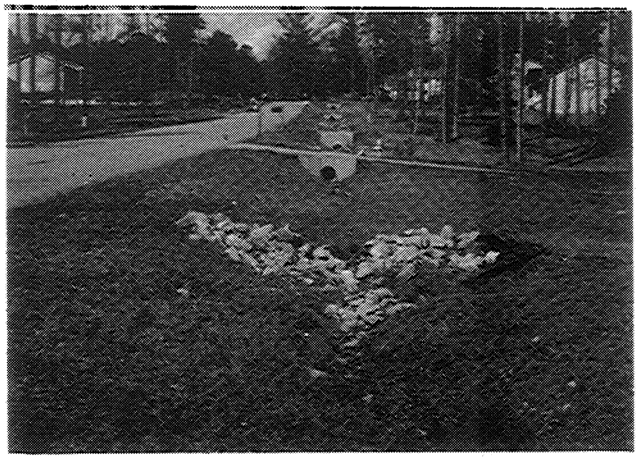
SECTION III: STRUCTURAL PRACTICES

Check Dam (Cd)



DEFINITION

Small temporary barrier, grade control structure, or dam constructed across a swale, drainage ditch, or area of concentrated flow.

PURPOSE

To minimize the erosion rate by reducing the velocity of storm water in areas of concentrated flow.

CONDITIONS

This practice is applicable for use in small open channels and is **not to be used in a live stream**. Specific applications include:

1. Temporary or permanent swales or ditches in need of protection during establishment of grass linings.
2. Temporary or permanent swales or ditches which, due to their short length of service or other reasons, cannot receive a permanent non-erodible lining for an extended period of time.
3. Other locations where small localized erosion and resulting sedimentation problems exist.

DESIGN CRITERIA

Formal design is not required. The following standards shall be used:

Drainage Area

For stone check dams, the drainage area shall not exceed two acres. For haybales, the drainage area shall not exceed one acre.

Height

The center of the check dam must be at least 9 inches lower than outer edges. Dam height should be 2 feet maximum measured to center of check dam. (See Figure 6-10.2)

Side Slopes

Side slopes shall be 2:1 or flatter.

Spacing

Two or more check dams in series shall be used for drainage areas greater than one acre. Maximum spacing between dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam. (See Figure 6-10.1)

Geotextiles

A geotextile should be used as a separator between the graded stone and the soil base and abutments. The geotextile will prevent the migration of soil particles from the subgrade into the graded stone. The geotextile shall be selected/specified in accordance with AASHTO M288-96 Section 7.3, *Separation Requirements*, Table 3. Geotextiles shall be "set" into the subgrade soils. The geotextile shall be placed immediately adjacent to the subgrade without any voids and extend five feet beyond the downstream toe of the dam to prevent scour.

CONSTRUCTION SPECIFICATIONS

The following types of check dams are used for this standard:

Stone Check Dams (Cd-S)

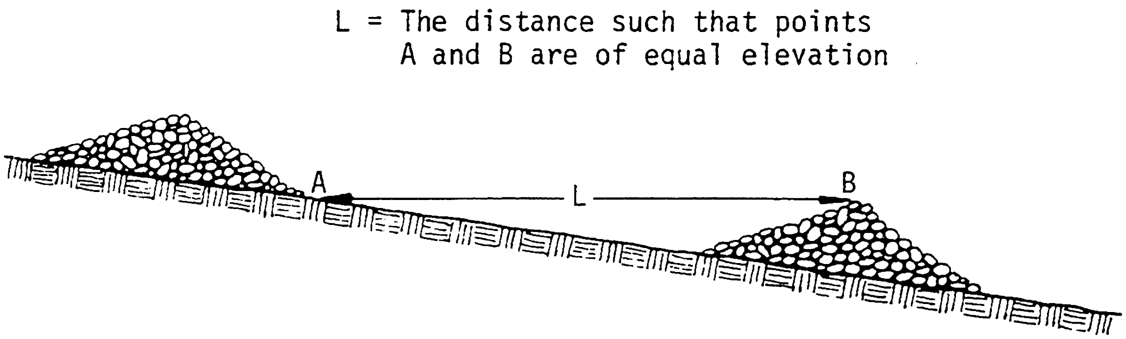
Stone check dams should be constructed of graded size 2-10 inch stone. (See Figure 6-10.2) Mechanical or hand placement shall be required to insure complete coverage of entire width of ditch or swale and that center of dam is lower than edges.

Haybale Check Dams (Cd-Hb)

Staked and embedded hay-bales may be used as temporary check dams in concentrated flow areas while vegetation is becoming established. They should not be used where the drainage area exceeds one acre. Haybales should be embedded a minimum of 4 inches. (See Figure 6-10.3)

MAINTENANCE

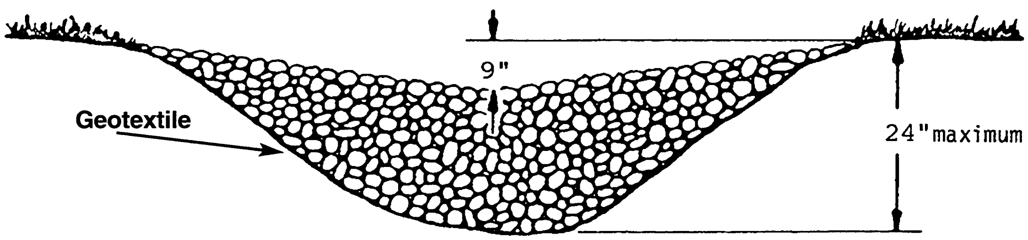
Periodic inspection and required maintenance must be provided. Sediment shall be removed when it reaches a depth of one-half the original dam height or before. If the area is to be mowed, check dams shall be removed once final stabilization has occurred. Otherwise, check dams may remain in place permanently. After removal, the area beneath the dam shall be seeded and mulched immediately.



SPACING BETWEEN CHECK DAMS

Figure 6-10.1

STONE CHECK DAM



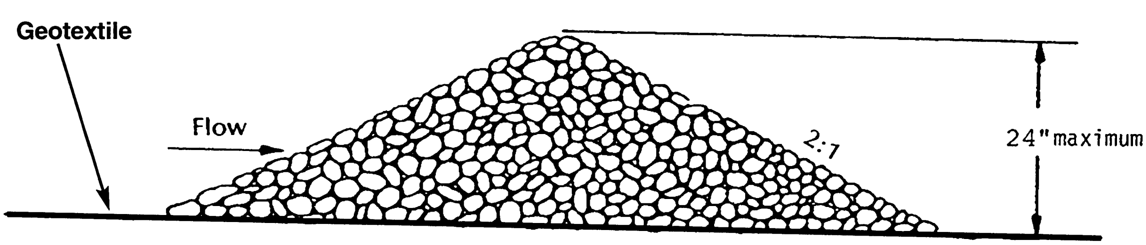
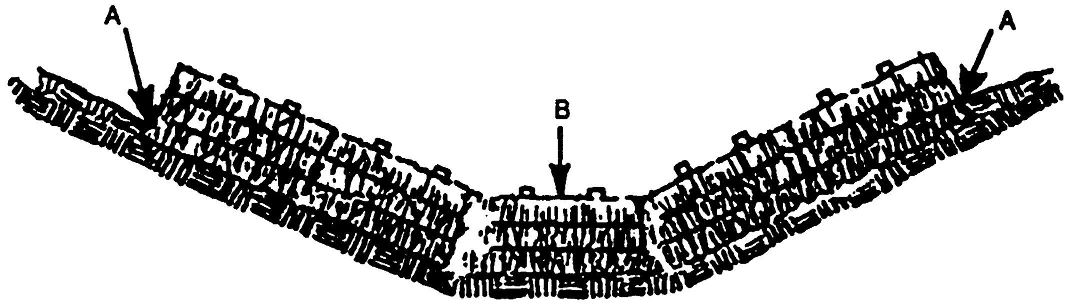
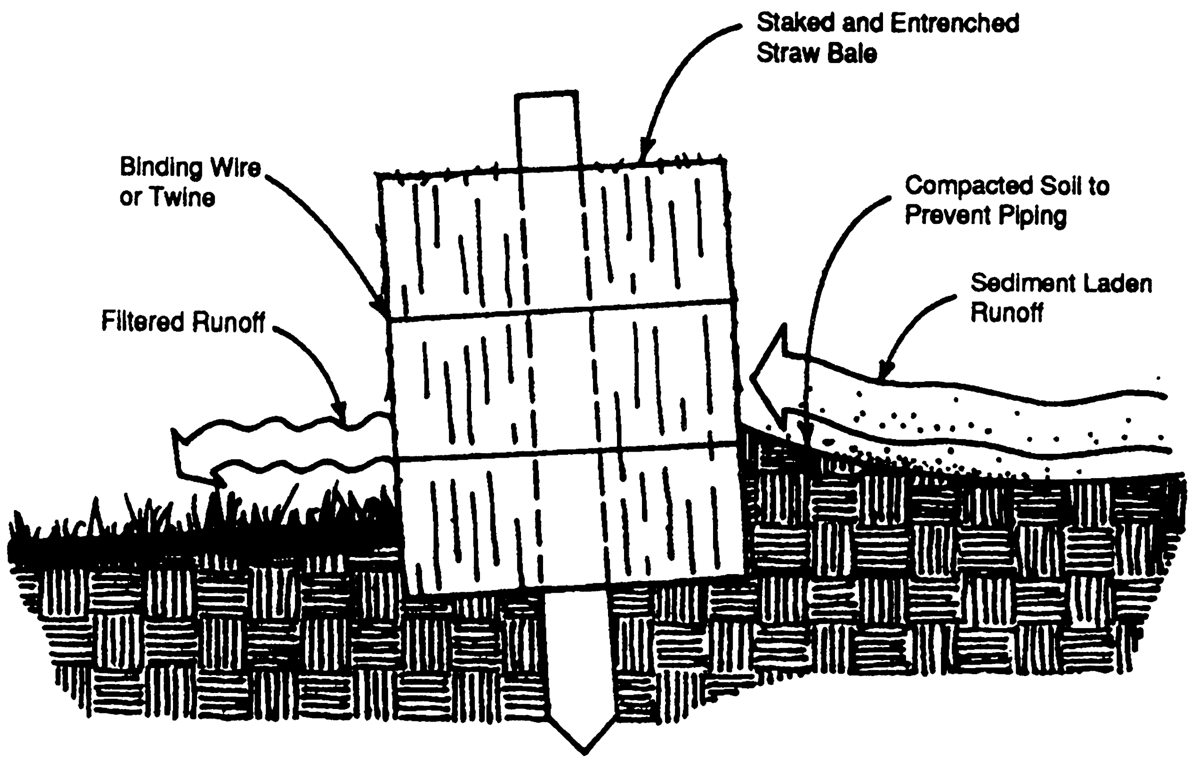


Figure 6-10.2



Points A should be higher than point B

PROPER PLACEMENT OF STRAW BALE BARRIER IN DRAINAGE WAY

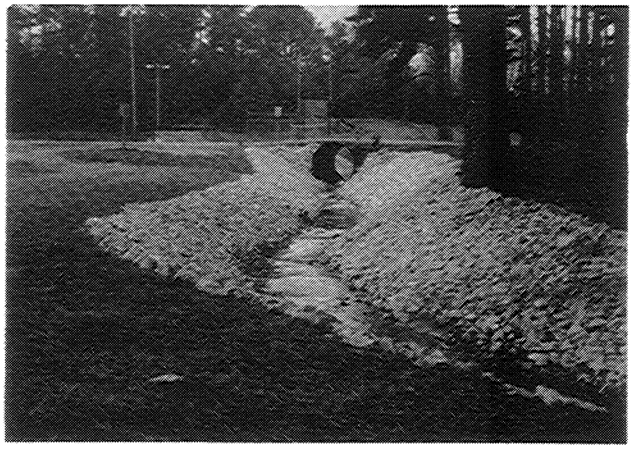


Note: Embed hay bales a minimum of 4 inches.

CROSS-SECTION OF A PROPERLY INSTALLED STRAW BALE

Figure 6-10.3

Channel Stabilization (Ch)



DEFINITION

Improving, constructing or stabilizing an open channel for water conveyance.

PURPOSE

Open channels are constructed or stabilized to be non-erosive, with no sediment deposition and to provide adequate capacity for flood water, drainage, other water management practices, or any combination thereof.

CONDITIONS

This standard applies to the improvement, construction or stabilization of open channels and existing ditches with drainage areas less than one square mile. **This standard applies only to channels conveying intermittent flow, not to channels conveying a continuous, live stream.**

An adequate outlet for the modified channel length must be available for discharge by gravity flow. Construction or other improvements of the channel should not adversely affect the environmental integrity of the area and must not cause significant erosion upstream or flooding and/or sediment deposition downstream.

DESIGN CRITERIA

Planning

The alignment and design of channels shall give careful consideration to the preservation of valuable fish and wildlife habitat and trees of significant value for wildlife food or shelter or for aesthetic purposes.

Where channel construction will adversely affect significant fish or wildlife habitat, mitigation measures should be included in the plan. Mitigation measures may include pools, riffles, flats, cascades or other similar provisions.

As many trees as possible are to be left inside channel rights-of-way considering the requirements of construction, operation, and maintenance.

Unusually large or attractive trees shall be preserved.

Realignment

The realignment of channels shall be kept to an absolute minimum and should be permitted only to correct an adverse environmental condition.

Channel Capacity

The capacity for open channels shall be determined by procedures applicable to the purposes to be served.

Hydraulic Requirements

Manning's formula shall be used to determine velocities in channels. The "n" values for use in this formula shall be estimated using currently accepted guides along with knowledge and experience regarding the conditions. Acceptable guides can be found in hydrology text-books.

Channel Cross-Section

The required channel cross-section and grade are determined by the design capacity, the materials in which the channel is to be constructed, and the requirements for maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains and tributary channels.

Channel Stability

All channel construction, improvement and modification shall be in accordance with a design expected to result in a stable channel which can be maintained.

Characteristics of a Stable Channel

1. Aggradation or degradation does not interfere with the function of the channel or affect adjacent areas.
2. The channel banks do not erode to the extent that the channel cross-section is changed appreciably.
3. Excessive sediment bars do not develop.
4. Excessive erosion does not occur around culverts, bridges or elsewhere.
5. Gullies do not form or enlarge due to the entry of uncontrolled surface flow to the channel.
6. The determination of channel stability considers "bankfull" flow. Bankfull flow is defined as flow in the channel which creates a water surface that is at or near normal ground elevation for a significant length of a channel reach. Excessive channel depth created by cutting through high ground should not be considered in determinations of bankfull flow.

CHANNEL LININGS AND STRUCTURAL MEASURES

Where channel velocities exceed safe velocities for vegetated lining due to increased grade or a change in channel cross-section, or where durability of vegetative lining is adversely affected by seasonal changes, channel linings of rock, concrete or other durable material may be needed. Grade stabilization structures may also be needed.

Channels may be stabilized by using one or more of the following methods:

Vegetated Lining (Ch-V)

Vegetated lining shall be designed to resist erosion when the channel is flowing at the bankfull discharge or 25-year frequency discharge, whichever is the lesser. *Temporary erosion control blankets or sod shall be used on all channels and concentrated flow areas to aid in the establishment of the vegetated lining. If a vegetated lining is desired in a channel with velocities between 5-10 ft/sec, permanent soil reinforcement matting shall be used.* Refer to specifications **Ds3 - Disturbed Area Stabilization (With Permanent Vegetation)**, **Ds4 - Disturbed Area Stabilization (With Sodding)**, and **Mb - Matting and Blankets**.

Rock Riprap Lining (Ch-Rp)

Rock riprap shall be designed to resist displacement when the channel is flowing at the bankfull discharge or 25-year frequency discharge, whichever is the lesser. *Rock riprap lining should be used when channel velocities are between 5 and 10 ft/sec.*

Dumped and machine placed riprap should not be installed on slopes steeper than 1-1/2 horizontal to 1 vertical. Rock shall be dense, resistant to the action of air and water, and suitable in all other respects for the purpose intended. Rock shall be installed according to standards specified in **Riprap, Appendix C**.

A filter blanket layer consisting of an appropriately designed graded filter sand and/or gravel or geotextile material shall be placed between the riprap and base material. The gradation of the filter blanket material shall be designed to create a graded filter between the base material and the riprap. A geotextile can be used as a substitution for a layer of sand in a graded filter or as the filter blanket. Criteria for selecting an appropriate geotextile and guidance for recommended drop heights and stone weights are found in AASHTO M288-96 Section 7.5, *Permanent Erosion Control Specifications.*

Concrete Lining (Ch-C)

If a channel has velocities high enough to require a concrete lining (when channel velocities exceed 10 ft/sec), methods should be utilized to reduce the velocity of the runoff and reduce erosion at the outlet - a common problem created by the smooth, concrete lining. Refer to specification **St - Storm Drain Outlet Protection** for information regarding energy dissipators.

If a concrete lining is chosen, it shall be designed according to currently accepted guides for structural and hydraulic adequacy. It must be designed to carry the required discharge and to withstand the loading imposed by site conditions.

A separation geotextile should be placed under concrete linings to prevent undermining in the event of stress cracks due to settlement of the base material. The separation geotextile will keep the base material soils in place and minimize the likelihood of a system failure.

Grade Stabilization Structures

Grade stabilization structures are used to reduce or prevent excessive erosion by reduction of velocities in the watercourse or by providing structures that can withstand and reduce the higher velocities. They may be constructed of concrete, rock, masonry, steel, aluminum, or treated wood.

These structures are constructed where the capability of earth and vegetative measures is exceeded in the safe handling of water at permissible velocities, where excessive grades or overall 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 erosion control practices.

The structures shall be designed hydraulically to adequately carry the channel discharge and structurally to withstand loadings imposed by the site conditions. The structure shall meet requirements of **Gr - Grade Stabilization Structure**.

CONSTRUCTION SPECIFICATIONS

1. Where needed, all trees, brush, stumps and other objectionable materials shall be removed so they will not interfere with the construction or proper functioning of the channel.
2. Where possible, trees will be left standing, and stumps will not be removed.
3. Excavation shall be at the locations and grades shown on the drawings. The lining shall not compromise the capacity of the channel, *e.g.* the emergency spillway shall be over-excavated so that the lining will be flush with the slope surface.
4. The geotextile shall be placed on a smooth graded surface. The geotextile shall be placed in such a manner that it will not excessively stretch or tear upon placement of the overlying materials. Care should be taken to place the geotextile in intimate contact with

the soil such that no void spaces exist between the underlying soil and the geotextile.

5. Construction plans will specifically detail the location and handling of spoils. Spoil material resulting from clearing, grubbing and channel excavation shall be disposed of in a manner which will:

a. not cause an increase in flood stage,

b. minimize overbank wash,

c. not cause an adverse effect on the environmental integrity of the area,

d. provide for the free flow of water between the channel and flood plain unless the valley routing and water surface profile are based on continuous dikes being installed,

e. leave the right-of-way in the best condition feasible, and

f. improve the aesthetic appearance of the site to the extent feasible.

6. Channel linings shall be established or installed immediately after construction or as soon as weather conditions permit.

7. 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 structures.

8. Materials used in construction shall be of permanency commensurate with the design frequency and life expectancy of the facility.

9. Earthfill, when used as a part of the structures, shall be placed according to the installation requirements for sediment basin embankments.

10. Construction operations shall be carried out in such a manner that erosion and air and water pollution will be minimized. State and local laws concerning pollution abatement shall be complied with.

11. Vegetation shall be established on all disturbed areas immediately after construction. If weather conditions cause a delay in establishing vegetation, the area shall be mulched in accordance with the standard for mulching. Refer to specification **Ds1 - Disturbed Area Stabilization (With Mulching Only)**. Seeding, fertilizing and mulching shall conform to the standard for permanent vegetative cover. Refer to specification **Ds3-Disturbed Area Stabilization (With Permanment Vegetation).**

12. All temporary access roads or travelways shall be appropriately closed to exclude traffic.

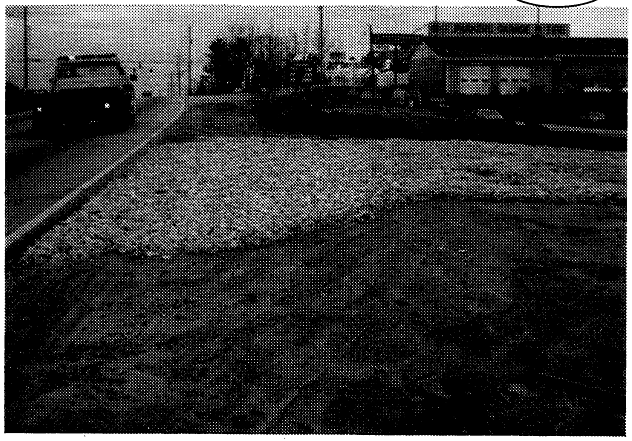
13. Trees and other fallen natural vegetation not causing a deterrent to stream flow should be left for the purpose of habitat.

TO BE SHOWN ON THE EROSION AND SEDIMENT CONTROL PLAN

1. **The velocity in the channel**, in ft/sec, for when the channel is flowing at the bank-full discharge or 25-year frequency discharge, whichever is the lesser.

2. **The type of lining to be used** to stabilize the channel, *i.e.* vegetation (**Ch-V**: indicate type of vegetation and matting or blanket to be used), riprap (**Ch-Rp**: indicate average stone size), or concrete (**Ch-C**).

Construction Exit (Co)



DEFINITION

A stone stabilized pad located at any point where traffic will be leaving a construction site to a public right-of-way, street, alley, sidewalk or parking area or any other area where there is a transition from bare soil to a paved area.

PURPOSE

To reduce or eliminate the transport of mud from the construction area onto public rights-of-way by motor vehicles or by runoff.

CONDITIONS

This practice is applied at appropriate points of construction egress. Geotextile underliners are required to stabilize and support the pad aggregates.

DESIGN CRITERIA

Formal design is not required. The following standards shall be used:

Aggregate Size

Stone will be in accordance with National Stone Association R-2 (1.5 to 3.5 inch stone).

Pad Thickness

The gravel pad shall have a minimum thickness of 6 inches.

Pad Width

At a minimum, the width should equal full width of all points of vehicular egress, but not less than 20 feet wide.

Washing

If the action of the vehicle travelling over the gravel pad does not sufficiently remove the mud, the tires should be washed prior to entrance onto public rights-of-way. When washing is required, it shall be done on an area stabilized with crushed stone and provisions that intercept the sediment-laden runoff and direct it into an approved sediment trap or sediment basin.

Location

The exit shall be located or protected to prevent sediment from leaving the site.

CONSTRUCTION SPECIFICATIONS

It is recommended that the entrance area be excavated to a depth of 3 inches and be cleared of all vegetation and roots.

Diversion Ridge

On sites where the grade toward the paved area is greater than 2%, a diversion ridge 6 to 8 inches high with 3:1 side slopes shall be constructed across the foundation approximately 15 feet above the road.

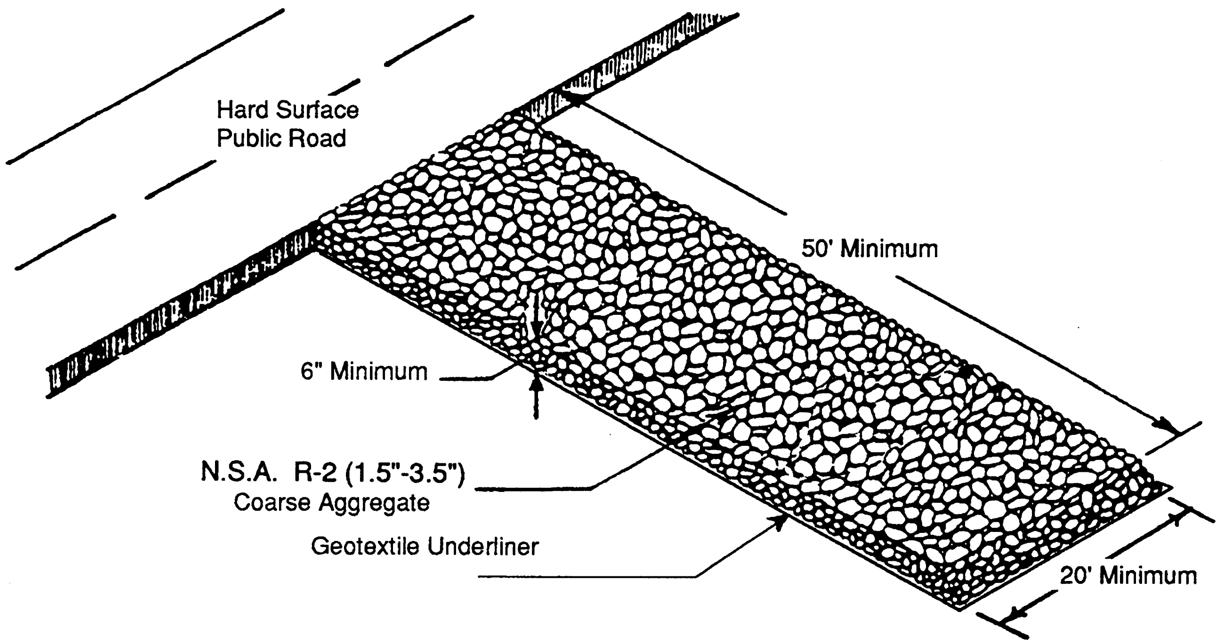
Geotextile

The geotextile underliner must be placed the full length and width of the entrance. Geotextile selection shall be based on AASHTO M288-98 specification:

1. For subgrades with a CBR greater than or equal to 3 or shear strength greater than 90 kPa, geotextile must meet requirements of section AASHTO M288-96 Section 7.3, *Separation Requirements*.
2. For subgrades with a CBR between 1 and 3 or sheer strength between 30 and 90 kPa, geotextile must meet requirements of section AASHTO M288-96 Section 7.4, *Stabilization Requirements*.

MAINTENANCE

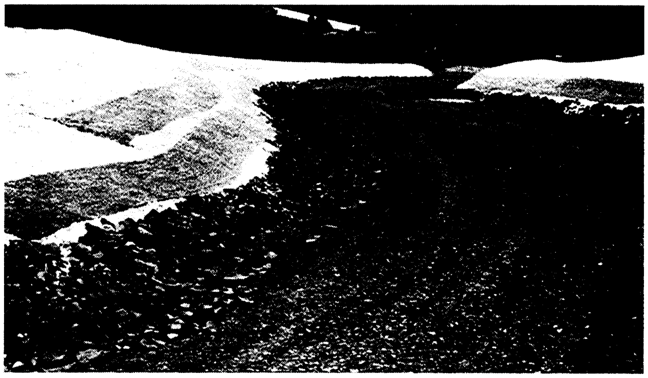
The exit shall be maintained in a condition which will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with 1.5 -3.5 inch stone, as conditions demand, and repair and/or cleanout of any structures to trap sediment. All materials spilled, dropped, washed, or tracked from vehicles or site onto roadways or into storm drains must be removed immediately.



CRUSHED STONE CONSTRUCTION EXIT

Figure 6-11.1

Construction Road Stabilization (Cr)



DEFINITION

A travelway constructed as part of a construction plan including access roads, subdivision roads, parking areas, and other on-site vehicle transportation routes.

PURPOSE

To provide a fixed route for travel for construction traffic and reduce erosion and subsequent regrading of permanent roadbeds between time of initial grading and final stabilization.

CONDITIONS

This practice is applicable where travelways are needed in a planned land use area or wherever stone-base roads or parking areas are constructed, whether permanent or temporary, for use by construction traffic.

PLANNING 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 rilling and muddying of the areas, requiring regrading before paving. The soil removed during this process may enter streams and other waters of the state via stormwater management systems, compromising the water quality. Also, because the roads become so unstable during wet weather, they are virtually unusable, limiting access, and causing delays in construction.

DESIGN CRITERIA

TEMPORARY ROADS AND PARKING AREAS

The type of vehicle or equipment, speed, loads, climatic, and other conditions under which vehicles and equipment are expected to operate shall be considered.

Location

Temporary roads shall be located to serve the purpose intended, facilitate the control and disposal of water, control or reduce erosion, and make the best use of topographic features.

Temporary roads shall follow the contour of the natural terrain to minimize disturbance of drainage patterns. If a temporary road must cross a stream, the crossing must be designed, installed and maintained according to specification **Sr - Temporary Stream Crossing**.

Temporary parking areas should be located on naturally flat areas to minimize grading.

Grade and Alignment

The gradient and vertical and horizontal alignment shall be adapted to the intensity of use, mode of travel, and level of development.

Grades for temporary roads should not exceed ten percent except for very short lengths (200 feet or less), but maximum grades of 20 percent or more may be used if necessary for special uses. Frequent grade changes generally cause fewer erosion problems than long continuous gradients.

Curves and switchbacks must be of sufficient radius for trucks and other large vehicles to negotiate easily. On temporary roads, the radius should be no less than 35 feet for standard vehicles and 50 feet for tractor-trailers.

Grades for temporary parking areas should be sufficient to provide drainage but should not exceed four percent.

Width

Temporary roadbeds shall be at least 14 feet wide for one-way traffic and 20 feet wide for two-way traffic. The width for two-way traffic shall be increased approximately four feet for trailer traffic. A minimum shoulder width shall be two feet on each side. Where turnouts are used, road width shall be increased to a minimum of 20 feet for a distance of 30 feet.

Side Slopes

All cuts and fills shall have side slopes designed to be stable for the particular site conditions and soil materials involved. All cut and fills shall be 2:1 or flatter to the extent possible. When maintenance by machine mowing is planned, side slopes shall be no steeper than 3:1.

Drainage

The type of drainage structure used will depend on the type of enterprise and runoff conditions. The capacity and design shall be consistent with sound engineering principles and shall be adequate for the class of vehicle, type of road, development, or use. Structures should be designed to withstand flows from a 25-year, 24-hour frequency storm or the storm specified in Title 12-7-1 of the Official Code of Georgia Annotated. Channels shall be designed to be on stable grades or protected with structures or linings for stability.

Water breaks or bars may be used to control surface runoff on low-intensity use roads.

Stabilization

Geotextile should be applied to the roadbed for additional stability. Geotextile selection shall be based on AASHTO M288-98 specification:

1. For subgrades with a CBR greater than or equal to 3 or shear strength greater than 90 kPa, geotextile must meet requirements of section AASHTO M288-96 Section 7.3, *Separation Requirements*.
2. For subgrades with a CBR between 1 and 3 or sheer strength between 30 and 90 kPa, geotextile must meet requirements of section AASHTO M288-96 Section 7.4, *Stabilization Requirements*.

A 6-inch course of coarse aggregate shall be applied immediately after grading or the completion of utility installation within the right-of-way. In areas experiencing "heavy duty" traffic situations, stone should be placed at an 8 to 10 inch depth to avoid excessive dissipation or maintenance needs.

All roadside ditches, cuts, fills, and disturbed areas adjacent to parking areas and roads shall be stabilized with appropriate temporary or permanent vegetation according to specification in **Ds2 and Ds3 - Disturbed Area Stabilization (With Temporary Seeding) and Disturbed Area Stabilization (With Permanent Vegetation)**.

PERMANENT ROADS AND PARKING AREAS

Permanent roads and parking areas shall be designed and constructed according criteria established by the Georgia Department of Transportation or local authority. Permanent roads and parking areas shall be stabilized in accordance with this specification, applying an initial base course of gravel immediately following grading.

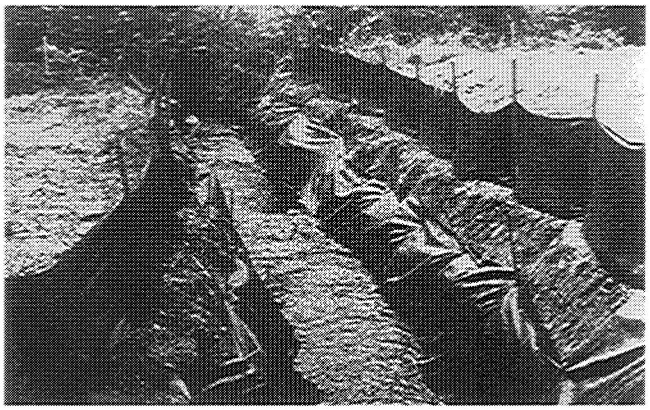
CONSTRUCTION SPECIFICATIONS

1. Trees, stumps, roots, brush, weeds, and other objectionable materials shall be removed from the work area.
2. Unsuitable material shall be removed from the roadbed and parking areas
3. Grading, subgrade preparation, and compaction shall be done as needed. Fill material shall be deposited in layers not to exceed 9 inches and compacted with the controlled movement of compacting and earth moving equipment.
4. The roadbed and parking area shall be graded to the required elevation. Subgrade preparation and placement of the surface course shall be in accordance with sound highway construction practice.
5. Structures such as culverts, pipe drops, or bridges shall be installed to the lines and grades shown on the plans or as staked in the field. Pipe conduits shall be placed on a firm foundation. Selected backfill material shall be placed around the conduit in layers not to exceed 6 inches. Each layer shall be properly compacted.
6. Roads shall be planned and laid out according to good landscape management principles.

MAINTENANCE

Roads and parking areas may require a periodic top dressing of gravel to maintain the gravel depth at 6 inches. Vegetated areas should be checked periodically to ensure a good stand of vegetation is maintained. Remove any silt or other debris causing clogging of roadside ditches or other drainage structure.

Stream Diversion Channel (Dc)



DEFINITION

A temporary channel constructed to convey flow around a construction site while a permanent structure is being constructed in the stream channel.

PURPOSE

To protect the streambed from erosion and allow work "in the dry".

CONDITIONS

Temporary stream diversion channels shall be used only on flowing streams with a drainage area less than one square mile. Structures or methodology for crossing streams with larger drainage areas should be designed by methods which more accurately define the actual hydrologic and hydraulic parameters which will affect the functioning of the structure.

PLANNING CONSIDERATIONS

Linear projects, such as utilities or roads, frequently cross and impact live streams creating a potential for excessive sediment loss into a stream by both the disturbance of the approach areas and by the work within the streambed and banks.

In cases where in-stream work is unavoidable, the amount of encroachment and time spent working in the channel shall be minimized. If construction in the streambed will take an extended period of time, substantial in-stream controls or stream diversion channel should be considered to prevent excessive sedimentation damage. To limit land-disturbance, overland pumping of the stream should be considered in low-flow conditions. Clearing of the stream bed and banks shall be kept to a minimum.

DESIGN CRITERIA

Drainage Area

Temporary stream diversion channels shall not be used on streams with a drainage area greater than one square mile (640 acres).

Size

The bottom width of the stream diversion shall be a minimum of six feet or equal to the bottom width of the existing streambed, whichever is greater.

Side Slopes

Side slopes of the stream diversion channel shall be no steeper than 2:1.

STREAM DIVERSION CHANNEL LININGS

Lining Materials	Symbol	Acceptable Velocity Range
Geotextile, polyethylene film, or sod	Dc-A	0 - 2.5 fps
Geotextile alone	Dc-B	2.5 - 9.0 fps
Class I riprap and geotextile	Dc-C	9.0 - 13.0 fps

Table 6-12.1

Depth and Grade

Depth and grade may be variable, dependent on site conditions, but shall be sufficient to ensure continuous flow of water in the diversion.

Channel Lining

A stream diversion channel shall be lined to prevent erosion of the channel and sedimentation in the stream. The lining is selected based upon the expected velocity of bankfull flow. Table 6-12.1 shows the selection of channel linings that may be used. Refer to specification **Mb - Matting and Blankets**.

Geotextile

Geotextiles should be used as a protective cover for soil or, if the channel is to be lined with rip-rap, as a separator between graded stone and the soil base. The geotextile will prevent erosion of the channel and the migration of soil particles from the subgrade into the graded stone. The geotextile shall be specified in accordance with AASHTO M288-96 Section 7.5, *Permanent Erosion Control Recommendations*. The geotextile should be placed immediately adjacent to the subgrade without any voids.

CONSTRUCTION SPECIFICATIONS

1. The channel shall be excavated, constructing plugs at both ends. Plugs can be constructed of compacted soil, riprap, sandbags or sheet piling.
2. Silt fence or a berm shall be placed along the sides of the channel to prevent unfiltered runoff from entering the stream. The berm can be constructed using the material excavated for the stream diversion.
3. The channel surface shall be smooth (to prevent tearing of the liner) and lined with the material specified in the plans. The outer edges of the geotextile shall be secured at the top of the channel with compacted soil.
4. The plugs are removed when the liner installation is complete, removing the downstream plug first.
5. As soon as construction in the streambed is complete, the diversion shall be replugged and backfilled. The liner should be inspected for damage and salvaged if possible.

4\. Upon removal of the lining, the stream shall immediately be restored and properly stabilized.

MAINTENANCE

The stream diversion channel shall be inspected at the end of each day to make sure that the construction materials are positioned securely. This will ensure that the work area stays dry and that no construction materials float downstream. All repairs shall be made immediately.

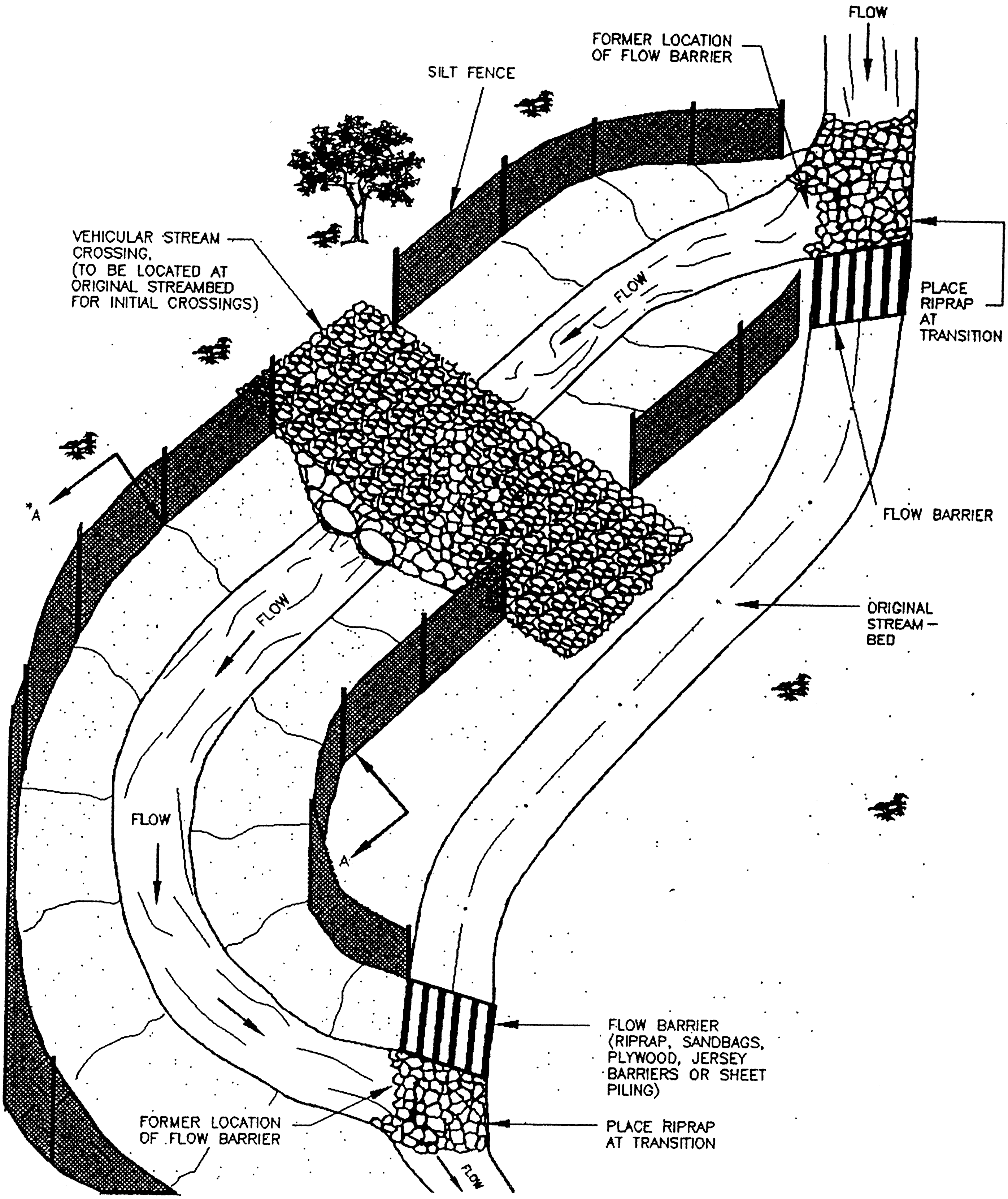
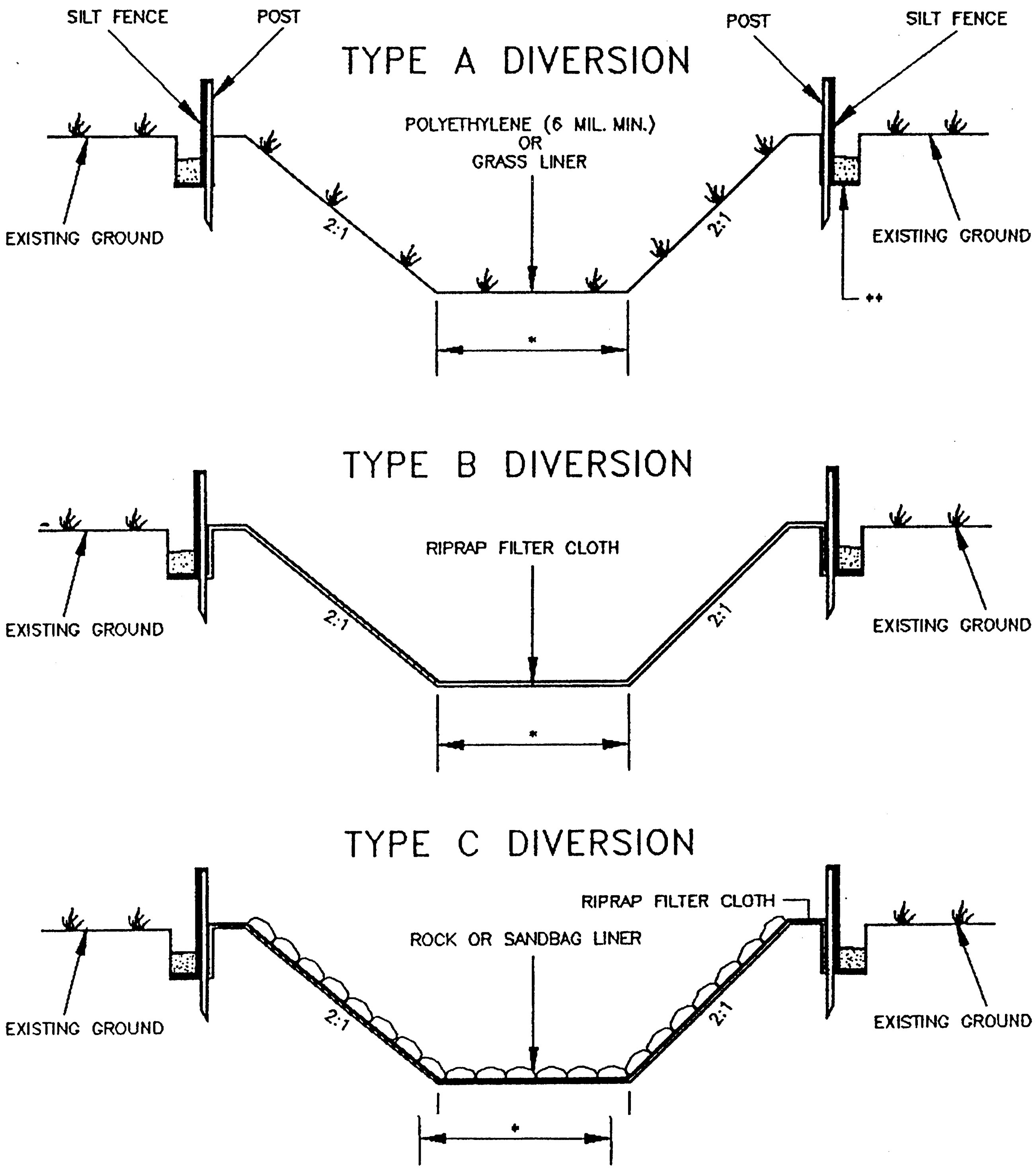


Figure 6-12.1 Stream diversion channel (perspective view).



