

# **MAINE EROSION AND SEDIMENT CONTROL BMPS**



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# Maine Erosion and Sedimentation Control BMPs

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## MAINE EROSION AND SEDIMENT CONTROL BMPS

### INTRODUCTION

The purpose of this handbook is to help land development consultants and contractors incorporate urban Best Management Practices (BMPs) for erosion and sedimentation control into project design, planning, and construction.

This compilation of BMPs provides a menu from which project designers and contractors may choose the practices appropriate to specific projects and sites. The selected BMPs, which will contain both temporary and permanent practices as well as structural and vegetative practices will provide the best protection against erosion and discharge of sediments at sites under construction.

There are other practices not detailed in this handbook that may remedy the problems encountered. However, it is the responsibility of the designer and/or contractor to show that the new practice will achieve the desired result of no discharge of sediment. Also creativity is encouraged. Use of some structural practices will require a professional engineer to design them in accordance with 32 MRSA Section 125.

### WHAT IS EROSION?

**Soil erosion** is the detachment of soil particles and loss of soil from an area by the action of water, ice, gravity or wind. While natural erosion has been occurring constantly at a slow rate since the earth was formed, accelerated erosion occurs because of disturbances by people. Water-generated erosion causes the most severe damage to a site undergoing development. The serious consequence of erosion is **sedimentation** - the deposition of eroded soil particles that have been transported by water. When the velocity of flow is insufficient to transport sediment, deposition occurs.

### THE IMPACT OF EROSION

As Maine's forested land is converted to commercial, industrial and residential land use, both the volume and quality of surface runoff change. This presents a potential threat to water resources. Large-scale development has a significant potential to impact Maine's water primarily because of the amount of land area exposed to erosive forces. Residential development also impacts water quality with increased volumes of runoff and the changed quality of runoff.

Human, animal and plant life also suffers adverse effects from erosion. As topsoil is lost, the land becomes less able to support vegetation. Our drinking water supplies become polluted because of erosion. Contaminants such as heavy metals or nutrients such as phosphorus attach to soil particles. When soil erodes, these pollutants are picked up and contribute to the so-called "non-point source pollution" of all surface waters.

Erosion also destabilizes stream banks, causing loss of property and recreational areas and altering fragile ecosystems. Sediments suspend in water and cover stream bottoms. These suspended solids screen out sunlight and act as abrasives on fish gills and scales. When a blanket of sediment forms on a naturally porous stream bottom, it becomes clogged, smothering organisms, destroying spawning areas and blocking fish passage.

As roadway shoulders and embankments erode and washouts around pipes and bridge abutments occur, buildings, bridges and guardrails become structurally unstable.

Finally--sedimentation can cause decreased channel capacity of waterways posing flooding problems and ultimately, the added cost of dredging to remove the sediment. Municipalities will suffer higher maintenance costs because of the more frequent need to clean water reservoirs, storm sewers, culverts and ditches.

Although many construction sites may be rapidly stabilized after the completion of construction, the permanent drainage systems and large amounts of impervious area cause long-term impacts because of the increased storm runoff and its potential to erode downstream areas.

Often the environmental impact of erosion is irreparable.

It is often less costly to plan for and prevent erosion than to repair the damage once it has begun. Repair costs are very labor intensive, leading to high expenses for a project.

## HOW EROSION OCCURS

In order to prevent erosion, or to control it effectively when it does occur, it is important to understand the four sequential processes involved: raindrop impact, sheet flow, rill/gully formation and stream flow.

Because the problems caused by erosion increase sequentially, it is vital to control erosion at its initial stages.

- **Raindrop** erosion occurs when raindrops fall and their impact dislodges soil particles and splashes them into the air. The dislodged soil particles can then be easily transported great distances by the flow of surface runoff.
- **Sheet** erosion occurs when the action of raindrop splash and runoff remove a layer of exposed surface soil. The water moves as broad sheets over the land and is not confined to small depressions.
- **Rill and gully** erosion occurs as runoff flows and concentrates in rivulets cutting several inches deep into the soil surface. These grooves are called rills and when not repaired gullies may develop.
- If rills and gullies are not controlled, **stream** and **channel** erosion result as the increase in the volume and velocity of runoff erode the banks and bottoms of the stream or channel.

## FACTORS LINKED TO EROSION

Erosion by rainfall and runoff is related closely to a soil's capacity to transfer water through its ground surface and to how particles in the soil cohere. **Soil properties** involved include: soil texture, percent organic matter, soil structure, soil infiltration capacity and soil permeability. Soils containing high proportions of silt and very fine sand are more erodible than the soils with higher percentage of clay or organic matter. Clay acts as a binder between the soil particles; organic matter maintains a favorable structure, which improves stability and permeability. Well-drained and well-graded gravels and gravel-sand mixtures with little or no silt are the least erodible soils. **Vegetative cover** shields the soil surface from the impact of falling rain and slows the velocity of runoff. Plants aid in aerating and absorbing water from the soil, thus maintaining its capacity to retain water. Plant root systems help hold soil particles in place.

**Topography** and **climate** also affect erosion. The size and shape of a watershed affects the amount and rate of runoff. Slope length and gradient determine the velocity and volume of runoff. The orientation of a slope may affect the vegetative cover. For example, because south-facing slopes tend to be dry, they have less vegetation and hence less erosion protection.

The frequency, intensity and duration of **rainfall** have an effect on soil loss. As both the volume and velocity of rainfall increase, the capacity of runoff to detach and transport soil increases. The seasonal fluctuation of temperatures tends to loosen soil. When precipitation falls as snow no erosion will take place. In the spring, the melting snow adds to the runoff and erosion hazards will be high.

**PLANNING FOR EROSION CONTROL**

Many common-sense practices will reduce a developing site's vulnerability to erosion, saving the developer, the contractors or the municipality and future occupants of the area time and money. Thus, the following considerations must be addressed in any effective erosion control plan.

**1) Plan the development to fit the site.**

After a site has been inventoried and its strengths and limitations identified, tailor the layout of the buildings, roads and utilities to the topography of the site with the following:

- Restrict construction activities to the least critical areas on the site.
- Protect and maximize existing native vegetation and natural forest floor, thereby reducing impervious areas on the site.
- Diffuse stormwater rather than concentrate it into channels.
- Align roadways following natural contours, rather than up and down steep slopes.
- Cluster buildings to minimize the amount of earth movement needed.
- Divert clean water away from the immediate construction area to reduce the threat of erosion and improve building conditions.

**2) Minimize the area of exposed soil at one time.**

The less soil that is bare and exposed to rainfall and spring snowmelt, the less erosion will occur. Take these specific steps to minimize exposed soil and to prevent erosion in those areas that must be disturbed:

- In general, plan to build large development projects in shorter phases rather than all at once.
- Preserve natural vegetation by flagging it in the field.
- Protect buffer strips of undisturbed vegetation between construction areas and environmentally vulnerable areas such as watercourses and wetlands.
- Lay down temporary mulching on any exposed soil until final grade is reached.
- Immediately seed and mulch areas ready for revegetation.

***Remember that all seeding requires mulch and some method of anchoring the mulch to protect the soil until vegetation has put out substantial good root and leaf growth.***

***Otherwise, enormous amounts of soil can wash away, often carrying new seedlings with it.***

In Maine, special measures must be taken during construction in the **late fall and winter** months. These are extremely vulnerable times, when no vegetation can grow. The real danger appears in the winter thaws and the springtime, when normal rainfall combines with snow-melt to produce vast amounts of runoff and the soil is frozen with little water percolating into it. Spring runoff can be devastating to an open construction site, and repair costs will often be greater than erosion prevention measures. An erosion control plan should be prepared specifically for this season (September 15th through April 15th); with additional upgraded measures used. See the WINTER CONSTRUCTION BMP.

**3) Provide channel stability in both natural and man-made waterways.**

One of the first orders of business on a development site is to build roads with ditches to drain them. Because the asphalt roadway no longer allows water to seep into the ground, a greater volume of water is being diverted into these channels rather than slowly flowing across the road surface as sheet flow.

The resulting combination contains all the elements of an erosion problem: a greater volume of water travelling at a faster velocity in a smaller, more concentrated area. Add a steep slope and the erosion problem becomes severe.

The project engineer must design new ditches for stability and capacity and all good erosion control plans will detail how to protect these roadside ditches.

#### **4) Stabilize cut and fill slopes caused by construction activities.**

Normal construction activities will often involve areas where cuts are made into a slope or an embankment is formed of fill materials. Usually, structural stability on these slopes needs an engineer's expertise to prevent slumping and the failure of the slopes.

Sometimes groundwater seeps need to be controlled or a slope must be graded to a specific angle due to the soil's nature.

In terms of erosion control, slopes are very vulnerable areas. Damage usually occurs when runoff is allowed to flow unchecked down the cut/fill face of the slope. A two-pronged approach is often used to protect slopes from erosion: 1) water control measures and 2) slope surface cover.

Three water control measures can be used on a slope:

- Divert and disperse the water, away from the slope and to a stable area where infiltration can occur such as undisturbed forest floor.
- Convey the water down the slope in a reinforced channel or chute.
- Collect the water in a catch basin and pipe it to a stable outlet at the base of the slope.
- For surface cover on slopes, various combinations of vegetation and structural materials can be used:
  - On slopes 2:1 or flatter, vegetation alone may be used with special anchoring such as netting to hold mulch on newly seeded area.
  - Steeper slopes usually need special structural materials such as riprap, gabions, revetments or retaining walls.

#### **5) Install additional erosion control measures when working adjacent to environmentally sensitive areas**

In areas of vulnerable or irreplaceable resources, back-up protection for a primary erosion control measure should be provided. The following site and/or construction characteristics would require two levels of protection and a special upgraded erosion control plan:

- Construction or soil disturbance within the watershed of a pond or lake which is vulnerable to the addition of phosphorous. (Contact the DEP, Bureau of Land and Water Quality for a listing of phosphorous sensitive lakes and ponds in your area.)
- Construction or soil disturbance within 250 feet of a lake, pond, river, brook, or perennial stream.
- Construction or soil disturbance within 100 feet of an intermittent stream.
- Construction or soil disturbance within 100 feet of a wetland.
- Construction which requires crossing a stream (with a culvert, bridge, etc.).
- Construction of detention ponds or phosphorus ponds.
- Construction adjacent for crossing intermittent or perennial channels.
- Channel or slope construction on slopes greater than 8%.
- Channel or slope construction from September 15 to April 15, when no vegetation can grow.
- Moderate to highly erodible soils that will be exposed for longer than 1 month. (Information about the erodibility of a soil is available from the USDA Soil Conservation Service or the local Soil and Water Conservation District.)

#### **6) Install additional erosion control measures if the site must have bare soil exposed for an extended time period**

In certain unique situations, such as the operation of gravel pits, clay mining areas, certain lumber operations and golf course construction, it is not possible to sequence construction to minimize exposed soil. These sites which have to be left open for extended time period merit additional erosion control measures.

Prevent soil from getting into the water via mulching, temporary seeding, etc.

Provide ways of filtering, settling or diverting dirty water by installing measures described above in item #5.

## **7) Use special measures if working in or crossing streams**

The Maine DEP policy prohibits excavation and filling in streams because they are at risk for severe erosion. Plans that propose this kind of construction are often denied and planners and contractors should avoid proposing or conducting earthwork in waterways or water bodies.

Whenever a planned road crosses a flowing stream and a culvert needs to be installed, the process of installing that culvert will impact the stream. Fill material will be brought in. Heavy machinery will be driven back and forth in the stream channel. It is almost impossible to install a crossing without causing a discharge of sediment downstream. Installation of detention basins or phosphorous ponds in or near streams will have the same problems.

The impact of a road crossing a larger and wider body of water, such as a brook or river, is worse as more of the waterway embankment and channel will be disturbed for a longer time period and it is extremely difficult to filter out suspended sediment from large volumes of water travelling at high velocities.

If construction will be carried out in or adjacent to streams, a good erosion control plan should clearly identify these areas as vulnerable, and target special measures for them. Determine how sensitive the downstream watershed is, and adjust protective measures. For example, a shallow, well-vegetated wetland can handle sediment far better than a lake.

In every case the following "common sense" management techniques should be applied:

- Keep stream crossings to a minimum.
- Install culverts quickly and at times of low steam flow (late summer).
- Use only clean fill at crossings (without fines).
- Erect silt fencing along stream edges and down-slope from small fill areas.
- Stabilize disturbed soil areas within 7 days or prior to storm events, whichever occurs first.
- Cross the stream channel and associated buffer areas in the least possible distance (e.g. by crossing at a right angle to the stream).
- Minimize the amount of excavation, soil disturbance, and/or fill used in buffer areas adjacent to stream crossings.

Under most circumstances, downstream areas must be protected from sedimentation. In some cases, streams are diverted from their natural channel to protect the waterway from siltation during the installation of stream crossings. Sometimes a temporary stabilized channel or pipe system is provided and the stream diverted into it while construction takes place in the original streambed. Once the crossing is completed and revegetated, the stream is redirected to its original channel.

There are some situations where no permanent stream crossing is called for on the final design plan, but a temporary stream crossing is needed for heavy machinery to access the construction area. Provisions for a temporary crossing (usually a culvert surrounded by clean gravel) should be included as a temporary measure during construction. Temporary bridges may be an effective means to cross streams for short periods, and may result in less disturbance than temporary culverts.

## **8) Protect storm sewer inlets and culverts from sediment.**

All construction sites will experience some degree of erosion and dirty water will flow across them. During construction, try to keep this water away from new or existing catch basins and culverts and clean them out once the site is fully stabilized.

- Install filter barriers such as silt fencing and hay bales around catch basin inlets and small culverts.
- Protect larger culverts with stone check dams and sediment traps.
- In some cases, install a temporary perforated riser at a culvert for use only during the construction phase.

To function properly, temporary structures need regular inspection and maintenance. And when construction is over, they must be removed to avoid seriously obstructing or plugging the storm system. Also, since the long-term maintenance is usually transferred to the owner or the town once the stormwater system is accepted; they need to be informed of their responsibility to regularly inspect and clean these systems.

### **9) Avoid tracking mud into roadways.**

Sites located near urban areas are usually most sensitive to the problem of mud tracking. Each municipality should evaluate this issue and determine how significant it is to their area.

Efforts should be made to keep mud off public roads because:

- Some soils reduce road friction, which may lead to skidding and accidents.
- Mud eventually washes from the road into the road's ditches and stormwater systems, increasing clean out and maintenance costs.
- Mud (and dust when it dries) is considered a nuisance.

To prevent mud tracking:

- Install gravel entrances at the junction of the construction site and public roadways.
- Make provisions to wash truck tires before leaving the construction site.
- Sweep public roads.

### **10) Monitor the effectiveness of erosion control measures and, as needed, adjust, maintain and repair them.**

To protect natural resources on a site, include provisions for regular inspection and maintenance in every erosion control plan.

- Note how frequently inspections will occur (for example, once a week, before and after every storm event).
- Designate a responsible party to do the inspection and the follow-up adjustments, repairs and maintenance.
- The owner, town and municipality should be provided with some form of follow-up inspection procedures to determine if the erosion control plan is being followed. Actual field inspection by the town is the best way of getting a plan implemented at the site.

### **11) Remove temporary erosion and sedimentation measures.**

When construction activity has ceased and good healthy vegetation is growing on the site, the temporary erosion control items such as silt fencing, temporary diversions, stream crossings and perforated risers, need to be removed.

If left on the site, they can seriously block the normal function of the designed stormwater system. The erosion control plan must include an agreement and designate a party to remove these temporary measures.

### **12) Keep the plans, maps, details and documents simple.**

The field documents used by the contractor need to clearly identify what erosion control measures are to be used and where they will be located. The narrative should be easy to follow and placed directly on the plans. A statement may be included to identify that the erosion control plan is the minimum that the contractor must do. Given the site and weather conditions, additional measures may be required.

Details for erosion control measures should be included and all the dimensions for them noted.

The map submission should clearly identify where erosion control measures will be placed on the site.

Having the erosion control plan readily accessible to both the contractor and the code enforcement officer promotes the implementation of the plan!

On larger projects or in sensitive areas, meet with the contractor prior to beginning construction to review the erosion control measures and construction limitations for the project.

## **ENVIRONMENTAL LAWS PERTAINING TO EROSION AND STORMWATER**

### **Erosion and Sediment Control Law (M.R.S.A. 420-C)**

The Erosion and Sedimentation Control Law (Erosion Control Law) applies everywhere in all organized areas of the state, for all sizes of projects.

- For projects on or after July 1, 1997. If a person is filling, displacing or exposing soil or other earthen materials, the Erosion Control Law requires that he or she take measures to prevent unreasonable erosion of soil or sediment beyond the site or into a protected natural resource, such as a river, stream, brook, lake, pond, or wetland. Erosion control measures must be installed before the activity begins, be maintained, kept in place and functional until the site is permanently stabilized.
- For property with chronic erosion problem resulting from human activity undertaken before July 1, 1997. By July, 2005, property subject to erosion of soil or sediment into a protected natural resource, and located in the watershed of a body of water most at risk (as listed in Ch. 502 of DEP rules), must be properly stabilized to prevent further erosion. All other property subject to such erosion of soil or sediment into a protected natural resource must be stabilized by July 1, 2010.

### **Natural Resources Protection Act-NRPA (38 M.R.S.A. 480 A-Z)**

The NRPA was promulgated in 1988. It regulates activities in, on, over, and adjacent to lakes, ponds, river, streams, brooks, freshwater wetlands and tidal areas. Activities regulated under the NRPA include disturbing soil, placing fill, dredging, removing or displacing soil, sand or vegetation, draining or dewatering and building permanent structures, in, on, over or adjacent to these areas. The law is designed to protect these natural resources and is administered and enforced by the DEP.

*Note: The DEP does have authority to enforce these laws. Enforcement actions can consist of voluntary site restoration, filing for an after the fact permit, monetary penalties, consent agreements, or court action. Contact the DEP or your local Soil and Water Conservation District to find out more about these laws.*

### **Maine Construction General Permit (W008157-5Y-A-N)**

As of March 10, 2003, construction activities in Maine will require a Maine Construction General Permit (MCGP). The permit is based on the federal National Pollutant Discharge Elimination System (NPDES), a program that applies nationwide. The MCGP sets standards for managing stormwater that may pick up pollutants, including soils, and discharge them to waters of the states, such as lakes, streams and wetlands. The requirement for a MCGP is triggered by the amount of disturbed area created during construction. In contrast to Maine's existing Stormwater Law, the MCGP applies solely to construction activity and not to ongoing stormwater management following construction. The MCGP applies in both organized and unorganized areas of Maine. Certain activities, such as forest management and farming, are exempt from the MCGP. Landowner, contractor, or developer may need a MCGP if the construction will result in any of the following:

- One acre or more of disturbed area,
- A common plan of development located in an organized area that also requires a Stormwater Law or Site Location of Development law permit, or
- A common plan of development located in an unorganized area.

### **Stormwater Management Law (38 M.R.S.A. 420-D)**

The Stormwater Management law was enacted by the Maine Legislature in 1996 as a measure to begin to address the stormwater quantity and quality impacts of development in organized areas of the state. The law requires that a permit be obtained from the Department of Environmental Protection (DEP) prior to construction of a project that includes 20,000 square feet or more of impervious area in the direct watershed of a waterbody most at risk from new development. The

law also requires that in any watershed, a proposed project which includes 1 acre or more of impervious area or 5 acres or more of disturbed area (filled, grubbed, excavated, etc.) receive a permit. The law establishes a permitting process administered by the DEP. Proposed plans for stormwater management must be reviewed by the DEP before a new project is built. The review allows the DEP to determine whether the project will meet stormwater quantity and quality standards. Contact the DEP for additional information.

### ***OTHER PERMITS***

Many construction activities will require local, state or federal permits prior to beginning construction. Be aware that construction in or adjacent to environmentally sensitive areas such as wetlands, streams and rivers, lakes and ponds generally require permits. Contact local, state and federal agencies to determine what regulations apply to your project.

**Wetlands:** Contact the US Army Corps of Engineers for information about federal permits regarding dredging, filling or building in or near wetlands. Contact the Department of Environmental Protection (DEP) for state permits for wetlands alteration. In unorganized areas of Maine contact the Land Use Regulation Commission (LURC) for these permits.

**Lakes and Ponds:** Contact the DEP for state permits for construction in or adjacent to ponds and lakes. In unorganized areas of Maine, contact LURC for these permits. Contact your local Code Enforcement Officer for information about shoreland zoning laws that may apply in these areas.

**Rivers and Streams:** Contact the US Army Corps of Engineers for information about federal permits on navigable waters. Contact the DEP for state permits for construction in or adjacent to streams (intermittent and perennial) and rivers. In unorganized areas contact LURC for these permits. Contact your local Code Enforcement Officer for information about shoreland zoning laws that may apply in these areas.

**KEY ACTIONS**

Successful erosion control depends on your performance. You can prevent erosion during severe storms if you use good judgement and act quickly. If you are diligent in doing the ten actions listed below, most erosion problems on your construction site will be prevented.

- Mark soil disturbance limits on your site.
- Install sediment barriers before you disturb soils.
- Limit the amount of soil disturbance at any one time.
- Mulch disturbed soils quickly.
- Protect steep slopes quickly.
- Protect ditches quickly.
- Inspect and repair erosion controls and sediment trapping measures before and after every storm.
- Stabilize all disturbed soils before winter.
- Limit earthwork in the winter.
- Remove temporary erosion controls when soils on the site are permanently stabilized.
- Divert, disperse and direct water run-off to areas of undisturbed forest floor wherever possible.

**EROSION AND SEDIMENT CONTROL PLAN****PURPOSE AND APPLICATION**

The erosion control plan must be prepared before construction begins, ideally during the project planning and design phases. The erosion control plan shall be submitted with the grading plan as required by the department and any local ordinances or be prepared as part of the general permit under MEPDES.

**CONSIDERATION**

A plan must be approved prior to the commencement of any work and include all necessary temporary and permanent erosion control measures, including those to be followed should the work stop at any time during the winter season. If the grading permit allows work to be done during and over winter (September 15 to April 15), the permit may require a **winter construction** operating and erosion control plan.

If the site or portion of the site is planned to be idle for more than 30 days, then mulching or vegetative stabilization must be accomplished within seven days. The winter construction plan should include a plan for the immediate (within 24 hours of the first forecast of a storm front) installation of emergency erosion control measures.

**SPECIFICATIONS**

The Erosion control plan should consist of three parts:

**1. A narrative**

- a brief description of the proposed land-disturbing activities, existing site conditions (including soil and vegetation), and adjacent areas (such as streams, wetlands, property lines and buildings) that might be affected by the proposed clearing and grading;
- a description of critical areas on the site - areas that have a potential for serious erosion problems, including the name, location and aerial extent of moderate and highly erodible soils and slopes on the project site;
- the date grading will begin and the expected date of stabilization;
- a brief description of the measures that will be used to control erosion and sedimentation on the site; and when these measures will be implemented;
- a description of an inspection and maintenance program, with provisions for frequency of inspection, repair and reconstruction of damaged structures, cleanout and disposal of trapped sediment, duration of maintenance program, and final disposition of the measures when site work is complete;
- A brief description of any substantial timber harvesting and associated road construction or other earthwork in the past five years.

**2. A map showing**

- site contours at sufficient interval and scale to identify runoff patterns before and after disturbance;
- final contours;
- limits of clearing and grading;
- existing buffers and vegetated areas in a condition that will effectively reduce erosion or off-site sedimentation;
- all critical areas within or near the project site, such as streams, lakes, wetlands, or the aerial extent of erodible soils;
- the location and types of erosion and sediment control measures, including the aerial extent of vegetative treatments;
- location/extent of timber harvesting and associated road construction or other earthwork in the past five years.

**3. Plan details**

- detailed drawings of erosion and sediment control structures and measures, showing dimensions, materials, and other important details;
- design criteria and calculations such as design particle size for sediment basins and peak discharge for channel design and outlets;
- seeding or vegetative specifications;
- inspection and maintenance notes;
- a description and design information regarding how pre-existing conditions resulting from past land uses leading to erosion and/or sedimentation will be corrected as part of the overall design.

**The narrative and details should be placed on the Erosion Control Plan map if possible.**

## **PLAN CHECKLIST**

It is not the responsibility of the plan reviewer to ensure that the plan is appropriate for the level of work suggested by the proposed project. The reviewer can only ensure that the plan meets the minimum standards set by the department and/or other authorizing ordinance.

Communications: Encourage informal communications between the plan reviewer and the plan preparer.

This will enable the reviewer to make informal suggestions that may save money and time, and it may result in a better, more effective plan. It will also enable the preparer to explain and justify the plan.

Incomplete Plans: Seriously incomplete plans will not be reviewed but will be sent back with a request for the missing information.

Required Information: Make sure all the required information has been submitted. A checklist can be used; however, having everything checked off does not necessarily mean that everything is in order.

Plan Concept: The concept should be examined first, starting with the general and moving to the specific. Does the plan make sense?

Schedule: Examine the construction schedule. Will grading be completed before the winter weather season? When will storm drainage facilities, paving, and utilities be installed in reference to the wet weather season? If grading will take place during months when there is a high probability of heavy rains, what extra precautions will be taken to protect against erosion, sedimentation, and changing drainage patterns (Is a winter construction plan necessary)?

Minimize Disturbance: Does the plan show areas that are not to be disturbed? Native vegetation should be retained to the maximum degree possible and stream buffer areas should be designated on the plan and flagged in the field. A well-conceived erosion control plan will minimize erosion by attempting to minimize disturbance and retain natural vegetation. A phased approach to development can assure that the extent and timing of grading does not exceed the contractor's ability to perform erosion and sediment control.

Site Drainage: Make sure you understand where all drainage comes from on and above the site, where it goes, and how it traverses the site. For large sites, prepare a drainage area map.

Sediment Basins and Traps: Locate all sediment basins and traps and define their tributary areas.

Erosion Control: Check the method used to prevent erosion. Hydraulic seeding and mulching may adequately stabilize some areas, but other areas, because of their proximity to sensitive features such as watercourses, or their steepness and erosive soil, may need far more intensive revegetation efforts. On steep and critical slopes, a reliable backup system such as erosion control mix or erosion control blankets is strongly recommended.

Channels and Outlets: Examine all drainageways where concentrated flows will occur. Be sure adequate erosion protection is provided both along channels and at channel and pipe outlets. Check the sources of runoff to be sure that all the runoff comes from undisturbed or stabilized areas or has been desilted by sediment basins or other sediment retention devices.

Miscellaneous: Look for haul roads, stockpile areas, and borrow areas. They are often overlooked and can have a substantial effect on drainage patterns. Have construction or access roads been surfaced with rock, as a minimum treatment, before the rainy season? Look at all points of vehicle access to the site and be sure mud and soil will not be tracked onto paved streets and that sediment-laden runoff will not escape from the site at these points. Pay particular attention to watercourses and their protection.

Plan Details: Once the plan concept has been shown to be adequate, check the details to be sure the concept is adequately described in the plans.

Structural Details: Be sure that sufficiently detailed drawings of each structure (sediment basin, dike, ditch, silt fence, etc.) are included so there is no doubt about location, dimensions, or method of construction.

Calculations: Determine if calculations have been submitted to support the capacity and structural integrity of all structures. Were the calculations made correctly? Non-engineered structures, such as straw bale barriers, do not generally need hydrologic calculations, however, supporting information such as drainage area and peak flow should be available if requested.

Vegetation: Review seed, fertilizer, and mulch specifications. Check quantities and methods of application to be sure they are appropriate and consistent with local guidelines. Are there stipulations so that ineffective revegetation and/or damage can be remedied immediately?

Maintenance: Be sure that general maintenance requirements and, where necessary, specific maintenance criteria, such as the frequency of sediment basin cleaning, are included. Are there stockpiles of spare materials (filter fabric, straw bales, stakes, gravel, etc.) to repair damaged control measures? Routine maintenance inspections should be part of the plans.

