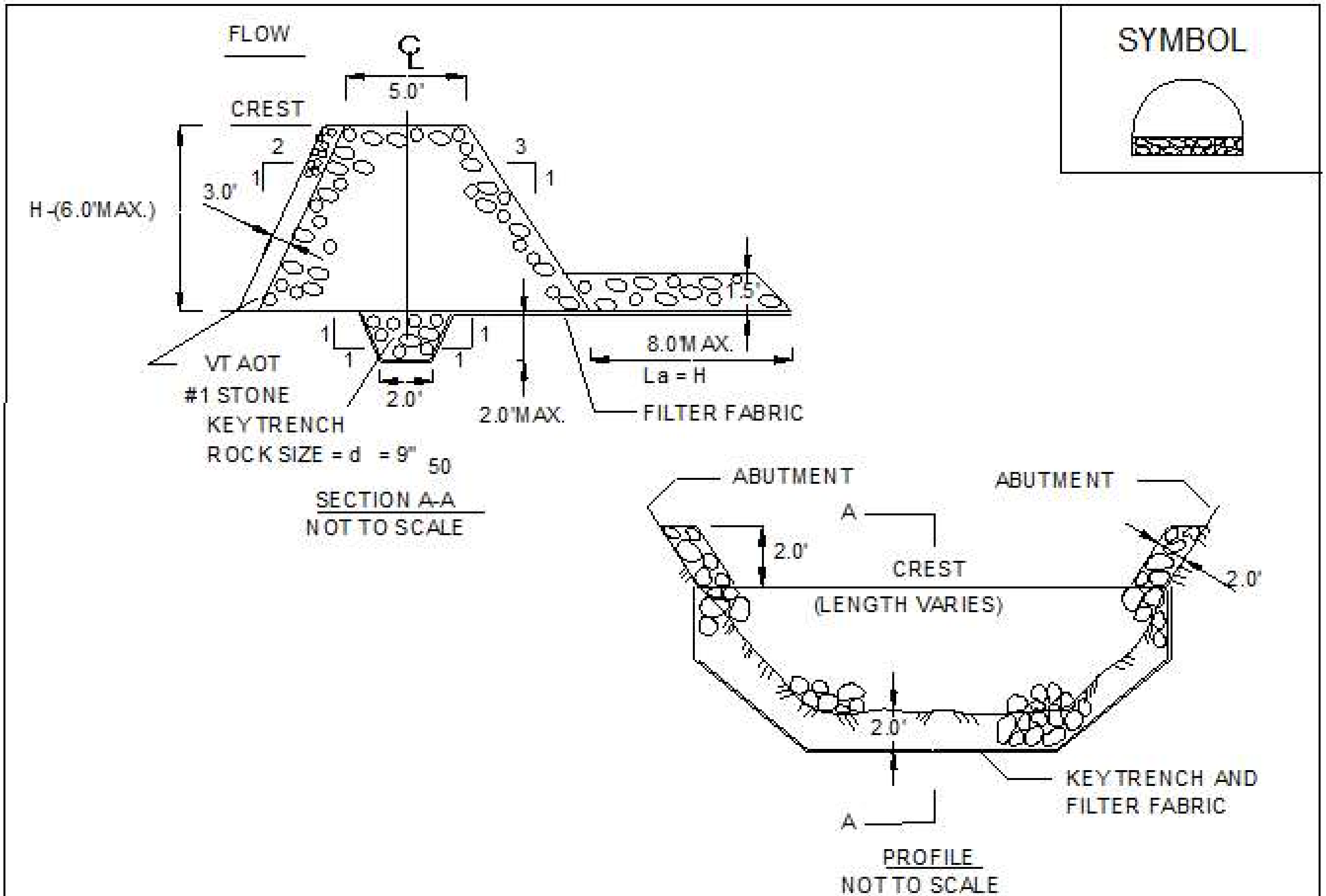
Remove the structure and any sediment immediately after the construction area has been permanently stabilized. All water should be removed from the basin prior to the removal of the rock dam. Sediment should be placed in designated disposal areas and not allowed to flow into streams or drainage ways during structure removal.

Plans and Specifications

Plans and specifications for rock dams shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum the following items should be included:

1. Location of the rock dam.
2. Construction detail.

Part 5 - Rock Dam



CONSTRUCTION SPECIFICATIONS

1. THE AREA UNDER THE ROCK DAM SHALL BE CLEARED AND STRIPPED OF ROOTS AND OTHER OBJECTIONABLE MATERIAL. THE RESERVOIR SHALL BE CLEARED AS NEEDED TO FACILITATE SEDIMENT REMOVAL.

2. DIMENSIONS SHOWN ARE MINIMUM. TRENCH SHALL BE EXCAVATED FROM ABUTMENT TO ABUTMENT ON THE DAM CENTERLINE. FILTER FABRIC SHALL BE PLACED FROM UPSTREAM EDGE OF KEYTRENCH TO DOWNSTREAM EDGE OF APRON. JOINTS WILL LAP A MINIMUM OF 1 FT. WITH UPSTREAM STRIP ON TOP.

3. CONSTRUCT THE ROCK EMBANKMENT TO THE DIMENSIONS SHOWN ON THE DRAWING. ROCK ABUTMENTS SHALL BE MAINTAINED 2 FT. ABOVE THE CREST.

4. THE ROCK DAM SHALL BE CONSTRUCTED PRIOR TO CLEARING THE BASIN AREA. STABILIZE ALL DISTURBED AREAS, EXCEPT THE BASIN AREA, WITH TEMPORARY SEEDING.

5. FENCES AND WARNING SIGNS SHOULD BE PLACED AS APPROPRIATE.

MAXIMUM DRAINAGE AREA: 50 ACRES

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	ROCK DAM

Figure 5.12 Rock Dam

Part 5 - Sediment Basin

Definition

A temporary barrier or dam constructed across a drainage way or at other suitable locations to intercept sediment laden runoff and to trap and retain the sediment.

Purpose

The purpose of a sediment basin is to intercept sediment-laden runoff and reduce the amount of sediment leaving the disturbed area in order to protect drainage ways, properties, and rights-of-way below the sediment basin.

Scope

This standard applies to the installation of temporary sediment basins on sites where: (a) failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities; (b) the drainage area does not exceed 100 acres; and (c) the basin is to be removed within 36 months after the beginning of construction of the basin.

Permanent (to function more than 36 months) sediment basins, or temporary basins exceeding the classification requirements for class 1 and 2, or structures that temporarily function as a sediment basin but are intended for use as a permanent pool shall be classified as permanent structures and shall conform to criteria appropriate for permanent structures. These structures shall be designed and constructed to conform to NRCS Standard And Specification No. 378 for Ponds in the National Handbook of Conservation Practices. Any impoundment, or pond that can contain 500,000 cubic feet of water may be required to obtain a permit from the VT DEC Dam Safety Program.

The total volume of permanent sediment basins shall be equal to or exceed the capacity requirements for temporary basins contained herein.

Classification of Temporary Sediment Basins
For the purpose of this standard, temporary sediment basins are classified as follows:

Class	1	2
Max. Drainage Area (acres)	100	100
Max. Height[1] of Dam (ft.)	10	15
Min. Embankment Top Width	8	10
Embankment Side Slopes	2:1 or Flatter	2 ½:1 or Flatter
Anti-Seep Control Required	Yes	Yes

[1] Height is measured from the low point of original ground at the downstream toe of the dam to the top of the dam.

Conditions Where Practice Applies

A sediment basin is appropriate where physical site conditions or land ownership restrictions preclude the installation of other erosion control measures to adequately control runoff, erosion, and sedimentation.

However, it is strongly encouraged to use a basin in addition to other EPSC measures if practicable. It may be used below construction operations which expose critical areas to soil erosion. The basin shall be maintained until the disturbed area is protected against erosion by permanent stabilization.

Design Criteria

Compliance with Laws and Regulations

Design and construction shall comply with state and local laws, ordinances, rules and regulations, including permits.

Part 5 - Sediment Basin

Location

The sediment basin should be located to obtain the maximum storage benefit from the terrain and for ease of cleanout of the trapped sediment. It should be located to minimize interference with construction activities and construction of utilities. Whenever possible, sediment basins should be located so that storm drains may outfall or be diverted into the basin. Do not locate basins in perennial streams.

Size and Shape of the Basin

The minimum runoff storage volume of the basin, as measured from the bottom of the basin to the elevation of the crest of the principal spillway shall be at least 3,600 cubic feet per acre draining to the basin. This 3,600 cubic feet is equivalent to one inch of runoff per acre of drainage area. The entire drainage area is used for this computation, rather than the disturbed area above, to maximize trapping efficiency. The length to width ratio shall be greater than 2:1, where length is the distance between the inlet and outlet. A wedge shape shall be used with the inlet located at the narrow end.

Surface Area

The following relationship between surface area and peak inflow rate gives a trapping efficiency of 75% for silt loam soils, and greater than 90% for loamy sand soils:

$A = 0.01\ Qp$ or, $A = 0.015\text{x D.A.}$
(whichever is greater)

where,
A = the basin surface area, acres, measured at the service spillway crest; and

Qp = the peak inflow rate for the design storm. (The minimum design storm will be a 10-year, 24-hour storm under construction conditions).

D.A. = contributing drainage area.

One half of the design sediment storage volume (67 cubic yards per acre drainage area) shall be in the form of a permanent pool, and the remaining half as drawdown volume.

Sediment basins shall be cleaned out when the permanent pool volume remaining as described above is reduced by 50 percent, except in no case shall the sediment level be permitted to build up higher than one foot below the principal spillway crest. At this elevation, cleanout shall be performed to restore the original design volume to the sediment basin.

The elevation corresponding to the maximum allowable sediment level shall be determined and shall be stated in the design data as a distance below the top of the riser and shall be clearly marked on the riser.

The basin dimensions necessary to obtain the required basin volume as stated above shall be clearly shown on the plans to facilitate plan review, construction, and inspection.

Spillway Design

Runoff shall be computed by the method outlined in: Chapter 2, Estimating Runoff, Engineering Field Handbook available in the Natural Resources Conservation Service offices or, by TR-55, Urban Hydrology for Small Watersheds. Runoff computations shall be based upon the worst soil cover conditions expected to prevail in the contributing drainage area during the anticipated effective life of the structure. The combined capacities of the principal and emergency spillway shall be sufficient to pass the peak rate of runoff from a ten-year frequency storm.

1. Principal spillway: A spillway consisting of a vertical pipe or box type riser joined (watertight connection) to a pipe (barrel) which shall extend through the embankment and outlet beyond the downstream toe of the fill. The minimum capacity of the principal spillway shall be 0.2 cfs per acre of drainage area when the water surface is at the emergency spillway crest elevation. For those

basins with no emergency spillway, the principal spillway shall have the capacity to handle the peak flow from a ten-year frequency rainfall event. The minimum size of the barrel shall be 8 inches in diameter.

a. Crest elevation: When used in combination with an emergency spillway, the crest elevation of the riser shall be a minimum one foot below the elevation of the control section of the emergency spillway.

b. Watertight riser and barrel assembly: The riser and all pipe connections shall be completely watertight except for the inlet opening at the top, or a dewatering opening. There shall not have any other holes, leaks, rips, or perforations in the structure.

c. Dewatering the basin: The drawdown volume will be discharged over a 10 hour period. The size of the orifice to provide this control can be approximated as follows:

$$A_o = \frac{A_s \times 2h^{0.5}}{T \times Cd \times 20{,}428} \quad \text{therefore,} \quad A_o = \frac{A_s \times 2h^{0.5}}{122{,}568}$$

where,
A_o = surface area of the dewatering orifice
A_s = surface area of the basin
h = head of water above orifice
Cd = coefficient of contraction for an orifice (0.6)
T = detention time needed to dewater the basin (10 hours)

d. Anti-vortex device and trash rack: An anti-vortex device and trash rack shall be securely installed on top of the riser and shall be the concentric type as shown in the details.

e. Base: The riser shall have a base attached with a watertight connection and shall have sufficient weight to prevent flotation of the riser. Two approved bases for risers ten feet or less in height are: 1) a concrete base 18 in. thick with the riser embedded 9 in. in the base, and 2) a ¼" minimum thickness steel plate attached to the riser by a continuous weld around the circumference of the riser to form a watertight connection. The plate shall have 2.5 feet of stone, gravel, or compacted earth placed on it to prevent flotation. In either case, each side of the square base shall be twice the riser diameter.

