

XVI. ENVIRONMENTAL PROTECTION

The purpose of this section is to provide the Contractor with specific guidelines pertaining to protection of the environment during the construction of this project. The intent is to reduce soil erosion, siltation, air pollution, water pollution and noise to their lowest reasonably achievable levels. The Contractor shall fully comply with the provisions of this section, with any provisions pertaining to Environmental Protection contained in the Special Provisions Section of this document and with the specific erosion/siltation control devices and requirements shown on the construction plans. In the event of conflicting specifications, the more restrictive shall apply.

A. TREES:

1. City Ordinance 722, Chapter 22, is quoted as follows:

"Any person desiring for any lawful purpose to remove, destroy, cut, severely prune (including the root system), or treat with a view to its preservation from disease or insects, any tree or shrub in or upon any public street or public property owned (or maintained) by the City of Charlotte, its agencies, boards, authorities, and commissions, shall first obtain a written permit (from the City Arborist) hereinafter provided for, on forms furnished by the City Landscaping Division. Any work performed under such permit must be done in strict accordance with the conditions of the permit and the provisions of this chapter."

The violation of any provision of Chapter 22 shall constitute a misdemeanor as provided by G.S. 14-4 and Section 1-6 of the City Code.

The above ordinance shall cover all trees encountered throughout this project. The requirement for a permit shall not apply to trees located within sanitary sewer or water main rights-of-way or temporary construction easements crossing private properties. The Contractor shall, however, conduct his operations in a manner to prevent limb, bark, or root injuries to trees, shrubs, or other types of vegetation that are to remain growing and also to prevent damage on adjacent property. When any such injuries unavoidably occur, all rough or scarred areas shall first be made reasonably smooth in accordance with generally accepted horticultural practices and the scars then thoroughly covered with an asphaltum base tree paint. Any trees or shrubs that are damaged, by any work pursuant to this contract, to such an extent as to destroy their value for shade or other landscape purposes, shall be reported to the owner (when the tree or shrub is off the right-of-way), the City Arborist, and the Construction Engineer for their cumulative decision as to the action that must be taken.

The Contractor will note that selective clearing operations may be required within public rights-of-way and temporary construction easements. Unless otherwise specified, all trees totally within permanent sewer or water rights-of-way will be

cleared. This may require the Contractor to implement care and caution when working in the vicinity of trees which are to remain and may further necessitate the use of guy wires or tie downs to hold small (less than 6" in diameter) or valuable trees in place during and after construction until such time as the root system re-establishes itself. Badly damaged roots shall be pruned back to healthy tissue, treated and trenches backfilled as soon as possible. Trees should be pruned sufficiently to balance the remaining roots and the wounds treated. If, for example, one-fourth of the feeding roots have been destroyed, the leaf surface shall also be reduced at least one-fourth without topping or improper pruning.

Valuable trees shall be provided with suitable protective devices or barriers placed in such a manner as to prevent mechanical injuries. Figures 1 and 2 below are examples of approved protective devices. The Contractor shall also do all that is reasonably possible to prevent consolidation and puddling of the soil over root systems of trees to be left in place.

2. **Trenching Around Trees:** When a trench is excavated within the drip area of a tree, the following procedures will be required as a minimum. Additional measures may be required by the property owner or the City Arborist and such requirements will be included as Special Provisions.
 - a. All roots that must be cut shall be cut cleanly.
 - b. Roots more than one inch (1") in diameter shall be treated with an approved wound dressing compound made specifically for that purpose and approved by the Engineer.
 - c. The trench must be backfilled as soon as possible. Roots shall not be exposed to air for extended periods and air pockets shall not be left in the backfill.
 - d. If the trench must be left open (e.g. at manhole locations), the roots shall be kept moist with wet burlap or peat moss.
 - e. The leaf surface of the tree shall be pruned back as directed by the Engineer or City Arborist, an amount proportional to the root loss.
 - f. Designated trees shall be fed with Davey Tree Company "Arboregreen" fertilizer or approved equal. The method of application and amount used shall be as recommended by the fertilizer manufacturer.

B. AIR POLLUTION

1. **Open Burning:** Open burning of materials resulting from any land clearing associated with this project or of any discarded construction materials or by-products is strictly prohibited. The single exception is that diseased trees may be burned provided that a permit is secured from the Air Quality Section,

Mecklenburg County Environmental Health Department.

2. **Dust Control:** The Contractor shall control dust throughout the life of the project within the project area and at all other areas affected by the construction. This includes, but is not specifically limited to, paved and unpaved roads, haul roads, access roads, disposal sites, borrow pits and material and equipment storage sites. Dust control measures may include but are not limited to wetting down disturbed earth surfaces or eliminating traffic across them, removing accumulations of dirt from paved areas by hand or mechanical means and washing streets at the end of the work day. Such dust control measures shall be taken when required by the Engineer or the controlling agency for streets and roadways. When the Contractor is required to wash dust or mud from paved streets, he shall provide adequate silt check barriers at storm drain inlets and/or discharge points emptying into or leading to a natural watercourse. At storm drain inlets or catch basins, excavated drop inlet protection (Erosion Control Detail 6.50) or Fabric Drop Inlet Protection (Erosion Control Detail 6.51) shall be constructed provided such construction does not impede traffic or create a hazard. Temporary Sediment Traps (Erosion Control Detail 6.60) or Check Dams (Erosion Control detail 6.83) shall be placed at storm drain or roadway ditch outlets as required to contain siltation within the roadway limits. Normally, these devices will be kept in place for the duration of the project or until the Engineer directed their removal. Where such devices would impede traffic or create a hazard, temporary protection during street washing operations will be provided by lining storm inlets with burlap bags filled with #67 washed stone. The burlap bags and all accumulated silt shall be removed immediately following street washing.

C. NOISE CONTROL

The Contractor shall keep the noise level on this project to the lowest level that is reasonable achievable through the use of proper mufflers on motorized equipment and through conduct of operations in a manner that minimizes noise. Further, work in populated areas may be restricted or prohibited during certain evening, weekend or holiday hours if required in the Special Provisions Section of this document. When working within the Charlotte City Limits, the Contractor is responsible for compliance with the City Noise Ordinance, Charlotte City Ordinance #1401.

D. WATER POLLUTION

The Contractor shall exercise every reasonable precaution throughout the life of the project to prevent pollution of rivers, streams and water impoundments. Pollutants such as chemicals, fuels, lubricants, bitumens, concretes, grouts, raw sewage or any other harmful waste shall not be discharged into or alongside of any watercourse or impoundment or into any channel leading thereto.

E. EROSION AND SILTATION CONTROL

The North Carolina Sedimentation Pollution Control Action of 1973 requires that all visible sediment be contained within the boundaries of a construction site, that cut and fill slopes be vegetated or otherwise stabilized within 30 working days and that all soil surfaces be stabilized and non erosive within 30 working days or 120 calendar days following completion of the ground disturbing activity, whichever period is shorter. For purposes of this specification, the construction site is defined as the permanent rights-of-way and temporary construction easements, access roads and public maintained road rights-of-way, as shown on the construction plans.

The Contractor shall exercise every reasonable precaution, throughout the life of the project, to contain all siltation within these boundaries and to prevent the eroding of soil and the silting of streams, lakes, reservoirs, other water impoundments, roadway surfaces, or other property. The erosion/siltation control measures for this project as stated in these specifications and/or as shown on the construction plans, have been approved by the North Carolina Department of Environment, Health And Natural Resources. The project is subject to periodic inspection by that Department during construction.

The erosion/siltation control measures shown on the construction plans and/or required by field conditions at the time of construction shall be installed concurrently with the clearing and grubbing operation and/or before any land disturbing activity in the drainage area within which they are located. They shall be maintained in proper working order until permanent ground cover is re-established and the Engineer directs their removal. Where cleared rights-of-way will be left more than 30 working days prior to actual construction, temporary ground cover will be established on all disturbed areas except an area along the center line as required for construction traffic. Temporary ground cover will consist of seeding, mulching and fertilizing as specified in the DS Section of these specifications. Particular attention will be given to prompt establishment of temporary ground cover along cut and fill slopes.

Once construction has begun, the Contractor will be required to keep site restoration and permanent seeding, fertilizing and mulching up with the land disturbing activity as closely as practical. No area of any project will be allowed to remain devoid of ground cover longer than 30 working days except as required for actual construction activity. Jute netting or stone rip-rap (Standard Detail #29) shall be placed as shown on the construction plans or as directed by the Engineer to stabilize the soil in areas with steep slopes and/or high velocity runoff. During construction, the Contractor shall make every effort to place excavated material on the side of the trench away from natural watercourses or impoundments and shall maintain erosion/siltation devices as necessary to prevent silt from escaping the site in the event of rainfall prior to backfill and restoration.

Fording of active streams with construction equipment will not be permitted. Temporary crossings shall be constructed using pipe or pipes of sufficient capacity to carry normal flow and placed in such a manner as to disrupt the natural flow as little as possible. Both faces of such crossings shall be covered with rock rip-rap. Spillways will be constructed to carry the flow from a 2-year storm. See Erosion

Control Detail #1 for construction details. Temporary crossings will be left in place only for the period of time they are needed for construction activities. They will be maintained in proper working order while in place and will be removed completely when no longer needed.

When shown on the construction plans or directed by the Engineer, temporary sediment traps conforming to Erosion Control Detail 6.60 shall be placed on each side of a creek before a temporary construction crossing or a pipe line crossing is made. Sediment traps shall be placed so that all runoff crossing the disturbed land area and entering the creek near the crossing is filtered through them. Where necessary, diversion ditches will be cut, or berms constructed, within the assigned right-of-way, to divert runoff to the silt basins. In addition to these basins, sediment fences (Erosion Control Detail 6.62) may be required to filter the runoff.

When the pipeline crosses the watercourse itself, the Contractor shall expedite his construction through the critical area (where potential erosion is obvious), thus limiting exposure time to potential erosion and sedimentation. After the pipeline crossing is completed and the creek banks are restored to the specified slope, the Contractor will either install rock rip-rap, or jute netting and vegetative cover as directed by the Engineer. Sediment fences may be required at the top of both creek banks to prevent surface water from eroding a creek bank face or silting the channel while vegetative cover is being restored.

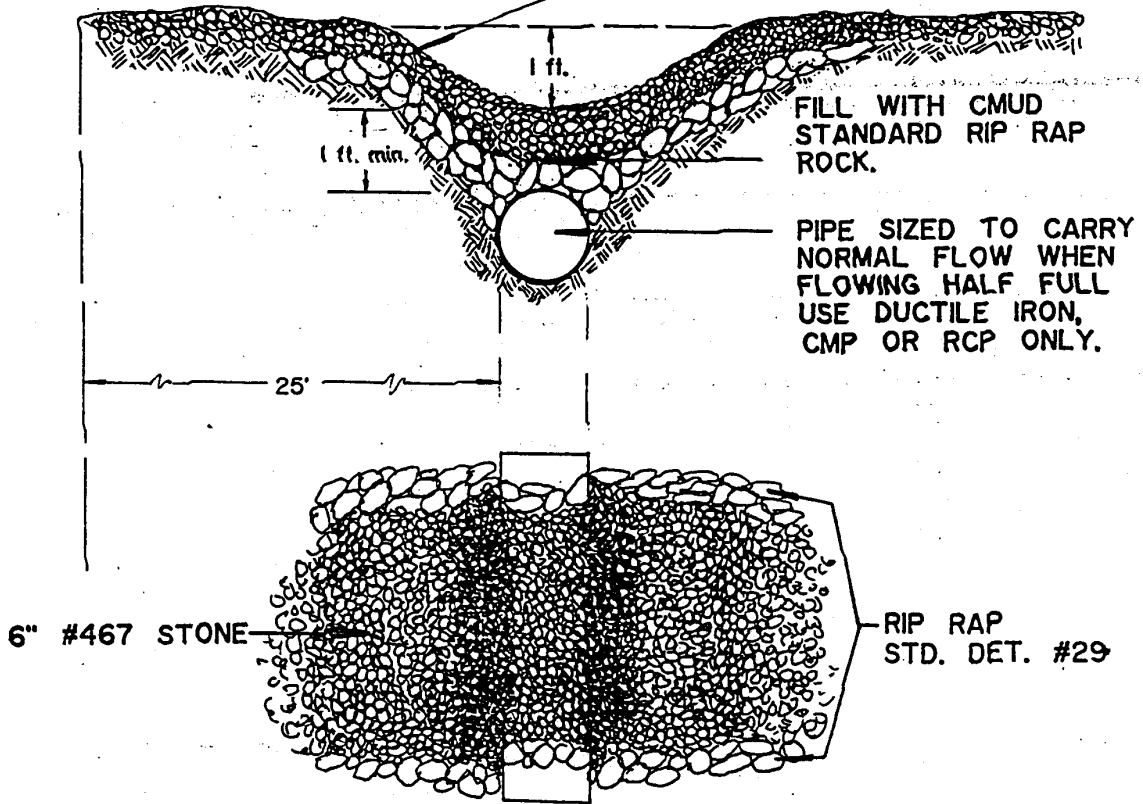
Before crossing wet-weather or drainage ditches, the Contractor shall construct temporary sediment traps conforming to Erosion Control Detail 6.60 or check dams conforming to Erosion Control Detail 6.83. These devices shall be located downstream from the crossing as directed by the Engineer. When working along existing roadways, the Contractor will place check dams conforming to Erosion Control Detail 6.83 in the roadway ditches and at ditch turnouts to prevent erosion of the ditches and the siltation of watercourses and/or adjacent property.