* 6' MINIMUM OR WIDTH OF EXISTING STREAM WHICHEVER IS LESS

** ENTRENCH SILT FENCE AND FILTER CLOTH IN SAME TRENCH

Figure 6-12.2 Stream diversion channel linings.

Diversion

Di

DEFINITION

A ridge of compacted soil, constructed above, across or below a slope.

PURPOSE

To reduce the erosion of steep, or otherwise highly erodible areas by reducing slope lengths, intercepting storm runoff and diverting it to a stable outlet at a non-erosive velocity.

CONDITIONS

Diversions are applicable when:

1. Runoff from higher areas is or has potential for damaging property, causing erosion, contributing to pollution, flooding, 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 slope needs to be reduced so that soil loss will be reduced to a minimum.

This standard applies to temporary and permanent diversions in developments involving land-disturbing activities.

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. Diversions should be tailored to fit the conditions for a particular field and local soil type(s).

A diversion consists of two components that must be designed - the ridge and the channel.

Ridge Design

The ridge shall be compacted and designed to have stable side slopes, which shall not be steeper than 2:1. The ridge shall be a minimum width of four feet at the design water elevation after settlement. Its design shall allow ten percent for settlement.

Channel Design

Land slope must be taken into consideration when choosing channel dimensions. On the steeper slopes, narrow and deep channels may be required. On the more gentle slopes, broad, shallow channels usually are applicable. The wide, shallow section will be easier to maintain. Since sediment deposition is often a problem in diversions, the designed flow velocity should be kept as high as the channel lining will permit.

Table 6-13.1 indicates the storm frequency required for the design of the diversion. The required storm frequency is based on the purpose of the diversion. The storm frequency is used to determine the required channel capacity, Q (peak rate of runoff).

The channel portion of the diversion may have a parabolic or trapezoidal cross-section. Detailed information for the design of these channels is provided in the specification **Wt - Stormwater Conveyance Channel**.

Outlets

Each diversion must have an adequate outlet. The outlet may be a constructed or natural waterway, a stabilized vegetated area or a stabilized open channel. In all cases, the outlet must discharge in such a manner as to not cause an erosion problem. Protected outlets shall be constructed and stabilized prior to construction of the diversion.

Stabilization

Channels shall be stabilized in accordance with item 5 of the construction specifications on page 6-94.

DIVERSIONS FOR ROADS AND UTILITY RIGHTS-OF-WAY

A detailed design is not required for this type of diversion. Diversions installed to divert water off a road or right-of-way shall consist of a series of compacted ridges of soil running diagonally across the road at a 30° angle. Ridges are constructed by excavating a channel up-stream for this type of diversion.

The compacted ridge height shall be 8-12" above the original road surface; the channel depth shall be 8-12" below the original road surface. Channel bottoms and ridge tops shall be smooth enough to be crossed by vehicular traffic. The maximum spacing between diversions shall be as follows:

Road Grade (Percent)	**Distance Between Diversions** (Feet)
1	400
2	250
5	125
10	80
15	60
20	50

Stable outlets shall be provided for each diversion.

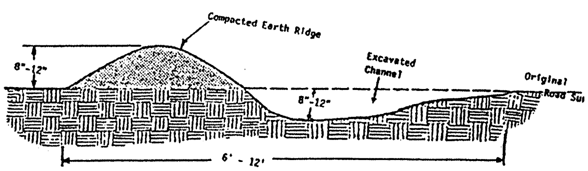


Figure 6-13.1 Typical diversion across road.

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 free of irregularities which will impede normal flow.
3. All fills shall be machine compacted as needed to prevent unequal settlement that would cause damage in the completed 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. Diversion channel shall be stabilized in accordance with specification **Ch - Channel Stabilization**.

Table 6-13.1 Diversion Design Criteria

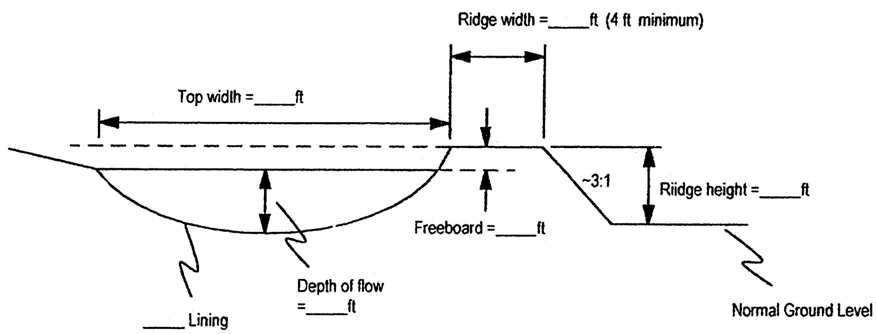
Diversion Type	Land or Improvement Protected	Storm[1] Frequency	Freeboard	Minimum Top Width
Temporary	Construction areas Building sites	10 years[2]	0.3'	4 feet
Permanent	Landscaped, recreation and similar areas.	25 years	0.3'	4 feet
	Dwellings, schools, commercial bldgs., and similar installations.	50 years	0.5'	4 feet

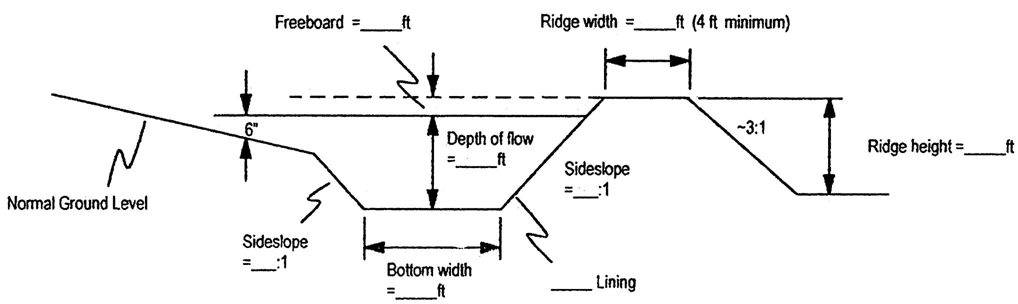
[1] Use 24-hour storm duration

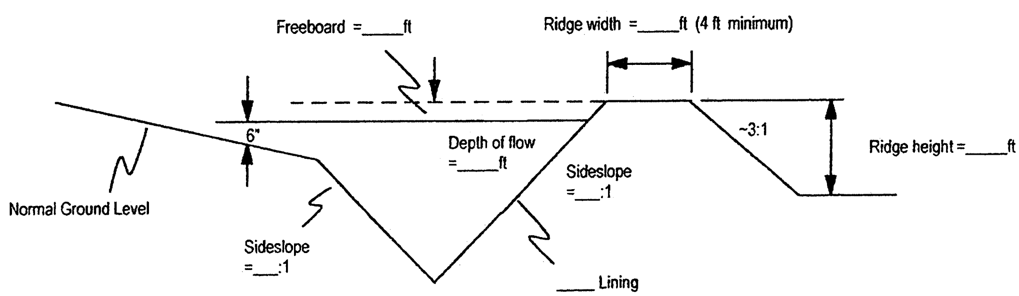
[2] Use 10 years or the storm frequency specified in Title 12 of the Official Code of Georgia Annotated

TO BE SHOWN ON THE EROSION AND SEDIMENT CONTROL PLAN

Complete the appropriate detail drawing for the channel cross-section of choice:







Temporary Downdrain Structure

Dn1

DEFINITION

A temporary structure used to convey concentrated storm water down the face of cut or fill slopes.

PURPOSE

To safely conduct storm runoff from one elevation to another without causing slope erosion and allowing the establishment of vegetation on the slope.

CONDITIONS

Temporary downdrains are used on slopes where a concentration of storm water could cause erosion damages. **These structures are removed once the permanent stormwater disposal system is installed.**

DESIGN CRITERIA

Formal design is not required. The following standards shall be used:

Placement

The temporary downdrain shall be located on undisturbed soil or well-compacted fill.

Diameter

The diameter of the temporary downdrain shall provide sufficient capacity required to convey the maximum runoff expected during the life of the drain. Refer to Table 6-14.1 for selecting pipe sizes.

Pipe Diameter for Temporary Downdrain Structure

Maximum Drainage Area Per Pipe (acre)	**Pipe Diameter** (inches)
0.3	10
0.5	12
1.0	18

Table 6-14.1

Downdrain Inlet and Outlet

Diversions are used to route runoff to the downdrain's Tee or "L" inlet at the top of the slope. Slope the entrance 1/2" per foot toward the outlet. Thoroughly compact selected soil around the inlet section to prevent the pipe from being washed out by seepage or piping. A stone filter ring or check dam may be placed at the inlet for added sediment filtering capacity. Refer to **Cd - Check Dam** and **Fr - Stone Filter Ring**. These sediment filtering devices should be removed if flooding or bank overwash occurs.

Rock riprap shall be placed at the outlet for energy dissipation. A Tee outlet, flared end section, or other suitable device may be used in conjunction with the riprap for additional protection. See Figure 6-14.1. Refer to **St - Storm Drain Outlet Protection**.

Pipe Material

Design the slope drain using heavy-duty, flexible materials such as non-perforated, corrugated plastic pipe or specially designed flexible tubing. Use reinforced, hold-down grommets or stakes to anchor the pipe at intervals not to exceed 10 feet with the outlet end securely fastened in place. The pipe must extend beyond the toe of the slope.

CONSTRUCTION SPECIFICATIONS

A common failure of slope drains is caused by water saturating the soil and seeping along the pipe. This creates voids from consolidation and piping causes washouts. Proper back-filling around and under the pipe "haunches" with stable soil material and hand compacting in 6-inch lifts to achieve firm contact between the pipe and the soil at all points will eliminate this type of failure.

1. Place slope drains on undisturbed soil or well-compacted fill at locations and elevations shown on the plan.
2. Slightly slope the section of pipe under the dike toward its outlet.

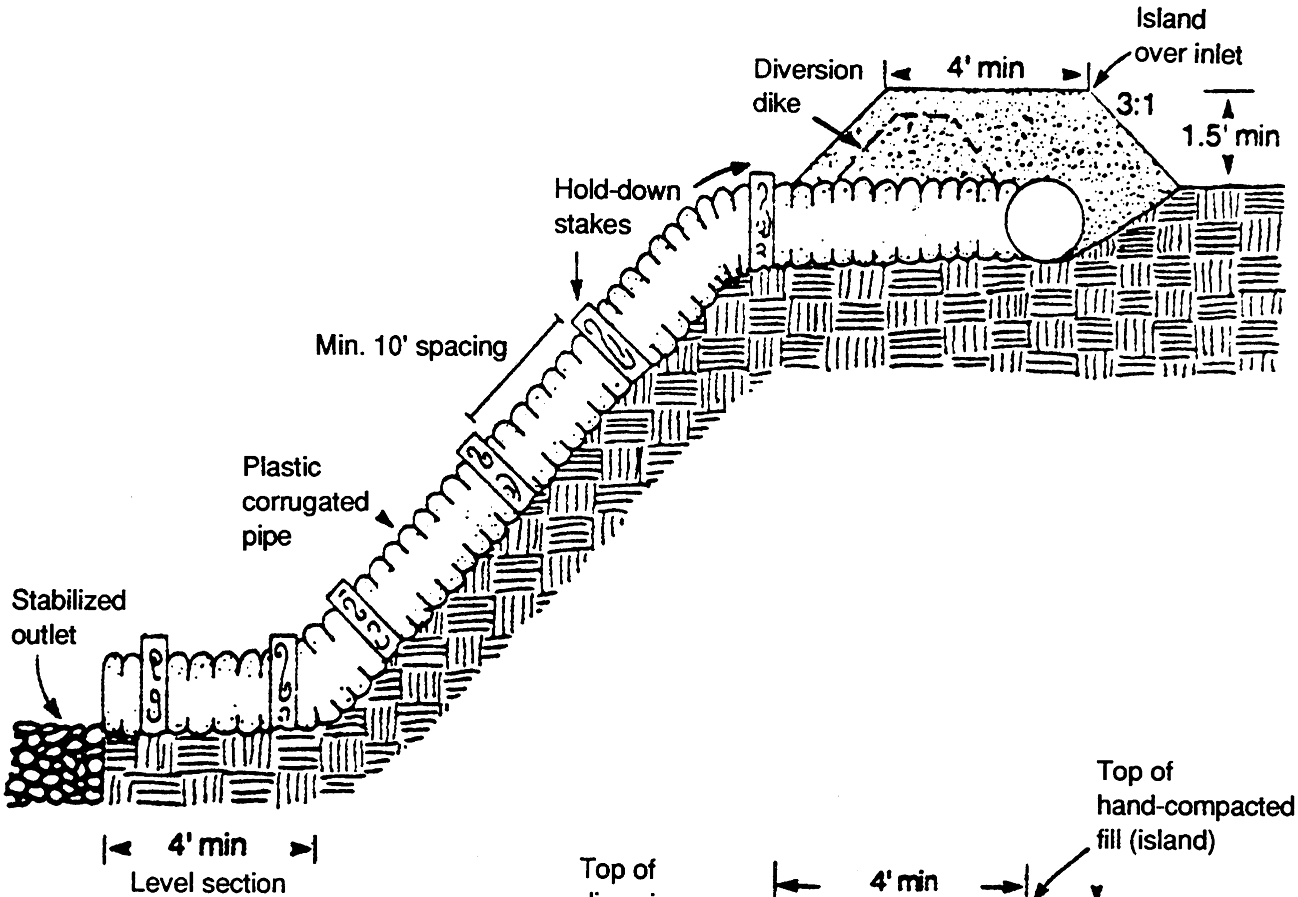
3. Hand tamp the soil under and around the entrance section in lifts not to exceed 6 inches.
4. Ensure that fill over the drain at the top of the slope has minimum dimensions of 1.5 ft. depth, 4 ft. top width, and 3:1 side slopes.
5. Ensure that all slope drain connections are water-tight.
6. Ensure that all fill material is well-compacted. Securely fasten the exposed section of the drain with grommets or stakes spaced no more than 10 feet apart.
7. Place the drain slightly diagonally across the slope, extending the drain beyond the toe of the slope. Curve the outlet uphill and adequately protect the outlet from erosion.
8. If the drain is conveying sediment-laden runoff, direct all flows into a sediment trap or sediment basin.
9. Make the settled, compacted dike ridge no less than one foot above the top of the pipe at every point.
10. Immediately stabilize all disturbed areas following construction.

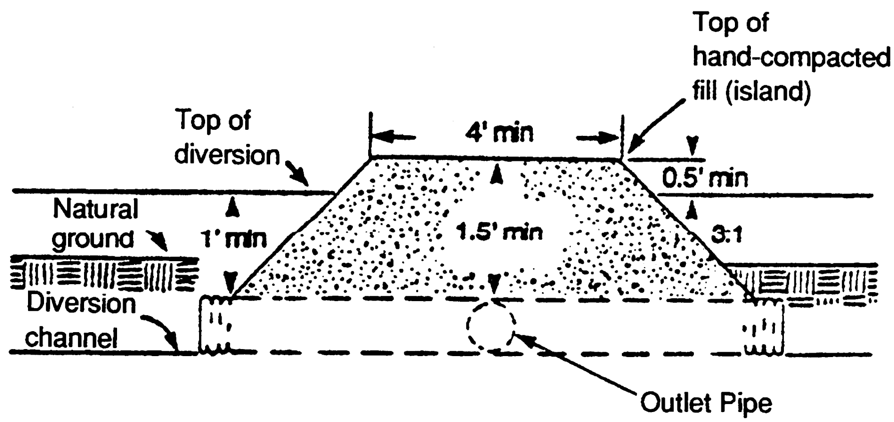
MAINTENANCE

Inspect the slope drain and supporting diversion after every rainfall and promptly make necessary repairs. When the protected area has been permanently stabilized and the permanent stormwater disposal system is fully functional, temporary measures may be removed, materials disposed of properly, and all disturbed areas stabilized appropriately. Refer to specifications **Ds3 and Ds4 - Disturbed Area Stabilization (With Permanent Vegetation and Sodding),** respectively, and **Mb - Matting and Blankets**.

TO BE SHOWN ON THE EROSION AND SEDIMENT CONTROL PLAN

1. **The drainage area for each downdrain,** in acres.
2. **The diameter of each downdrain,** in inches, based on Table 6-14.1.
3. **The dimensions of the outlet protection**, including flow rate, velocity, and apron length, upstream and downstream widths, average stone diameter and depth.





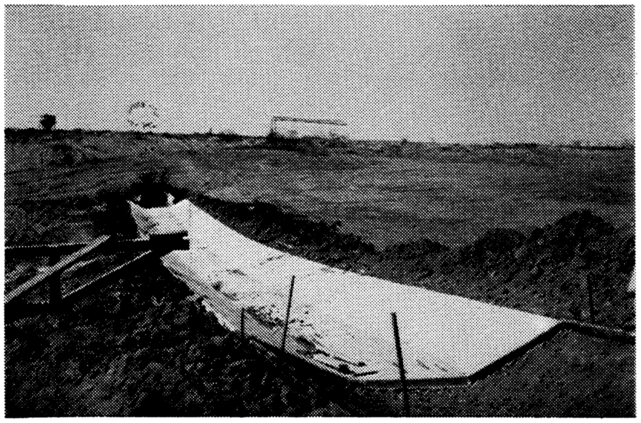
Inlet Detail

Make all pipe connections watertight and secure so that the joints will not separate in use.

DOWNDRAIN PIPE AND INLET DETAIL

Figure 6-14.1

Permanent Downdrain Structure (Dn2)



DEFINITION

A permanent structure to safely convey surface runoff from the top of a slope to the bottom of the slope.

PURPOSE

The purpose of this standard is to convey storm runoff safely down cut or fill slopes to minimize erosion.

CONDITIONS

Several types of structures may be used as a permanent downdrain. All structures shall satisfy the standards and specification set forth by the Georgia Department of Transportation. The following types of structures may be used:

Paved Flume
The paved flume may have a parabolic, rectangular or trapezoidal cross-section.

Pipe
The pipe may be constructed of materials including steel, plastic, etc..

Sectional
A prefabricated sectional conduit of half round or third round pipe may be used.

Downdrain structures are to be used where concentrated water will cause excessive erosion on cut and fill slopes.

DESIGN CRITERIA

Permanent downdrain structures should be designed by professionals familiar with these structures.

Capacity
Flumes shall be adequately designed to safely convey runoff water concentrations down steep slopes based on a minimum 25-year, 24-hour storm in accordance with criteria in Appendix A of this manual.

Slope
The slope shall be sufficient to prevent the deposition of sediment.

Outlet Stabilization
Outlets must be stabilized using criteria in **St - Storm Drain Outlet Protection**.

MAINTENANCE

Inspect for damage after each rainfall.

Filter Ring

Fr

DEFINITION

A temporary stone barrier constructed at storm drain inlets and pond outlets.

PURPOSE

This structure reduces flow velocities, preventing the failure of other sediment control devices. It also prevents sediment from leaving the site or entering drainage systems, prior to permanent stabilization of the disturbed area.

CONDITIONS

Filter rings shall be used in conjunction with other sediment control measures, except where other practices defined in this manual are not appropriate (such as inlets to concrete flumes). They can be installed at or around devices such as inlet sediment traps, temporary downdrain inlets, and detention pond retrofits to provide additional sediment filtering capacity.

DESIGN CRITERIA

Formal design is not required. The following standards shall be used:

Location

The filter ring shall surround all sides of the structure receiving runoff from disturbed areas. It should be placed a minimum of four feet from the structure. The ring is not intended to substantially impound water, causing flooding or damage to adjacent areas.

The filter ring may also be placed below storm drains discharging into detention ponds, creating a centralized area, or "forebay", for sediment accumulation. This provides for easier, more localized clean-out of the pond. If utilized above a retrofit structure, it should be a minimum of 8 to 10 feet from the retrofit.

Stone Size

When utilized at inlets with diameters less than 12 inches, the filter ring shall be constructed of stone no smaller than 3-5 inches (15 - 30 lbs.).

When utilized at pipes with diameters greater than 12 inches, the filter ring shall be constructed of stone no smaller than 10-15 inches (50 - 100 lbs.).

The larger stone can be faced with smaller filter stone on the upstream side for added sediment filtering capabilities. However, the smaller filter stone is more prone to clogging, requiring higher maintenance.

Height

The filter ring shall be constructed at a height no less than two feet from grade.

CONSTRUCTION SPECIFICATIONS

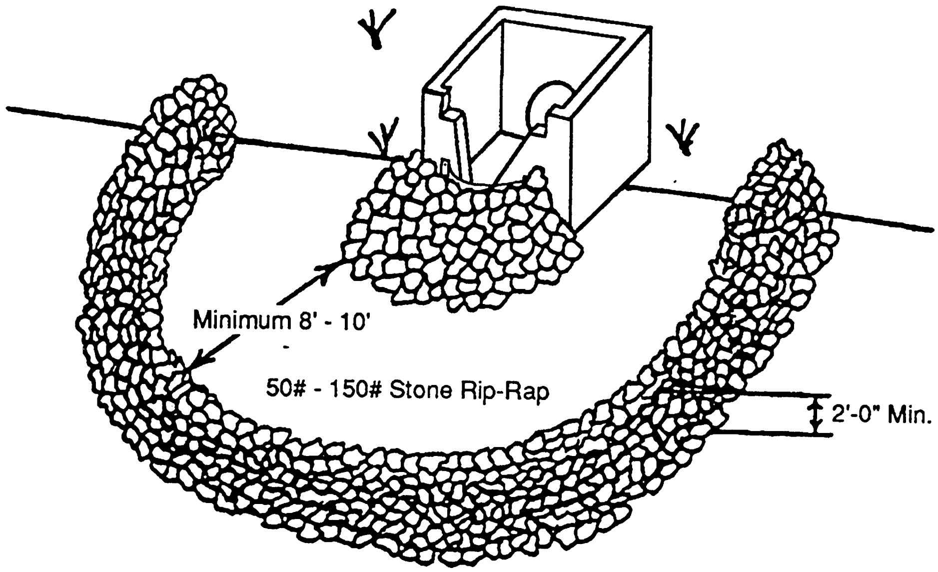
Mechanical or hand placement of stone shall be required to uniformly surround the structure to be supplemented. Refer to Appendix C for rock riprap specifications.

The filter ring may be constructed on natural ground surface, on an excavated surface, or on machine compacted fill.

A common failure of filter rings is caused by their placement too close or too high above the structure it is enhancing. When utilized below a storm drain outlet, it shall be placed such that it does not create a condition causing water to back-up into the storm drain and inhibit the function of the storm drain system.

MAINTENANCE

The filter ring must be kept clear of trash and debris. This will require continuous monitoring and maintenance, which includes sediment removal when one-half full. Structures are temporary and should be removed when the land-disturbing project has been stabilized.



STONE FILTER RING

Figure 6-15.1

Gabion

Ga

DEFINITION

Gabions are large, multi-celled, welded wire or rectangular wire mesh boxes, used in channel revetments, retaining walls, abutments, check dams, etc.

PURPOSE

Rock-filled baskets, properly wired together, form flexible monolithic building blocks used for construction of erosion control structures. Gabions are used to stabilize steep or highly erosive slopes.

DESIGN CRITERIA

Construction plans and drawings should be prepared by professionals familiar with the use of gabions. Erosion and sediment control construction design should ensure that foundations are properly prepared to receive gabions, that the gabion structure is securely "keyed" into the foundations and abutment surfaces, and that rock used is durable and adequately sized to be retained in the baskets

CONSTRUCTION SPECIFICATIONS

How the Gabion is Filled

The gabion is usually filled with 4 - 8 inch pieces of stone, preferably placed by hand, but sometimes dumped mechanically, into the basket. Hand-packing allows the complete filling of the basket; allowing the basket to gain strength and maintain its integrity. The filled gabion then becomes a large, flexible, and permeable building block from which a broad range of structures may be built. This is done by setting and wiring individual units together in courses and filling them in place. Details are provided by the manufacturer.

Geotextiles

It is recommended that geotextiles be used behind all gabion structures. Geotextiles shall be specified in accordance with AASHTO M288-96 Section 7.5, *Permanent Erosion Control Requirements*.

If there is seepage flow or unidirectional flow from the protected soil mass, the appropriate geotextile should be selected based on an appropriate filter design to prevent the build-up of hydrostatic pressure behind the geotextile.

Corrosion Resistance of Gabions

The wire mesh or welded wire used in gabions is heavily galvanized. For highly corrosive conditions, a PVC (polyvinyl chloride) coating must be used over the galvanizing. Such treatment is an economical solution to deterioration of the wire near the ocean, in some industrial areas, in polluted streams, and in soils such as muck and peat. However, extra care should be taken during construction and installation because the corrosion resistance of the baskets is compromised if the PVC coating is chipped-off. Also, baskets manufactured completely of plastic are available.

Flexibility

An outstanding advantage of the gabion is its flexibility of application. This property is especially important when a structure is on unstable ground or in areas where scour from waves or currents can undermine it.

Durability

Gabions are durable because they support plant growth which develops a living coating for the wire mesh and stones. After the first few years, the strength of the structure may be enhanced by the soil, silt, and roots that fill the voids between the individual stones.

Strength

Steel wire baskets have the strength and flexibility to withstand forces generated by water and earth masses. Also, the pervious nature of the gabion allows it to absorb and dissipate much of the energy developed. This is particularly so on coast protection installations where a compact gabion structure often remains long after a massive rigid structure fails.

Permeability

Hydrostatic heads do not develop behind a gabion wall. The wall is pervious to water and stabilizes a slope by the combined action of draining and retaining. Drainage is accomplished by gravity and by evaporation as the porous structure permits active air circulation through it. Moreover, as plant growth invades the structure, transpiration further assists in removing moisture from the backfill. This system is much more efficient than weep holes in standard masonry walls.

Economy

Gabion installations are more economical than rigid or semi-rigid structures for a number of reasons. The following are among the more important ones.

- Little maintenance is required.
- Gabion construction is simple and does not require skilled labor.
- Preliminary foundation preparation is unnecessary; the surface needs only to be reasonably level and smooth.
- No costly drainage provision is required because of the gabion's porosity.

Landscaping

Because gabions permit the growth of natural vegetation and maintain the natural environment of the area, they provide attractive and natural building blocks for decorative landscaping.

They can be used effectively and economically in parks, along highways, including use as a sound barrier, and around bridge approaches to create walkways, rock gardens, patios, and terraces ... to beautify the banks of lakes and ponds ... to accent trees and other plantings.

In fact, their application to decorative landscaping is limited only by the ingenuity of the landscaper.

Typical Installations

- River training and flood control:

Gabion aprons	Counterforts
Longitudinal works	Drop structures or weirs
Training walls	Spurs, spur dikes, or groins
Revetments	
Bank paving	

- Channel linings
- Retaining walls
- Bridge abutments and wings
- Marinas and boat ramps
- Culvert headwalls and outlet aprons
- Shore and beach protection

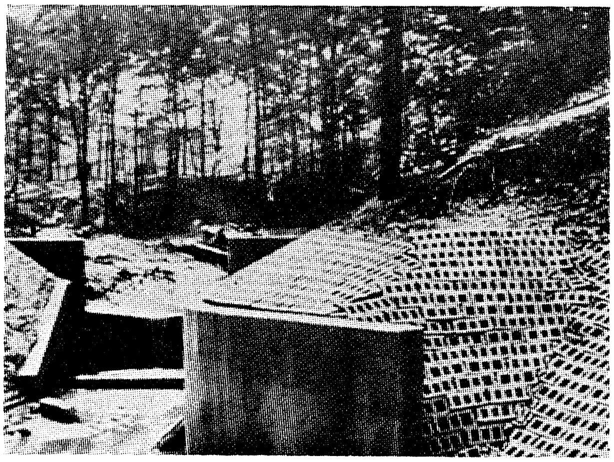
MAINTENANCE

Periodic inspection should be performed for signs of undercutting or excessive erosion at transition areas.

Source: National Crushed Stone Association

Grade Stabilization Structure

Gr



DEFINITION

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

PURPOSE

Grade stabilization structures are installed to stabilize the grade in natural or artificial channels, prevent the formation or advance of gullies, and reduce erosion and sediment pollution.

CONDITIONS

This standard applies to sites where structures are needed to stabilize channel grades but does not apply to sites where water is to be impounded.

DESIGN CRITERIA

Structures

Structures constructed of concrete, rock, masonry, steel, aluminum or treated wood or by soil bioengineering methods shall be designed in accordance with sound engineering practices. Design data for small reinforced concrete drop spillways and formless concrete chute spillways are contained herein.

Geotextile should be placed under stabilization structures such as revetment mats and riprap as part of a permanent erosion control system. The geotextile should be selected/specified in accordance with AASHTO M288-96 Section 7.5, *Permanent Erosion Control.*

Capacity

The condition of adjacent areas is considered when determining the storm frequency used to design the grade stabilization structure. Structures shall be designed to protect areas from overbank flow damage up to and including storm frequencies specified in Table 6-16.1.

Adjacent Area	Storm Frequency
Residences, commercial buildings, recreation buildings, etc.	100-year, 24-hour storm
Recreation and landscaped areas	25-year,[2] 24-hour storm[1]
Agricultural land	25-year,[2] 24-hour storm[1]

[1] 50 percent of peak flood flow may be carried around island-type structures provided overbank flow damage from erosion and flooding can be tolerated. Peak flood flow will be determined by methods contained in Appendix A.
[2] Or the storm frequency specified in Title 12 of the Official Code of Georgia Annotated.

Table 6-16.1

Embankment

Earthfill embankments shall have a minimum top width of 10 feet and side slopes of 3:1 or flatter.

Keyway

A keyway no less than 8 feet wide and 2 feet deep shall be constructed along the centerline of the structure and embankment.

Outlet

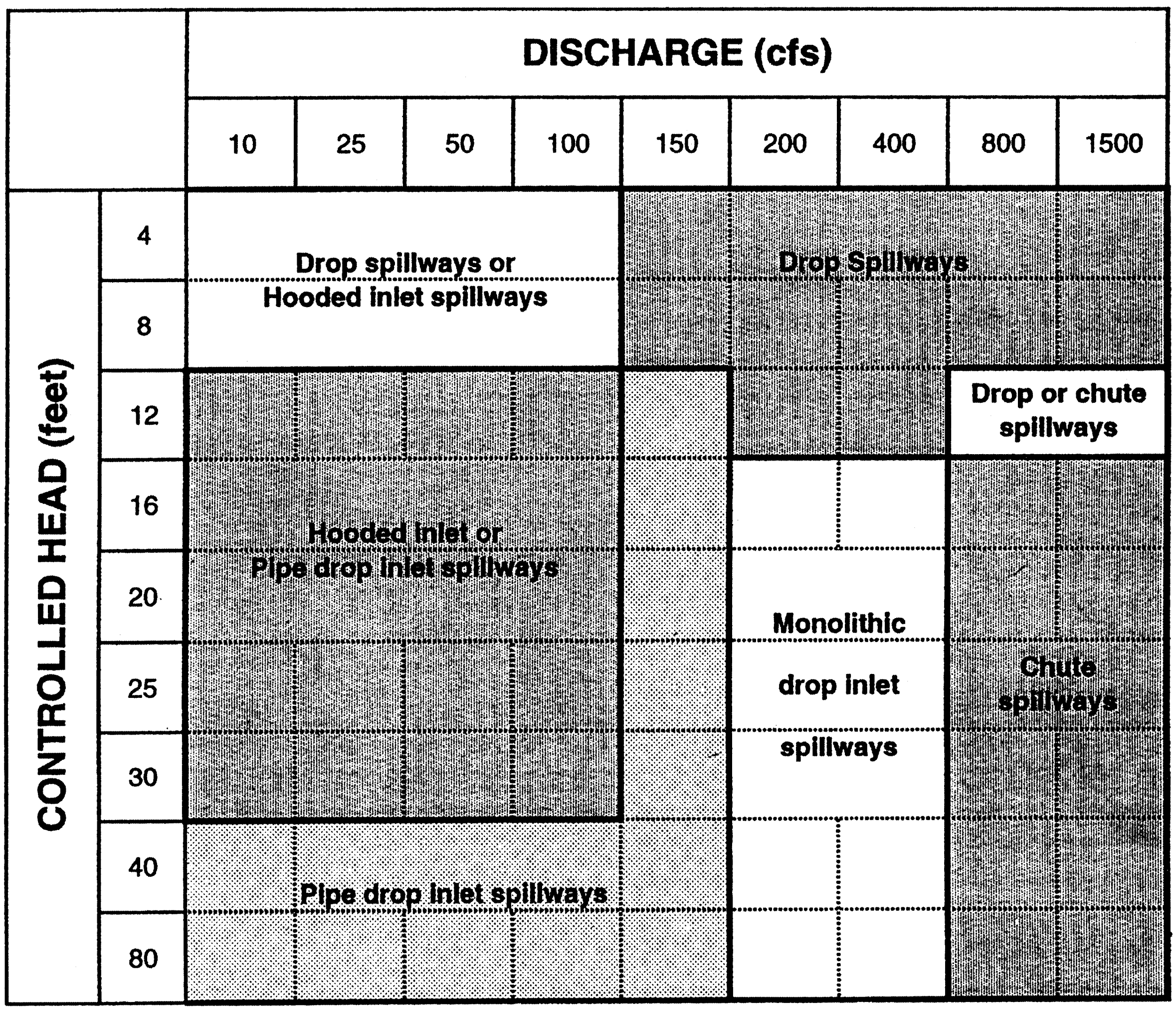
All structures shall discharge into stable outlets.

CONSTRUCTION SPECIFICATIONS

Excavations shall be dewatered prior to filling.

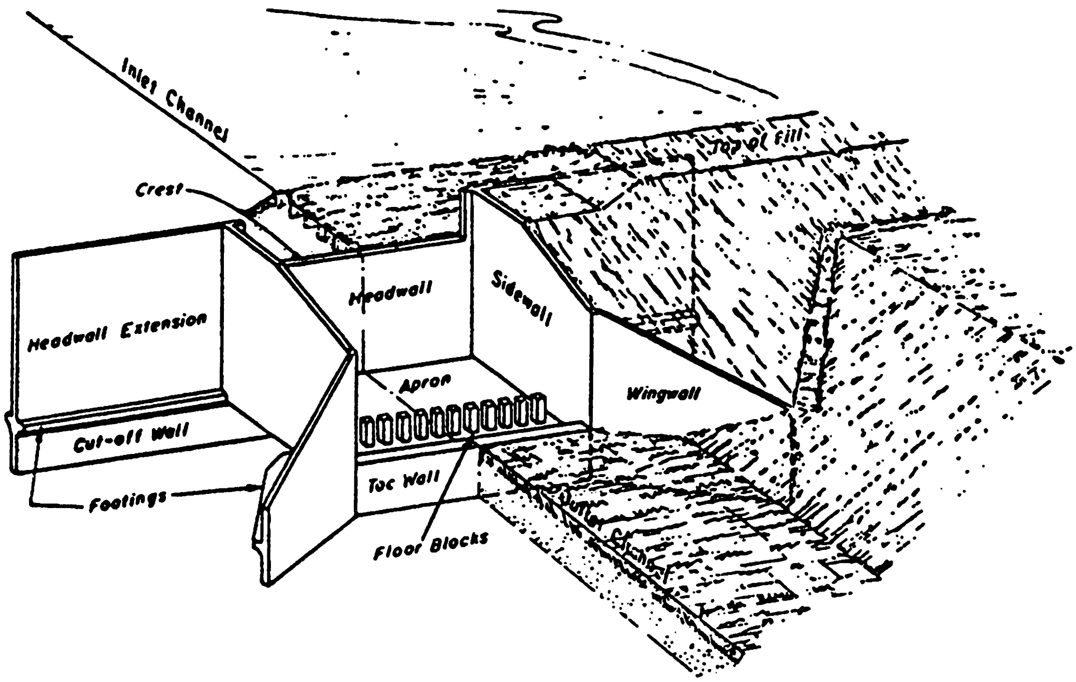
Structures shall be placed on compacted earthfill. Earthfill material shall be moderately to slowly permeable with the most plastic being used in the center of the embankment and adjacent to structures. Materials shall be constructed in 6 - 8 inch horizontal lifts and compacted to approximately 95% of standard density. The embankment shall be overbuilt 10% in height to allow for settlement. Embankment surfaces shall be completed to the required lines and grades.

Protective cover shall be applied immediately after completion of the structure. Refer to specifications **Ds3 and Ds4 - Disturbed Area Stabilization (With Permanent Vegetation and Sodding),** respectively, and **Mb - Matting and Blankets**.



Note: Chart shows most economical structure as related to discharge and controlled head providing site conditions are adequate.

Figure 6-16.1



STRAIGHT DROP SPILLWAY

Figure 6-16.2

Planning and design of straight drop spillways normally require the assistance of an engineer. Local personnel may be trained to plan and install small drop spillway structures when standard plans are available.

Measurement locations for symbols F (overfall in feet), h (depth of weir in feet), s (depth of stilling pool in feet), and L (length of weir in feet) are shown in Figure 6-16.3

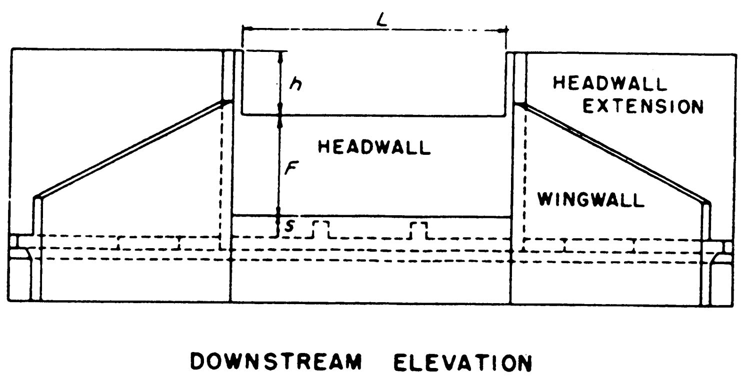
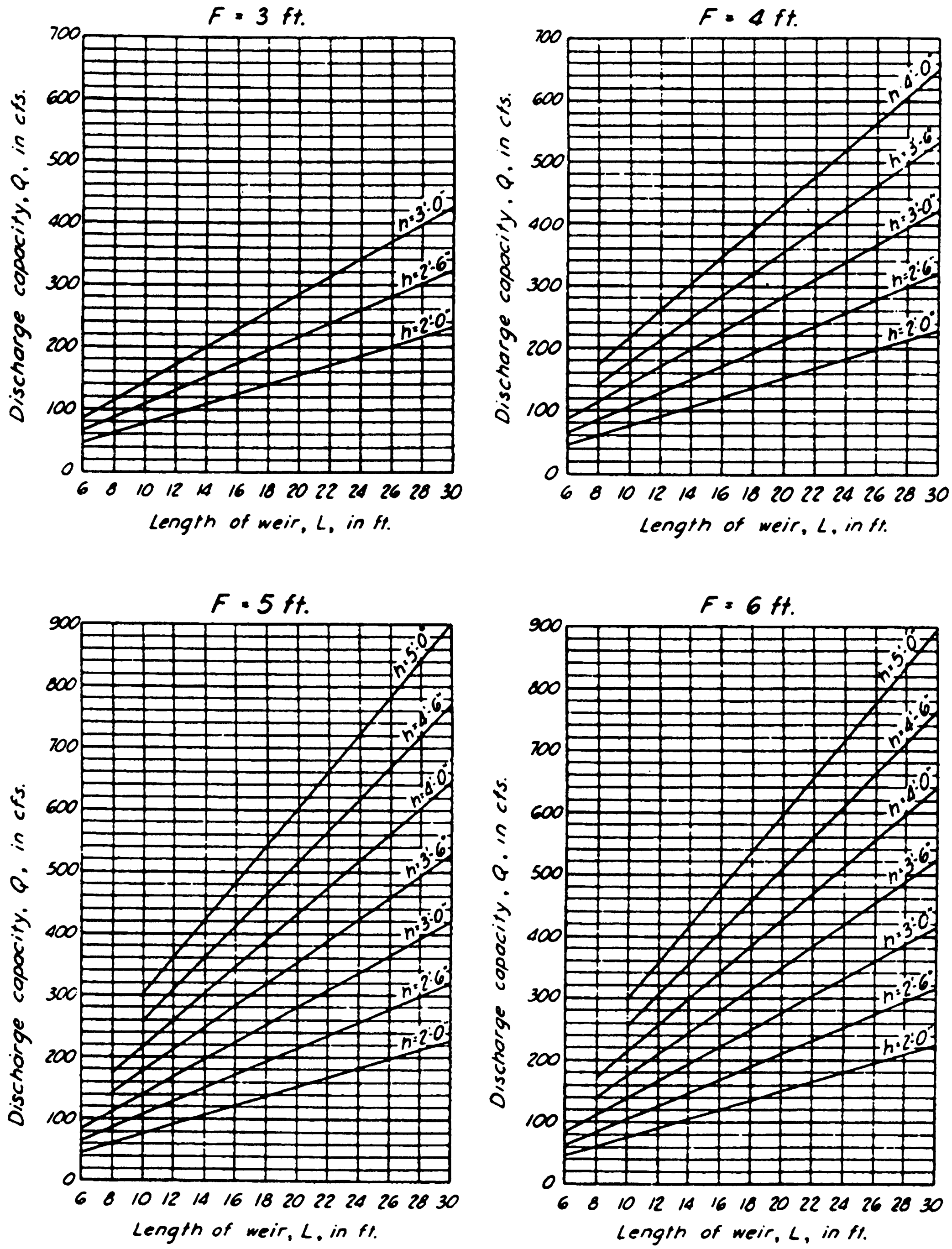


Figure 6-16.3 - Symbols for straight drop spillway.