Contingencies: The plan must provide for unforeseen field conditions, scheduling delays, and other situations that may affect the assumed conditions. For example, straw mulch may need to be installed as an emergency measure during severe summer thunderstorms, or sediment basins may need to be cleaned more frequently.

Signature: Where applicable, the erosion and sediment control plan should be signed by the preparer who shall be a qualified professional.

Technical Review: Where applicable, the erosion and sediment control plan shall be reviewed by a certified professional in erosion and sediment control or the engineering consultant for the project.

Site assessment: Ensure that existing conditions on the site are adequately described or assessed, sufficient for the proposed measures to be evaluated.

**ACKNOWLEDGEMENTS**

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***Production***

**2003 Revision:** Marianne Hubert, Senior Environmental Engineer, Division of Watershed Management, Bureau of Land and Water Quality, Department of Environmental Protection

***Illustrations***

The illustrations were obtained from various sources for the original manual. Some detail drawings for this revised manual were obtained from a software package, Erosion Draw 3.0 purchased through Salix, Applied Earthcare. Ross Cudlitz, Engineering Assistance & Design, Inc. made the corrections to some of these drawings.

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**A-1 TEMPORARY MULCHING****PURPOSE & APPLICATIONS**

Temporary mulching is the application of plant residues or other suitable materials to the soil surface. Its purpose is to prevent erosion by protecting the exposed soil surface and to aid in the growth of vegetation by conserving available moisture, controlling weeds, and providing protection against extreme heat and cold. Mulches can also protect the infiltration rate of the soil, prevent soil compaction, and provide a suitable microclimate for seed germination. This is the quickest and most cost effective method of controlling runoff and erosion on disturbed soils and its value should not be underestimated.

**CONSIDERATIONS**

- In sensitive areas (within 100 ft of streams, wetlands and in lake watersheds) temporary mulch must be applied **within 7 days of exposing soil or prior to any storm event.**
- Areas, which have been temporarily or permanently seeded, shall be mulched immediately following seeding.
- Areas which cannot be seeded within the growing season shall be mulched for over-winter protection and the area should be seeded at the beginning of the growing season.
- Mulch can be used in conjunction with tree, shrub, vine, and ground cover plantings.
- Mulch anchoring should be used on slopes greater than 5% in late fall (past September 15), and over-winter (September 15 - April 15).

**SPECIFICATIONS**

The choice of materials for mulching will be based on soil and site conditions, season, and economics.

**Type of Mulch****Hay or Straw Mulches**

Organic mulches including hay and straw need to be air-dried, free of undesirable seeds and coarse materials. Application rate must be 2 bales (70-90 pounds) per 1000 SQ FT or 1.5 to 2 tons (90-100 bales) per acre to cover 75 to 90 % of the ground surface. Hay mulch is subject to wind blowing unless kept moist or anchored. See the detail drawing at the back of this section.

**Anchoring methods:**

**Netting** over hay with jute, wood fiber or plastic netting to soil surface. Staple mats according to manufacturer's recommendation.

**Peg and Twine:** After mulching with hay, drive 4-6 pegs per sq. yd in size to within 2-3 in. of soil surface. Secure mulch to surface by stretching twine between pegs in criss-cross pattern. Secure around each peg with two or more turns. Drive pegs flush with soil where mowing is planned.

**Tracking:** Apply hay mulch and drive tracked equipment up and down slope over entire surface so cleat marks are parallel to contour lines. Tracking is suitable for areas less than 3% and not subject to wind blowing.

**Erosion Control Mix**

Erosion control mix can be manufactured on or off the project site. It must consist primarily of organic material and will include any of the following: shredded bark, stump grindings, composted bark or other acceptable products based on a similar raw source. Wood or bark chips, ground construction debris or reprocessed wood products will not be acceptable as the organic component of the mix.

It can be used as a stand-alone reinforcement:

- On slopes 2 horizontal to 1 vertical or less.
- On frozen ground or forested areas.

- At the edge of gravel parking areas and areas under construction.

Other reinforcement BMPs (i.e. riprap) should be used:

- On slopes with groundwater seepage;
- At low points with concentrated flows and in gullies;
- At the bottom of steep perimeter slopes exceeding 100 feet in length;
- Below culvert outlet aprons; and
- Around catch basins and closed storm systems.

**Composition**

Erosion control mix shall contain a well-graded mixture of particle sizes and may contain rocks less than 4" in diameter. Erosion control mix must be free of refuse, physical contaminants, and material toxic to plant growth. The mix composition shall meet the following standards:

- The organic matter content shall be between 80 and 100%, dry weight basis.
- Particle size by weight shall be 100 % passing a 6" screen and a minimum of 70 %, maximum of 85%, passing a 0.75" screen.
- The organic portion needs to be fibrous and elongated.
- Large portions of silts, clays or fine sands are not acceptable in the mix.
- Soluble salts content shall be < 4.0 mmhos/cm.
- The pH should fall between 5.0 and 8.0.

**Installation**

When used as mulch, the length and steepness of the slope determine the appropriate thickness of the erosion control mix. **Erosion control mix is not recommended for slopes steeper than 2:1.** For other slopes, the following minimums apply:

**On slopes of 3:1 or less;** 2 inches plus an additional 1/2 inch per 20 feet of slope up to 100 feet;  
**On slopes between 3:1 and 2:1,** 4 inch plus an additional 1/2 inch per 20 feet of slope up to 100 feet.

*The thickness of the mulch at the bottom of the slope needs to be:*

	<i>&lt; 3:1 slope</i>	<i>slopes between 3:1 and 2:1</i>
<i>&lt; 20' of slope</i>	<i>2.0"</i>	<i>4.0"</i>
<i>&lt; 60' of slope</i>	<i>3.0"</i>	<i>5.0"</i>
<i>&lt; 100' of slope</i>	<i>4.0"</i>	<i>6.0"</i>

- The mulch may be placed with a hydraulic bucket, with a pneumatic blower or by hand.
- It shall be placed evenly and must provide 100 % soil coverage, with the soil totally invisible.

Any required repairs should be made immediately, with additional erosion control mix placed on top of the mulch to reach the recommended thickness. When the mix is decomposed, clogged with sediment, eroded or ineffective, it must be replaced or repaired. Erosion control mix mulch should be left in place. Vegetation adds stability and should be promoted. If the mulch needs to be removed spread it out into the landscape.

**Chemical Mulches and Soil Binders**

Wide ranges of synthetic, spray-on materials are marketed to protect the soil surface. These are emulsions that are mixed with water and applied to the soil. They may be used alone, but most often are used to hold wood fiber, hydro-mulches or straw to the soil surface. Consult with the manufacturer to determine adequate application rates, especially for steep slopes and fall applications. Avoid application during windy days. A 24-hour curing period at a soil temperature higher than 45 degrees Fahrenheit is often required. Application should generally be heaviest at edges of areas and at crests of ridges and banks to prevent loss by wind. The remainder of the area should have binder applied uniformly. Binders may be applied after mulch is spread or may be sprayed into the mulch as it is being blown onto the soil. Applying straw and binder together is more effective. Seeding rates frequently need to be increased when using this method.

When used alone, chemical mulches do not have the capability that organic mulches have to insulate the soil or retain soil moisture. Chemical mulches generally decompose in 60-90 days.

### **Erosion Control Blankets and Mats**

Mats are manufactured combinations of mulch and netting designed to retain soil moisture and modify soil temperature. See the detail drawing located at the back of this section.

During the growing season (April 15 - September 15) use mats (or mulch and netting) on:

- the base of grassed waterways
- steep slopes (15% or greater)
- any disturbed soil within 100 feet of lakes, streams and wetlands

During the late fall and winter (September 15 - April 15) use heavy grade mats on all areas noted above plus use lighter grade mats (or mulch and netting) on:

- side slopes of grassed waterways
- moderate slopes (>>8%)

**NOTE:** *There may be cases where mats will be needed on slopes flatter than 8%. Also, this will vary with the length of the slope.*

The most critical aspect of installing mats is obtaining firm continuous contact between the mat and the soil. Without such contact the mat is useless and erosion occurs. Install mats and staple in accordance with the manufacturer's recommendations.

#### **Installation**

**Apply mulch prior to any storm event.** This is applicable in extremely sensitive areas such as within 100 feet of lakes, ponds, rivers, streams, and wetlands. It will be necessary to closely monitor weather predictions to have adequate warning of significant storms.

#### **Require mulching within a specified time period (from original soil exposure)**

This time period should be no greater than 7 days in extremely sensitive areas (within 100 feet of rivers and streams, wetlands, and in lake and pond watersheds. This 7-day limit should be reduced further if possible.

In other areas, the time period can range from 14 to 30 days, the length of time varying with site conditions (soil erodibility, season of year, extent of disturbance, proximity to sensitive resources, etc.) and the potential impact of erosion on adjacent areas. Other state or local restrictions may also apply.

This approach is easier to plan for and execute, however it may result in exposing the site to major storm events that occur during that 7-day period of exposed soil.

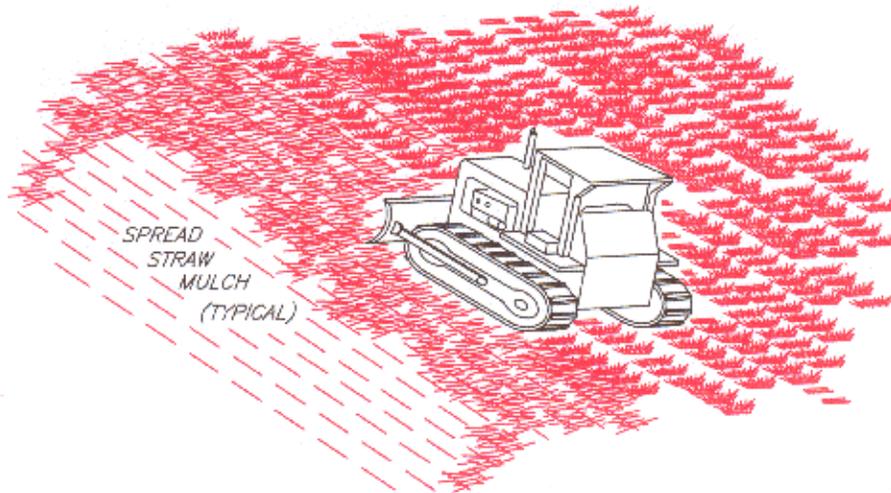
#### **Guidelines for Fall/Winter Mulch Application**

When mulch is applied to provide protection over winter (past the growing season), it should be applied to a depth of four inches (150-200 lbs. of hay per 1000 sq. ft or double standard application rate). Seeding cannot generally be expected to grow up through this depth of mulch and will be smothered. If vegetation is desired, the mulch will need to be removed in the springtime and the area seeded and mulched.

### **MAINTENANCE**

All mulches must be inspected periodically, in particular after rainstorms, to check for rill erosion. If less than 90% of the soil surface is covered by mulch, additional mulch shall be immediately applied. Nets must be inspected after rain events for dislocation or failure. If washouts or breakage occur, re-install the nets as necessary after repairing damage to the slope. Inspections shall take place until grasses are firmly established (95% soil surface covered with grass).

Where mulch is used in conjunction with ornamental plantings, inspect periodically throughout the year to determine if mulch is maintaining coverage of the soil surface. Repair as needed.



*'TRACKING' WITH MACHINERY ON SANDY SOIL PROVIDES ROUGHENING WITHOUT UNDUE COMPACTION.*

## STRAW ANCHORING

*NOTES:*

- 1. ROUGHEN SLOPE WITH BULLDOZER*
- 2. BROADCAST SEED AND FERTILIZER.*
- 3. SPREAD STRAW MULCH 3" (75mm) THICK. (2 1/2 TONS PER ACRE)*
- 4. PUNCH STRAW MULCH INTO SLOPE BY RUNNING BULLDOZER UP AND DOWN SLOPE.*

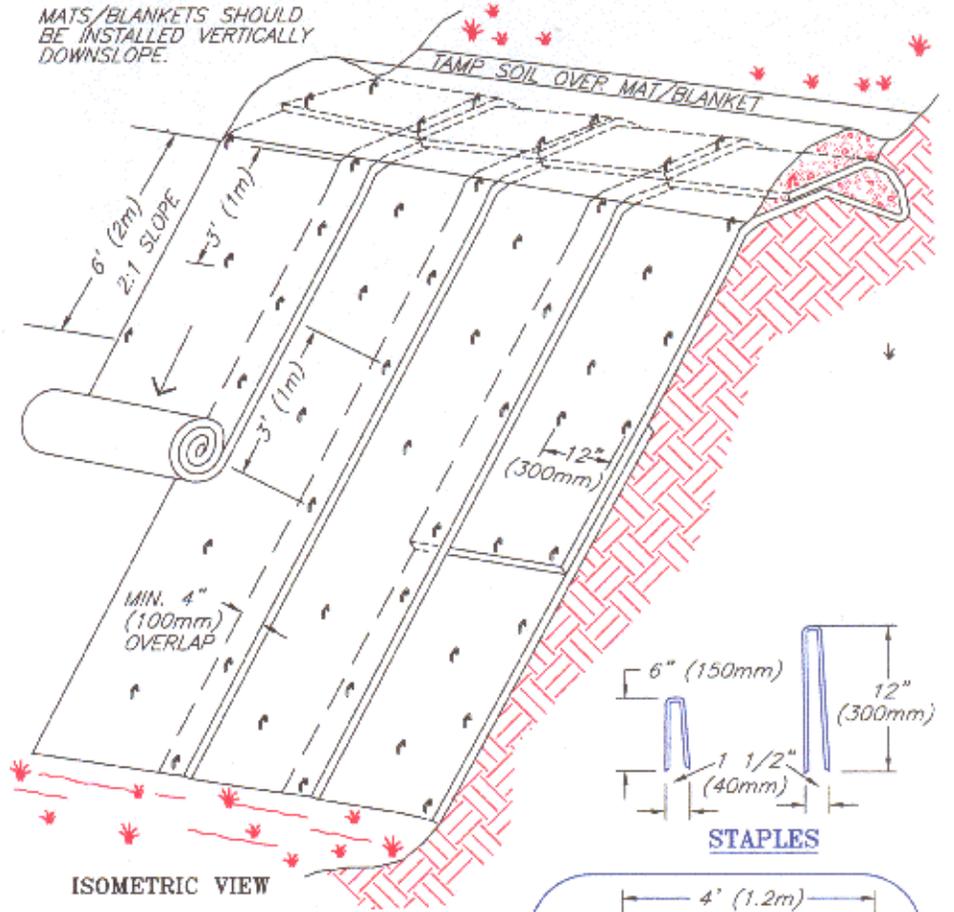
**STRAW  
ANCHORING**

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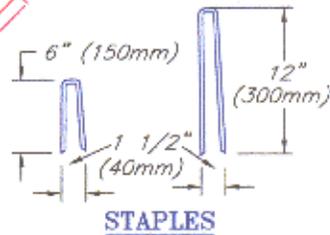
FILE: STRWANCH

MATS/BLANKETS SHOULD BE INSTALLED VERTICALLY DOWNSLOPE.

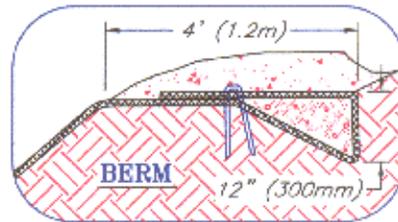


ISOMETRIC VIEW

**TYPICAL SLOPE  
SOIL STABILIZATION**



STAPLES



NOT TO SCALE

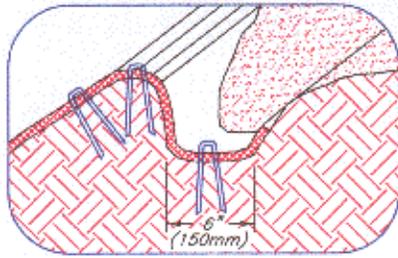
**EROSION BLANKETS &  
TURF REINFORCEMENT MATS  
SLOPE INSTALLATION**

NOTES:

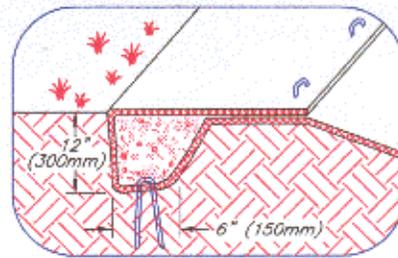
1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS.
3. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.

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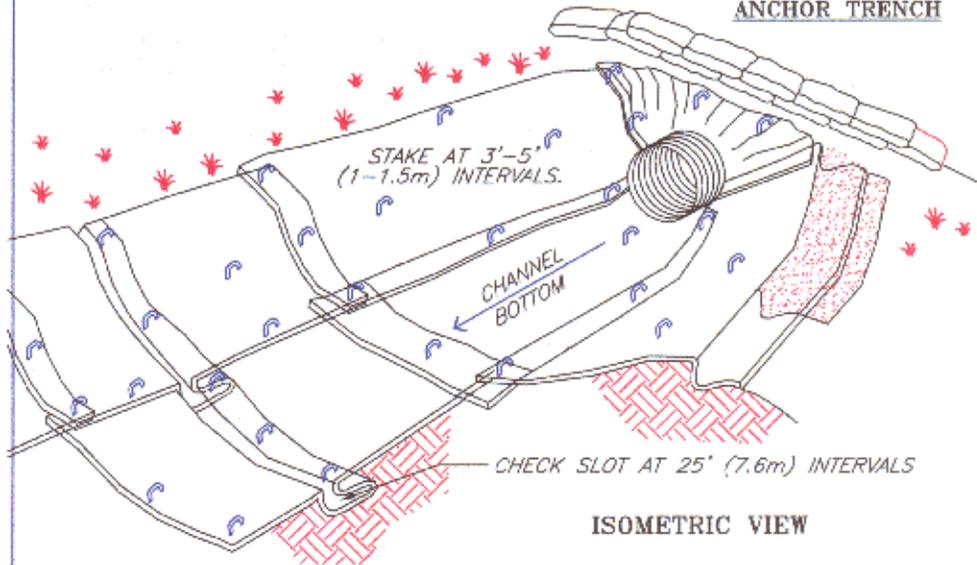
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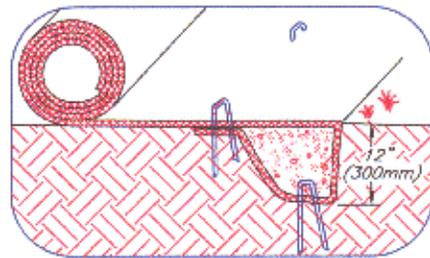
**LONGITUDINAL ANCHOR TRENCH**



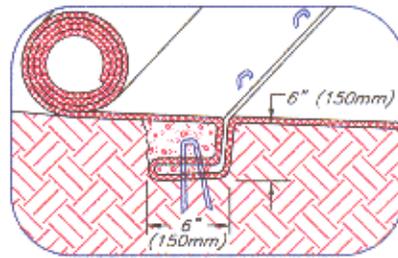
**TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH**



**ISOMETRIC VIEW**



**INITIAL CHANNEL ANCHOR TRENCH**



**INTERMITTENT CHECK SLOT**

**NOTES:**

1. CHECK SLOTS TO BE CONSTRUCTED PER MANUFACTURERS SPECIFICATIONS.
2. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.

**EROSION BLANKETS & TURF REINFORCEMENT MATS CHANNEL INSTALLATION**

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FILE: BLNKTCHA

**A-2 TEMPORARY VEGETATION****PURPOSE & APPLICATIONS**

Temporary grass and legume cover is the establishment of vegetative cover on soils exposed for periods of up to 12 months. The purpose is to reduce erosion and sedimentation by stabilizing disturbed areas that will not be brought to final grade for a year or less and to reduce problems associated with mud and dust production from exposed soil surface during construction.

Runoff and sheet erosion caused by splash erosion (rain drop impact on bare soil), is the source of most fine particles in sediment. To reduce the sediment load in runoff, the soil surface itself should be protected. The most efficient and economical means of controlling sheet and rill erosion is to establish a vegetative cover. Annual plants that sprout rapidly and survive for only one growing season are suitable for establishing temporary vegetative cover.

Temporary seeding may prevent costly maintenance operations on other erosion control systems. For example, sediment basin clean-outs will be reduced if the drainage area of the basin is vegetated where grading and construction are not taking place.

Temporary seeding is essential to preserve the integrity of earthen structures used to control sediment, such as dikes, diversions, and the banks and dams of sediment basins.

Temporary vegetative cover should be applied where exposed soil surfaces are not to be fine-graded for periods from 30 days to one year. Such areas include denuded areas, soil stockpiles, dikes, dams, sides of sediment basins, temporary roadbanks, etc.

**CONSIDERATIONS**

- Proper seedbed preparation and the use of quality seed are important in this practice just as in permanent seeding. Failure to carefully follow sound agronomic recommendations will often result in an inadequate stand of vegetation that provides little or no erosion control.
- Nutrients and pesticides used to establish and maintain a vegetation cover must be managed to protect the surface and ground water quality.
- Temporary seeding should be used extensively in sensitive areas (ponds and lake watersheds, steep slopes, streambanks, etc.).
- Late fall seeding may fail and cause water quality deterioration in spring runoff events, thus other measures such as mulching should be implemented.

**SPECIFICATIONS****Site Preparation**

Grade as needed and feasible to permit the use of equipment for seedbed preparation, seeding, mulch application, and mulch anchoring. Install needed erosion control measures such as diversions, grade stabilization structures sediment basins and grassed waterways.

**Seedbed Preparation**

Apply limestone and fertilizer according to soil test recommendations such as those offered by the University of Maine Soil Testing Laboratory. Soil sample mailers are available from the local Cooperative Extension Service office. If soil testing is not feasible on small or variable sites, or where timing is critical, fertilizer may be applied at the rate of 600 pounds per acre or 13.8 pounds per 1,000 square feet of 10-10-10 (N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O) or equivalent. Apply limestone (equivalent to 50 percent calcium plus magnesium oxide) at a rate of 3 tons per acre (138 lb. per 1,000 square feet).

## Seeding

- Select seed from recommendations in enclosed table.
- Where the soil has been compacted by construction operations, loosen soil to a depth of 2 inches before applying fertilizer, lime and seed.
- Apply seed uniformly by hand, cyclone seeder, drill, cultipacker type seeder or hydroseeder (slurry including seed and fertilizer). Hydroseeding that includes mulch may be left on soil surface. Seeding rates must be increased 10 % when hydroseeding.

## Mulching

Apply mulch over seeded area according to the TEMPORARY MULCHING BMP.

## MAINTENANCE

Temporary seeding shall be periodically inspected. At a minimum, 95% of the soil surface should be covered by vegetation. If **any evidence of erosion or sedimentation is apparent**, repairs shall be made and other temporary measures used in the interim (mulch, filter barriers, check dams, etc.).

### Temporary Seeding Rates and Dates

Seed	Lb./Ac	Seeding Depth	Recommended Seeding Dates	Remarks
Winter Rye	112(2.0 bu)	1-1.5 in	8/15-10/1	Good for fall seeding. Select a hardy species, such as Aroostook Rye.
Oats	80 (2.5 bu)	1-1.5 in.	4/1-7/1 8/15-9/15	Best for spring seeding. Early fall seeding will die when winter weather moved in, but mulch will provide protection.
Annual Ryegrass	40	.25 in	4/1-7/1	Grows quickly but is of short duration. Use where appearance is important. With mulch, seeding may be done throughout growing season.
Sudangrass	40 (1.0 bu)	.5-1in	5/15-8/15	Good growth during hot summer periods.
Perennial	40 (2.0 bu)	.25 in	8/15-9/15	Good cover, longer lasting than Annual Ryegrass. Mulching will allow seeding throughout growing season.
Temporary mulch with or without dormant seeding			10/1-4/1	Refer to TEMPORARY MULCHING BMP and/or PERMANENT VEGETATION BMP.

**A-3 OVERWINTER CONSTRUCTION AND STABILIZATION****PURPOSE & APPLICATIONS**

If a construction site is not stabilized with pavement, a road gravel base, 75 % mature vegetation cover or riprap by November 15 then the site needs to be protected with over-winter stabilization. An area considered open is any area not stabilized with pavement; vegetation, mulching, erosion control mix, erosion control mats, riprap or gravel base on a road. The winter construction period is from November 1 through April 15.

**CONSIDERATIONS**

Winter excavation and earthwork shall be completed such that no more than 1 acre of the site is without stabilization at any one time. Limit the exposed area to those areas in which work is to occur during the following 15 days and that can be mulched in one day prior to any snow event. All area shall be considered denuded until the subbase gravel is installed in roadway areas or the areas of future loam and seed have been loamed, seeded and mulched. A cover of erosion control mix performs the best. Refer to the TEMPORARY MULCHING BMP.

Any added measures, which may be necessary to control erosion/sedimentation, must be installed. These may be dependent upon site conditions, the actual site size and weather conditions.

To minimize areas without erosion control protection, continuation of earthwork operations on additional areas shall not begin until the exposed soil surface on the area being worked has been stabilized.

**SPECIFICATIONS****Natural Resource Protection**

Any areas within 100 feet from any natural resources, if not stabilized with a minimum of 75 % mature vegetation catch, shall be mulched by December 1 and anchored with plastic netting or protected with an erosion control cover.

During winter construction, a double row of sediment barriers (i.e. silt fence backed with hay bales or erosion control mix) will be placed between any natural resource and the disturbed area. Projects crossing the natural resource shall be protected a minimum distance of 100 feet on either side from the resource. Existing projects not stabilized by December 1 shall be protected with the second line of sediment barrier to ensure functionality during the spring thaw and rains.

**Sediment Barriers**

During frozen conditions, sediment barriers may consist of erosion control mix berms or any other recognized sediment barriers as frozen soil prevents the proper installation of hay bales or silt fences.

**Mulching**

All area shall be considered to be denuded until seeded and mulched. Hay and straw mulch shall be applied at a rate of 150 lb. per 1,000 square feet or 3 tons/acre (twice the normal accepted rate of 75-lbs./1,000 s.f. or 1.5 tons/acre) and shall be properly anchored. Erosion control mix must be applied with a minimum 4 inch thickness.

Mulch shall not be spread on top of snow. The snow will be removed down to a one-inch depth or less prior to application.

After each day of final grading, the area will be properly stabilized with anchored hay or straw or erosion control matting.

An area shall be considered to have been stabilized when exposed surfaces have been either mulched or adequately anchored so that ground surface is not visible though the mulch.

Between the dates of November 1 and April 15, all mulch shall be anchored by either mulch netting, asphalt emulsion chemical, tracking or wood cellulose fiber. The cover will be considered sufficient when the ground surface is not visible through the mulch. After November 1<sup>st</sup>, mulch and anchoring of all exposed soil shall occur at the end of each final grading workday.

### **Soil Stockpiling**

Stockpiles of soil or subsoil will be mulched for over winter protection with hay or straw at twice the normal rate or with a four-inch layer of erosion control mix. This will be done within 24 hours of stocking and re-established prior to any rainfall or snowfall. Any soil stockpile will not be placed (even covered with mulch) within 100 feet from any natural resources.

### **Seeding**

Between the dates of October 15 and April 1<sup>st</sup>, loam or seed will not be required. During periods of above freezing temperatures finished areas shall be fine graded and either protected with mulch or temporarily seeded and mulched until such time as the final treatment can be applied. If the date is after November 1<sup>st</sup> and if the exposed area has been loomed, final graded with a uniform surface, then the area may be dormant seeded at a rate of 3 times higher than specified for permanent seed and then mulched.

Dormant seeding may be placed prior to the placement of mulch or erosion control blankets. If dormant seeding is used for the site, all disturbed areas shall receive 4' of loam and seed at an application rate of 5lbs/1000 s.f. All areas seeded during the winter will be inspected in the spring for adequate catch. All areas insufficiently vegetated (less than 75 % catch) shall be revegetated by replacing loam, seed and mulch.