Borrow and/or spoil areas, either at the project site or at any location used by the Contractor (and approved by the Engineer), shall be subject to all erosion control requirements contained herein and to periodic inspection. Excavated soils either at the site or at borrow areas will be piled in such a manner and sufficient precautions taken to prevent erosion and runoff causing sediment to be carried away from the disturbed area.

Failure of the Contractor to comply with any of the preceding requirements will result in the Contractor receiving formal notification to initiate such measures. If compliance is not forthcoming within 48 hours of receipt of same, the Engineer will suspend all work and pursuant to the North Carolina Sedimentation Pollution Control Act of 1983 (GS 113A-54), report the violation to the North Carolina Sedimentation Control Commission for legal disposition.

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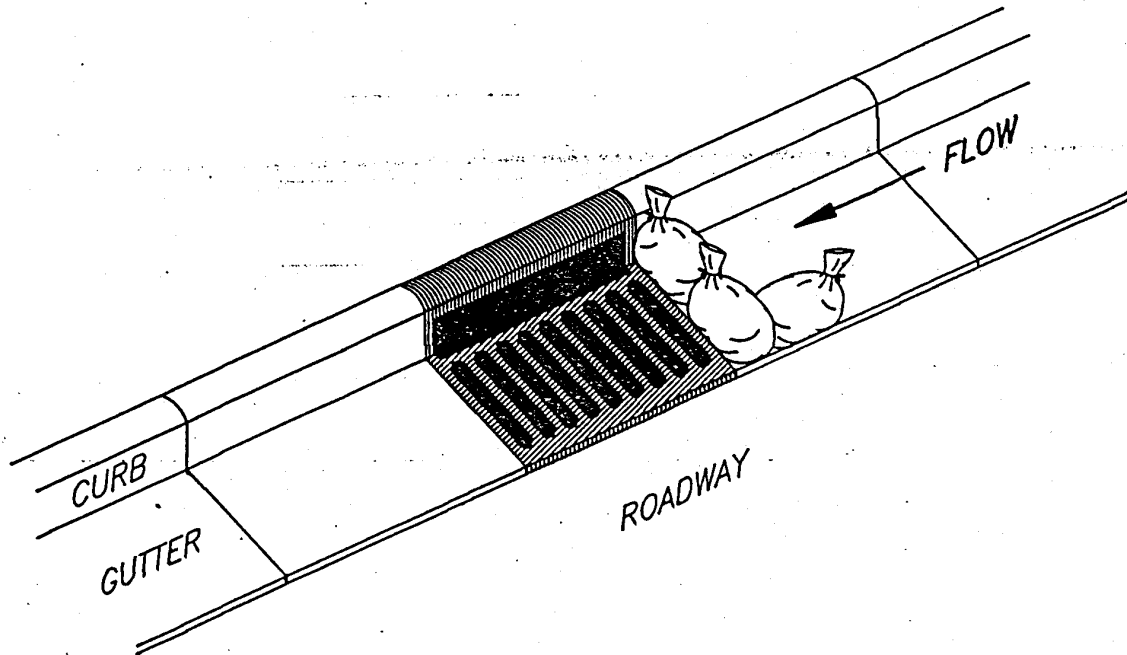
#467 COARSE AGGREGATE 6" DEEP.
EXTEND 25' EACH SIDE OF BANKS.



NOTES:

1. SLOPE APPROACHES TO CROSSING 2:1 OR FLATTER.
2. SPILLWAY LENGTH = BANK TO BANK WIDTH OF STREAM OR AS SHOWN ON PLANS.
3. PIPE TO EXTEND COMPLETELY ACROSS PERMANENT RIGHT OF WAY AND 1 ft BEYOND LIMITS OF RIP RAP.
4. CROSSING TO BE REMOVED UPON COMPLETION OF CONSTRUCTION. RIP RAP STONE TO BE USED TO RIP RAP BANKS.

CHARLOTTE-MECKLENBURG UTILITY DEPARTMENT ENGINEERING DIVISION CHARLOTTE, NORTH CAROLINA			
Job No.	File No.	STANDARD DETAIL EROSION CONTROL	
Scale:	NONE		
PLAN	NONE	TEMPORARY STREAM CROSSING	
PROFILE	NONE		
As Built	Date	OLD	WOC
Drawn By	Designed By	Drawn By	Project Eng.
		Approved By	Date
			Sheet 1 of 1



STONE FILLED BURLAP BAGS

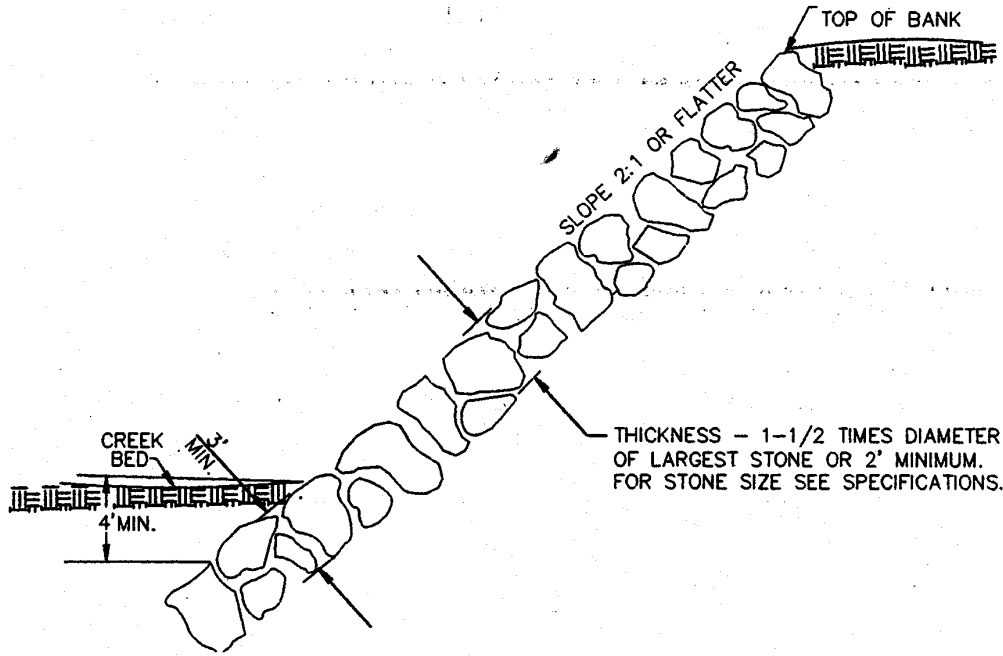
ALL STONE SHALL BE ANGULAR, CLEAN WASHED CRUSHED STONE GRADED IN ACCORDANCE WITH STANDARD SIZES #467 OR #357 IN ASTM D448 FOR "STANDARD SIZES FOR COARSE AGGREGATE".

BAGS SHALL BE MADE OF BURLAP WEIGHING AT LEAST 9 OUNCES PER SQUARE YARD OR NCF-120 FABRIC (MANUFACTURED BY ONSITE SYSTEMS INC.) OR AN APPROVED EQUAL AND SHALL HAVE DIMENSIONS OF 12" Lx6" Wx6" D WHEN FULL.

FOR DUAL DIRECTIONAL FLOW, BAGS SHALL BE PLACED ON BOTH SIDES OF CATCH BASIN IN THE SAME MANNER AS SHOWN ABOVE.

CHARLOTTE-MECKLENBURG UTILITY DEPARTMENT ENGINEERING DIVISION CHARLOTTE, NORTH CAROLINA				
Job No. _____ File No. _____ Scale: <u>NONE</u>		STANDARD DETAIL EROSION CONTROL		
PLAN PROFILE Max. _____ Vert. _____				
As Built _____ Date _____		STONE FILLED BURLAP BAGS		
No. 1 Date: _____ By: _____ Position: _____	Drawn By: <u>KJS</u> Checked By: _____	Design: <u>RMB</u> Project-Eng: <u>W.D.C.</u>	Approved By: <u>RCW</u> Date: <u>5/91</u>	Sheet <u>2</u> of _____

DUNCAN-PARNELL, INC., CHARLOTTE 482 784-3333 FAX

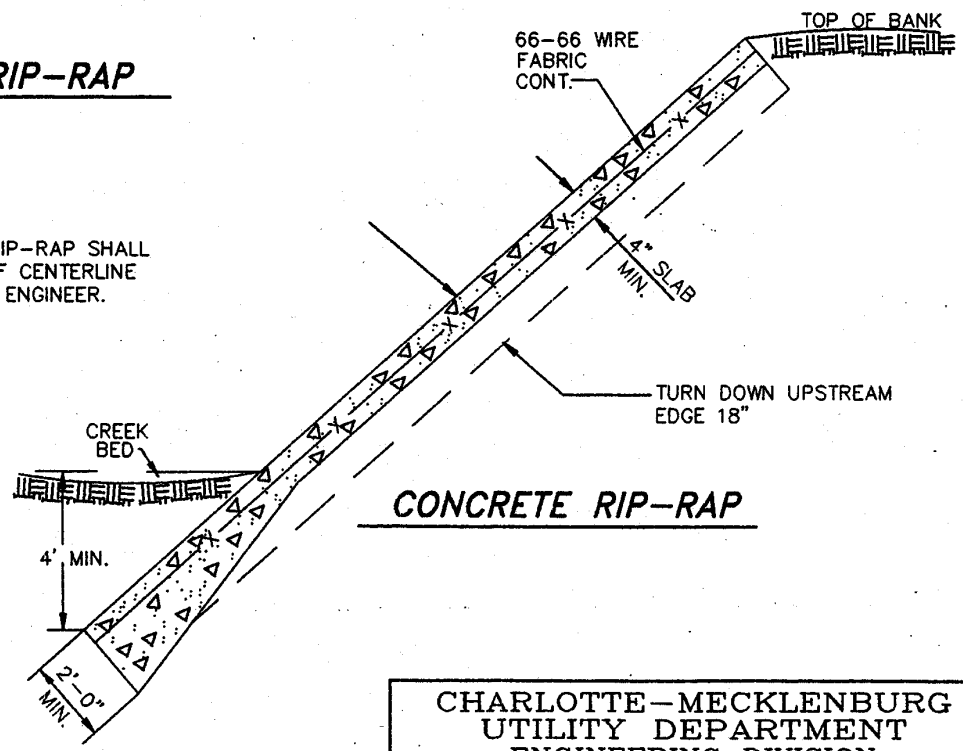


THICKNESS - 1-1/2 TIMES DIAMETER OF LARGEST STONE OR 2' MINIMUM. FOR STONE SIZE SEE SPECIFICATIONS.

STONE RIP-RAP

NOTE:

MINIMUM WIDTH OF RIP-RAP SHALL BE 10' EACH SIDE OF CENTERLINE OR AS DIRECTED BY ENGINEER.