For risers greater than ten feet high, computations shall be made to design a base which will prevent flotation. The minimum factor of safety shall be 1.20 (Downward forces = 1.20 x upward forces).

f. Anti-Seep Collars: Anti-seep collars shall be installed around all conduits through earth fills of impoundment structures according to the following criteria:

1) Collars shall be placed to increase the seepage length along the conduit by a minimum of 15 percent of the pipe length located within the saturation zone.

2) Collar spacing shall be between 5 and 14 times the vertical projection of each collar.

3) All collars shall be placed within the saturation zone.

4) The assumed normal saturation zone (phreatic line) shall be determined by projecting a line at a slope of 4 horizontal to 1 vertical from the point where the normal water (riser crest) elevation touches the upstream slope of the fill to a point where this line intersects the invert of the pipe conduit. All fill located within this line may be assumed as saturated.

When anti-seep collars are used, the equation for revised seepage length becomes:

$2(N)(P)=1.15(L_S)$ or,
$N=(0.075)(L_S)/P$

Where:

L_S = Saturated length is length, in feet, of pipe between riser and intersection of phreatic line and pipe invert.

N = number of anti-seep collars.

P = vertical projection of collar from pipe, in feet.

5) All anti-seep collars and their connections shall be watertight. Seepage diaphragms may be used in lieu of anti-seep collars. They shall be designed in accordance to USDA NRCS Pond Standard 378.

g. Outlet: An outlet shall be provided, including a means of conveying the discharge in an erosion free manner to an existing stable channel. Where discharge occurs at the property line, drainage easements will be obtained in accordance with local ordinances. Adequate notes and references will be shown on the erosion and sediment control plan.

Protection against scour at the discharge end of the pipe spillway shall be provided. Measures may include basin, riprap, revetment, excavated plunge pools, or other approved methods.

2. Emergency Spillways: The entire flow area of the emergency spillway shall be constructed in undisturbed ground (not fill). The emergency spillway cross-section shall be trapezoidal with a minimum bottom width of eight feet. This spillway channel shall have a straight control section of at least 20 feet in length; and a straight outlet section for a minimum distance equal to 25 feet.

a. Capacity: The minimum capacity of the emergency spillway shall be that required to pass the peak rate of runoff from the 10-year 24-hour frequency storm, less any reduction due to flow in the pipe spillway.

Emergency spillway dimensions may be determined by using the method described in the detail.

b. Velocities: The velocity of flow in the exit channel shall not exceed 5 feet per second for vegetated channels. For channels with erosion protection other than vegetation, velocities shall be within the non-erosive range for the type of protection used.

c. Erosion Protection: Erosion protection shall be provided for by vegetation as prescribed in this publication or by other suitable means such as riprap, asphalt or concrete.

d. Freeboard: Freeboard is the difference between the design high water elevation in the emergency spillway and the top of the settled embankment. If there is no emergency spillway, it is the difference between the water surface elevation required to pass the design flow through the pipe and the top of the settled embankment. Freeboard shall be at least one foot.

Embankment Cross-Section

Class 1 Basins: The minimum top width shall be eight feet. The side slopes shall not be steeper than 2:1.

Class 2 Basins: The minimum top width shall be ten feet. The side slopes shall not be steeper than 2 ½:1.

Entrance of Runoff into Basin

Points of entrance of surface runoff into excavated sediment basins shall be protected to prevent erosion.

Part 5 - Sediment Basin

Considerable care should be given to the major points of inflow into basins. In many cases the difference in elevation of the inflow and the bottom of the basin is considerable, thus creating a potential for severe gullying and sediment generation. Often a riprap drop at major points of inflow would eliminate gullying and sediment generation.

Diversions, grade stabilization structures or other water control devices shall be installed as necessary to ensure direction of runoff and protect points of entry into the basin. Points of entry should be located so as to ensure maximum travel distance of entering runoff to point of exit (the riser) from the basin.

Disposal

The sediment basin plans shall indicate the method(s) of disposing of the sediment removed from the basin. The sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the basin, adjacent to a stream or floodplain. Disposal sites will be covered by an approved sediment control plan.

The sediment basin plans shall also show the method of dismantling of the sediment basin after the drainage area is stabilized, and shall include the stabilization of the sediment basin site. Water contained within the storage areas shall be removed from the basin by pumping, cutting the top of the riser, or other appropriate method prior to removing or breaching the embankment. Sediment shall not be allowed to flush into a stream or drainage way.

Chemical Treatment

Chemical applications shall not be applied unless a site- and project-specific authorized EPSC Plan is inclusive of specific chemical treatment proposed for use. Otherwise a permittee must seek written apprvoal from the VT DEC after permit authorization prior to use.

Precipitation of sediment is enhanced with the use of specific chemical flocculants that can be applied to the sediment basin in liquid, powder, or solid form. Flocculants include polyacrylimides, aluminum sulfate (alum), and polyaluminum chloride. Cationic polyelectrolytes have a greater toxicity to fish and other aquatic organisms than anionic polyelectrolytes because they bind to the gills of fish resulting in respiratory failure. Chemical treatment shall not be substituted for proper erosion and sediment control. To reduce the need for flocculants, proper controls include planning, phasing, sequencing and practice design in accordance to these Standards.

Safety

Sediment basins are attractive to children and can be very dangerous. Local ordinances and regulations must be adhered to regarding health and safety. The developer or owner shall check with local building officials on applicable safety requirements. If fencing of sediment basins is required, the location of and type of fence shall be shown on the plans.

<u>Construction Specifications</u>

Site Preparation

Areas under the embankment shall be cleared, grubbed, and stripped of topsoil to remove trees, vegetation, roots, or other objectionable material. In order to facilitate cleanout and restoration, the pool area (measured at the top of the pipe spillway) will be cleared of all brush, trees, and other objectionable materials.

Cutoff-Trench

A cutoff trench shall be excavated along the centerline of earth fill embankments. The minimum depth shall be two feet. The cutoff trench shall extend up both abutments to the riser crest elevation. The minimum bottom width shall be four feet, but wide enough to permit operation of excavation and compaction equipment. The side slopes shall be no steeper than 1:1. Compaction requirements shall be the same as those for embankment. The trench shall be dewatered during the back-filling/compaction operations.

Embankment

The fill material shall be taken from approved areas shown on the plans. It shall be clean mineral soil free of roots, woody vegetation, oversized stones, rocks, or other objectionable material. Relatively pervious materials such as sand or gravel (Unified Soil Classes GW, GP, SW & SP) shall not be placed in the embankment. Areas on which fill is to be placed shall be scarified prior to placement of fill. The fill material shall contain sufficient moisture so that it can be formed by hand into a ball without crumbling. If water can be squeezed out of a ball, it is too wet for proper compaction. Fill material shall be placed in six to eight-inch thick continuous layers over the entire length of the fill. Compaction shall be obtained by routing and hauling the construction equipment over the fill so that the entire surface of each layer of the fill is traversed by at least one wheel or tread track of the equipment or by the use of a compactor. The embankment shall be constructed to an elevation 10 percent higher than the design height to allow for settlement.

Pipe Spillway

The riser shall be securely attached to the barrel or barrel stub by welding the full circumference making a watertight structural connection. The barrel stub must be attached to the riser at the same percent (angle) of grade as the outlet conduit. The connection between the riser and the riser base shall be watertight. All connections between barrel sections must be achieved by approved watertight bank assemblies. The barrel and riser shall be placed on a firm, smooth foundation of impervious soil. Pervious materials such as sand, gravel, or crushed stone shall not be used as backfill around the pipe or anti-seep collars. The fill material around the pipe spillway shall be placed in four-inch layers and compacted under and around the pipe to at least the same density as the adjacent embankment.

A minimum depth of two feet of hand compacted backfill shall be placed over the pipe spillway before crossing it with construction equipment. Steel base plates on risers shall have at least 2 ½ feet of compacted earth, stone, or gravel placed over it to prevent flotation.

Emergency Spillway

The emergency spillway shall be installed in undisturbed ground. The achievement of planned elevations, grades, design width, entrance and exit channel slopes are critical to the successful operation of the emergency spillway and must be constructed within a tolerance of +/- 0.2 feet.

Vegetative Treatment

Stabilize the embankment and emergency spillway in accordance with the appropriate vegetative standard and specification immediately following construction. In no case shall the embankment remain unstabilized for more than seven (7) days.

Erosion and Pollution Control

Construction operations shall be carried out in such a manner that erosion and water pollution will be minimized. State and local laws shall be complied with concerning pollution abatement.

Safety

State and local requirements shall be met concerning fencing and signs, warning the public of hazards of soft sediment and floodwater.

<u>Maintenance</u>

1. Repair all damages caused by soil erosion and construction equipment at or before the end of each working day.
2. Sediment shall be removed from the basin when it

reaches the specified distance below the top of the riser (shall not exceed 50 percent capacity). This sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the embankment, adjacent to a stream or floodplain.

Final Disposal

When temporary structures have served their intended purpose and the contributing drainage area has been properly stabilized, the embankment and resulting sediment deposits are to be leveled or otherwise disposed of in accordance with the approved sediment control plan. The proposed use of a sediment basin site will often dictate final disposition of the basin and any sediment contained therein. If the site is scheduled for future construction, then the basin material and trapped sediments must be removed, safely disposed of, and backfilled with a structural fill. When the basin area is to remain open space, the pond may be pumped dry, graded, and back filled.

<u>Plans and Specifications</u>

Sediment basin designs and construction plans submitted for review to VT DEC shall include the following:

1. Specific location of the basin.
2. Plan view of the storage basin and emergency spillway, showing existing and proposed contours.
3. Cross section of dam, principal spillway, emergency spillway, and profile of emergency spillway.
4. Details of pipe connections, riser to pipe connections, riser base, anti-seep control, trash rack cleanout elevation, and anti-vortex device.
5. Runoff calculations for 1 and 10-year frequency storms, if required.
6. Storage Computation
    a. Total required
    b. Total Available
    c. Level of sediment at which cleanout shall be required; to be stated as a distance from the riser crest to the sediment surface.
7. Calculations showing design of pipe and emergency spillway.

TEMPORARY SEDIMENT BASIN DESIGN DATA SHEET

Computed ________________ Date ______________ Checked by____________________ Date___________
Project____
Sub Watershed#_________________________ Location________________________
Total Area draining to basin ________________________________ Acres

BASIN SIZE DESIGN

1. Minimum sediment storage volume = 134 cu. yds. x__________ acres of drainage area = ___________ cu.yds.
2. a. Cleanout at 50 percent of minimum required volume = ________ cu. yds.
   b. Elevation corresponding to scheduled time to clean out_______________
   c. Distance below top of riser____________ feet
3. Minimum surface area is larger of 0.01 $Q_{(1)}$_________ or, 0.015 DA = ___________ use ___________ acres

DESIGN OF SPILLWAYS & ELEVATIONS

Runoff

4. $Q_{p(10)}$ = ____________________________ cfs
   (EFH, Ch. 2, TR-55; Attach runoff computation sheet)

Pipe Spillway (Q_{ps})

5. Min. pipe spillway cap., Q_{ps} = 0.2 x__________ ac. Drainage = ________ cfs
   Note: If there is no emergency spillway, then req'd Q_{ps} = $Q_{p(10)}$ = ________ cfs.
6. H = ________ ft. Barrel length = ________ ft
7. Barrel: Diam. _______ inches; Q_{ps} = (Q)____________ x (cor.fac.)________ = _________ cfs.
8. Riser: Diam. _______ inches; Length__________ ft.; h = _________ ft. Crest Elev. _____________
9. Trash Rack: Diam__________ inches; H = __________ inches

Emergency Spillway Design

10. Emergency Spillway Flow, Q_{es} = Q_p - Q_{ps} = ___________ - ____________ = ___________ cfs.
11. Width _______ ft.; H_p__________ ft Crest elevation ___________; Design High Water Elev. ___________
    Entrance channel slope___________________________ % ; Top of Dam Elev. ________________
    Exit channel slope ______________________________ %

ANTI-SEEP COLLAR/ SEEPAGE DIAPHRAGM DESIGN

Collars:

12. y = ________ ft; z = _______ :1; pipe slope = ________ %, L_s = _______ ft.
    Use________ collars, ________ - __________ inches square; projection = ________ ft

Diaphragms:

________ width ________ ft height __________ ft.

DEWATERING ORIFICE SIZING

13. $$Ao = \frac{A_s \times (2h)^{0.5}}{122,568}$$ = ________ sq. ft.; h = ______ ft.; therefore use, __________________________

Part 5 - Temporary Sediment Basin

Design Data Sheet
Instructions for Use of Form

1. Minimum required sediment storage volume is 134 cubic yards (3600 cubic feet) per acre from each acre of drainage area. Values larger than 134 cubic yards per acre may be used for greater protection. Compute volume using entire drainage area although only part may be disturbed.