If dormant seeding is not used for the site, all disturbed areas shall be revegetated in the spring.

### **Overwinter stabilization of ditches and channels**

All stone-lined ditches and channels must be constructed and stabilized by November 15. All grass-lined ditches and channels must be constructed and stabilized by September 1. If a ditch or channel is not grass-lined by September 1, then one of the following actions must be taken to stabilize the ditch for late fall and winter.

Install a sod lining in the ditch: A ditch must be lined with properly installed sod by October 1. Proper installation includes: pinning the sod onto the soil with wire pins, rolling the sod to guarantee contact between the sod and underlying soil, watering the sod to promote root growth into the disturbed soil, and anchoring sod at the base of the ditch with jute or plastic mesh to prevent the sod from sloughing during flow conditions. See the PERMANENT VEGETATION BMP section.

Install a stone lining in the ditch: A ditch must be lined with stone riprap by November 15. A registered professional engineer must be hired to determine the stone size and lining thickness needed to withstand the anticipated flow velocities and flow depths within the ditch. If necessary, the contractor will regrade the ditch prior to placing the stone lining so to prevent the stone lining from reducing the ditch's cross-sectional area.

### **Overwinter stabilization of disturbed slopes**

All stone-covered slopes must be constructed and stabilized by November 15. And all slopes to be vegetated must be seeded and mulched by September 1. The department will consider any area having a grade greater than 15% to be a slope. If a slope to be vegetated is not stabilized by September 1, then one of the following actions must be taken to stabilize the slope for late fall and winter.

Stabilize the soil with temporary vegetation and erosion control mats -- By October 1 the disturbed slope must be seeded with winter rye at a seeding rate of 3 pounds per 1000 square feet and then install erosion control mats or anchored mulch over the seeding. If the rye fails to grow at least three inches or fails to cover at least 75% of the slope by November 1, then the contractor will cover the slope with a layer of erosion control mix or with stone riprap as described in the following standards.

Stabilize the soil with sod -- The disturbed slope must be stabilized with properly installed sod by October 1. Proper installation includes the contractor pinning the sod onto the slope with wire pins, rolling the sod to guarantee contact between the sod and underlying soil, and watering the sod to promote root growth into the disturbed soil. The contractor will not use late-season sod installation to stabilize slopes having a grade greater than 33% (3H:1V) or having groundwater seeps on the slope face.

Stabilize the soil with erosion control mix – Erosion control mix must be properly installed by November 15. The contractor will not use erosion control mix to stabilize slopes having grades greater than 50% (2H:1V) or having groundwater seeps on the slope face. See the TEMPORARY MULCHING BMP section.

Stabilize the soil with stone riprap -- Place a layer of stone riprap on the slope by November 15. The development's owner will hire a registered professional engineer to determine the stone size needed for stability on the slope and to design a filter layer for underneath the riprap. See the RIPRAP SLOPE STABILIZATION BMP section.

### **Overwinter stabilization of disturbed soils**

By September 15, all disturbed soils on areas having a slope less than 15% must be seeded and mulched. If the disturbed areas are not stabilized by this date, then one of the following actions must be taken to stabilize the soil for late fall and winter.

Stabilize the soil with temporary vegetation -- By October 1, seed the disturbed soil with winter rye at a seeding rate of 3 pounds per 1000 square feet, lightly mulch the seeded soil with hay or straw at 75 pounds per 1000 square feet, and anchor the mulch with plastic netting. Monitor growth of the rye over the next 30 days. If the rye fails to grow at least three inches or fails to cover at least 75% of the disturbed soil before November 1, then mulch the area for over-winter protection as described below.

Stabilize the soil with sod -- Stabilize the disturbed soil with properly installed sod by October 1. Proper installation includes pinning the sod onto the soil with wire pins, rolling the sod to guarantee contact between the sod and underlying soil, and watering the sod to promote root growth into the disturbed soil.

Stabilize the soil with mulch -- By November 15, mulch the disturbed soil by spreading hay or straw at a rate of at least 150 pounds per 1000 square feet on the area so that no soil is visible through the mulch. Immediately after applying the mulch, anchor the mulch with plastic netting to prevent wind from moving the mulch off the disturbed soil.

### **MAINTENANCE**

Maintenance measures shall be applied as needed during the entire construction season. After each rainfall, snow storm or period of thawing and runoff, the site contractor shall perform a visual inspection of all installed erosion control measures and perform repairs as needed to insure their continuous function.

Following the temporary and/or final seeding and mulching, the contractor shall, in the spring, inspect and repair any damages and/or bare spots. An established vegetative cover means a minimum of 85 to 90 % of areas vegetated with vigorous growth.

### **STABILIZATION SCHEDULE BEFORE WINTER**

- September 15** All disturbed areas must be seeded and mulched.  
All slopes must be stabilized, seeded and mulched.  
All grass-lined ditches and channels must be stabilized with mulch or an erosion control blanket.
- October 1** If the slope is stabilized with an erosion control blanket and seeded.  
All disturbed areas to be protected with an annual grass must be seeded at a seeding rate of 3 pounds per 1000 square feet and mulched.
- November 15** All stone-lined ditches and channels must be constructed and stabilized.  
Slopes that are covered with riprap must be constructed by that date.

**December 1** All disturbed areas where the growth of vegetation fails to be at least three inches tall or at least 75% of the disturbed soil is covered by vegetation, must be protected for over-winter.

NOTE: The dates given are for projects in South-Central Maine. Adjust the dates given based on the project's location within the state – reducing times up to three weeks for project's in Northern Maine and extending times up to two weeks for project's on the coast in extreme Southern Maine.

**B-1 SEDIMENT BARRIERS****PURPOSE & APPLICATIONS**

A sediment barrier is a temporary barrier installed across or at the toe of a slope. Sediment barriers may consist of filter fence, straw or hay bales, a berm of erosion control mix, or other filter materials. Its purpose is to intercept and retain small amounts of sediment from disturbed or unprotected areas.

The sediment barrier is used where:

- Sedimentation can pollute or degrade adjacent wetland and/or watercourses.
- Sedimentation will reduce the capacity of storm drainage systems or adversely affect adjacent areas.
- The contributing drainage area is less than 1/4 acre per 100 ft of barrier length, the maximum length of slope above the barrier is 100 feet, and the maximum gradient behind the barrier is 50 percent (2:1). If the slope length is greater, other measures such as diversions may be necessary to reduce the slope length.
- Sediment barriers shall not be used in areas of concentrated flows. Under no circumstances should hay bale or erosion control mix barriers be constructed in live streams or in swales where there is the possibility of a washout.

**CONSIDERATIONS**

- Sediment barriers are effective only if installed and maintained properly.
- Silt fencing generally is a better filter than hay bale barriers.
- If there is evidence of end flow on properly installed barriers, extend barriers uphill or consider replacing them with temporary check dams.
- Straw or hay bales should only be used as a temporary barrier for no longer than 60 days.
- Silt fences (synthetic filter) can be used for 60 days or longer depending on ultraviolet stability and manufacturer's recommendations.
- Sediment barriers should be installed prior to any soil disturbance of the contributing drainage area above them.

**SPECIFICATIONS****Filter Fences**

This sediment barrier utilizes synthetic filter fabrics. It is designed for situations in which only sheet or overland flows are expected. Generally pre-manufactured synthetic silt fencing with posts attached is used. See the detail drawing located at the back of this section for the proper installation of silt fences.

- The filter fabric shall be a pervious sheet of propylene, nylon, polyester or ethylene yarn and shall be certified by the manufacturer or supplier.
- The filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 degrees F to 120 degrees F.
- Posts for silt fences shall be either 4-inch diameter wood or 1.33 pounds per linear foot steel with a minimum length of 5 feet. Steel posts shall have projections for fastening wire to them.
- The height of a silt fence should not exceed 36 inches as higher fences may impound volumes of water sufficient to cause failure of the structure.
- The filter fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are necessary, filter cloth shall be spliced together only at support post, with a minimum 6-inch overlap, and securely sealed.
- Post spacing shall not exceed 6 feet.

- A trench shall be excavated approximately 4 inches wide and 4 inches deep along the line of posts and upgradient from the barrier.
- The standard strength of filter fabric shall be stapled or wired to the post, and 8 inches of the fabric shall be extended into the trench. The fabric shall not extend more than 36 inches above the original ground surface. Filter fabric shall not be stapled to existing trees.
- The trench shall be backfilled and the soil compacted over the filter fabric.
- Silt fences shall be removed when they have served their useful purpose, but not before the upslope areas have been permanently stabilized.

### **Straw/Hay Bales**

See the detail drawing located at the back of this section for the proper installation of hay bales.

- Bales shall be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another.
- All bales shall be either wire-bound or string-tied. Bales shall be installed so that bindings are oriented around the sides, parallel to the ground surface to prevent deterioration of the bindings.
- The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches.
- After the bales are staked and chinked, the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be build up to 4 inches against the uphill side of the barrier. Ideally, bales should be placed 10 feet away from the toe of slope.
- At least two stakes or rebars driven through the bale shall securely anchor each bale. The first stake in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or re-bars shall be driven deep enough into the ground to securely anchor the bales.
- The gaps between bales shall be chinked (filled by wedging) with hay to prevent water from escaping between the bales.

### **Problems with Straw or Hay Bale Barriers**

There are three major reasons why straw bale barriers are not as effective as hoped they would be:

- When improperly placed and installed (such as staking the bales directly to the ground with no soil seal or entrenchment), hay bales allow undercutting and end flow.
- Inadequate maintenance.
- Inspection shall be frequent and repair or replacement shall be made promptly as needed. Bale barriers shall be removed when they have served their usefulness, but not before the up-slope areas have been permanently stabilized.

### **Erosion Control Mix Berms**

Erosion control mix can be manufactured on or off the project site. It must consist primarily of organic material, separated at the point of generation, and may include: shredded bark, stump grindings, composted bark, or acceptable manufactured products. Wood and bark chips, ground construction debris or reprocessed wood products will not be acceptable as the organic component of the mix.

#### **Composition**

Erosion control mix shall contain a well-graded mixture of particle sizes and may contain rocks less than 4" in diameter. Erosion control mix must be free of refuse, physical contaminants, and material toxic to plant growth. The mix composition shall meet the following standards:

- The organic matter content shall be between 80 and 100%, dry weight basis.
- Particle size by weight shall be 100 % passing a 6" screen and a minimum of 70 %, maximum of 85%, passing a 0.75" screen.
- The organic portion needs to be fibrous and elongated.
- Large portions of silts, clays or fine sands are not acceptable in the mix.
- Soluble salts content shall be < 4.0 mmhos/cm.

- The pH should fall between 5.0 and 8.0.

#### **Installation**

- The barrier must be placed along a relatively level contour. It may be necessary to cut tall grasses or woody vegetation to avoid creating voids and bridges that would enable fines to wash under the barrier through the grass blades or plant stems.
- On slopes less than 5 % or at the bottom of steeper slopes (<2:1) up to 20 feet long, the barrier must be a *minimum of 12" high*, as measured on the uphill side of the barrier, *and a minimum of two feet wide*. *On longer or steeper slopes*, the barrier should be wider to accommodate the additional runoff.
- Frozen ground, outcrops of bedrock and very rooted forested areas are locations where berms of erosion control mix are most practical and effective.
- Other BMPs should be used at low points of concentrated runoff, below culvert outlet aprons, around catch basins and closed storm systems, and at the bottom of steep perimeter slopes that are more than 50 feet from top to bottom (i.e., a large up gradient contributing watershed).

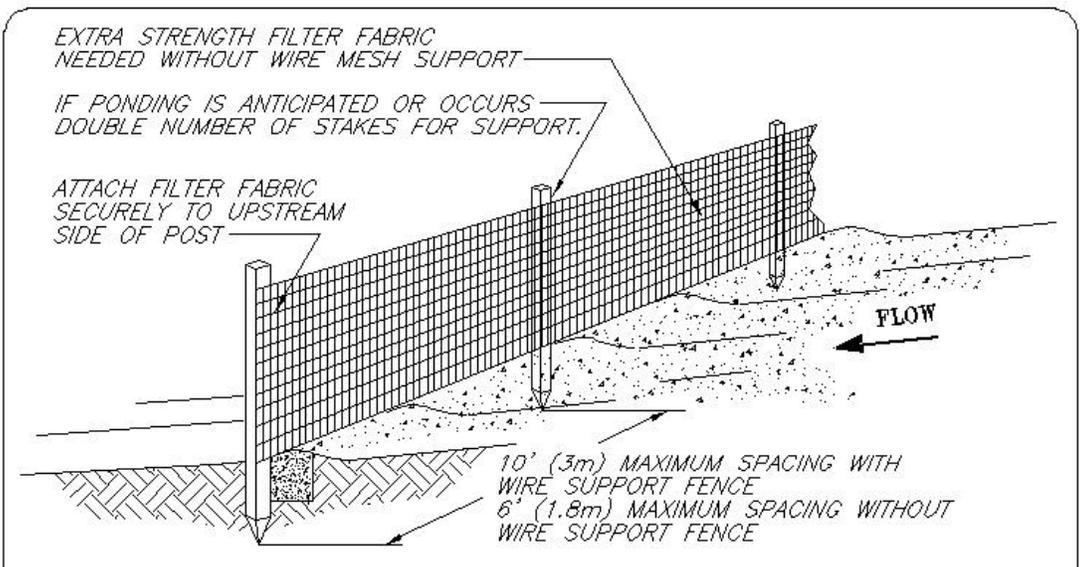
#### **Continuous Contained Berms**

A new product, the filter sock can be an effective sediment barriers as it adds containment and stability to a berm of erosion control mix. The organic mix is placed in the synthetic tubular netting and performs as a sturdy sediment barrier (a vehicle may drive over it without ill effect). It works well in areas where trenching is not feasible such as over frozen ground or over pavement. A continuous contained berm of erosion control mix may be effective when placed in waterways such as ditches and swales or in area of concentrated water flow as the netting prevents the movement and displacement of the organic material. See the detail drawing located at the back of this section for the proper installation of continuous contained berms.

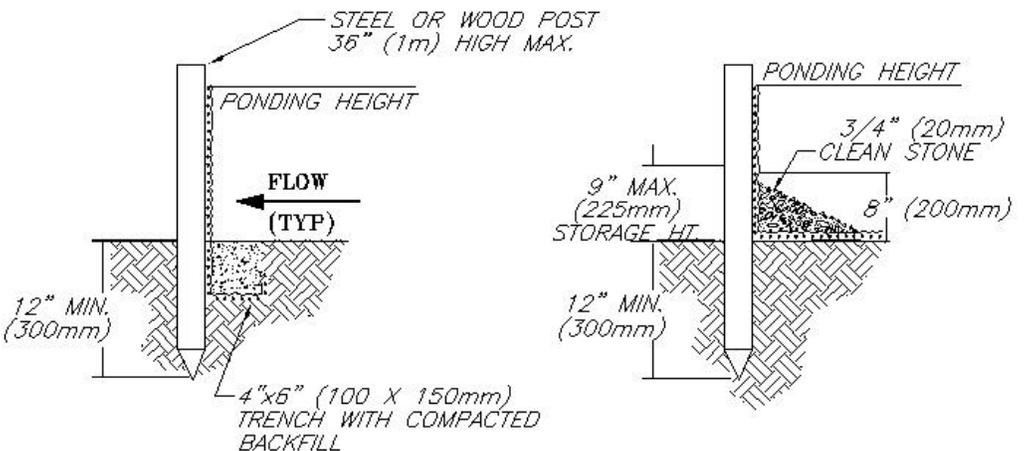
Seeds may be added to the organic filler material and can permanently stabilize a shallow slope. The containment will provide stability while vegetation is rooting through the netting.

#### **MAINTENANCE**

- Hay bale barriers, silt fences and filter berms shall be inspected immediately after each rainfall and at least daily during prolonged rainfall. They shall be repaired immediately if there are any signs of erosion or sedimentation below them. If there are signs of undercutting at the center or the edges of the barrier, or impounding of large volumes of water behind them, sediment barriers shall be replaced with a temporary check dam.
- Should the fabric on a silt fence or filter barrier decompose or become ineffective prior to the end of the expected usable life and the barrier still is necessary, the fabric shall be replaced promptly.
- Sediment deposits should be removed after each storm event. They must be removed when deposits reach approximately one-half the height of the barrier.
- Filter berms should be reshaped as needed.
- Any sediment deposits remaining in place after the silt fence or filter barrier is no longer required should be dressed to conform to the existing grade, prepared and seeded.



NOTE: PRE-FABRICATED SILT FENCE IS ACCEPTABLE IF INSTALLED PER MANUFACTURER.



**TRENCH DETAIL**

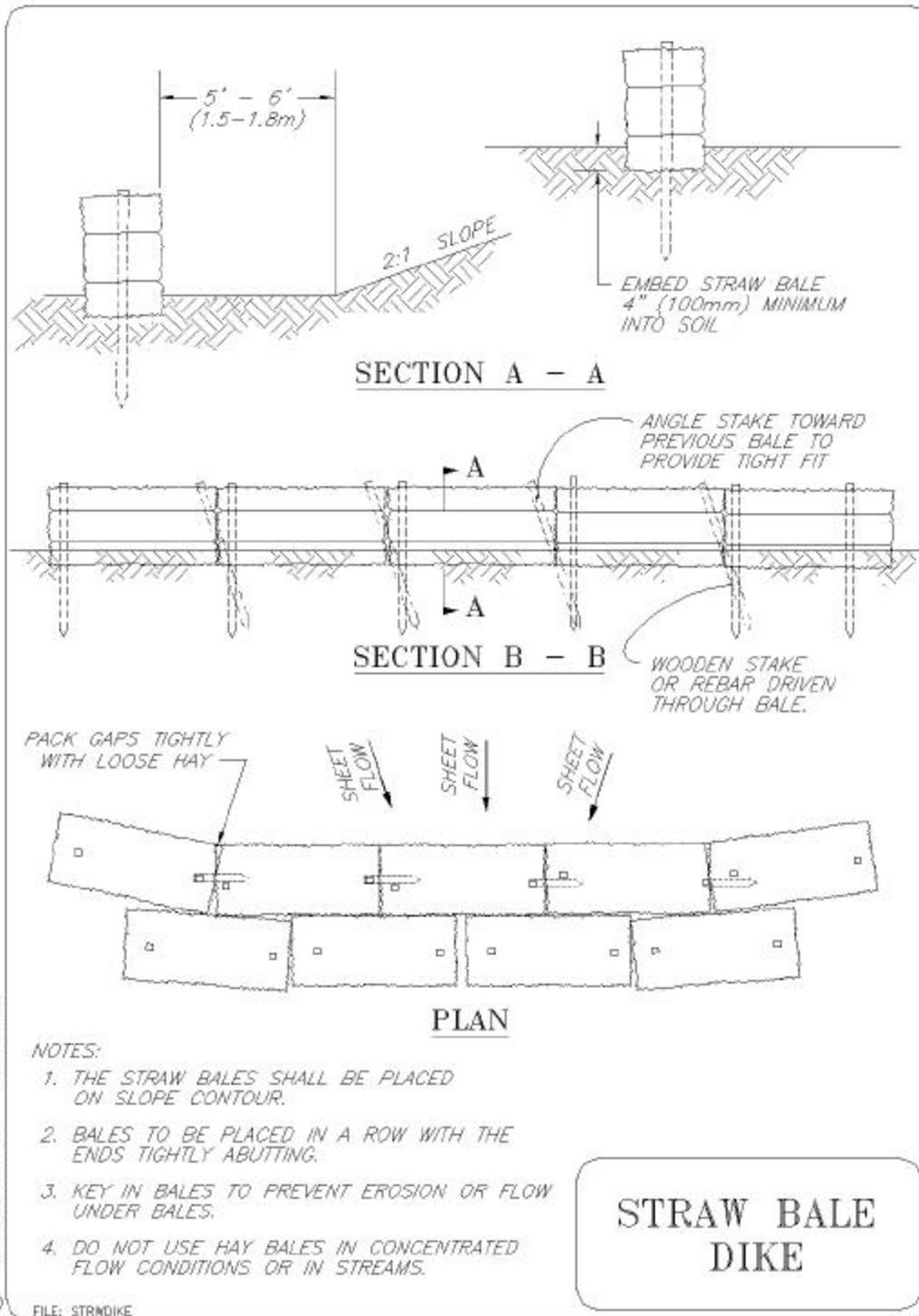
**LEDGE, FROZEN GROUND, HEAVY ROOTS INSTALLATION WITHOUT TRENCHING**

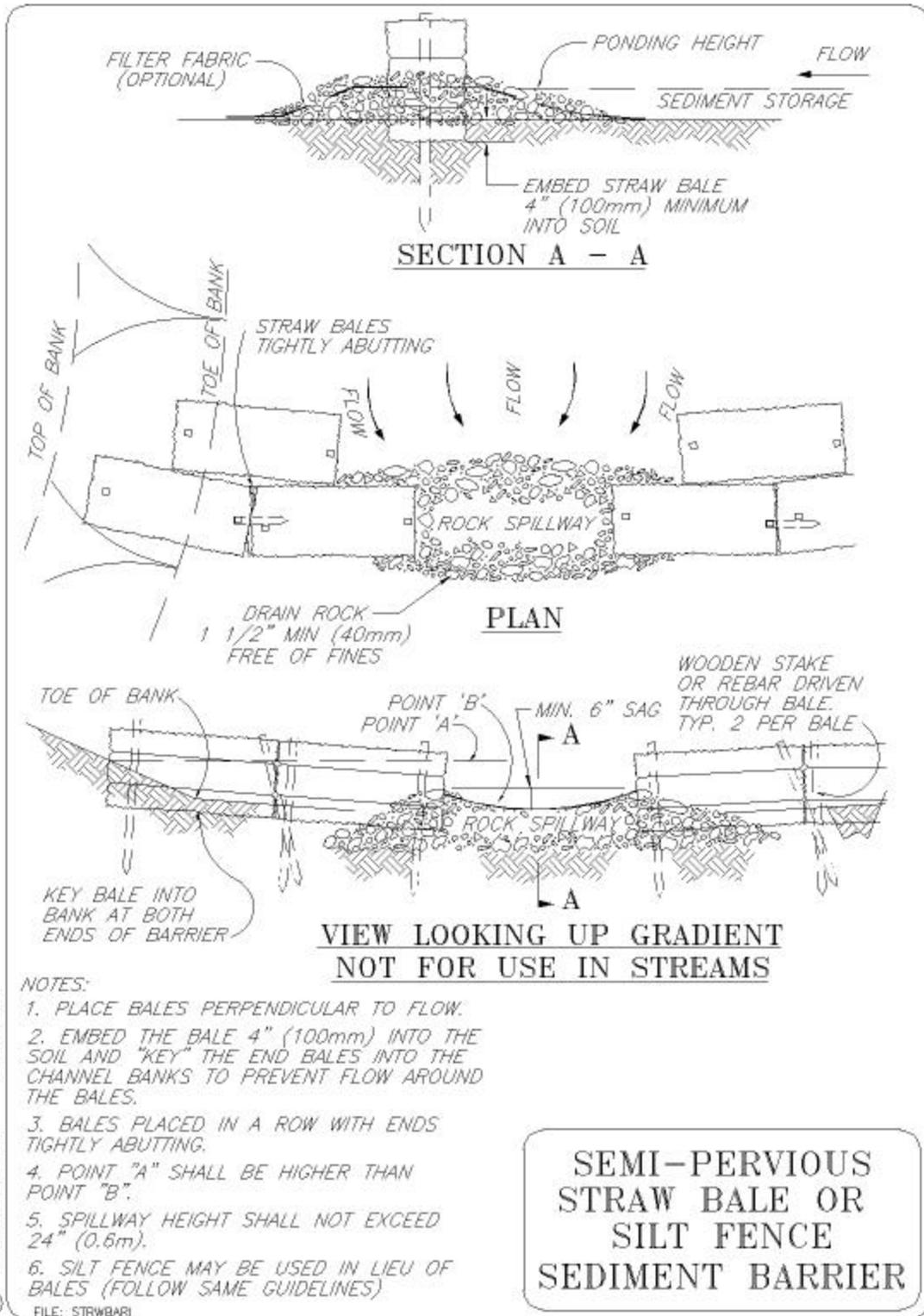
- NOTES:
1. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.
  2. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY. 9" (225mm) MAXIMUM RECOMMENDED STORAGE HEIGHT.
  3. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.
  4. DO NOT PLACE SILT FENCE IN STREAMS OR CONCENTRATED FLOW CONDITIONS.

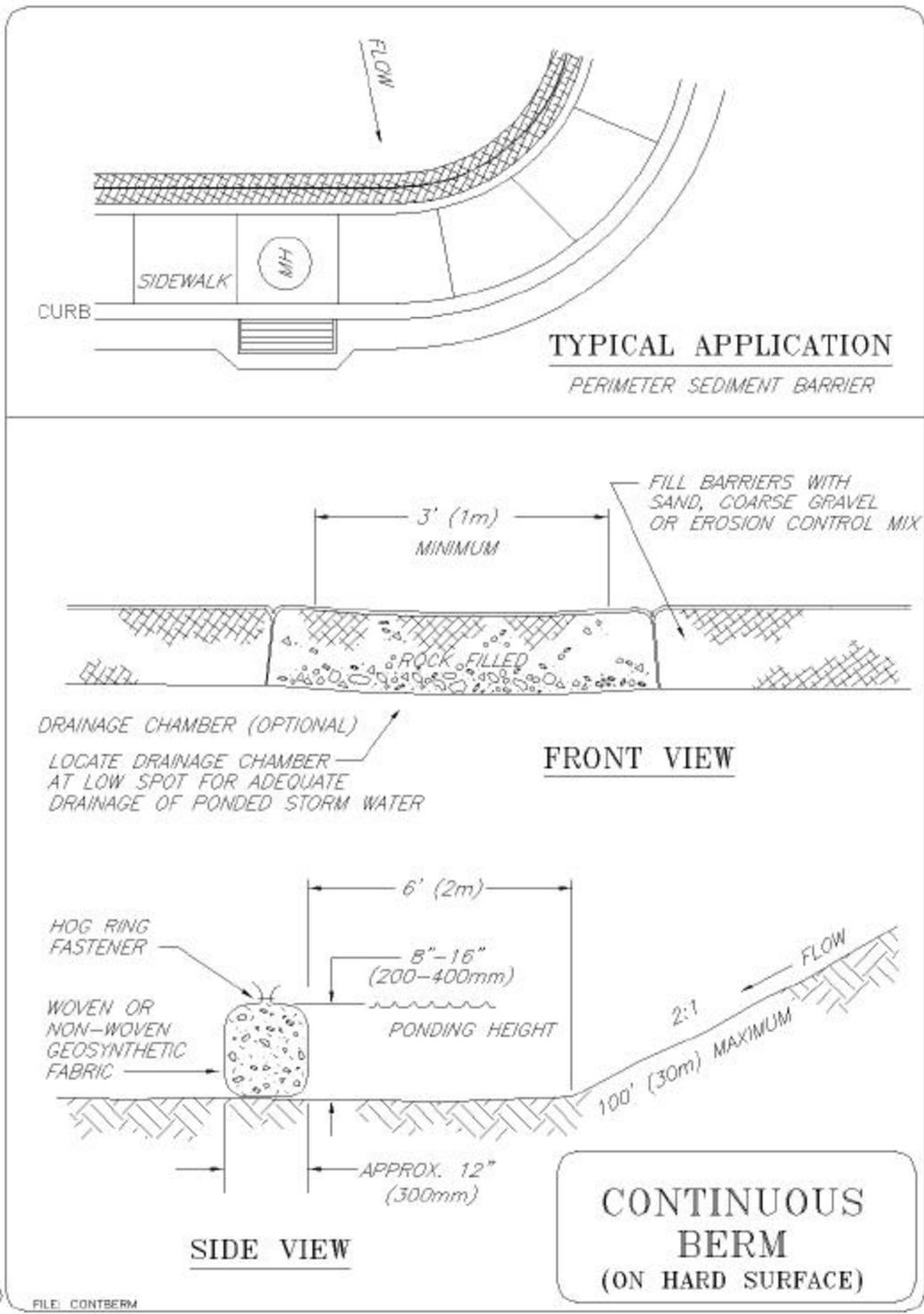
SILT FENCE

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FILE: SILTFENC







**B-2 TEMPORARY CHECK DAMS****PURPOSE & APPLICATIONS**

Temporary check dams are small temporary dams constructed across a swale or drainage ditch. Their purpose is to reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch. This practice also traps small amounts of sediment generated in the ditch itself. However, this is not a sediment trapping practice and should not be used as such. This practice is limited to use in small open channels that drain 10 acres or less. It should **not** be used in a stream, including perennially flowing streams or intermittent stream channels. Check dams can be constructed of either stone, contained berms of erosion control mix.