CONCRETE RIP-RAP

CHARLOTTE-MECKLENBURG
UTILITY DEPARTMENT
ENGINEERING DIVISION
CHARLOTTE, NORTH CAROLINA

Job No. _____	File No. _____
PLAN Scales _____	NTS
PROFILE Hor. _____	Vert. _____
As Built _____	Date _____
Surveyed By _____	Designed By _____

**STANDARD DETAIL
EROSION CONTROL**

**STONE & CONCRETE
RIP-RAP**

Drawn By _____	Project-Engr _____	Approved By _____	Date _____	Sheet 3 Of _____
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No.	Date	By	Revision

TREE PROTECTION - BARRIERS

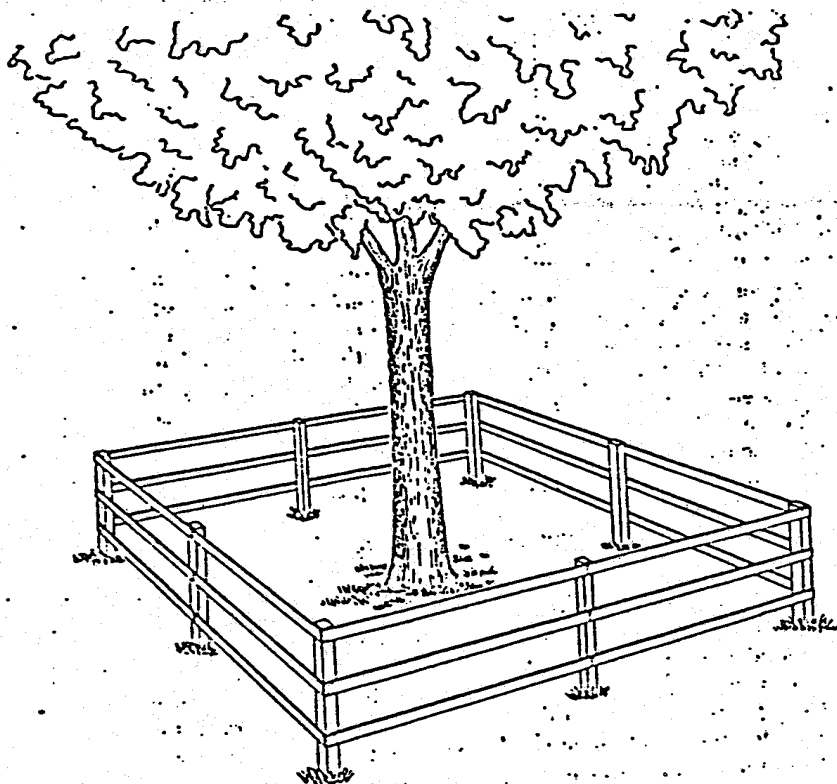
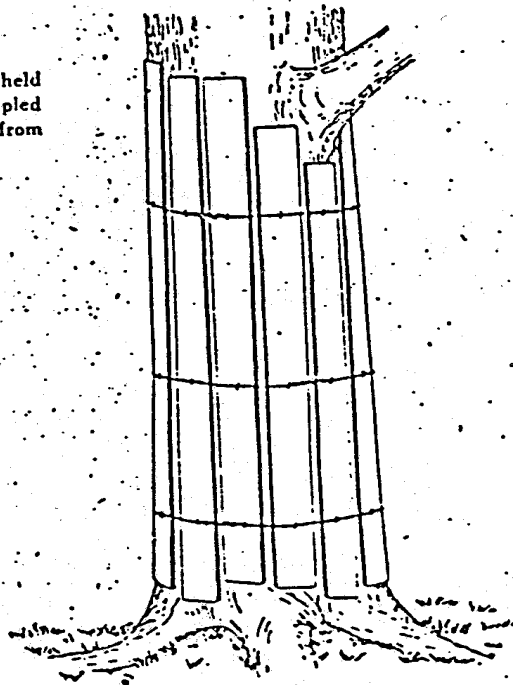


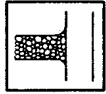
FIGURE 1.—A simple barrier to protect the tree trunk and part of the root system from mechanical injury.

FIGURE 2.—Planks or split poles held firmly against a tree trunk by stapled wires or rope will protect bark from much mechanical injury.



6.06

TEMPORARY GRAVEL CONSTRUCTION ENTRANCE/EXIT



Definition A graveled area or pad located at points where vehicles enter and leave a construction site.

Purpose To provide a buffer area where vehicles can drop their mud and sediment to avoid transporting it onto public roads, to control erosion from surface runoff, and to help control dust.

Conditions Where Practice Applies Wherever traffic will be leaving a construction site and moving directly onto a public road or other paved off-site area. Construction plans should limit traffic to properly constructed entrances.

Design Criteria Aggregate Size—Use 2-3 inch washed stone.

Dimensions of gravel pad—

Thickness: 6 inches minimum

Width: 12-ft minimum or full width at all points of the vehicular entrance and exit area, whichever is greater

Length: 50-ft minimum

Location—Locate construction entrances and exists to limit sediment from leaving the site and to provide for maximum utility by all construction vehicles (Figure 6.06a). Avoid steep grades and entrances at curves in public roads.

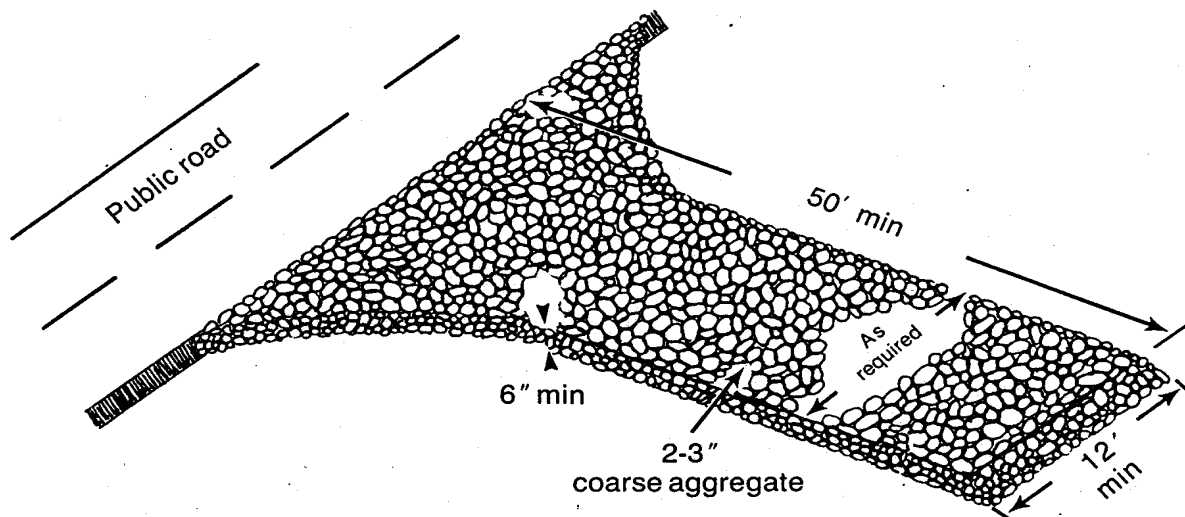


Figure 6.06a Gravel entrance/exit keeps sediment from leaving the construction site (modified from Va SWCC).

Washing—If conditions at the site are such that most of the mud and sediment are not removed by vehicles traveling over the gravel, the tires should be washed. Washing should be done on an area stabilized with crushed stone that drains into a sediment trap or other suitable disposal area. A wash rack may also be used to make washing more convenient and effective.

Construction Specifications

1. Clear the entrance and exit area of all vegetation, roots, and other objectionable material and properly grade it.
2. Place the gravel to the specific grade and dimensions shown on the plans, and smooth it.
3. Provide drainage to carry water to a sediment trap or other suitable outlet.
4. Use geotextile fabrics because they improve stability of the foundation in locations subject to seepage or high water table.

Maintenance

Maintain the gravel pad in a condition to prevent mud or sediment from leaving the construction site. This may require periodic topdressing with 2-inch stone. After each rainfall, inspect any structure used to trap sediment and clean it out as necessary. Immediately remove all objectionable materials spilled, washed, or tracked onto public roadways.

References

Runoff Conveyance Measures
6.30, Grass-lined Channels

Sediment Traps and Barriers
6.60, Temporary Sediment Trap

6.20

→ TD →

TEMPORARY DIVERSIONS

Definition A temporary ridge or excavated channel or combination ridge and channel constructed across sloping land on a predetermined grade.

Purpose To protect work areas from upslope runoff and to divert sediment-laden water to appropriate traps or stable outlets.

Conditions Where Practice Applies This practice applies to construction areas where runoff can be diverted and disposed of properly to control erosion, sedimentation, or flood damage. Specific locations and conditions include:

- above disturbed existing slopes, and above cut or fill slopes to prevent runoff over the slope;
- across unprotected slopes, as slope breaks, to reduce slope length;
- below slopes to divert excess runoff to stabilized outlets;
- where needed to divert sediment-laden water to sediment traps;
- at or near the perimeter of the construction area to keep sediment from leaving the site;
- above disturbed areas before stabilization to prevent erosion and maintain acceptable working conditions.
- Temporary diversions may also serve as sediment traps when the site has been overexcavated on a flat grade; they may also be used in conjunction with a sediment fence.

Planning Considerations

It is important that diversions are properly designed, constructed and maintained since they concentrate water flow and increase erosion potential (Figure 6.20a). Particular care must be taken in planning diversion grades. Too much slope can result in erosive velocity in the diversion 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 diversions.

Sufficient area must be available to construct and properly maintain diversions. It is usually less costly to excavate a channel and form a ridge or dike on the

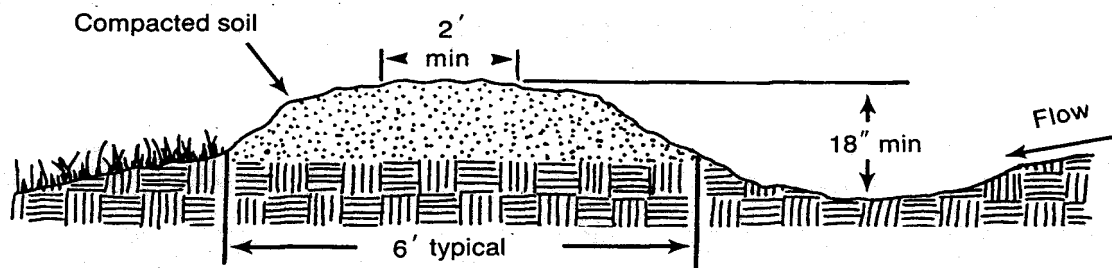


Figure 6.20a Temporary earthen diversion dike.

6.20.1

downhill side with the spoil than to build diversions by other methods. Where space is limited, it may be necessary to build the ridge by hauling in diking material or using a silt fence to divert the flow. Use gravel to form the diversion dike where vehicles must cross frequently (Figure 6.20b).

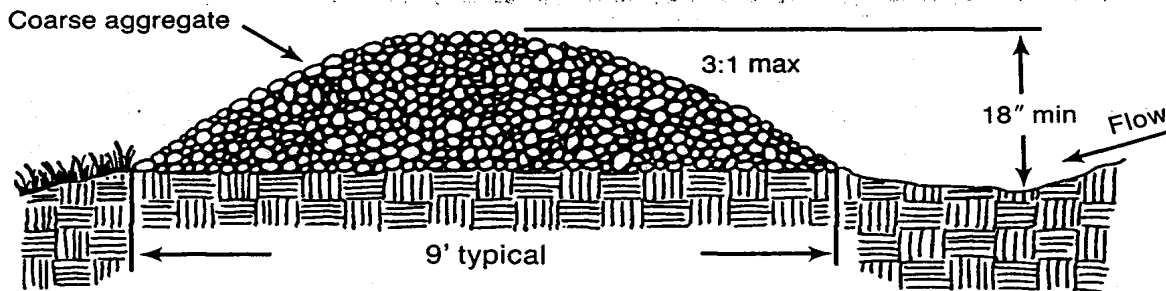


Figure 6.20b Temporary gravel diversion dike for vehicle crossing (modified from Va SWCC).

Plan temporary diversions to function 1 year or more, or they may be constructed anew at the end of each day's grading operation to protect new fill. Diversions that are to serve longer than 30 working days should be seeded and mulched as soon as they are constructed to preserve dike height and reduce maintenance.