Weir capacities for low-overall straight drop spillways can be determined from figure 6-16.4 for various combinations of F, h, and L.

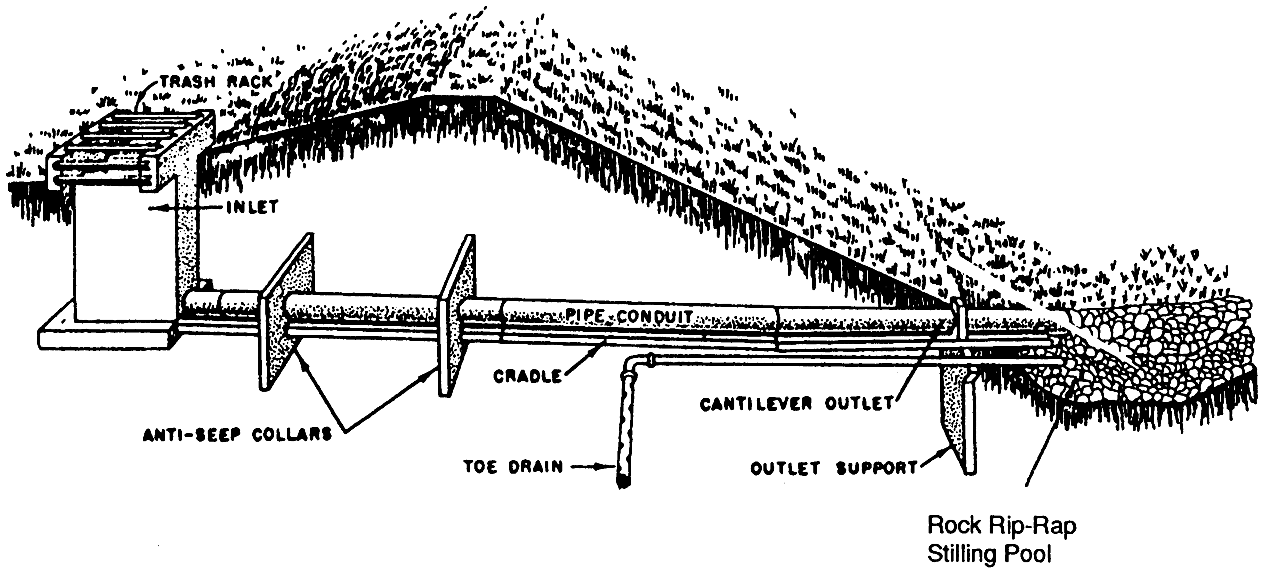


Note: h = total depth of weir, in feet (including freeboard)
c = net drop from crest to top of transverse sill, in feet
(For type B drops keep h ÷ F less than 0.75)

$$Q = \frac{3.1\ Lh^{3/2}}{(1.10 + 0.01\ F)}$$

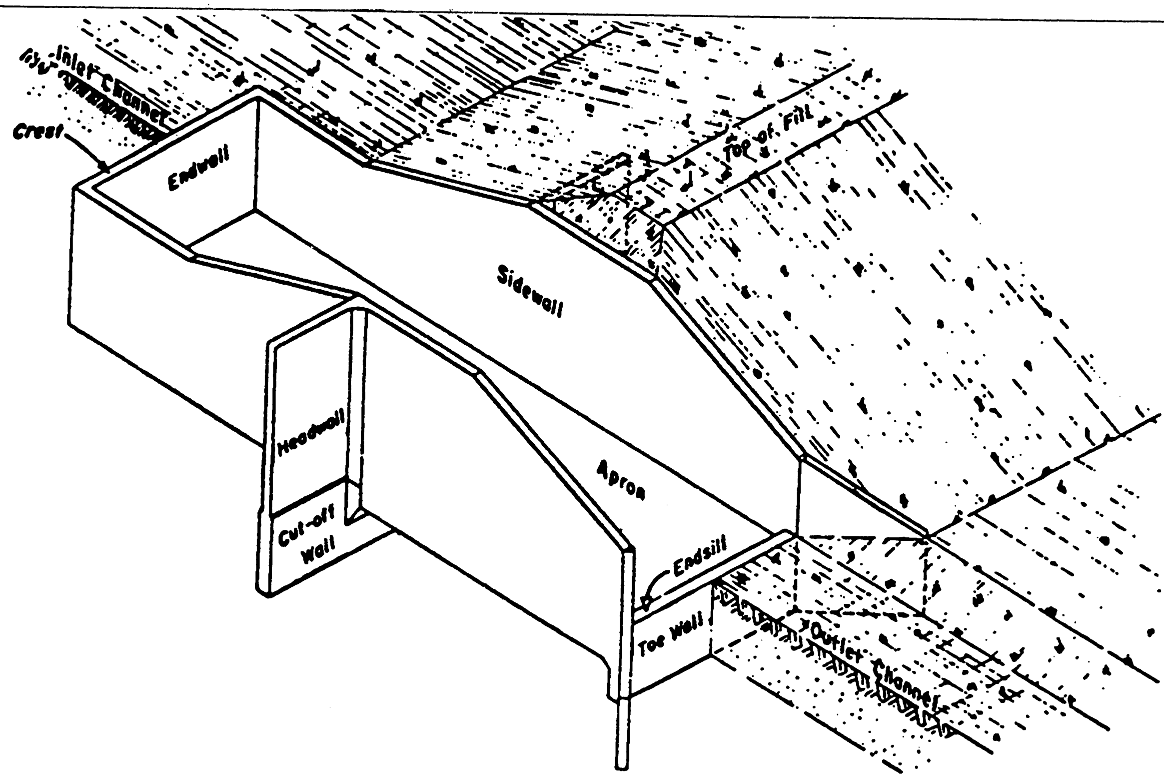
WEIR CAPACITY FOR STRAIGHT DROP SPILLWAYS

Figure 6-16.4



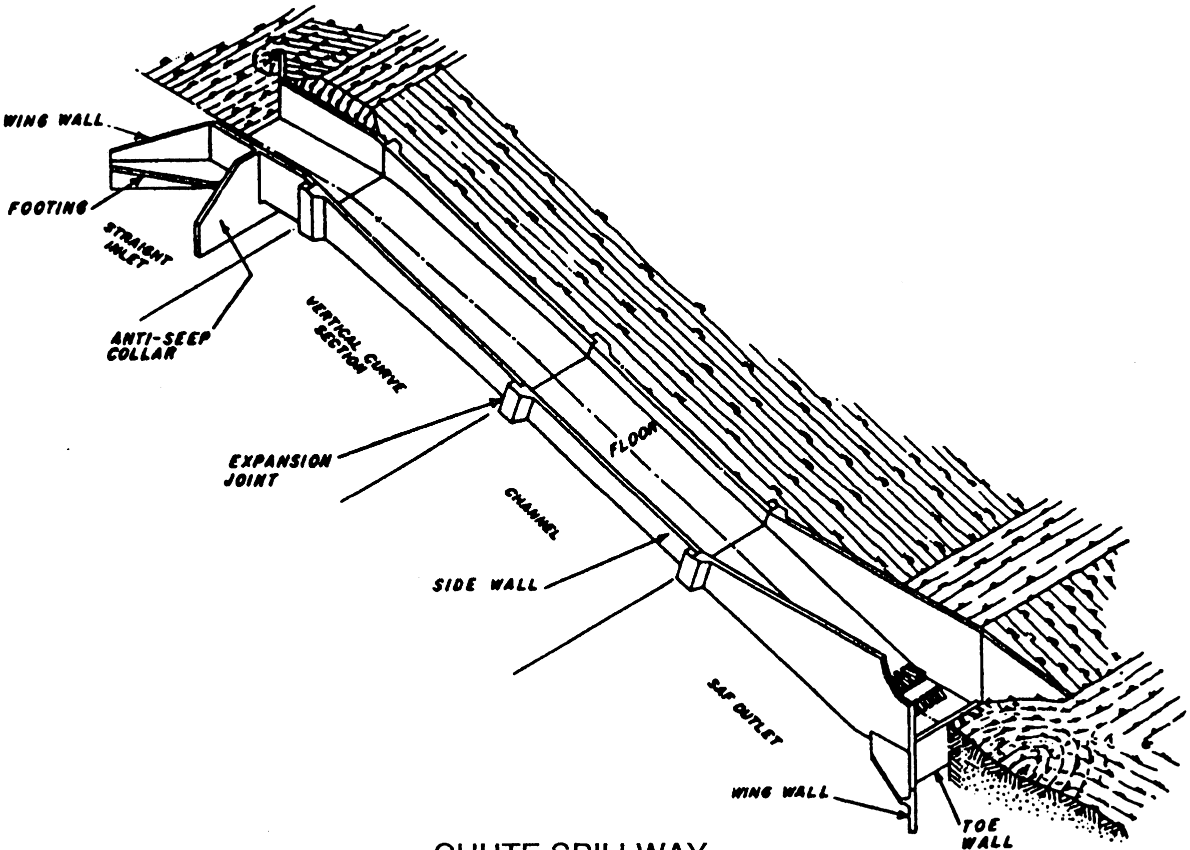
DROP INLET SPILLWAY

Figure 6-16.5



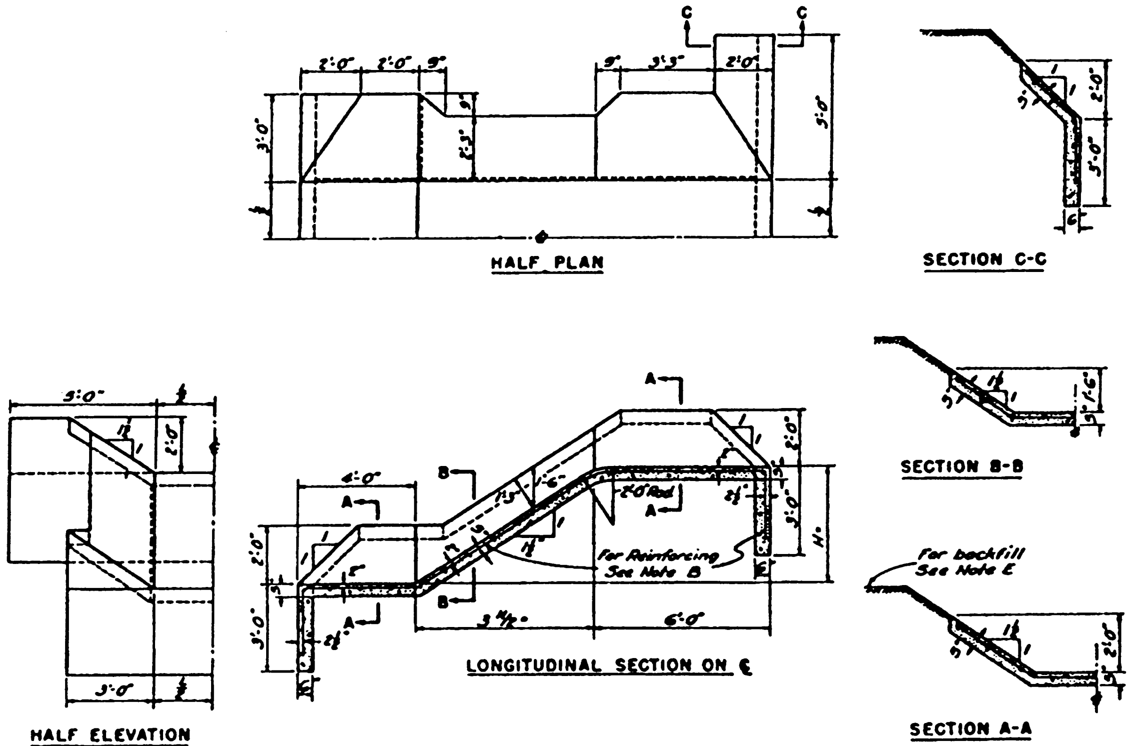
BOX INLET DROP SPILLWAY

Figure 6-16.6



CHUTE SPILLWAY

Figure 6-16.7



NOTES:-

A. Use 5 inch thickness of concrete throughout except as dimensioned otherwise.

B. Reinforcing as indicated shall be (1) 3/8"ϕ reinforcing steel 12" o.c. both ways; or (2) No. 2 gauge welded wire fabric 6" o.c. both ways. (common designation 6x6 2/2). Reinforcing bars or mesh should be lapped one foot at all joints.

C. Spillways of this type shall be constructed on solid ground. Seep areas should be avoided or properly drained with a carefully constructed toe drainage system.

D. This spillway shall not be used as a part of a water impounding structure.

E. The disturbed area adjacent to the spillway shall be backfilled, compacted and sodded.

F. The length (L) of the spillway shall be limited by the amount of concrete that can be adequately mixed, placed and finished in one day's time with the labor and equipment available or a Max. L=8'-0"

6. The maximum "H" for this spillway is 5'-0"

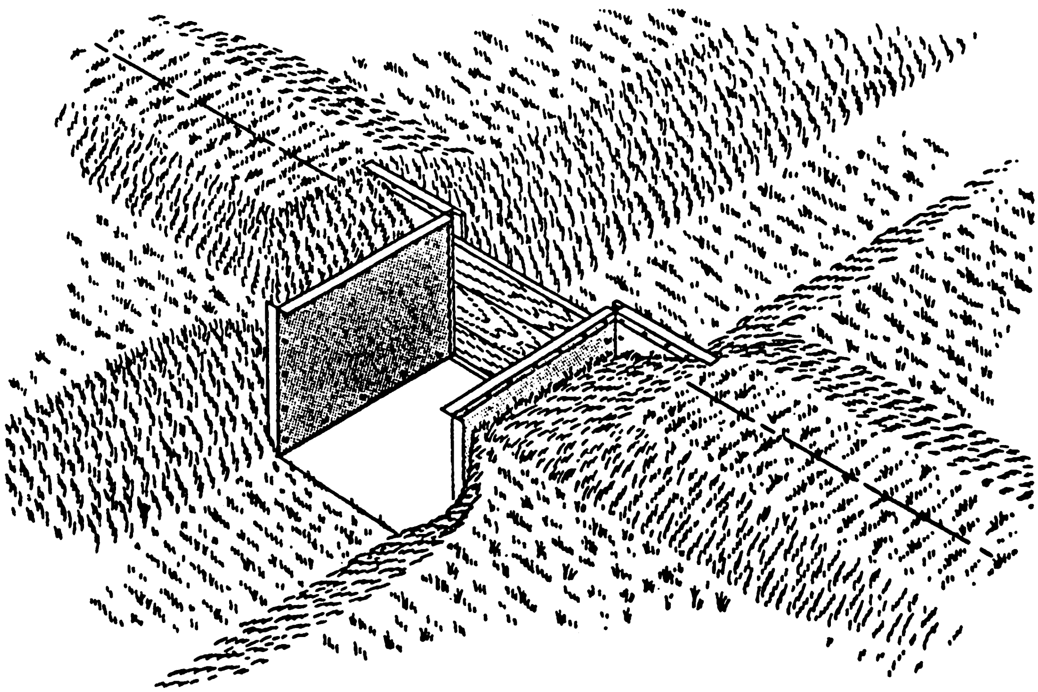
STRUCTURAL DETAILS

Discharge Capacity of Spillway in c.f.s.				
Length of Crest (L) in feet	2	4	6	8
with no freeboard	30	45	60	75
with 6" freeboard	18	28	38	48

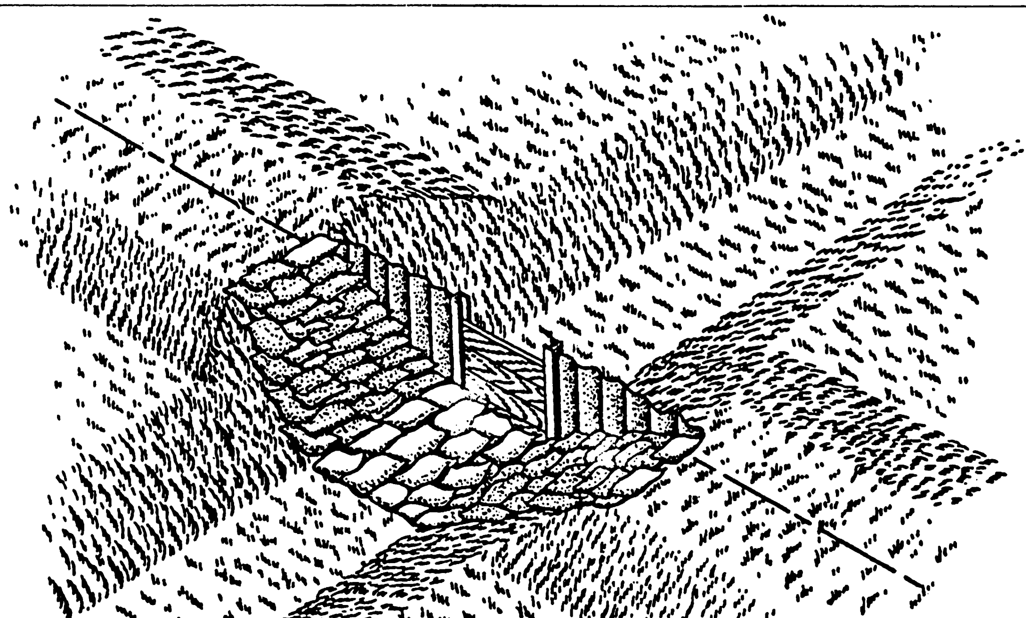
Concrete Volumes in Cubic Yards				
Head "H" Feet	Length of Crest (L) in feet			
	2'-0"	4'-0"	6'-0"	8'-0"
4'-0"	3.5	4.2	4.9	5.6
5'-0"	3.7	4.4	5.2	6.0

Typical Plan - Formless Concrete Chute

Figure 6-16.8



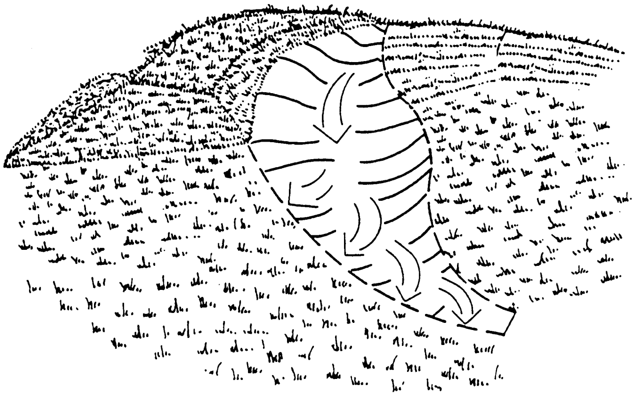
PREFABRICATED METAL STRUCTURE
Figure 6-16.9



SHEET PILING HEADWALL WITH SAND-CEMENT BAG SIDEWALLS AND APRON.
Figure 6-16.10

SMALL, LOW COST WATER CONTROL STRUCTURES

Level Spreader (Lv)



DEFINITION

A storm flow outlet device constructed at zero grade across the slope whereby concentrated runoff may be discharged at non-erosive velocities onto undisturbed areas stabilized by existing vegetation.

PURPOSE

To dissipate storm flow energy at the outlet by converting storm runoff into sheet flow and to discharge it onto areas stabilized by existing vegetation without causing erosion.

CONDITIONS

Where sediment-free storm runoff is intercepted and diverted onto undisturbed stabilized areas (*i.e.*, at diversion outlets, etc.). This practice applies only in those situations where the spreader can be constructed on undisturbed soil and where the area directly below the level lip is stabilized by existing vegetation. The water must not be allowed to reconcentrate below the point of discharge.

DESIGN CRITERIA

Length

A specific design for level spreaders will not be required. However, spreader length will be determined by estimating the peak stormflow from the 10-year, 24-hour storm or the storm specified in Title 12 of the Official Code of Georgia Annotated and selecting the appropriate length from Table 6-17.1

Designed Q10/24 (cfs)	Minimum Length "L" (feet)
up to 10	10
11 to 20	20
21 to 30	30
31 to 40	40
41 to 50	50

Table 6-17.1

Outlets

Final discharge will be over the level lip onto an undisturbed, stabilized area. The outlet shall be generally smooth to create uniform sheet flow.

CONSTRUCTION SPECIFICATIONS

The minimum acceptable width shall be 6 feet. The depth of the level spreader as measured from the lip shall be at least 6 inches and the depth shall be uniform across the entire length of the measure.

The grade of the channel for the last 15 feet of the dike or diversion entering the level spreader shall be less than or equal to 1%.

The level lip shall be constructed on zero percent grade to insure uniform spreading of storm runoff (converting channel flow to sheet flow). For calculation purposes, a grade of 0.1% may be needed, however, the level spreader shall be installed at zero percent grade.

Level spreaders must be constructed on undisturbed soil (not on fill).

The entrance to spreader shall be graded in a manner to insure that runoff enters directly onto the zero percent graded channel.

Storm runoff converted to sheet flow must discharge onto undisturbed stabilized areas.

All disturbed areas shall be vegetated immediately after construction is completed. Refer to specifications **Ds3 and Ds4 - Disturbed Area Stabilization (With Permanent Vegetation and Sodding),** respectively and **Mb - Matting and Blankets**.

MAINTENANCE

Periodic inspection and maintenance must be provided.

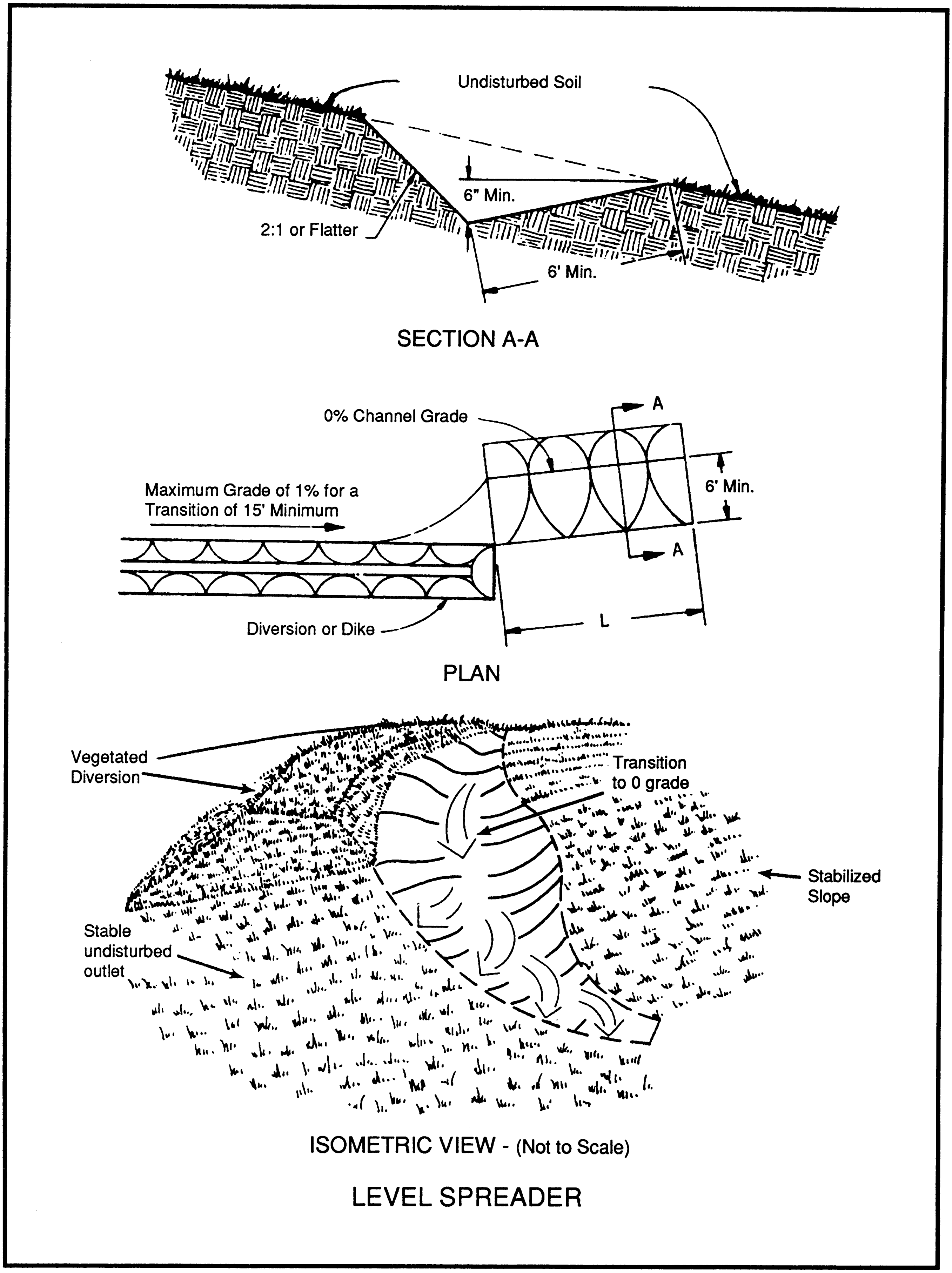

Undisturbed Soil
6" Min.
2:1 or Flatter
6' Min.
SECTION A-A
0% Channel Grade
A
Maximum Grade of 1% for a Transition of 15' Minimum
6' Min.
A
Diversion or Dike
L
PLAN
Vegetated Diversion
Transition to 0 grade
Stabilized Slope
Stable undisturbed outlet
ISOMETRIC VIEW - (Not to Scale)
LEVEL SPREADER

Figure 6-17.1

Rock Filter Dam (Rd)

DEFINITION

A permanent or temporary stone filter dam installed across small streams or drainageways.

PURPOSE

This structure is installed to serve as a sediment filtering device in drainageways. In some cases, it may also reduce the velocity of stormwater flow through a channel. This structure is not intended to substantially impound water. Before structures of any kind are installed in flowing streams, the appropriate agencies and local officials should be contacted.

CONDITIONS

This practice is applicable for use in small channels which drain 50 acres or less. The rock filter dam must be used in conjunction with other appropriate sediment control measures to reduce the amount of sediment reaching the channel. This practice may be used:

1. as an additional sediment control measure below construction projects such as culvert installations, dam construction, or any project that may involve grading activity directly in a stream, or
2. at the upstream end of ponds or lakes to trap incoming sediment loads.

DESIGN CRITERIA

Formal design is not required, but it is recommended that a qualified engineer be consulted before a structure of any kind is installed in a flowing stream. (Refer to Figure 6-18.1)

The following standards shall be followed:

Drainage Area

The drainage area to the dam shall not exceed 50 acres.

Height

The dam should not be higher than the channel banks or exceed the elevation of the upstream property line. The center of the rock dam should be at least six inches lower than the outer edges of the dam at the channel banks.

Side Slopes

The side slopes shall be 2:1 or flatter.

Location

The dam shall be located as close to the source of sediment as possible and so that it will not cause water to back up on upstream adjacent property.

Stone Size

The stone size shall be determined by the design criteria established in **Riprap - Appendix C**. The rock dam can be faced with smaller stone on the upstream side for additional filtering effect. However, this may make the dam more prone to clogging.

Top Width

The width across the top of the dam should be no less than 6 feet.

Geotextile

Geotextiles should be used as a separator between the graded stone, the soil base, and the abutments. The geotextile will prevent the migration of soil particles from the subgrade into the graded stone. The geotextile shall be specified in accordance with AASHTO M288-96 Section 7.5, *Permanent Erosion Control Recommendations*. The geotextile should be placed immediately adjacent to the subgrade without any voids and extend five feet beyond the downstream toe of the dam to prevent scour.

CONSTRUCTION SPECIFICATIONS

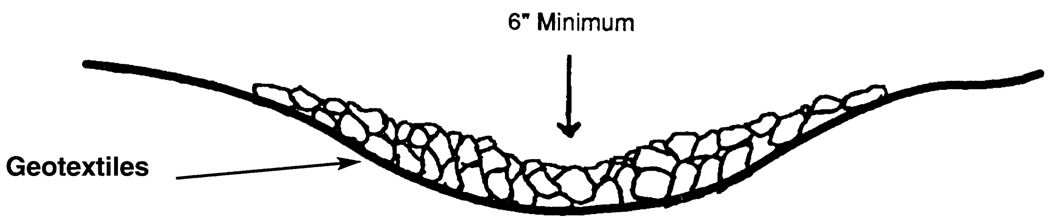
Mechanical or hand placement will be required to insure that the rock dam extends completely across the channel and securely ties into both channel banks. The center of the dam must be no less than six inches lower than the lowest side, to serve as a type of weir. Gabions can be installed to serve as rock filter dams, but should follow recommended sizing and installation specifications. Refer to specification **Ga - Gabion**.

MAINTENANCE

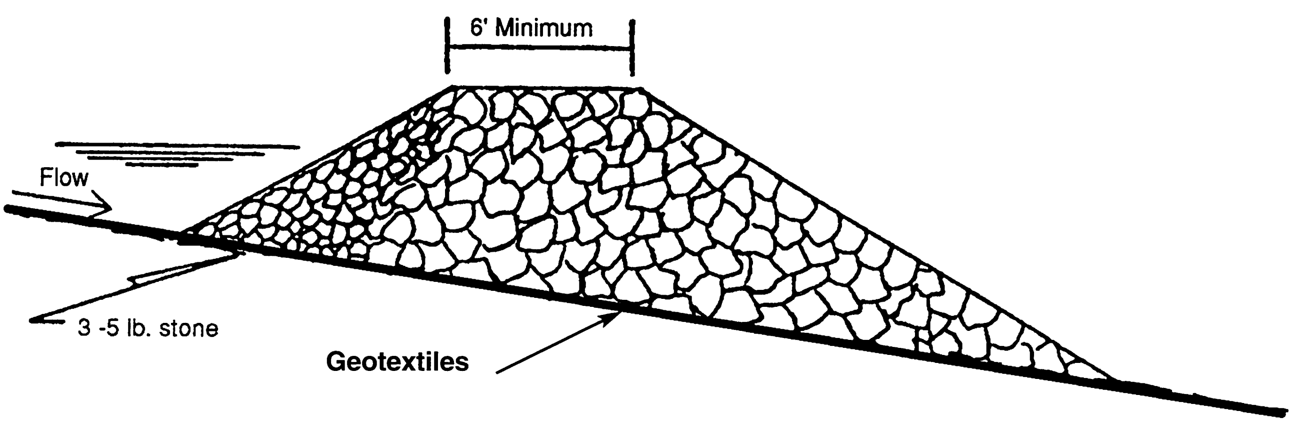
Rock dams should be removed once disturbed areas have been stabilized. Periodic inspection and required maintenance must be provided. Sediment shall be removed when it reaches a depth of one-half of the original height of the dam.

TO BE SHOWN ON THE EROSION AND SEDIMENT CONTROL PLAN

1. **Figure 6-18.1**, noting rock size as specified in Appendix C.



NOTE: Sediment Trap is to be cleaned out when volume becomes half full.

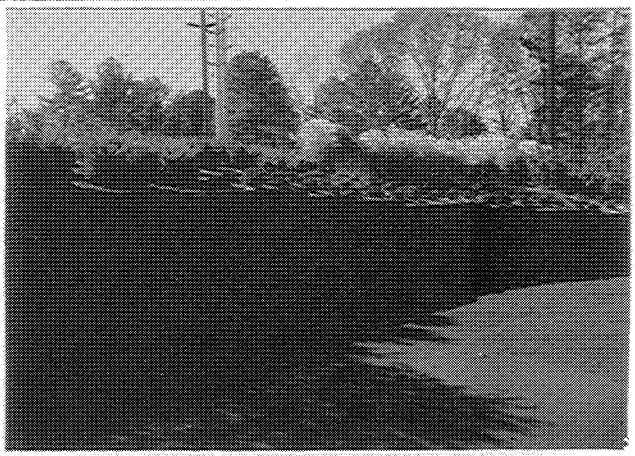


NOTE: Rock size determined according to specifications set forth in Appendix C.

Figure 6-18.1

Retaining Wall

Re



DEFINITION

A wall constructed of one or more of the following: concrete masonry, reinforced concrete cribbing, treated timbers, steel pilings, gabions, stone drywall, rock riprap, etc.

PURPOSE

To assist in the stabilization of cut or fill slopes where stable slopes are not attainable without the use of the wall.

CONDITIONS

Use in conjunction with cut or fill slopes which, because of space limitations or unstable material, do not allow the stable slope criteria listed above, *e.g.* cuts into steep hillsides on small lots or cuts into hillsides behind shopping centers to provide loading space.

DESIGN CRITERIA

General

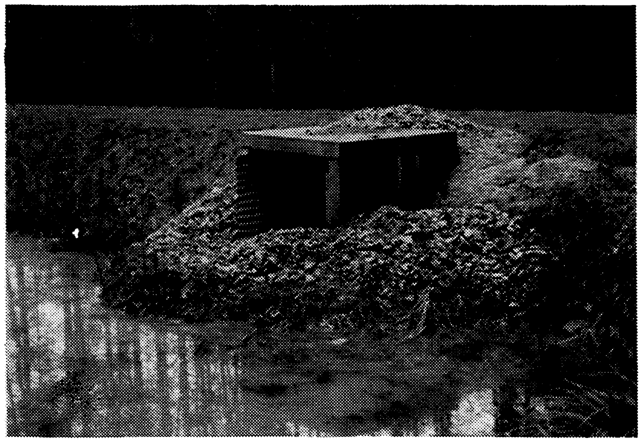
The design of a retaining wall is a complicated process. Many factors must be taken into account such as: stresses and forces outside and within the wall, allowable height, minimum thickness. Other considerations are: foundation design with respect to loadings, bearing values of soils, footing dimensions. Additional design factors are safety hazards, subsurface and surface drainage and appearance.

Each situation requires a *specific design* which is within the capabilities of the design engineer.

Consideration should be given to all of the alternative methods with regard to construction of the wall. Some methods are:

1. Concrete masonry
2. Concrete cribbing
3. Gabions
4. Steel piling
5. Stone drywall
6. Rock riprap, etc.
7. Treated timbers
8. Geotextile wrapped-face wall
9. Geotextile reinforced steep slopes

Retrofitting (Rt)



DEFINITION

A device or structure placed in front of a permanent stormwater detention pond outlet structure to serve as a temporary sediment filter.

PURPOSE

This structure allows permanent stormwater detention basins to function as temporary sediment retention basins for land-disturbing projects.

CONDITIONS

This standard applies under the following conditions:
1. **Shall not be used in detention basins on live streams** or in basins with a total contributing drainage area of 100 acres or more.
2. Shall only be used in detention basins large enough to store 67 cubic yards of sediment per acre of disturbed area in the project.
3. Shall be considered a temporary structure and will be removed as soon as project is permanently stabilized. All accumulated sediment shall be removed, and the pond shall be brought to final grade (if possible), prior to the removal of the retrofit.

DESIGN CRITERIA

1. The height of the retrofit should be approximately one-half the height of the stormwater management outlet structure.
2. **The pond must be capable of storing the required volume of sediment in addition to the required stormwater volume.** The required sediment storage volume shall be achieved by either excavating the basin or raising the outlet structure's invert to achieve 67 cubic yards per acre of sediment storage. Remove sediment when one-third of the sediment storage capacity, not total pond capacity, is lost to sediment accumulation. This volume shall be marked on the riser or by setting a marked post near the riser.
3. For effective trapping efficiency, the sediment delivery inlets should be at the upper end of the basin.
4. For effective trapping efficiency, the length-width ratio of the basin shall be at least 2:1. If the length-width ratio is not at least 2:1, the flow length shall be increased with the use of baffles installed within the basin.

CONSTRUCTION SPECIFICATIONS

The following types of structures are acceptable under the designated conditions:

Perforated Half-Round Pipe with Stone Filter
(Rt-P) (See Figure 6-19.1)
a. Should be used only in detention ponds with less than 30 acre total drainage area.
b. Never to be used on exposed pipe end or winged headwall.
c. Diameter of half-round pipe should be 1.5 times the diameter of the principal pipe outlet or wider than the greatest width of the concrete weir.
d. Perforations and stone sizes are shown in Figure 6-19.1.
e. Shall be fixed by specified means (bolts, etc) to concrete outlet structure.

Slotted Board Dam with Stone (Rt-B)
(See Figure 6-19.3)
a. Can be used in detention ponds with drainage areas up to 100 acres.
b. Can be used with open end pipe outlets, winged headwalls, or concrete weir outlets.
c. Should be installed with minimum size 4 x 4 inch posts.
d. Boards should have 0.5-1.0 inch space between them.
e. Minimum size 3-4 inch stone filter shall be in-stalled around the upstream side of the board dam.

All disturbed areas shall be vegetated immediately after construction with permanent vegetation. Refer to **Ds3 and Ds4 - Disturbed Area Stabilization (With Permanent Vegetation) and Disturbed Area Stabilization (With Sodding)** and **Mb - Matting and Blankets**.