Some specific applications include:

- Temporary ditches or swales which, because of their short length of service, cannot receive a non-erodible lining, but still need some protection to reduce erosion.
- Permanent ditches or swales which for some reason cannot receive a permanent non-erodible lining for an extended period of time.
- Either temporary or permanent ditches or swales, which need protection during the establishment of grass linings.

**CONSIDERATIONS**

- This practice should be used in areas of concentrated flow.
- Don't install these in a flowing stream or a dry streambed!
- Consider leaving the dam in place permanently to avoid unnecessary disturbance of the soil on removal.
- If it is necessary to remove a stone check dam from a grass-lined channel, which will be mowed, care should be taken to ensure that all stones are removed. This should include any stone which has washed downstream.
- Since hay bales check dams are embedded in the soil, their removal will result in more disturbance of the soil than will removal of stone check dams. Consequently, extra care should be taken to stabilize the area when hay dams are used in permanent ditches or swales.

**SPECIFICATIONS**

The following criteria should be adhered to when specifying check dams.

- The drainage area of the ditch or swale being protected should not exceed 10 acres.
- The maximum height of the check dam should be 2 feet. The center of the check dam must be at least 6 inches lower than the outer edges. The maximum spacing between the dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.
- Check dams should be installed before runoff is directed to the swale or drainage ditch.

**Stone Check Dams**

Stone check dams should be constructed of 2 to 3 inch stone. Hand or mechanical placement will be necessary to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges. See the detail drawing located at the back of this section for the proper installation of stone check dams.

**Straw/Hay Bales**

See the detail drawing located at the back of this section for the proper installation of straw/hay bale check dams.

- Bales shall be placed in a single row, across the swale, tightly abutting one another.

- All bales shall be either wire-bound or string-tied. Bales shall be installed so that bindings are oriented around the sides, parallel to the ground surface to prevent deterioration of the bindings.
- The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches.
- After the bales are staked and chinked, the excavated soil shall be backfilled against the barrier.
- At least two stakes or rebars driven through the bale shall securely anchor each bale. The first stake in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or re-bars shall be driven deep enough into the ground to securely anchor the bales.
- The gaps between bales shall be chinked (filled by wedging) with hay to prevent water from escaping between the bales.

#### **Problems with Hay Bale Barriers**

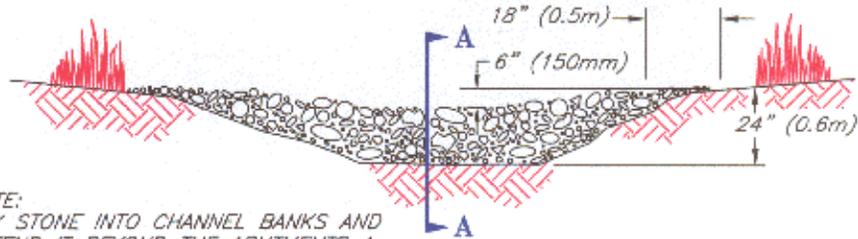
- When used in streams and drainage ways where high water velocities and volumes have destroyed or impaired their effectiveness.
- Improperly placed and installed bales, such as staking directly to the ground with no soil seal or entrenchment, allows undercutting and end flow.
- Inadequate maintenance.

### ***MAINTENANCE***

Regular inspections must be made to ensure that the center of the dam is lower than the edges. Erosion caused by high flows around the edges of the dam must be corrected immediately. If evidence of siltation in the water is apparent downstream from the check dam, the check dam must be inspected and adjusted immediately.

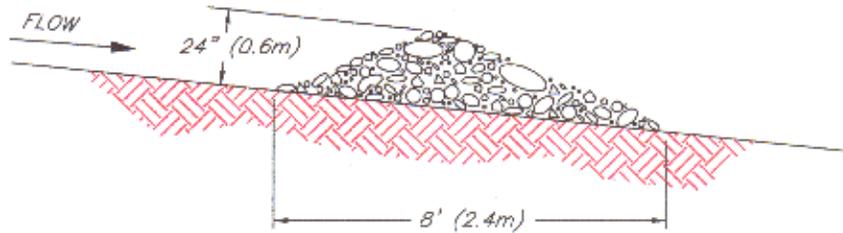
Check dams must be checked for sediment accumulation after each significant rainfall. Sediment must be removed when it reaches one half of the original height or before.

If it is possible, leave the dam in place permanently. Another option is to spread the material, i.e. stone or hay along the ditch invert to provide additional protection. In temporary ditches and swales, check dams must be removed and the ditch filled in when it is no longer needed. In permanent structures, check dams can be removed when a permanent lining has been established. If a check dam must be removed from a grass lined ditch, wait until the grass has matured to protect the ditch or swale. The area beneath the check dam must be seeded and mulched immediately after they are removed.



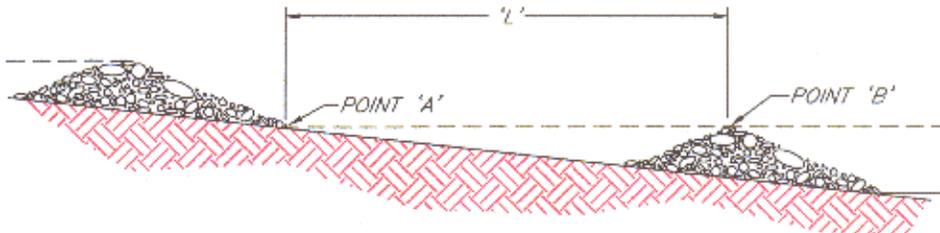
NOTE:  
KEY STONE INTO CHANNEL BANKS AND  
EXTEND IT BEYOND THE ABUTMENTS A  
MINIMUM OF 18" (0.5m) TO PREVENT  
FLOW AROUND DAM.

**VIEW LOOKING UPSTREAM**



**SECTION A - A**

'L' = THE DISTANCE SUCH THAT POINTS 'A' AND  
'B' ARE OF EQUAL ELEVATION.

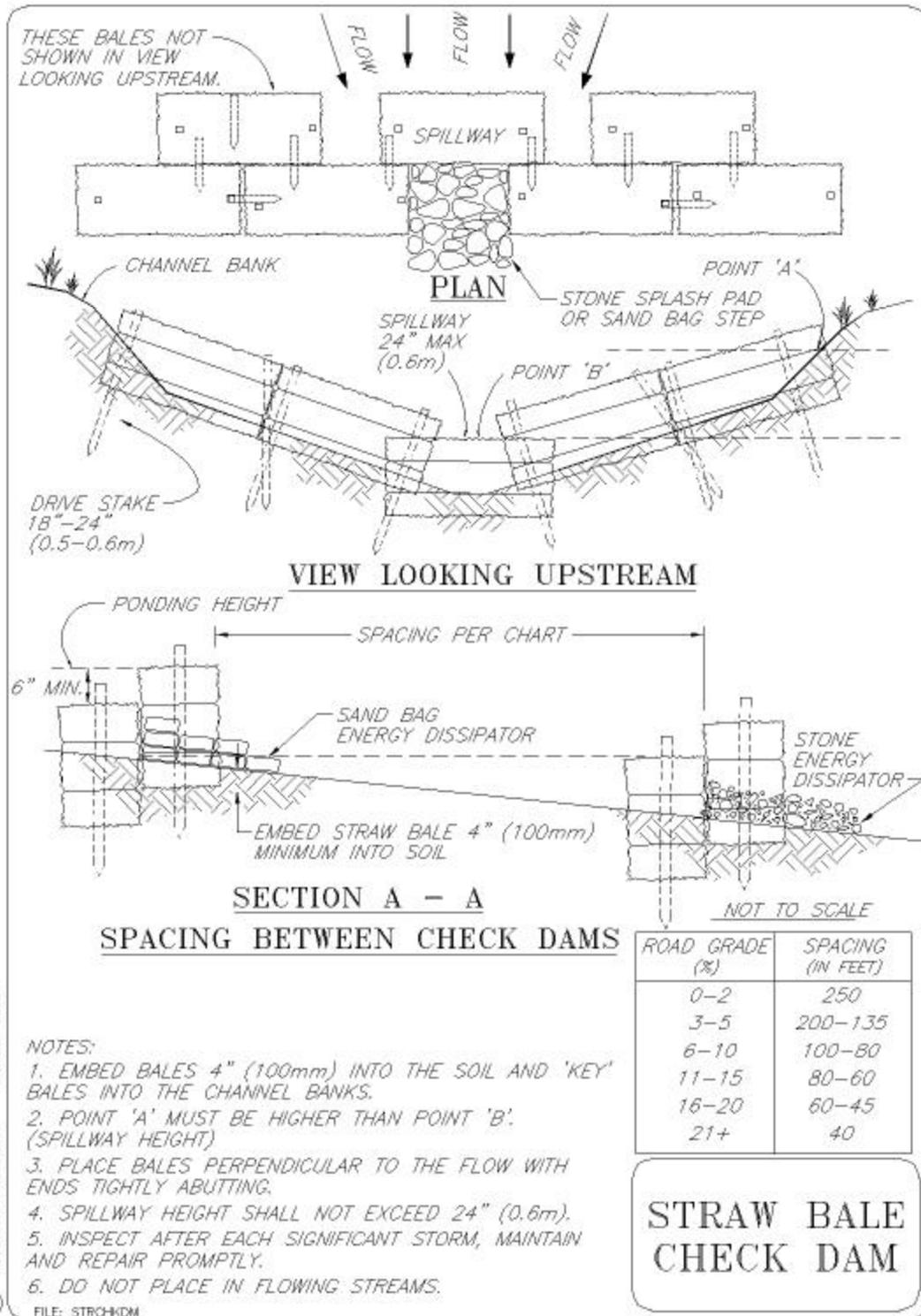


**SPACING BETWEEN CHECK DAMS**

NOT TO SCALE

**ROCK  
CHECK DAM**

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FILE: RCKCHKDM



**B-3 STORMDRAIN INLET PROTECTION*****PURPOSE & APPLICATIONS***

A storm drain inlet protection is a sediment filter installed around a storm drain drop inlet or curb inlet to reduce sediment discharge. The purpose of storm drain inlet protection is to prevent sediment from entering a storm drainage system prior to permanent stabilization of the disturbed area. Stormdrains made operational before their drainage area is stabilized can convey large amounts of sediment to storm sewer systems or natural drainage ways and in extreme cases, the storm sewer itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

***CONSIDERATIONS***

- This practice applies mainly to enclosed drainage systems.
- If these systems outlet to a stream, water quality must be protected.
- This practice contains several types of inlet filters and traps which have different applications dependent upon site conditions and the type of inlet. Other innovative techniques for accomplishing the same purpose are encouraged, but they should be installed only after careful study of their effectiveness.
- Note that these various inlet protection devices are for drainage areas of **less than one acre**. Runoff from large disturbed areas should be routed through a sediment trap or sediment basin.
- The best way to prevent sediment from entering the storm sewer system is to stabilize the site as quickly as possible, preventing erosion and stopping sediment at its source.

***SPECIFICATIONS*****Design Criteria**

- The drainage area shall be no greater than 1 acre.
- The inlet protection device shall be constructed in a manner that will facilitate clean-out and disposal of trapped sediments and minimize interference with construction activities.
- Any resultant ponding of stormwater must not cause excessive inconvenience or damage to adjacent areas or structures.

**Hay Bale Drop Inlet Structure**

See the detail drawing located at the back of this section for the proper installation of hay bale sediment barrier.

- Hay Bales shall be as specified in the SEDIMENT BARRIER BMP
- Bales shall be string-tied with the bindings oriented around the sides rather than over and under the bales.
- Bales shall be placed lengthwise in a single row surrounding the inlet, with the ends of adjacent bales pressed together.
- The filter barrier shall be entrenched and backfilled. A trench shall be excavated around the inlet the width of a bale to a minimum depth of 4 inches. After the bales are staked, the excavated soil shall be backfilled and compacted against the filter barrier.
- Each bale shall be securely anchored and held in place by at least two stakes or rebars driven through the bale.
- Loose straw shall be wedged between bales to prevent water from entering between bales.

### **Silt Fence Drop Inlet Sediment Filter**

See the detail drawing located at the back of this section for the proper installation of silt fence sediment barrier.

- Silt fence shall be as specified in the SEDIMENT BARRIER BMP and shall be cut from a continuous roll to avoid joints.
- Stakes shall be spaced around the perimeter of the inlet a maximum of 3 feet apart and securely driven into the ground (minimum of 8 inches).
- A trench shall be excavated approximately 4 inches wide and 4 inches deep around the outside perimeter of the stakes and 8 inches of the fabric shall be extended into the trench.
- The height of the filter barrier shall be a minimum of 15 inches and shall not exceed 18 inches.
- The trench shall be backfilled and the soil compacted over the fabric.

### **Gravel and Wire Mesh Drop Inlet Sediment Filter**

This filtering device has no overflow mechanism; therefore, ponding is likely especially if sediment is not removed regularly. This type of device must never be used where overflow may endanger an exposed fill slope. Consideration should also be given to the possible effects of ponding on traffic movement, nearby structures, working areas, adjacent property, etc. See the detail drawing located at the back of this section for the proper installation of block and gravel sediment barrier.

#### With Gravel

- Wire mesh shall be laid over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. Hardware cloth or comparable wire mesh with 1/2-inch openings shall be used. If more than one strip of mesh is necessary, the strips shall be overlapped.
- Stone for French drains shall be placed over the wire mesh as indicated on Figure 16.3. The depth of stone shall be at least 12 inches over the entire inlet opening. The stone shall extend beyond the inlet opening at least 18 inches on all sides. Stone gradation shall be well graded with the maximum stone size of 6 inches and a minimum stone size of 1 inch.
- If the stone filter becomes clogged with sediment so that it no longer adequately performs its function, the stones must be pulled away from the inlet, cleaned and replaced.

#### With Concrete Blocks and Gravel

- Place concrete blocks lengthwise on their side in a single row around the perimeter of the inlet, with the ends of adjacent blocks abutting. The height of the barrier can be varied, depending on design needs, by stacking combinations of 4-inch, 8-inch and 12-inch wide blocks. The barrier of blocks shall be at least 12 inches high and no greater than 24 inches high.
- Wire mesh shall be placed over the outside vertical face (webbing) of the concrete blocks to prevent stone from being washed through the holes in the blocks. Hardware cloth or comparable wire mesh with 1/2-inch openings shall be used.
- Stone shall be piled against the wire to the top of the block barrier. Stone gradation shall be well graded with the maximum stone size of 6 inches and minimum stone size of 1 inch.
- If the stone filter becomes clogged with sediment so that it no longer adequately performs its function, the stone must be pulled away from the blocks, cleaned and replaced.

### **Curb Inlet Sediment Filter**

#### With Gravel

- Hardware cloth or comparable wire mesh with 1/2-inch openings shall be placed over the curb inlet opening so that at least 12 inches of wire extends across the inlet cover and at least 12 inches of wire extends across the concrete gutter from the inlet opening.
- Stone shall be piled against the wire so as to anchor it against the gutter and inlet cover and to cover the inlet opening completely. Maine Department of Transportation stone for French drains shall be used.
- If the stone filter becomes clogged with sediment so that it no longer adequately performs its function, the stone must be pulled away from the block, cleaned and replaced.

#### With Concrete Blocks and Gravel

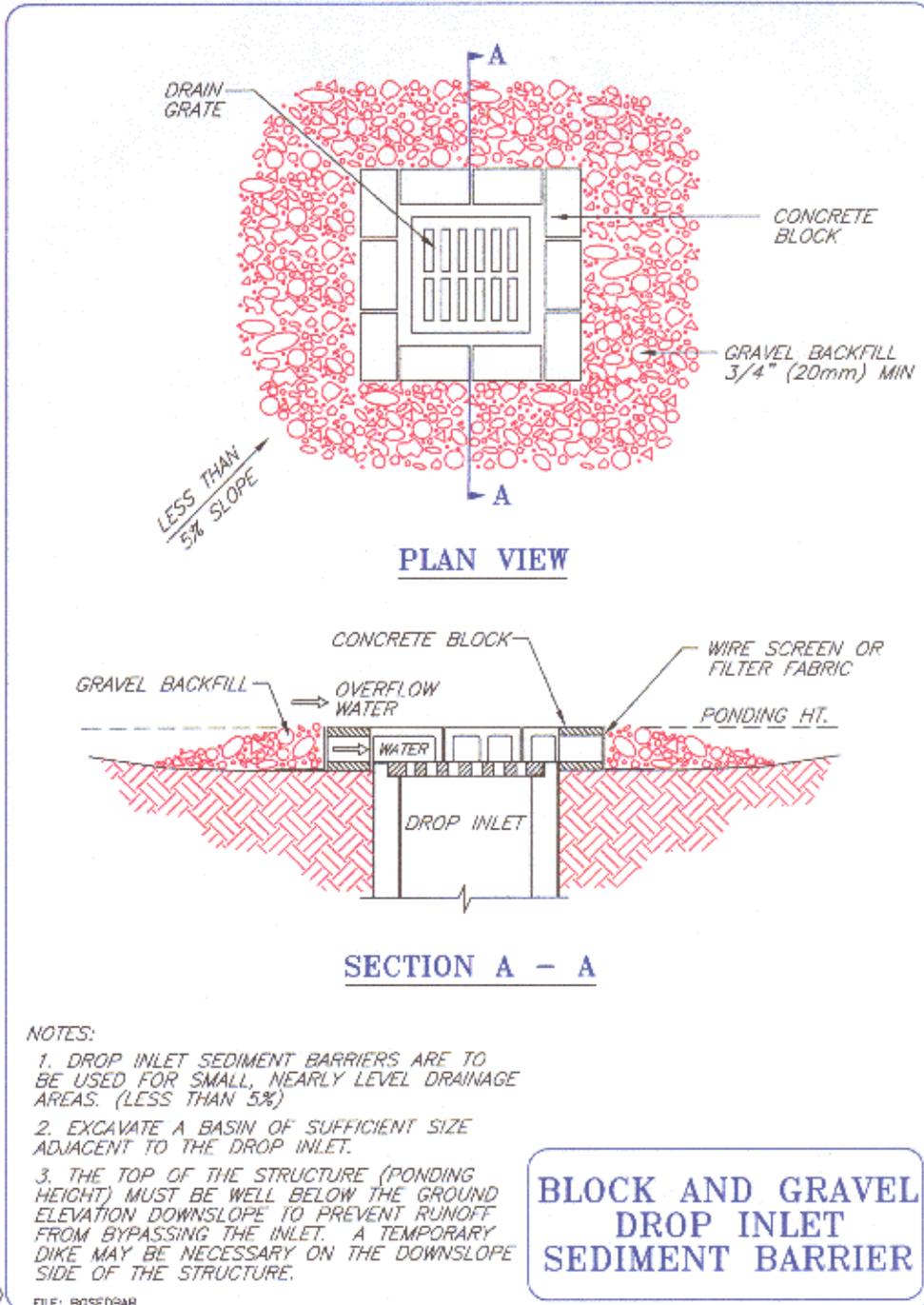
- Two concrete blocks shall be placed on their sides abutting the curb at either side of the inlet opening.
- A 2-inch by 4-inch stud shall be cut and placed through the outer holes of each spacer block to help keep the front blocks in place.
- Concrete blocks shall be placed on their sides across the front of the inlet and abutting the spacer blocks.
- Wire mesh shall be placed over the outside vertical face (webbing) of the concrete blocks to prevent stone from being washed through the holes in the blocks. Chicken wire or hardware cloth with 1/2-inch openings shall be used.
- Maine Department of Transportation stone for French drains shall be piled against the wire to the top of the barrier.
- If the stone filter becomes clogged with sediment so that it no longer adequately performs its function, the stone must be pulled away from the blocks, cleaned and replaced.

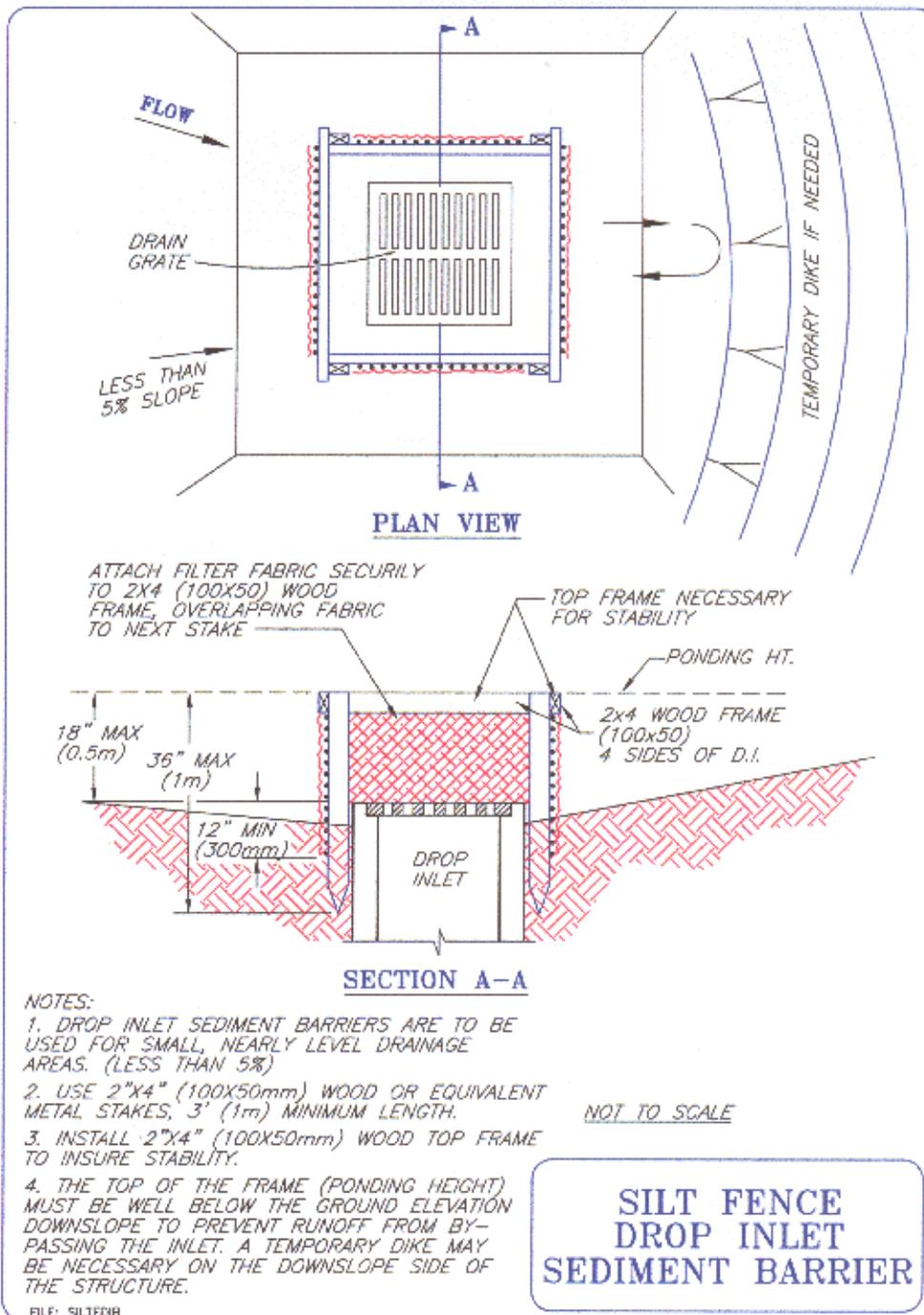
#### **Manufactured Sediment barriers and filters**

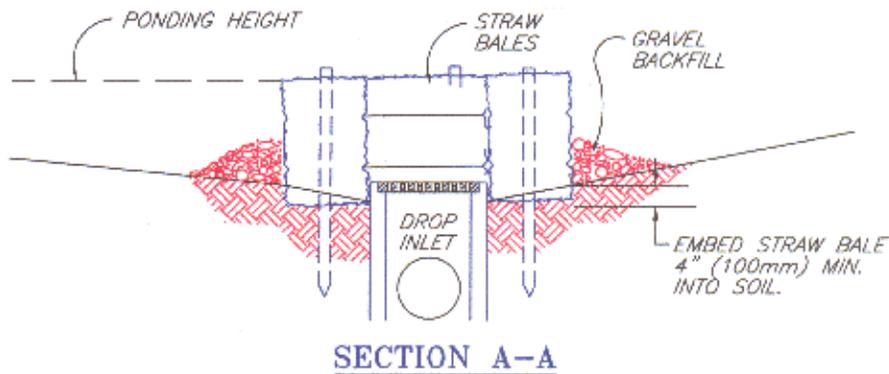
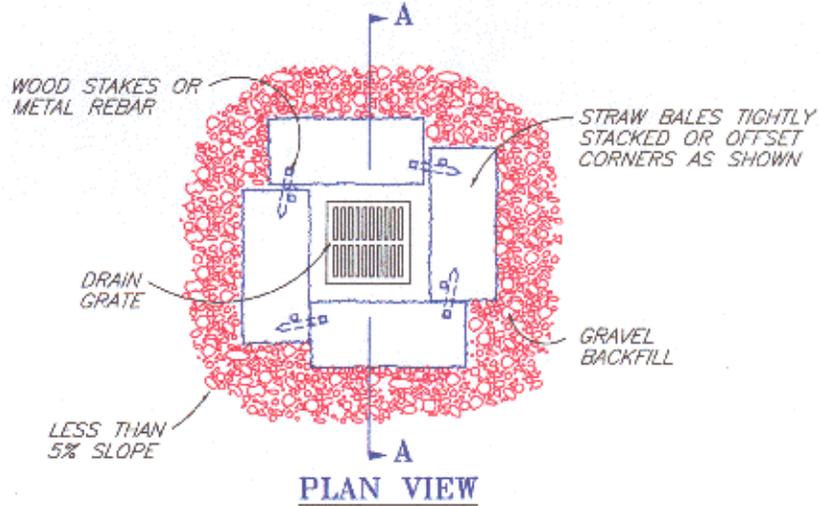
There are now various types of off-the-shelf systems with the function to detain stormwater and collect sediments such as the silt sock or other manufactured materials. These measures are acceptable as long as they are installed, used and maintained as specified by the vendor or manufacturer.

#### ***MAINTENANCE***

- The structure shall be inspected before and after each rain event and repaired as needed.
- Sediment shall be removed and the stormdrain sediment barrier restored to its original dimensions when the sediment has accumulated to 1/2 the design depth of the trap. Removed sediment shall be deposited in a suitable area and in such a manner that it will not erode.
- Structures shall be removed and the area stabilized when the remaining drainage area has been properly stabilized.
- All catchbasins and stormdrain inlet must be cleaned at the end of construction and after the site has been fully stabilized.