2. The volume of a naturally shaped basin (no excavation in basin) may be approximated by the formula V = (0.4)(A)(d), where V is in cubic feet, A is the surface area of the basin, in square feet, and d is the maximum depth of the basin, in feet. Volume may be computed from contour information or other suitable methods.

3. If volume of basin is not adequate for required storage, excavate to obtain the required volume.

4. The minimum surface area of the basin pool at the storage volume elevation will be the larger of the two elevations shown.

5. USDA-NRCS TR-55 or the NRCS Engineering Field Handbook, Chapter 2, or comparable method, are the preferred methods for runoff computation. Runoff curve numbers will be computed for the drainage area that reflects the maximum construction condition.

6. Required minimum discharge from pipe spillway equals 0.2 cfs/ac. times total drainage area. (This is equivalent to a uniform runoff of 5 in. per 24 hours). The pipe shall be designed to carry Qp if site conditions preclude installation of an emergency spillway to protect the structure.

7. Determine value of "H" from field conditions; "H" is the interval between the centerline of the outlet pipe and the emergency spillway crest, or if there is no emergency spillway, to the design high water.

8. See Pipe Spillway Design Charts.

9. See Riser Inflow Curves.

10. Compute the orifice size required to dewater the basin over a 10 hour period.

11. See Trash Rack and Anti-Vortex Device Design details.

12. Compute Q_{es} by subtracting actual flow carried by the pipe spillway from the total inflow, Qp.

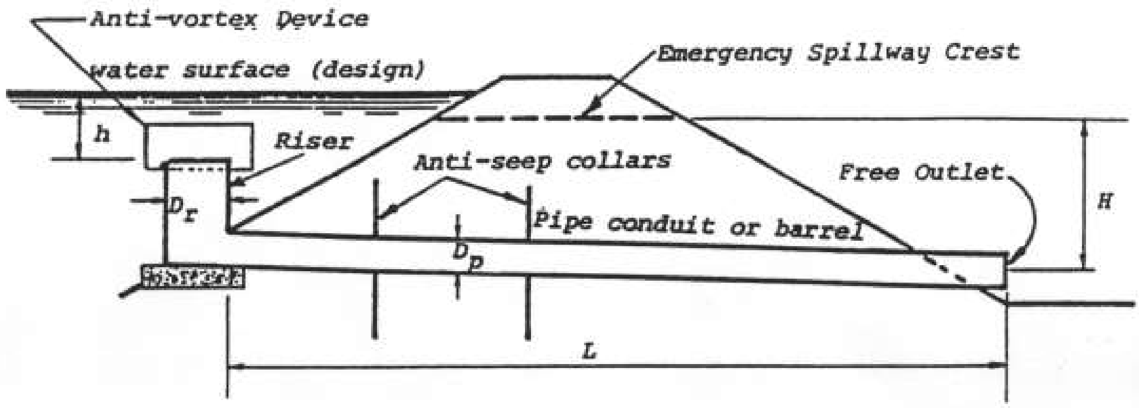
13. Use appropriate tables to obtain values of Hp, bottom width, and actual Q_{es}. If no emergency spillway is to be used, so state, giving reason(s).

14. See Anti-Seep Collar / Seepage Diaphragm Design.

15. Fill in design elevations. The emergency spillway crest must be set no closer to riser crest than value of h, which causes pipe spillway to carry the minimum, required Q. Therefore, the elevation difference between spillways shall be equal to the value of h, or one foot, whichever is greater. Design high water is the elevation of the emergency spillway crest plus the value of Hp, or if there is no emergency spillway, it is the elevation of the riser crest plus h required to handle the 10-year storm. Minimum top of dam elevation requires 1.0 ft. of freeboard above design high water.

Part 5 - Pipe Spillway Design

Pipe Spillway Design



H = Head on pipe spillway (pipe flow), ft. (centerline of outlet to emergency spillway crest or to design high water if no emergency spillway)

h = Head over riser crest, ft.

L = Length of pipe in ft.

D_p = Diameter of pipe conduit (barrel)

Dr = Diameter of riser

To use charts for pipe spillway design:

- Enter chart, Figures 5.14 and 5.15 with H and required discharge.
- Find diameter of pipe conduit that provides equal or greater discharge
- Enter chart, Figure 5.13 with actual pipe discharge. Read across to select smallest riser that provides discharge within weir flow portion of rating curve. Read down to find corresponding h required. This h must be 1 foot or less.

Example:

Given: Q (required) = 5.8 cfs, L = 60 ft., H = 9 ft. to centerline of pipe = Free outlet
Find: Pipe size, actual Q and size of riser, use corrugated metal pipe, n = 0.025

Q of 12 in. pipe = 5.95 cfs x (correction factor) 1.07 = 6.4 cfs from the Pipe Flow Chart. From Riser Inflow Curves smallest riser = 18 in. (@ h = 0.60).

Design Example #1

Snooks Pond is a senior citizen assisted living center under construction. A sediment basin will be utilized as a component of the erosion and sediment control plan for the project. The Drainage area to the basin is 20 acres, the one year storm peak discharge is 32 cubic feet per second, and 88 cfs for the 10 year storm based on analysis of the site under maximum construction condition. Design the sediment basin when the overall head (H) is 10 feet and the smooth steel pipe spillway is used. An emergency spillway can be constructed on the site. Base the design volumes and elevations on the stage storage curve developed for the natural topography or as excavated.

Design Example # 2

Us the same data as example #1, but no emergency spillway is possible.

Notes:

1. Use a 1.0 foot minimum between riser crest and emergency spillway crest, thus riser crest = 1.0 ft
2. To provide 50% of the storage as permanent pool, the dewatering orifice is set at the out elevation.

Part 5 - Temporary Sediment Basin

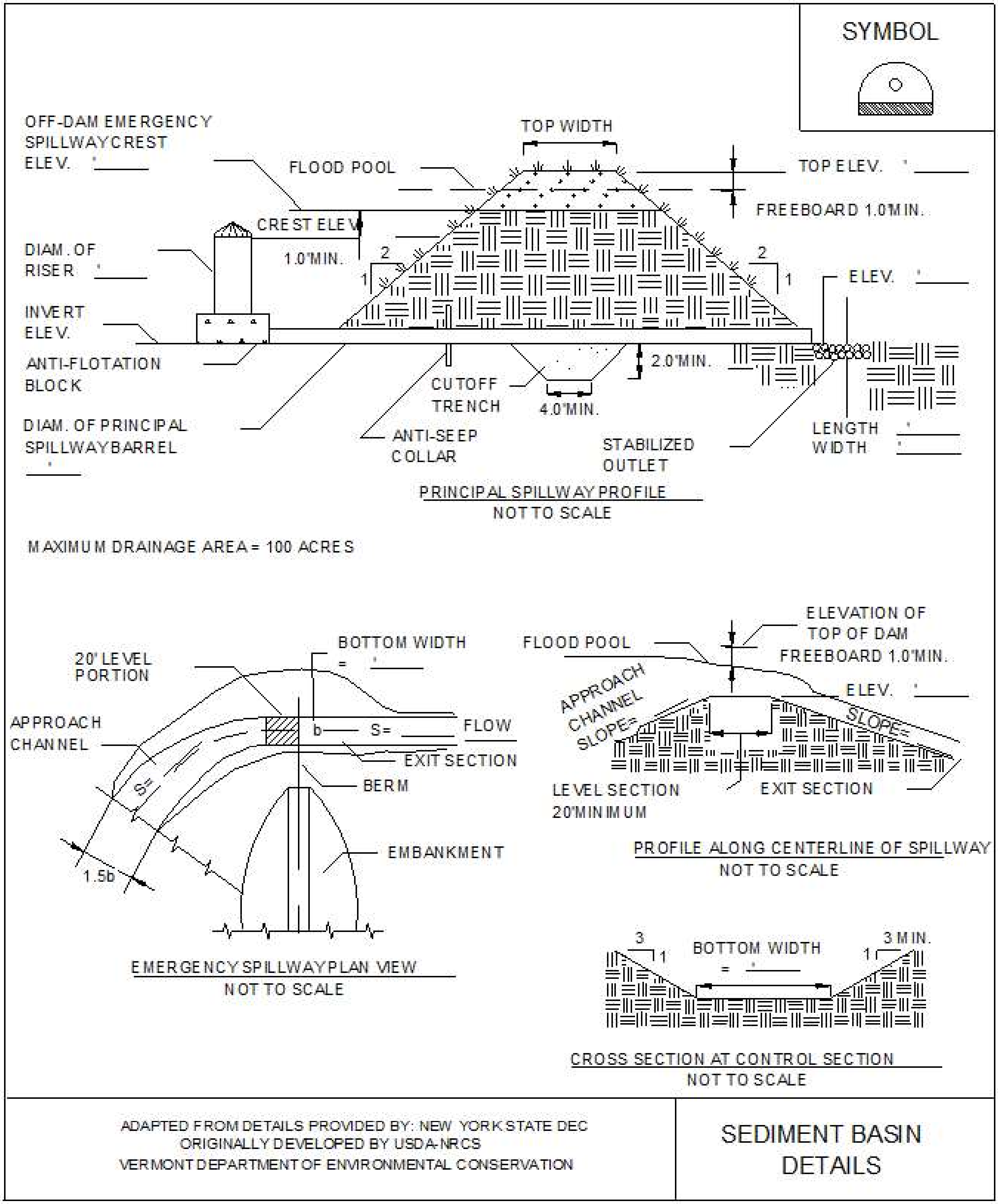


Figure 5.13 Sediment Basin

TEMPORARY SEDIMENT BASIN DESIGN DATA SHEET

Computed JQP Date 7-06 Checked by ANR Date 7-06

Project HAPPY ACRES

Sub Watershed# 3 Location WATERBURY, VT

Total Area draining to basin 20 Acres

BASIN SIZE DESIGN

1. Minimum sediment storage volume = 134 cu. yds. x 20 acres of drainage area = 2,680 cu.yds.
2. a. Cleanout at 50 percent of minimum required volume = 1,340 cu. yds.
   b. Elevation corresponding to scheduled time to clean out 96.5
   c. Distance below top of riser 3.5 feet
3. Minimum surface area is larger of 0.01 $Q_{(1)}$ 0.32 or, 0.015 DA = 0.30 use 0.32 acres

DESIGN OF SPILLWAYS & ELEVATIONS

Runoff

4. $Q_{p(10)}$ = 88 cfs
   (EFH, Ch. 2, TR-55, or Section 4; Attach runoff computation sheet)

Pipe Spillway (Q_{ps})

5. Min. pipe spillway cap., Q_{ps} = 0.2 x 20 ac. Drainage = 4 cfs
   Note: If there is no emergency spillway, then req'd $Q_{ps} = Q_{p(10)}$ = — cfs.
6. H = 10 ft. Barrel length = 85 ft
7. Barrel: Diam. 12 inches; Q_{ps} = (Q) 10.2 x (cor.fac.) .945 = 9.6 cfs.
8. Riser: Diam. 21 inches; Length 9 ft.; h = 1.0 ft. Crest Elev. 100.0
9. Trash Rack: Diam. 30 inches; H = 11 inches

Emergency Spillway Design

10. Emergency Spillway Flow, $Q_{es} = Q_p - Q_{ps}$ = 88 - 10 = 78 cfs.
11. Width 20 ft.; H_p 1.4 ft Crest elevation 101.0 ; Design High Water Elev. 102.4
    Entrance channel slope 2 % ; Top of Dam Elev. 103.4
    Exit channel slope 72.7 %

ANTI-SEEP COLLAR/
SEEPAGE DIAPHRAGM DESIGN

Collars:

12. y = 8 ft.; z = 2 :1; pipe slope = 1 %, L_s = 50 ft.
    Use ___ collars, ___ - ___ inches square; projection = ___ ft.