Where design velocities exceed 2 ft/sec, a channel liner is usually necessary to prevent erosion (Table 8.05a, Appendix 8.05).

Temporary diversions may serve as in-place sediment traps if overexcavated 1 to 2 ft and placed on a nearly flat grade. The dike serves to divert water as the stage increases. A combination silt fence and channel in which fill from the channel is used to stabilize the fence can trap sediment and divert runoff simultaneously.

Wherever feasible, build and stabilize diversions and outlets before initiating other land-disturbing activities.

Design Criteria

Drainage areas—5 acres or less.

Capacity—peak runoff from 10-year storm.

Velocity—See Table 8.05a, Permissible Velocities for Erosion Protection, Appendix 8.05.

Ridge design—

side slope:	2:1 or flatter
	3:1 or flatter at points where vehicles cross
top width:	2 ft minimum
freeboard:	0.3 ft minimum
settlement:	10% of total fill height minimum

Channel design— shape: parabolic, trapezoidal, or V-shaped
side slope: 2:1 or flatter
3:1 or flatter where vehicles cross

Grades—Either a uniform or a gradually increasing grade is preferred. Sudden decreases in grade accumulate sediment and should be expected to cause overtopping. A large increase in grade may erode.

Outlet—Design the outlet to accept flow from the diversion plus any other contributing areas. Divert sediment-laden runoff and release through a sediment-trapping device (Practice 6.60, *Temporary Sediment Trap* and Practice 6.61, *Sediment Basin*). Flow from undisturbed areas can be dispersed by a level spreader (Practice 6.40, *Level Spreader*).

Small diversions—Where the diversion channel grade is between 0.2 and 3%, a permanent vegetative cover is required. A parabolic channel and ridge 1.5 ft deep and 12 ft wide may be used for diversions with flows up to 5 cfs. This depth does not include freeboard or settlement. Side slopes should be 3:1 or flatter and the top of the dike must be at least 2 ft wide.

Construction Specifications

1. Remove and properly dispose of all trees, brush, stumps, and other objectionable material.
2. Ensure that the minimum constructed cross section meets all design requirements.
3. Ensure that the top of the dike is not lower at any point than the design elevation plus the specified settlement.
4. Provide sufficient room around diversions to permit machine regrading and cleanout.
5. Vegetate the ridge immediately after construction, unless it will remain in place less than 30 working days.

Maintenance

Inspect temporary diversions once a week and after every rainfall. Immediately remove sediment from the flow area and repair the diversion ridge. Carefully check outlets and make timely repairs as needed. When the area protected is permanently stabilized, remove the ridge and the channel to blend with the natural ground level and appropriately stabilize it.

References

Surface Stabilization

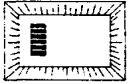
- 6.10, Temporary Seeding
- 6.11, Permanent Seeding
- 6.14, Mulching

Outlet Protection

- 6.40, Level Spreader
- 6.41, Outlet Stabilization Structure

6.50

EXCAVATED DROP INLET PROTECTION (Temporary)



Definition An excavated area in the approach to a storm drain drop inlet or curb inlet.

Purpose To trap sediment at the approach to the storm drainage systems. This practice allows use of permanent stormwater conveyance at an early stage of site development.

Conditions Where Practice Applies Where storm drain drop inlets are to be made operational before permanent stabilization of the disturbed drainage area. This method of inlet protection is applicable where relatively heavy flows are expected and overflow capability is needed (Figure 6.50a). Frequent maintenance is required and temporary flooding in the excavated area will occur. This practice can be used in combination with other temporary inlet protection devices such as Practice 6.51, *Fabric Drop Inlet Protection* and Practice 6.52, *Block and Gravel Inlet Protection*.

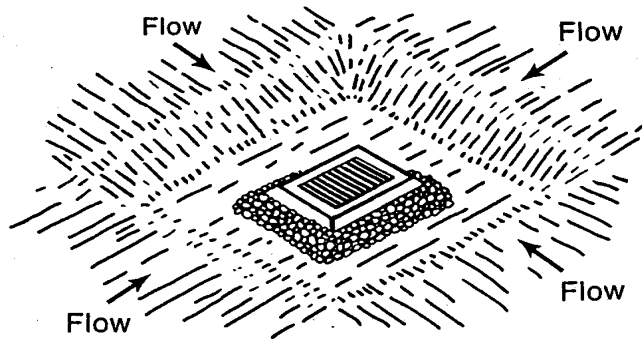
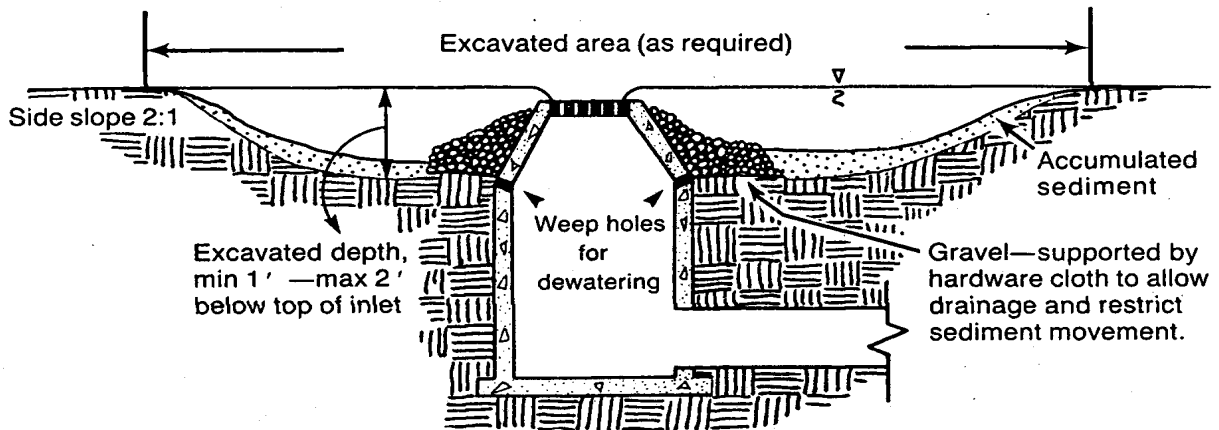


Figure 6.50a Excavated drop inlet protection.

6.50.1

6.51

FABRIC DROP INLET PROTECTION (Temporary)



Definition A temporary fabric barrier placed around a drop inlet.

Purpose To help prevent sediment from entering storm drains during construction operations. This practice allows early use of the storm drain system.

Conditions Where Practice Applies Where storm drain inlets are to be made operational before permanent stabilization of the disturbed drainage area. This method of inlet protection is effective where the inlet drains a small, nearly level area with slopes generally less than 5% and where shallow sheet flows are expected. The immediate land area around the inlet should be relatively flat (less than 1%) and located so that accumulated sediment can be easily removed.

This practice must not be used near the edge of fill material and must not divert water over cut or fill slopes.

Design Criteria Ensure that drainage areas do not exceed 1 acre per inlet.

Keep the maximum height of fabric above the crest of the drop inlet at 1.5 ft. This height allows a shallow temporary desilting pool to form behind the fabric but limits the pressure against the fabric if overtopping occurs. The selected height of the top of the barrier should allow overflow into the drop inlet and not let overflow bypass the inlet to unprotected lower areas.

For fabric barriers, use stakes with a minimum length of 3 ft, and space them a maximum of 3 ft apart, and securely drive them into the ground.

Drive the stakes close to the drop inlet so that overflow will fall directly into the structure and not on unprotected soil.

To attach the fabric, make a frame around the stakes a maximum of 1.5 ft above the top of the drop inlet. This will serve as a stable crest for overflow during rainfall.

Ensure that both fabric and supporting stakes are sufficiently strong to hold a 1.5 ft head of water without failure (Figure 6.51a).

Improved performance and sediment storage volume can be obtained by excavating the area (Practice 6.50, *Excavated Drop Inlet Protection*).

Construction Specifications

1. As synthetic fabric, use a pervious sheet of nylon, polyester, or ethylene yarn—extra strength (50 lb/1 inch minimum)—that contains ultraviolet ray inhibitors and stabilizers. Fabric should be sufficiently porous to provide adequate drainage of the temporary sediment pool. Burlap may be used for short-term applications. It must be replaced every 60 days.

2. Cut fabric from a continuous roll to eliminate joints.

6.51.1

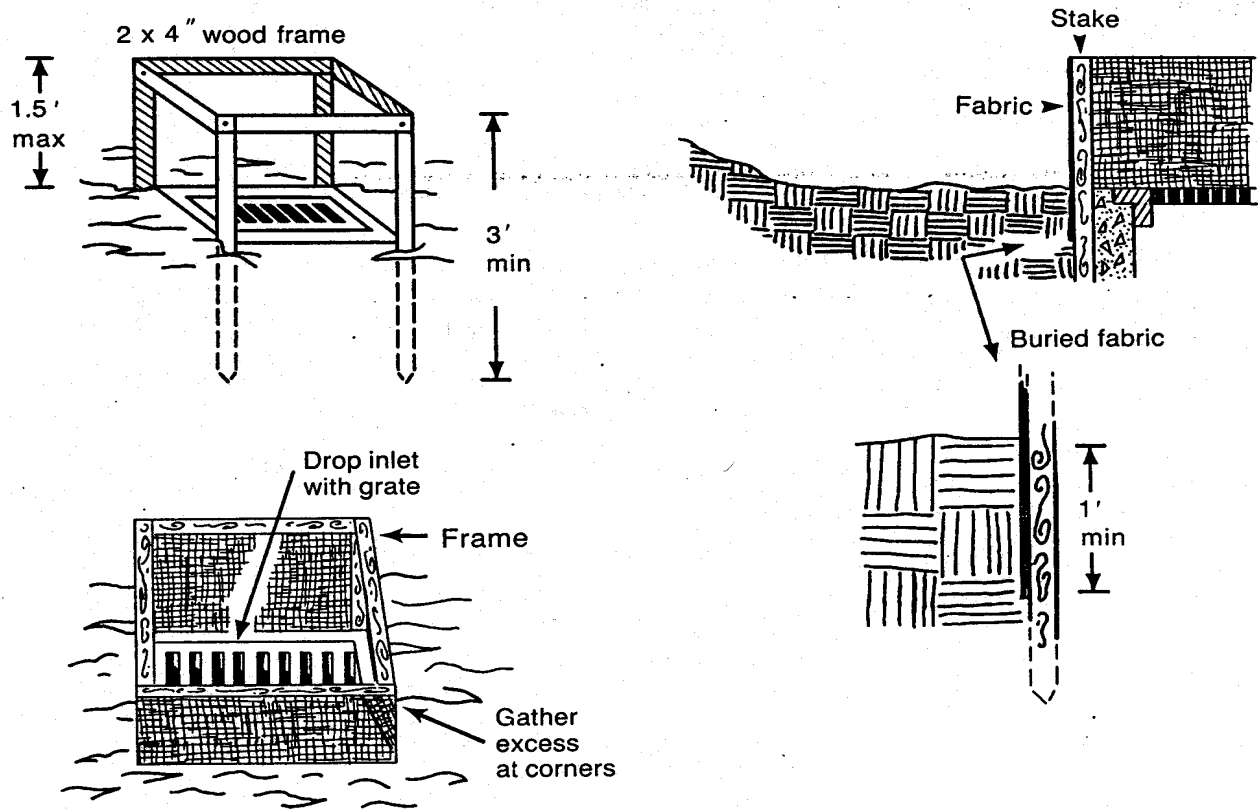


Figure 6.51a Installation of fabric and supporting frame for inlet protection.

3. For stakes, use 2 x 4-inch wood (preferred) or equivalent metal with a minimum length of 3 ft.
4. Space stakes evenly around the perimeter of the inlet a maximum of 3 ft apart, and securely drive them into the ground, approximately 18 inches deep.
5. To provide needed stability to the installation, frame with 2 x 4-inch wood strips around the crest of the overflow area at a maximum of 1.5 ft above the drop inlet crest.
6. Place the bottom 12 inches of the fabric in a trench and backfill the trench with at least 4 inches of crushed stone or 12 inches of compacted soil.
7. Fasten fabric securely to the stakes and frame. Joints must be overlapped to the next stake.
8. The top of the frame and fabric must be well below the ground elevation downslope from the drop inlet to keep runoff from bypassing the inlet. It may be necessary to build a temporary dike on the down slope side of the structure

to prevent bypass flow. Material from within the sediment pool may be used for diking.