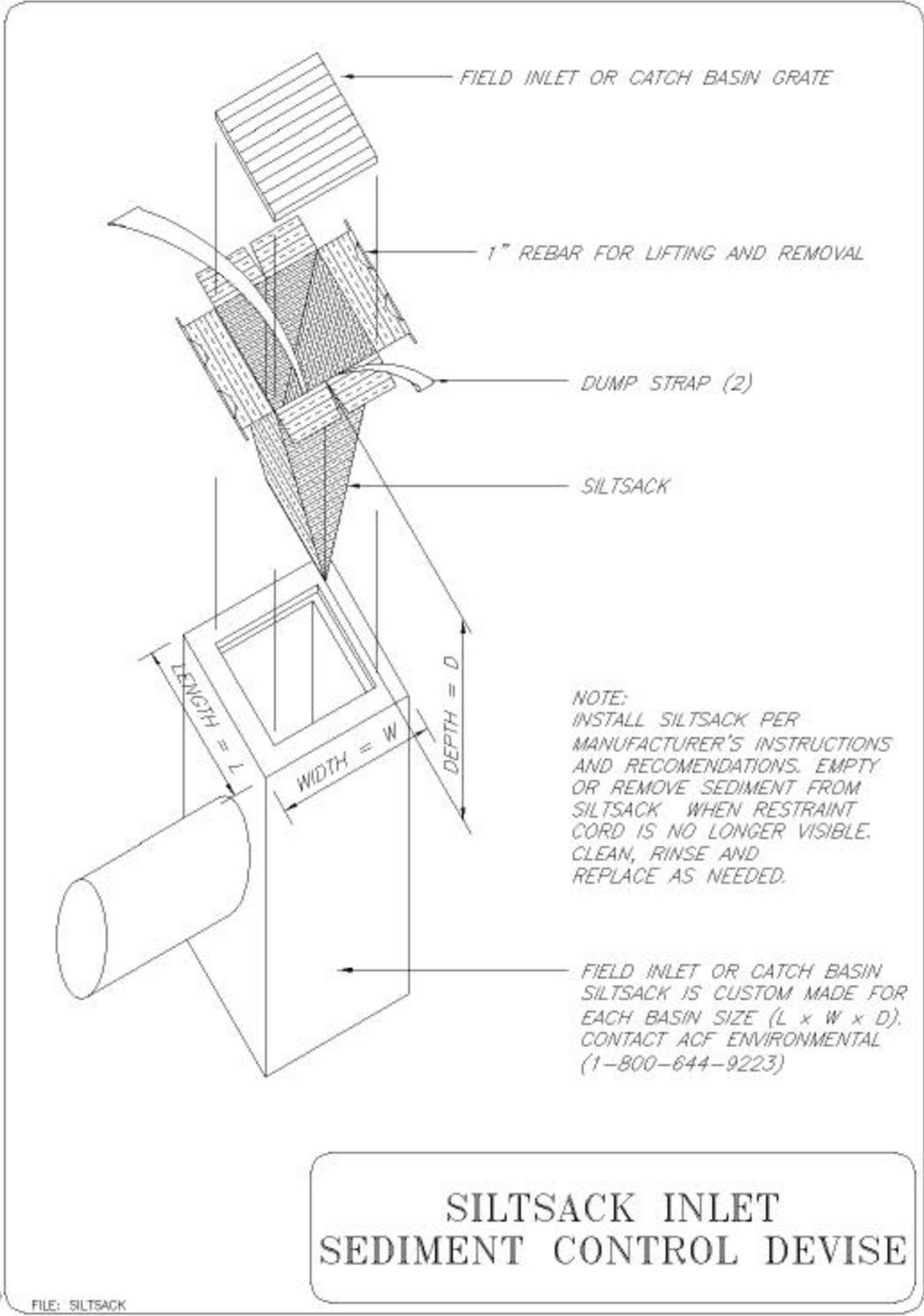


**NOTES:**

1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)
2. EMBED THE BALES 4" (100mm) INTO THE SOIL AND OFFSET CORNERS OR PLACE BALES WITH ENDS TIGHTLY ABUTING. GRAVEL BACKFILL WILL PREVENT EROSION OR FLOW AROUND THE BALES.
3. THE TOP OF THE STRUCTURE (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BYPASSING THE INLET. EXCAVATION OF A BASIN ADJACENT TO THE DROP INLET OR A TEMPORARY DIKE ON THE DOWNSLOPE OF THE STRUCTURE MAY BE NECESSARY.

**STRAW BALE/GRAVEL  
DROP INLET  
SEDIMENT BARRIER**

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FILE: STRWGRVB



ME DEP 2003

FILE: SILTSACK

**B-4 STABILIZED CONSTRUCTION EXIT****PURPOSE & APPLICATIONS**

A stabilized construction entrance or exit is a stabilized pad of aggregate underlain with filter cloth located at any point where traffic will be leaving a construction site to a public right-of-way, street, alley, sidewalk or parking area. Its purpose is to reduce or eliminate the tracking of sediment onto public roads by motor vehicles. This will protect water quality in areas where public roads drain to surface waters. This BMP is applicable wherever traffic will be leaving a construction site and moving directly onto a public road or other paved area.

It applies to areas where water quality is an issue and stormwater runoff from public roadways is considered an important source of non-point source pollution in the watershed. Finally, mud deposited on public roadways eventually becomes maintenance cost to the municipal public works department increasing the expense of catch basin, ditch and culvert clean-out.

**CONSIDERATIONS**

Only construction traffic *leaving* the site should be directed over the temporary stabilized exit. Consider providing a separate, unprotected, entrance for traffic entering the site. This will increase the longevity of the stabilized exit by eliminating heavy loads entering the site and reducing the total traffic by half.

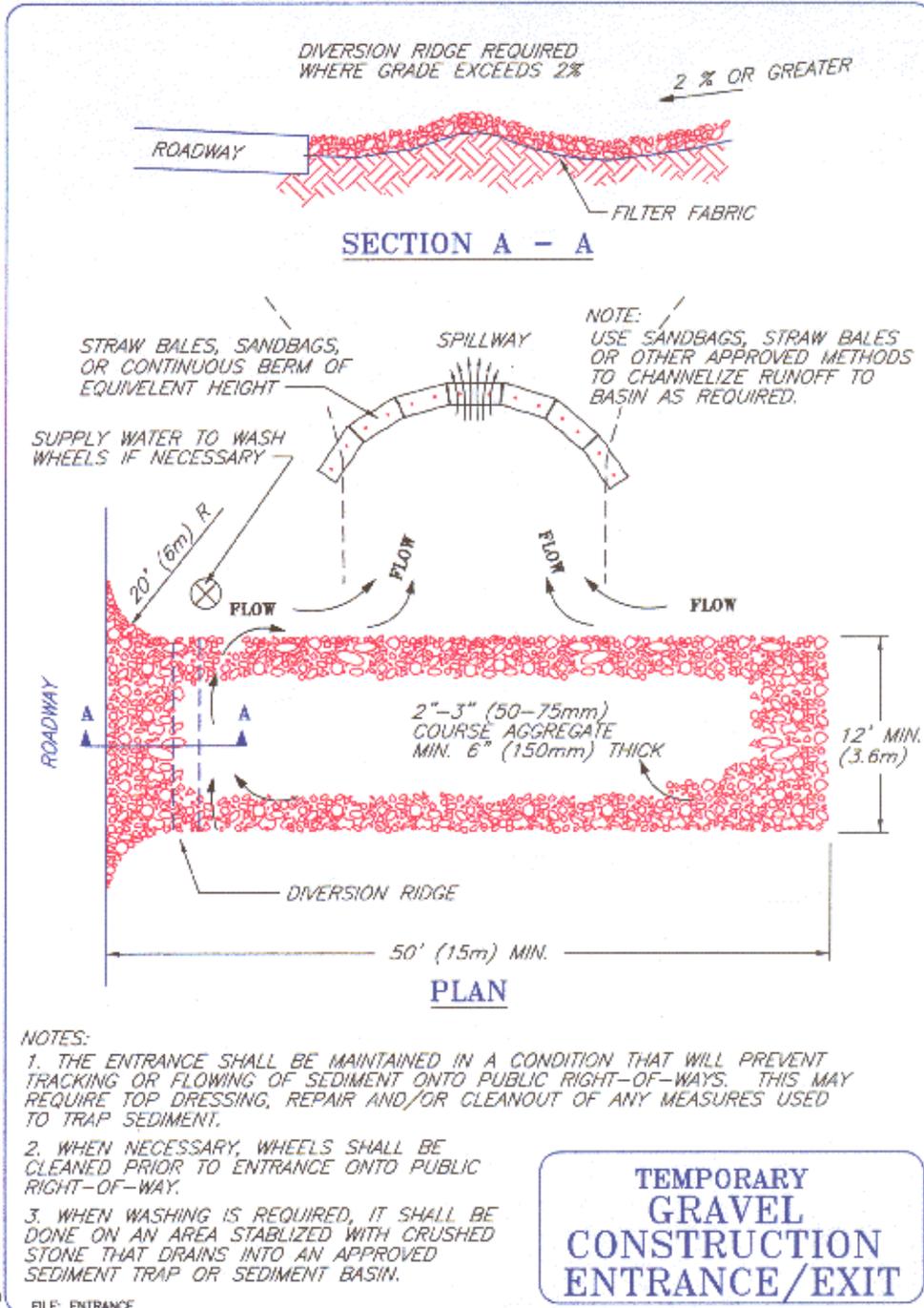
**SPECIFICATIONS**

See the detail drawing located at the back of this section for the proper installation of construction exit. It should include:

- **Aggregate Size:** Use 2-3 inch stone, or reclaimed or recycled concrete equivalent.
- **Aggregate thickness:** Not less than six (6) inches.
- **Width:** 10-foot minimum, but not less than the full width of points where ingress or egress occurs.
- **Length:** As required, but not less than 50 feet (except on a single residence lot where a 30 foot minimum would apply).
- **Geotextile:** To be placed over the entire area to be covered with aggregate. Piping of surface water under entrance shall be provided as required. If piping is impossible, a mountable berm with 5:1 slopes will be permitted.
- **Criteria for Geotextile:** The filter cloth shall be woven or non-woven fabric. The fabric shall be inert to commonly encountered chemicals, hydro-carbons, mildew, rot resistant, and conform to the fabric properties as shown:

**MAINTENANCE**

The exit shall be maintained in a condition that will prevent tracking of sediment onto public rights-of-way. When the control pad becomes ineffective, the stone shall be removed along with the collected soil material and redistributed on site in a stable manner. The entrance should then be reconstructed. The contractor shall sweep or wash pavement at exits, which have experienced mud-tracking on to the pavement or traveled way. When washing is required, it shall be done on an area stabilized with aggregate, which drains into an approved sediment trapping device. All sediment shall be prevented from entering storm drains, ditches, or waterways.



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**B-5 DUST CONTROL****PURPOSE & APPLICATIONS**

Dusty conditions occur when a disturbed site or road surface has dried out. Soil fines can actually shrink due to moisture loss which, in turn, loosens and weakens the soil surface. It is necessary to prevent the blowing and movement of dust from exposed soil surfaces, and reduce the presence of dust. Dust can cause off-site damage, be a health hazard to humans, wildlife and plant life, or become a traffic safety hazard. This practice is applicable to areas subject to dust blowing and soil movement where on-site and off-site damage is likely to occur if preventive measures are not taken. Water or calcium chloride can help to control dusting by preserving the moisture level in the road surface materials.

- A gravel road surface may lose one half inch of material per year resulting in a significant cost.
- This material which is mostly fine soils is essential in maintaining the integrity of a gravel road surface. Soil fines are the binders that hold the road surface material in a tight, hard mass and the fewer the fines, the looser the gravel, which adversely affects traction and can result in washboarding.

**CONSIDERATIONS**

- Use traffic control to restrict traffic to predetermined routes.
- Maintain as much natural vegetation as is practicable.
- Use phasing of construction to reduce the area of land disturbed at any one time.
- The use of temporary mulching, permanent mulching, temporary vegetative cover, permanent vegetative cover, or sodding will reduce the need for dust control.
- Use mechanical sweepers on paved surfaces where necessary to prevent dust buildup. Stationary sources of dust, i.e., rock crushers, should utilize fine water sprays to control dust.

**SPECIFICATIONS**

**Water:** The exposed soil surface should be moistened periodically with adequate water to control dust.

**Calcium Chloride:** A commercial chemical product that is either loose dry granules or flakes and to be used only when other methods are not practical. The flakes are fine enough to feed through a spreader at a rate that will keep the surface moist but not cause pollution or plant damage.

Liquid applications are more cost-effective on larger sites and the application rate will vary, depending on the relative quality of materials in a given road surface. Some calcium chloride suppliers may require a road sample before recommending an application rate. Generally, 30% calcium chloride is recommended for most gravel roads.

**Stone:** Cover surface with crushed stone or coarse gravel. In areas adjacent to waterways, use only chemically stable aggregate.

**Other Products:** There are now other products that are available to stabilize roads. These have not been tested in the state however; the DEP would entertain their use. However, it is the contractor's ultimate responsibility to mitigate dust and soil loss.

**MAINTENANCE**

When temporary dust control measure are used, repetitive treatment shall be applied as needed to accomplish control.

**C-1 LAND GRADING AND SLOPE PROTECTION****PURPOSE & APPLICATIONS**

Land grading and slope protection is the shaping of the existing land surface in accordance with a plan as determined by engineering survey and layout. Its purpose is to provide for erosion control and vegetative establishment on those areas where the existing land surface is to be reshaped by grading. Land grading is generally not recommended in areas with an existing intact forest floor and/or native vegetation.

**CONSIDERATIONS**

- Land grading is a major source of sedimentation and must be carefully planned and carried out.
- The use of phasing, natural buffers, mulching, and temporary and permanent seeding should be the primary methods of addressing erosion control for land grading projects.
- Fall and winter erosion control measures must be upgraded and refined to protect the site from spring runoff and snowmelt.

**Plan the project to fit the site.**

Inventory the site and evaluate its strengths and weaknesses. Tailor the lay-out of buildings, roads and utilities to the topography of the site. Follow these general guidelines:

- Restrict construction activities to the least critical areas on the site.
- Protect and maximize existing native vegetation and natural forest floor, thereby reducing impervious areas on the site.
- Disperse stormwater to areas or undisturbed forest floor wherever possible, rather than concentrate it into channels.
- Align roadways following natural contours rather than up and down steep slopes.
- Cluster buildings to minimize the amount of earth movement needed.
- Divert clean water away from the immediate construction area to reduce the threat of erosion.

**Minimize the area of exposed soil exposed at one time.**

- Sequence construction of a project. Don't open up the whole site at one time. Build in phases.
- Preserve natural vegetation by flagging it and protecting it in the field.
- Create buffer strips of undisturbed vegetation between construction areas and environmentally vulnerable areas such as watercourses, ponds and wetlands.
- Lay down temporary mulching on any exposed soil until final grade is reached.
- Immediately re-seed areas ready for revegetation.
- If construction extends into the fall and winter months, upgrade all erosion control measures to protect the site from spring runoff.

**SPECIFICATIONS****Grading Plan Design Specifications**

The plan must show existing and proposed contours of the area(s) to be graded. The plan shall also include practices for erosion control, slope stabilization, safe disposal of runoff water and drainage, such as waterways, lined ditches, reverse slope benches (include grade and cross section), grade stabilization structures, retaining walls, and surface and subsurface drains. The plan shall also include phasing of these practices. See the detail drawings located at the back of this section for proper land grading. The following shall be incorporated into the plan:

- Provisions shall be made to safely conduct surface runoff to storm drains, protected outlets or to stable water courses to ensure that surface runoff will not damage slopes or other graded areas (See VEGETATED WATERWAY BMP and WATER DIVERSION BMP).
- Cut and fill slopes that are to be stabilized with grass shall not be steeper than 2:1. Where the slope is to be mowed, the slope should be no steeper than 3:1 (4:1 is preferred because of

safety factors related to mowing steep slopes). Slopes exceeding 2:1 shall require special design and stabilization considerations that shall be adequately shown on the plans.

- Reverse slope benches or diversions shall be provided whenever the vertical interval (height) of any 2:1 slope exceeds 20 feet; for 3:1 slope it shall be increased to 30 feet and for 4:1 to 40 feet. Benches shall be located to divide the slope face as equally as possible and shall convey the water to a stable outlet. Soils, seeps, rock outcrops, etc. shall also be taken into consideration when designing benches.
- Benches shall be a minimum of 5 to 6 feet wide to provide for ease of maintenance.
  - Benches shall be designed with a reverse slope of 6:1 or flatter to the toe of the upper slope and with a minimum of one foot in depth. The bench gradient to the outlet shall be between 2 percent and 3 percent, unless accompanied by appropriate design and computations.
  - The flow length within a bench shall not exceed 800 feet (See WATER DIVERSION BMP).
- Surface water shall be diverted from the face of all cut and/or fill slopes by the use of diversions, ditches and swales or conveyed downslope by the use of a designed structure, except where:
  - The face of the slope is or shall be stabilized and the face of all graded slopes shall be protected from surface runoff until they are stabilized.
  - The face of the slope shall not be subject to any concentrated flows of surface water such as from natural drainage ways, graded swales, downspouts, etc.
  - Vegetation, gravel, riprap or other stabilization method must protect the face of the slope.
- South facing slopes of cuts and fills in silty and clayey soils are especially prone to shallow sloughing during the spring day/night freeze/thaw cycles. This shallow or deep sloughing may also be due to seepage not removed by subsurface drainage.
- On slopes with shallow sloughing, the soil should be removed to the depth of the slough or one and one half foot, whichever is greater, and filled with 6 inches of bank run gravel covered with one foot of field stone with an average size of at least 3 inches. Properly sized geotextile may be substituted for the gravel if desired. This stone should extend down the slope to a source of drainage, either a berm or a subsurface tile system.
- Cut slopes occurring in ripable rock may be serrated. See the detail drawings located at the back of this section for proper slope stepping. These serrations shall be made with conventional equipment as the excavation is made. Each step or serration shall be constructed on the contour and will have steps cut at two-foot intervals with nominal three-foot horizontal shelves. These steps will vary depending on the slope ratio or the cut slope. The nominal slope line shall be 1.5:1. These steps will weather and act to hold moisture, lime, fertilizer and seed thus producing a much quicker and longer lived vegetative cover and better slope stabilization. Overland flow shall be diverted from the top of all serrated cut slopes and carried to a suitable outlet.
- Subsurface drainage shall be provided where necessary to intercept seepage that would otherwise adversely affect slope stability or create excessively wet site conditions.
- Slopes shall not be created so close to property lines as to endanger adjoining properties without adequate protection against sedimentation, erosion, slippage, settlement, subsidence or other related damages.
- Stockpiles, borrow areas and spoil shall be shown on the plans and shall be subject to the provisions of this BMP.
- All disturbed areas shall be stabilized structurally or with vegetation in compliance with the appropriate BMPs.

### **Construction Specifications**

- All graded or disturbed areas including slopes shall be protected during clearing and construction in accordance with the approved erosion and sediment control plan until they are adequately stabilized.

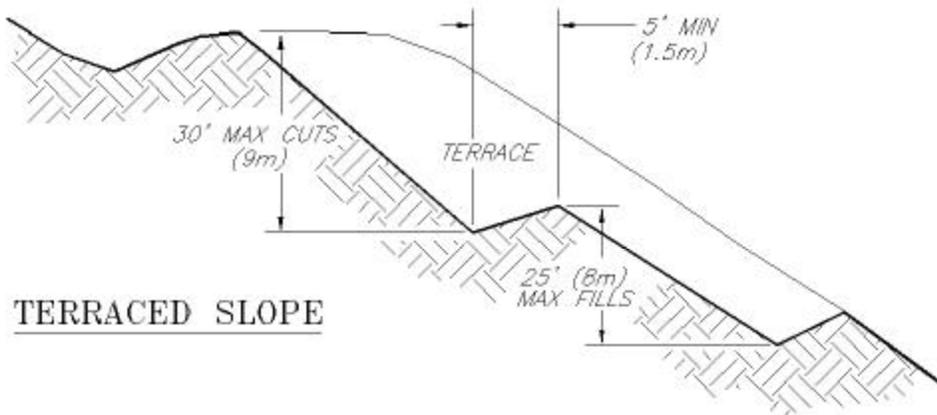
- All erosion, and sediment control practices and measures shall be constructed, applied and maintained in accordance with the approved erosion and sediment control plan.
- Areas to be filled shall be cleared, grubbed and stripped of topsoil to remove trees, vegetation, roots or other objectionable materials.
- Areas shall be scarified to a minimum depth of 3 inches prior to placement of topsoil.
- All fills shall be compacted as required to reduce erosion, slippage, settlement, subsidence or other related problems. Fill intended to support buildings, structures and conduits, etc., shall be compacted in accordance with local requirements or codes.
- All fills shall be placed and compacted in layers not to exceed 8 inches in thickness.
- Except for approved landfills or non-structural fills, fill material shall be free of brush, rubbish, rocks, logs, stumps, building debris and other objectionable materials that would interfere with or prevent construction of satisfactory lifts.
- Frozen material or soft, mucky or highly compressible materials shall not be incorporated into fill slopes or structural fills.
- Fill shall not be placed on a frozen foundation.
- All benches shall be kept free of sediment during all phases of development.
- Seeps or springs encountered during construction shall be handled appropriately.
- All graded areas shall be permanently stabilized immediately following finished grading.

### **Timing and Phasing**

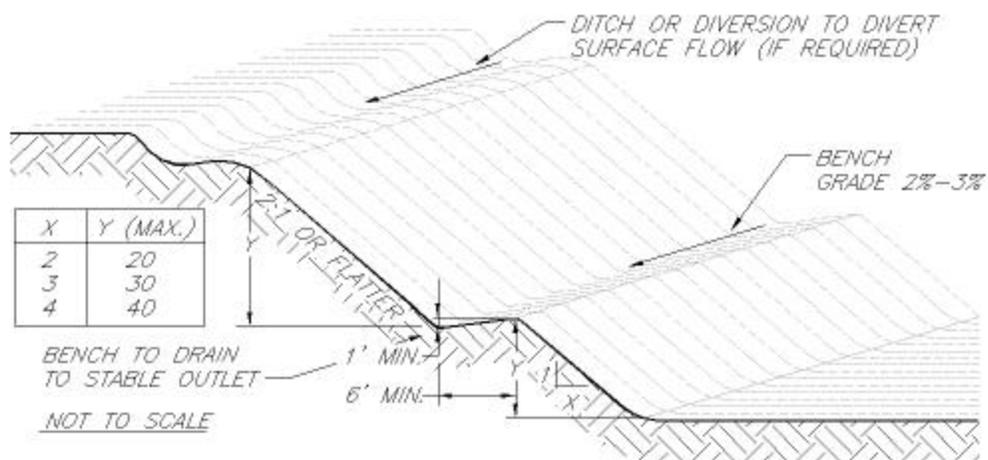
Grading shall be planned so as to minimize the length of time between initial soil exposure and final grading. On large projects this should be accomplished by phasing the operation and completing the first phase up to final grading and seeding before starting the second phase, and so on.

### ***MAINTENANCE***

Any sign of rill or gully erosion shall be immediately investigated and repaired as needed.



**TERRACED SLOPE**



- NOTES:
1. VERTICAL CUT DISTANCE SHALL BE LESS THAN HORIZONTAL DISTANCE.
  2. VERTICAL CUT SHALL NOT EXCEED 2 FT. (0.6m) IN SOFT MATERIAL AND 3 FT. (0.9m) IN ROCKY MATERIAL.
  3. LOAM, SEED, AND MULCH REQUIRED.

**STEPPED OR  
TERRACED SLOPE**

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FILE: STPSLOPE

**C-2 TOPSOIL****PURPOSE & APPLICATIONS**

Topsoiling is the spreading of topsoil of a suitable quality over an area to be stabilized by establishing vegetation. Topsoil is the surface layer of the natural soil profile, generally characterized as being darker than the subsoil due to the presence of organic matter. It is the major zone of root development, containing nutrients available to plants, and supplying a large amount of the water to plants.

Vegetative growth is more rapid on sites with at least 4 inches of topsoil, and the health and quality of the vegetation is better than on sites with little or no topsoil. Topsoiling is applicable in the following situations:

- Where the use of topsoil is determined to be the most effective method of providing a suitable growth medium.
- Where high-quality turf is desirable to withstand intensive use or meet aesthetic requirements.
- Where the subsoil's texture, pH, or nutrient balance of the available soil cannot be modified by reasonable means to provide an adequate growth medium (sands, gravels, clays).
- The subsoil material is too shallow to provide an adequate root zone and to supply necessary moisture and nutrients for plant growth.
- The subsoil contains substances potentially toxic to plant growth.
- On slopes that are 2 to 1 (2 horizontally to 1 vertically) or flatter.

**CONSIDERATIONS**

- Stockpile and reuse existing native topsoil from the site.
- Consider using topsoil substitutes as an alternative to mining prime farmland soils.
- In site planning, the option of topsoiling should be compared with that of preparing a seedbed in subsoil. Limed and fertilized subsoils with proper seedbed preparation may provide an adequate growth medium if moisture is not limiting. Another option may be to use topsoil substitutes or soil amendments such as compost in lieu of natural topsoil.
- Topsoiling is a required procedure when establishing vegetation on shallow soils, soils containing potentially toxic materials, and soil with a pH of 4 or below (high acid).

**SPECIFICATIONS**

If topsoiling is to be done, the following items should be considered:

- Determine the volume of available topsoil exists on the site. Topsoil should be spread at a minimum compacted depth of 4 inches.
- Stockpile topsoil so that it meets specifications and does not interfere with work on the site.
- Allow sufficient time in scheduling for topsoil to be spread and bonded with the subsoil prior to seeding, sodding or planting.

**Stripping:** Stripping shall be confined to the immediate construction areas. A 4 to 6-inch stripping depth is common, but depth may vary depending on the particular soil. All perimeter dikes, basins, and other sediment controls shall be in place prior to stripping.

**Stockpiling:** Topsoil shall be stockpiled in such a manner that natural drainage is not obstructed and no off-site sediment damage shall result.

**Side Slopes:** Side slopes of the stockpile shall not exceed 2 to 1 (2 horizontally to 1 vertically).

**Sediment Barrier:** A sediment barrier shall surround all topsoil stockpiles. Refer to the SEDIMENT BARRIERS BMP.

**Temporary Seeding:** Temporary seeding of stockpiles shall be completed within 7 days of the formation of the stockpile, in accordance with the TEMPORARY VEGETATION BMP. In critical areas (near lakes, streams or wetlands) temporary seeding shall be completed within 24 hours.

**Grading:** Previously established grades on the areas to be topsoiled shall be maintained according to the approved plan. See the detail drawings located at the back of this section for proper grading.

**Liming:** Where the pH of subsoil is 6.0 or less, ground agricultural limestone shall be spread in accordance with the soil texture or the vegetative establishment practice being used.

**Bonding:** After the areas to be topsoiled have been brought to grade, and immediately prior to spreading the topsoil, the subgrade shall be loosened by discing or scarifying to a depth of at least 2 inches to ensure bonding with subsoil.

**Applying Topsoil:** Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed sodding or seeding. The topsoil shall be uniformly distributed to a minimum compacted depth of 4 inches. Any irregularities in the surface resulting from topsoiling or other operations shall be corrected in order to prevent the formation of depressions or water pockets. It is necessary to compact the topsoil enough to ensure good contact with the underlying soil and to obtain a uniform firm seedbed for the establishment of a high maintenance turf. However, undue compaction is to be avoided as it increases runoff velocity and volume, and prevents seed germination.

### 1. Topsoil Materials

Site investigations shall be made to determine if there is sufficient topsoil of good quality to justify stripping. High quality topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, clay loam). Other soil types with high organic content may be found suitable after testing. It shall be free of debris, trash, stumps, rocks, roots, and noxious weeds. It shall give evidence of being able to support healthy vegetation. It shall contain no substance that is potentially toxic to plant growth.