Diaphragms:

\# 1 width 7 ft. height 10 ft.

DEWATERING ORIFICE SIZING

13. $Ao = \frac{A_s \times (2h)^{0.5}}{122,568}$ = 0.30 sq. ft.; h = 3.5 ft.; therefore use, 7.4" → USE 6" ORIFICE

Figure 5.14a Sediment Basin Design Example #1

TEMPORARY SEDIMENT BASIN DESIGN DATA SHEET

Computed JQP Date 7-06 Checked by ANR Date 7-06
Project HAPPY ACRES
Sub Watershed# 4 Location WATERBURY, VT
Total Area draining to basin 20 Acres

BASIN SIZE DESIGN

1. Minimum sediment storage volume = 134 cu. yds. x 20 acres of drainage area = 2,680 cu.yds.
2. a. Cleanout at 50 percent of minimum required volume = 1,340 cu. yds.
   b. Elevation corresponding to scheduled time to clean out 96.5
   c. Distance below top of riser 3.5 feet
3. Minimum surface area is larger of 0.01 $Q_{(1)}$ 0.32 or, 0.015 DA = 0.30 use 0.32 acres

DESIGN OF SPILLWAYS & ELEVATIONS

Runoff

4. $Q_{p(10)}$ = 88 cfs
   (EFH, Ch. 2, TR-55, or Section 4; Attach runoff computation sheet)

Pipe Spillway (Q_{ps})

5. Min. pipe spillway cap., Q_{ps} = 0.2 x 20 ac. Drainage = 4 cfs
   Note: If there is no emergency spillway, then req'd $Q_{ps} = Q_{p(10)}$ = ________cfs.
6. H = 10 ft. Barrel length = 85 ft
7. Barrel: Diam. 36 inches; Q_{ps} = (Q) 91.2 x (cor.fac.) 0.955 = 87.1 cfs.
8. Riser: Diam. 54 inches; Length 9 ft.; h = 1.7 ft. Crest Elev. 100.0
9. Trash Rack: Diam. 78 inches; H = 25 inches

Emergency Spillway Design

10. Emergency Spillway Flow, $Q_{es} = Q_p - Q_{ps}$ = __________ - __________ = __________cfs.
11. Width ______ft.; H_p________ft Crest elevation __________; Design High Water Elev. __________
    Entrance channel slope______________________% ; Top of Dam Elev. ______________
    Exit channel slope ______________________%

ANTI-SEEP COLLAR/ SEEPAGE DIAPHRAGM DESIGN

Collars:

12. y = 8 ft.; z = 2 :1; pipe slope = 1 %, L_s = 50 ft.
    Use 2 collars, 4' - 6 inches square; projection = 1.8 ft.

Diaphragms:

\# 1 width 7 ft. height 10 ft.

DEWATERING ORIFICE SIZING

13. $$A_o = \frac{A_s \times (2h)^{0.5}}{122{,}568}$$ = 0.30 sq. ft.; h = 3.5 ft.; therefore use, 7.4" → USE 6" ORIFICE

Figure 5.14b Sediment Basin Design Example #2

Part 5 - Riser Inflow Chart

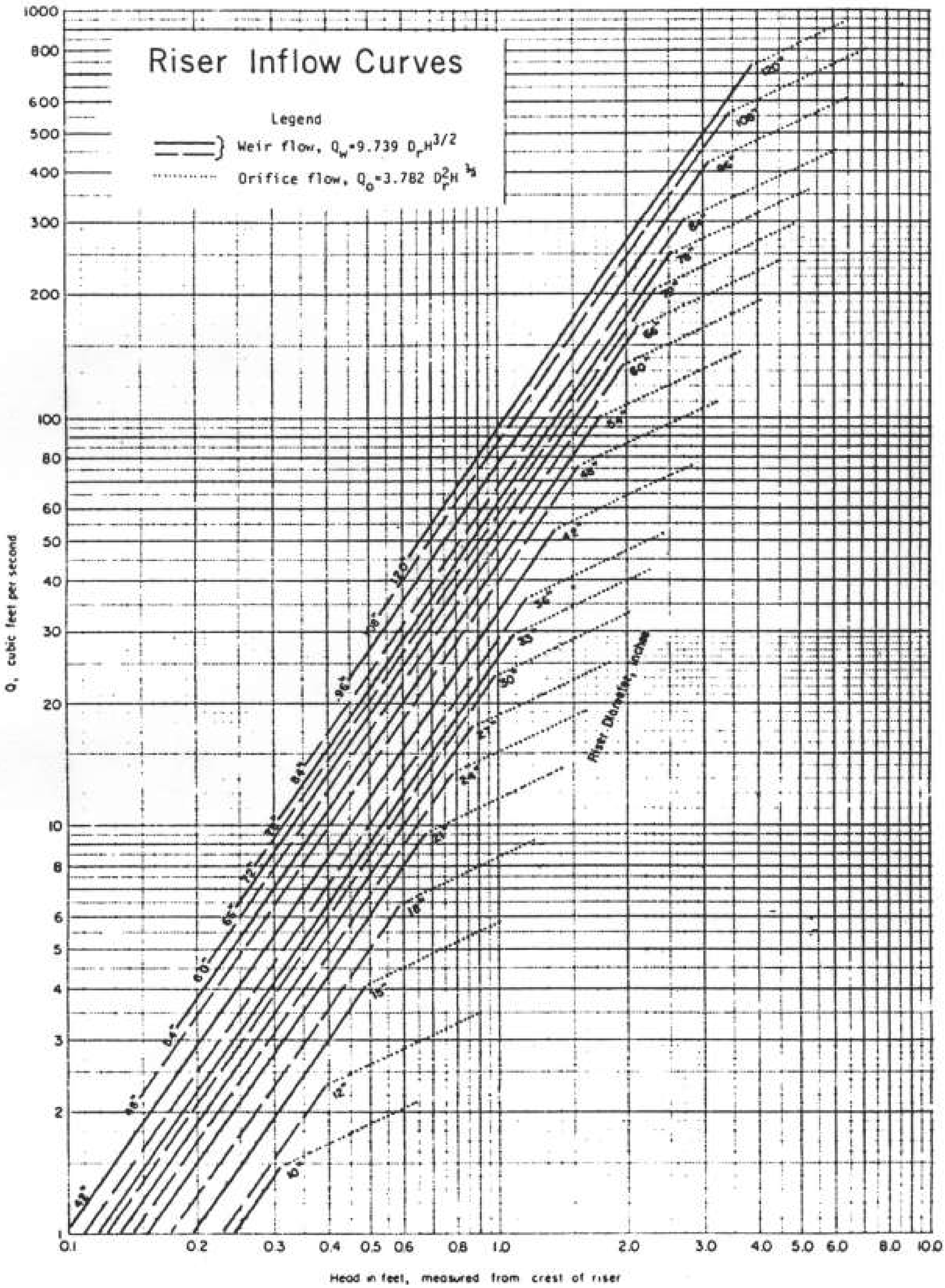


Figure 5.15 Riser Inflow Chart (USDA-NRCS)

Part 5 - Pipe Flow Chart

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_m = K_e + K_b = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

H, in feet	6"	8"	10"	12"	15"	18"	21"	24"	30"	36"	42"	48"	54"	60"	66"	72"	78"	84"	90"	96"	102"
	diameter of pipe in inches																				
1	0.33	0.70	1.25	1.98	3.48	5.47	7.99	11.0	18.8	28.8	41.1	55.7	72.6	91.8	113	137	163	191	222	255	290
2	0.47	0.99	1.76	2.80	4.92	7.74	11.3	15.6	26.6	40.8	58.2	78.8	103	130	160	194	231	271	314	360	410
3	0.58	1.22	2.16	3.43	6.02	9.48	13.8	19.1	32.6	49.9	71.2	96.5	126	159	196	237	282	331	384	441	502
4	0.67	1.40	2.49	3.97	6.96	10.9	16.0	22.1	37.6	57.7	82.3	111	145	184	226	274	326	383	444	510	580
5	0.74	1.57	2.79	4.41	7.78	12.2	17.9	24.7	42.1	64.5	92.0	125	162	205	253	306	365	428	496	570	648
6	0.82	1.72	3.05	4.86	8.52	13.4	19.6	27.0	46.1	70.6	101	136	178	225	277	336	399	469	544	624	710
7	0.88	1.86	3.30	5.25	9.20	14.5	21.1	29.2	49.8	76.3	109	147	192	243	300	362	431	506	587	674	767
8	0.94	1.99	3.53	5.61	9.84	15.5	22.6	31.2	53.2	81.5	116	158	205	260	320	388	461	541	628	721	820
9	1.00	2.11	3.74	5.95	10.4	16.4	24.0	33.1	56.4	86.5	123	167	218	275	340	411	489	574	666	764	870
10	1.05	2.22	3.94	6.27	11.0	17.3	25.3	34.9	59.5	91.2	130	176	230	290	358	433	516	605	702	806	917
11	1.10	2.33	4.13	6.58	11.5	18.2	26.5	36.6	62.4	95.6	136	185	241	304	376	454	541	635	736	845	962
12	1.15	2.43	4.32	6.87	12.1	19.0	27.7	38.2	65.2	99.9	142	193	252	318	392	475	565	663	769	883	1004
13	1.20	2.53	4.49	7.15	12.6	19.7	28.8	39.8	67.8	104	148	201	262	331	408	494	588	690	800	919	1045
14	1.25	2.63	4.66	7.42	13.0	20.5	29.9	41.3	70.4	108	154	208	272	343	424	513	610	716	830	953	1085
15	1.29	2.72	4.83	7.68	13.5	21.2	30.9	42.8	72.8	112	159	216	281	355	439	531	631	741	860	987	1123
16	1.33	2.81	4.99	7.93	13.9	21.9	32.0	44.2	75.2	115	165	223	290	367	453	548	652	765	888	1019	1160
17	1.37	2.90	5.14	8.18	14.3	22.6	32.9	45.5	77.5	119	170	230	229	378	467	565	672	789	915	1051	1195
18	1.41	2.98	5.29	8.41	14.8	23.2	33.9	46.8	79.8	120	174	236	308	389	480	581	692	812	942	1081	1230
19	1.45	3.06	5.43	8.64	15.2	23.9	34.8	48.1	82.0	126	179	243	316	400	494	597	711	834	967	1111	1264
20	1.49	3.14	5.57	8.87	15.6	24.5	35.7	49.4	84.1	129	184	249	325	410	506	613	729	856	993	1139	1297
21	1.53	3.22	5.71	9.09	15.9	25.1	36.6	50.6	86.2	132	188	255	333	421	519	628	747	877	1017	1168	1329
22	1.56	3.29	5.85	9.30	16.3	25.7	37.5	51.8	88.2	135	193	261	341	430	531	643	765	898	1041	1195	1360
23	1.60	3.37	5.98	9.51	16.7	26.2	38.3	53.0	90.2	138	197	267	348	440	543	657	782	918	1064	1222	1390
24	1.63	3.44	6.11	9.72	17.0	26.8	39.1	54.1	92.1	141	201	273	356	450	555	671	799	937	1087	1248	1420
25	1.66	3.51	6.23	9.92	17.4	27.4	39.9	55.2	94.0	144	206	279	363	459	566	685	815	957	1110	1274	1450
26	1.70	3.58	6.36	10.1	17.7	27.9	40.7	56.3	95.9	147	210	284	370	468	577	699	831	976	1132	1299	1478
27	1.73	3.65	6.48	10.3	18.1	28.4	41.5	57.4	97.7	150	214	290	377	477	588	712	847	994	1153	1324	1507
28	1.76	3.72	6.60	10.5	18.4	29.0	42.3	58.4	99.5	153	218	295	384	486	599	725	863	1013	1174	1348	1534
29	1.79	3.78	6.71	10.7	18.7	29.5	43.0	59.5	101	155	221	300	391	494	610	738	878	1030	1195	1372	1561
30	1.82	3.85	6.83	10.9	19.1	30.0	43.7	60.5	103	158	225	305	398	503	620	750	893	1048	1216	1396	1588
L, in feet	Correction Factors For Other Pipe Lengths																				
20	1.69	1.63	1.58	1.53	1.47	1.42	1.37	1.34	1.28	1.24	1.20	1.18	1.16	1.14	1.13	1.11	1.10	1.10	1.09	1.08	1.08
30	1.44	1.41	1.39	1.36	1.32	1.29	1,27	1.24	1.21	1.18	1.15	1.13	1.12	1.11	1.10	1.09	1.08	1.07	1.07	1.06	1.06
40	1.26	1.27	1.25	1.23	1.21	1.20	1.18	1.17	1.14	1.12	1.11	1.10	1.09	1.08	1.07	1.06	1.06	1.05	1.05	1.05	1.04
50	1.16	1.16	1.15	1.14	1.13	1.12	1.11	1.10	1.09	1.08	1.07	1.06	1.06	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03
60	1.07	1.07	1.07	1.06	1.06	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	.94	.94	.95	.95	.95	.95	.96	.96	.96	.97	.97	.97	.98	.98	.98	.98	.98	.98	.99	.99	.99
90	.89	.89	.90	.90	.91	.91	.92	.92	.93	.94	.94	.95	.95	.96	.96	.96	.97	.97	.97	.97	.94
100	.85	.85	.86	.86	.87	.88	.89	.89	.90	.91	.92	.93	.93	.94	.94	.95	.95	.95	.96	.96	.94
120	.78	.79	.79	.90	.81	.82	.83	.83	.85	.86	.87	.89	.89	.90	.91	,.89	.92	.93	.93	.94	.92
140	.72	.73	.74	.75	.76	.77	.78	.79	.81	.82	.84	.85	.86	.87	.88	.86	.89	.90	.91	.91	.90
160	.68	.69	.69	.70	.71	.73	.74	.75	.77	.79	.80	.82	.83	.84	.85	.92	.87	.88	.89	.89	