Maintenance Inspect the fabric barrier after each rain and make repairs as needed.

Remove sediment from the pool area as necessary to provide adequate storage volume for the next rain. Take care not to damage or undercut the fabric during sediment removal.

When the contributing drainage area has been adequately stabilized, remove all materials and any unstable sediment and dispose of them properly. Bring the disturbed area to the grade of the drop inlet and smooth and compact it. Appropriately stabilize all bare areas around the inlet.

References *Inlet Protection*
6.50, Excavated Drop Inlet Protection (Temporary)
6.52, Block and Gravel Inlet Protection (Temporary)

6.60

TEMPORARY SEDIMENT TRAP



Definition A small, temporary ponding basin formed by an embankment or excavation to capture sediment.

Purpose To detain sediment-laden runoff and trap the sediment to protect receiving streams, lakes, drainage systems, and protect adjacent property.

Conditions Where Practice Applies At the outlets of diversions, channels, slope drains, or other runoff conveyances that discharge sediment-laden water.

Below areas that are 5 acres or less.

Where access can be maintained for sediment removal and proper disposal.

In the approach to a storm water inlet located below a disturbed area as part of an inlet protection system.

Structure life limited to 2 years.

Planning 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. Ensure the drainage areas for each trap does not exceed 5 acres.

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.

In preparing plans for sediment traps, it is important to consider provisions to protect the embankment from failure from storm runoff that exceeds the design capacity. Consider nonerosive emergency bypass areas, particularly if there could be severe consequences from failure. If a bypass is not possible and failure would have severe consequences, consider alternative sites.

Sediment trapping is achieved primarily by settling within a pool formed by an embankment. The sediment pool may also be formed by excavation, or by a combination of excavation and embankment. Sediment-trapping efficiency is a function of surface area and inflow rate (Practice 6.61, *Sediment Basin*). Therefore, maximize the surface area in the design. 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.

Because well-planned sediment traps are key measures to preventing off-site sedimentation, they should be installed in the first stages of project development.

6.60.1

Design Criteria Ensure drainage area for a sedimentation trap does not exceed 5 acres.

Storage capacity—Keep the minimum volume of the sediment trap at 1800 ft³/acre based on disturbed area draining into the basin. Measure volume below the crest elevation of the outlet. The volume of a natural sediment trap may be satisfactorily approximated by the equation:

$$\text{volume (ft}^3\text{)} = 0.4 \times \text{surface area (ft}^2\text{)} \times \text{maximum pool depth (ft)}$$

Trap cleanout—Remove sediment from the trap and restore the capacity to original trap dimensions when sediment has accumulated to one-half the design depth.

Trap efficiency—Keep the surface area at peak flow as large as possible. Research by Barfield and Clar (1985) indicates that use of the following equation will give trap efficiency of 75% for most Coastal Plain and Piedmont soils:

$$\text{surface area at design flow (acres)} = (0.01) \text{ peak inflow rate (cfs)}$$

Embankment—Ensure that embankments for temporary sediment traps do not exceed 5 ft in height measured at the center line from the original ground surface to the top of the embankment. Additional freeboard may be added to the embankment height to allow flow through a designated bypass location. Construct embankments with a minimum top width of 5 ft and side slopes of 2:1 or flatter. Machine compact embankments.

Excavation—Where sediment pools are formed or enlarged by excavation, keep side slopes at 2:1 or flatter for safety.

Outlet section—Construct the sediment trap outlet using a stone section of embankment located at the low point in the basin. The stone section serves two purposes: (1) the top section serves as a nonerosive spillway outlet for flood flows, and (2) the bottom section provides a means of dewatering the basin between runoff events.

Stone size—Construct the outlet using well-graded stones with a d₅₀ size of 9 inches (class B erosion control stone is recommended,) and a maximum stone size of 14 inches. A 1-ft thick layer of 1/2 - 3/4-inch aggregate (N.C. DOT #57 washed stone is recommended) should be placed on the inside face to reduce drainage flow rate.

Side slopes—Keep the side slopes of the spillway section at 2:1 or flatter. To protect the embankment, keep the sides of the spillway at least 21 inches thick.

Depth—Keep the crest of the spillway outlet a minimum of 1.5 ft below the settled top of the embankment.

Protection from piping—Place filter cloth on the foundation below the riprap to prevent piping. An alternative would be to excavate a keyway trench across the riprap foundation and up the sides to the height of the dam.

Weir length and depth—Keep the spillway weir at least 4 ft long and sized to pass the peak discharge of the 10-yr storm (Figure 6.60a). A maximum flow depth of 1 ft, a minimum freeboard of 0.5 ft, and maximum side slopes of 2:1 are recommended. Weir length may be selected from Table 6.60a shown for most site locations in North Carolina.

**Table 6.60a
Design of Spillways**

Drainage Area (acres)	Weir Length ¹ (ft)
1	4.0
2	6.0
3	8.0
4	10.0
5	12.0

¹Dimensions shown are minimum

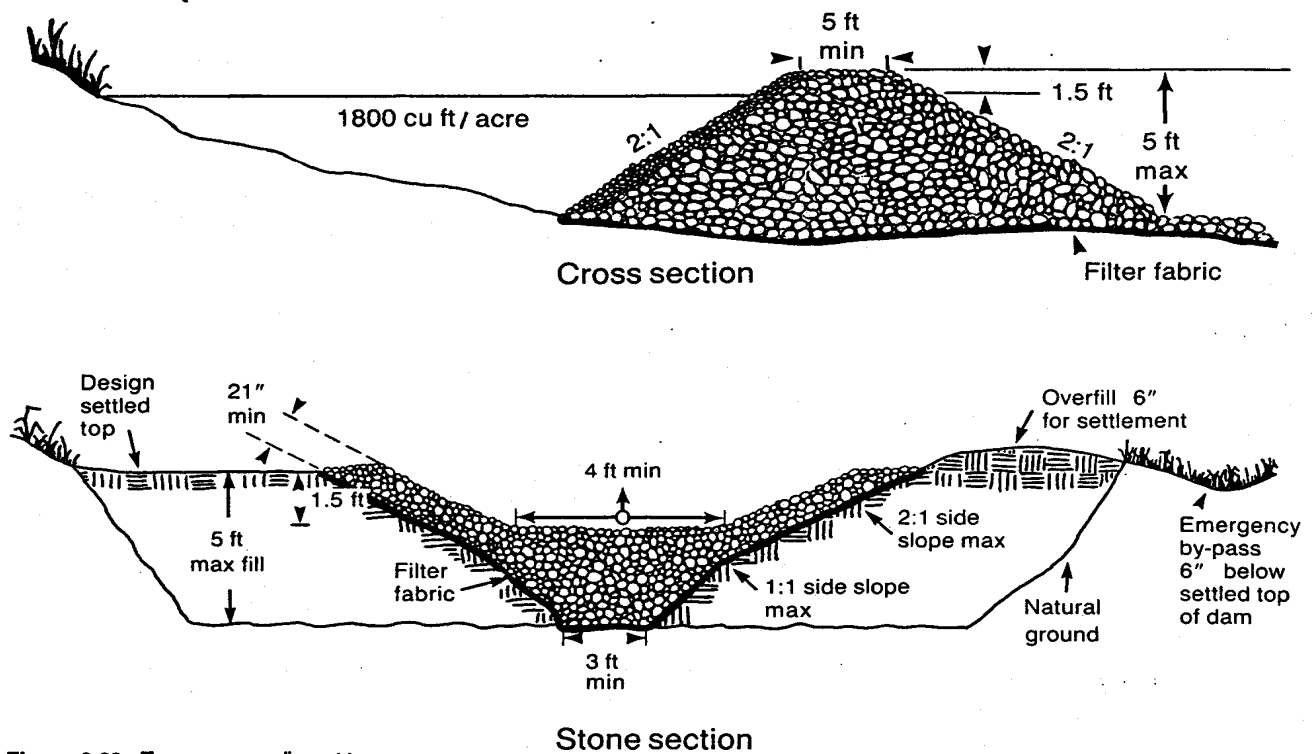


Figure 6.60a Temporary sediment trap.

Construction Specifications

1. Clear, grub, and strip the area under the embankment of all vegetation and root mat. Remove all surface soil containing high amounts of organic matter and stockpile or dispose of it properly. Haul all objectionable material to the designated disposal area.

-
2. Ensure that fill material for the embankment is free of roots, woody vegetation, organic matter, and other objectionable material. Place the fill in lifts not to exceed 9 inches and machine compact it. Over fill the embankment 6 inches to allow for settlement.
 3. Construct the outlet section in the embankment. Protect the connection between the riprap and the soil from piping by using filter fabric or a keyway cutoff trench between the riprap structure and the soil.
 - Place the filter fabric between the riprap and soil. Extend the fabric across the spillway foundation and sides to the top of the dam; or
 - excavate a keyway trench along the centerline of the spillway foundation extending up the sides to the height of the dam. The trench should be at least 2 ft deep and 2 ft wide with 1:1 side slopes.
 4. Clear the pond area below the elevation of the crest of the spillway to facilitate sediment cleanout.
 5. All cut and fill slopes should be 2:1 or flatter.
 6. Ensure that the stone (drainage) section of the embankment has a minimum bottom width of 3 ft and maximum side slopes of 1:1 that extend to the bottom of the spillway section.
 7. Construct the minimum finished stone spillway bottom width, as shown on the plans, with 2:1 side slopes extending to the top of the over filled embankment. Keep the thickness of the sides of the spillway outlet structure at a minimum of 21 inches. The weir must be level and constructed to grade to assure design capacity.
 8. Material used in the stone section should be a well-graded mixture of stone with a d_{50} size of 9 inches (class B erosion control stone is recommended) and a maximum stone size of 14 inches. The stone may be machine placed and the smaller stones worked into the voids of the larger stones. The stone should be hard, angular, and highly weather-resistant.
 9. Ensure that the stone spillway outlet section extends downstream past the toe of the embankment until stable conditions are reached and outlet velocity is acceptable for the receiving stream. Keep the edges of the stone outlet section flush with the surrounding ground and shape the center to confine the outflow stream (*References: Outlet Protection*).
 10. Direct emergency bypass to natural, stable areas. Locate bypass outlets so that flow will not damage the embankment.
 11. Stabilize the embankment and all disturbed areas above the sediment pool and downstream from the trap immediately after construction (*References: Surface Stabilization*).
 12. Show the distance from the top of the spillway to the sediment cleanout level (one-half the design depth) on the plans and mark it in the field.
-

Maintenance

Inspect temporary sediment traps after each period of significant rainfall. Remove sediment and restore the trap to its original dimensions when the sediment has accumulated to one-half the design depth of the trap. Place the sediment that is removed in the designated disposal area and replace the contaminated part of the gravel facing.

Check the structure for damage from erosion or piping. Periodically check the depth of the spillway to ensure it is a minimum of 1.5 ft below the low point of the embankment. Immediately fill any settlement of the embankment to slightly above design grade. Any riprap displaced from the spillway must be replaced immediately.

After all sediment-producing areas have been permanently stabilized, remove the structure and all unstable sediment. Smooth the area to blend with the adjoining areas and stabilize properly (*References: Surface Stabilization*).

References

Outlet Protection

6.41, Outlet Stabilization Structure

Surface Stabilization

6.10, Temporary Seeding

6.11, Permanent Seeding

6.15, Riprap

North Carolina Department of Transportation

Standard Specifications for Roads and Structures

6.61

SEDIMENT BASIN

Definition An earthen embankment suitably located to capture sediment.

Purpose To retain sediment on the construction site and prevent sedimentation in off-site streams, lakes, and drainageways.

Conditions Where Practice Applies

Special limitation—This practice applies only to the design and installation of sediment basins where failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use of public roads or utilities. Regardless of hazard classification, structures larger than 15 ft or higher, and having a maximum storage capacity of 10 acre-ft or more are subject to the N.C. Dam Safety Act.

Sediment basins are needed where erosion control measures are not adequate to prevent off-site sedimentation. Specific criteria for installation of a sediment basin are as follows:

- Keep the drainage area less than 100 acres.
- Ensure that basin location provides a convenient concentration point for sediment-laden flows from the area served.
- Ensure that basin location allows access for sediment removal and proper disposal under all weather conditions.
- Keep the basin life limited to 3 years, unless it is designed as a permanent structure.
- Do not locate sediment basins in perennial streams.