All topsoil shall be tested by a recognized laboratory for the following and shall meet the requirements given:

- Organic matter content shall be not less than 3% by weight.
- pH range shall be 6.0-7.5. If pH is less than 6.0, lime shall be added in accordance with the soil test results and seeds requirements.
- Soluble salts shall not exceed 500 ppm.
- If additional off-site topsoil is needed, it must meet the standards stated above.

### 2. Topsoil Substitutes and soil Amendments

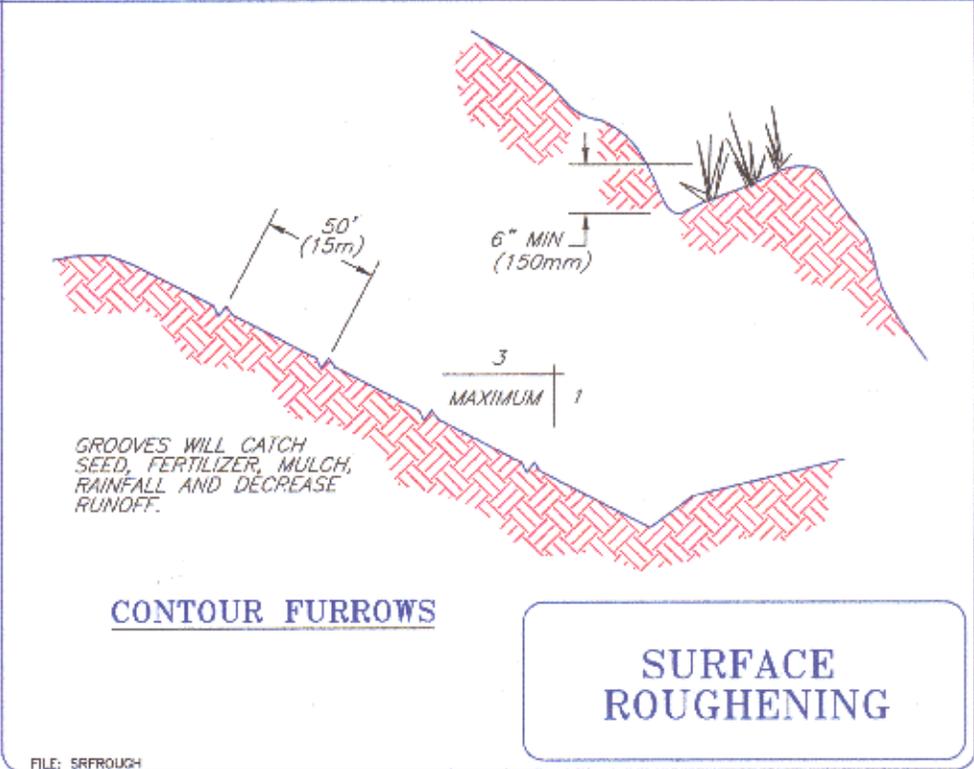
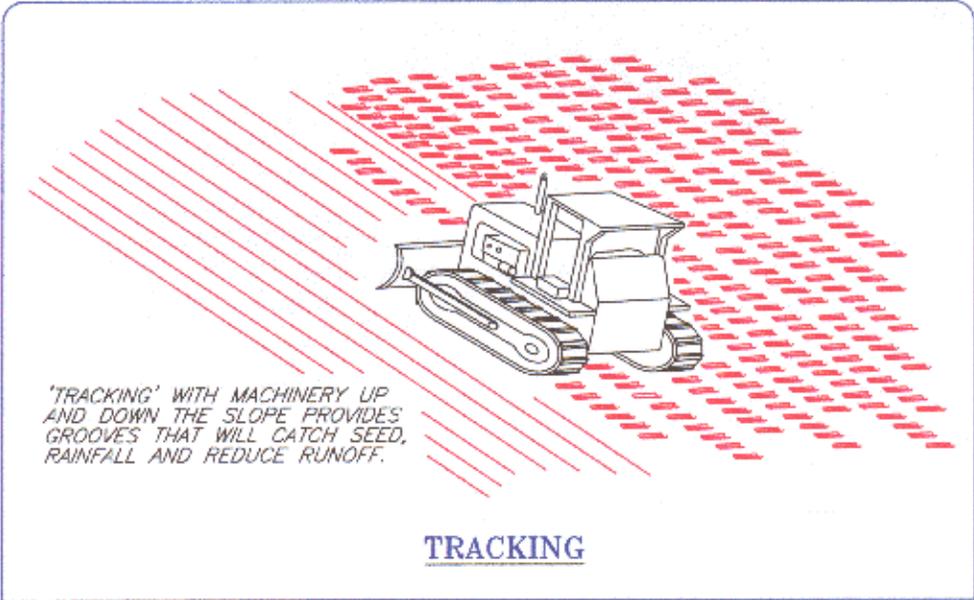
Using state regulated topsoil substitutes and soil amendments promotes recycling of our state's resources. Topsoil substitutes such as erosion control mix can be valuable materials for plant growth and are often rich in nutrients. Refer to the TEMPORARY MULCHING BMP. Successful establishment of vegetation can be very rapid and can be a cost-effective option when compared to purchasing topsoil. Also, specific blends of materials can be tailored to balance or correct the fertility of the existing soil conditions on the site.

The following general criteria apply to topsoil substitutes. For more detailed information, contact the generator directly.

**Nutrient Content:** Compare the nutrient content of the material with the nutrient needs of the plant cover to be planted. Additional nutrients may be needed to provide a balance for the particular plant species desired. Many of these materials are very nutrient rich. If misused, they can deteriorate water quality.

**Setbacks:** Contact the generator of the material you wish to use for information about any setbacks from wells and waterbodies that may apply to the material.

**Limits of Use:** Contact the generator directly about any limitations imposed on the material.



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FILE: SRFROUGH

**C-3 PERMANENT VEGETATION*****PURPOSE & APPLICATIONS***

Permanent vegetative cover should be established on disturbed areas where permanent, long lived vegetative cover is needed to stabilize the soil, to reduce damages from sediment and runoff, and to enhance the environment.

***CONSIDERATIONS***

- Nutrients and pesticides used to establish and maintain vegetation must be minimized to protect surface and ground water quality.
- Water temperatures may be altered due to changes in shading reduction of natural and manmade channels and ponds.
- Provisions shall be made for surface and subsurface drainage, and for disposal of runoff without causing erosion. Facilities may include diversions, grade stabilization structures, streambanks stabilization or waterways.
- Refer to the First Killing Frost map located at the back of this section.

***SPECIFICATIONS*****Seedbed Preparation**

- Grade as feasible to permit the use of conventional equipment for seedbed preparation, seeding, mulch application and anchoring, and maintenance.
- Apply limestone and fertilizer according to soil tests such as those offered by the University of Maine Soil Testing Laboratory. Soil sample mailers are available from the local Cooperative Extension Service Office. If soil testing is not feasible on small or variable sites, or where timing is critical, fertilizer may be applied at the rate of 800 pounds per acre or 18.4 pounds per 1,000 square feet using 10-20-20 (N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O) or equivalent. Apply ground limestone (equivalent to 50% calcium plus magnesium oxide) at a rate of 3 tons per acre (138 lb. Per 1,000 sq. ft).
- Work lime and fertilizer into the soil as nearly as practical to a depth of 4 inches with a disc, spring tooth harrow or other suitable equipment. The final harrowing operation should be on the general contour. Continue tillage until a reasonably uniform, fine seedbed is prepared. All but clay or silty soils and coarse sands should be rolled to firm the seedbed wherever feasible.
- Remove from the surface all stones 2 inches or larger in any dimension. Remove all other debris, such as wire, cable, tree roots, concrete, clods, lumps or other unsuitable material.
- Inspect seedbed just before seeding. If traffic has left the soil compacted; the area must be tilled and firmed as above.

**Seeding Dates**

Spring seeding usually give the best results for all seed mixes or with legumes. Permanent seeding should be made 45 days prior to the first killing frost or as a dormant seeding with mulch after the first killing frost and before snowfall. When crown vetch is seeded in later summer, at least 35% of the seed should be hard seed (unscarified).

If seeding cannot be done within the seeding dates, mulch according to the TEMPORARY MULCHING BMP and OVERWINTER STABILIZATION AND CONSTRUCTION to protect the site and delay seeding until the next recommended seeding period.

- Select a seed mixture that is appropriate for the soil type and moisture content as found at the site, for the amount of sun exposure and for level of use. Select a mixture

recommended by the Maine Department of Transportation (MDOT), the USDA Soil Conservation Service or your local Soil and Water Conservation District. Recommendations for seed mixtures can be found in Appendix A.

- Inoculate all legume seed with the correct type and amount of inoculant.
- Apply seed uniformly by hand, cyclone seeder, drill, cultipacker type seeder or hydroseeder (slurry including seed and fertilizer). Normal seeding depth is from 1/4 to 1/2 inch. Hydroseeding with mulch may be left on soil surface.
- Where feasible, except where either a cultipacker type seeder or hydroseeder is used, the seedbed should be firmed following seeding operations with a roller, or light drag. Seeding operations should be on the contour.
- Apply mulch according to the TEMPORARY MULCHING BMP. All newly seeded areas will need mulching and mulch anchoring.

### **Hydroseeding**

When hydroseeding (hydraulic application), a seedbed is prepared in the conventional way or by hand raking to loosen and smooth the soil and to remove surface stones larger than 6 inches in diameter. Slopes must be no steeper than 2 to 1 (2 feet horizontally to 1 foot vertically). Lime and fertilizer may be applied simultaneously with the seed. The use of fiber mulch on critical areas is not recommended (unless it is used to hold straw or hay). Better protection is gained by using straw mulch and holding it with adhesive materials or 500 pounds per acre of wood fiber mulch. Seeding rates must be increased 10% when hydroseeding.

### **Dormant Seeding**

Seeding should not occur within 45 days of the first killing frost. During this period the seeds are likely to germinate but probably will not be able to survive the winter. The following methods may be used to perform a dormant seeding:

- When soil conditions permit, between the first killing frost and before snow fall, prepare the seedbed, lime and fertilize, apply the selected seed mixture, and mulch and anchor. Double the regular seeding rates for this type of seeding.
- Dormant seeds need to be anchored extremely well on slopes, but should not be used in ditch bases and areas of concentrated flows. Dormant seeding shall not be used in watersheds sensitive to water quality impacts (fisheries, phosphorus sensitive lakes and ponds, etc.). Instead, construction sites next to sensitive areas shall be stabilized with temporary or permanent seeding by September 15.
- Dormant seeding requires inspection in the spring. All areas where cover is inadequate must be immediately reseeded and mulched as soon as possible.

### **Sodding**

Sodding is the stabilization of eroding areas by covering them with cut pieces of turf. It is an important emergency measure, which may be used between September 15th, and November 15th when new seeding cannot be guaranteed. Locations particularly suited to stabilization with sod are:

- Waterways carrying intermittent flow
- The areas around drop inlets in grassed swales
- Residential or commercial lawns where aesthetics is a factor

In swales and waterways where concentrated flow will occur, properly pegged sod is preferable to seed because there is no lag time between installation and the time when the channel is protected by vegetation. By framing the inlet with sod strips, drop inlets in grassed areas can be kept free of mulch, seed, and mud, and the grade immediately around the inlet can be maintained. It is initially more costly to install sod than to seed. But this cost is justified in places where sod can perform better than seed in controlling erosion. Ground preparation and proper maintenance are as important with sod as with seed.

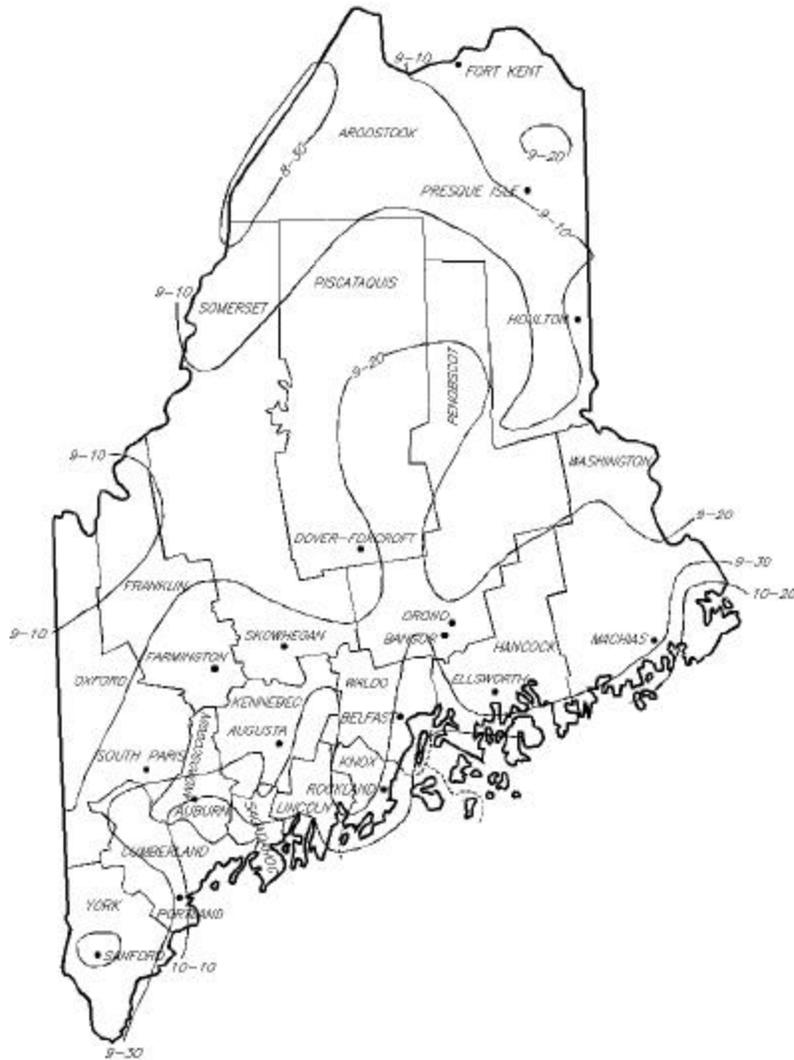
- Before laying sod, provide adequate drainage where internal water movement, especially at the toe of slopes, may cause seeps or soil slippage. And grade slopes 2:1 or flatter.
- Seedbed Preparation

- Provide the best possible soil conditions for sodding. The desirable soil textures include sandy loam, loam, and silt loam
- Fill areas must be compacted enough to prevent uneven settling. The entire surface to be sodded shall be free from large clods, stones, or other debris. The soil shall be loosened to a depth of 1 inch and thoroughly dampened, if not already moist and incorporate needed lime and fertilizer uniformly. Sod shall not be laid on dry soil.
- Lay strips of sod at right angles to direction of slope or flow of water starting at the lowest elevation. Wedge the edges and ends of the sod strips together and tamp or roll. Stagger joints. Make the top of the sod strips flush with the top of the undisturbed ground.
- Use wire staples, fine mesh wire or wood pins and binder twine on very steep slopes to hold sod in place until secured by plant growth.
- Irrigate sodded area immediately after installation.
- Establishment Dates: In Maine, sod can be established from April 1st to November 15th (may vary with region of state).
- In sodded Waterways, care shall be taken to prepare the soil adequately in accordance with this specification. The sod type shall consist of plant materials able to withstand the designed velocity (See VEGETATED WATERWAYS BMP).
- Sod strips in waterways shall be laid perpendicular to the direction of flow. Care should be taken to butt ends of strips tightly.
- After rolling or tamping, sod shall be pegged or stapled to resist washout during establishment. Chicken wire, jute or other netting may be pegged over the sod for extra protection.
- When sod is installed to stabilize areas of concentrated flow (inlets, diversions, ditches, etc.), installation must be completed before runoff is directed to that area.
- After the first week, sod shall be watered as necessary to maintain moisture in the root zone and prevent dormancy of sod.
- No more than 1/3 of the shoot (grass leaf) should be removed by mowing. Grass height should be maintained between 2 and 3 inches unless otherwise specified.

### **MAINTENANCE**

- Lime according to a soil test or at a minimum of every five years using a rate of 2 tons per acre (100 pounds per 1,000 sq. ft).
- Fertilize grasses according to a soil test or broadcast biennially, 300 pounds of 10-10-10 or equivalent per acre (7.5 pounds per 1,000 sq. ft).
- Fertilize legumes according to a soil test or broadcast every three years 300 pounds of 0-20-20 or equivalent per acre (7.5 pounds per 1,000 sq. ft).

FIRST KILLING FROST DATES FOR MAINE (UNIVERSITY OF MAINE)  
 32 DEGREE AVERAGE DATE OF FIRST FREEZE IN FALL



32° AVERAGE DATE OF FIRST FREEZE IN FALL (BASED ON DATA FROM 1931-1968)

SOURCE: MAINE AGRIC. EXP. STA.,  
 BULLETIN 679 "FREEZE IN MAINE"  
 G.R. COOPER, PROF. OF BOTANY, UNIVERSITY OF MAINE  
 R.E. LAUTZENHEISER, CLIMATOLOGIST FOR NEW ENGLAND

FIRST KILLING  
 FROST DATES

ME DEP 2003

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FILE: FROSTDATES

**C-4 PERMANENT MULCHING*****PURPOSE & APPLICATIONS***

Permanent mulch is long-term cover that provides a good buffer around disturbed areas. Permanent mulch such as erosion control mix or landscaping mulch can be used as a permanent ground cover, as an overwinter stabilization mulch, or left to naturalize. It is not designed to support grass vegetation, but legumes or woody vegetation may be established to add stability. Permanent mulch must not be used in areas of concentrated water flows and any evidence of groundwater seepage on slopes may require the erosion control mix to be replaced with riprap.

***SPECIFICATIONS***

Erosion control mix can be manufactured on or off the project site. It shall consist primarily of organic material, separated at the point of generation, and may include: shredded bark, stump grindings, composted bark, or flume grit and fragmented wood generated from water-flume log handling systems. Wood chips, ground construction debris, reprocessed wood products or bark chips will not be acceptable as the organic component of the mix. Erosion control mix shall contain a well-graded mixture of particle sizes and may contain rocks less than 4" in diameter. Erosion control mix must be free of refuse, physical contaminants, and material toxic to plant growth. Refer to the TEMPORARY MULCHING BMP for composition and installation specification.

***MAINTENANCE***

- The mulched area should be inspected regularly and after each large rainfall. Any required repairs should be made immediately, with additional erosion control mix placed on top of the mulch to reach the recommended thickness. When the mulch is decomposed, clogged with sediment, eroded or ineffective, it must be replaced or repaired.
- Erosion control mix mulch should be left in place. Vegetation adds stability and should be promoted.
- If the mulch needs to be removed spread it out into the landscape.

***OTHER USES***

Beside the temporary/semi-permanent stabilization of slopes, permanent mulches such as erosion control mix has been used successfully to stabilize areas covered with snow and that may be problem sites with the spring thaw. It has also been used in construction yards to mitigate the mud.

In these applications, the erosion control mix application rate will need to be adjusted for the site conditions, use and long-term effectiveness. With time, the organic component of the erosion control mix will decompose and become ineffective. Any required repairs should be made immediately, with additional erosion control mix placed on top to reach the desired thickness.

**C-5 VEGETATED BUFFERS****PURPOSE & APPLICATIONS**

A vegetated buffer strip is a constructed or natural strip or area of vegetation for removing sediment, organic matter and other pollutants from runoff. Its purpose is to use the vegetation to remove sediment and other pollutants from runoff by filtration, infiltration, absorption, adsorption, decomposition, and volatilization. In addition to filtering sediment, vegetated buffers of well-developed native vegetation also provide shade, coarse woody debris, nutrient uptake and numerous other benefits to water bodies.

This practice applies to land undergoing development where buffers are needed to reduce sediment damage to adjacent property. Buffer strips shall only be used to remove sediment from overland (sheet) flow. Buffers are not effective in removing sediment from concentrated flows. Vegetated buffers are especially valuable as a "polishing" step from sedimentation traps and basins where a suspended silt and clay material is a problem.

**CONSIDERATIONS**

- Buffer is effective only as long as the flow through the filter is shallow sheet flow.
- Vegetative buffers cannot be expected to remove all sediments or adequately protect adjacent areas from sediment damage. Vegetative filters should only be considered as one component of the erosion and sediment control system. The effectiveness of buffers can vary considerably depending on the type of vegetation, the height and density of the vegetation, season of the year, type of sediment (sand, silt or clay), the size of the area exposed, and the topography of the exposed area.
- It is always preferable to use existing vegetation rather than replanting. Existing vegetation should be well developed, preferably composed of a suitable density of woody shrubs and tree stems of a range of sizes, age classes and species, and an intact forest floor. Naturally occurring coarse woody debris adds surface roughness, increasing water residence time and infiltration, and should not be removed or otherwise disturbed.
- Vegetative buffers shall be planned and established prior to disturbing the land that will produce the sediment.
- There are not precise design criteria that will guarantee a particular level of sediment removal.
- Careful plant selection can improve wildlife habitat for food and nesting.

**Restabilization of a Disturbed Area**

Disturbed areas may be stabilized in many different ways. Most commonly, a permanent cover of grasses and legumes is established. There are locations, however, where other types of vegetation are preferred. The following situations are examples of ways in which trees, shrubs, vines, and ground covers may be used:

- Protecting or re-establishing native forest cover is highly preferred in buffer areas of adequate width adjacent to surface water bodies.
- On cut and fill slopes adjacent to paved areas of shopping centers, schools, industrial parks, or other non-residential projects to control erosion.
- Where ornamentals are desirable for landscaping purposes.
- To reduce or eliminate the need for mowing and maintenance, especially in problem areas (shade, steep slopes, inaccessible places).
- In areas where pedestrian movement should be limited.
- Where woody plants are desirable for soil conservation or to establish wildlife habitat.
- Along streambanks to provide shading and leaf litter for fish habitat and as a buffer from runoff filled with sediment and nutrients.

## **SPECIFICATIONS**

In unorganized areas, contact the Land Use Regulation Commission (LURC) directly for information about widths of buffers that apply in unorganized areas.

### **Construction of Grassed Filter Strips**

Grassed filter strips can be built below areas where sedimentation can be expected during construction. They should be built and stabilized very early in the construction sequence to be sure they are functional.

A critical factor to determine for an effective buffer strip is the required width. Effective buffer strip widths may vary from only a few feet in relatively well drained flat areas to as much as several hundred feet in steeper areas with more impermeable soils.

Amount and rate of runoff that will pass through the strip is determined by:

- Land use and treatment above the strip.
- Slope of land above the strip.
- Length of slope above the strip.
- Erodibility of soil above the strip.

Physical properties of the filter strip itself are determined by:

- Slope of the land in the strip.
- Type of vegetation.
- Degree of maintenance the buffer will receive.

### **Installation Requirements**

The minimum width of the buffer strip shall be 25 feet **or** in accordance with local CEO or DEP regulations.

The width of the buffer shall be increased proportionately for slopes longer than 150 feet or for higher sediment concentrations. When using filter strips at inlets to storm sewers, as large an area as possible should be provided to ensure it will function as intended. Buffers should be placed along the contours whenever possible. No construction shall be allowed within buffer strip areas.

Vegetation must be adapted to sediment-producing areas. Both existing and established vegetation must be healthy and have a vigorous growth habit. Establishing vegetation by seed shall be done in accordance with the measures for PERMANENT VEGETATION BMPs.

### **Using Natural Vegetated Filter Strips**

Trees, shrubs, natural forest litter, debris, and the organic duff layer must be protected for this function. Ideally, vegetation should be well developed, preferably composed of a suitable density of woody shrubs and tree stems of a range of sizes, age classes and species, and an intact forest floor. Naturally occurring coarse woody debris adds surface roughness, increasing water residence time and infiltration, and should not be removed or otherwise disturbed.

**Forest Management:** Any timber harvesting in a Natural Vegetated Filter Strip in the past ten years should have retained a healthy stand of trees and shrubs, regenerated new seedlings of native species, and minimized disturbance of the forest floor. Active forest management of Natural Vegetated Filter Strips may occur without impairing their function as long as Forestry Best Management Practices developed by the Maine Forest Service in 2003 are observed. Consult Maine Forest Service for additional information.

### **Natural Resources Protection Act**

DEP regulations require that an undisturbed strip of vegetation be maintained adjacent to wetlands and waterbodies (including both intermittent and perennial streams). For more information about this law, contact the DEP Bureau of Land and Water Quality.

### **Phosphorus Control in Lake Watersheds**

Refer to the DEP publication "Phosphorus Control in Lake Watersheds: A Technical Guide to Evaluating New Development" for information about this subject.

### **Wildlife Buffers**

The Department of Inland Fisheries and Wildlife recommends the following natural vegetated buffers for wildlife protection along streams and wetlands:

- **Minimum width of undisturbed vegetation:** 100 feet on either side of stream/wetland (200-foot corridor total width).
- **Width of zone of minimum disturbance:** 150 feet additional on either side of stream/wetland (500-foot corridor total width).

The zone of minimum disturbance can be managed for forestry production with IF&W guidelines. The recommended width will vary with the value of the stream or wetland. Consult IF&W to determine the appropriate width and refer to the IF&W publication and maps "Significant Fish and Wildlife Resources of Maine."

### **Plant Selection**

There are many plants that may be used for buffers; however native species of plants should be selected as they are best adapted to Maine climate, they are fairly easy to grow, and are commonly available from commercial nurseries. Information on such plants can be obtained from nurserymen, landscape architects, the Natural Resources Conservation Service (NRCS) and the University of Maine Cooperative Extension Service. Ideally, emphasis should not be merely on selection of a single appropriate species, but on re-establishing native forest vegetation assemblages and structures, including a natural forest floor. Further assistance on plant selection, planting, health and care is available from the Maine Forest Service.

**Trees:** Selection of trees depends on the desired function of the tree, whether it is shade, privacy screening, noise screening, appearance, and enhancement of wildlife habitat. The following characteristics of the tree should be considered when making choices:

- "Hardiness Zones" are based on average annual minimum temperature.
- The eventual height of a tree must be considered in relation to its planting location to avoid future problems with power lines and buildings.
- Some trees attain mature height at an early age, others take many years. If "instant shade" is desired, rapid growth is needed. Slow-growing trees are usually less brittle and live longer.
- Some trees obstruct underground pipelines with fibrous roots.
- Maintenance problems can be avoided by not selecting trees that drop seedpods, flowers, or twigs in large amounts. On the other hand, these same species may provide exceptional sources of food for wildlife.
- If good soil and drainage are not available, trees tolerant of poor growing conditions must be planted.
- If a tree is unusually attractive in appearance, some other shortcomings may be overlooked.
- Evergreens are useful for privacy screens and noise screens. Deciduous trees are preferable for shade trees in the summer and allow light to filter through in the winter.
- Some trees provide excellent food and nesting areas for wildlife. Tall shade trees on the southern side of streambanks provide shading necessary for Maine fisheries.
- Consider the prior use of the land; adverse soil conditions, such as poor drainage or acidity; exposure to wind; temperature extremes; location of utilities, paved areas, and security lighting; and traffic patterns.
- Spring is the preferred planting season for deciduous trees (hardwoods) and early fall (August-September) for evergreens. Trees to be planted as bare-rooted seedlings should be handled only while dormant in the spring, or after leaf fall in autumn.
- Dig generous sized planting holes with perpendicular sides. Loosen the soil at the bottom of the hole. Set trees and shrubs at the same level as they were at the nursery. Spread the roots out and work soil over and around them. Alternate the soil with layers of peat or compost until the hole is nearly full, compacting the soil firmly with your foot around the roots. Fill the hole with water. Finally, fill the hole with loose dirt, shaping a shallow basin to retain water. Support newly planted trees as needed to prevent excessive swaying. Stakes or guy wires may be used
- Wait until the second year when feeder roots are established to fertilize bare rootstock.
- Soil around the tree should be thoroughly watered after the tree is set in place and when the soil becomes dry. Mulching around the base of the tree (use bark mulch since straw or hay may attract mice) is helpful in preventing roots from drying out.