Figure 5.16 Pipe Flow Chart; "n" = 0.025 (USDA-NRCS)

Part 5 - Pipe Flow Chart

PIPE FLOW CHART n = 0.013

FOR REINFORCED CONCRETE PIPE INLET $K_m = K_e + K_b = 1.00$ AND 70 FEET OF REINFORCED CONCRETE PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

diameter of pipe in inches

H, in feet	12"	15"	18"	21"	24"	30"	36"	42"	48"	54"	60"	66"	72"	78"	84"	90"	96"	102"
1	3.22	5.44	8.29	11.8	15.9	26.0	38.6	53.8	71.4	91.5	114	139	167	197	229	264	302	342
2	4.55	7.69	11.7	16.7	22.5	36.8	54.6	76.0	101	129	161	197	236	278	324	374	427	483
3	5.57	9.42	14.4	20.4	27.5	45.0	66.9	93.1	124	159	198	241	289	341	397	458	523	592
4	6.43	10.9	16.6	23.5	31.8	52.0	77.3	108	143	183	228	278	334	394	459	529	604	683
5	7.19	12.2	18.5	26.3	35.5	58.1	86.4	120	160	205	255	311	373	440	513	591	675	764
6	7.88	13.3	20.3	28.8	38.9	63.7	94.6	132	175	224	280	341	409	482	562	647	739	837
7	8.51	14.4	21.9	31.1	42.0	68.8	102	142	189	242	302	368	441	521	607	699	798	904
8	9.10	15.4	23.5	33.3	44.9	73.5	109	152	202	259	323	394	472	557	685	748	854	966
9	9.65	16.3	24.9	35.3	47.7	78.0	116	161	214	275	342	418	500	590	688	793	905	1025
10	10.2	17.2	26.2	37.2	50.2	82.2	122	170	226	289	361	440	527	622	725	836	954	1080
11	10.7	18.0	27.5	39.0	52.7	86.2	128	178	237	304	379	462	553	653	761	877	1001	1133
12	11.1	18.9	28.7	40.8	55.0	90.1	134	186	247	317	395	482	578	682	794	916	1045	1184
13	11.6	19.6	29.9	42.4	57.3	93.7	139	194	257	330	411	502	601	710	827	953	1088	1232
14	12.0	20.4	31.0	44.1	59.4	97.3	145	201	267	342	427	521	624	736	858	989	1129	1278
15	12.5	21.1	32.1	45.6	61.5	101	150	208	277	354	442	539	646	762	888	1024	1169	1323
16	12.9	21.8	33.2	47.1	63.5	104	155	215	286	366	457	557	667	787	917	1057	1207	1367
17	13.3	22.4	34.2	48.5	65.5	107	159	222	294	377	471	574	688	812	946	1090	1244	1409
18	13.7	23.1	35.2	49.9	67.4	110	164	228	303	388	484	591	708	835	973	1121	1280	1450
19	14.0	23.7	36.1	51.3	69.2	113	168	234	311	399	497	607	727	858	1000	1152	1315	1489
20	14.4	24.3	37.1	52.6	71.0	116	173	240	319	409	510	623	746	880	1026	1182	1350	1528
21	14.7	24.9	38.0	53.9	72.8	119	177	246	327	419	523	638	764	902	1051	1211	1383	1566
22	15.1	25.5	38.9	55.2	74.5	122	181	252	335	429	535	653	782	923	1076	1240	1415	1603
23	15.4	26.1	39.8	56.5	76.2	125	186	258	342	439	547	668	800	944	1100	1268	1447	1639
24	15.8	26.7	40.6	57.7	77.8	127	189	263	350	448	559	682	817	964	1123	1295	1478	1674
25	16.1	27.2	41.5	58.9	79.4	130	193	269	357	458	571	696	834	984	1147	1322	1509	1708
26	16.4	27.7	42.3	60.0	81.0	133	197	274	364	467	582	710	850	1004	1169	1348	1539	1742
27	16.7	28.3	43.1	61.2	82.5	135	201	279	371	476	593	723	867	1023	1192	1373	1568	1775
28	17.0	28.8	43.9	62.3	84.1	138	204	285	378	484	604	737	883	1041	1214	1399	1597	1808
29	17.3	29.3	44.7	63.4	85.5	140	208	290	384	493	615	750	898	1060	1235	1423	1625	1840
30	17.6	29.8	45.4	64.5	87.0	142	212	294	391	501	625	763	913	1078	1256	1448	1653	1871
L, in feet	Correction Factors For Other Pipe Lengths																	
20	1.30	1.24	1.21	1.18	1.15	1.12	1.10	1.08	1.07	1.06	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03
30	1.22	1.18	1.15	1.13	1.12	1.09	1.08	1.06	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02
40	1.15	1.13	1.11	1.10	1.08	1.07	1.05	1.05	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02
50	1.09	1.08	1.07	1.06	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01
60	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	.96	.97	.97	.97	.98	.98	.98	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99
90	.93	.94	.94	.95	.95	.96	.97	.97	.98	.98	.98	.98	.98	.99	.99	.99	.99	.99
100	.90	.91	.92	.93	.93	.95	.95	.96	.97	.97	.97	.98	.98	.98	.98	.98	.98	.99
120	.84	.86	.87	.89	.90	.91	.93	.94	.94	.95	.96	.96	.96	.97	.97	.97	.97	.98
140	.80	.82	.83	.85	.86	.88	.90	.91	.92	.93	.94	.94	.95	.95	.96	.96	.96	.97
160	.76	.78	.80	.82	.83	.86	.88	.89	.90	.91	.92	.93	.94	.94	.95	.95	.95	.96

Figure 5.17 Pipe Flow Chart; "n" = 0.013 (USDA-NRCS)