Planning Considerations

Select key locations for sediment basins during initial site evaluation. Install basins before any site grading takes place within the drainage area.

Select basin sites to capture sediment from all areas that are not treated adequately by other sediment traps. Always consider access for cleanout and disposal of the trapped sediment. Locations where a pond can be formed by constructing a low dam across a natural swale are generally preferred to sites that require excavation. If practical, divert sediment-free runoff away from the basin.

Sediment trapping efficiency is primarily a function of sediment particle size and the ratio of basin surface area to inflow rate. Therefore, design the basin to have a large surface area for its volume. Figure 6.61a shows the relationship between the ratio of surface area to peak inflow rate and trap efficiency observed by Barfield and Clar (1985).

Sediment basins with an expected life greater than 3 years should be designed as permanent structures. In these cases, the structure should be designed by a qualified professional engineer experienced in the design of dams. Permanent ponds and artificial lakes are beyond the scope of this practice standard. USDA

6.61.1

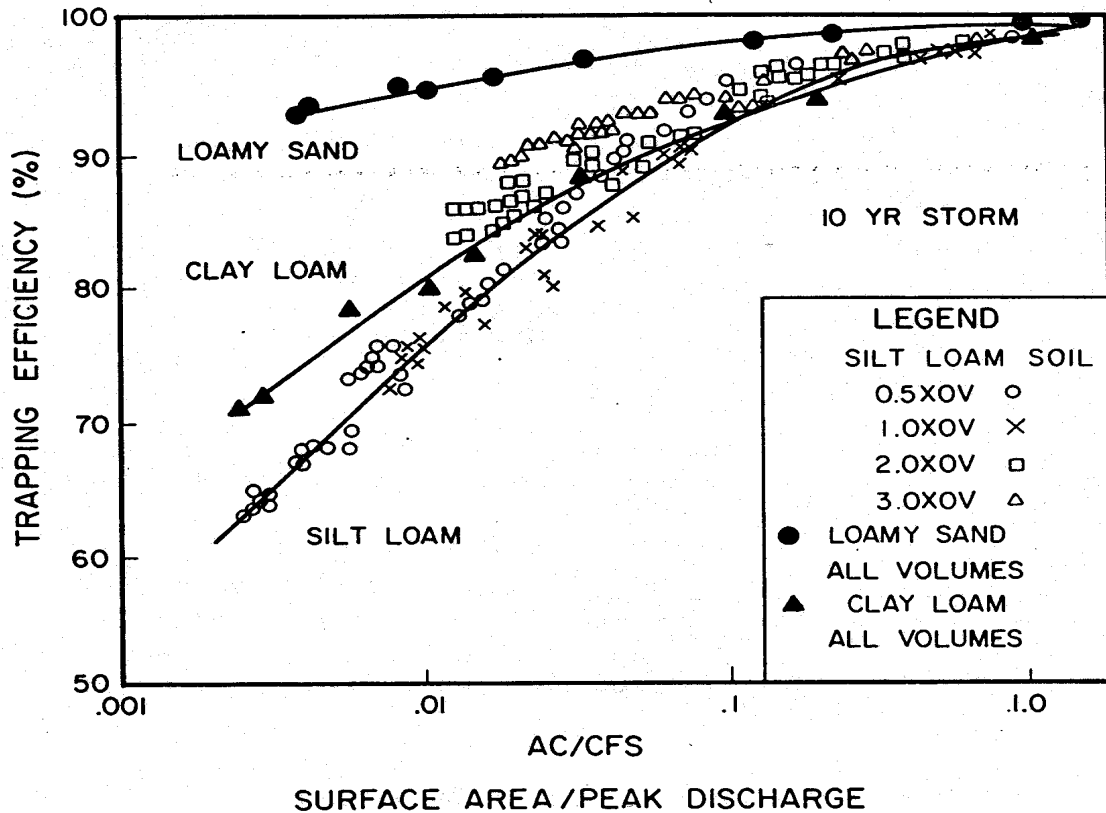


Figure 6.61a Graph showing the relationship between the ratio of surface area to peak inflow rate and trap efficiency.
(source: Barfield and Clar)

Soil Conservation Service Practice Standard Ponds Code No. 378 provides criteria for design of permanent ponds.

Design Criteria Drainage areas—Limit drainage areas to 100 acres.

Design basin life—Ensure a design basin life of 3 years or less.

Dam height—Limit dam height to 15 ft. Dams 15 ft or higher and with storage volume of 10 acre-ft or more are governed by the N.C. Dam Safety Act. Height of a dam is measured from the top of the dam to the lowest point at the downstream toe. Volume is measured to the top of the dam.

Basin locations— Select areas that:

- provide capacity for storage of sediment from as much of the planned disturbed area as practical;
- exclude runoff from undisturbed areas, where practical;
- provide access for sediment removal throughout the life of the project;

- interfere minimally with construction activities.

Surface area—Recent studies (Barfield and Clar, 1985) indicate that the following relationship between surface area and peak inflow rate gives a trapping efficiency greater than 75% for most sediment in the Coastal Plain and Piedmont regions:

$$A = 0.01q$$

Where A is basin surface area in acres and q is peak inflow rate in cfs. Area is measured at design capacity of the principal spillway.

Basin shape—Ensure that the flow length to basin width ratio is greater than 2:1 to improve trapping efficiency. This basin shape may be attained by site selection, excavation, or installing baffles. Length is measured at the elevation of the principal spillway.

Storage volume—Ensure that the sediment storage volume of the basin, as measured to the elevation of the crest of the principal spillway, is at least 1,800 ft³/acre for the disturbed area draining into the basin (1800 ft³ is equivalent to 1/2 inch of sediment per acre of basin drainage area). Where possible, the entire drainage basin is used for this computation, rather than the disturbed area alone, to help ensure adequate trapping efficiency.

Remove sediment from the basin when approximately one-half of the storage volume has been filled.

Spillway capacity—The spillway system must carry the peak runoff from the 10-yr storm with a minimum 1 ft freeboard in the emergency spillway. Base runoff computations on the disturbed soil cover conditions expected during the effective life of the structure.

Principal spillway—Construct the principal spillway with a vertical riser connected to a horizontal barrel that extends through the embankment and outlets beyond the downstream toe of the dam, or an equivalent design.

- Capacity—Ensure a minimum capacity of 0.2 cfs/acre of drainage area, with the water surface at the emergency spillway crest elevation.

Sediment cleanout elevation—Show the distance from the top of the riser to the pool level when the basin is 50% full. This elevation should also be marked in the field with a permanent stake set at this ground elevation (not the top of the stake).

Crest elevation—Keep the crest elevation of the riser a minimum of 1 ft below the crest elevation of the emergency spillway.

Riser and Barrel—Keep the minimum barrel size at 8 inches for corrugated metal pipe or 6 inches for smooth wall pipe to facilitate installation and reduce potential for failure from blockage. Ensure that the pipe is capable of withstanding the maximum external loading without yielding, buckling, or cracking. To improve the efficiency of the principal spillway system, make the cross-sectional area of the riser at least 1.5 times that of the barrel.

Pipe Connections—Ensure that all conduit connections are watertight.

Rod and lug type connector bands with gaskets are preferred for corrugated metal pipe to assure watertightness under maximum loading and internal pressure. Do not use dimple (universal) connectors under any circumstances.

Basin dewatering—Many new techniques are available for dewatering sediment basins. A single hole placed just above the sediment cleanout level will dewater the basin slowly and not interfere with trap efficiency.

The size of the dewatering hole may be approximated as follows:

$$A_o = \frac{A_s \times \sqrt{2h}}{T \times C_d \times 20,428}$$

where:

- A_o = surface area of the dewatering hole, ft²
- A_s = surface area of the basin, ft²
- h = head of water above the hole, ft
- C_d = coefficient of contraction for an orifice, approximately 0.6, and
- T = detention time or time needed to dewater the basin, hours (recommended 10 hours).

NOTE: Perforating the riser with multiple holes with a combined surface area equal to A_o is acceptable. Perforated risers that dewater the basin rapidly may interfere with sediment trapping.

The basin may also be dewatered by perforating the lower half of the riser with 1/2-inch holes with a spacing of approximately 3 inches in each outside valley. Cover the perforated section with 2 ft of 1/2 - 3/4-inch gravel. Use NCDOT Standard #57, or #5 washed stone when it is available.

It is important that a suitable trash guard be installed to prevent the dewatering holes from becoming clogged.

- **Trash guard**—Install a trash guard on the top of the riser to prevent trash and other debris from clogging the conduit. A combination anti-vortex device and trash guard improves the efficiency of the principal spillway and protects against trash intake.
- **Protection against piping**—Install at least one watertight anti-seep collar with a minimum projection of 1.5 ft around the barrel of principal spillway conduits, 8 inches or larger in diameter. Locate the anti-seep collar slightly downstream from the dam center line. A properly designed drainage diaphragm installed around the barrel may be used instead of an anti-seep collar when it is appropriate.
- **Protection against flotation**—Secure the riser by an anchor with buoyant weight greater than 1.1 times the water displaced by the riser.
- **Outlet**—Protect the outlet for the barrel against erosion.

Discharge velocities must be within allowable limits for the receiving stream (*References: Outlet Protection*).

Emergency spillway—Construct the entire flow area of the emergency spillway in undisturbed soil (not fill). Make the cross section trapezoidal with side slopes of 3:1 or flatter. Make the control section of the spillway straight and at least 20 ft long. The inlet portion of the spillway may be curved to improve alignment, but ensure that the outlet section is straight due to supercritical flow in this portion.

- **Capacity**—The minimum design capacity of the emergency spillway must be the peak rate of runoff from the 10-yr storm, less any reduction due to flow in the principal spillway. In no case should freeboard of the emergency spillway be less than 1 ft above the design depth of flow.
- **Velocity**—Ensure that the velocity of flow discharged from the basin is nonerosive for the existing conditions. When velocities exceed that allowable for the receiving areas, provide outlet protection (*References: Outlet Protection*).

Embankment—

- **Cut-off trench**—Excavate a trench at the centerline of the embankment. Ensure that the trench is in undisturbed soil and extends through the length of the embankment to the elevation of the riser crest at each end. A minimum of 2 ft depth is recommended.
- **Top width**—The minimum top width of the dam is shown in Table 6.61a.
- **Freeboard**—Ensure that the minimum difference between the design water elevation in the emergency spillway and the top of the settled embankment is 1 ft.
- **Side slopes**—Make the side slopes of the impoundment structure 2.5:1 or flatter (Figure 6.61b).
- **Allowance for settlement**—Increase the constructed height of the fill at least 10% above the design height to allow for settlement.
- **Erosion protection**—Stabilize all areas disturbed by construction (except the lower 1/2 of the sediment pool) by suitable means immediately after completing the basin (*References: Surface Stabilization*).

Design information included in the Appendices may be used to develop final plans for sediment basins (*References: Appendices*).

Trap efficiency—Improve sediment basin trapping efficiency by employing the following considerations in the basin design:

- **Surface area**—In the design of the settling pond, allow the largest surface area possible. Studies of Barfield and Clar (1985) indicate that surface area (in acres) should be larger than 0.01 times the peak inflow rate in cfs.
- **Length**—Maximize the length-to-width ratio of the basin to prevent short circuiting, and ensure use of the entire design settling area.