**Shrubs:** Much of what has been said about trees also applies to shrubs. A shrub is an erect woody plant less than 15 feet tall, usually with several trunks rising from a common base. Some have the appearance of small trees, and some lie close to the ground.

**Vines and Ground Covers**

Low growing plants that sprawl, trail, spread, or send out runners. Some are suitable only as part of a maintained landscape, and some can stabilize large areas with little care.

**Forest Protection**

Often it is necessary to protect desirable wooded areas and individual trees from injury during construction. The purpose is to ensure the survival of desirable trees where they will be effective for erosion and sediment control, watershed protection, landscape beautification, dust and pollution control, noise reduction, shade and other environmental benefits while the land is being developed

**Selecting Trees to be Retained:** The proper development of a wooded site requires completion of a plan for tree preservation before clearing and construction begins. Trees should be identified by species and located on a topographical map, either as stands or as individuals, depending on the density and value of the trees.

**Life expectancy and present age:** Preference should be given to long-lived tree species, such as white pine, red or white oak, beech, sugar maple and other species. Older trees that may be excessively stressed by construction should be assessed by a qualified arborist or forester. Retaining such trees while allowing natural regeneration of younger individuals is preferable, since older trees may provide greater environmental and aesthetic benefits. However, if preservation of individual trees is likely to cause unsafe conditions during or after construction, replacement with new trees may be considered.

**Health:** Individual trees and groups of trees should be evaluated by a qualified arborist or forester for signs of stress, disease, loss of vigor or structural defect. Safety or environmental risks should be evaluated in relation to the setting and present or potential environmental or aesthetic benefits. Indicators of potentially hazardous conditions may include fire or lightning scars, insect or disease damage, obvious rot or damage, overhanging limbs and crown vigor. Species considerations may include crown shape, size at maturity, shade or moisture tolerance and rooting habit. Land use history of the site may influence tree characteristics. Maintenance of tree/forest vigor may require thinning, pruning or other treatments. Contact the Maine Forest Service for additional assistance.

**Wildlife:** Preference should be given to trees that provide food, cover, and nesting sites for birds and game.

**Survival needs of the tree:** Chosen trees must have enough room to develop naturally. They will be subject to injury from increased exposure to sunlight, heat radiated from buildings and pavement, and wind. It is best to retain groups of trees rather than individuals. As trees mature, they can be thinned gradually.

**Relationship to other trees:** Individual species should be evaluated in relation to other species on the site. Species diversity of wooded areas should be maintained. Individual species should be retained unless warranted by natural stand development patterns (e.g. elimination of gray birch, popple or similar early successional species). Trees standing alone generally have higher landscape value than those in a wooded situation. However, tree groups are much more effective in preventing erosion and excess stormwater runoff.

**Protection During Construction**

If lot size allows, select trees to be saved before siting the building. No tree should be destroyed or altered until the design of buildings and utility systems is final.

Critical areas, such as flood plains, streambanks, lake and pond shore, steep slopes, and wetlands, should be left in their natural condition or only partially developed as open space.

Locate roadways to cause the least damage to valuable stands. Follow original contours, where feasible, to minimize cuts and fills.

**Plan Identification:** Groups of trees and individual trees selected for retention should be accurately located on the plan and designated as "tree(s) to be saved." Individual specimens that are not part of a tree group should also have their species and diameter noted on the plan.

**Clearing Limits:** The limits of clearing should be located outside the drip line of any tree to be retained, preferably at a minimum of 15 ft from the trunk, and in no case closer than five feet to the trunk of such a tree.

**Tree Marking:** Marking individual trees and stands of trees to be retained within the limits of clearing should be visibly marked with a bright-colored surveyor's ribbon or flagging applied in a band circling the tree at a height visible to equipment operators.

**Equipment Operation and Storage:** Heavy equipment travel, storage or stockpiles of any construction materials including topsoil should not be permitted within the drip line of any tree to be retained (or a minimum of 15 ft from the trunk of the tree). Heavy equipment operating over tree roots will probably kill a tree (even though it may take a few years to die). A five-foot minimum should only be used in the case of protecting an existing or recently cut tree line near the edge of the construction zone where equipment will be limited to only one side of the trees which will dramatically increase the survival rate.

**Storage and Disposal of Toxic Materials:** No toxic materials should be stored within 100 feet of the drip line of any trees to be retained. All construction debris, including paint, acid, nails, gypsum board, wire, chemicals, fuels and lubricants, must be properly disposed of.

**Fencing:** Any device may be used which will effectively protect the roots, trunk and tips of trees retained on the site. However, trees to be retained within 40 feet of a proposed building or earth moving activities should be protected by fencing. Fencing should be highly visible, of sturdy construction and at least 3 feet high. Fences may be snow fence, board fencing, synthetic fabric fence, plastic fence or similar materials. Additional trees may be left standing as protection between the trunks to be retained and the limits of clearing. To be effective, the trunks of the trees in the buffer must be no more than six feet apart to prevent passage of equipment and material through the buffer. These additional trees should be re-examined prior to the completion of construction and either given sufficient treatment to ensure survival or removed.

**Trunk Armoring:** As a last resort, a tree trunk can be armored with burlap wrapping and 2-inch studs wired vertically no more than two inches apart to a height of five feet encircling the trunk. The root zone within the drip line will still require protection with this alternative. Nothing should ever be nailed to a tree. Fencing and armoring devices should be in place before any earthwork activity is begun, kept in good repair for the duration of construction activities, and be the last items removed during the final cleanup, upon the project's completion.

**Raising the Grade:** When the ground level must be raised around an existing tree or tree group, a well should be created slightly beyond the drip line of the tree(s) to retain the natural soil in the area of the feeder roots. In the case of an individual tree, when the above alternative is not practical or desirable, a dry well can be constructed around the trunk with space to allow for trunk growth. Drainage within the well and around the root system inside the drip line should be provided.

**Lowering the Grade:** Trees should be protected from harmful grade cuts by the construction of a tree wall. Tree walls should be located outside the drip line of any tree to be retained and in no case, closer than 5 feet to the tree trunk. Following excavation, all tree roots that are exposed and/or damaged should be trimmed cleanly, painted with tree wound dressing (if desirable) and covered with moist peat moss, burlap or other suitable material to keep them from drying out. The wall should be constructed of large stones, brick, building tile, concrete block, or cinder block. If drainage through the wall is necessary, install tile drains or perforated PVC pipes.

**Trenching and Tunneling:** To reduce the amount of root area damaged or killed by trenching activities, excavate as far away as possible from the crown drip line. The ends of damaged and cut roots should be cut off smoothly and may be protected by painting with a tree wound dressing.

**Cleanup:** The time that follows completion of a construction project can be critical for trees. Trees protected throughout the development operation are often destroyed by carelessness during the final cleanup and landscaping. Fences and barriers should be removed after everything else is cleaned up and carried away.

## **MAINTENANCE**

**Buffers:** Inspect buffers regularly for signs of erosion and channelization of water. Repair them as needed to promote sheet flow conditions.

**During Construction:** Even with precautions, some damage to protected trees may occur. In such cases, the following maintenance guidelines should be followed.

**Mulching:** Disturbed soil between trees and shrubs must be mulched or planted with permanent vegetation to prevent erosion. Refer to the MULCHING BMP or the PERMANENT VEGETATION BMP to select a method for stabilizing these areas.

**Soil Aeration:** If the soil has become compacted over the root zone of any tree, the ground should be aerated by punching small holes in it with suitable aerating equipment.

**Repair of Damage:** Any damage to the crown, trunk or root system of any tree retained on the site should be repaired immediately. Damaged roots should immediately be cut off cleanly inside the exposed or damaged area. Cut surfaces may be allowed to air dry.

All tree limbs damaged during construction or removed for any other reason should be cut off above the collar at the preceding branch junction. Larger limbs will require 3 cuts to safely remove the damaged limb without damaging the trunk.

**Maintenance of Trees:** Like all plants, trees require water and fertilizer to grow. Ideally, young trees should receive an inch of water each week for the first two years after planting. When rain does not supply this need, the tree should be watered deeply but not more often than once per week.

Transplanted trees should be fertilized one year or so after planting. There are many sophisticated ways to supply fertilizer to trees, but some simple methods are adequate. The best material for small trees is well-rotted stable manure, if it can be obtained. Add it as a 2-inch layer of mulch around the tree annually.

**Maintenance of Shrubs:** Proper pruning, water, and application of fertilizer every three years or so will keep shrubs healthy. Maintain the mulch cover or turf cover surrounding the shrubs. A heavy layer of mulch reduces weeds and retains moisture.

**Maintenance of Vines:** Trim old growth as needed to improve the appearance of ground covers. Most covers need once-a-year trimming to promote growth. Maintain mulch cover with additions of mulch where needed. Fertilize as described above every 3-4 years.

## D-1 GEOTEXTILES

### **PURPOSE AND APPLICATIONS**

Geotextiles (often called "filter fabrics") are any permeable, synthetic, textile material used with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a man-made project, structure or system. The purpose of geotextiles is:

**In separation**, layers of different sizes of solid particles are separated from one another by the geotextile. Geotextiles are often placed underneath riprap to prevent underlying soil from eroding away.

**In drainage**, the geotextile allows water to pass and in the special case of drainage "transmission," the geotextile itself acts as a drain to transmit water through soils of low permeability. Geotextiles can be wrapped around perforated drainpipes to filter out fines that can clog them.

**For reinforcement**, the geotextile is used as a reinforcing element in the earth through either stress distribution or increase in soil modulus.

**In filtration**, the fabric acts similar to a two-dimensional sand filter, allowing water to move from the soil while retaining the soil.

### **CONSIDERATION**

Proper material selection and installation is the key to success. Some products may look similar, but have very different characteristics. It is important to call the manufacturer or consult their literature when you have questions about which material to use or how to use it as there are many different types, grades of both woven and non-woven geotextiles.

#### **Woven Geotextiles**

The opening size of the fabric is critical when the geotextile serves as a filter for piping or if seepage gradients are significant. It provides a means of evaluating the retention characteristics of a geotextile and adequate resistance to clogging. To use a woven geotextile, the soil gradation must be known and ask the manufacturer for guidance concerning their fabric and proper selection.

#### **Nonwoven Geotextiles**

The size opening is not a critical property with nonwoven geotextiles as these geotextiles have a wide range of size openings. In general, nonwoven geotextiles retain more soil fines than do woven geotextiles. The structure of the mechanically bonded needle-punched fabric helps to decrease the internal fabric clogging potential. The nonwoven geotextiles have very good permeability characteristics and should be strongly considered where seepage flows are a concern. Nonwoven geotextiles have a rougher surface than wovens. Therefore, the bond between the soil and the geotextiles offer more resistance to sliding along the plane of contact.

### **SPECIFICATIONS**

#### **Design Criteria**

The design for filtration requires retention of the soil while allowing sufficient flow through the textile and the prevention of clogging. Woven geotextiles require more critical evaluation and analysis than nonwovens in most applications.

#### **Installation Specifications**

Satisfactory performance of the selected geotextile is greatly dependent on the installation procedures and field preparation of the surface to be protected. When geotextiles are used adjacent to fill or backfill, the fill soils placement is critical in preventing conditions subject to plugging of the geotextile. The following techniques all minimize the movement of soil particles towards the geotextile surface and provide more area for flow through the geotextile.

- Prepare soil surfaces adjacent to geotextiles so that all flow channels or voids larger than the openings in the geotextile are eliminated.
- Utilize soil compaction and placement techniques to ensure that intimate contact between the geotextile and the soil is maintained.
- Provide a surface area as large as possible for the filter (i.e., it is better to place the geotextile around the periphery of the drain trench with gravel and pipe inside than to place the geotextile around the pipe where the surface area is smallest).

### **Slope Protection**

Geotextile material is often used to prevent soil erosion beneath riprap armoring. Erosion can occur under and around ripped ditches, particularly if the side slopes are steep. Water flowing over the riprap can actually lift soil out from underneath the stones. This undercutting can be curtailed by using a geotextile layer between the riprap and the native soil. The geotextile covers the soil surface and protects it from erosion.

The method of placement of rock or other material on the geotextile may have to be specified. Placement should be accomplished by equipment capable of controlling the drop. Pushing or rolling rock over the geotextile should not be allowed. The maximum drop is 3 feet for protected (6-inch sand or soil cushion for bedding) or unprotected geotextile. Where conditions require a larger drop, the strength of the geotextile and/or thickness of cushioning material needs to be increased.

To prevent movement of surface soil, where groundwater and seepage pressures are a factor, the geotextile must be kept in intimate contact with the soil. This is especially true on sloping surfaces where flow may occur beneath the geotextile. A sand layer bedding material may have to be specified to insure this contact in some cases. Gravel placed on the geotextile will hold it in place and minimize voids under the riprap. Embedment of the geotextile in a trench to form a cutoff at regular intervals down the slope will also help prevent riling beneath the geotextile. Cutoffs may have to be placed more closely spaced in highly erodible soils and spaced wider apart in more stable soils.

When a geotextile is used as a filter material replacement for the purpose of preventing particle migration, it is recommended that laps of adjacent geotextile panels require matching sewing or other positive joining methods. The method of joining laps should be specified on the drawings or in the construction details.

- Use non-woven geotextiles for this type of application because they are more permeable and they conform to the soil surface better.
- Anchor the upper ends of geotextile in a small trench to prevent it from slipping when the riprap is laid in the ditch.
- Overlap multiple sheets of geotextile by 1-2 feet (upslope fabric should overlap the downslope fabric, just like shingles on a roof).
- The soil surface should be relatively smooth and free of protruding rocks and debris that can puncture and tear the fabric.

### **Subsurface Drainage**

Geotextiles can be used to improve subsurface drainage by removing groundwater from chronically soft, muddy sections of a road, a landscaped area or an embankment. Typically, this type of drain consists of a trench filled with gravel and/or perforated plastic pipe. The trench is designed to intercept the groundwater and drain it to a lower spot. Lining the trench with a geotextile prevents the pipe from clogging and extends the life of the drain. The geotextile also acts as a barrier between the gravel and surrounding soil, thereby preserving the permeability of the gravel.

- Lay the geotextile in the trench with the ends extending up over both sides of the trench. Once the trench has been filled with gravel, the ends can be folded over the top and then covered with soil.
- Overlap multiple sheets of geotextile by at least 1-2 feet.

- Make sure the drain has a continual downhill pitch and discharges into a stable area.
- See that the soil surface is free from rocks or other protrusions to ensure good contact between the soil and the geotextile.

Use manufacturers recommended normal condition non-woven geotextiles where material will not be dropped more than five (5) feet onto the geotextile, where trench depths will be no deeper than ten (10) feet from the normal ground surface and sharp, angular aggregates are not used.

Heavier geotextiles are recommended when trench depths of greater than ten (10) feet or sharp, angular aggregates are used. The tensile strength should be no less than 150 pounds and burst strength no less than 300 psi.

To prevent rock movement to surface soil, where groundwater and seepage pressures are a factor, the geotextile must be in intimate contact with the subgrade soil. Voids between the geotextile and the base soil need to be minimized to prevent the collecting of fines behind the geotextile and subsequent clogging. The geotextile should be pulled flat during installation to eliminate wrinkles and folds that create voids.

If flow in the plane of the geotextile is a concern in the drain installation, the thickness of the geotextile becomes an important criterion. A heavier weight nonwoven needle punched fabric should be used.

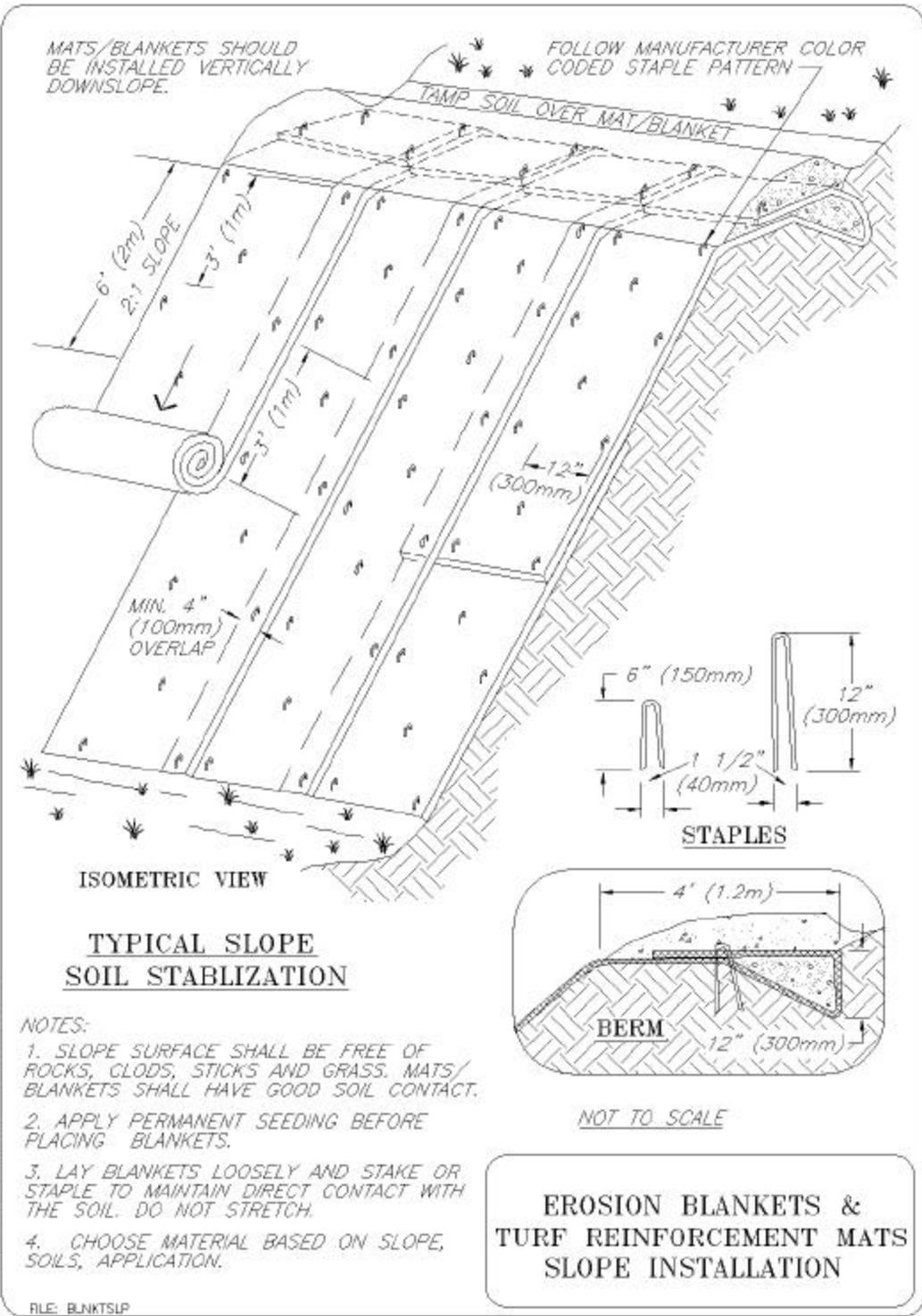
### **Road Stabilization**

Stabilization is a way to firm up soft roads that are prone to tire rutting. This situation results from a road base or subgrade that is poorly drained. The first step is to grade and crown the existing road surface. Then, roll out the geotextile fabric over the full road width, covering the entire problem area. The final step is to cover the geotextile with at least 10-12 inches of good road gravel. Using geotextile will enhance the road stability by dispersing the vehicle weight over a broader area preserving the integrity of the good gravel over the poor soils beneath it.

- Use woven geotextiles for stabilization because of their superior strength. Some heavier weight, non-woven types may suffice. Check with the product manufacturer for their recommendations for light to medium loading in both weight and frequency or traffic.
- Always overlap sheets of geotextile by as much as 2-3 feet. If the subgrade is soft and it is determined that the potential for rutting is high, the overlap should be increased
- Remove protruding rocks and other debris from the road before putting down geotextile to prevent punctures and tears.

### ***MAINTENANCE***

If any sign of damage is apparent, geotextiles must be repaired or replaced as needed to maintain their performance.



## D-2 RIPRAP SLOPE STABILIZATION

### PURPOSE & APPLICATIONS

Riprap is a permanent, erosion-resistant ground cover constructed of large, loose, angular or sub-angular (rounded) stone. Riprap may be used, as appropriate, at storm drain outlets, on channel banks and/or bottoms, roadside ditches, drop structures, at the toe of slopes, or to stabilize streams. Its purpose is:

- To protect the soil surface from the erosive forces of concentrated runoff.
- To slow the velocity of concentrated runoff while enhancing the potential for infiltration.
- To stabilize slopes with seepage problems and/or fine textured non-cohesive soils.

This practice is applicable at soil-water interfaces where the soil conditions, water turbulence and velocity, expected vegetative cover, etc., are such that the soil may erode under the design flow conditions.

### CONSIDERATIONS

Riprap along streambanks can lead to thermal pollution as the sun heats the stone to high temperatures. As the rain falls on the stone, it warms up and raises the stream temperature. Several fish species are very sensitive to small increases in temperature and whenever riprap is used along streams, it should be used in combination with vegetation to shade the stone.

Use vegetation whenever possible as it provides habitat for wildlife species and a buffer capable of taking up pollutants and nutrients from runoff. If riprap is unavoidable, then use a combination of riprap and plantings to provide some vegetative cover.

Since riprap is used where erosion potential is high, construction must be sequenced so that the riprap is put in place with the minimum delay. Disturbance of areas where riprap is to be placed should be undertaken only when final preparation and placement of the riprap can follow immediately behind the initial disturbance. Where riprap is used for outlet protection, the riprap should be placed before or in conjunction with the construction of the pipe or channel so that it is in place when the pipe or channel begins to operate.

No riprap can be installed or repaired along the rivers, ponds, lakes, or the ocean without permission from the DEP and Army Corps of Engineers and all requirements of state laws and permit requirements of local, state and federal agencies must be met.

### SPECIFICATIONS

Riprap is composed of three sections:

- The typical **armor layer** is composed of rough, angular rock.
- The **underlying filter layer** supports the stone against settlement, allows groundwater to drain through the structure, and prevents the soil beneath from being washed through the armor layer by waves or groundwater seepage.
- The **toe protection** prevents downward movement of the riprap layer. It is usually constructed by trenching in the riprap at the toe of the slope.

#### Design Criteria

**Types of Riprap:** Refer to MDOT specifications for information about standard types of riprap.

**Gradation:** Since graded riprap consists of a variety of stone sizes, a method is needed to specify the size range of the mixture of stone. The average size of stone in a mixture is described as the D50. In other words, it is specifying a diameter of stone in the mixture for which 50 percent, by weight, will be smaller and 50 percent will be larger.

A mixture composed primarily of the larger stone size but with a sufficient mixture of other sizes filling the progressively smaller voids between the stones is described as a well-graded mixture. The diameter of the largest stone size in such a mixture should be 1.5 times the D50 size.

The designer, after determining the riprap size that will be stable under the flow conditions, shall consider that size to be minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size.

**Thickness:** The minimum thickness of the riprap layer shall be 2.2 times the maximum stone diameter (for a  $D_{50}$  of 12" or smaller), but not less than 6 inches. For  $D_{50}$  specified greater than 12 inches, the riprap layer thickness shall be 2 times the  $D_{50}$ .

**Quality of Stone:** Stone for riprap shall consist of sub-angular field stone or rough unhewn quarry stone of approximately rectangular shape. The stone shall be hard and of such quality that it will not disintegrate on exposure to water or weathering, be chemically stable and it shall be suitable in all other respects for the purpose intended. The bulk specific gravity (saturated surface-dry basis) of the individual stones shall be at least 2.5. Rubble concrete may be used, if locally allowable and provided it has a density of at least 150 pounds per cubic foot, and otherwise meets the requirements.

**Filter Blankets:** A filter blanket is a layer of material placed between the riprap and the underlying soil surface to prevent soil movement into or through the riprap. The need for a filter blanket is determined by comparing the particle sizes of the overlying material and the base material:

- **Gravel filter blanket:** The filter material should be a minimum of 6 inches thick. The material shall be a DOT Type C underdrain and shall be free from organic matter. It may be crushed, uncrushed or a washed gravel with the following specifications:

	% By Weight Passing Mesh Sieves
1 inch	100 %
3/4 inch	90 – 100 %
3/8 inch	0 – 75 %
No. 4	0 – 25 %
No. 10	0 – 5.0 %

- **Geotextile filter:** Geotextile filter cloth may be used in place of or in conjunction with gravel filters. Filter blankets should always be provided where seepage from underground sources threatens the stability of the riprap.

### Installation Requirements

**Subgrade Preparation:** The subgrade for the riprap or filter shall be prepared to the required lines and grades. Any fill required in the subgrade shall be compacted to a density approximating that of the surrounding undisturbed material. If placed on fill, fill shall be 95% compacted as determined by Standard Proctor Density. Brush, trees, stumps and other objectionable material (i.e., organic matter) shall be removed.

**Filter Blanket:** Placement of the filter blanket should be done immediately after slope preparation. For granular filters the stone should be spread in a uniform layer to the specified depth. Where more than one layer of filter material is used, the layers should be spread so that there is minimal mixing of layers.

For geotextile filter cloths, the cloth should be placed directly on the prepared slope. The edges of the sheets should overlap by at least 12 inches. Anchor according to the manufacturer's recommendations and with the pins suggested by the manufacturer. The upper end of the cloth should be buried a minimum of 12 inches deep. The lower end should be toed in. Care should be taken not to damage the cloth when placing the riprap. If damage occurs, that sheet should be removed and replaced or repaired. For large stone, 12 inches or greater, a 4-inch layer of gravel shall be used to prevent damage to the cloth, protection from ultraviolet rays and to provide interfacial contact.

**Stone Placement:** Placement of riprap should follow immediately after placement of the filter. The riprap should be placed so that it produces a dense well-graded mass of stone with a minimum of voids. The desired distribution of stones throughout the mass may be obtained by selective loading at the quarry, controlled clumping of successive loads during final placing, or by combination of these methods. The riprap should be placed to its full thickness in one operation.

The riprap should not be placed in layers nor dumped as it segregates the various stone sizes. Care should be taken to not dislodge the underlying material when placing the stones. The finished slope should be free of pockets of small stone or clusters of large stones. Hand placing may be necessary to achieve the required grades and a good distribution of stone sizes. Final thickness of the riprap blanket should be within plus or minus 1/4 of the specified thickness.

### **Shoreline Riprap Slope Stabilization**

In shoreline situations, riprap is generally only used to stabilize areas eroding due to wave scouring and wave impact but it cannot be relied on alone to stabilize slopes failing due to seepage or soil instability. In these cases, stabilization may require the installation of groundwater drains, soil reinforcements, or retaining walls.

**Strength:** Shore protection structures must be strong, and this can only be achieved by using massive and heavy components that cannot be dislodged by waves.

**Flexibility** is also desired because it allows the structures to compensate for settlement, consolidation and toe scour.

**Wave Height:** Wind action or, less critically, moving vessels generate waves and the design water level and wave's height are the defining criteria for appropriately sizing the stones in a riprap embankment. The height of wind-driven waves depends upon the wind speed, direction, duration, fetch length and depth. The U.S. Army Corps of Engineers should be consulted to properly identify the fetch, wind direction and wave height for the site.

**Stone Selection:** Stone revetment is a proven method of shoreline protection as it is durable. When the height of waves is greater than 5 feet, quarried stones should be used. If the waves are less than 5 feet, than riprap may be sufficient. The stones should be clean, hard, dense, durable, and free of cracks and cleavages

**Filter Layer:** A filter layer of either special filter cloth or a 6-inch layer of well-graded stone should be provided to prevent the loss of slope material through voids in the armor. Once the fabric is in place, put a layer of ¾-inch washed stone about 3 inches deep on top of the fabric to help distribute the riprap load and prevent rupture of the filter cloth. If using a stone filter layer, get a clean, well-graded mix containing stone sizes ranging from ¾ of an inch to 3 inches.