Part 5 - Optional Sediment Basin Dewatering

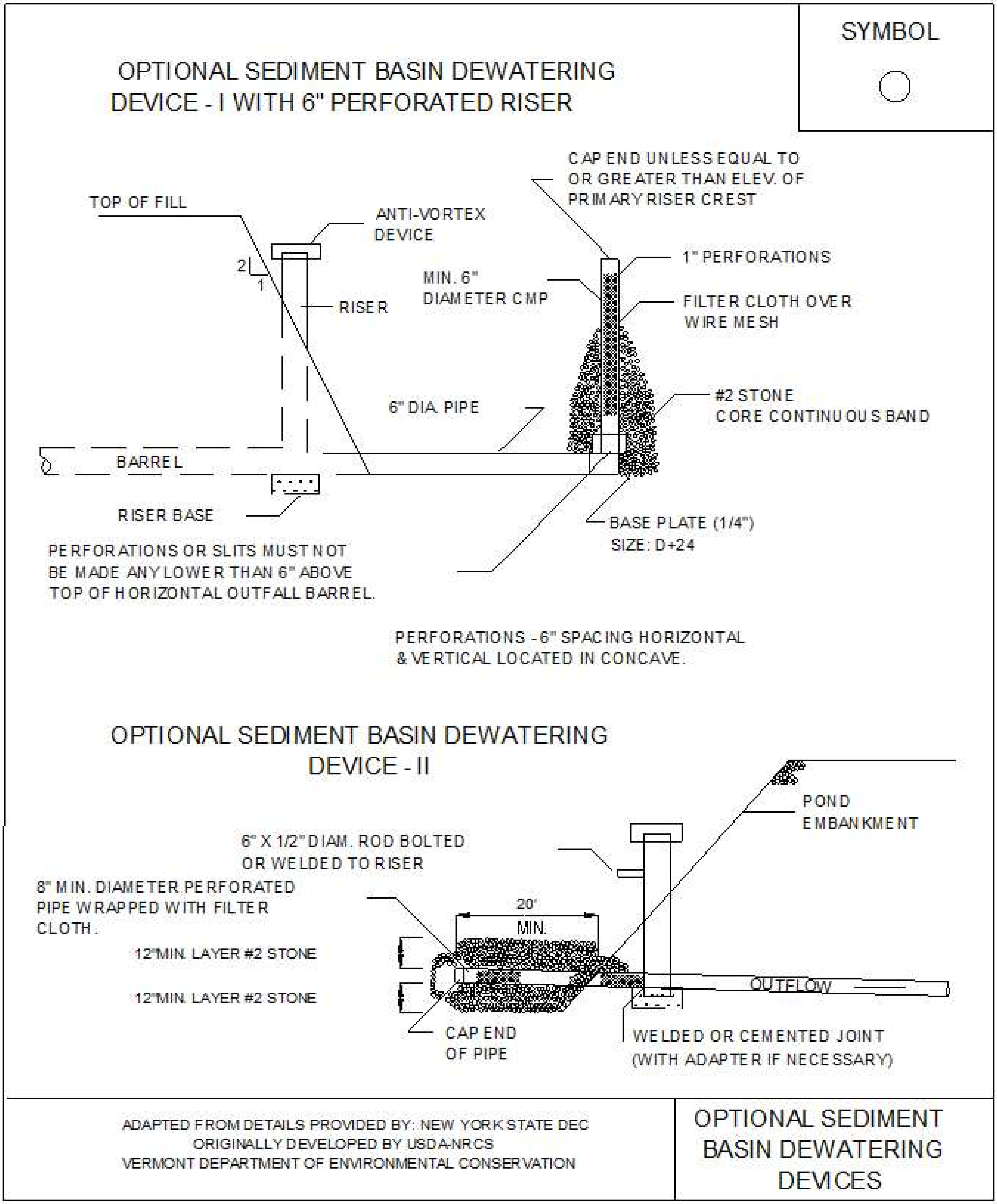


Figure 5.18 Optional Sediment Basin Dewatering Methods

Part 5 - Concentric Trash Rack and Anti-Vortex Device

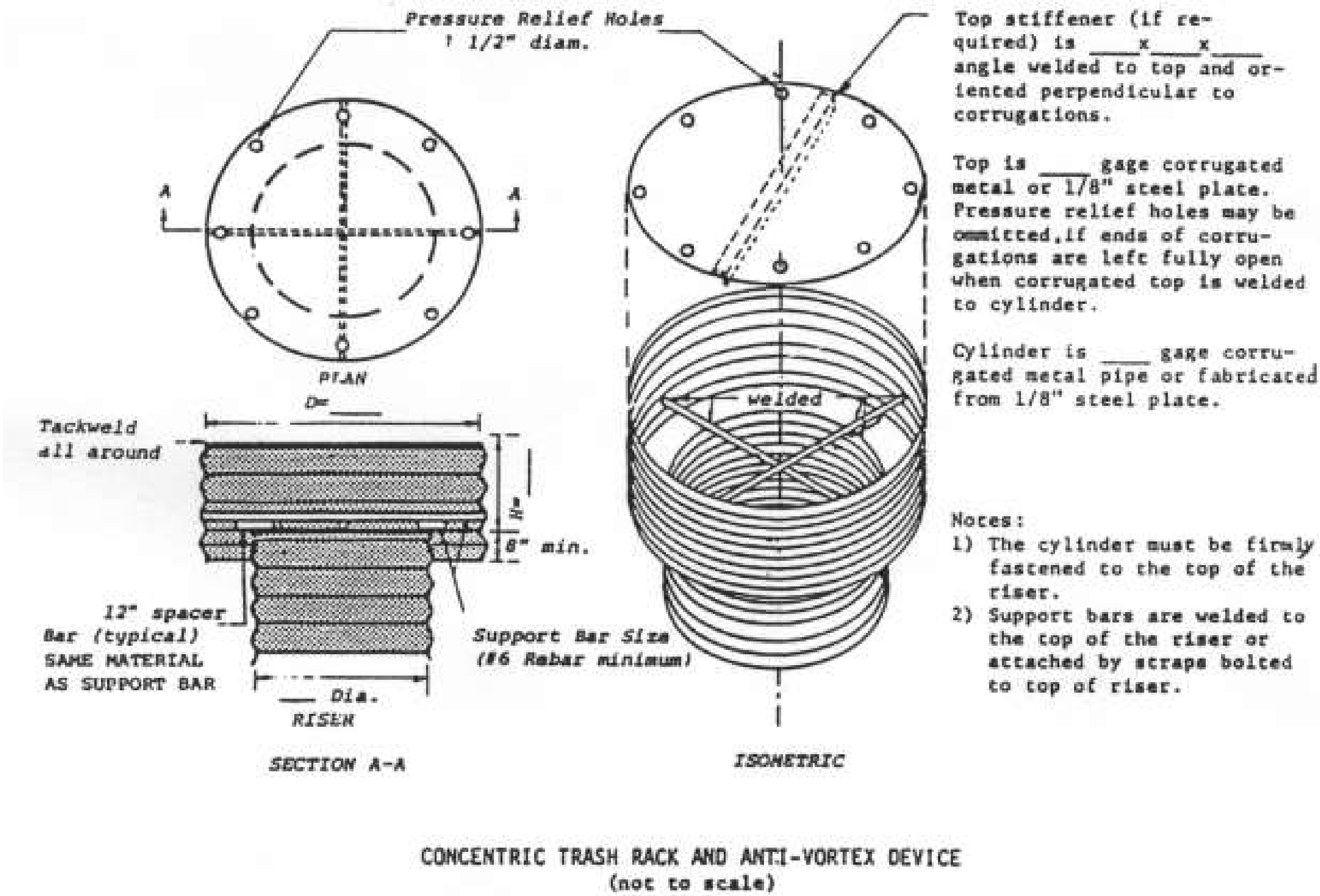


Figure 5.19 Concentric Trash Rack and Anti-Vortex Device (USDA-NRCS)

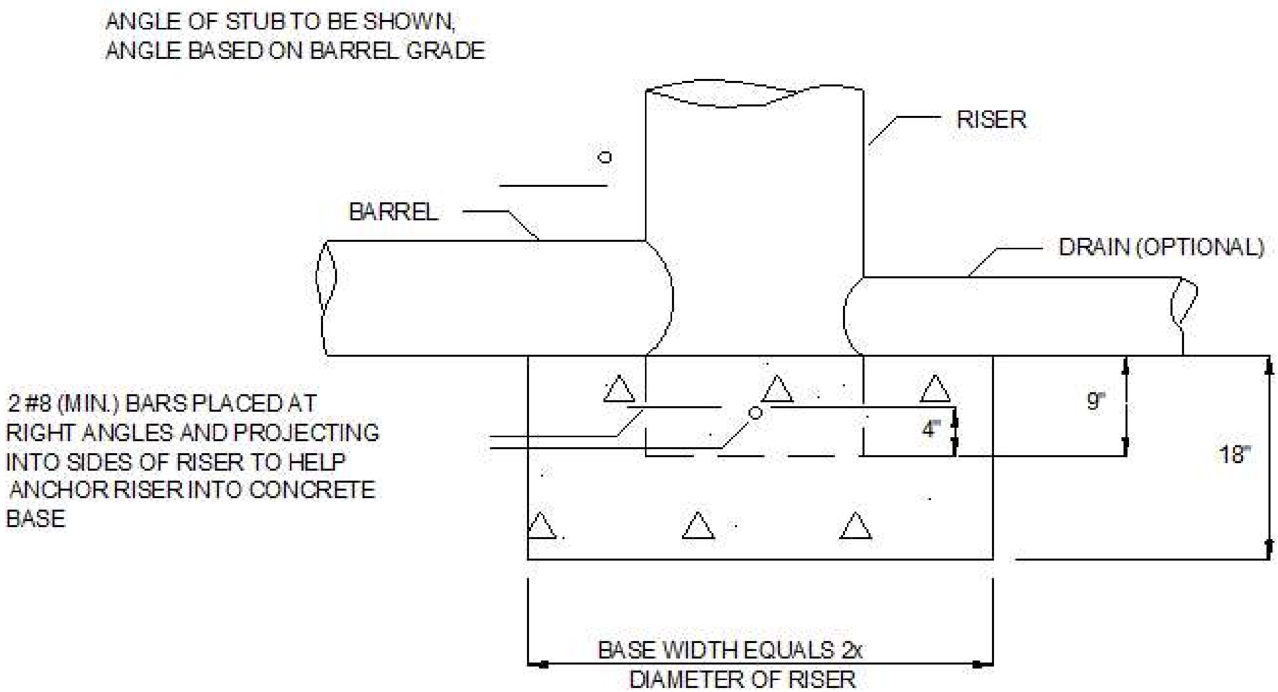
Part 5 - Concentric Trash Rack and Anti-Vortex Device

Riser Diam.(in)	Cylinder Diam (in.)	Thick. Gage	H (in.)	Minimum Size Support Bar	Minimun Top Thickness	Stiffener
12	18	16	6	#6 Rebar	16 ga.	—
15	21	16	7	#6 Rebar	16 ga.	—
18	27	16	8	#6 Rebar	16 ga.	—
21	30	16	11	#6 Rebar	16 ga.	—
24	36	16	13	#6 Rebar	14 ga.	—
27	42	16	15	#6 Rebar	14 ga.	—
36	54	14	17	#8 Rebar	12 ga.	—
42	60	14	19	#8 Rebar	12 ga.	—
48	72	12	21	1 1/4" pipe or 1 1/4x1 1/4x1/4 angle	10 ga.	—
54	78	12	25	See 48" Riser	10 ga.	—
60	90	12	29	1 1/2" pipe or 1 1/2x1 1/2x1/2 angle	8 ga.	—
66	96	10	33	2" pipe or 2x2x3/16 angle	8 ga. w/stiffener	2x2x1/4 angle
72	102	10	36	———See 66" Riser———		2 1/2x2 1/2x1/4 angle
78	114	10	39	2 1/2" pipe or 2x2x1/4 angle	See 72" Riser	See 72" Riser
84	120	10	42	2 1/2" pipe or 2 1/2x2 1/2x1/4 angle	See 72" Riser	2 1/2x 2 1/2x 5/16 angle

Note: The criteria for sizing the cylinder is that the area between the inside of the cylinder and the outside of the riser is equal to or greater than the area inside the riser. Therefore, the above table is invalid for use with concrete pipe risers.

Figure 5.20 Concentric Trash Rack and Anti-Vortex Device Design Table (USDA-NRCS)

Part 5 - Riser Base Detail - Sediment Basin



CONSTRUCTION SPECIFICATIONS

1. THE CONCRETE BASE SHALL BE POURED IN SUCH A MANNER TO INSURE THAT THE CONCRETE FILLS THE BOTTOM OF THE RISER TO THE INVERT OF THE OUTLET PIPE TO PREVENT THE RISER FROM BREAKING AWAY FROM THE BASE.
2. WITH ALUMINUM OR ALUMINIZED PIPE, THE EMBEDDED SECTION MUST BE PAINTED WITH CHROMATE OR EQUIVALENT.
3. RISER BASE MAY BE SIZED AS COMPUTED USING FLOATATION WITH A FACTOR OF SAFETY OF 1.2.

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	RISER BASE DETAIL SEDIMENT BASIN

Figure 5.21 Riser Base Detail - Sediment Basin

Part 5 - Anti-Seep Collar Design

This procedure provides the anti-seep collar dimensions for only temporary sediment basins to increase the seepage length by 15% for various pipe slopes, embankment slopes and riser heights.

The first step in designing anti-seep collars is to determine the length of pipe within the saturated zone of the embankment. This can be done graphically or by the following equation, assuming that the upstream slope of the embankment intersects the invert of the pipe at its upstream end. (See embankment-invert intersection on the drawing below:

$$L_s = y\,(z + 4)\left[1 + \frac{\text{pipe slope}}{0.25 - \text{pipe slope}}\right]$$

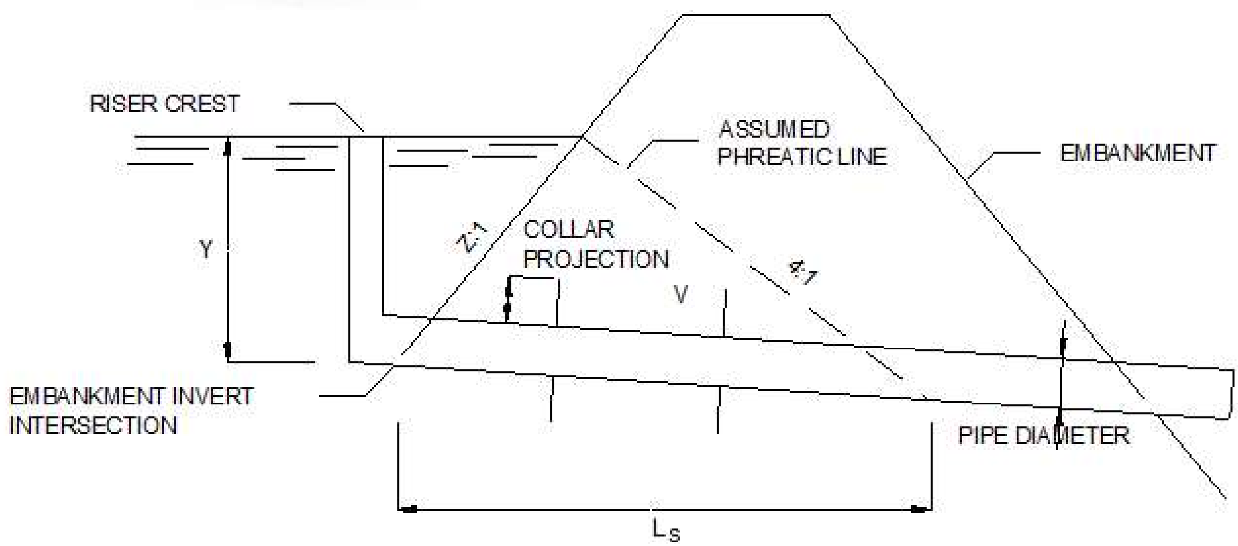
Where: L_s = length of pipe in the saturated zone (ft.)

y = distance in feet from upstream invert of pipe to highest normal water level expected to occur during the life of the structure, usually the top of the riser.

z = slope of upstream embankment as a ratio of z ft. horizontal to one ft. vertical.

pipe slope = slope of pipe in feet per foot.