MAINTENANCE

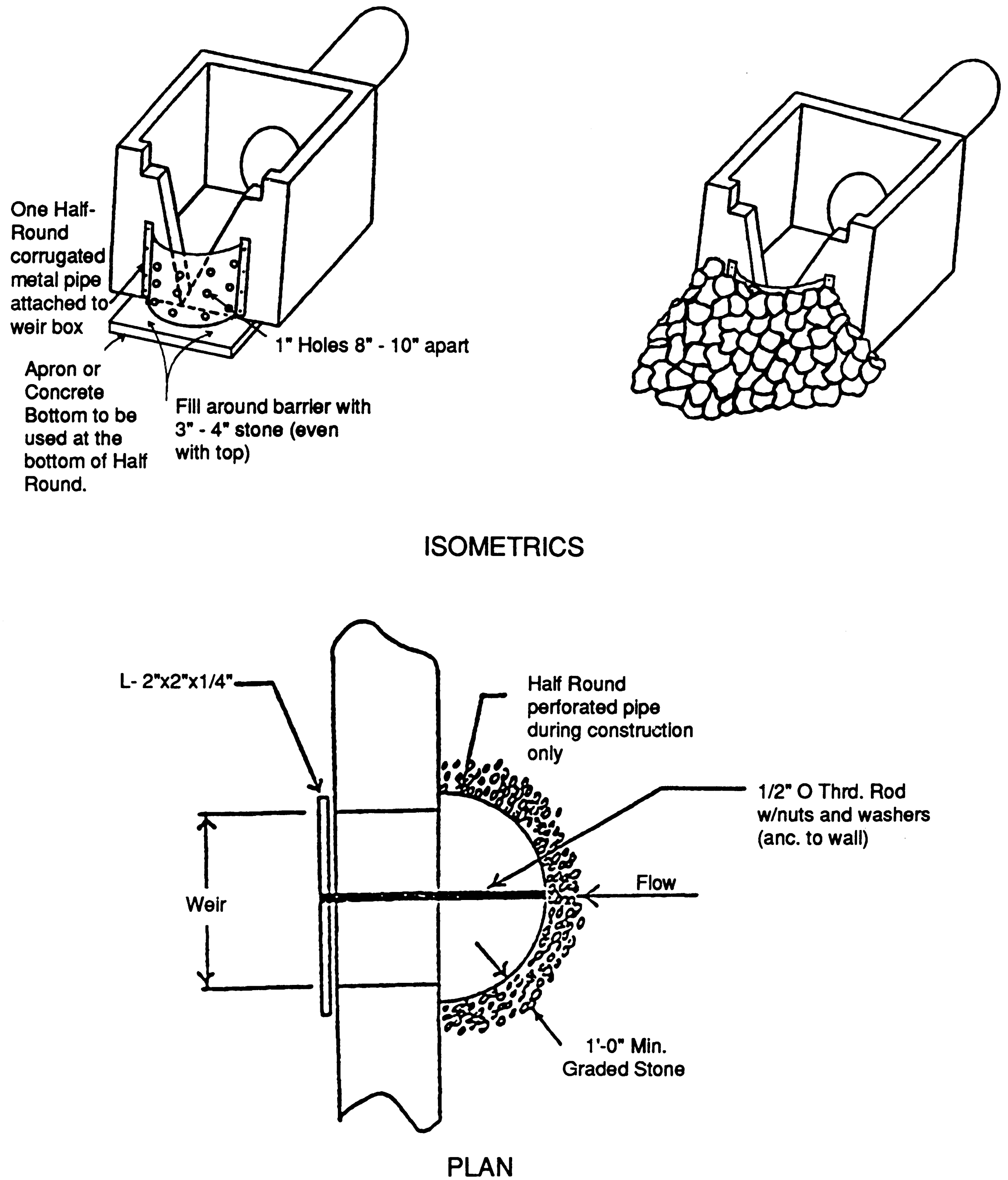
Retrofit structures shall be kept clear of trash and debris. This will require continuous monitoring and maintenance, which includes sediment removal when one-third of the sediment storage capacity has been lost. *Structures are temporary and shall be removed when disturbed areas have been permanently stabilized.*

TO BE SHOWN ON THE EROSION AND SEDIMENT CONTROL PLAN

Storage Calculations

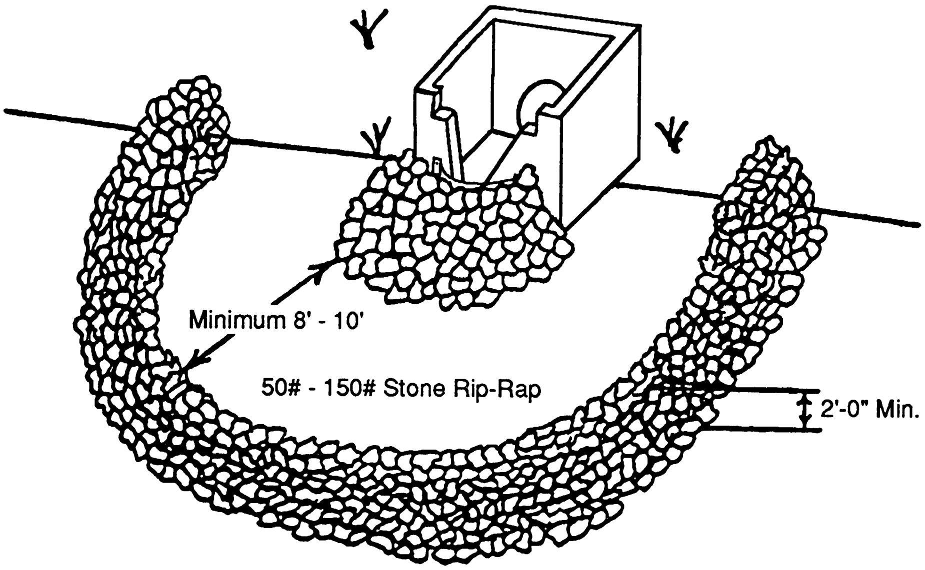
1. Required stormwater storage = _______ cy
   (as determined by local ordinance)
2. Required sediment storage = _______ cy
   (67 cy/ac * ______ ac disturbed area)
3. Total required storage = __(1)__ + __(2)__ = __(3)__ cy
4. Available storage = __(4)__ cy
5. Is the available storage (4) greater than the total required storage (3)?
   ______ yes ______ no
6. If "no", the sediment storage capacity of the pond must be increased. Choose the method to be used:
   ______ Raise the invert of the outlet structure ______ inches
   ______ Undercut the pond ______ feet
   ______ Other ____
7. Clean-out elevation = _______ ft
   (Elevation corresponding to 22 cy/ac * ______ ac disturbed area)
8. Is the length-width ratio 2:1 or greater?
   ______ yes ______ no
9. If "no", the length of flow must be increased. Choose the method to be used:
   ______ Baffles (Type of baffle: _____________)
   ______ Other ____

Note the CMP diameter and height if a half-round CMP retrofit is to be used.
Diameter = _______ inches Height = ______ feet



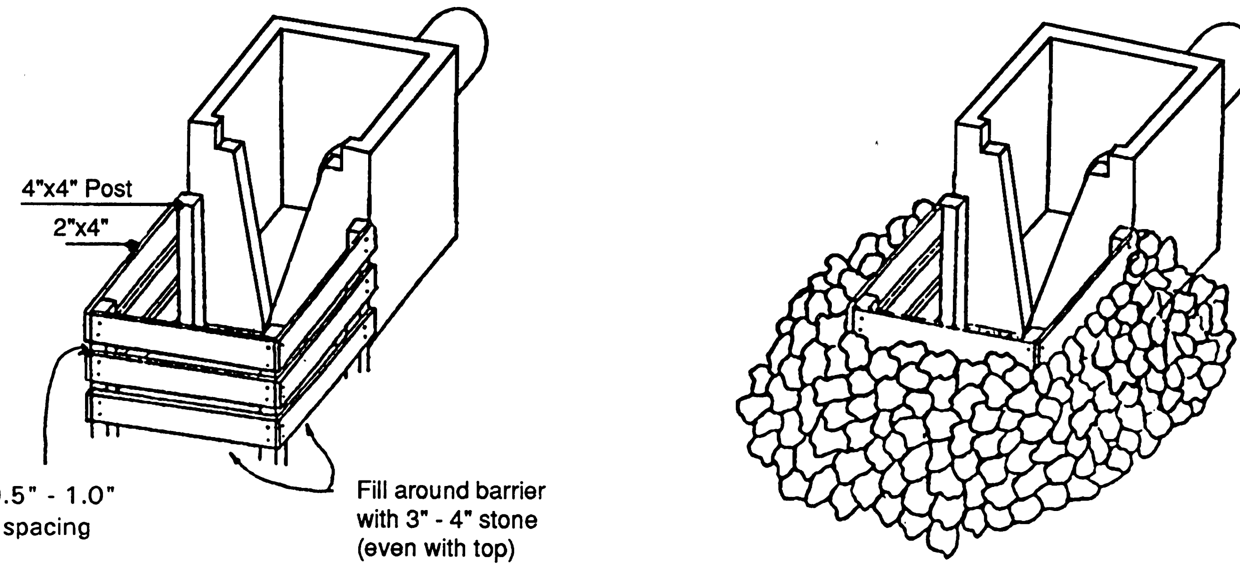
PERFORATED HALF-ROUND PIPE WITH STONE FILTER

Figure 6-19.1



STONE FILTER RING

Figure 6-19.2



SLOTTED BOARD DAM WITH STONE FILTER

Figure 6-19.3

Sediment Barrier (Sd1)

DEFINITION

Sediment barriers are temporary structures typically constructed of silt fence supported by steel or wood posts. Other types of barriers may include sandbags, straw bales, brush piles or other filtering material.

PURPOSE

To prevent sediment carried by sheet flow from leaving the site and entering natural drainage ways or storm drainage system by slowing storm water runoff and causing the deposition of sediment at the structure.

CONDITIONS

Barriers should be installed where runoff can be stored behind the barrier without damaging the fence or the submerged area behind the fence.

Silt fence shall not be installed across streams, ditches, waterways, or other concentrated flow areas.

DESIGN CRITERIA

HAY OR STRAW BALES

Hay or straw bales retain sediment load transported by sheet flow from disturbed areas. The bales' comparatively low flow rate should be considered when choosing the appropriate sediment barrier. Ponding above the bale can occur rapidly. The slope lengths contributing runoff to a bale barrier cannot exceed those listed in Table 6-20.1. Straw and hay bales shall not be used if the project duration is expected to exceed three months.

CRITERIA FOR STRAW OR HAY BALE PLACEMENT

Land Slope	Maximum Slope Length Above Bale
Percent	Feet
< 2	75
2 to 5	50
5 to 10	35
10 to 20	20
> 20	10

Table 6-20.1

SILT FENCE

Like hay or straw bales, silt fence is designed to retain sediment transported by sheet flow from disturbed areas. Silt fence performs the same function as hay or straw bales, allows a higher flow rate, and is usually faster and cheaper to install. Approved silt fence fabrics are listed in the Georgia Department of Transportation Qualified Products List #36 (QPL-36). See Table 6-20.5 for current Georgia DOT silt fence specifications.

Where all runoff is to be stored behind the fence (where no stormwater disposal system is present), maximum slope length behind a silt fence shall not exceed those shown in Table 6-20.2. The drainage area shall not exceed 1/4 acre for every 100 feet of silt fence.

CRITERIA FOR SILT FENCE PLACEMENT

Land Slope	Maximum Slope Length Above Fence
Percent	Feet
< 2	100
2 to 5	75
5 to 10	50
10 to 20	25
> 20*	15

*In areas where the slope is greater than 20%, a flat area length of 10 feet between the toe of the slope to the fence should be provided.

Table 6-20.2

Type A Silt Fence (Sd1-A)

This 36-inch wide filter fabric shall be used on developments where the life of the project is greater than or equal to six months.

Type B Silt Fence (Sd1-B)

Though only 22-inches wide, this filter fabric allows the same flow rate as Type A silt fence. Type B silt fence shall be limited to use on minor projects, such as residential home sites or small commercial developments where permanent stabilization will be achieved in less than six months.

Type C Silt Fence (Sd1-C)

Type C fence is 36-inches wide with wire reinforcement. The wire reinforcement is necessary because this fabric allows almost three times the flow rate as Type A silt fence. Type C silt fence shall be used where runoff flows or velocities are particularly high or where slopes exceed a vertical height of 10 feet.

Provide a riprap splash pad or other outlet protection device for any point where flow may top the sediment fence. 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.

CONSTRUCTION SPECIFICATIONS

Sandbags (Sd1-S)

(if approved by local issuing authority)

Should be installed so that flow under or between bags is minimal. Anchoring with steel rods may be required if structure height exceeds two bags.

Hay or Straw Bales (Sd1-Hb)

(if approved by local issuing authority)

Bales will be placed in a single row, lengthwise, on the contour and embedded in the soil to a depth of 4 inches. Bales must be securely anchored in place by stakes or bars driven through the bales or by other acceptable means to prevent displacement. See Figures 6-20.1 and 6-20.2 for installation requirements.

Brush Barrier (Sd1-Bb)

(only during timber clearing operations)

Brush obtained from clearing and grubbing operations may be piled in a row along the perimeter of disturbance at the time of clearing and grubbing. Brush barriers should not be used in developed areas or locations where aesthetics are a concern.

Brush should be wind-rowed on the contour as nearly as possible and may require compaction. Construction equipment may be utilized to satisfy this requirement.

The minimum base width of the brush barrier shall be 5 feet and should be no wider than 10 feet. The height of the brush barrier should be between 3 and 5 feet.

If a greater filtering capacity is required, a commercially available filter fabric may be placed on the side of the brush barrier receiving the sediment-laden runoff. The lower edge of the fabric must be buried in a 6-inch deep trench immediately uphill from the barrier. The upper edge must be stapled, tied or otherwise fastened to the brush barrier. Edges of adjacent fabric pieces must overlap each other. See Figure 6.20.3

Silt Fence

The manufacturer shall have either an approved color mark yarn in the fabric or label the fabricated silt fence with both the manufacturer and fabric name every 100 feet.

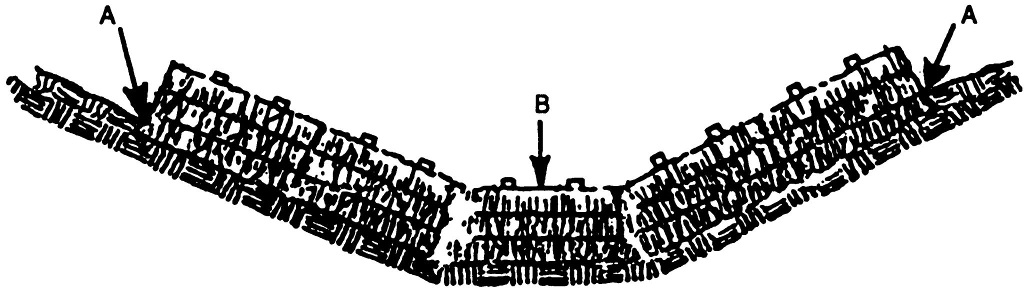
The temporary silt fence shall be installed according to this specification, as shown on the plans or as directed by the engineer. For installation of the fabric, see Figures 6-20.4, 6-20.5, and 6-20.6 respectively.

Post installation shall start at the center of the low-point (if applicable) with remaining posts spaced 6 feet apart for Type A and B silt fences and 4 feet apart for Type C silt fence. While Type A and B silt fences can be used with both wood and steel posts, only steel posts shall be used with Type C silt fence. For post size requirements, see Table 6-20.3. Fasteners for wood posts are listed in Table 6-20.4.

Along stream buffers and other sensitive areas, two rows of Type C silt fence or one row of Type C silt fence backed by haybales shall be used.

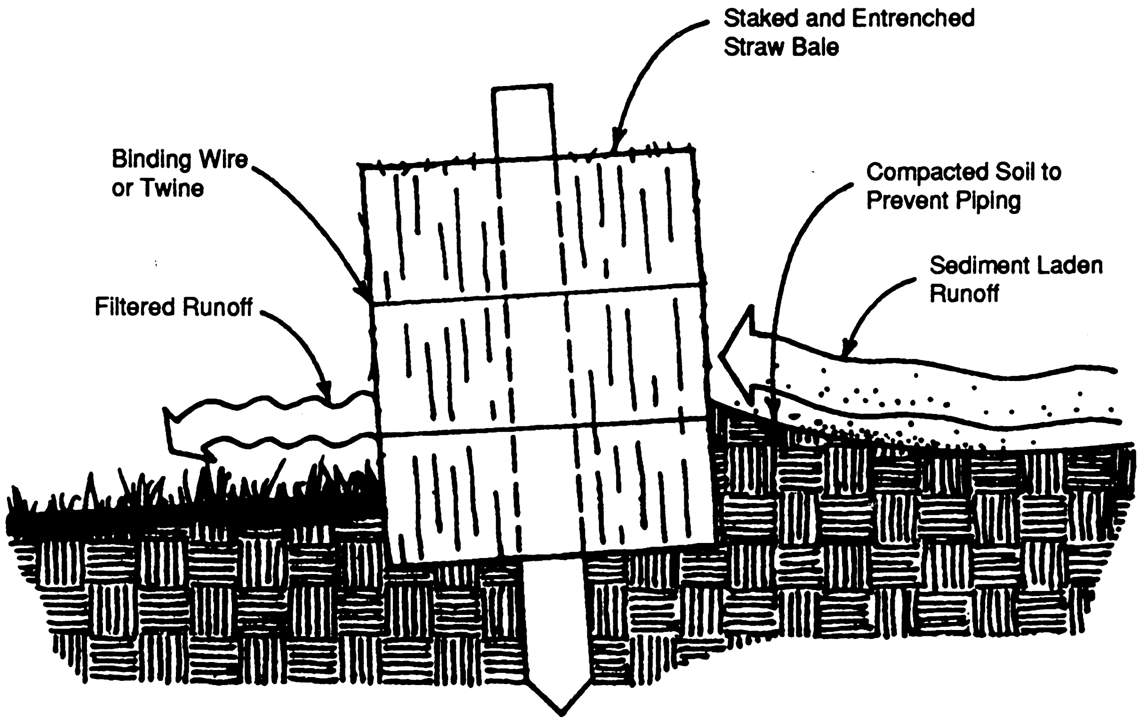
MAINTENANCE

Sediment shall be removed once it has accumulated to one-half the original height of the barrier. Filter fabric shall be replaced whenever it has deteriorated to such an extent that the effectiveness of the fabric is reduced (approximately six months). Temporary sediment barriers shall remain in place until disturbed areas have been permanently stabilized. All sediment accumulated at the barrier shall be removed and properly disposed of before the barrier is removed.



Points A should be higher than point B

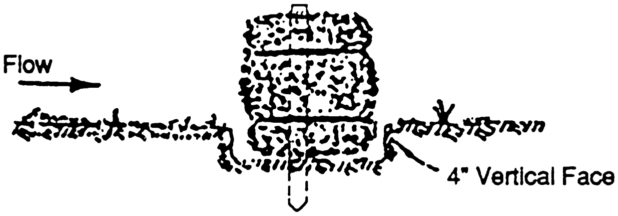
PROPER PLACEMENT OF STRAW BALE BARRIER IN DRAINAGE WAY



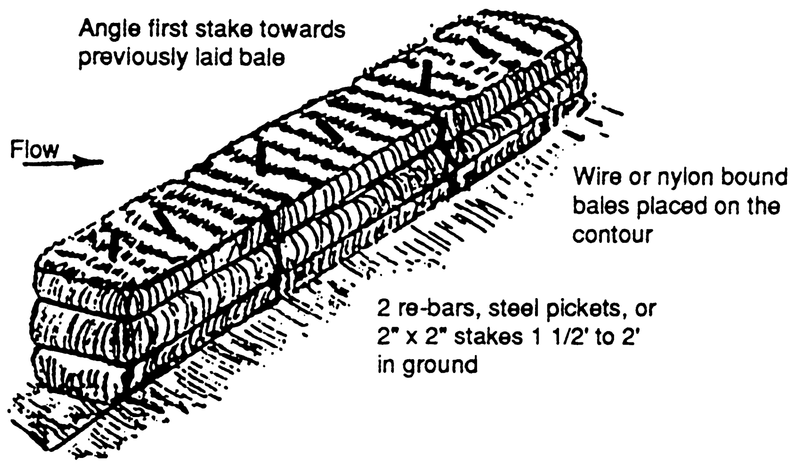
Note: Embed hay bales a minimum of 4 inches.

CROSS-SECTION OF A PROPERLY INSTALLED STRAW BALE

Figure 6-20.1



EMBEDDING DETAIL



ANCHORING DETAIL

NOTE:

- Anchor and embed into soil to prevent washout or water working under barrier
- Repair or replacement must be made promptly as needed

STAKED HAYBALE BARRIERS

Figure 6-20.2

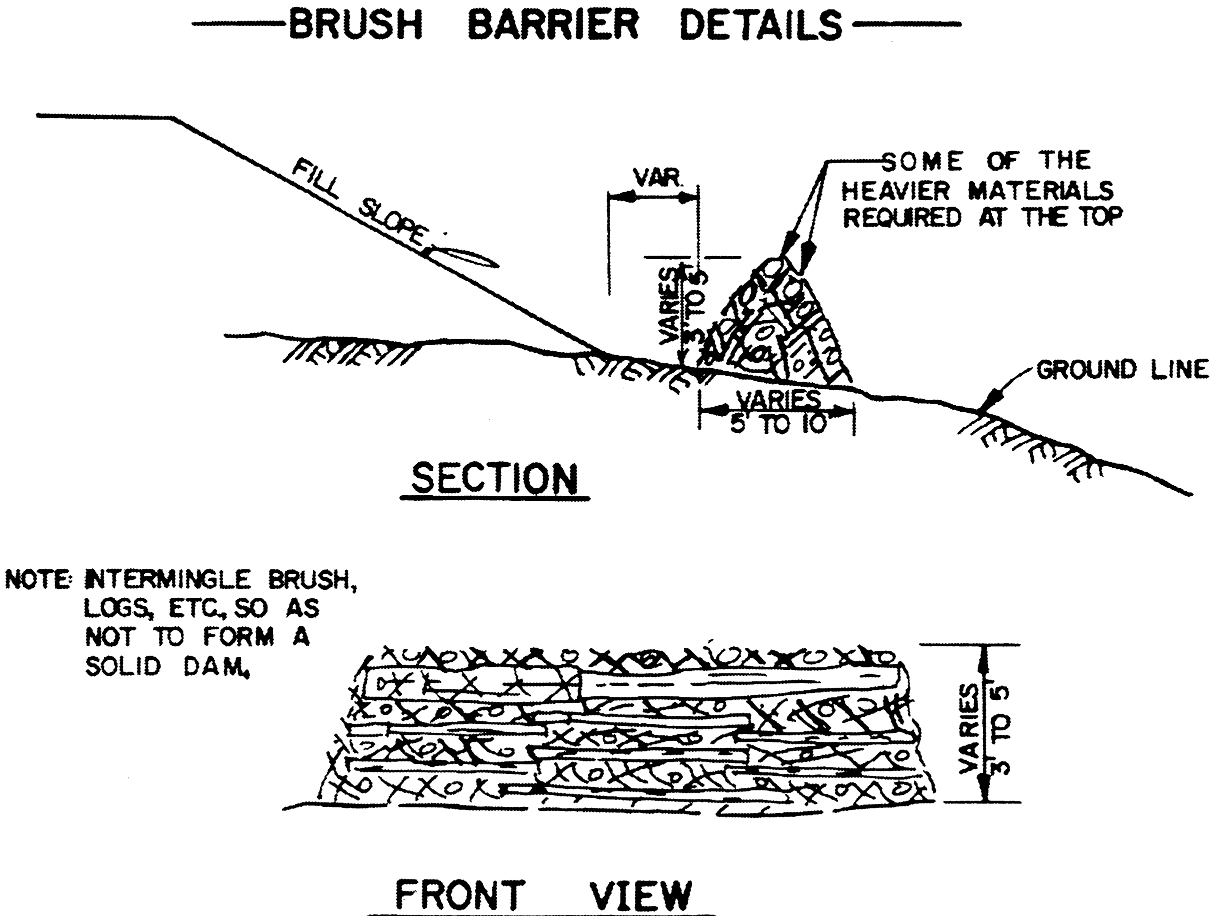

BRUSH BARRIER DETAILS
FILL SLOPE
VAR.
SOME OF THE HEAVIER MATERIALS REQUIRED AT THE TOP
VARIES 3' TO 5'
GROUND LINE
VARIES 5' TO 10'
SECTION
NOTE: INTERMINGLE BRUSH, LOGS, ETC., SO AS NOT TO FORM A SOLID DAM.
VARIES 3' TO 5'
FRONT VIEW

Figure 6-20.3

POST SIZE

Table 6-20.3

	Minimum Length	Type of Post	Size of Post
Type A	4'	Soft wood Oak Steel	3" dia. or 2x4 1.5" x 1.5" 1.3lb./ft. min.
Type B	3'	Soft wood Oak Steel	2" dia. or 2x2 1" x 1" .75lb./ft. min.
Type C	4'	Steel	1.3lb./ft. min.

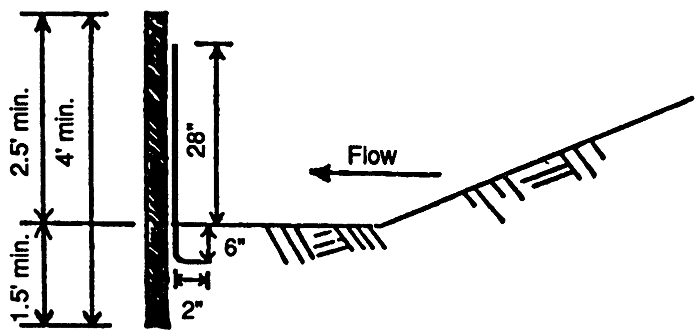
FASTENERS FOR WOOD POSTS

Table 6-20.4

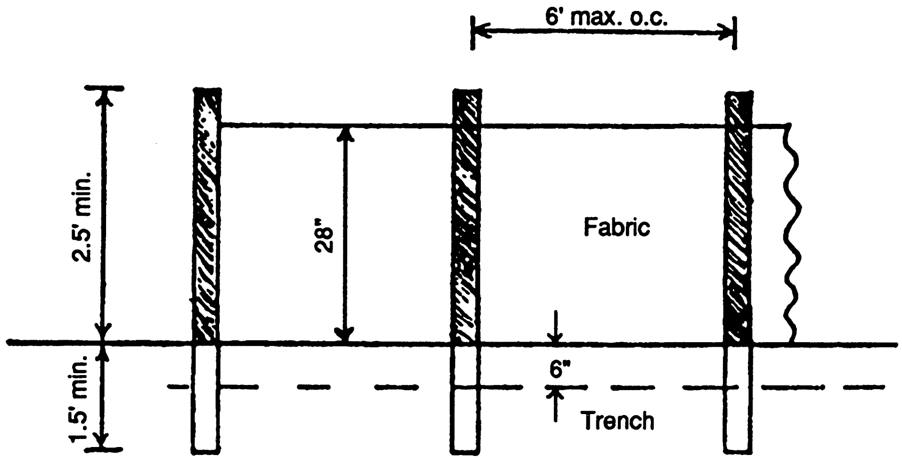
	Gauge	Crown	Legs	Staples/Post
Wire Staples	17 min.	3/4" wide	1/2" long	5 min.

	Gauge	Length	Button Heads	Nail/Post
Nails	14 min.	1"	3/4"	4 min.

Note: Filter fabric may also be attached to the post by wire, cord, and pockets.



SIDE VIEW

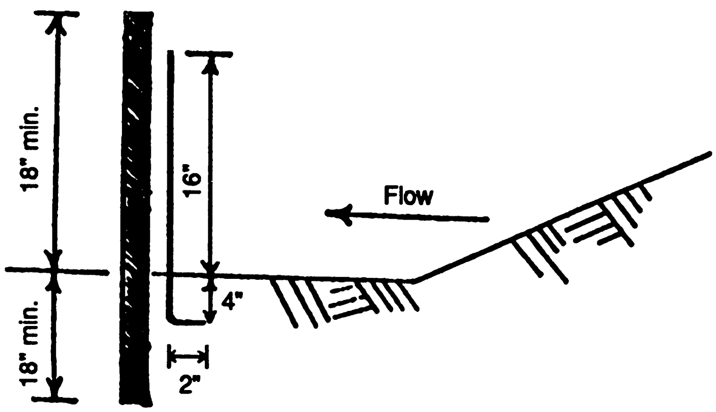


FRONT VIEW

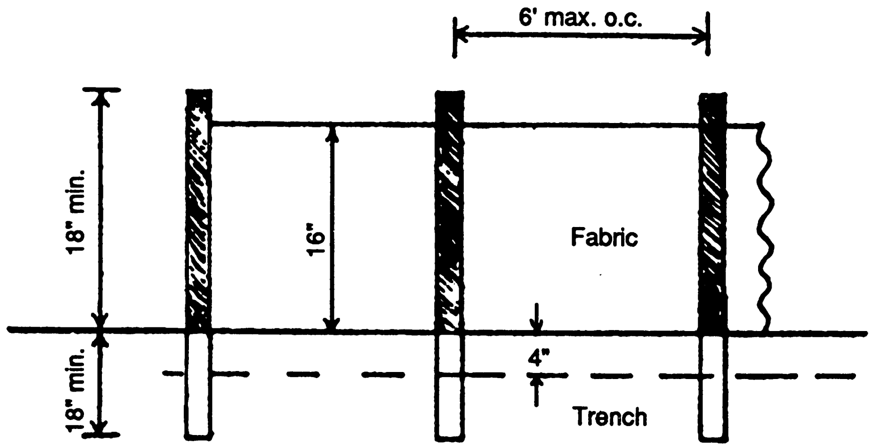
NOTE:
Use 36" D.O.T. approved fabric.
Use wood or steel posts.

SILT FENCE - TYPE A

Figure 6-20.4



SIDE VIEW

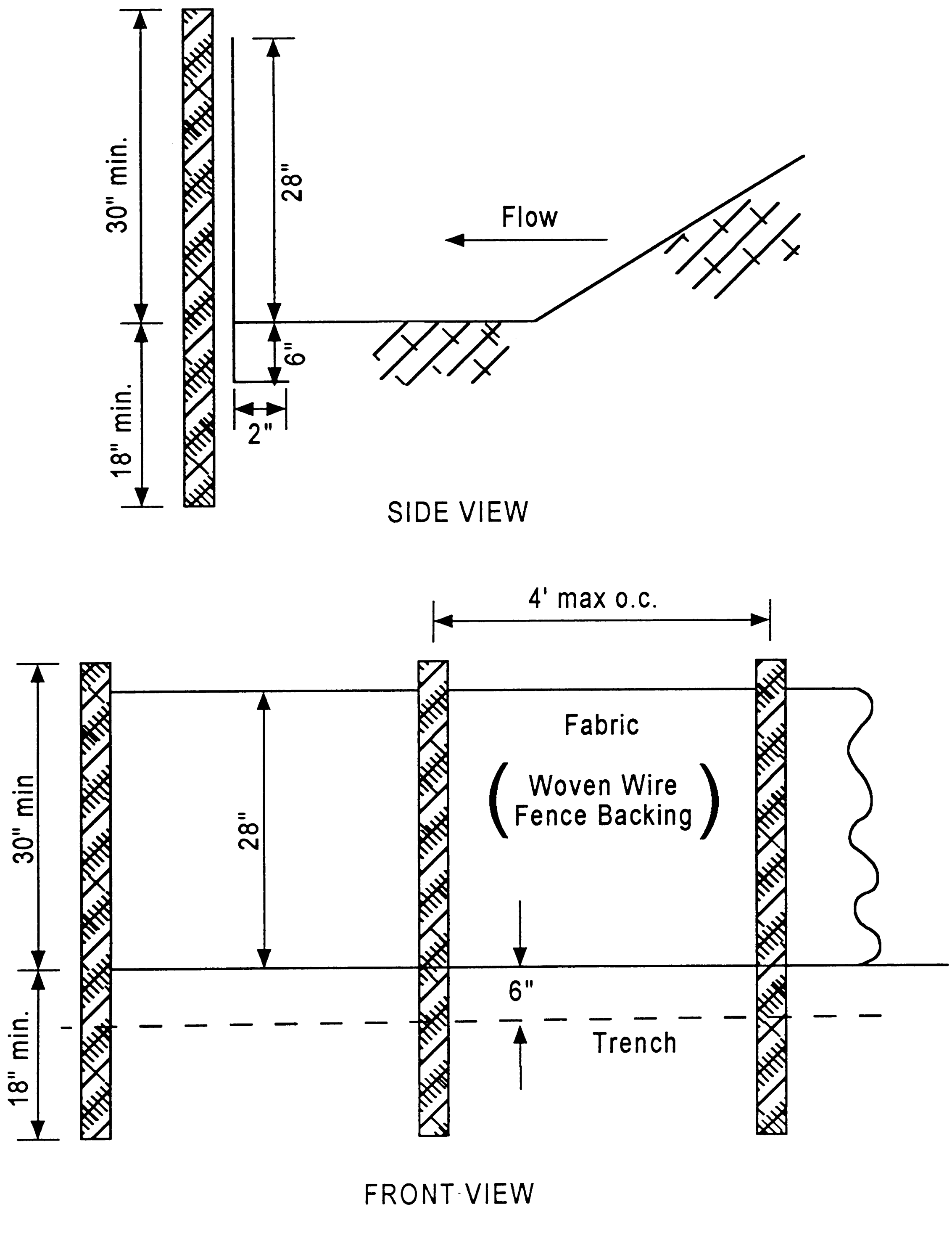


FRONT VIEW

NOTE:
Use 22" D.O.T. approved fabric.
Use wood or steel posts.

SILT FENCE - TYPE B

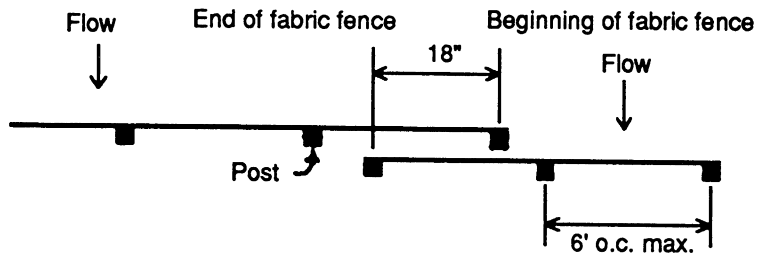
Figure 6-20.5



NOTE:
Use 36" D.O.T. approved fabric.
Use steel posts.- only

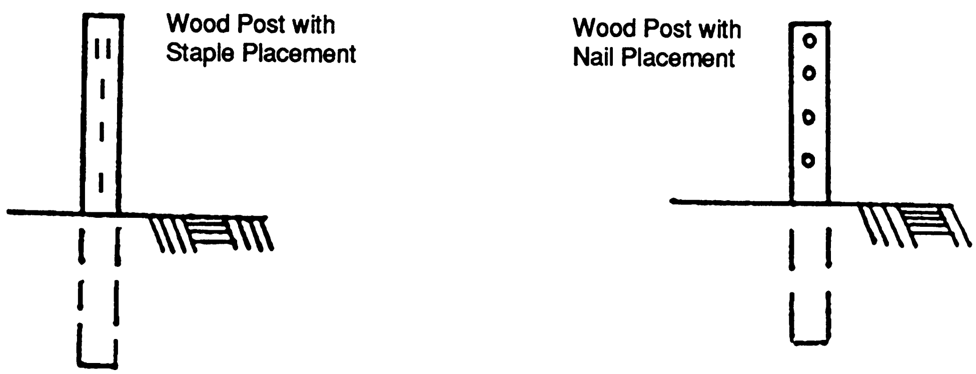
SILT FENCE - TYPE C

Figure 6-20.6



TOP VIEW - (Not to scale)

OVERLAP AT FABRIC ENDS



FRONT VIEWS

FASTENERS FOR SILT FENCES

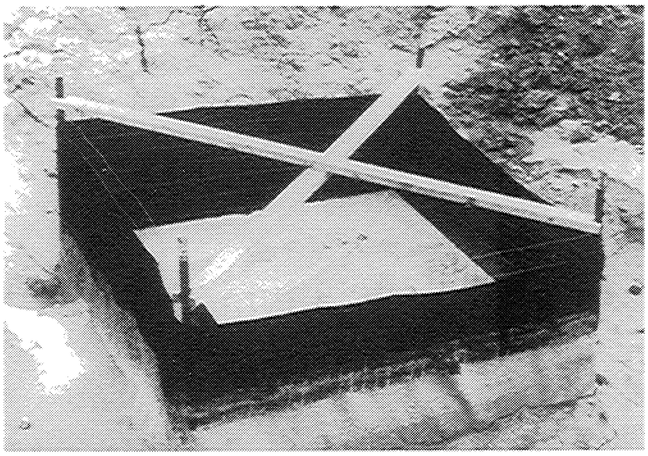
Figure 6-20.7

Table 6-20.5

TYPE FENCE	A	B	C
Tensile Strength (Lbs. Min.) (1) (ASTM D-4632)	Warp - 120 Fill - 100	Warp - 120 Fill - 100	Warp - 260 Fill - 180
Elongation (% Max.) (ASTM D-4632)	40	40	40
AOS (Apparent Opening Size) (Max. Sieve Size) (ASTM D-4751)	#30	#30	#30
Flow Rate (Gal/Min/Sq. Ft.) (GDT-87)	25	25	70
Ultraviolet Stability (2) (ASTM D-4632 after 300 hours weathering in accordance with ASTM D-4355)	80	80	80
Bursting Strength (PSI Min.) (ASTM D-3786 Diaphragm Bursting Strength Tester)	175	175	175
Minimum Fabric Width (Inches)	36	22	36

(1) Minimum roll average of five specimens.
(2) Percent of required initial minimum tensile strength.

Inlet Sediment Trap (Sd2)



DEFINITION

A temporary protective device formed around a storm drain drop inlet to trap sediment.

PURPOSE

To prevent sediment from leaving the site, or from entering storm drainage systems, prior to permanent stabilization of the disturbed area.

CONDITIONS

Sediment traps should be installed at or around all storm drain drop inlets that receive runoff from disturbed areas.

DESIGN CRITERIA

Many sediment filtering devices can be designed to serve as temporary sediment traps. Sediment traps must be self-draining unless they are otherwise protected in an approved fashion that will not present a safety hazard. *The drainage area entering the inlet sediment trap shall be no greater than one acre.*

If runoff may bypass the protected inlet, a temporary dike should be constructed on the down slope side of the structure. Also, a stone filter ring may be used on the up slope side of the inlet to slow runoff and filter larger soil particles. Refer to **Fr - Stone Filter Ring**.

Excavated Inlet Sediment Trap

An excavation may be created around the inlet sediment trap to provide additional sediment storage. The trap shall be sized to provide a minimum storage capacity calculated at the rate of 67 cubic yards per acre of drainage area. A minimum depth of 1.5 feet for sediment storage should be provided. Side slopes shall not be steeper than 2:1.

CONSTRUCTION SPECIFICATIONS

Sediment traps may be constructed on natural ground surface, on an excavated surface, or on machine compacted fill provided they have a non-erodible outlet.

Filter Fabric with Supporting Frame (Sd2-F)

This method of inlet protection is applicable where the inlet drains a relatively flat area (slope no greater than 5%) and shall not apply to inlets receiving concentrated flows, such as in street or highway medians. As shown in Figure 6-21.1, Type C silt fence supported by steel posts shall be used. The stakes shall be spaced evenly around the perimeter of the inlet a maximum of 3 feet apart, and securely driven into the ground, approximately 18 inches deep. The fabric shall be entrenched 12 inches and backfilled with crushed stone or compacted soil. Fabric and wire shall be securely fastened to the posts, and fabric ends must be overlapped a minimum of 18 inches or wrapped together around a post to provide a continuous fabric barrier around the inlet.

Baffle Box (Sd2-B)

For inlets receiving runoff with a higher volume or velocity, a baffle box inlet sediment trap should be used. As shown in Figure 6-21.2, the baffle box shall be constructed of 2" x 4" boards spaced a maximum of 1 inch apart or of plywood with weep holes 2 inches in diameter. The weep holes shall be placed approximately 6 inches on center vertically and horizontally. Gravel shall be placed outside the box, all around the inlet, to a depth of 2 to 4 inches. The entire box is wrapped in Type C filter fabric that shall be entrenched 12 inches and backfilled.

Block and Gravel Drop Inlet Protection (Sd2-Bg)

This method of inlet protection is applicable where heavy flows are expected and where an overflow capacity is necessary to prevent excessive ponding around the structure. As shown in Figure 6-21.3, one block is placed on each side of the structure on its side in the bottom row to allow pool drainage. The foundation should be excavated at least 2 inches below the crest of the storm drain. The bottom row of blocks are placed against the edge of the storm drain for lateral support and to avoid washouts when overflow occurs. If needed, lateral support may be given to subsequent rows by placing 2" x 4" wood studs through block openings. Hardware cloth or comparable wire mesh with 1/2 inch openings shall be fitted over all block openings to hold gravel in place. Clean gravel should be placed 2 inches below the top of the block on a 2:1 slope or flatter and smoothed to an even grade. DOT #57 washed stone is recommended.

Gravel Drop Inlet Protection (Sd2-G)

This method of inlet protection is applicable where heavy concentrated flows are expected. As shown in Figure 6-21.4, stone and gravel are used to trap sediment. The slope toward the inlet shall be no steeper than 3:1. A minimum 1 foot wide level stone area shall be left between the structure and around the inlet to prevent gravel from entering the inlet. On the slope toward the inlet, stone 3 inches in diameter and larger should be used. On the slope away from the inlet, 1/2 to 3/4 inch gravel (#57 washed stone) should be used at a minimum thickness of 1 foot.

Sod Inlet Protection (Sd2-S)

This method of inlet protection is applicable only at the time of permanent seeding, to protect the inlet from sediment and mulch material until permanent vegetation has become established. As shown in Figure 6-21.6, the sod shall be placed to form a turf mat covering the soil for a distance of 4 feet from each side of the inlet structure. Sod strips shall be staggered so that adjacent strip ends are not aligned.

Excavated Inlet Sediment Trap

The sediment trap shall be placed immediately around the inlet. The excavation shall be constructed immediately outside of the sediment trap and provide a minimum depth of 1.5 feet for sediment storage.

Curb Inlet Protection (Sd2-P)

Once pavement has been installed, a curb inlet filter shall be installed on inlets receiving runoff from disturbed areas. **This method of inlet protection shall be removed if a safety hazard is created.**

One method of curb inlet protection uses "pigs-in-a-blanket" - 8-inch concrete blocks wrapped in filter fabric. See Figure 6-21.5. Another method uses gravel bags constructed by wrapping DOT #57 stone with filter fabric, wire, plastic mesh, or equivalent material.

A gap of approximately 4 inches shall be left between the inlet filter and the inlet to allow for overflow and prevent hazardous ponding in the roadway. *Proper installation and maintenance are crucial due to possible ponding in the roadway, resulting in a hazardous condition.*

Several other methods are available to prevent the entry of sediment into storm drain inlets. Figure 6-21.7 shows of one of these alternative methods.

MAINTENANCE

The trap shall be inspected daily and after each rain and repairs made as needed.

Sediment shall be removed when the sediment has accumulated to one-half the height of the trap. Sediment shall be removed from curb inlet protection immediately. For excavated inlet sediment traps, sediment shall be removed when one-half of the sediment storage capacity has been lost to sediment accumulation. Sod inlet protection shall be maintained as specified in **Ds4 - Disturbed Area Stabilization (With Sodding)**.

Sediment shall not be washed into the inlet. It shall be removed from the sediment trap and disposed of and stabilized so that it will not enter the inlet, again.

When the contributing drainage area has been permanently stabilized, all materials and any sediment shall be removed, and either salvaged or disposed of properly. The disturbed area shall be brought to proper grade, then smoothed and compacted. Appropriately stabilize all disturbed areas around the inlet.