Table 6.61a
Acceptable Dimensions for
Basin Embankment

Fill Height	Minimum Top Width
less than 10 ft	8.0 ft
10 feet to 15 ft	10.0 ft

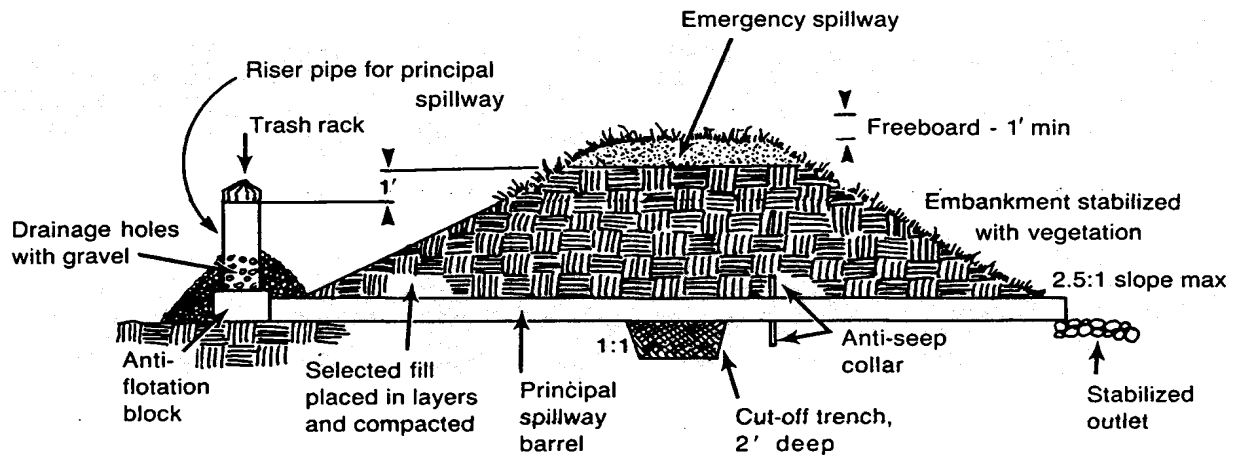


Figure 6.61b Section through embankment and basin controls.

- Inlets—Locate the sediment inlets to the basin the greatest distance from the principal spillway.
- Dewatering—Allow the maximum reasonable detention period before the basin is completely dewatered—at least 10 hours.
- Inflow rate—Reduce the inflow velocity and divert all sediment-free runoff.

Construction Specifications

1. Site preparations—Clear, grub, and strip topsoil from areas under the embankment to remove trees, vegetation, roots, and other objectionable material. To facilitate sediment cleanout and restoration, clear the pool area of all brush, trees, and other objectionable materials. Stockpile all topsoil or soil containing organic matter for use on the outer shell of the embankment to facilitate vegetative establishment. Place temporary sediment control measures below the basin as needed.

2. Cut-off trench—Excavate a cut-off trench along the centerline of the earth fill embankment. Cut the trench to stable soil material, but in no case make it less than 2 ft deep. The cut-off trench must extend into both abutments to at least the elevation of the riser crest. Make the minimum bottom width wide enough to permit operation of excavation and compaction equipment but in no case less than 2 ft. Make side slopes of the trench no steeper than 1:1. Compaction requirements are the same as those for the embankment. Keep the trench dry during backfilling and compaction operations.

3. Embankment—Take fill material from the approved areas shown on the plans. It should be clean mineral soil, free of roots, woody vegetation, rocks, and other objectionable material. Scarify areas on which fill is to be placed before placing fill. The fill material must contain sufficient moisture so it can be formed by hand into a ball without crumbling. If water can be squeezed out of the ball, it is too wet for proper compaction. Place fill material in 6 to 8-inch continuous layers over the entire length of the fill area and then compact it. Com-

paction may be obtained by routing the construction hauling equipment over the fill so that the entire surface of each layer is traversed by at least one wheel or tread track of the heavy equipment, or a compactor may be used. Construct the embankment to an elevation 10% higher than the design height to allow for settling.

4. Conduit spillways—Securely attach the riser to the barrel or barrel stub to make a watertight structural connection. Secure all connections between barrel sections by approved watertight assemblies. Place the barrel and riser on a firm, smooth foundation of impervious soil. Do not use pervious material such as sand, gravel, or crushed stone as backfill around the pipe or anti-seep collars. Place the fill material around the pipe spillway in 4-inch layers and compact it under and around the pipe to at least the same density as the adjacent embankment. Care must be taken not to raise the pipe from firm contact with its foundation when compacting under the pipe haunches.

Place a minimum depth of 2 ft of hand-compacted backfill over the pipe spillway before crossing it with construction equipment. Anchor the riser in place by concrete or other satisfactory means to prevent flotation. In no case should the pipe conduit be installed by cutting a trench through the dam after the embankment is complete.

5. Emergency spillway—Install the emergency spillway in undisturbed soil. The achievement of planned elevations, grade, design width, and entrance and exit channel slopes are critical to the successful operation of the emergency spillway.

6. Inlets—Discharge water into the basin in a manner to prevent erosion. Use diversions with outlet protection to divert sediment-laden water to the upper end of the pool area to improve basin trap efficiency (*References: Runoff Control Measures and Outlet Protection*).

7. Erosion control—Construct the structure so that the disturbed area is minimized. Divert surface water away from bare areas. Complete the embankment before the area is cleared. Stabilize the emergency spillway embankment and all other disturbed areas above the crest of the principal spillway immediately after construction (*References: Surface Stabilization*).

8. Safety—Sediment basins may attract children and can be dangerous. Avoid steep side slopes, and fence and mark basins with warning signs if trespassing is likely. Follow all state and local requirements.

Maintenance

Check sediment basins after periods of significant runoff. Remove sediment and restore the basin to its original dimensions when sediment accumulates to one-half the design depth.

Check the embankment, spillways, and outlet for erosion damage, and inspect the embankment for piping and settlement. Make all necessary repairs immediately. Remove all trash and other debris from the riser and pool area.

6.62

SEDIMENT FENCE (SILT FENCE)



Definition A temporary sediment barrier consisting of filter fabric buried at the bottom, stretched, and supported by posts.

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

Conditions Where Practice Applies Below small disturbed areas less than 1/4 acre per 100 ft of fence.
Where runoff can be stored behind the sediment fence without damaging the fence or the submerged area behind the fence.

Do not install sediment fences across streams, ditches, or waterways.

Planning Considerations A sediment fence is a permeable barrier that should be planned as a system to retain sediment on the construction site. The fence retains sediment primarily by retarding flow and promoting deposition. In operation, generally the fence becomes clogged with fine particles, which reduce flow rate. This causes a pond to develop more quickly behind the fence. The designer should anticipate ponding and provide sufficient storage areas and overflow outlets to prevent flows from overtopping the fence. Since sediment fences are not designed to withstand high heads, locate them so that only shallow pools can form. Tie the ends of a sediment fence into the landscape to prevent flow around the end of the fence before the pool reaches design level. Provide stabilized outlets to protect the fence system and release stormflows that exceed the design storm.

Deposition occurs as the storage pool forms behind the fence. The designer can direct flows to specified deposition areas through appropriate positioning of the fence or by providing an excavated area behind the fence. Plan deposition areas at accessible points to promote routine cleanout and maintenance. Show deposition areas in the erosion and sedimentation control plan. A sediment fence acts as a diversion if placed slightly off the contour. This may be used by the designer to control shallow, uniform flows from small disturbed areas and to deliver sediment-laden water to deposition areas.

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

Design Criteria Ensure that the drainage area is no greater than 1/4 acre per 100 ft of fence.

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

Where all runoff is to be stored behind the fence, ensure that the maximum slope length behind a sediment fence does not exceed the specifications shown in Table 6.62a.

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

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

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

Slope	Slope Length (ft)
< 2%	100
2 to 5%	75
5 to 10%	50
10 to 20%	25
>20%	15

Provide a riprap splash pad or other outlet protection device for any point where flow may overtop the sediment fence, such as natural depressions or swales. Ensure that the maximum height of the fence at a protected, reinforced outlet does not exceed 1 ft and that support post spacing does not exceed 4 ft.

The design life of a synthetic sediment fence should be 6 months. Burlap is only acceptable for periods up to 60 days.

Construction Specifications

MATERIALS

1. Use a synthetic filter fabric or a pervious sheet of polypropylene, nylon, polyester, or polyethylene yarn, which is certified by the manufacturer or supplier as conforming to the requirements shown in Table 6.62b.

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

2. Ensure that posts for sediment fences are either 4-inch diameter pine, 2-inch diameter oak, or 1.33 lb/linear ft steel with a minimum length of 4 ft. Make sure that steel posts have projections to facilitate fastening the fabric.

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

Table 6.62b
Specifications For Sediment Fence Fabric

Physical Property	Requirements
Filtering Efficiency	85% (min)
Tensile Strength at 20% (max.) Elongation	Standard Strength- 30 lb/lin in (min) Extra Strength- 50 lb/lin in (min)
Slurry Flow Rate	0.3 gal/sq ft/min (min)

CONSTRUCTION

1. Construct the sediment barrier of standard strength or extra strength synthetic filter fabrics.
2. Ensure that the height of the sediment fence does not exceed 18 inches above the ground surface. (Higher fences may impound volumes of water sufficient to cause failure of the structure.)
3. Construct the filter fabric from a continuous roll cut to the length of the barrier to avoid joints. When joints are necessary, securely fasten the filter cloth only at a support post with overlap to the next post.
4. Support standard strength filter fabric by wire mesh fastened securely to the upslope side of the posts using heavy duty wire staples at least 1 inch long, or tie wires. Extend the wire mesh support to the bottom of the trench.
5. When a wire mesh support fence is used, space posts a maximum of 8 ft apart. Support posts should be driven securely into the ground to a minimum of 18 inches.
6. Extra strength filter fabric with 6-ft post spacing does not require wire mesh support fence. Staple or wire the filter fabric directly to posts.
7. Excavate a trench approximately 4 inches wide and 8 inches deep along the proposed line of posts and upslope from the barrier (Figure 6.62a).
8. Backfill the trench with compacted soil or gravel placed over the filter fabric.
9. Do not attach filter fabric to existing trees.

Maintenance

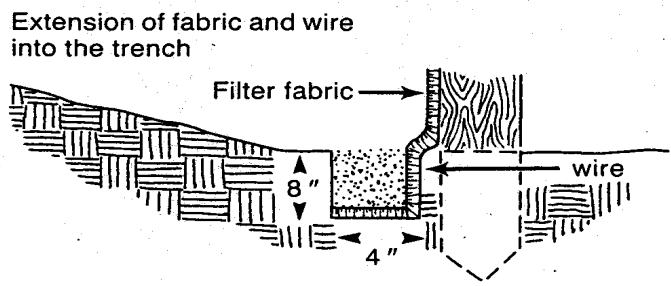
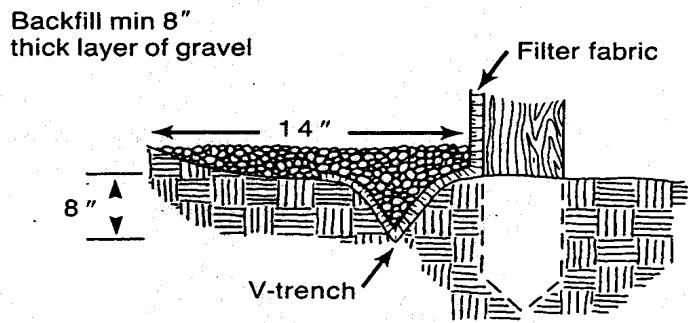
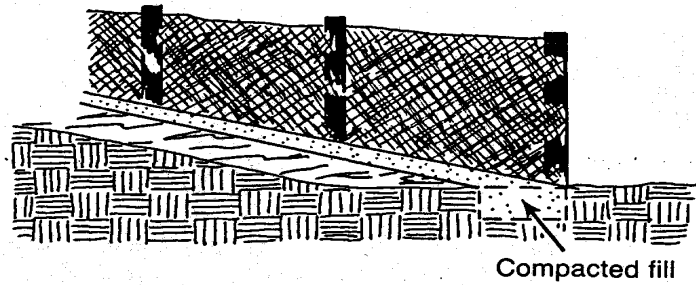
Inspect sediment fences at least once a week and after each rainfall. Make any required repairs immediately.

Should the fabric of a sediment fence collapse, tear, decompose or become ineffective, replace it promptly. Replace burlap every 60 days.

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

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

Figure 6.62a Installation detail of a sediment fence.



References

Runoff Control Measures
6.20, Temporary Diversions

Outlet Protection
6.41, Outlet Stabilization Structure

Sediment Traps and Barriers
6.60, Temporary Sediment Trap
6.61, Sediment Basin

Appendix
8.03, Estimating Runoff

6.63

ROCK DAM

Definition A rock embankment located to capture sediment.

Purpose To retain sediment on the construction site and prevent sedimentation in off-site streams, lakes, and drainage ways.