This procedure is based on the approximation of the phreatic line as shown in the drawing below:



ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC
ORIGINALLY DEVELOPED BY USDA-NRCS
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

ANTI-SEEP COLLAR DESIGN

Figure 5.22a Anti-Seep Collar Design

Part 5 - Anti-Seep Collar Design

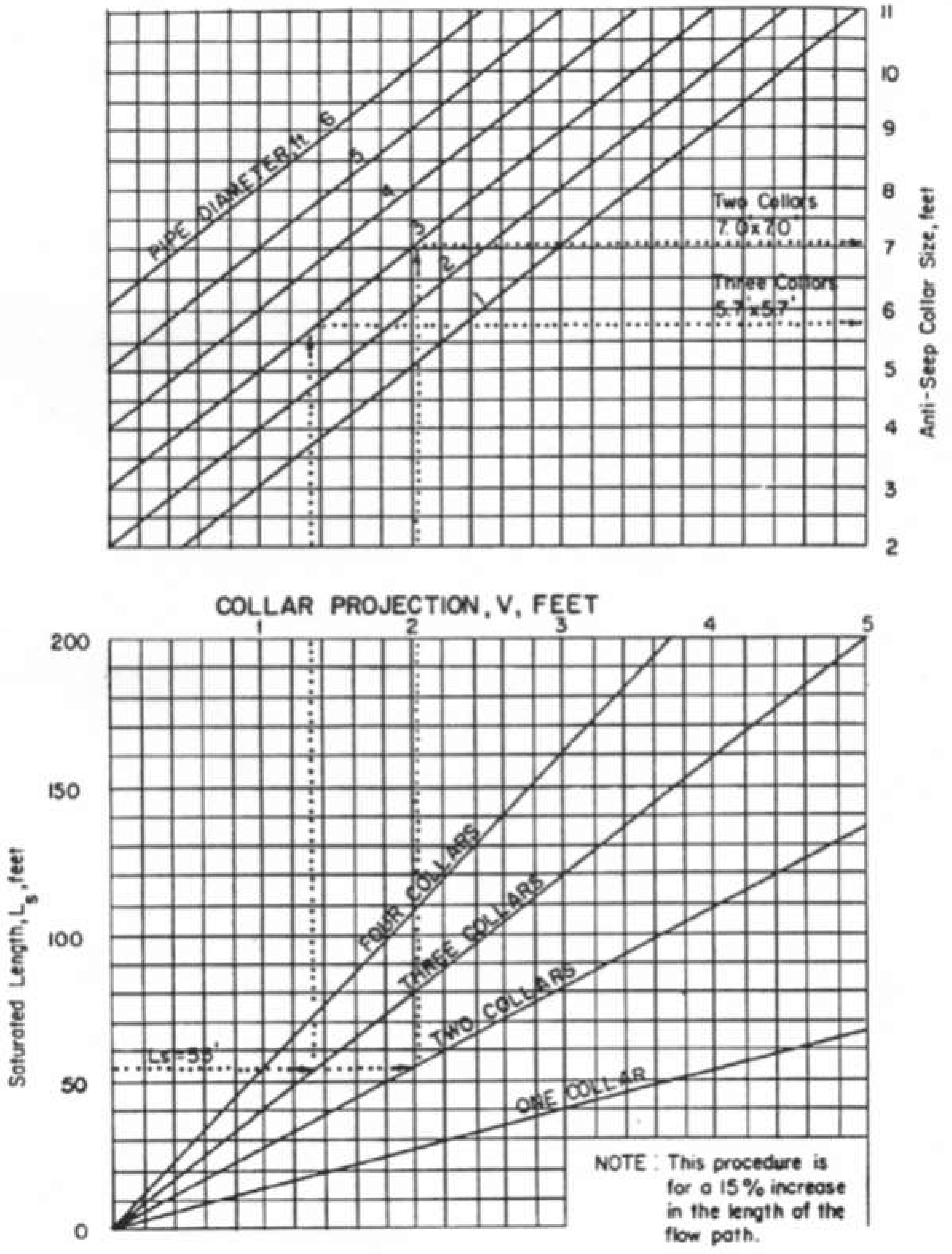


Figure 5.22b Anti-Seep Collar Design Charts (USDA-NRCS)

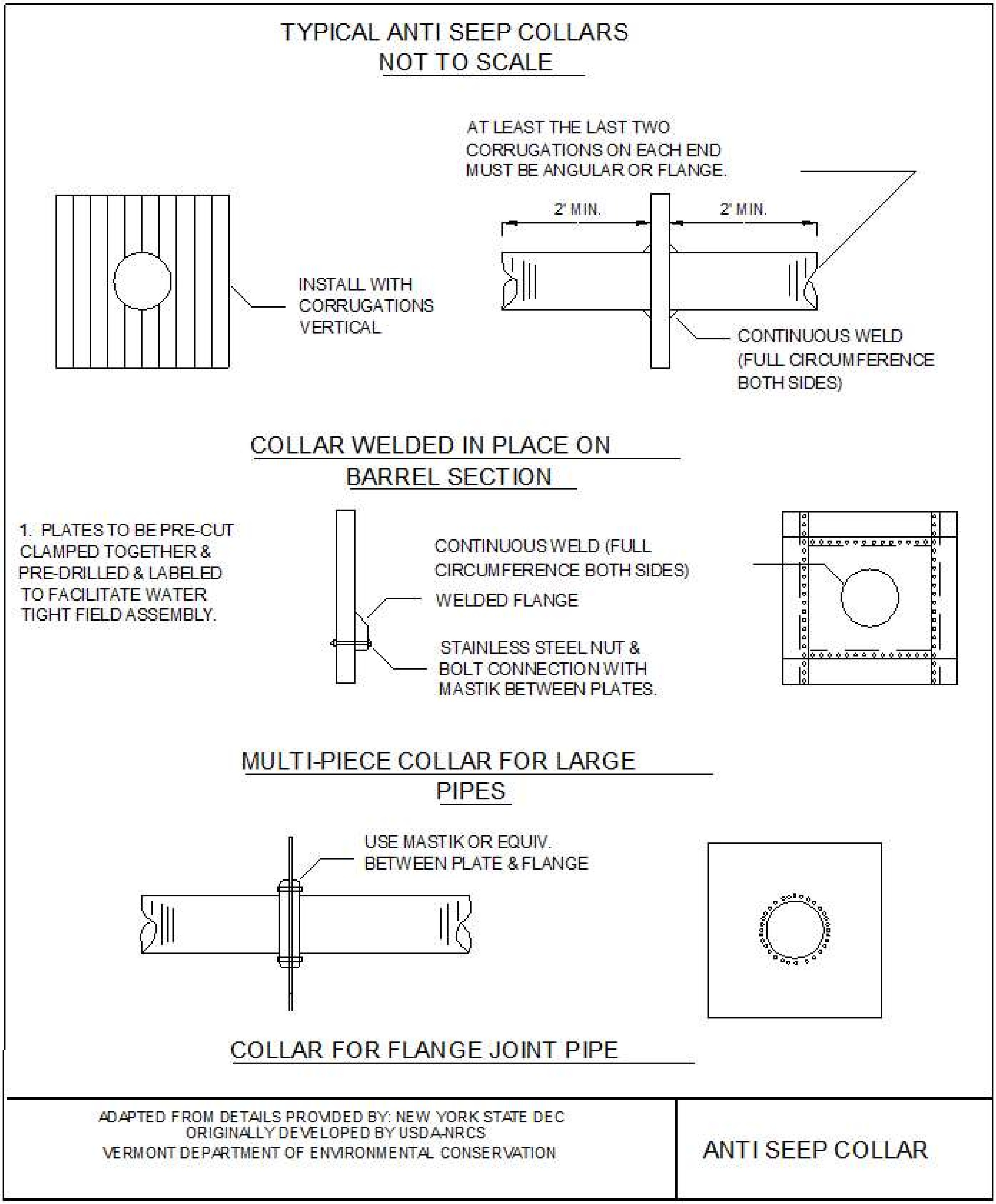
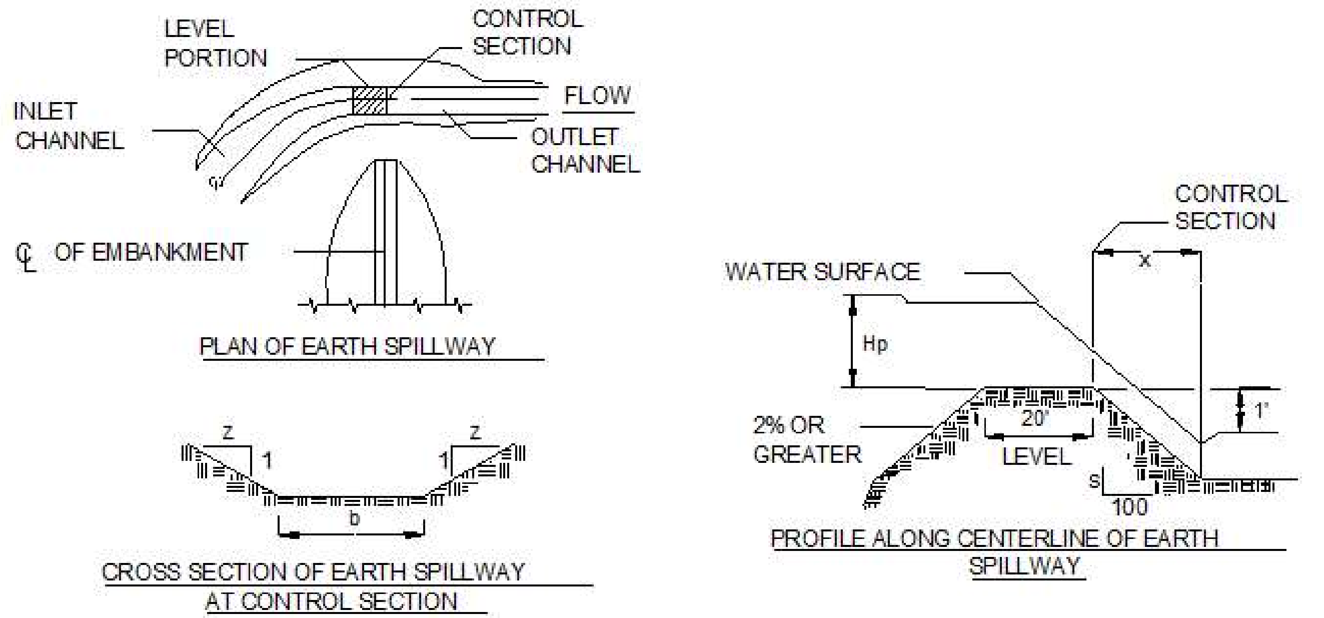


Figure 5.22c Anti-Seep Collar Design (USDA-NRCS)



LEGEND

n = MANNING'S COEFFICIENT OF ROUGHNESS.

Hp = DIFFERENCE IN ELEVATION BETWEEN CREST OF EARTH SPILLWAY AT THE CONTROL SECTION AND WATER SURFACE IN RESERVOIR, IN FEET.

b = BOTTOM WIDTH OF EARTH SPILLWAY AT THE CONTROL SECTION, IN FEET.

Q = TOTAL DISCHARGE, IN cfs.

V = VELOCITY. IN FEET PER SECOND, THAT WILL EXIST IN CHANNEL BELOW CONTROL SECTION, AT DESIGN Q, IF CONSTRUCTED TO SLOPE (S) THAT IS SHOWN.