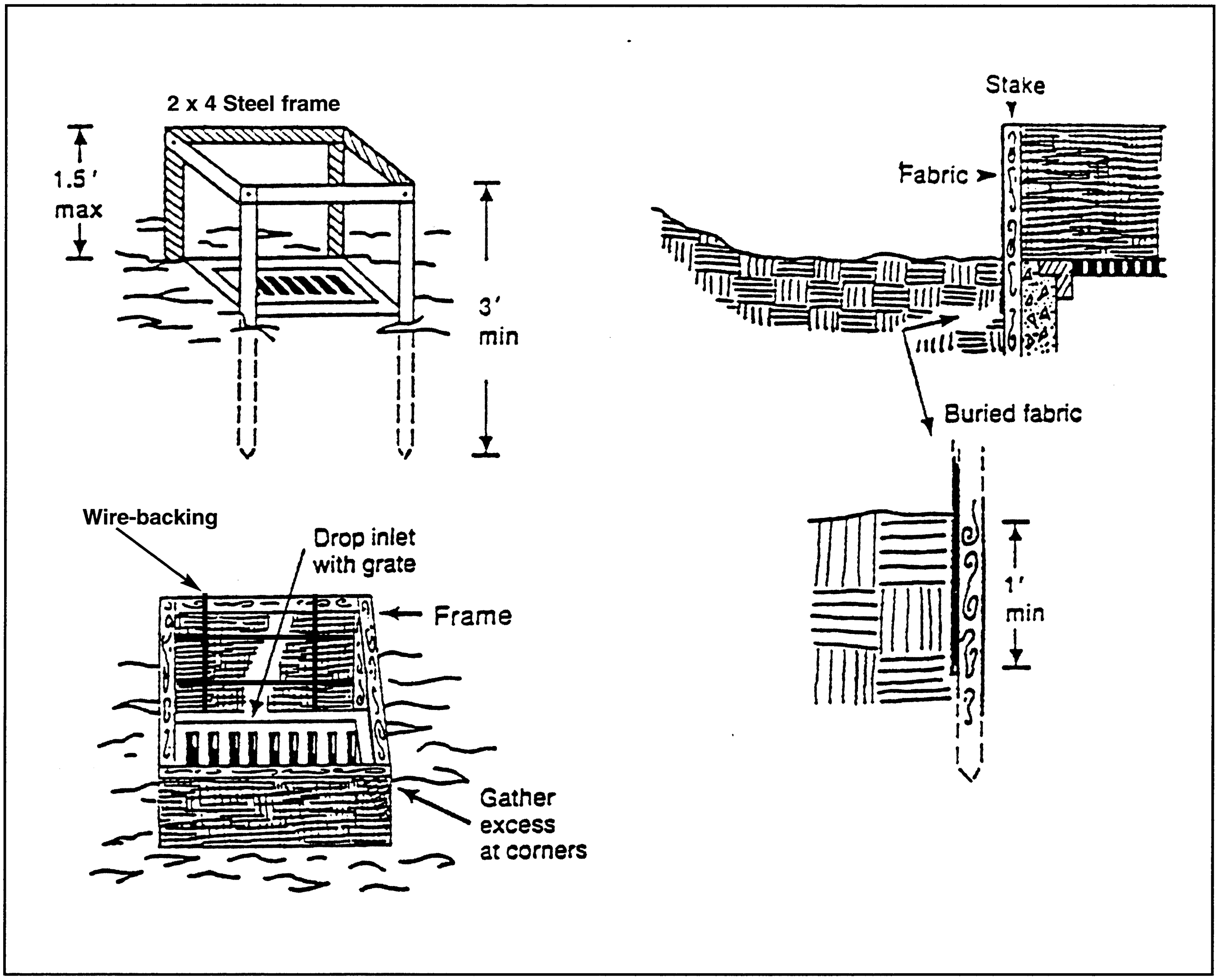
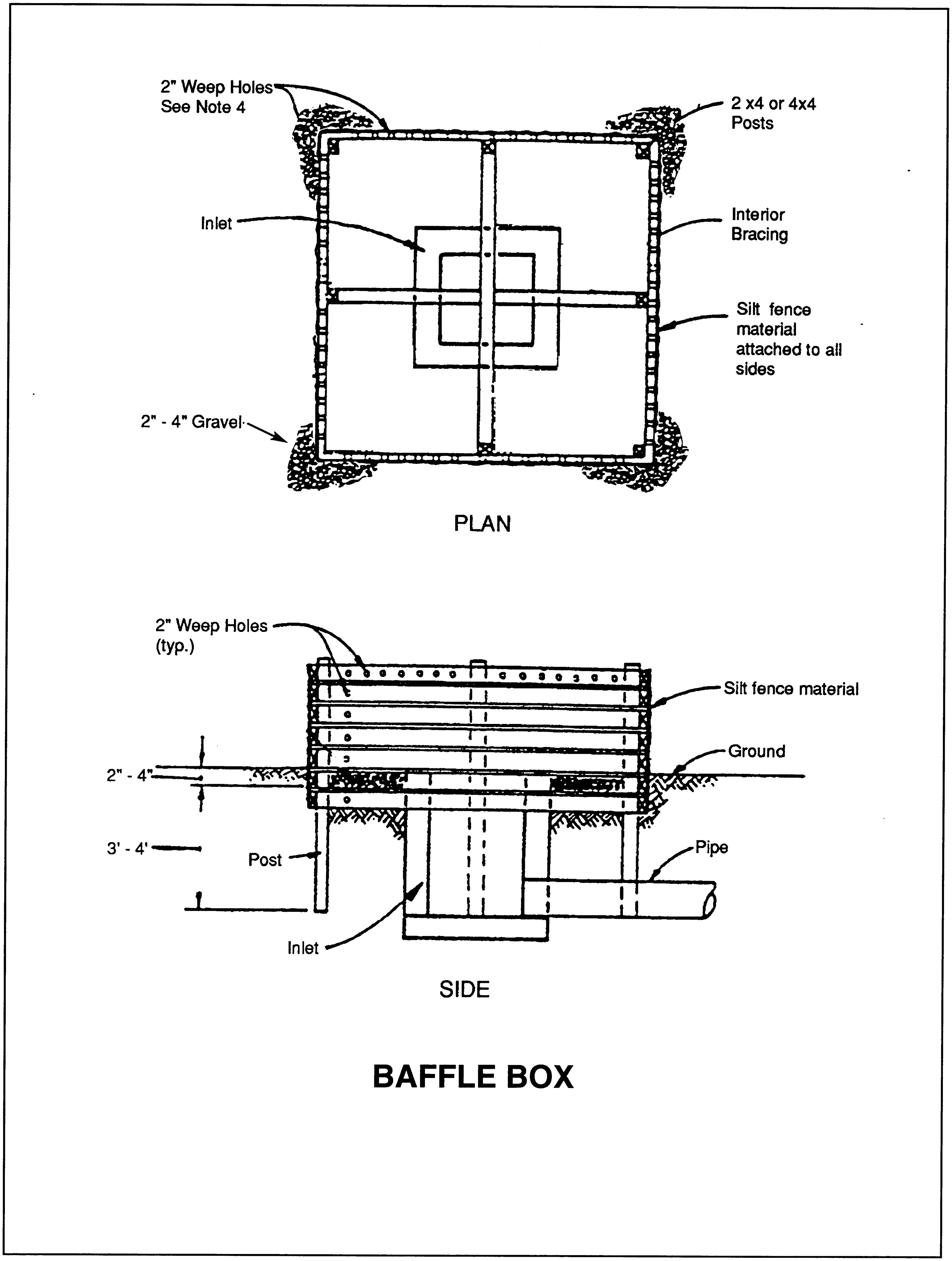


Figure 6-21.1 - Fabric and supporting frame for inlet projection



2" Weep Holes
See Note 4
2 x4 or 4x4
Posts
Inlet
Interior
Bracing
Silt fence
material
attached to all
sides
2" - 4" Gravel
PLAN
2" Weep Holes
(typ.)
Silt fence material
Ground
2" - 4"
3' - 4'
Post
Pipe
Inlet
SIDE
BAFFLE BOX

Figure 6-21.2

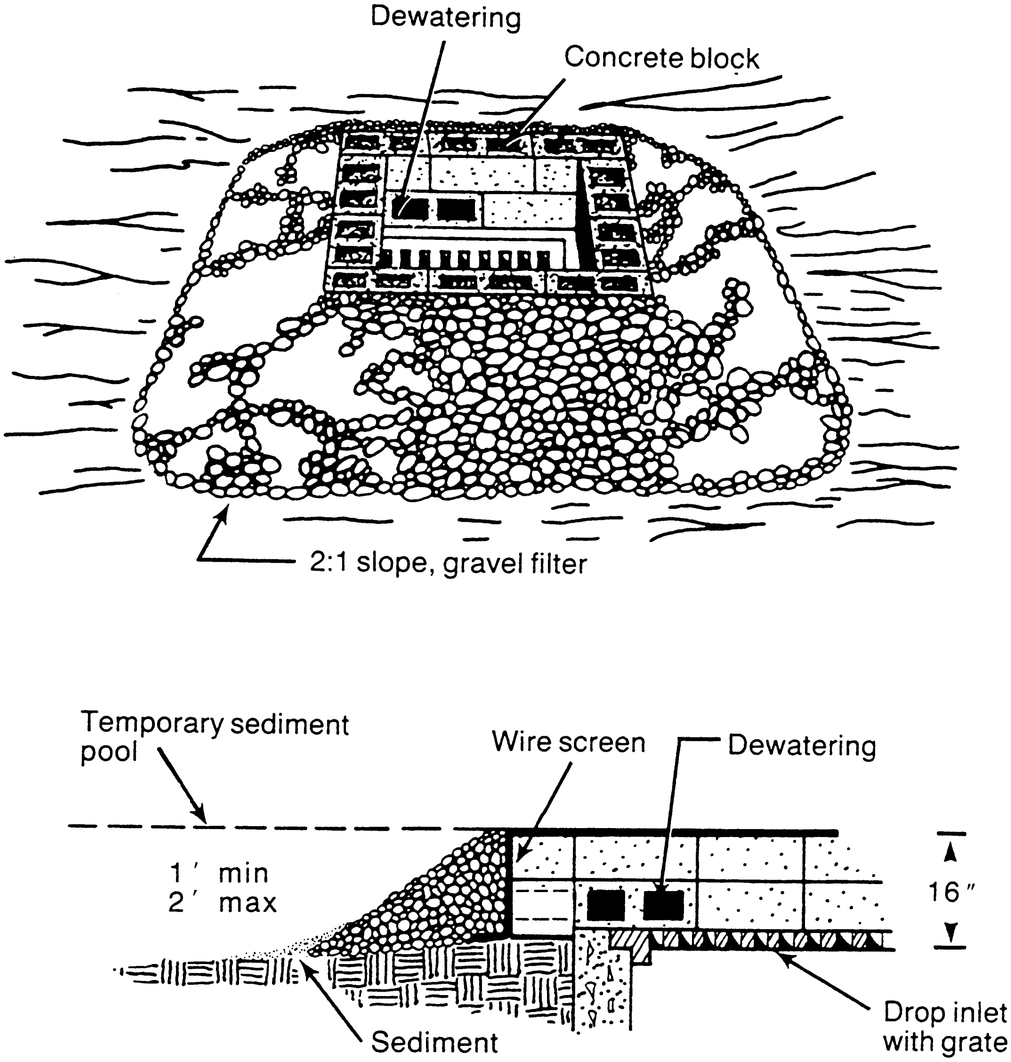


Figure 6-21.3– Block and gravel drop inlet protection

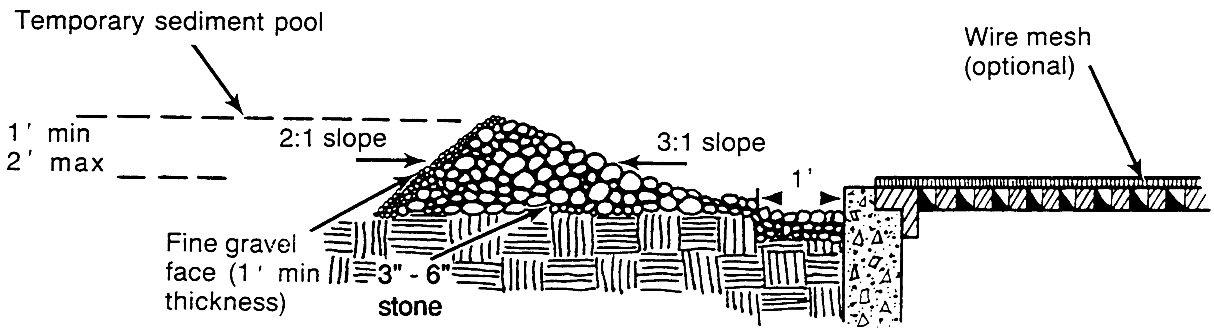
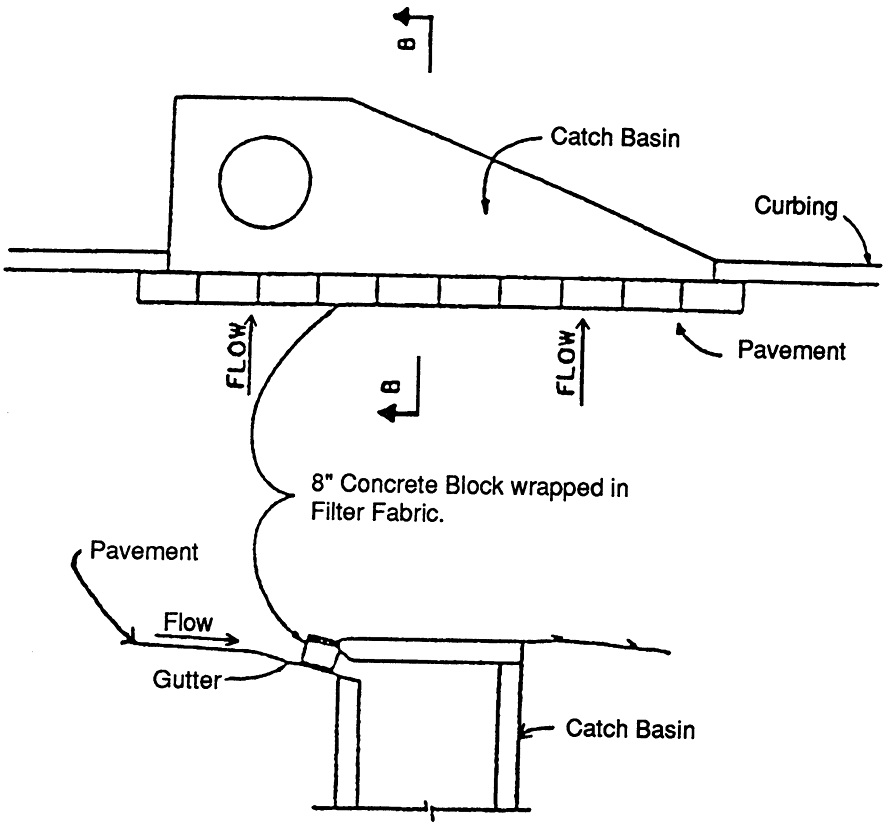


Figure 6-21.4 – Gravel drop inlet protection (gravel donut)



SECTION B-B

NOTE:
Install filter after any asphalt pavement installation.

CURB INLET FILTER
"PIGS IN BLANKET"

Figure 6-21.5

Figure 6-14.6 – Sod strips protect inlet area from erosion (source: Va SWCC)

Figure 6-21.7 - Alternative inlet sediment trap

TO BE SHOWN ON THE EROSION AND SEDIMENT CONTROL PLAN

If the **EXCAVATED INLET SEDIMENT TRAP** is used, show the following information:

1. **Drainage area** =_______ ac
2. Required sediment storage = 67 cy/ac * drainage area
   Required sediment storage = 67 cy/ac * ______ ac
   Required sediment storage = ______ cy = _______ cf
3. Assume excavation **depth** (minimum of 1.5 ft.) =_______ ft
4. Assume **slope of sides** (shall not be steeper than 2:1) =__:1
5. Determine required surface area
   SA_{min} = Required sediment storage / excavation depth
   SA_{min} = ______ cy /_______ ft
   SA_{min} = ______ sf
6. Assume shape of excavation and determine dimensions.
   (A rectangular shape with 2:1 length to width ratio is recommended.)
   Shape: _________
   Dimensions: l =______ ft w =______ ft diameter (*if applicable*) = ______ft

Provide a detail showing the depth, length and width, or diameter *(if applicable)*, and side slopes of the excavation.

Temporary Sediment Basin (Sd3)

DEFINITION

A basin created by the construction of a barrier or dam across a concentrated flow area or by excavating a basin or by a combination of both. A sediment basin typically consists of a dam, a pipe outlet, and an emergency spillway. The size of the structure will depend upon the location, size of the drainage area, soil type, and rainfall pattern.

PURPOSE

To detain runoff waters and trap sediment from erodible areas in order to protect properties and drainage ways below the installation from damage by excessive sedimentation and debris. The water is temporarily stored and the bulk of the sediment carried by the water drops out and is retained in the basin while the water is automatically released.

CONDITIONS

This practice applies to critical areas where physical site conditions, construction schedules, or other restrictions preclude the installation or establishment of erosion control practices to satisfactorily reduce runoff, erosion, and sedimentation. The structure may be used in combination with other practices and should remain in effect until the sediment-producing area is permanently stabilized.

This standard applies to the installation of temporary (to be removed within 18 months) sediment basins on sites where: (1) failure of the structure would not result in loss of life or interruption of use or service of public utilities, and (2) the drainage area does not exceed 150 acres.

DESIGN CRITERIA

Compliance With Laws and Regulations

Design and construction shall comply with state and local laws, ordinances, rules and regulations. Basins shall be constructed according to the approved erosion and sediment control plan unless modified by the design engineer.

Location

Sediment basins shall never be placed in live streams. They should be located so that storm drains discharge into the basin. The sediment basin should be located to obtain the maximum storage benefit from the terrain and for ease of clean-out of the trapped sediment. It should be located to minimize interference with construction activities and construction of utilities.

Volume

The sediment storage volume of the basin, as measured to the elevation of the crest of the principal spillway, shall be at least 67 cubic yards per acre for the disturbed area draining into the basin (67 cubic yards is equivalent to 1/2 inch of sediment per acre of drainage area). *The entire drainage basin area should be used for this computation*, rather than the disturbed area alone, to help ensure adequate trapping efficiency. *Sediment shall be removed from the basin when approximately one-third of the storage volume has been lost to sediment accumulation.* This volume shall be marked on the riser or by setting a marked post near the riser.

Surface Area

Studies (Barfield and Clar, 1985) indicate that the following relationship between surface area and peak inflow rate gives a trapping efficiency from greater than 75% for clay loam to 95% for loamy sandy soils.

$$A = 0.01q$$

where A is basin surface area in acres and q is peak inflow rate in cfs. Area is measured at the crest of the principal spillway riser. The minimum peak inflow rate is determined from a 2-year, 24-hour storm.

Shape

It is recommended that the designer of a sediment basin incorporate features to maximize detention time within the basin. Suggested methods of accomplishing this objective are:

1. Length to width ratio greater than 2:1, where length is the distance between the inlet and outlet.
2. A wedge shape with the inlet located at the narrow end.
3. Installation of baffles or diversions.

Procedure for Determining or Altering Sediment Basin Shape

As specified in the Standard and Specification, the pool area at the elevation of crest of the principal spillway shall have a length to width ratio of at least 2:1. The purpose of this requirement is to minimize the "short-circuiting" effect of the sediment-laden inflow to the riser and thereby increasing 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 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 (We) is equal to the Area (A) divided by the length (L). The length to width ratio (L:W) is found by the equation:

$$L:W = l/We \text{ where } We = A/L$$

In the event there is more than one inflow point, *any inflow point which conveys more than 30 percent of the total peak inflow rate shall meet the length-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 shall be placed mid-way between the inflow point and the riser. The baffle length shall be as required to provide the minimum 2:1 length-width ratio. The effective length (Le) shall be the shortest distance the water must flow from the inflow point around the end of the baffle to the outflow point. Then:

$$L:W = Le / We \text{ where } We = A/Le$$

Three examples are shown on the following pages. 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, Le = L1a + L1b = L2a + L2d. Otherwise, the length-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 L1 = L2. A baffle detail is also shown. For examples of sediment basin baffles, refer to Figure 6-22.2.

The dimensions necessary to obtain the required basin volume and surface area shall be clearly shown on the plans to facilitate plan review, construction and inspection.

Spillways

Runoff may be computed by the method outlined in Appendix A. Other approved equivalent methods may be used. 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 25-year, 24-hour frequency storm.* Even if the principal spillway is designed to convey the peak rate of runoff from a 25-year, 24,-hour storm, an emergency spillway shall be present.

1. **Principal spillway** - A spillway consisting of a vertical pipe or box type riser joined (watertight connection) to a pipe which shall extend through the embankment and outlet beyond the downstream toe of the fill shall be provided. See figure 6-22.3. The metal gauge thickness shall comply with DOT or NRCS specifications. The discharge shall be based on a 2-year, 24-hour storm for the total drainage area without causing flow through the emergency spillway. The appropriate disturbed soil cover condition shall be used. *The minimum size of the pipe shall be 8 inches in diameter.* Principal spillway capacities may be determined from Table 6-22.1. Weir flow discharge above the crest of the riser may be determined from Table 6-22.2. Principal spillway pipe, riser pipe, and trash rack proportions are shown in Table 6-22.2.

a. **Crest elevation** - The crest elevation of the riser shall be a minimum of one foot below the elevation of the control section of the emergency spillway.

b. **Watertight barrel assembly** - The riser and all pipe connections shall be completely water tight except for the inlet opening at the top or dewatering openings, and shall not have any other holes, leaks, rips or perforations.

c. **Dewatering the basin** - Retention time within the basin is an important factor in effective sediment retention. The method used to dewater the sediment basin may be selected from the following two methods:

Perforated Riser Pipe The perforated riser pipe is the conventional method for dewatering a sediment basin. The lower half of the riser is perforated with 1/2-inch holes spaced approximately 3-inches apart. It is covered with two feet of 3 to 4 inch stone.

Skimmer Outlet The skimmer-type dewatering device operates at the surface of the ponded water and will not withdraw sediment from the submerged volume of the basin. As compared to conventional perforated risers, skimmers discharge a 45 percent less mass of sediment. However, skimmers are mechanically more complex and will require frequent inspection and maintenance in order to operate as designed. See Figure 6-22.4.

d. **Trash rack and anti-vortex device** - A trash rack and anti-vortex device shall be securely installed on top of the riser and may be the type as shown in Figure 6-22.5.

e. **Base** - The riser shall have a base attached with a watertight connection and shall have sufficient weight to prevent flotation of the riser. *A concrete base 18" thick with the riser embedded 9-inches in the base is recommended.* Computations shall be made to design a base which will prevent flotation. See Figure 6-22.6 and Table 6-22.3 for details.

f. **Anti-Seep Collars** - One anti-seep collar shall be installed around the pipe, near the center of the dam, when **any** of the following conditions exist:

1. The settled height of the dam is greater than 15 feet.
2. The conduit is smooth pipe larger than 8" in diameter.
3. The conduit is corrugated metal pipe larger than 12" in diameter.

Use an anti-seep collar with an 18-inch projection for heads (H) less than or equal to 10 feet and a 24-inch projection for heads (H) greater than 10 feet. The anti-seep collar and its connection shall be watertight.

g. **Outlet** - An outlet shall be provided, including a means of conveying the discharge in an erosion-free manner to an existing stable area. 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 excavated plunge pools, riprap, impact basins, revetments, or other approved methods. Refer to specification **St - Storm Drain Outlet Protection**.

h. For typical features of a temporary sediment basin, see Figure 6-22.1.

2. **Emergency Spillway** - *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. See Figure 6-22.7.

a. **Capacity** - The minimum capacity of the emergency spillway shall be that *required to pass the peak rate of runoff from the 25-year, 24-hour frequency storm, less any reduction due to flow in the principal spillway.* The appropriate disturbed soil cover condition shall be used. Emergency spillway dimensions may be determined by using the method described in this section. Refer to Table 6-22.4 and Figure 6-22.7.

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. Vegetation, riprap, asphalt or concrete shall be provided to prevent erosion. Refer to specification **Ch - Channel Stabilization**.

c. **Freeboard** - Freeboard is the difference between the design high water elevation in the emergency spillway and the top of the settled embankment. *The freeboard shall be at least one foot.*

Entrance of Runoff Into Basin

Points of entrance of surface runoff into excavated sediment basins shall be protected to prevent erosion and sediment generation. Dikes, swales or other water control devices shall be installed as necessary to direct runoff into the basin. Points of runoff entry should be located as far away from the riser as possible, to maximize travel time. Refer to **St - Storm Drain Outlet Protection**.

CONSTRUCTION SPECIFICATIONS

Site Preparation

Areas under the embankment and under structural works shall be cleared, grubbed, and stripped of topsoil. All trees, vegetation, roots and other objectionable material shall be removed and disposed of by approved methods. In order to facilitate clean-out or restoration, the pool area (measured at the top of the pipe spillway) will be cleared of all brush and trees.

Cut-off Trench

A cut-off trench will be excavated along the centerline of earth fill embankments. *The minimum depth shall be 2 feet.* The cut-off trench shall extend up both abutments to the riser crest elevation. The minimum bottom width shall be 4 feet, but wide enough to permit operation of compaction equipment. The side slopes shall be no steeper than 1:1. Compaction requirements shall be the same as those for the embankment. The trench shall be drained during the backfilling and 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 be placed in the downstream section of the embankment. Areas on which fills are 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 the ball, it is too wet for proper compaction. *Fill material shall be placed in six-inch 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 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 5 percent higher than the design height to allow for settlement.*

Principal Spillway

The riser shall be securely attached to the pipe or pipe stub by welding the full circumference making a watertight structural connection. The pipe 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 pipe sections must be achieved by approved watertight band assemblies The pipe and riser shall be placed on a firm, smooth foundation of impervious soil as the embankment is constructed. Breaching the embankment is unacceptable. Pervious materials such as sand, gravel, or crushed stone shall not be used as backfill around the pipe or anti-seep collar. *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.* Care must be taken not to raise the pipe from firm contact with its foundation when compacting under the pipe haunches. A minimum depth of two feet of hand compacted backfill shall be placed over the pipe spillway before crossing it with construction equipment.

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. If the emergency spillway requires erosion protection other than vegetation, *the lining shall not compromise the capacity of the emergency spillway, e.g.* the emergency spillway shall be over-excavated so that the lining will be flush with the slope surface.

Vegetative Treatment

Stabilize the embankment and all other disturbed areas in accordance with the appropriate permanent vegetative measure, Ds3, immediately following construction. *In no case shall the embankment remain unstabilized for more than seven (7) days.* Refer to specifications **Ds2, Ds3, and Ds4 - Disturbed Area Stabilization (Temporary Seeding, Permanent Vegetation, and Sodding)** respectively.

Erosion and Pollution Control

Construction operations will be carried out in such a manner that erosion and water pollution will be minimized. State and local law concerning pollution abatement shall be complied with.

Safety

State and local requirements shall be met concerning fencing and signs warning the public of hazards of soft sediment and floodwater.

MAINTENANCE

Repair all damages caused by soil erosion or construction equipment at or before the end of each working day.

Sediment shall be removed from the basin when it reaches the specified distance below the top of the riser. *Sediment shall not enter adjacent streams or drainageways during sediment removal or disposal.* 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 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 embankment and trapped sediment 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 backfilled.

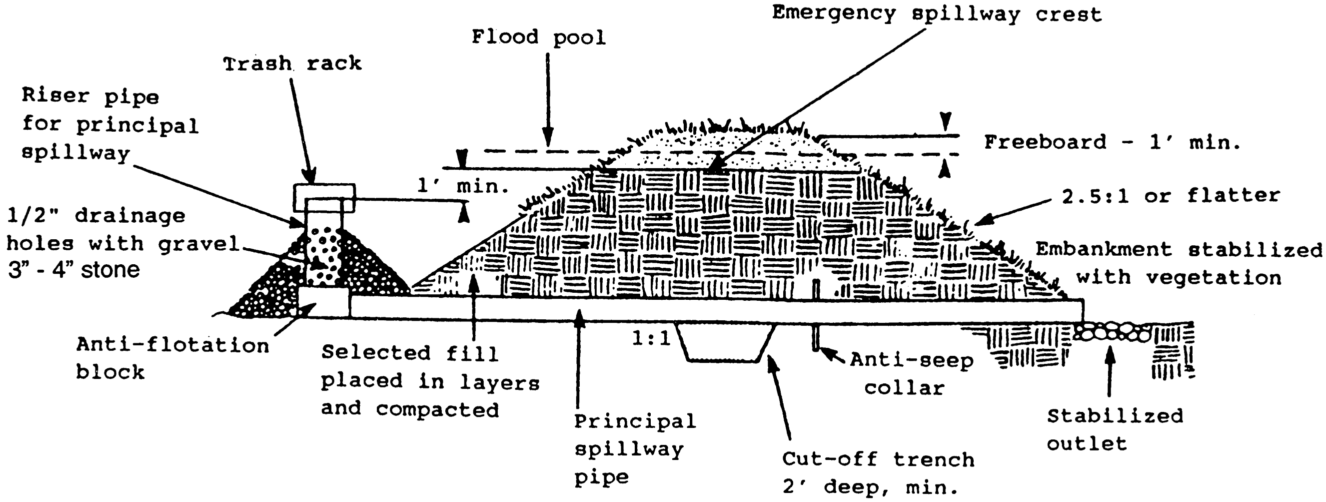
TO BE SUBMITTED WITH/ON THE EROSION AND SEDIMENT CONTROL PLAN

ON THE E&SC PLAN

1. The specific location of the basin, showing existing and proposed contours.
2. Maintenance equipment access points.
3. Completed Figures 6-22.8 and 6-22.9. (details for the cross section of dam, principal spillway, and emergency spillway, and profile of emergency spillway).
4. Details of trash rack, concrete riser base, and outlet structure assembly. (Refer to Figures 6-22.4 to 6-22.7.

ON 8 1/2" X 11" SHEET(S)

1. Hydrological study, including information regarding stage/storage relationship.
2. Temporary sediment basin design sheet, p.6-168 to 6-170.
3. Completed Figures 6-22.8 and 6-22.9 (details for the cross section of the dam, principal spillway, and emergency spillway, and profile of emergency spillway).

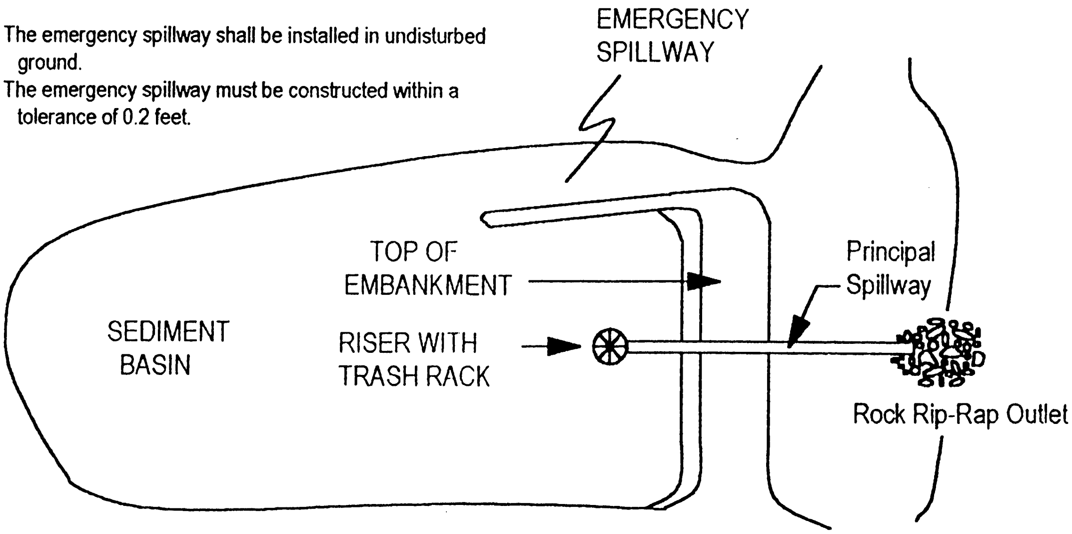


CROSS SECTION

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

NOTES:

1. The emergency spillway shall be installed in undisturbed ground.
2. The emergency spillway must be constructed within a tolerance of 0.2 feet.



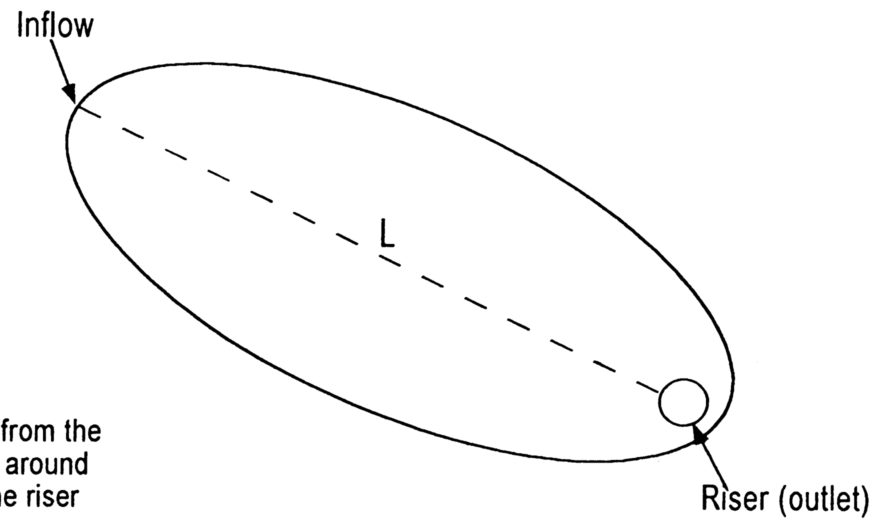
PLAN VIEW

Figure 6-22.1 - Basic components of a temporary sediment basin.

SEDIMENT BASIN BAFFLES

Examples: Plan Views - not to scale

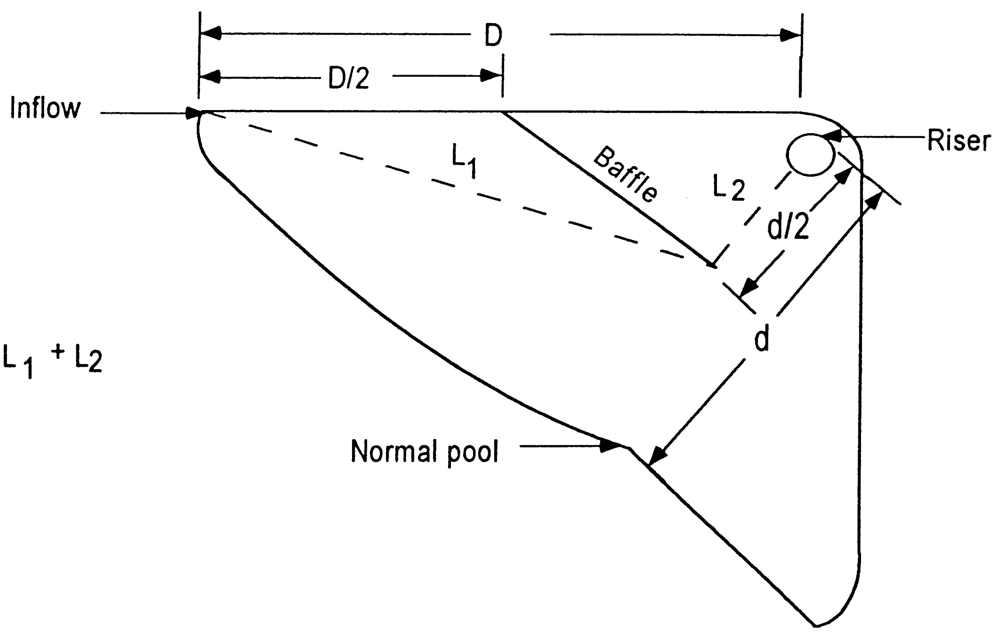
A.



$L_e = L$

L_e = Total distance from the point of inflow around the baffle to the riser

B.



$L_e = L_1 + L_2$

Figure 6-22.2

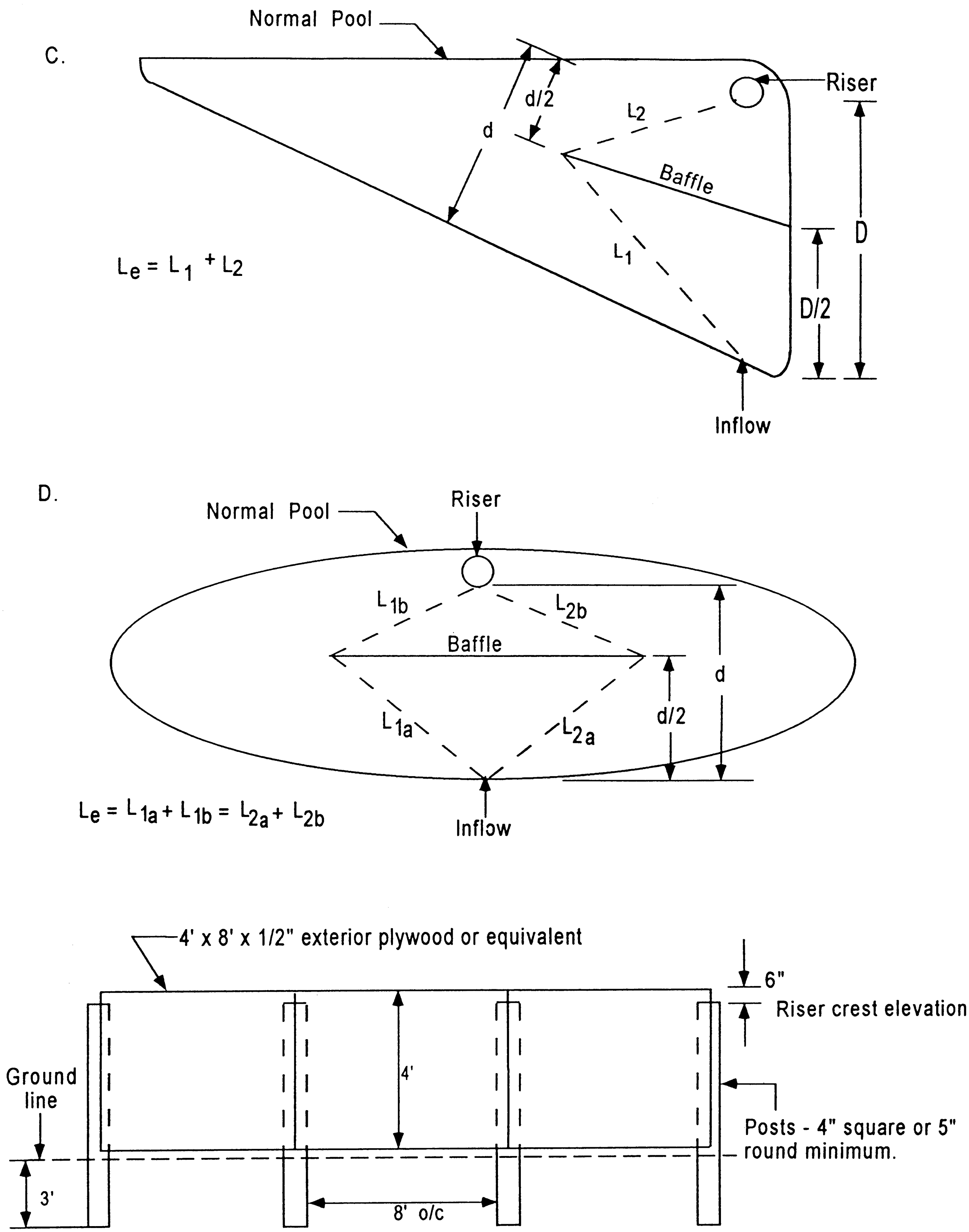
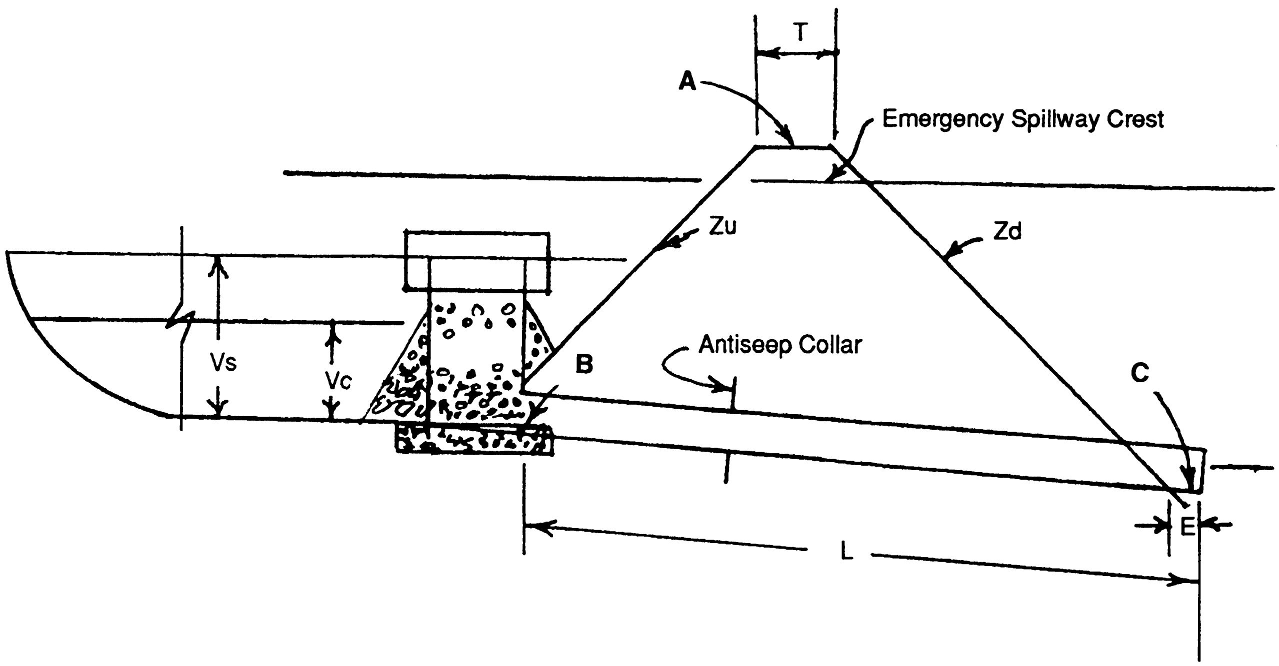


Figure 6-22.2 continued



PRINCIPAL SPILLWAY DESIGN

T = Top width of dam, ft.

Zu = Upstream side slope

Zd = Downstream side slope

A = Top of dam elevation

B = Lowest elevation of pipe at riser

C = Lowest elevation of pipe at outlet

E = Extended length of pipe beyond toe of dam

L = Total length of pipe, ft.