Conditions Where Practice Applies The rock dam may be used instead of the standard sediment basin with barrel and riser (Practice 6.61, *Sediment Basin*). The height of the dam is limited to 8 ft, and drainage area should be no larger than 50 acres.

The rock dam is preferred where a stable, earthen embankment would be difficult to construct, and riprap and gravel are readily available. The site must be accessible for periodic sediment removal.

A rock dam should not be located in a live stream.

Planning Considerations

A sediment basin formed by a rock embankment is used primarily where it is desirable to have the top of the structure serve as the overflow outlet and where suitable rock is readily available. A long weir crest is designed to keep flow depth shallow and discharge velocities low. The inside face of the rock dam must be covered with gravel to reduce the rate of seepage through the dam so that a sediment pool will form during runoff events. The pool should drain slowly through the gravel to improve basin trapping efficiency.

The abutments of the rock dam must be higher than the top of the dam to prevent any water from flowing against the soil. A cutoff trench should be installed under the entire length of dam and suitable filter fabric placed between the rock structure and its soil base and abutments. This prevents "piping" or soil movement in the foundation and abutments. Rock should extend downstream from the toe of the dam, on zero grade, a sufficient distance to stabilize flow and prevent erosion.

For other planning considerations see Practice 6.61, *Sediment Basin*.

Design Criteria **Drainage area**—limited to 50 acres

Design basin life—3 years or less

Dam height—limited to 8 ft

Basin locations—select areas that:

- provide a large surface area to trap sediment;
- intercept runoff primarily from disturbed areas;
- are accessible for periodic sediment removal;
- interfere minimally with construction activities.

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Basin volume—The volume of the basin should be at least 1800 ft³/acre based on disturbed area draining into the basin, and measured 1 ft below the top of the dam.

Spillway capacity—The spillway should carry peak runoff for a 10-year storm with maximum flow depth 1 ft and a minimum freeboard 1 ft. The top of the rock embankment may serve as the spillway.

Embankment—

Top width— 5 ft minimum

Side slopes— Maximum: 2:1 upstream slope
3:1 downstream slope

Rock abutments should extend to an elevation at least 2 ft above the spillway. Abutments should be 2 ft thick with 2:1 side slopes. The rock abutments should extend down the downstream face of the dam to the toe, at least 1 ft higher than the rest of the dam to protect the earth abutments from scour.

Outlet protection—A rock apron at least 1.5 ft thick should extend downstream from the toe of the dam, on zero grade, a sufficient distance to prevent channel erosion, or a distance equal to the height of the dam whichever is greater.

Rock fill—Rock should be well graded, hard, erosion resistant stone with a minimum d₅₀ size of 9 inches.

Protection from "piping"—A keyway lined with geotextile filter fabric should be on the soil foundation under the rock fill. To prevent soil movement and piping under the dam, the filter fabric must extend from the keyway to the downstream edge of the apron and must run under the dam's abutments.

Basin dewatering—The entire upstream face of the rock structure should be covered with fine gravel (NCDOT #57 washed stone or equivalent) a minimum of 1 ft thick to reduce the drainage rate.

Trap efficiency—To obtain maximum trapping efficiency, consider the following design principles :

- Allow surface area, 0.01 acres per cfs based on the 10-yr storm.
- Locate sediment inflow to the basin away from the dam to prevent short circuits from inlets to the outlet.
- Design for a long detention period before the basin is completely drained (8 hrs or more).

Construction Specifications

1. Clear the areas under the embankment and strip it of roots and other objectionable material. Clear the reservoir area to facilitate sediment removal.
2. Excavate a cutoff trench a minimum of 2 ft deep and 2 ft wide with 1:1 side slopes under the total length of the dam at its centerline. Line the trench with extra-strength filter fabric before backfilling with rock. Apply filter fabric under the rockfill embankment, from the upstream edge of the keyway to the

downstream edge of the apron. Overlap filter material a minimum of 1 ft at all joints, with the upstream strip laid over the downstream strip.

3. Construct the embankment with well-graded rock and gravel to the size and dimensions shown on the drawings. It is important that rock abutments be at least 2 ft higher than the spillway crest and at least 1 ft higher than the downstream face of the dam, all the way to the toe, to prevent scour and erosion at the abutments.

4. Sediment-laden water from the construction site should be diverted into the basin reservoir at the furthest area from the dam.

5. Construct the rock dam before the basin area is cleared to minimize sediment yield from construction of the basin. Stabilize immediately all areas disturbed during the construction of the dam except the sediment pool (*References: Surface Stabilization*).

6. **Safety**—Sediment basins should be considered dangerous because they attract children. Steep side slopes should be avoided. Fences with warning signs may be needed if trespassing is likely. All state and local requirements must be followed.

Maintenance

Check sediment basins after each rainfall. Remove sediment and restore original volume when sediment accumulates to about one-half the design volume.

Check the structure for erosion, piping, and rock displacement after each significant rainstorm and repair immediately.

Remove the structure and any unstable sediment immediately after the construction site has been permanently stabilized. Smooth the basin site to blend with the surrounding area and stabilize. All water and sediment should be removed from the basin prior to dam removal. Sediment should be placed in designated disposal areas and not allowed to flow into streams or drainageways during structure removal.

References

Surface Stabilization

6.10, Temporary Seeding

6.11, Permanent Seeding

6.12, Sodding

6.13, Trees, Shrubs, Vines, and Ground Covers

Runoff Control Measures

6.20, Temporary Diversions

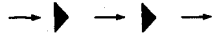
Outlet Protection

6.41, Outlet Stabilization Structure

North Carolina Department of Transportation

Standard Specifications for Roads and Structures

6.83

CHECK DAM

Definition	Small temporary stone dams constructed across a drainageway.
Purpose	To reduce erosion in a drainage channel by restricting the velocity of flow in the channel.
Conditions Where Practice Applies	<p>This practice may be used as a temporary or emergency measure to limit erosion by reducing flow in small open channels. Limit drainage areas to 2 acres or less. Do not use check dams in live streams.</p> <p>Check dams may be used to:</p> <ul style="list-style-type: none"> • reduce flow in small temporary channels that are degrading, but, where permanent stabilization is impractical due to their short period of usefulness; • reduce flow in small eroding channels where construction delays or weather conditions prevent timely installation of nonerosive liners.
Planning Considerations	<p>Check dams are an expedient way to reduce gulying in the bottom of channels that will be filled or stabilized at a later date. It is usually better to line the channel or divert the flow to stabilize the channel than to install check dams. However, under circumstances where this is not feasible, check dams may be helpful.</p> <p>Check dams installed in grass-lined channels may kill the vegetative lining if submergence after rains is too long and/or silting is excessive. All stone and riprap must be removed if mowing is planned as part of vegetative maintenance.</p> <p>Consider the alternative of protecting the channel bottom with materials such as riprap, concrete, fiberglass mat, or other protective linings in combination with grass before selecting check dams.</p>
Design Criteria	<p>The following criteria should be used when designing a check dam:</p> <ul style="list-style-type: none"> • Ensure that the drainage area above the check dam does not exceed 2 acres. • Keep the maximum height at 2 ft at the center of the dam. • Keep the center of the check dam at least 9 inches lower than the outer edges at natural ground elevation. • Keep the side slopes of the dam at 2:1 or flatter. • Ensure that the maximum spacing between dams places the toe of the upstream dam at the same elevation as the top of the downstream dam (Figure 6.83a). • Stabilize overflow areas along the channel to resist erosion caused by check dams.

6.83.1

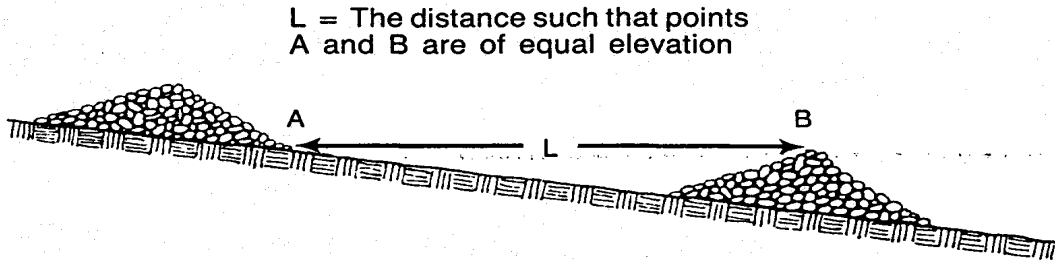


Figure 6.83a Space check dams in a channel so that the crest of downstream dam is at elevation of the toe of upstream dam.

- Use 2 to 15-inch stone (N.C. Department of Transportation class A or class B erosion control stone).
- Key the stone into the ditch banks and extend it beyond the abutments a minimum of 18 inches to avoid washouts from overflow around the dam.

Construction Specifications

1. Place stone to the lines and dimensions shown in the plan on a filter fabric foundation.
2. Keep the center stone section at least 9 inches below natural ground level where the dam abuts the channel banks.
3. Extend stone at least 1.5 ft beyond the ditch banks (Figure 6.83b) to keep overflow water from undercutting the dam as it re-enters the channel.
4. Set spacing between dams to assure that the elevation at the top of the lower dam is the same as the toe elevation of the upper dam.
5. Protect the channel downstream from the lowest check dam, considering that water will flow over and around the dam (Practice 6.41, *Outlet Stabilization Structure*).
6. Make sure that the channel reach above the most upstream dam is stable.
7. Ensure that channel appurtenances, such as culvert entrances below check dams, are not subject to damage or blockage from displaced stones.

Maintenance

Inspect check dams and channels for damage after each runoff event.

Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam. Correct all damage immediately. If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel (Practice 6.31, *Riprap-lined and Paved Channels*).

Remove sediment accumulated behind the dams as needed to prevent damage to channel vegetation, allow the channel to drain through the stone check dam, and prevent large flows from carrying sediment over the dam. Add stones to dams as needed to maintain design height and cross section.

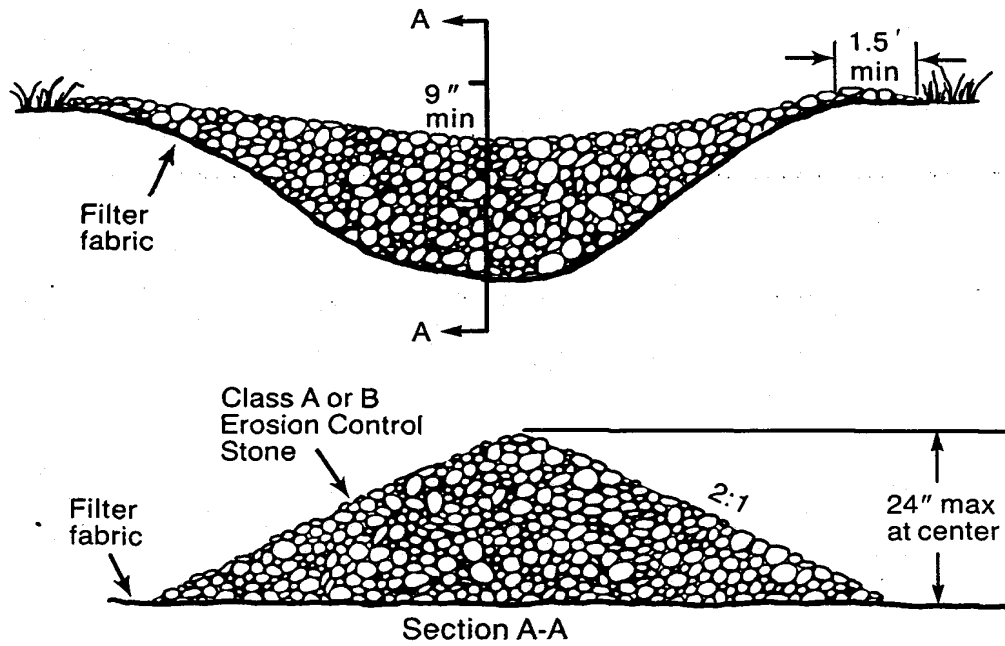


Figure 6.83b Stone check dam—Stone should be placed over the channel banks to keep water from cutting around the dam.

References

Runoff Conveyance Measures

6.30, Grass-lined Channels

6.31, Riprap-lined and Paved Channels

Outlet Protection

6.41, Outlet Stabilization Structure

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