S = FLATTEST SLOPE (S), IN %, ALLOWABLE FOR CHANNEL BELOW CONTROL SECTION.

X = MINIMUM LENGTH OF CHANNEL BELOW CONTROL SECTION, IN FEET.

z = SIDE SLOPE RATIO.

NOTES:

1) FOR A GIVEN Hp A DECREASE IN THE EXIT SLOPE FROM S AS GIVEN IN THE TABLE DECREASES SPILLWAY DISCHARGE BUT INCREASING THE EXIT SLOPE FROM S DOES NOT INCREASE DISCHARGE. IF AN EXIT SLOPE (Se) STEEPER THAN S IS USED, THEN VELOCITY (Ve) IN THE EXIT CHANNEL WILL INCREASE ACCORDING TO THE FOLLOWING RELATIONSHIP:

$$Ve = V \quad 0.3\left(\frac{Se}{S}\right)$$

ADAPTED FROM DETAILS PROVIDED BY: NEW YORK STATE DEC ORIGINALLY DEVELOPED BY USDA-NRCS VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION	DESIGN DATA FOR EARTH SPILLWAYS

Figure 5.23a Design Data for Earth Spillways

Part 5 - Vegetated Spillway Design Data

Discharge Q CFS	Slope Range		Bottom Width Feet	Stage Feet
	Minimum Percent	Maximum Percent		
15	3.3	12.2	8	.83
	3.5	16.2	12	.69
20	3.1	8.9	8	.97
	3.2	13.0	12	.81
	3.3	17.3	16	.70
25	2.9	7.1	8	1.09
	3.2	9.9	12	.91
	3.3	13.2	16	.79
	3.3	17.2	20	.70
30	2.9	6.0	8	1.20
	3.0	8.2	12	1.01
	3.0	10.7	16	.88
	3.3	13.8	20	.78
35	2.8	5.1	8	1.30
	2.9	6.9	12	1.10
	3.1	9.0	16	.94
	3.1	11.3	20	.85
	3.2	14.1	24	.77
40	2.7	4.5	8	1.40
	2.9	6.0	12	1.18
	2.9	7.6	16	1.03
	3.1	9.7	20	.91
	3.1	11.9	24	.83
45	2.6	4.1	8	1.49
	2.8	5.3	12	1.25
	2.9	6.7	16	1.09
	3.0	8.4	20	.96
	3.0	10.4	24	.89
50	2.7	3.7	8	1.57
	2.8	4.7	12	1.33
	2.8	6.0	16	1.16
	2.9	7.3	20	1.03
	3.1	9.0	24	.94
60	2.6	3.1	8	1.73
	2.7	3.9	12	1.47
	2.7	4.8	16	1.28
	2.9	5.9	20	1.15
	2.9	7.3	24	1.05
	3.0	8.6	28	.97
70	2.5	2.8	8	1.86
	2.6	3.3	12	1.60
	2.6	4.1	16	1.40
	2.7	5.0	20	1.26
	2.8	6.1	24	1.15
	2.9	7.0	28	1.05
80	2.5	2.9	12	1.72
	2.6	3.6	16	1.51
	2.7	4.3	20	1.35
80	2.8	5.2	24	1.24
	2.8	5.9	28	1.14
	2.9	7.0	32	1.06
90	2.5	2.6	12	1.84
	2.5	3.1	16	1.61
	2.6	3.8	20	1.45
	2.7	4.5	24	1.32
	2.8	5.3	28	1.22
	2.8	6.1	32	1.14
100	2.5	2.8	16	1.71
	2.6	3.3	20	1.54
	2.6	4.0	24	1.41
	2.7	4.8	28	1.30
	2.7	5.3	32	1.21
	2.8	6.1	36	1.13
120	2.5	2.8	20	1.71
	2.6	3.2	24	1.56
	2.7	3.8	28	1.44
	2.7	4.2	32	1.34
	2.7	4.8	36	1.26
140	2.5	2.7	24	1.71
	2.5	3.2	28	1.58
	2.6	3.6	32	1.47
	2.6	4.0	36	1.38
	2.7	4.5	40	1.30
160	2.5	2.7	28	1.70
	2.5	3.1	32	1.58
	2.6	3.4	36	1.49
	2.6	3.8	40	1.40
	2.7	4.3	44	1.33
180	2.4	2.7	32	1.72
	2.4	3.0	36	1.60
	2.5	3.4	40	1.51
	2.6	3.7	44	1.43
200	2.5	2.7	36	1.70
	2.5	2.9	40	1.60
	2.5	3.3	44	1.52
	2.6	3.6	48	1.45
220	2.4	2.6	40	1.70
	2.5	2.9	44	1.61
	2.5	3.2	48	1.53
240	2.5	2.6	44	1.70
	2.5	2.9	48	1.62
	2.6	3.2	52	1.54
260	2.4	2.6	48	1.70
	2.5	2.9	52	1.62
280	2.4	2.6	52	1.70
300	2.5	2.6	56	1.69

Figure 5.23b Design Data for Vegetated Spillways Excavated in Erosion Resistant Soils

Side Slopes of 3 horizontal: 1 vertical (USDA-NRCS)

Part 5 - Vegetated Spillway Design Data

Disoharge Q CFS	Slope Range		Bottom Width Feet	Stage Feet
	Minimum Percent	Maximum Percent		
10	3.5	4.7	8	.68
15	3.4	4.4	12	.69
	3.4	5.9	16	.60
20	3.3	3.3	12	.80
	3.3	4.1	16	.70
	3.5	5.3	20	.62
25	3.3	3.3	16	.79
	3.3	4.0	20	.70
	3.5	4.9	24	.64
30	3.3	3.3	20	.78
	3.3	4.0	24	.71
	3.4	4.7	28	.65
	3.4	5.5	32	.61
35	3.2	3.2	24	.77
	3.3	3.9	28	.71
	3.5	4.6	32	.66
	3.5	5.2	36	.62
40	3.3	3.3	28	.76
	3.4	3.8	32	.71
	3.4	4.4	36	.67
	3.4	5.0	40	.64
45	3.3	3.3	32	.76
	3.4	3.8	36	.71
	3.4	4.3	40	.67
	3.4	4.8	44	.64
50	3.3	3.3	36	.75
	3.3	3.8	40	.71
	3.3	4.3	44	.68
60	3.2	3.2	44	.75
	3.2	3.7	48	.72
70	3.3	3.3	52	.75
80	3.1	3.1	56	.78

Figure 5.23c Design Data for Vegetated Spillways Excavated in Very Erodible Soils

Side Slopes of 3 horizontal: 1 vertical (USDA-NRCS)

Part 5 - Procedure for Determining or Altering Sediment Basin Shape

As specified in the Standard and Specification, the pool area at the elevation of the crest of the principal spillway shall have a length to width ratio of at least 2.0 to 1. The purpose of this requirement is to minimize the "short circuiting" effect of the sediment laden inflow to the riser and thereby increase the effectiveness of the sediment basin. The purpose of this procedure is to prescribe the parameters, procedures, and methods of determining and modifying the shape of the basin.

The length of the flow path (L) is the distance from the point of inflow to the riser (outflow point). The point of inflow is the point that the stream enters the normal pool (pool level at the riser crest elevation). The pool area (A) is the area of the normal pool. The effective width (W_e) is found by the equation:

$$W_e = A/L \text{ and L:W ratio} = L/W_e$$

In the event there is more than one inflow point, any inflow point that conveys more than 30 percent of the total peak inflow rate shall meet the length to width ratio criteria.

The required basin shape may be obtained by proper site selection by excavation or by constructing a baffle in the basin. The purpose of the baffle is to increase the effective flow length from the inflow point to the riser. Baffles (see Figure 5.24 on following page) shall be placed midway between the inflow point around the end of the baffle to the outflow point.

Then:

$$W_e = A/L_e \text{ and L:W ratio} = L_e/W_e$$

Three examples are shown on the following page. Note that for the special case in example C the water is allowed to go around both ends of the baffle and the effective length, $L_e = L_1 + L_2$. Otherwise, the length to width ratio computations are the same as shown above. This special case procedure for computing Le is allowable only when the two flow paths are equal, i.e., when $L_1 = L_2$.

Part 5 - Sediment Basin Baffle

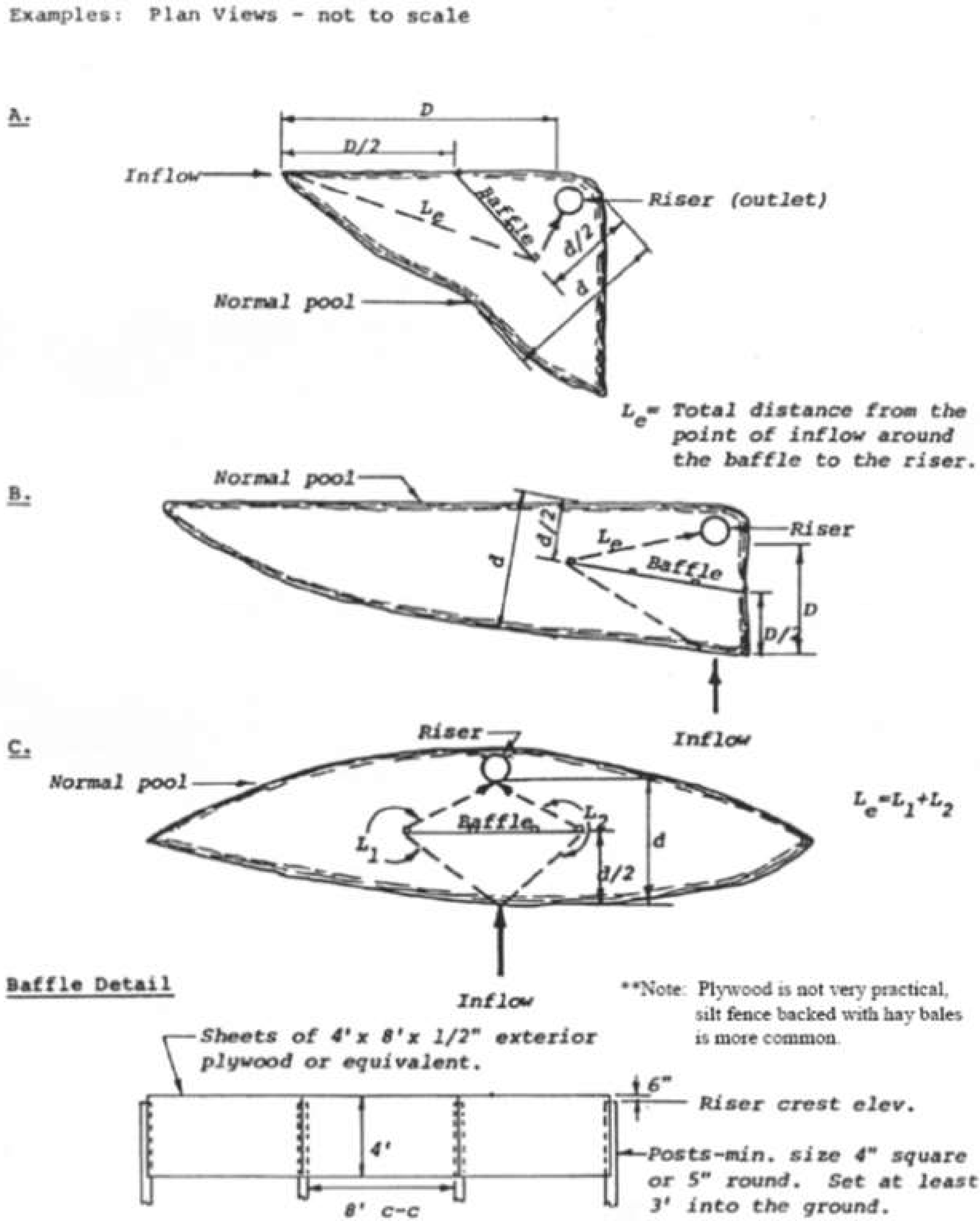


Figure 5.24 Sediment Basin Baffle Details (USDA-NRCS)