L = [A - (B + C) / 2] [Zu + Zd] + T + E

Figure 6-22.3

PIPE FLOW CHART FOR CORRUGATED METAL PIPE DROP INLET PRINCIPAL SPILLWAY CONDUIT

For Corrugated Metal Pipe Inlet $K_m = K_a + K_b = 1.0$ and 70 Feet of Corrugated Metal Conduit (full flow assumed), n = 0.025
(Note correction factors for pipe lengths other than 70 feet)

	Diameter Of Pipe In Inches							
H, in feet	8"	12"	18"	24"	30"	36"	42"	48"
	Discharge In Cubic Feet Per Second							
3	1.22	3.43	9.48	19.1	32.6	49.9	71.2	96.5
4	1.40	3.97	10.9	22.1	37.6	57.7	82.3	111
5	1.57	4.43	12.2	24.7	42.1	64.5	92.0	125
6	1.72	4.86	13.4	27.0	46.1	70.6	101	136
7	1.86	5.25	14.5	29.2	49.8	76.3	109	147
8	1.99	5.61	15.5	31.2	53.2	81.5	116	158
9	2.11	5.95	16.4	33.1	56.4	86.5	123	167
10	2.22	6.27	17.3	34.9	59.5	91.2	130	176
11	2.33	6.58	18.2	36.6	62.4	95.6	136	185
12	2.43	6.87	19.0	38.2	65.2	99.9	142	193
13	2.53	7.15	19.7	39.8	67.8	104	148	201
14	2.63	7.42	20.5	41.3	70.4	108	154	208
15	2.72	7.68	21.2	42.8	72.8	112	159	216
16	2.81	7.93	21.9	44.2	75.2	115	165	223
17	2.90	8.18	22.6	45.5	77.5	119	170	230
18	2.98	8.41	23.2	46.8	79.8	120	174	236
19	3.06	8.64	23.9	48.1	82.0	126	179	243
20	3.14	8.87	24.5	49.4	84.1	129	184	249
L, in feet	Correction Factors For Other Pipe Lengths							
30	1.41	1.36	1.29	1.24	1.21	1.18	1.15	1.13
40	1.27	1.23	1.20	1.17	1.14	1.12	1.11	1.10
50	1.16	1.14	1.12	1.10	1.09	1.08	1.07	1.06
60	1.07	1.06	1.05	1.05	1.04	1.04	1.03	1.03
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	0.94	0.95	0.95	0.96	0.96	0.97	0.97	0.97
90	0.89	0.90	0.91	0.92	0.93	0.94	0.94	0.95
100	0.85	0.86	0.88	0.89	0.90	0.91	0.92	0.93
120	0.79	0.90	0.82	0.83	0.85	0.86	0.87	0.89
140	0.73	0.75	0.77	0.79	0.81	0.82	0.84	0.85
160	0.69	0.70	0.73	0.75	0.77	0.79	0.80	0.82

Table 6-22.1

Table 6-22.2

WEIR FLOW (Q) OVER RISER CREST FOR CIRCULAR RISERS WITH TRASH RACK

$$Q = CLh^{3/2}$$

$$Q = 3.1 \times (\pi) \times (D/12) \times h^{3/2}$$

Riser Diameter (D_r) in inches

Flow In Cubic Feet Per Second

HEAD-h in feet	12	18	24	30	36	48	54	60	HEAD-h in feet
0.1	0.3	0.5	0.6	0.8	0.9	1.2	1.4	1.5	0.1
0.2	0.9	1.3	1.7	2.2	2.6	3.5	3.9	4.4	0.2
0.3	1.6	2.4	3.2	4.0	4.8	6.4	7.2	8.0	0.3
0.4	2.5	3.7	4.9	6.2	7.4	9.9	11.1	12.3	0.4
0.6	4.5	6.8	9.1	11.3	13.6	18.1	20.4	22.6	0.6
0.8		10.5	13.9	17.4	20.9	27.9	31.4	34.8	0.8
1.0			19.5	24.3	29.2	39.0	43.8	48.7	1.0
1.2			25.6	32.0	38.4	51.2	57.6	64.0	1.2
1.4				40.3	48.4	64.5	72.6	80.7	1.4
1.6				49.3	59.1	78.8	88.7	98.6	1.6
1.8					70.6	94.1	105.8	117.6	1.8
2.0					82.6	110.2	124.0	137.7	2.0
2.2						127.1	143.0	158.9	2.2
2.4							162.9	181.0	2.4
2.6							183.7	204.1	2.6
2.8								228.1	2.8
3.0								253.0	3.0

Pipe, Riser, and Trash Rack Proportions

Eq. 6-10 $D_r \geq (1.50)\ (D_{ps})$

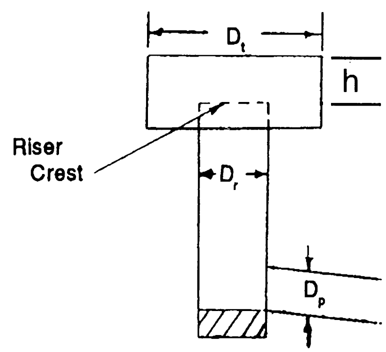
where D_r = diameter of riser

D_{ps} = diameter of principal spillway

Eq. 6-11 $D_t \geq (1.4)\ (D_r)$

where D_t = diameter of trash rack

D_r = diameter of riser



EXAMPLE: The peak runoff for a 2-year, 24-hour rain is 32 cfs. Select a pipe size for a head of 12 feet and length of 100 feet. From Table 6-15.1, 38.2 x 0.89 = 34 cfs discharge for a 24-inch diameter pipe.

Using Equation 6-10 $D_r \geq (1.5)\ (D_p)$

$D_r \geq (1.5)\ (24) \geq$ 36 inch diameter riser

Using Equation 6-11 $D_t \geq (1.4)\ (D_r)$

$D_t \geq (1.4)\ (36) \geq$ 50 inch diameter (Use 54 inch)

Determine h - From Table 6-15.2

Q = 34 cfs D_r = 36" h = 1.2'

NOTE: h = minimum distance between the crest of the riser and the crest of the emergency spillway.

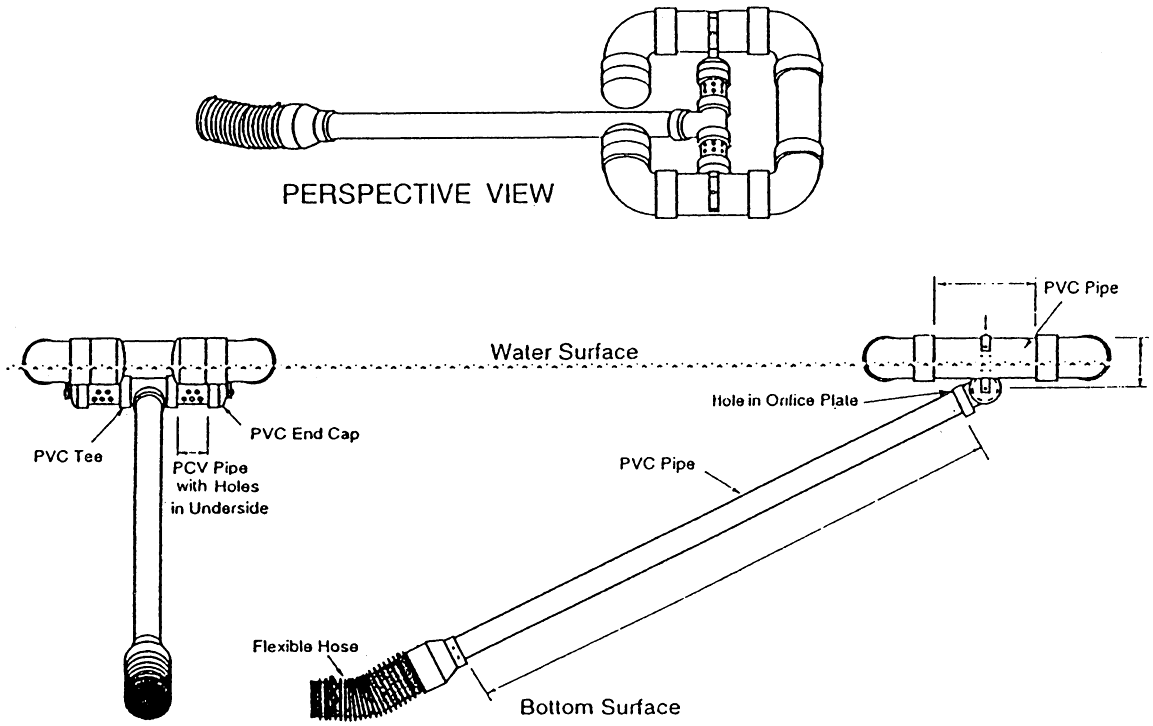
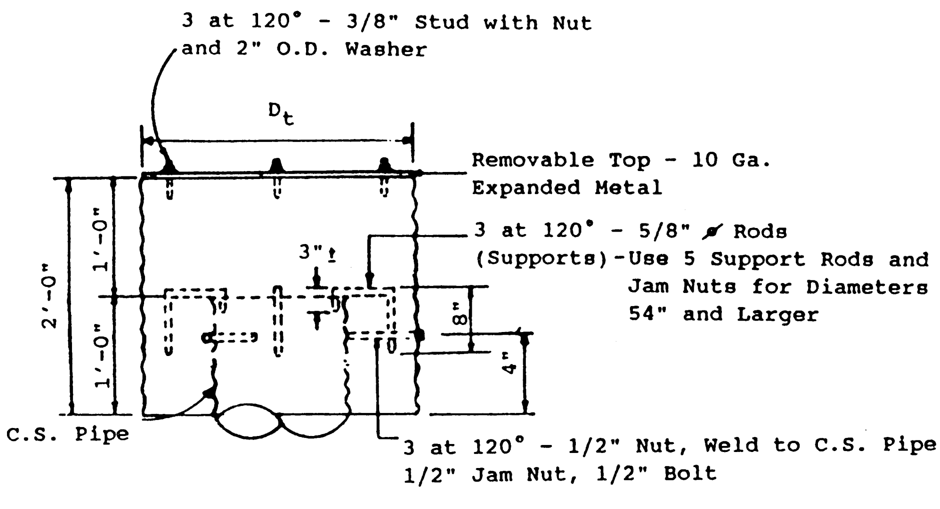
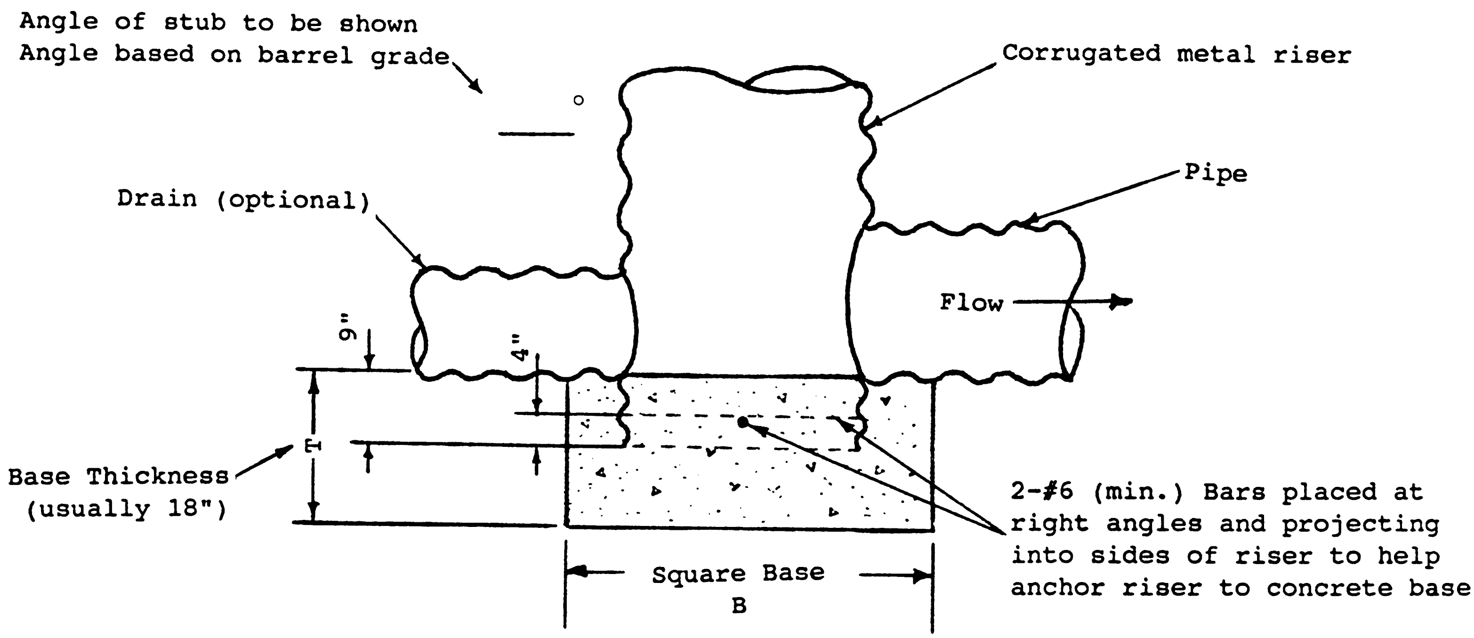


Figure 6-22.4 - Skimmer outlet



Typical Trash Rack

Figure 6-22.5



CONCRETE RISER BASE DETAIL

Figure 6-22.6

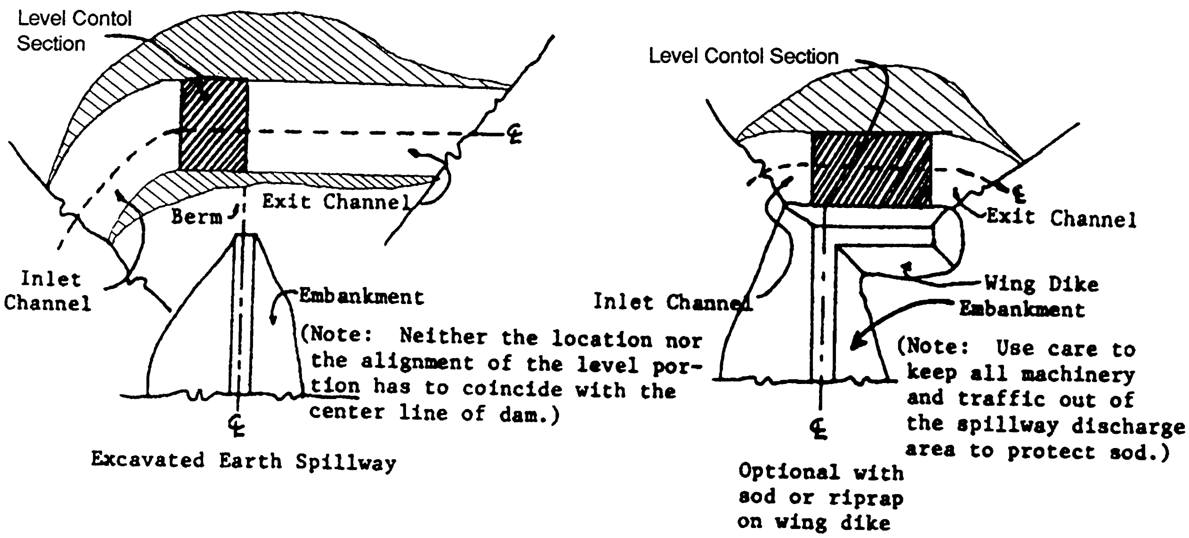
Riser Pipe Diameter (in)	Buoyant Force (lbs /V.F. of Riser Height)[1]	Volume of Concrete per Vertical Foot of Riser Height (c.f./V.F.) Needed to Prevent Flotation[2]
12	49.0	0.69
18	110.3	1.54
21	150.1	2.10
24	196.0	2.75
30	306.3	4.29
36	441.1	6.18
48	784.1	10.98
54	992.4	13.90
60	1225.2	17.16

EXAMPLE: Find the volume of concrete required to stabilize a 24 inch diameter riser 10 feet high.

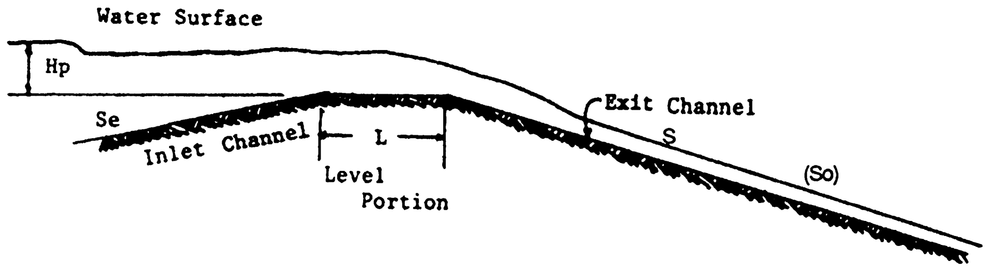
VOL. = (2.75 cu.ft./V.F.) (10 feet) = 27.5 cu. ft. = 1 cu. yd.

CONCRETE VOLUME REQUIRED TO PREVENT FLOTATION OF RISER

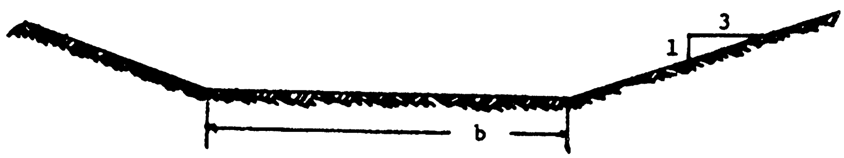
Table 6-22.3



PLAN VIEW OF EARTH SPILLWAYS



PROFILE ALONG CENTERLINE



CROSS-SECTION OF CONTROL SECTION

LEGEND:

Hp = Difference in Elevation between Crest of Earth Spillway at the Control Section and Water Surface in resevoir, in feet.
b = Bottom Width of Earth Spillway at the Control Section, in feet. (Table 6-22.4)
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. (Table 6-22.4)
S = Flattest Slope (S), in %, allowable for Channel below Control Section. (Table 6-22.4)
Se = Entry Slope
So = Exit Slope

NOTES:

1. For Q, V, S relationship see the chart on the following page.
2. For a given Hp, a decrease in the exit slope as given in the table decreases spillway discharge, but increasing the exit slope from S does not increase discharge. If an exit slope (So) is steeper than S is used, then velocity (Vo) in the exit channel will increase according to the following relationship:

$$Vo = V(So/S)^{0.3}$$

Figure 6-22.7

DESIGN DATA FOR EARTH SPILLWAYS

STAGE (Hp) IN FEET	SPILLWAY VARIABLES	BOTTOM WIDTH (b) IN FEET																
		8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
0.5	Q	6	7	8	10	11	13	14	15	17	18	20	21	22	24	25	27	28
	V	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
	S	3.9	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
0.6	Q	8	10	12	14	16	18	20	22	24	26	28	30	32	34	35	37	39
	V	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	S	3.7	3.7	3.7	3.7	3.6	3.7	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
0.7	Q	11	13	16	18	20	23	25	28	30	33	35	38	41	43	44	46	48
	V	3.2	3.2	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
	S	3.5	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
0.8	Q	13	16	19	22	26	29	32	35	38	42	45	46	48	51	54	57	60
	V	3.5	3.5	3.5	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
	S	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
0.9	Q	17	20	24	28	32	35	39	43	47	51	53	57	60	64	68	71	75
	V	3.7	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
	S	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
1.0	Q	20	24	29	33	38	42	47	51	56	61	63	68	72	77	81	86	90
	V	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	S	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
1.1	Q	23	28	34	39	44	49	54	60	65	70	74	79	84	89	95	100	105
	V	4.2	4.2	4.2	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
	S	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
1.2	Q	28	33	40	45	51	58	64	69	76	80	86	92	98	104	110	116	122
	V	4.4	4.4	4.4	4.4	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
	S	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
1.3	Q	32	38	46	53	58	65	73	80	86	91	99	106	112	119	125	133	140
	V	4.5	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
	S	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
1.4	Q	37	44	51	59	66	74	82	90	96	103	111	119	127	134	142	150	158
	V	4.7	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
	S	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
1.5	Q	41	50	58	66	75	85	92	101	108	116	125	133	142	150	160	169	178
	V	4.8	4.9	4.9	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.1	5.1	5.1
	S	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5
1.6	Q	46	56	65	75	84	94	104	112	122	132	142	149	158	168	178	187	197
	V	5.0	5.1	5.1	5.1	5.1	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
	S	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1.7	Q	52	62	72	83	94	105	115	126	135	145	156	167	175	187	196	206	217
	V	5.2	5.2	5.2	5.3	5.3	5.3	5.3	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
	S	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1.8	Q	58	69	81	93	104	116	127	138	150	160	171	182	194	204	214	226	233
	V	5.3	5.4	5.4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.6	5.6	5.6	5.6	5.6	5.6
	S	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
1.9	Q	64	76	88	102	114	127	140	152	164	175	188	201	213	225	235	248	260
	V	5.5	5.5	5.5	5.6	5.6	5.6	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
	S	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
2.0	Q	71	83	97	111	125	138	153	164	178	193	204	218	232	245	256	269	283
	V	5.6	5.7	5.7	5.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.9	5.9	5.9	5.9	5.9	5.9
	S	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
2.1	Q	77	91	107	122	135	149	162	177	192	207	220	234	250	267	276	291	305
	V	5.7	5.8	5.9	5.9	5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	S	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3

DATA TO RIGHT OF HEAVY VERTICAL LINES SHOULD BE USED WITH CAUTION, AS THE RESULTING SECTIONS WILL BE EITHER POORLY PROPORTIONED, OR HAVE VELOCITIES IN EXCESS OF 6 FEET PER SECOND.

Source: USDA-SCS

Table 6-22.4

TEMPORARY SEDIMENT BASIN DESIGN DATA SHEET
EXAMPLE PROBLEM

Computed by___________ _ Date___________
Checked by ___________ _ Date___________

Project Name Independence School, Paradise City
Basin No. ___________ 1_______________
Total area draining to basin = 18.1 acres
Disturbed area draining to basin = 18.1 acres

Volume

1. Compute minimum required storage volume (V_s)
   $\mathbf{V_s}$ = 67 cy/ac * 18.1 acres = 1212.7 cy
2. Compute volume of basin at clean-out (V_c)
   $\mathbf{V_c}$ = 22 cy/ac * 18.1 acres = 398.2 cy
3. Determine elevation corresponding to minimum required storage volume, V_s
   Minimum riser crest elevation = 1052.5 ft (determined by stage/storage relationship)
4. Determine elevation corresponding to clean-out volume, V_c
   Clean-out elevation = 1051.9 ft (determined by stage/storage relationship)
   Note: Clean-out elevation shall be clearly marked on the riser or marked by a post near the riser.
5. Compute length of riser
   Riser length = Minimum elevation of riser crest – Lowest elevation of pipe at riser
   Riser length = 1052.5 ft – 1050.0 ft
   Riser length = 2.5 ft

Stormwater Runoff

6. Compute peak discharge from a 2-yr, 24-hr storm event.
   $\mathbf{Q_2}$ = 26 cfs (Attach runoff computation sheet.)
7. Compute peak discharge from a 25-yr, 24-hr storm event.
   $\mathbf{Q_{25}}$ = 46 cfs (Attach runoff computation sheet.)

Surface Area/Configuration Design

8. Compute minimum basin surface area (SA_{min})
   SA_{min} = 0.01 ac/cfs * Q_2
   SA_{min} = 0.01 ac/cfs * 26 cfs
   $\mathbf{SA_{min}}$ = 0.26 ac = 43560 sf/ac * 0.26 ac = 11310 sf
9. Check available area at elevation of riser crest
   Available area = 18532 sf (determined by stage/storage relationship)
   Available area ≥ SA_{min} ? Yes ___X___ No ______
10. Compute required length to achieve 2:1 L:W ratio
    Average width = 80 ft
    Required length = 2 * average width
    Required length = 2 * 80 ft
    Required length = 160 ft
    Available length = 170 ft
    2:1 L:W ratio satisfied? Yes ___X___ No ______
    If no, refer to Figure 6-22.2 for baffle designs. Note any required baffles on E&SC plan and include calculations and details for baffle(s).

TEMPORARY SEDIMENT BASIN DESIGN SHEET
Project Name <u>Independence School, Paradise City</u>
Page 2

Principal Spillway (ps)

11. Determine maximum principal spillway capacity = Q_2 = 26 cfs
12. Compute the vertical distance between the centerline of the outlet pipe and the emergency spillway crest (H)
    H = 9.75 ft
13. Compute the total pipe length of the principal spillway, L, using Figure 6-22.3.
    L = [A – (B+C)/2] [Zu+Zd] + T + E
    L = 70 ft
14. Determine diameter of principal spillway (D_{ps}) and flow through the principal spillway (Q) from Table 6-22.1 using H and Q_2.
    $\mathbf{D_{ps}}$ = 24 in. **Q** = 33.1 cfs (value directly from table)
15. Compute actual flow through the principal spillway, using Table 6-22.1 to determine the correction factor for pipe length, L.
    Q_{ps} = Q * correction factor = 33.1 cfs * 1.00
    $\mathbf{Q_{ps}}$ = 33.1 cfs
16. Compute riser diameter (D_r)
    $D_r \geq 1.5 * D_{ps}$
    $D_r \geq 1.5 *$ 24 in.
    $D_r \geq$ 36 in.
    $\mathbf{D_r}$ = 36 in.
17. Compute trash rack diameter (D_t)
    $D_t \geq 1.4 * D_r$
    $D_t \geq 1.4 *$ 36 in.
    $D_t \geq$ 50.4 in.
    $\mathbf{D_t}$ = 54 in.
18. Determine the minimum distance between the riser crest and the emergency spillway crest, **h**, using Table 6-22.2 D_r, and Q_{ps}.
    h = 1.1 ft

Concrete Riser Base Design

19. Determine the volume of concrete per vertical foot of riser height needed (from Table 6-22.3) to prevent flotation.
    Required volume of concrete per vertical foot = 6.18 cf/v.f.
20. Compute total volume of concrete required.
    Total required volume of concrete = Required volume per vertical foot * Riser length
    Total required volume of concrete = 6.18 cf/v.f. * 2.5 ft
    Total volume of concrete required = 15.45 cf
21. Assume base thickness (usually 18") (B).
    B = 18 in = 1.5 ft
22. Compute required surface area.
    Required surface area = Total volume required / B
    Required surface area = 15.45 cf / 1.5 ft
    Required surface area = 10.3 sf
23. Compute riser base length (l) and width (w) (assume square base).
    $l = w = (\text{required surface area})^{1/2}$
    $l = w = (10.3 \text{ sf})^{1/2}$
    l = **w** = 3.21 ft = 12in/ft * 3.21 ft = 39 in.

TEMPORARY SEDIMENT BASIN DESIGN SHEET
Project Name Independence School, Paradise City
Page 3

Anti-Seep Collar Design

24. Determine if anti-seep collar is required. If yes to any of the following conditions, a collar is required:
    ______ The settled height of the dam is greater than 15 feet.
    ______ The principal spillway diameter (D_{ps}) is smooth pipe larger than 8".
    ___X___ The principal spillway diameter (D_{ps}) is corrugated metal pipe larger than 12".
25. Determine size of anti-seep collar required.
    ___X___ **18-inch projection** (for heads (H) less than or equal to 10 feet).
    ______ **24-inch projection** (for heads (H) greater than 10 feet).

Emergency Spillway (es)

26. Compute minimum capacity of emergency spillway (Q_{es})
    $Q_{es} = Q_{25} - Q_{ps}$ = 46 cfs - 33 cfs
    $\mathbf{Q_{es}}$ = 13 cfs
27. Determine stage (H_p), bottom width (b), velocity (V) and minimum exit slope (S) using Table 6-22.4 and Q_{es}.
    $\mathbf{H_p}$ = 0.7 ft **b** = 10 ft **V** = 3.2 fps **S** = 3.5 %
28. Actual entrance channel slope, $\mathbf{S_e}$ = 5 %
29. Actual exit channel slope, $\mathbf{S_o}$ = 7 %
    Note: If S_o is steeper than S (from Table 6-22.4), then the velocity in the exit channel will increase.
    a.) Calculate exit velocity (V_o)
    $V_o = V (S_o /S)^{0.3}$ = 3.8 fps * (7 / 3.5) $^{0.3}$
    $\mathbf{V_o}$ = 4.7 fps
    Note: Refer to Channel Stabilization (Ch) to determine the proper lining for the emergency spillway.
    Grass ___X___ **Rip-rap** ______ **Concrete** ______

Design Elevations

30. **Riser crest elevation** = 1052.5 ft
31. Compute minimum emergency spillway crest elevation
    Minimum emergency spillway crest elevation = Riser crest elevation + h
    Minimum emergency spillway crest elevation = 1052.5 ft + 1.1 ft
    Minimum emergency spillway crest elevation = 1053.6 ft
    Actual emergency spillway crest elevation = 1053.6 ft
32. Determine design high water elevation
    Design high water elevation = Emergency spillway crest elevation + Stage elevation (Hp)
    Design high water elevation = 1053.6 ft + 0.9 ft
    Design high water elevation = 1054.5 ft
33. Determine elevation of top of dam
    Elevation of top of dam = Design high water elevation + 1 ft freeboard
    Elevation of top of dam = 1054.5 ft + 1 ft
    Elevation of top of dam = 1055.5 ft

TEMPORARY SEDIMENT BASIN DESIGN SHEET

Computed by______________ Date______________
Checked by ______________ Date______________

Project Name ______________________________
Basin No. ______________________________
Total area draining to basin = ________ acres
Disturbed area draining to basin = ________ acres

Volume

1. Compute minimum required storage volume (V_s).
   V_s = 67 cy/ac * ________ acres = ________ cy
2. Compute volume of basin at clean-out (V_c).
   V_c = 22 cy/ac * ________ acres = ________ cy
3. Determine elevation corresponding to minimum required storage volume, $V_{s.}$
   Minimum riser crest elevation = ________ ft (determined by stage/storage relationship)
4. Determine elevation corresponding to clean-out volume, $V_{c.}$
   Clean-out elevation = ________ ft (determined by stage/storage relationship)
   Note: Clean-out elevation shall be clearly marked on the riser or marked by a post near the riser.
5. Compute length of riser.
   Riser length = Minimum elevation of riser crest – Lowest elevation of pipe at riser
   Riser length = ________ ft - ________ ft
   Riser length = ________ ft

Stormwater Runoff

6. Compute peak discharge from a 2-yr, 24-hr storm event.
   Q_2 = ________ cfs (Attach runoff computation sheet.)
7. Compute peak discharge from a 25-yr, 24-hr storm event.
   Q_{25} = ________ cfs (Attach runoff computation sheet.)

Surface Area/Configuration Design

8. Compute minimum basin surface area (SA_{min}).
   SA_{min} = 0.01 ac/cfs * Q_2
   SA_{min} = 0.01 ac/cfs * ________ cfs
   SA_{min} = ________ ac = 43560 sf/ac * ________ ac = ________ sf
9. Check available area at elevation of riser crest.
   Available area = ________ sf (determined by stage/storage relationship)
   Available area SA_{min}? Yes ________ No ________
10. Compute required length to achieve 2:1 L:W ratio.
    Average width = ________ ft
    Required length = 2 * average width
    Required length = 2 * ________ ft
    Required length = ________ ft
    Available length = ________ ft
    2:1 L:W ratio satisfied? Yes ________ No ________
    If "no", refer to Figure 6-22.2 for baffle designs. Note any required baffles on E&SC plan and include calculations and details for baffle(s).

Principal Spillway (ps)

11. Determine maximum principal spillway capacity.
    Q_{max} = Q_2 = ________ cfs
12. Compute the vertical distance between the centerline of the outlet pipe and the emergency spillway crest (H).

H = ________ ft

13. Compute the total pipe length of the principal spillway, L, using Figure 6-22.3.
$L = [A - (B+C)/2] [Zu+Zd] + T + E$ = [_____- (_____+_____)/2] [_____+_____] + _____ + _____
L = ________ ft
14. Determine diameter of principal spillway (D_{ps}) and flow through the principal spillway (Q) from Table 6-22.1 using H and Q_{max}.
D_{ps} = ________ in. **Q** = ________ cfs (value directly from table)
15. Compute actual flow through the principal spillway, using Table 6-22.1 to determine the correction factor for pipe length, L.
Q_{ps} = Q * correction factor = ________ cfs * ________
Q_{ps} = ________ cfs
16. Compute riser diameter (D_r).
$D_r = 1.5 * D_{ps}$
D_r = 1.5 * ________ in.
D_r = ________ in.
D_r = ________ in.
17. Compute trash rack diameter (D_t).
$D_t = 1.4 * D_r$
D_t = 1.4 * ________ in.
D_t = ________ in.
D_t = ________ in.
18. Determine the minimum distance between the riser crest and the emergency spillway crest, **h**, using Table 6-22.2 D_r, and Q_{ps}.
h = ________ ft

Concrete Riser Base Design

19. Determine the volume of concrete per vertical foot of riser height needed, from Table 6-22.3 to prevent flotation.
Required volume of concrete per vertical foot = ________ cf/v.f.
20. Compute total volume of concrete required.
Total required volume of concrete = Required volume per vertical foot * Riser length
Total required volume of concrete = ________ cf/v.f. * ________ ft
Total volume of concrete required = ________ cf
21. Assume base thickness, B (usually 18").
B = ________ in = ________ ft
22. Compute required surface area.
Required surface area = Total volume required / B
Required surface area = ________ cf / ________ ft
Required surface area = ________ sf
23. Compute riser base length (l) and width (w) (assume square base).
$l = w = (\text{required surface area})^{1/2}$
l = w = (________ sf)$^{1/2}$
l = **w** = ________ ft = 12in/ft * ________ ft = ________ in

Anti-Seep Collar Design

24. Determine if anti-seep collar is required. If yes, to any of the following conditions, a collar is required:
________ The settled height of the dam is greater than 15 feet.
________ The principal spillway diameter (D_{ps}) is smooth pipe larger than 8".
________ The principal spillway diameter (D_{ps}) is corrugated metal pipe larger than 12".

TEMPORARY SEDIMENT BASIN DESIGN SHEET

Project Name ____________________

Page 3

25. Determine size of anti-seep collar required.

________ **18-inch projection** (for heads (H) less than or equal to 10 feet).

________ **24-inch projection** (for heads (H) greater than 10 feet).

Emergency Spillway (es)

26. Compute minimum capacity of emergency spillway (Q_{es})

$Q_{es} = Q_{25} - Q_{ps}$ = ________ cfs - ________ cfs

Q_{es} = ________ cfs

27. Determine stage (H_p), bottom width (b), velocity (V) and minimum exit slope (S) using Table 6-22.4 and Q_{es}.

H_p = ________ ft **b** = ________ ft **V** = ________ fps **S** = ________ %

28. Actual entrance channel slope, **S_e** = ________ %

29. Actual exit channel slope, **S_o** = ________ %

Note: If S_o is steeper than S (from Table 6-22.4), then the velocity in the exit channel will increase.

a.) Calculate new exit velocity (V_o)

$V_o = V (S_o / S)^{0.3}$ = ________ fps * (________ / ________) $^{0.3}$

V_o = ________ fps

Note: Refer to Channel Stabilization (Ch) to determine the proper lining for the emergency spillway.

Grass ______ **Rip-rap** ________ **Concrete** ________

Design Elevations

30. **Riser crest elevation** = ________ ft

31. Compute minimum emergency spillway crest elevation.

Minimum emergency spillway crest elevation = Riser crest elevation + h

Minimum emergency spillway crest elevation = ________ ft + ________ ft

Minimum emergency spillway crest elevation = ________ ft

32. Determine design high water elevation

Design high water elevation = Minimum emergency spillway crest elevation + Stage elevation (Hp)

Design high water elevation = ________ ft + ________ ft

Design high water elevation = ________ ft

33. Determine elevation of top of dam

Elevation of top of dam = Design high water elevation + 1 ft freeboard

Elevation of top of dam = ________ ft + 1 ft

Elevation of top of dam = ________ ft

PLEASE NOTE THAT DESIGN VALUES DETERMINED BY THIS SHEET REPRESENT THE MINIMUM REQUIREMENTS FOR A TEMPORARY SEDIMENT BASIN.

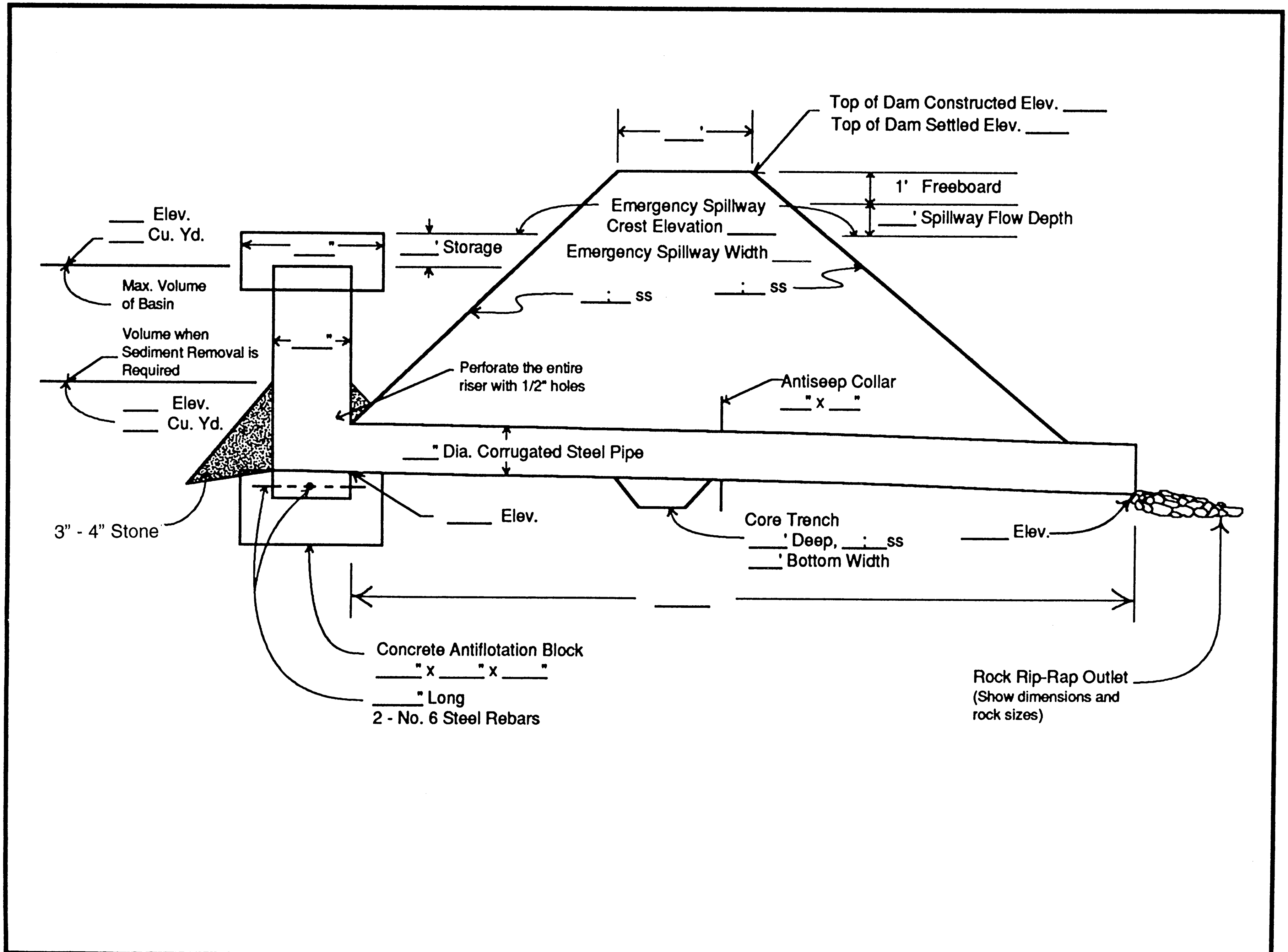
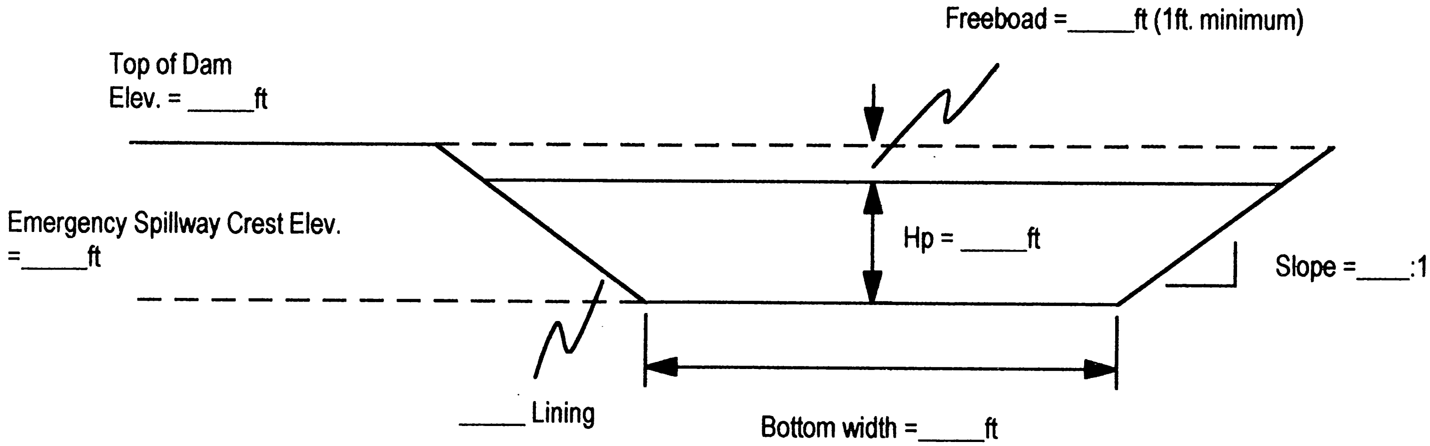
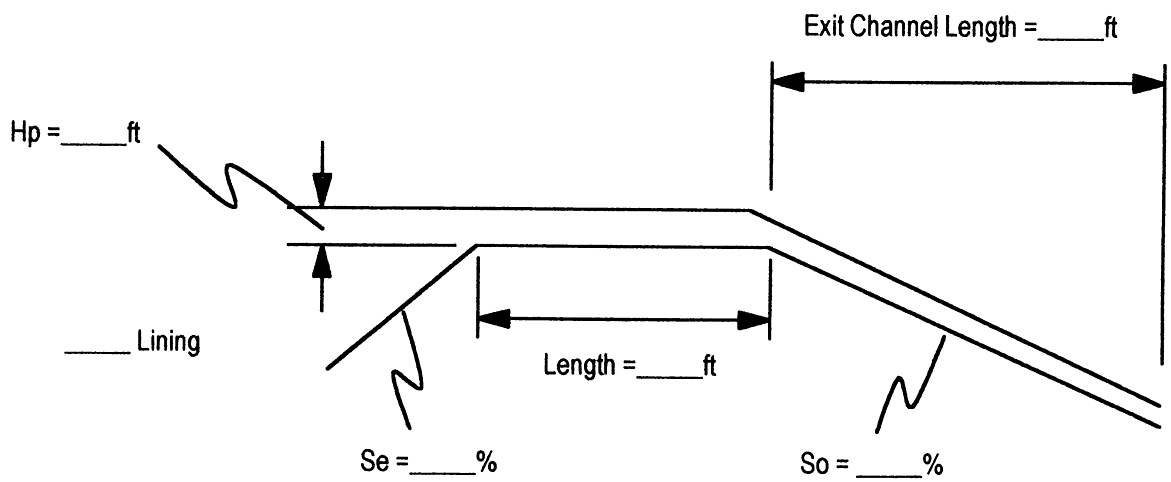


Figure 6-22.8 - Temporary sediment basin cross-sectional detail.

Cross-Sectional Detail of Emergency Spillway



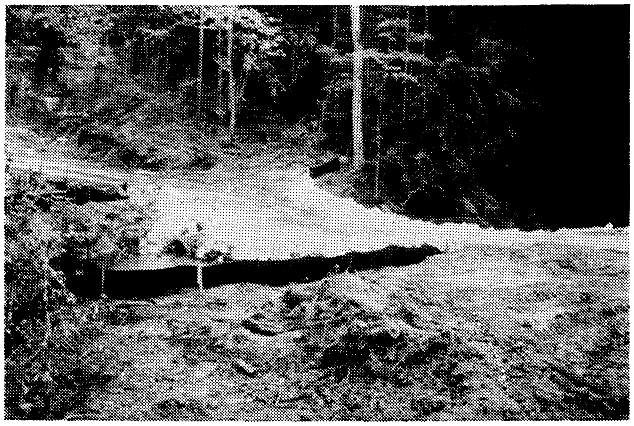
Profile Along Centerline



Emergency Spillway

Figure 6-22.9

Temporary Stream Crossing (Sr)



DEFINITION

A *temporary* structure installed across a flowing stream or watercourse for use by construction equipment.

PURPOSE

This standard provides a means for construction vehicles to cross streams or watercourses without moving sediment into streams, damaging the streambed or channel, or causing flooding.

CONDITIONS

Temporary stream crossings shall not be used on streams with drainage areas greater than one square mile. Structures may include bridges, round pipes or pipe arches.

Temporary stream crossings should be in place for less than one year and should not be used by the general public.

DESIGN CRITERIA

Size

The structure shall be large enough to convey the full bank flow of the stream, typically flows produced by a 2-year, 24-hour frequency storm, without appreciably altering the stream flow characteristic.

Location

The temporary stream crossing shall be perpendicular to the stream. Where approach conditions dictate, the crossing may vary 15% from the perpendicular.

Overflow Protection

Structures shall be protected from washout during periods of peak discharges by diverting water around the structures. Methods to be considered for washout protection may include elevation of bridges above adjacent flood plain lands, crowning of fills over pipes, or by the use of diversions, dikes or island type structures. Two types of stream crossings that may be used are bridges and culverts. Frequency and intended use, stream channel conditions, overflow areas, potential flood damage, and surface runoff control should be considered when selecting the type of temporary stream crossing to be used.

Temporary Bridge Crossing (Sr-B)

A temporary access bridge causes the least erosion of the stream channel crossing when the bridge is installed and removed. It also provides the least obstruction to flow and fish migration. Provided that the bridge is properly designed and appropriate materials are used, a temporary access bridge will be long-lasting and will require little maintenance. However, it is generally the most expensive crossing to design and construct; creating the greatest safety hazard if not adequately designed, installed and maintained.

Temporary Culvert Crossing (Sr-C)

A temporary access culvert can control erosion effectiviely, but can cause eosion when it is installed and removed. It is the most common stream crossing. A temorary culvert can be easily constructed and enables heavy equipment loads to be used. However, culverts create the greatest obstruction to flood flows and are subject to blockage and washout.

Table 6-23.1 shall be used to determine the culvert size necessary to safely convey streamflow. *Please note that the required pipe size is based on cross-sectional area of the pipe; e.g. if a 24 inch pipe is prescribed by Table 23.1, two 12 inch pipes could not be substitued because less flow area is provided.*

CORRUGATED METAL PIPE (CMP) DIAMETERS FOR TEMPORARY STREAM CROSSINGS [a]

Drainage Area	Average Slope of Watershed			
(Acres)	1%	4%	8%	16%
1-25	24	24	30	30
26-50	24	30	36	36
51-100	30	36	42	48
101-150	30	42	48	48
151-200	36	42	48	54
201-250	36	48	54	54
251-300	36	48	54	60
301-350	42	48	60	60
351-400	42	54	60	60
401-450	42	54	60	72
451-500	42	54	60	72
501-550	48	60	60	72
551-600	48	60	60	72
601-640	48	60	72	72

Table 6-23.1

[a] Assumptions for determining the table: USDA-NRCS Peak Discharge Method; CN = 65; Rainfall depth (average for Georgia) = 3.7" for 2-year frequency. Pipe diameters shown in the table are in inches.

CONSTRUCTION SPECIFICATIONS

All Crossings

1. Clearing of the stream bed and banks shall be kept to a minimum.
2. All surface water from the construction site shall be diverted onto undisturbed areas adjoining the stream. Line unstable stream banks with riprap or otherwise appropriately stabilize them.
3. The structure shall be removed as soon as it is no longer necessary for project construction.
4. Upon removal of the structure, the stream shall immediately be restored to its original cross-section and properly stabilized.

Temporary Bridge Crossing (Sr-B)

1. The temporary bridge shall be constructed at or above bank elevation to prevent the entrapment of floating materials and debris.
2. Abutments shall be placed parallel to and on stable banks.
3. Bridges shall be constructed to span the entire channel. If the channel width exceeds eight feet (as measured from the tops of the banks), a footing, pier or bridge support may be constructed within the waterway.
4. Bridges shall be securely anchored at only one end using steel cable or chain. This will prevent channel obstruction in the event that floodwaters float the bridge. Large trees, large boulders, or driven steel anchors can serve as anchors.

Temporary Culvert Crossing (Sr-C)

1. The invert elevation of the culvert shall be installed on the natural streambed grade.
2. The culvert(s) shall extend a minimum of one foot beyond the upstream and downstream toe of the aggregate placed around the culvert. In no case shall the culvert exceed 40 feet in length.
3. The culvert(s) shall be covered with a minimum of one foot of aggregate. If multiple culverts are used, they shall be separated by a minimum of 12 inches of compacted aggregate fill.

MAINTENANCE

The structure shall be inspected after every rainfall and at least once a week, whether it has rained or not, and all damages repaired immediately. The structure shall be removed immediately after construction is fininshed, and the streambed and banks must be stabilized. Refer to specification **Bf - Buffer Zone**.

TO BE SHOWN ON THE EROSION AND SEDIMENT CONTROL PLAN

1. Drainage area (ac), average slope of watershed (%), and stream flow rate at bankfull flow (cfs).

2. Detailed dimensions of components for the type of crossing to be used.

TEMPORARY BRIDGE CROSSING

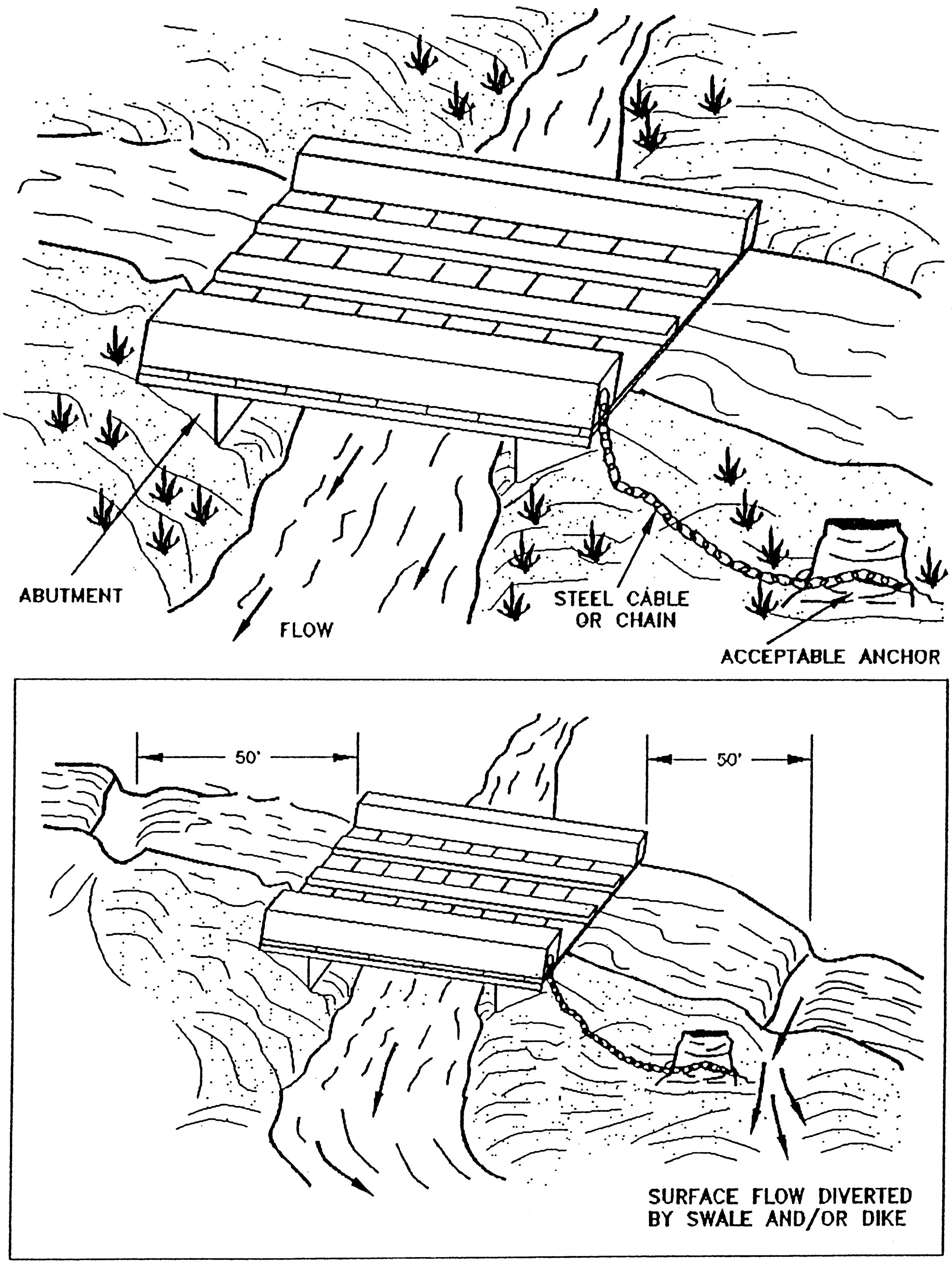
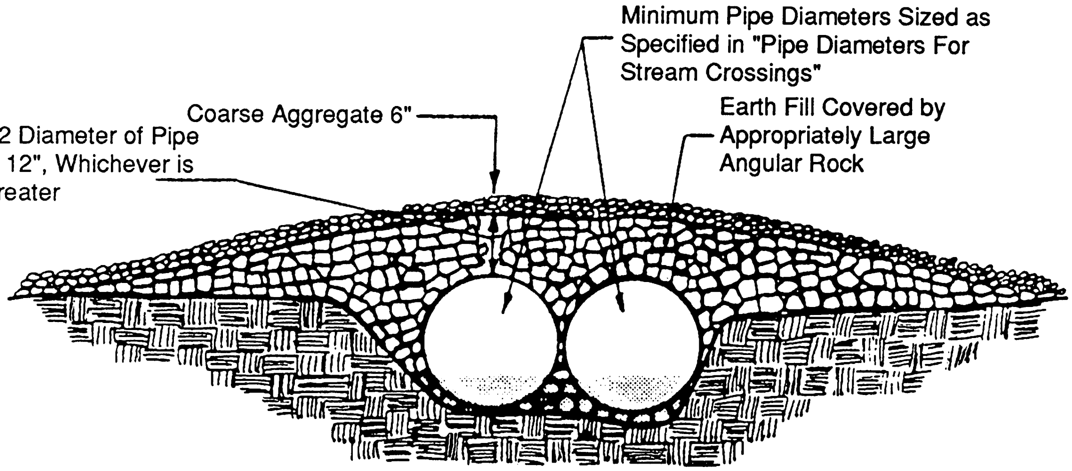
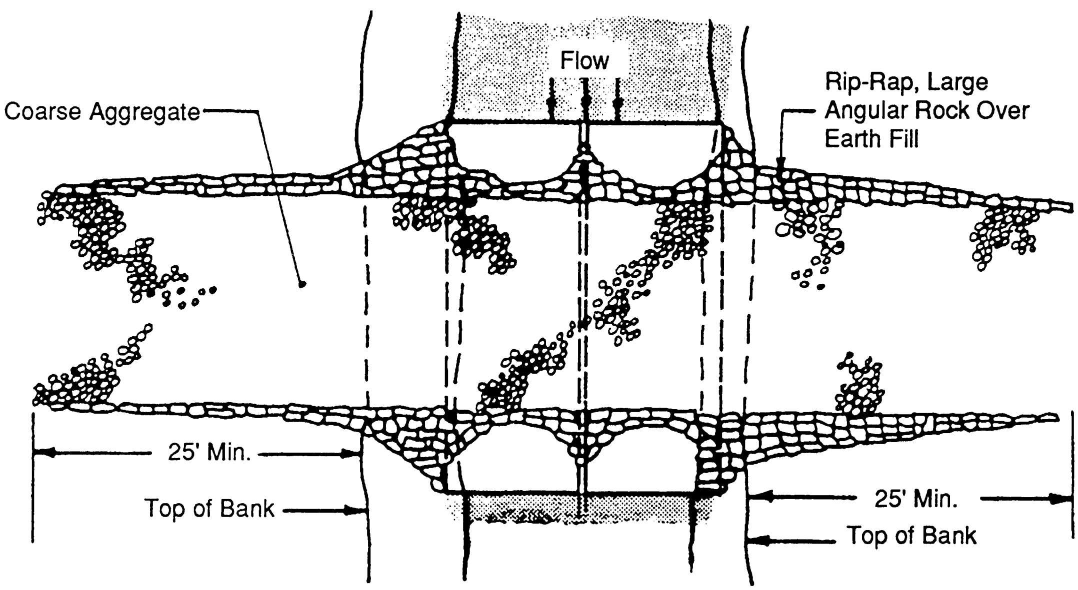


Figure 6-23.1



ELEVATION



PLAN

GENERAL NOTES:

1. Not to scale.
2. This type of crossing can be installed in both a wet or dry weather stream condition where the drainage area exceeds 10 acres.
3. Remove during cleanup.

Figure 6-23.2

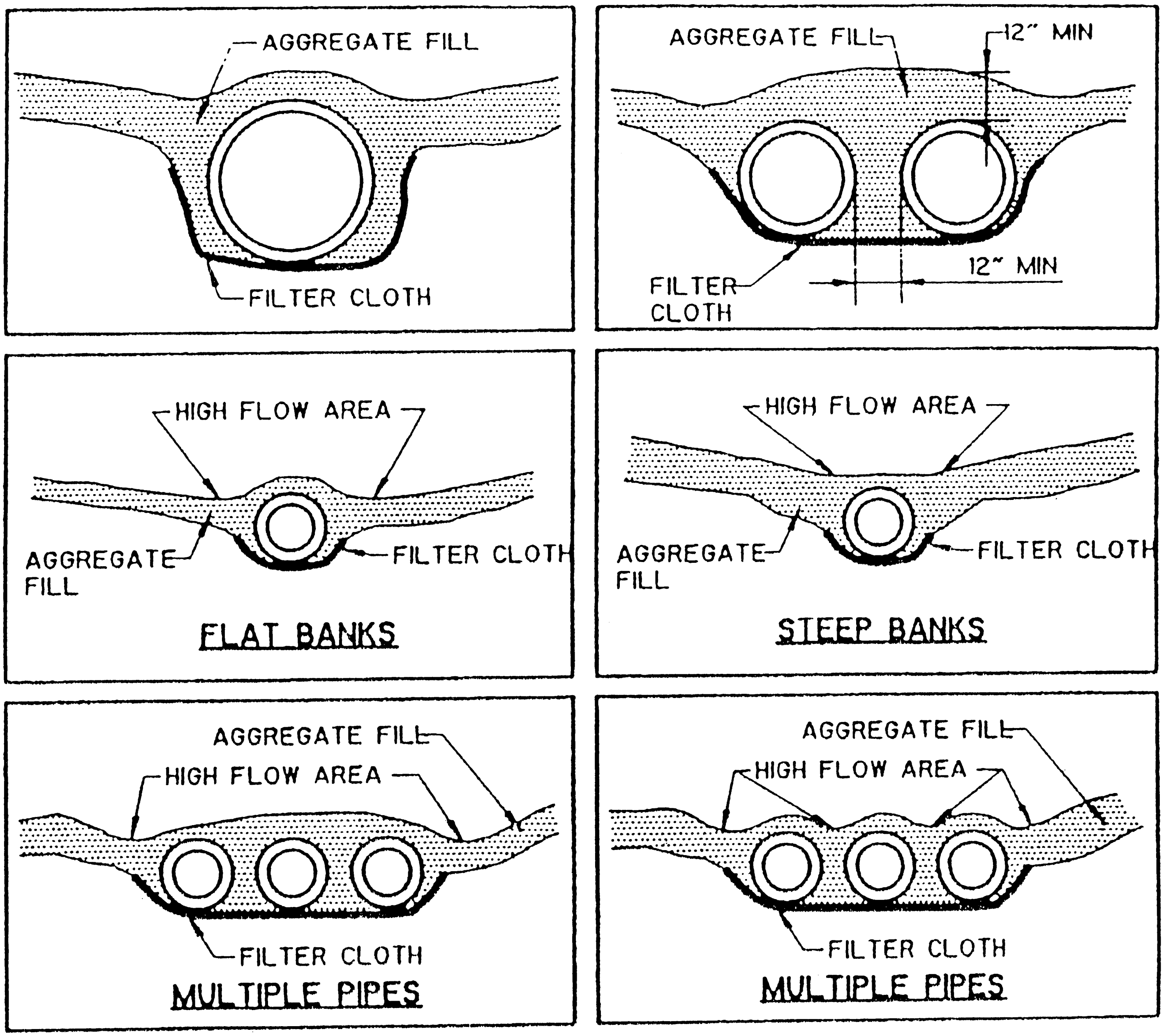


Figure 6-23.3 - Configuration of temporary culvert crossing.

Storm Drain Outlet Protection

St

DEFINITION

Paved and/or riprapped channel sections, placed below storm drain outlets.

PURPOSE

To reduce velocity of flow before entering receiving channels below storm drain outlets.

CONDITIONS

This standard applies to all storm drain outlets, road culverts, paved channel outlets, etc., discharging into natural or constructed channels. Analysis and/or treatment will extend from the end of the conduit, channel or structure to the point of entry into an existing stream or publicly maintained drainage system.

DESIGN CRITERIA

Structurally lined aprons at the outlets of pipes and paved channel sections shall be designed according to the following criteria:

Capacity

Peak stormflow from the 25-year, 24-hour frequency storm or the storm specified in Title 12-7-1 of the Official Code of Georgia Annotated or the design discharge of the water conveyance structure, whichever is greater.

Tailwater Depth

The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. Manning's Equation may be used to determine tailwater depth. If the tailwater depth is less than half the diameter of the outlet pipe, it shall be classified as a Minimum Tailwater Condition. If the tailwater depth is greater than half the pipe diameter, 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 Length and Thickness

The apron length and d_{50}, stone median size, shall be determined from the curves according to tailwater conditions:

Minimum Tailwater- Use Figure 6-24.1
Maximum Tailwater- Use Figure 6-24.2
Maximum Stone Size = 1.5 x d50
Apron Thickness = 1.5 x dmax

Apron Width

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). If the pipe discharges onto a flat area with no defined channel, the width of the apron shall be determined as follows:

a. The upstream end of the apron, adjacent to the pipe, shall have a width three times the diameter of the outlet pipe.

b. For a Minimum Tailwater Condition, the downstream end of the apron shall have a width equal to the pipe diameter plus the length of the apron. Refer to Figure 6-24.1.

c. For a Maximum Tailwater Condition, the down stream end shall have a width equal to the pipe diameter plus 0.4 times the length of the apron. Refer to Figure 6-24.2.

Bottom Grade

The apron shall be constructed with no slope along its length (0.0% grade). The invert elevation of the downstream end of the apron shall be equal to the elevation of the invert of the receiving channel. There shall be no overfall at the end of the apron.

Side Slope

If the pipe discharges into a well-defined channel, the side slopes of the channel shall not be steeper than 2:1.

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

Geotextile
Geotextiles should be used as a separator between the graded stone, the soil base, and the abutments. The geotextile will prevent the migration of soil particles from the subgrade into the graded stone. The geotextile shall be specified in accordance with AASHTO M288-96 Section 7.5, *Permanent Erosion Control Recommendations*. The geotextile should be placed immediately adjacent to the subgrade without any voids.

Materials
The apron may be lined with riprap, grouted riprap, or concrete. The median sized stone for riprap, d_{50}, shall be determined from the curves, Figures 6-24.1and 6-24.2, according to the tailwater condition. The gradation, quality and placement of riprap shall conform to Appendix C.

Refer to Figure 6-24.4, for alternative structures to achieving energy dissipation at an outlet. For information regarding the selection and design of these alternative energy dissipators, refer to:

FHWA Standard (REF. Hydraulic Design of Energy Dissipators for Culverts and Channels; HEC No. 14, FHWA, Available from the Superintendent of Doucments, U.S. Government Printing Office, Washington, D.C. 20402.

CONSTRUCTION SPECIFICATIONS

1. Ensure that the subgrade for the filter and riprap follows the required lines and grades shown in the plan. Compact any fill required in the subgrade to the density of the surrounding undisturbed material. Low areas in the subgrade on undisturbed soil may also be filled by increasing the riprap thickness.
2. The riprap and gravel filter must conform to the specified grading limits shown on the plans.
3. Geotextile must meet design requirements and be properly protected from punching or tearing during installation. Repair any damage by removing the riprap and placing another piece of filter fabric over the damaged area. All connecting joints should overlap a minimum of 1 ft. If the damage is extensive, replace the entire filter fabric.
4. Riprap may be placed by equipment, but take care to avoid damaging the filter.
5. The minimum thickness of the riprap should be 1.5 times the maximum stone diameter.
6. Construct the apron on zero grade with no overfall at the end. Make the top of the riprap at the downstream end level with the receiving area or slightly below it.
7. Ensure that the apron is properly aligned with the receiving stream and preferably straight throughout its length. If a curve is needed to fit site conditions, place it in the upper section of the apron.
8. Immediately after construction, stabilize all disturbed areas with vegetation.
9. Stone quality - Select stone for riprap from field stone or quarry stone. The stone should be hard, angular, and highly weather-resistant. The specific gravity of the individual stones should be at least 2.5.
10. Filter - Install a filter to prevent soil movement through the openings in the riprap. The filter should consist of a graded gravel layer or a synthetic filter cloth. See Appendix C; p. C-1.

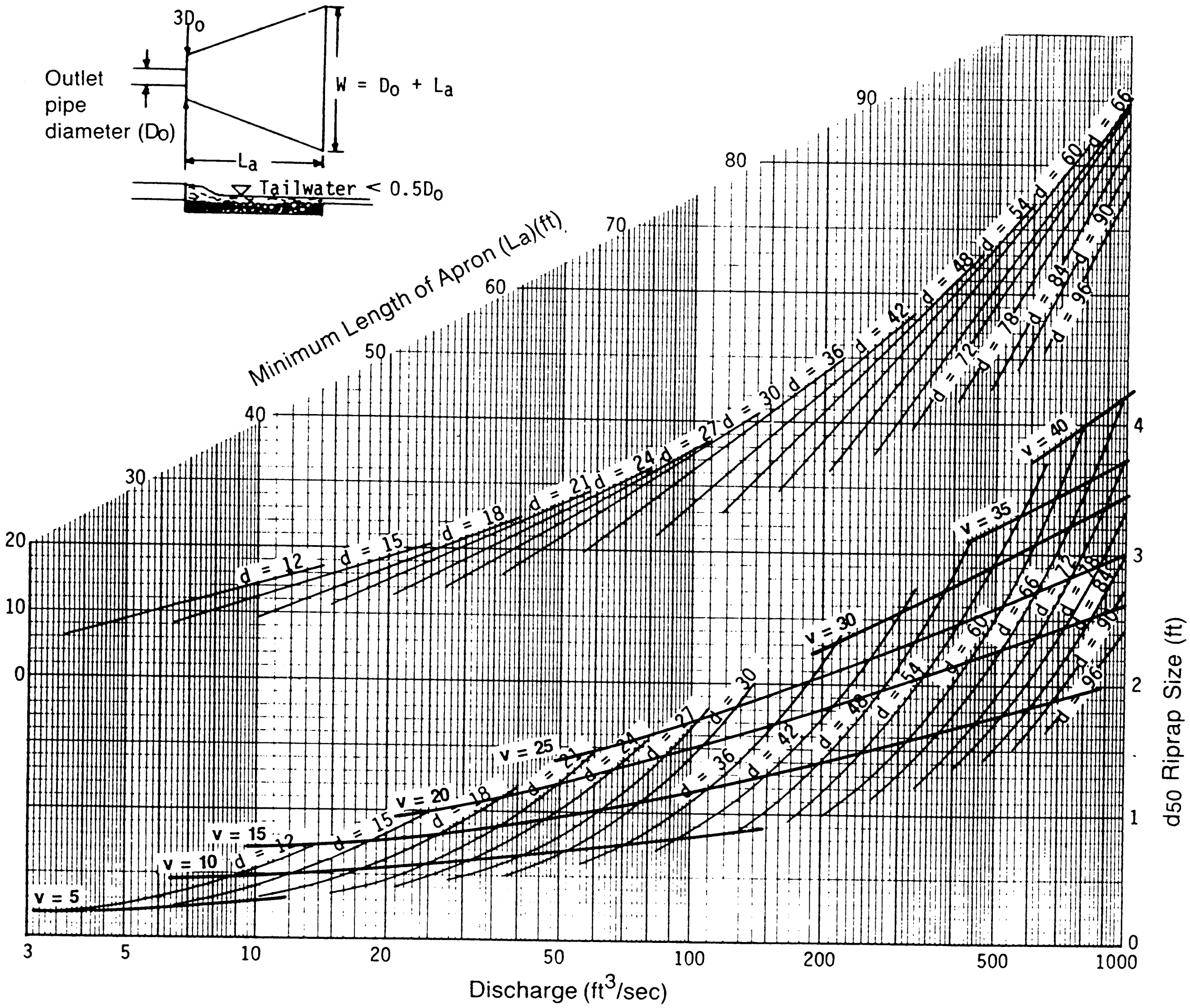
MAINTENANCE

Inspect riprap outlet structures after heavy rains to see if any erosion around or below the riprap has taken place or if stones have been dislodged. Immediately make all needed repairs to prevent further damage.

TO BE SHOWN ON THE EROSION AND SEDIMENT CONTROL PLAN

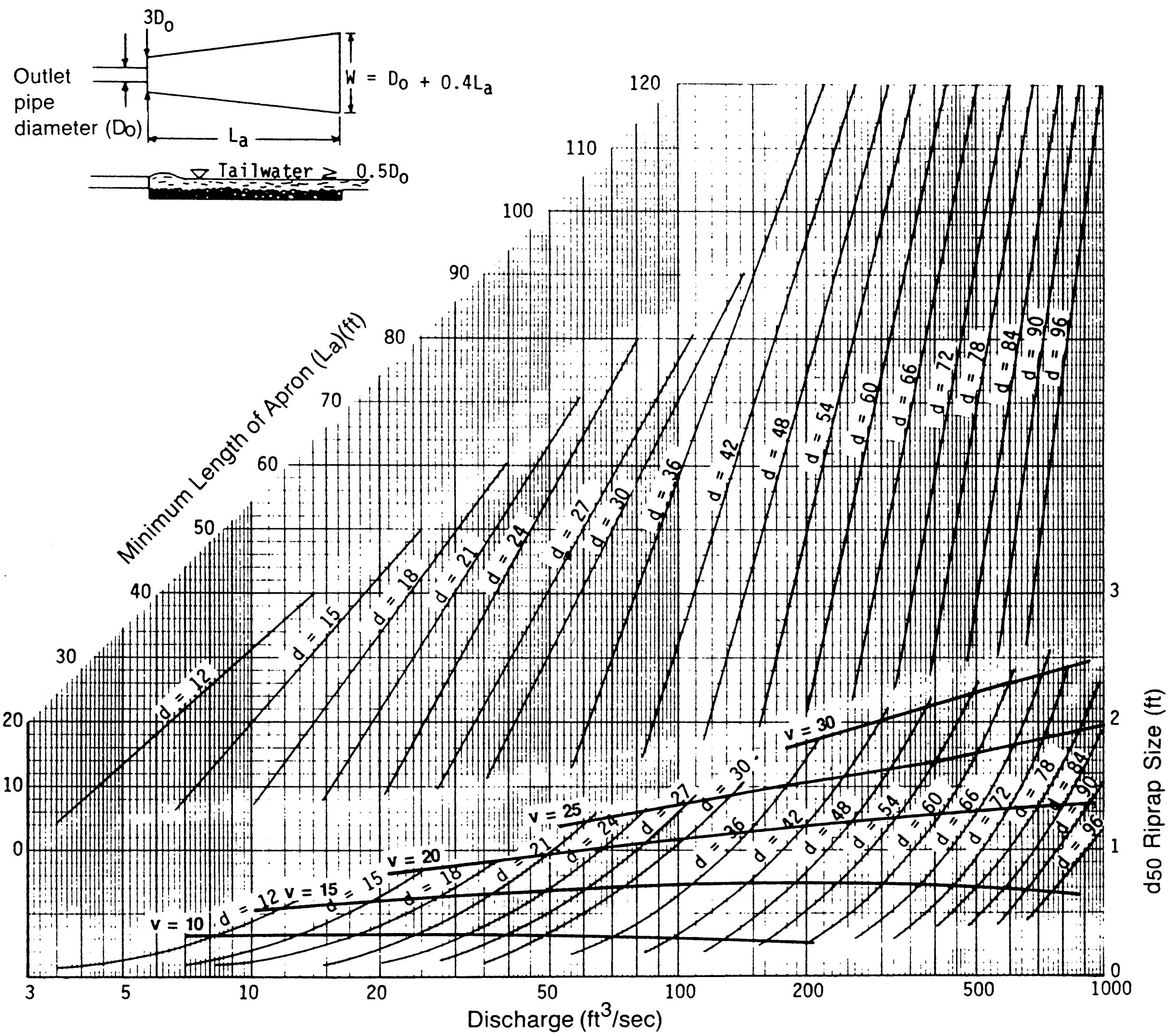
1. The flow characteristics of the pipe at full flow including pipe diameter, flow rate (cfs), velocity (fps), and tailwater condition.

2. The dimensions of the apron including length (La), width at the headwall (W_1), downstream width (W_2), average stone diameter (d50), and stone depth (D) designed in accordance with Figures 6-24.1 and 6-24.2.



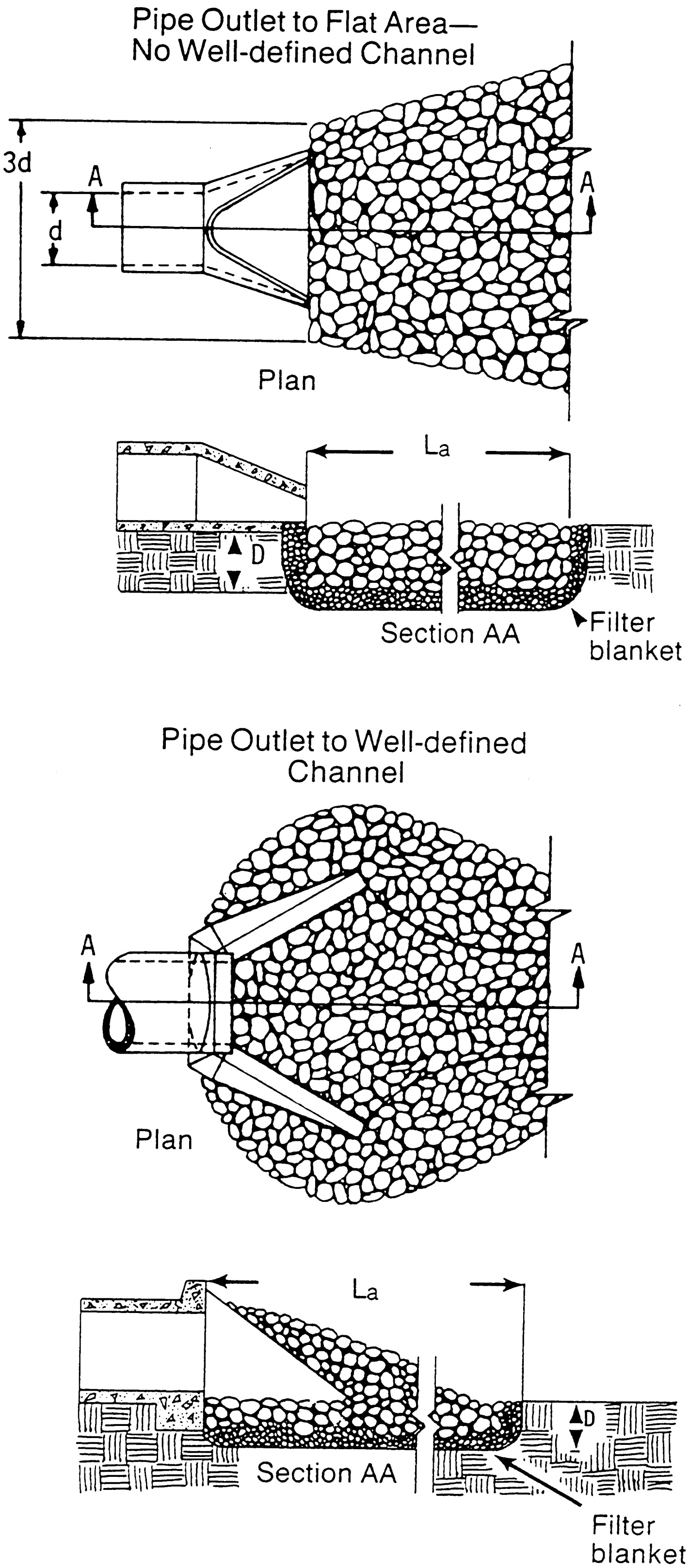
Curves may not be extrapolated.

Figure 6-24.1 - Design of outlet protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter).



Curves may not be extrapolated.

Figure 6-24.2 - Design of outlet protection from a round pipe flowing full, maximum tailwater condition (T_w > 0.5 diameter).

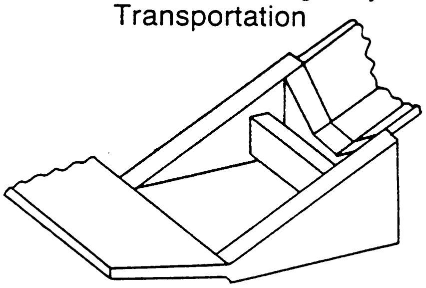


Notes

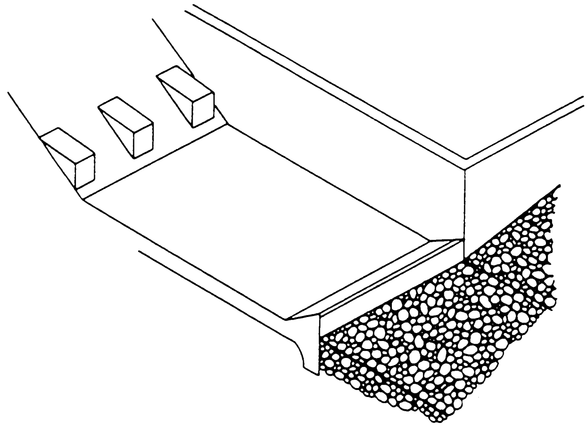
1. L_a is the length of the riprap apron.
2. D = 1.5 times the maximum stone diameter but not less than 6".
3. In a well-defined channel extend the apron up the channel banks to an elevation of 6" above the maximum tailwater depth or to the top of the bank, whichever is less.
4. A filter blanket or filter fabric should be installed between the riprap and soil foundation.

Figure 6-24.3 - Riprap outlet protection (modified from Va SWCC).

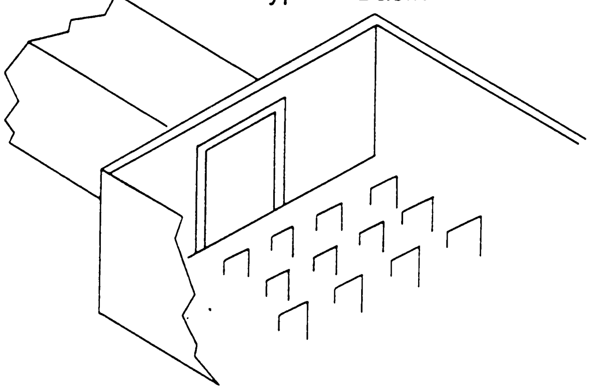
Virginia Department of Highways and Transportation



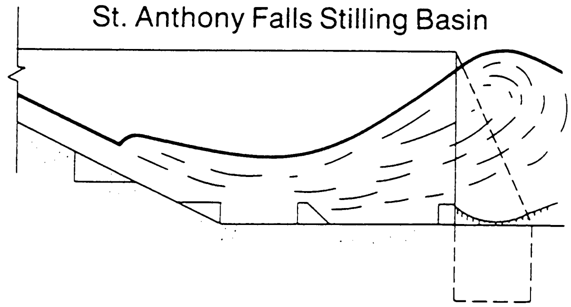
Colorado State University Rigid Boundary Basin



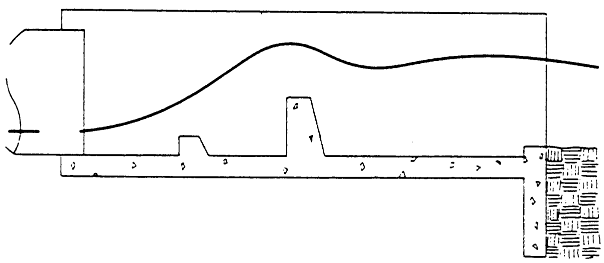
USBR Type IV Basin



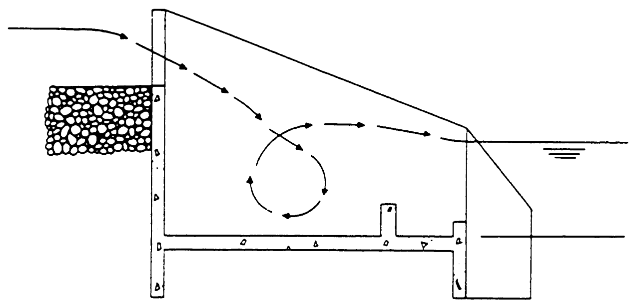
St. Anthony Falls Stilling Basin



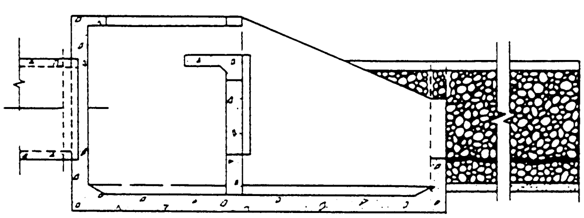
Contra Costa County, Calif.



Straight Drop Spillway Stilling Basin



USBR Type VI Baffle Wall Basin



T-fitting on CMP Outlet

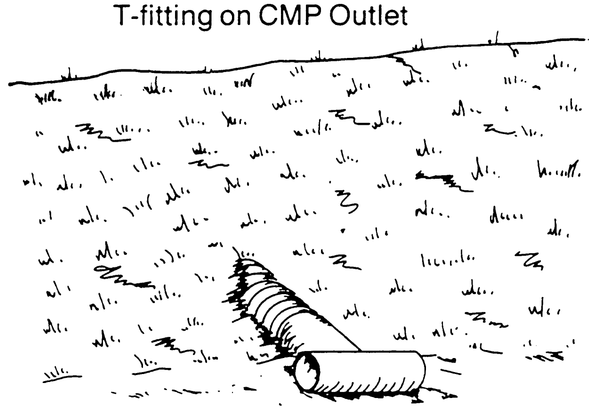
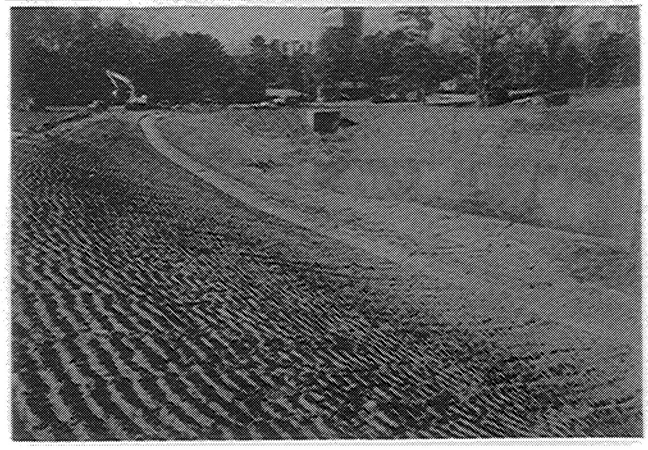


Figure 6-24.4 - Alternative structures for energy dissipation at an outlet (modified from Goldman, Jackson, and Bursztynsky).

Surface Roughening (Su)



DEFINITION

Providing a rough soil surface with horizontal depressions created by operating a tillage or other suitable implement on the contour, or by leaving slopes in a roughened condition by not fine-grading them.

PURPOSE

The purposes of surface roughening are to aid in establishment of vegetative cover with seed, to reduce runoff velocity and increase infiltration and to reduce erosion and provide for sediment trapping.

CONDITIONS

All slopes steeper than 3:1 require surface roughening, either stair-step grading, grooving, furrowing, or tracking if they are to be stabilized with vegetation. However, if the slope is to be stabilized with erosion control blankets or soil reinforcement matting, the soil surface should not be roughened.

Areas with grades less steep than 3:1 should have the soil surface lightly roughened and loosened to a depth of 2 to 4 inches prior to seeding. Areas which have been graded and will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place. Slopes with a stable rock face do not require roughening or stabilization.

DESIGN CRITERIA

Graded areas with smooth, hard surfaces give a false impression of "finished grading" and a job well done. It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but encourage water infiltration, speed the establishment of vegetation, and decrease runoff velocity. Rough, loose soil surfaces give lime, fertilizer and seed some natural coverage. Niches in the surface provide microclimates which generally provide a cooler and more favorable moisture level than hard flat surfaces. This aids seed germination.

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

1. Disturbed areas which will not require mowing maybe stair-step graded, grooved, or left rough after filling.
2. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material which sloughs from above, and provides a level site where vegetation can become established.
3. Areas which will be mowed (these areas should have slopes less steep than 3:1) may have small furrows left by discing, harrowing, raking, or seed planting machinery operated on the contour.
4. It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as effective as other forms of roughening, as the soil surface is severly compacted and runoff is increased.

CONSTRUCTION SPECIFICATIONS

Cut Slopes Steeper than 3:1

Cut slopes with a gradient steeper than 3:1 should not be mowed. They shall be stair-step graded or grooved (see Figure 6-25.1).

1. *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.

The ratio of the vertical cut distance to the horizontal distance shall be less than 1:1 and the horizontal portion of the "step" shall slope toward the vertical wall.

Individual vertical cuts shall not be more than 30 inches on soft soil material and not more than 40 inches in rocky materials.

2. *Grooving* consists of using machinery to create a series of ridges and depressions which run perpendicular to the slope (on the contour).

Grooves may be made with any appropriate implement which can be safely operated on the slope and which will not cause undue compaction. Suggested implements include discs, tillers, spring harrows, and the teeth on a front-end loader bucket. Such grooves shall not be less than 3 inches deep nor further than 15 inches apart.

Fill Slopes Steeper than 3:1

Fill slopes with a gradient steeper than 3:1 should not be mowed. They shall be grooved or allowed to remain rough as they are constructed. Method (1) or (2) below may be used.

1. Groove according to #2 of "Cut Slopes Steeper than 3:1".
2. As lifts of the fill are constructed, soil and rock material may be allowed to fall naturally onto the slope surface (see Figure 6-25.1).

Colluvial materials (soil deposits at the base of slopes or from old stream beds) shall not be used in fills as they flow when saturated.

Cuts, Fills, and Graded Areas Which Will Be Mowed (less than 3:1)

Mowed slopes should not be steeper than 3:1. Excessive roughness is undesirable where mowing is planned.

These areas may be roughened with shallow grooves such as remain after tilling, discing, harrowing, raking, or use of a multipacker-seeder. The final pass of any such tillage implement shall be on the contour (perpendicular to the slope).

Grooves formed by such implements shall be not less than one inch deep and not further than 12 inches apart.

Fill slopes which are left rough as constructed may be smoothed with a dragline or pickchain to facilitate mowing.

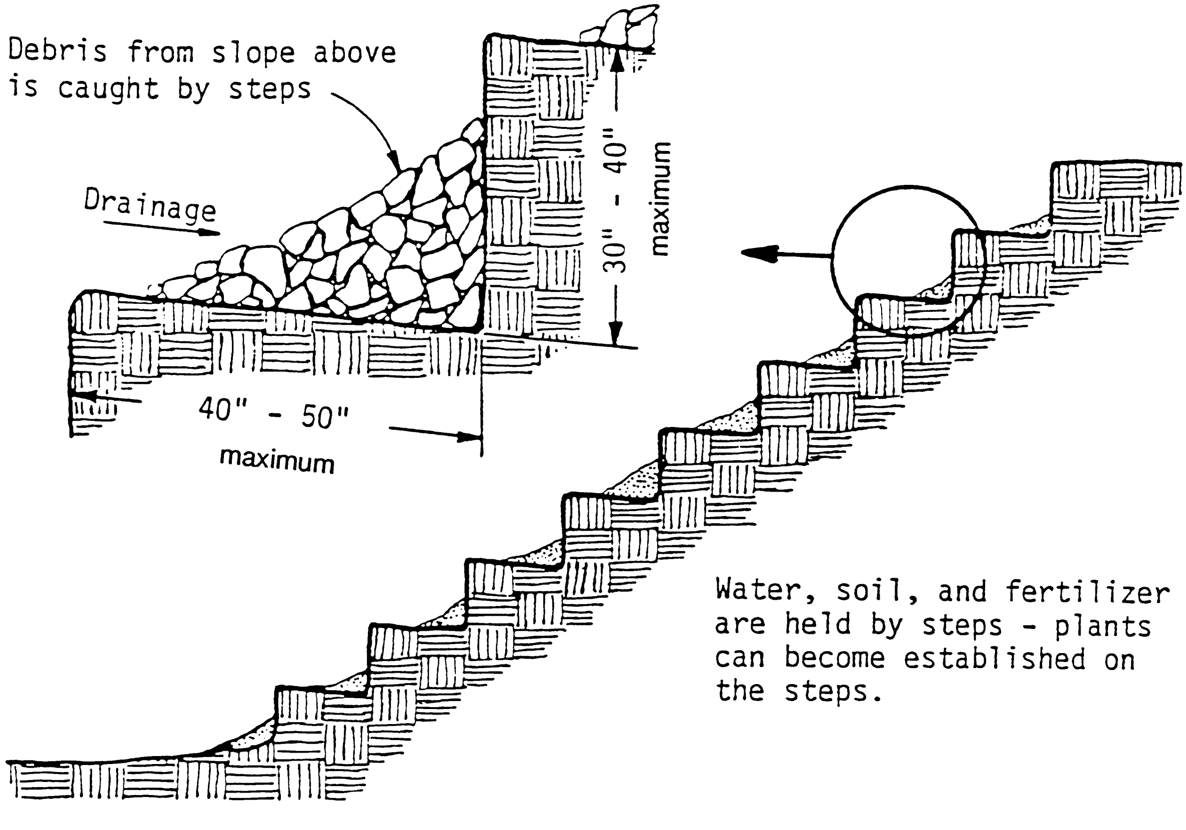
Roughening With Tracked Machinery

Roughening with tracked machinery on clayed soils is not recommended unless no alternatives are available. Undue compaction of surface soil results from this practice. Sandy soils do not compact severely and may be tracked. In no case is tracking as effective as the other roughening methods described.

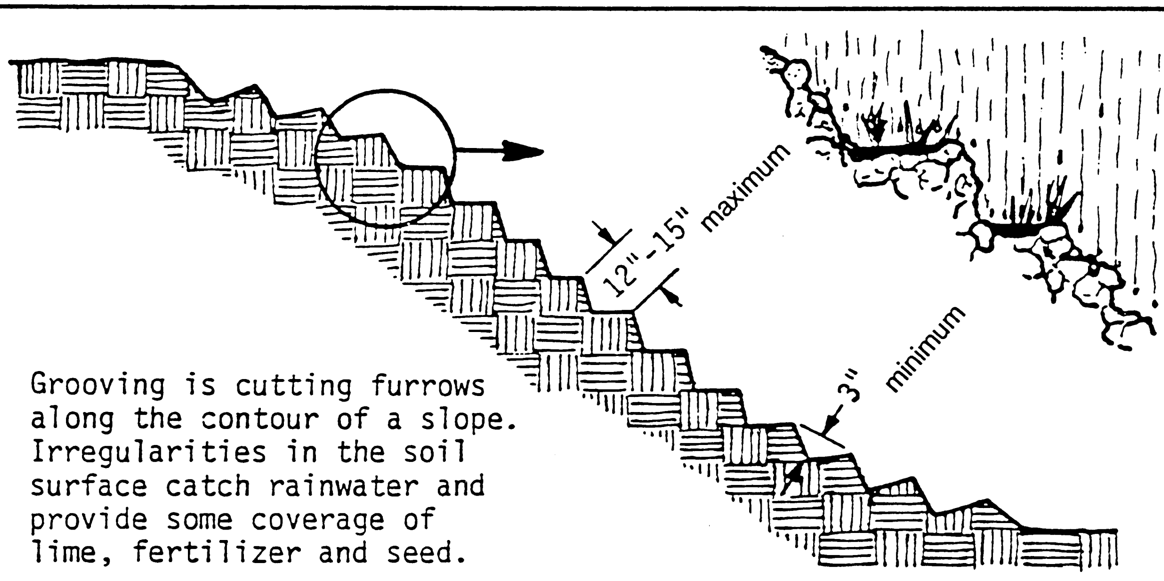
When tracking is the chosen surface roughening technique, it shall be done by operating tracked machinery up and down the slope to leave horizontal depressions in the soil. As few passes of the machinery as possible should be made to minimize compaction.

Seeding

Roughened areas shall be seeded and mulched as soon as possible to obtain optimum seed germination and seeding growth. Refer to specifications **Ds1, Ds2, Ds3, and Ds4 - Disturbed Area Stabilization (With Mulching Only, Temporary Seeding, Permanent Vegetation, and Sodding),** respectively.

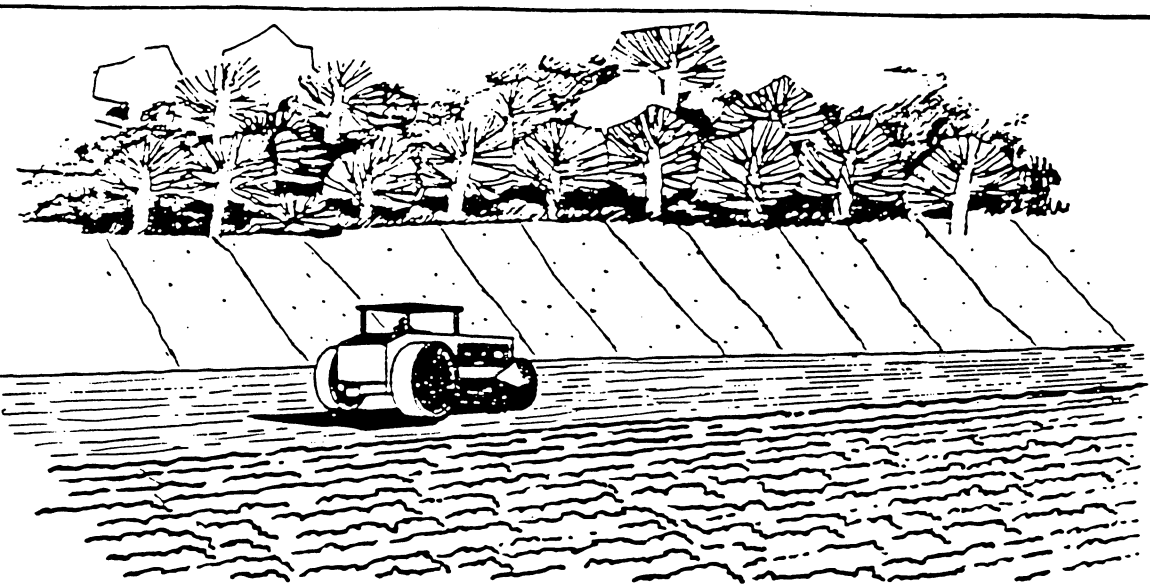


STAIR STEPPING CUT SLOPES



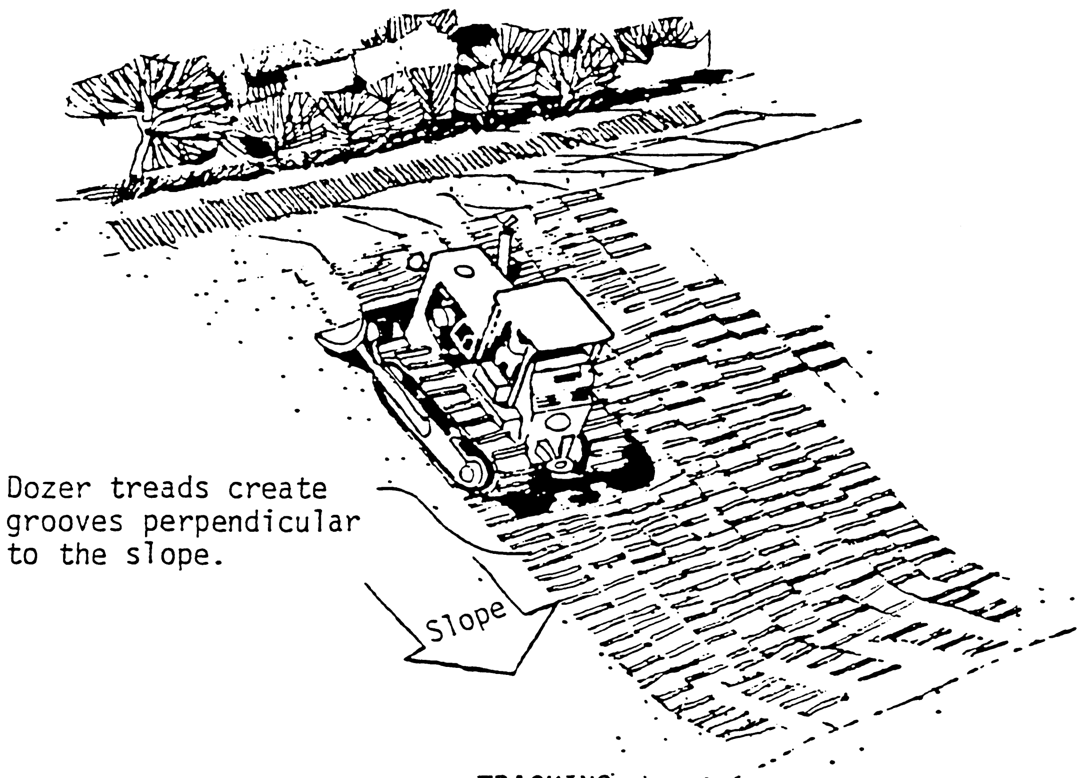
GROOVING SLOPES

Figure 6-25.1



Each lift of the fill is compacted, but the outer face of the slope is allowed to remain loose so that the rocks, clods, etc. reach the natural angle of repose.

FILL SLOPE TREATMENT

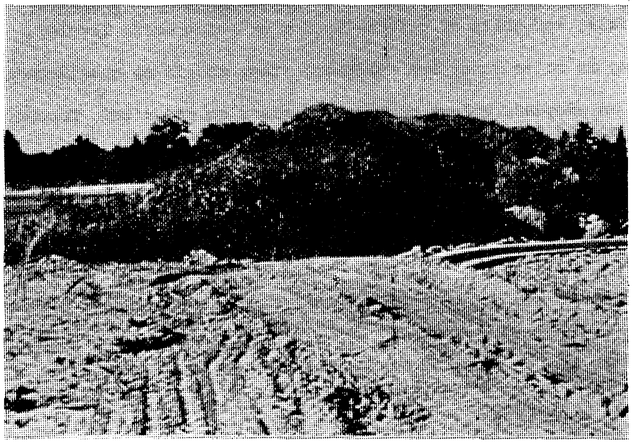


TRACKING

Figure 6-25.2

Topsoiling

Tp



DEFINITION

Stripping off the more fertile top soil, storing it, then spreading it over the disturbed area after completion of construction activities.

PURPOSE

To provide a suitable soil medium for vegetative growth on areas where other measures will not produce or maintain a desirable stand.

CONDITIONS

This practice is recommended for sites of 2:1 or flatter slopes where:

1. The texture of the exposed subsoil or parent material is not suitable to produce adequate vegetative growth.
2. The soil material is so shallow that the rooting zone is not deep enough to support plants with continuing supplies of moisture and food.
3. The soil to be vegetated contains material toxic to plant growth.

CONSTRUCTION SPECIFICATIONS

Materials

Topsoil should be friable and loamy, free of debris, objectionable weeds and stones and contain no toxic substance that may be harmful to plant growth. A pH range of 5.0-7.5 is acceptable. Soluble salts should not exceed 500 ppm.

Testing

Field exploration should be made to determine whether the quantity and quality of surface soil justifies stripping.

Stripping

Stripping should be confined to the immediate construction area.

A 4 to 6 inch stripping depth is common, but may vary depending on the particular soil.

Topsoil pH

If pH value is less than 6.0, lime shall be applied and incorporated with the topsoil to adjust the pH to 6.5 or higher. Topsoils containing soluble salts greater than 500 parts per million shall not be used.

Stockpiles

The location of topsoil stockpiles should not obstruct natural drainage or cause off-site environmental damage.

Stabilization

Stockpiles shall be contained by sediment barriers to prevent sedimentation on adjacent areas. Stockpiles shall be stabilized in accordance with specifications **Ds1 and Ds2 - Disturbed Area Stabilization (With Mulching) and (With Temporary Grassing)**, respectively, or **Pm - Polyacrylamide** or **Tb - Tackifiers and Binders**.

Site Preparation (Where topsoil is to be added)

Topsoiling When topsoiling, maintain needed erosion control practices such as diversions, grade stabilization structures, berms, dikes, level spreaders, waterways, sediment basins, etc.

Grading Grades on the areas to be topsoiled which have been previously established shall be maintained.

Liming Soil tests should be used to determine the pH of the soil. Where the pH of the subsoil is 5.0 or less or composed of heavy clays, agricultural limestone shall be spread at the rate of 100 pounds per 1,000 square feet. Lime shall be distributed uniformly over designated areas and worked into the soil in conjunction with tillage operations as described in the following procedure.

Bonding Use one of the following methods to insure bonding of topsoil and subsoil:

1. **Tilling.** After the areas to be topsoiled have been brought to grade, and immediately prior to dumping and spreading the topsoil, the subgrade shall be loosened by discing or scarifying to a depth of at least 3 inches to permit bonding of the topsoil to the subsoil.

2. **Tracking**. Passing a bulldozer over the entire surface area of the slope to leave horizontal depressions.

Applying Topsoil

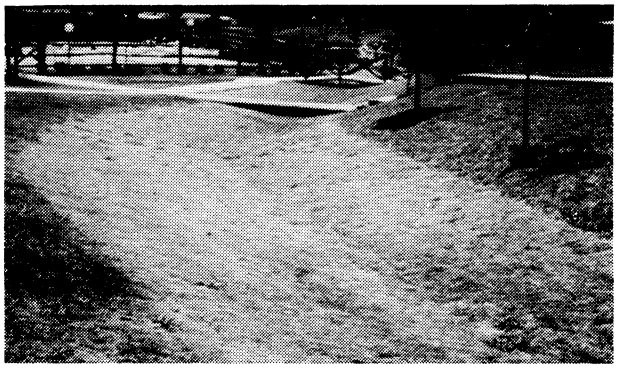
1. Topsoil should be handled only when it is dry enough to work without damaging soil structure.
2. A uniform application of 5 inches (unsettled) is recommended, but may be adjusted at the discretion of the engineer or landscape architect.

Cubic Yards Of Topsoil Required For Application To Various Depths

Depth (Inches)	Per 1,000 Square Feet	Per Acre
1	3.1	134
2	6.2	268
3	9.3	403
4	12.4	537
5	15.5	672
6	18.6	806

Table 6-26.1

Vegetated Waterway or Stormwater Conveyance Channel (Wt)



DEFINITION

A natural or constructed channel that is shaped or graded to required dimensions and established in suitable vegetation for the stable conveyance of runoff.

PURPOSE

To dispose of runoff without causing damage either by erosion or by flooding.

CONDITIONS

This standard applies to all sites where added channel capacity and/or stabilization is required to control erosion resulting from concentrated runoff and where such control can be achieved by this practice alone or in combination with others.

DESIGN CRITERIA

Capacity

The minimum capacity shall be that required to convey the peak runoff expected from a 25-year, 24-hour storm or the storm specified in Title 12-7-1 of the Official Code of Georgia Annotated. Peak runoff values used in determining the capacity requirements shall be as outlined in Appendix A or by other accepted methods.

The design of a waterway is based on the determination of channel dimensions that will carry the estimated flow without damage to the channel or its lining. Vegetative linings vary in their protective ability according to type and density. Therefore, safe velocities under various conditions are a matter for careful consideration.

Velocity

In designing grassed waterways, care must be taken to ensure that the design velocity is well within the limits of permissible velocities given in Table 6-27.1. These values apply to uniform good stands of each type of cover.

Cross Section

The minimum design capacity of a waterway receiving water from developing areas, diversions, or other tributary channels shall be that depth required to keep the design water surface elevation in the channel to prevent overflow.

The bottom width of waterways or outlets shall not exceed 50 feet unless multiple or divided waterways or other means are provided to control meandering of low flows within this limit. See Figure 6-27.1.

Drainage

Tile or other suitable subsurface drainage measures shall be provided for sites having high water tables or seepage problems. Where there is base flow, a stone center or lined channel will be required. See Appendix C for rock riprap specifications.

Stone Center

Stone center waterways shall be constructed as shown in Figure 6-27.2 and Table 6-27.2 and stabilized with riprap according to the specification **Riprap - Appendix C**.

Geotextiles should be used as an erosion control measure beneath the riprap center. The geotextile shall be specified in accordance with AASHTO M288-96 Section 7.5, *Permanent Erosion Control Requirements*.

Vegetative Retardance Factor

The design of a vegetated waterway is more complicated than for a bare channel since the value for "n" varies where grass linings are used. Tests show that vegetation tends to bend and oscillate under the influence of velocity and depth of flow. Thus the retardance to flow varies as these factors change.

Five general retardance curves designated as A, B, C, D, and E have been developed for various cover conditions. The vegetated conditions under which the various retardance values apply in Georgia are shown in Table 6-27.1. These cover classifications are based on tests in experimental channels when the covers were green and generally uniform.

VEGETATIVE COVER TYPE	GOOD STAND				MAXIMUM PERMISSIBLE VELOCITY, V_1 FEET PER SECOND
	FOR CAPACITY AND V_2		FOR STABILITY AND V_1		
	RETARDANCE	PLANT HT. NOT MOWED	RETARDANCE	PLANT HT. MOWED	
BERMUDAGRASS	B	12"	D	2-6"	5
BAHIA	C	6-12"	D	2-6"	4
TALL FESCUE GRASS MIXTURES[1]	B	18"	D	6"	4
SERICEA LESPEDEZA WEEPING LOVEGRASS	B	19"	D	2-6"	3
STONE CENTER	RIPRAP STONE SIZE CAN BE DETERMINED IN APPENDIX C.				

Permissible Velocities and Retardances for Vegetated and Rock-Lined Waterways

Table 6-27.1

[1] Mixtures of Tall Fescue, Bahia, and/or Bermuda.

NOTE: For Planting instructions, refer to Disturbed Area Stabilization (With Permanent Vegetation) Ds3, p. 6-139.

"The Stormwater Conveyance Channel Design Sheets" shall be used to design grass-lined channels. These design sheets include the cross-sectional detail that shall be included on the erosion and sediment control plan.

If a stone center waterway is selected, it shall be designed according to Tables 6-27.2 and 6-27.3. Cross-sectional details on the erosion and sediment control plan shall include all information noted in Figure 6-27.2, including the maximum stone size of the rock to be used.

An example of how to design a grass-lined channel with a parabolic cross-section is provided on p. 6-198

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 or outlet shall be excavated or shaped to line, grade, and cross section as required to meet the criteria specified herein. It will be free of bank projections or other irregularities which will impede normal flow. If the channel must have erosion protection other than vegetation, *the lining shall not compromise the capacity of the emergency spillway,* i.e. the channel shall be over-excavated so that the lining will be flush with the slope surface.
3. Fills shall be compacted as needed to prevent unequal settlement that would cause damage in the completed waterway
4. All earth removed and not needed in construction shall be spread or disposed of so that it will not interfere with waterway functioning.
5. *Stabilization*

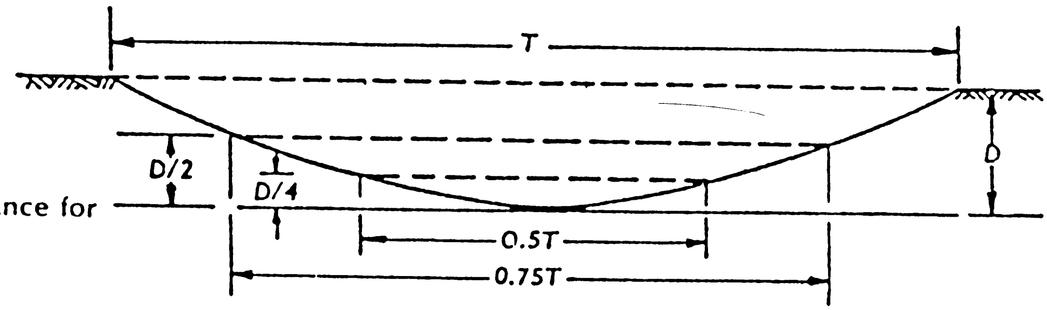
Applicable vegetative standards shall be followed for time of seeding, sprigging or sodding, liming and fertilizing, and site and seedbed preparation.

Erosion control blankets or matting or sod shall be used to aid in the establishment of vegetation. Installation methods should follow manufacturer recommendations. Refer to specification **Ds4 - Disturbed Area Stabilization (With Sodding)** and **Mb - Erosion Control Matting and Blankets**.

Mulching shall be a requirement for all seeded or sprigged channels.

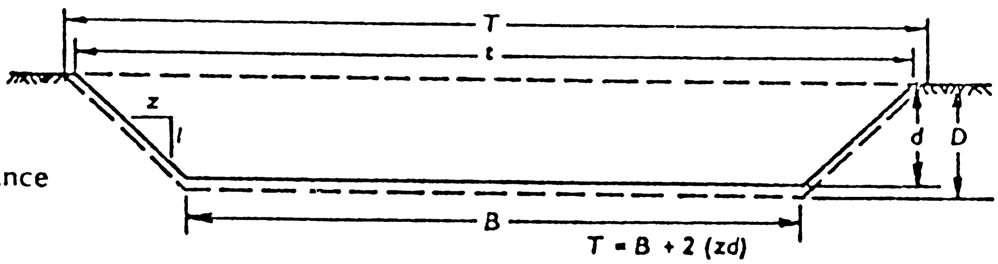
Temporary protection during establishment should be provided when conditions permit through temporary diversions or other means to dispose of water.

T = design top width
D = design depth
Both values include allowance for the vegetative lining.



PARABOLIC CROSS SECTION

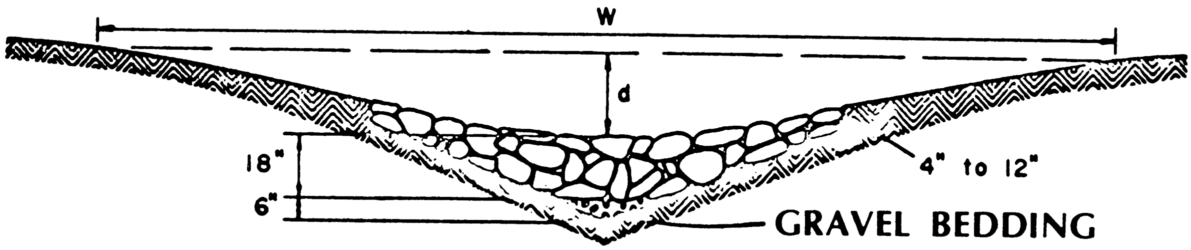
B = design bottom width
d = design depth
D = design depth plus allowance for vegetative lining
t = design top width
T = design top width plus allowance for vegetative lining
z = side slope ratio



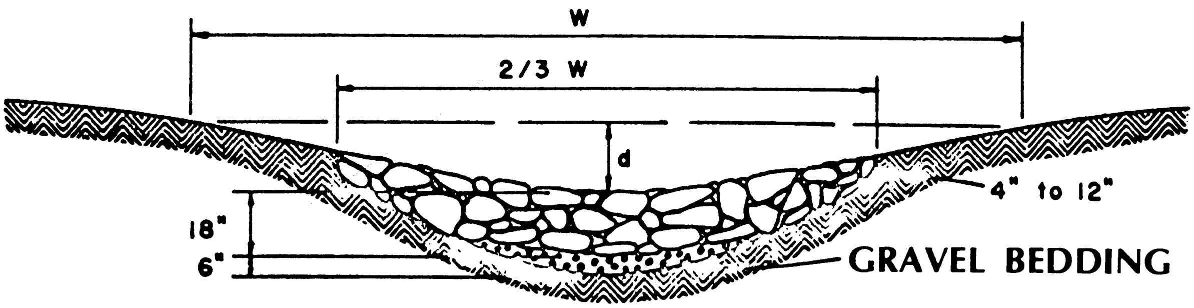
TRAPEZOIDAL CROSS SECTION

Figure 6-27.1 - Typical Waterway Cross Section

STONE CENTER WATERWAYS



Waterway with stone center drain
V section shaped by motor patrol

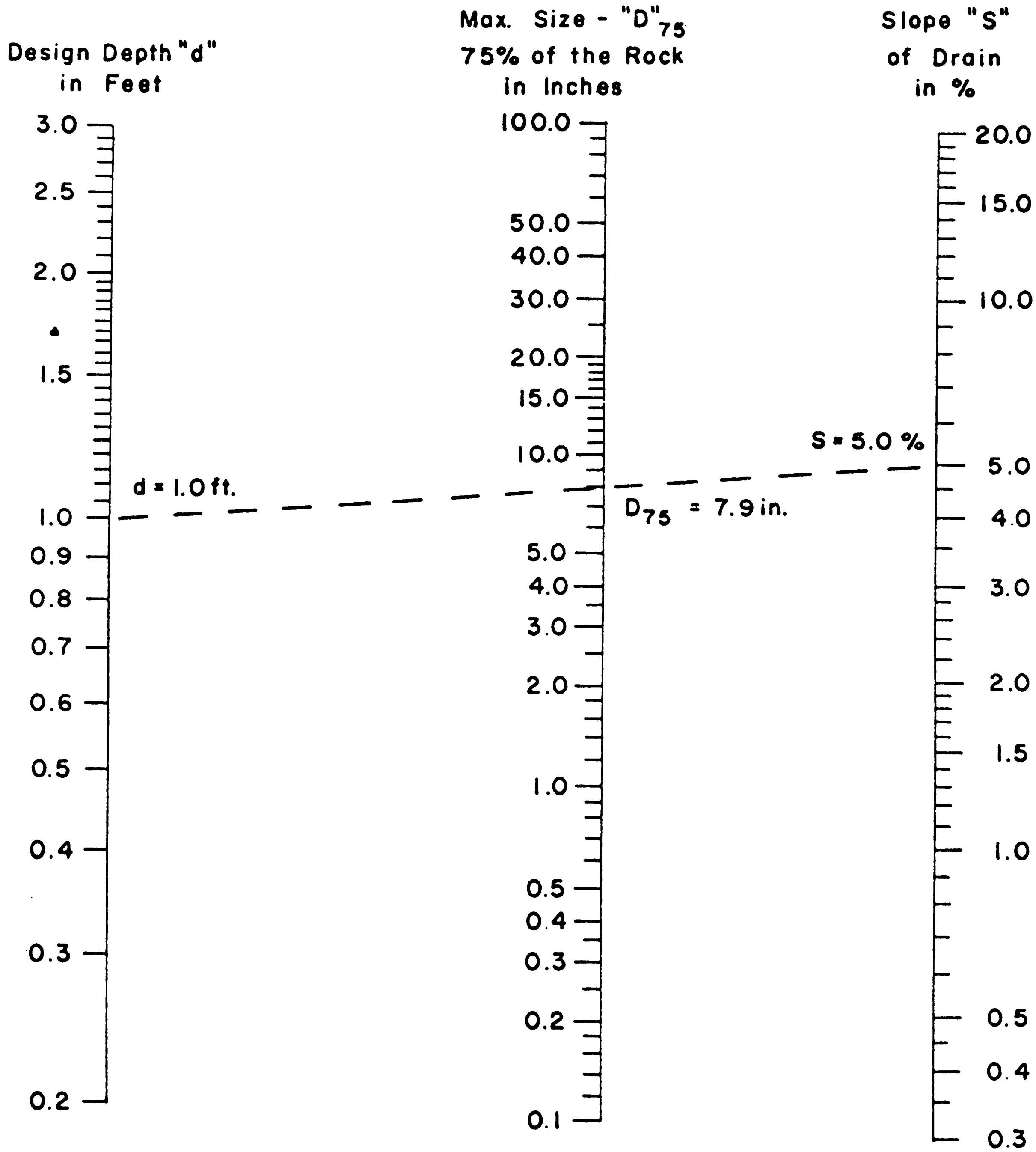


Waterway with stone center drain
Rounded section shaped by bulldozer

Figure 6-27.2 - Waterway with stone center.

Grade	6 Percent		8 Percent		10 Percent		12 Percent		15 Percent	
V	8.0	10	8.0	10	8.0	10.0	8.0	10.0	8.0	10.0
D	1.3	1.6	1.1	1.3	1.0	1.2	0.9	1.1	0.8	0.9
Q	Top Widths									
20							5		5	
25					5		6		6	4
30			5		6		7		7	5
35			6		7		8	5	8	6
40	6		7		8	5	9	6	10	7
45	7		8		9	6	10	6	11	7
50	7		9	6	10	7	11	7	12	8
55	8		9	6	11	7	12	8	13	9
60	9		10	7	12	8	13	8	14	9
65	9		11	7	12	9	14	9	16	11
70	10	7	12	8	13	9	15	10	17	11
75	11	7	13	9	14	10	16	10	18	12
80	12	8	14	9	15	10	18	11	19	13
90	13	9	15	10	17	12	20	13	21	15
100	14	10	17	11	19	13	22	14	24	16
110	16	11	19	13	21	14	24	15	26	18
120	17	11	21	14	23	16	26	17	29	20
130	19	12	22	15	25	17	29	18	31	21
140	20	13	24	16	27	18	31	19	33	23
150	22	14	26	17	29	20	33	21	36	24
160	23	15	27	18	31	21	35	22	38	26
170	25	16	29	19	33	22	37	24	40	28
180	26	17	31	20	34	23	39	25	43	29
190	27	18	32	22	36	25	42	26	45	31
200	29	19	34	23	38	26	44	28	47	33
220	32	21	38	25	42	29	48	31	52	38
240	35	23	41	27	46	31	53	33	57	39
260	38	25	44	30	50	34	57	36	62	42
280	40	27	48	32	54	36	61	39	67	45
300	43	29	51	34	57	39	66	42	71	49

Figure 6-27.2 - Velocity, Top Width and Depth for Parabolic Stone Center Waterways



EXAMPLE: **"d" = 1.0 Feet** "S" = 5%

Place straight edge at "d" value in Design Depth column and at "S" value in Slope column. Read rock size in middle column 7.9 inches. Say 8 inches.

FOR DESIGN:

25% of the rock by volume should be in sizes of 8 inches or slightly larger. The remaining 75% or less should be of well graded material, smaller than 8 inches, including sufficient sands and gravels to fill the voids between the larger rock.

Figure 6-27.3 - Determination of rock size for stone center waterway

STORMWATER CONVEYANCE CHANNEL DESIGN SHEET

Vegetated Parabolic Channel

EXAMPLE

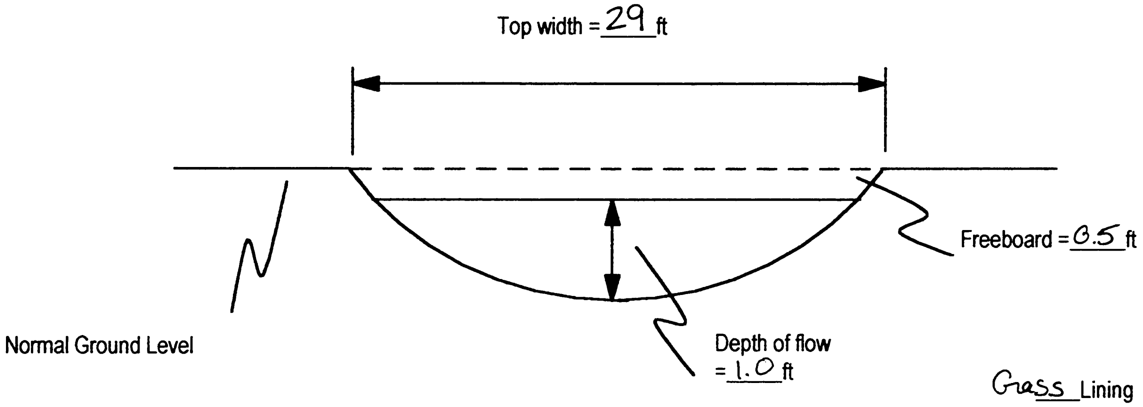
Computed by ______________ Date _________
Checked by ______________ Date _________

Project Name ___________________________

1. Compute peak rate of runoff for 25-year, 24-hour storm.
   Q_{25} = **55** cfs
2. Determine grade of channel.
   Grade = **6**%
3. Determine which vegetative cover will be used. Refer to Ds3 - Disturbed Area Stabilization (Using Permanent Vegetation).
   Vegetative cover = **Bermudagrass**
4. Determine retardances and permissible velocities for channel using Table 6-27.1
   The **retardance class for capacity** (unmowed vegetation) is **B**.
   The **retardance class for stability** (mowed vegetation) is **D**.
   Maximum permissible velocity, V_1, is **5** fps.
5. Determine dimensions of the parabolic channel. **Use Table 6-28.1**, for retardances "D" and "B".
   For a grade of **6**% and a Q_{25} of **55** cfs,
   Top width, T = **29.1** ft *(includes allowance for vegetative lining)*
   Depth, D = **1.0** ft *(includes allowance for vegetative lining)*
   Velocity for unmowed vegetation, V_2 = **2.8** fps.

Parabolic Channel

Example



STORMWATER CONVEYANCE CHANNEL DESIGN SHEET

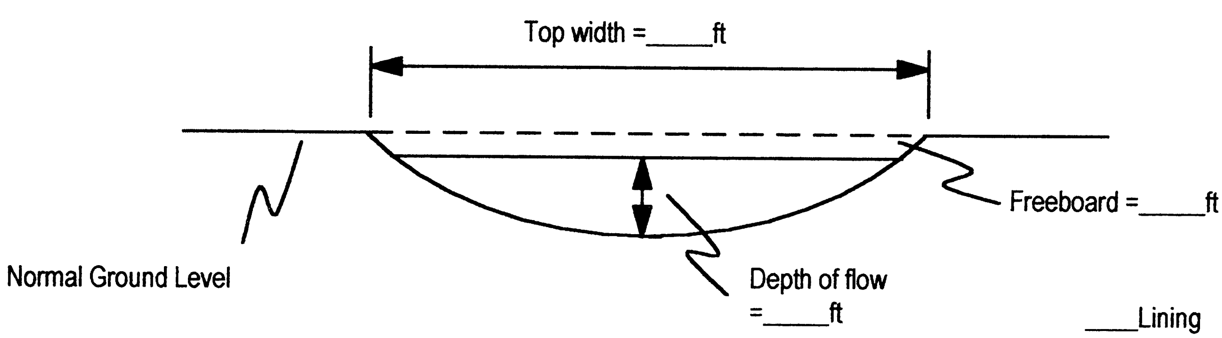
Vegetated Parabolic Channel

Computed by ______________ Date _________
Checked by ______________ Date _________

Project Name ___________________________

1. Compute peak rate of runoff for 25-year, 24-hour storm.
   Q_{25} = _________ cfs
2. Determine grade of channel.
   Grade = _________ %
3. Determine which vegetative cover will be used. Refer to Ds3 - Disturbed Area Stabilization (Using Permanent Vegetation).
   Vegetative cover = ____________________
4. Determine retardances and permissible velocities for channel using Table 6-27.1.
   The **retardance class for capacity** (unmowed vegetation) is ________ .
   The **retardance class for stability** (mowed vegetation) is ________ .
   Maximum permissible velocity, V_1, is ________ fps.
5. Determine dimensions of the parabolic channel. Use Table 6-28.1 for retardances "D" and "B". Use Table 6-28.2 for retardance "D" and "C".
   For a grade of ________% and a Q_{25} of ________ cfs,
   Top width, T = _________ ft *(includes allowance for vegetative lining)*
   Depth, D = _________ ft *(includes allowance for vegetative lining)*
   Velocity for unmowed vegetation, V_2 = _________ fps.

Parabolic



STORMWATER CONVEYANCE CHANNEL DESIGN SHEET

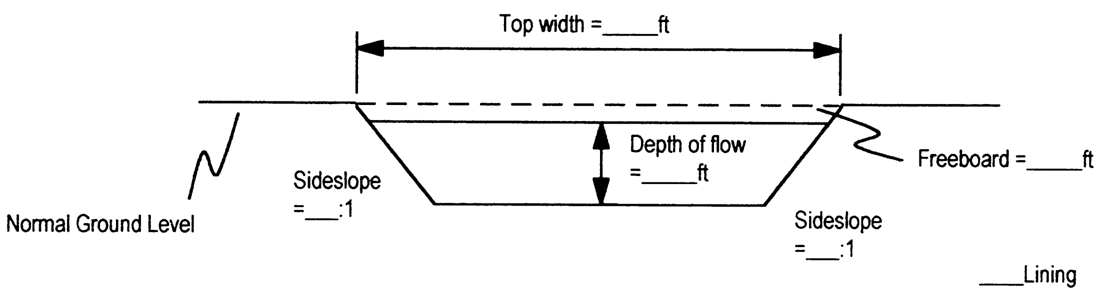
Vegetated Trapezoidal or Triangular Channel

Computed by _____________ Date _________
Checked by _____________ Date _________

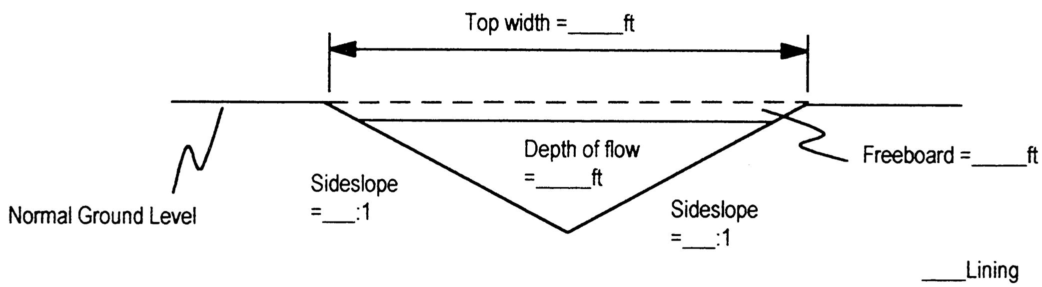
Project Name __________________________

1. Compute peak rate of runoff for 25-year, 24-hour storm.
   Q_{25} = ________ cfs
2. Determine grade of channel.
   Grade = ________ %
3. Determine which vegetative cover will be used. Refer to Ds3 - Disturbed Area Stabilization (Using Permanent Vegetation).
   Vegetative cover = ___________________
4. Determine retardances and permissible velocities for channel using Table 6-27.1.
   The **retardance class for capacity** is ________ and the unmowed plant height is ________ in.
   The **retardance class for stability** is ________ and the mowed plant height is ________ in.
   Maximum permissible velocity, V_1, is ________ fps.
5. Determine dimensions of the channel. Use Table 6-28.3 for retardance "D". Use Table 6-28.4 for retardance "C".
   For a grade of ________% and Q_{25} of ________ cfs,
   Side slopes (z:1) = ________
   Bottom width, B = ________ ft *(0 for triangular channel)*
   Design depth, d = ________ ft
   Area of channel, A = ________ sf.
6. Calculate the constructed depth of the channel.
   Constructed depth, D = Design depth, d + Unmowed plant height
   Constructed depth, D = ________ ft + ________ ft
   Constructed depth, D = ________ ft
7. Calculate the top width of the channel.
   Top width, T = Bottom width + 2(Side slope * design depth)
   Top width, T = B + 2(z*d)
   Top width, T = ________ ft + 2(_____ * ________ ft)
   Top width, T = ________ ft

Trapezoidal



Triangular



TO BE SUBMITTED WITH/ON THE EROSION AND SEDIMENT CONTROL PLAN

GRASS-LINED CHANNEL

1. **Stormwater Conveyance Channel Design Sheet** for the appropriate channel shape.

2. **Cross-sectional detail** of the channel (include with Design Sheet *and* show on E&SC plan).

STONE CENTER CHANNEL

1. **Cross-sectional detail** of the channel on the E&SC plan.