**Stone Size for the Armor Layer:** To assure that a riprap shoreline will remain stable, you must specify the size of the stone to be used for the armor layer. The thickness of the riprap layer should be at least 2 times the D50. Be sure that you get a mixture, which includes smaller stone sizes so that small voids in the rock mix can be filled.

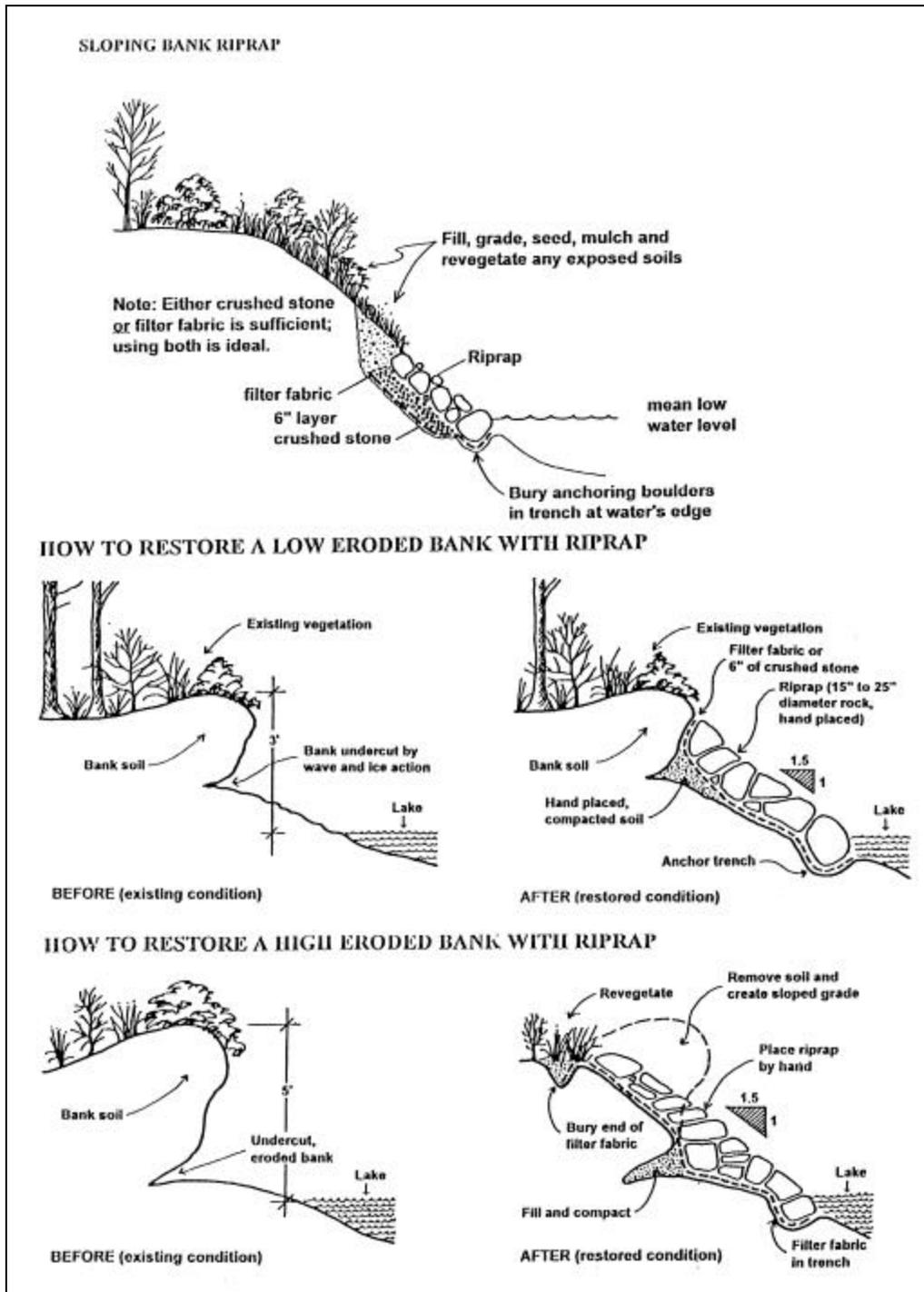
### **INSTALLATION**

Install the riprap when the water level is the lowest. Ideally, machinery should be parked on a flat area at the top of the slope, reaching out over the slope. Unstable slopes, however, may have to be worked from the side or toe to avoid possible slope failure due to the weight of the machinery.

- Prior to placing the riprap, the existing ground should be graded to an appropriate slope, preferably no steeper than 1.5 horizontal feet to 1 vertical foot (1.5:1). Clean, well-graded fill material should be added as needed to achieve a uniform grade. The fill should be free of large stones (larger than 6 inches) and firmly compacted before construction proceeds.
- Dig a trench at the toe of the slope to key in the riprap. The key should be at least three feet deep.
- Install the filter layer using proper construction methods for the material. Key-in the filter fabric at the top of the riprap edge and extend the fabric into the toe trench. A stone filter should extend into the toe trench and, if possible, be compacted against the native soil prior to placing the riprap.
- Stone placement should start at the toe trench and work upwards; making sure the armor layer is at least two stones thick and completely covers the fabric or stone filter. An excavator bucket may be used to compact the stone into a solid, interlocking mass. In addition, it may be necessary to place smaller stones by hand in order to get a uniform surface.

## MAINTENANCE

Despite its strength, riprap is not maintenance free. Inspect the slope in the spring, in the fall, and after severe storms for slumping, sliding, or seepage problems. Correct any problems immediately. Severe slumping or sliding may indicate that the slope is failing due to forces other than wave impact. Make a careful inspection of the land to the side of the riprap area. Near the riprap edge, erosion may be accelerated. If this is the case, additional measures may be necessary to halt the erosion.



**D-3 GABIONS****PURPOSE & APPLICATIONS**

A gabion wall is made of stacked flexible woven-wire baskets used to stabilize channels embankments and slopes, and can be used as revetments, retaining walls, abutments, check dams, and for other similar use. It is designed to:

- Protect the soil surface from the erosive forces of concentrated runoff and wave action.
- Slow the velocity of concentrated runoff while enhancing the potential for infiltration.
- Stabilize slopes with seepage problems and/or non-cohesive soils.

**CONSIDERATIONS**

- Whenever gabions are used along streams, they should be used in combination with vegetation to shade the stone.
- Construction must be sequenced so that the gabions are put in place with the minimum possible delay. Disturbance of areas where gabions are to be placed should be undertaken only when final preparation and placement of the gabions can follow immediately behind the initial disturbance.

**SPECIFICATIONS**

The design for a gabion wall must follow the manufacturer's specifications but all the following conditions must also be met:

- The design for gabions must include the design storm, riprap stone size and quality and filter specifics.
- The gabions should not be exposed to the abrasion from sand or gravel transported by moving water.
- The Manning's "n" value used for gabions shall be 0.025.
- The pH of the soil and water should be above 5 and the soil and water resistivity is more than 4,000 ohms/cm or plastic coated gabions shall be used.
- A gravel filter or geotextile fabric is needed and must be based on the D<sub>50</sub> size of the rock used to fill the gabions.
- The rock used to fill the gabions must be larger than the gabion mesh opening.

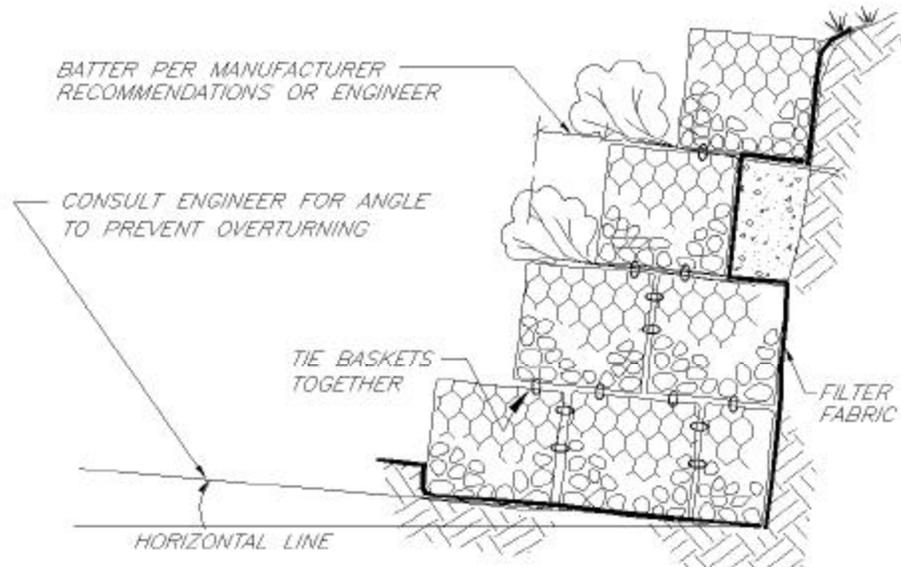
**Installation Requirements**

- Manufacturer's directions will be closely followed for the installation.
- Care should be taken when placing aggregates to ensure that the sheathing on PVC coated gabions is not broken or damaged.

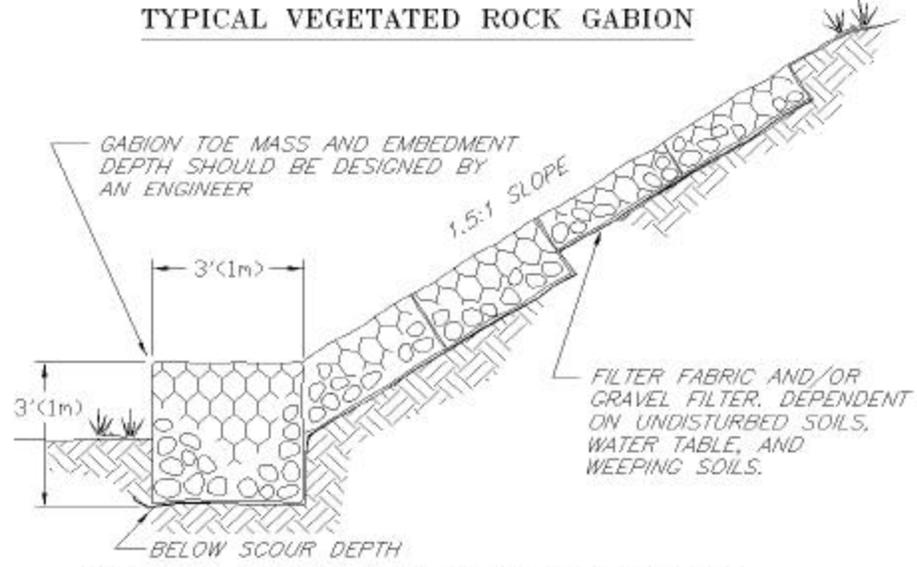
After a gabion has been filled, the lid shall be bent over until it meets the sides and edges. The lid shall then be secured to the sides, ends and diaphragms with the connecting wire in the manner described above for assembly.

**MAINTENANCE**

Periodic inspection for signs of undercutting or excessive erosion at transition areas is essential and repairs must be carried out promptly.



**TYPICAL VEGETATED ROCK GABION**



**TYPICAL GABION AND GABION MATTRESS**

**NOTES**

1. BEDDING FOR GABION MASS SHALL BE STONE, GRAVEL, SAND OR NATIVE MATERIAL CAPABLE OF SUPPORTING WEIGHT.
2. VINYL COATED BASKETS RECOMMENDED IN WET CONDITIONS TO HELP PREVENT RUSTING AND PREMATURE FAILURE.

**GABIONS  
FOR  
(NON-STREAM APPLICATIONS)**

1996 JOHN McCLAH ME DEP 2003

FILE: GABIONS

**E-1 PIPE/CULVERT INSTALLATION****PURPOSE & APPLICATIONS**

A water conveyance conduit is a pipe installed beneath the surface of the ground with or without inlet devices to collect surface and subsurface water and to convey it to a suitable outlet without causing damage by erosion or flooding. This practice applies where:

- Excess surface and subsurface water needs to be disposed of,
- A buried outlet is needed for diversions,
- An underground outlet can be installed to safely dispose of excess water,
- Surface outlets are impractical because of stability problems, climatic conditions, land use, or equipment traffic.

**CONSIDERATIONS**

A pipe installed in or discharging to a stream will require a state permit under the Natural Resource Protection Act.

Every effort should be made to use surface ditching or channels rather than underground enclosed pipe systems for the following reasons:

- Underground enclosed pipe systems are prone to plugging with trash and debris, requiring constant maintenance. Surface ditching is less prone to plugging and problems are immediately obvious.
- If underground systems fail, they are very difficult and costly to repair.
- Surface ditching provides opportunities for pollutants to be volatilized and exposed to ultraviolet light which promotes their decomposition. Vegetated ditches can also promote biological metabolism and decay of these pollutants.
- A subsurface system will reduce groundwater recharge since infiltration is reduced.

**SPECIFICATIONS****Design Specifications**

**Capacity:** The underground outlet shall be designed with adequate capacity to ensure that the system functions according to the standards for the specific practice. For example, an underground outlet can be used in combination with a diversion, waterway, or a surface drain to carry part or all of the design flow. The capacity of the underground outlet for natural basins must be adequate for the intended purpose without causing damage to local works of improvements. The size (frequency in years) of the design storm will be based on state or local regulations as appropriate.

**Inlet:** An inlet can be a catch basin, collection box, a perforated riser, or other appropriate devices. Its capacity shall be adequate to provide the maximum design flow in the conduit or a flow-control device should be installed. Refer to the PIPE INLET PROTECTION BMP for additional information.

Perforated risers must be of durable material, structurally sound, and resistant to damage by rodents or other animals. Catch basins must be large enough to facilitate maintenance and cleaning operations. The inlet must have an appropriate trash guard to ensure that trash or other debris entering the inlet passes through the conduit without plugging. The trash guard must also be capable of preventing the entry of people and animals. Pressure-relief facilities shall be designed and installed if needed to control uplift pressures. If junction boxes and other structures are needed, they shall be designed and installed in a manner that facilitates maintenance activities.

**Outlets:** The outlet shall be sufficiently stable for all anticipated flow conditions. It shall be designed for the maximum anticipated water surface at design flow. A continuous section of closed conduit with a headwall shall be used at the outlet. The outlet will include an armored plunge pool or apron, or other energy dissipation device. Refer to the PIPE OUTLET

PROTECTION BMP. The design of the energy dissipater will dictate the type of outlet pipe support (reinforced concrete bedding and pier) needed to maintain stability. All outlets must have a positive animal guard to prevent entry of people and animals.

**Protection:** Before the outlet is installed, all disturbed areas shall be reshaped and regraded so that they blend with the surrounding land features and conditions. Areas that are not planned to stay bare or covered by structural works shall be established to vegetation or otherwise protected from erosion as soon as possible after construction.

### **Construction Specifications**

Conduits and appurtenances shall be installed to the line and grade shown in the plans or as staked in the field and according to the recommendations of the manufacturers. Conduits shall be bedded and backfilled with the native material if suitable or with a well-compacted sand. The ends of the conduits shall be protected during installation. All appurtenant structures, including trash and animal guards, shall be installed promptly, and provisions shall be made for protecting them during installation.

Vegetation, riprap or other protective cover must be established promptly within 7 days of installation.

### **Material Specifications**

Materials shall meet or exceed the design requirements against leakage and must withstand internal pressure or vacuum and external loading. Plastic, concrete, aluminum, and steel shall meet the requirements specified in the material specification section following, or specified MDOT specs appropriate for the design for internal pressures and external loading. All materials specified for subsurface drains can be used for underground outlets if designed for proper pressure conditions. Conduits can be perforated or non-perforated, depending on the design requirements.

### ***MAINTENANCE***

Underground culverts must be maintained by keeping inlets, trash guards, and collection boxes and structures clean and free of materials that can reduce the flow. All leaks shall be repaired promptly to ensure proper functioning of the conduit. Animal guards must be inspected periodically and maintained in proper working order.

# CULVERT SIZES (ROUND) FOR STREAM CROSSINGS (3x RULE)

## AVERAGE STREAM WIDTH

Take two measurements across the stream from bank to bank where you intend to place the culvert. Measurements should be taken at the normal high water line (NHWL). To find the NHWL during low flow periods look for water stains on rocks or a debris line along the bank. Add the first measurement to the second and divide this number by 2. This equals the average stream width.

**Example: 36in. + 47 in. = 83in.  $83 \div 2 =$  avg. stream width of 41.5 inches. (Round up to 42in.)**

## AVERAGE STREAM DEPTH

Take 3 measurements from the bottom of the stream to the NHWL.

Add the measurements together and divide this number by 3. This equals the avg. stream depth.

**Example: 12in. + 16in. + 14in. = 42in.  $42 \div 3 =$  average stream depth of 14 inches.**

## USING THE TABLE

Take the average width and depth figures and determine where they intersect on the table above.

\*For example, for an average stream width of 42 inches (on the left side of the table), and an average stream depth of 14 inches (along the top of the table), the intersect shows a culvert diameter of 48 inches.

Average Stream Width		Average Stream Depth (Inches)														
Feet	Inches	2	4	6	8	10	12	14*	16	18	20	22	24	26	28	30
1	12	12	15	18	21	21	24	30	30	30	30	36	36	36	36	42
1.5	18	12	18	21	24	30	30	36	36	36	42	42	42	42	48	48
2	24	15	21	24	30	30	36	36	42	42	48	48	48	54	54	54
2.5	30	15	21	30	30	36	42	42	48	48	48	54	54	60	60	60
3	36	18	24	30	36	42	42	48	48	54	54	60	60	60	66	66
3.5	42*	18	30	36	36	42	48	48	54	54	60	60	66	66	72	72
4	48	21	30	36	42	48	48	54	54	60	66	66	66	72	72	78
4.5	54	21	30	36	42	48	54	54	60	66	66	72	72	78	78	84
5	60	21	30	42	48	48	54	60	66	66	72	72	78	78	84	84
5.5	66	24	36	42	48	54	60	60	66	72	72	78	78	84	84	90
6	72	24	36	42	48	54	60	66	66	72	78	78	84	90	90	96
6.0	78	24	36	42	54	60	60	66	72	78	78	84	90	90	96	96
7	84	30	36	48	54	60	66	72	72	78	84	84	90	96	96	102
7.5	90	30	42	48	54	60	66	72	78	84	84	90	96	96	102	102
8	96	30	42	48	54	66	66	72	78	84	90	90	96	96	102	108
8.5	102	30	42	48	60	66	72	78	84	84	90	96	102	102	108	108
9	108	30	42	54	60	66	72	78	84	90	96	96	102	108	108	114
9.5	114	30	42	54	60	66	72	78	84	90	96	102	102	108	114	114
10	120	30	48	54	66	72	78	84	90	96	96	102	108	114	114	120
10.5	126	36	48	54	66	72	78	84	90	96	102	108	108	114	120	120
11	132	36	48	60	66	72	78	84	90	96	102	108	114	114	120	126
11.5	138	36	48	60	66	78	84	90	96	102	108	108	114	120	126	126
12	144	36	48	60	66	78	84	90	96	102	108	114	120	120	126	132
12.5	150	36	48	60	72	78	84	90	96	102	108	114	120	126	132	132
13	156	36	54	60	72	78	90	96	102	108	114	114	120	126	132	138
13.5	162	36	54	66	72	84	90	96	102	108	114	120	126	132	132	138
14	168	36	54	66	72	84	90	96	102	108	114	120	126	132	138	144
14.5	174	36	54	66	78	84	90	96	108	114	120	126	126	132	138	144
15	180	42	54	66	78	84	96	102	108	114	120	126	132	138	144	144

**E-2 PIPE INLET PROTECTION****PURPOSE & APPLICATIONS**

Pipe inlet protection is a protective armor for the immediate area around the inlet of a pipe or culvert to protect it from scour and deterioration. This standard applies to the inlets of underground conduits designed to dispose of excess surface and subsurface water, culverts, and to principal spillways in ponds.

**CONSIDERATIONS**

Durability, ease of maintenance, and availability of materials as well as aesthetics and safety should be considered when selecting the appropriate inlet protection measure.

**SPECIFICATIONS****Design Criteria**

All inlets to hydraulic conduits will be adequately protected from scour caused by the entrance velocity, turbulence, and suction of the water entering the inlet. Protective measures shall extend no less than one pipe diameter, or maximum dimension on rectangular conduits, on the sides, top, and approach channel. An inlet "pool" will be beneficial for fish habitat. One of the following options must be used to stabilize the inlet structure:

**Vegetative Measures** Vegetation shall be installed according to the standards of the PERMANENT VEGETATION BMP. All newly seeded areas must be mulched. Mulch must be anchored with netting or matting. Refer to the TEMPORARY MULCH BMP.

On gravel and clay embankments the slope must be flatter than 2:1 and the conduit must extend beyond the fill by at least 1/2 pipe diameter on both sides and top.

On sand and silt embankments the slope must be flatter than 2.5:1 and the conduit extend beyond the fill by at least one pipe diameter on both sides and top.

**Riprap:** Riprap shall be installed according to the RIPRAP SLOPE STABILIZATION BMP and the RIPRAP WATERWAYS BMP AND be of a size able to withstand the velocity of flow up to a maximum D50 of 12 inches.

Gabion mats shall be installed according to the GABION BMP.

Riprap protection or gabions must be underlain with a gravel filter or a geotextile to prevent piping through the backfill material.

**Inlet Protection:** Inlet works shall extend at least one pipe diameter beyond the conduit. Rigid inlet retaining wall types shall be reinforced to be able to withstand settling, frost heaving, and other associated loading without cracking or otherwise failing.

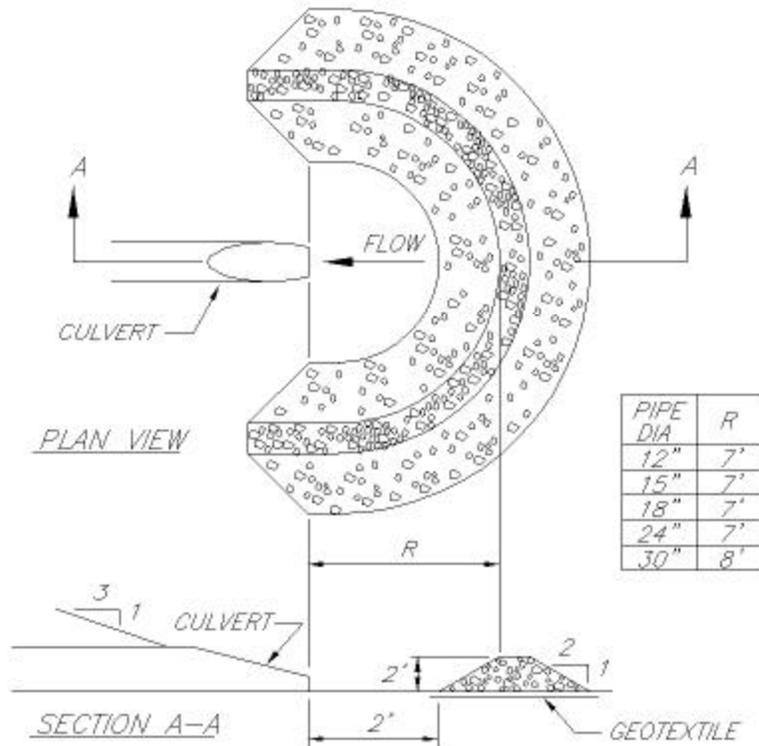
Structural non-rigid retaining walls built of various kinds of block shall have a camber inward of at least 1/2:1 and have protection from piping.

**Construction Specifications**

Refer to the RIPRAP, GABIONS and PERMANENT VEGETATION BMPs. Use industry standards for reinforced concrete structures or any other manufactured system.

**MAINTENANCE**

Refer to the appropriate BMPs to stabilize the inlet structure.



NOTES:

1. USE 2" TO 3" STONE.
2. PLACE STONE OVER GEOTEXTILE.
3. ONCE THE AREAS UPSTREAM FROM THE CHECK DAM ARE STABILIZED BY VEGETATION, THE SEDIMENT TRAPPED BEHIND/WITHIN THE DAM SHALL BE RELOCATED TO AN AREA UNDERGOING FINAL GRADING.
4. THE CHECK DAMS SHALL BE FLATTENED AND GRADED IN A MANNER WHICH PROTECTS THE AREA FROM EROSION AND CHANNEL BLOCKAGE. (GEOTEXTILE MUST BE REMOVED).
5. THE GEOTEXTILE SHALL BE DISPOSED OF OFFSITE.
6. THE AREA CONTRIBUTING TO THE CHECK DAM SHALL NOT EXCEED 10 ACRES.

**TEMPORARY CHECK DAM  
AT CULVERT ENTRANCE**

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FILE: CHRDAMCULV

**E-3 PIPE OUTLET PROTECTION****PURPOSE & APPLICATIONS**

Pipe outlet protection is a protective armor for the immediate area around the outlet of a pipe or culvert to protect it and the receiving channel from scour and deterioration. This practice is applicable to the outlets of underground conduits designed to dispose of excess surface and subsurface water, culverts, and to principal spillways in detention and sediment ponds. Types of outlet protection are natural plunge pools, ripraped aprons, and ripraped plunge pools. The type of protection should be dependent upon site conditions such as water volume discharge, foundation soils and tailwater.

**CONSIDERATIONS**

All outlets to hydraulic conduits must be adequately protected from scour caused by the exit velocity, turbulence, and suction of the water leaving the outlet.

The outlets of pipes and structurally lined channels are points of critical erosion potential. Stormwater transported through man-made conveyance systems at design capacity generally reaches a velocity exceeding the capacity of the receiving channel. To prevent scour at stormwater outlets, a flow transition structure is needed which will absorb the initial impact of the flow and to reduce the flow.

**Apron:** The most commonly used device for outlet protection is a structurally lined apron. This structure protects and stabilizes the fill slope around and above the culvert. The apron is generally lined with riprap, grouted riprap or concrete. They are constructed at a zero grade for a distance that is related to the outlet flow rate and the tailwater level.

**Plunge Pool:** Where flow is excessive for the economical use of an apron, excavated stilling basins or plunge pools may be used. The plunge pool allows the dissipation of energy at the outlet of the pipe and into the channel.

If the pipe is a stream crossing, fish passage will be an issue and a NRPA permit will be required. The plunge pool design, access and elevation of the pipe will need to be adequate for a constant flow. The Department of Inland Fisheries and Wildlife will need to be consulted for guidance and to determine the design needed for fish passage.

If the drainage pipe discharges into a natural vegetated filter area, an energy dissipator is also required. See LEVEL SPREADER BMP. If the outlet drains into another conveyance structure such as a ditch or constructed swale, only a plunge pool will be needed.

**SPECIFICATIONS****Design Criteria**

Details must include all dimensions of the structure, D50 of riprap chosen, depth of riprap layer and depth of gravel filter layer.

**Fish Passage:** The selection of an appropriate outlet protection method must consider the impact on fish passage. In general, the flow depth and velocity must be taken into account. The flow velocity for fish passage generally should not exceed 2 feet per second.

**Design:** In watersheds less than 640 acres (1 square mile) it is recommended that structures be designed to accommodate flows from the 25 year storm event or check with local and state requirements. Above that acreage, FEMA rules govern and the culvert should be designed for a 100-year storm if it is in a floodplain. DOT requires their structures to pass the 10-year storm.

**Natural Outlet Conditions:** There are situations where a natural earth pool will be adequate. Where no outlet protection is proposed, it must be shown that THE existing receiving channel conditions (soil type) can withstand the anticipated maximum velocity based on bare soil velocity as found in Appendix B, HYDROGEOLOGIC SOIL GROUPS. The soils on-site must be verified at the time of installation to ensure that they can withstand the design velocities.

## Aprons

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

**Tailwater Depth:** The depth of tailwater immediately below the pipe outlet during the 10-year storm must be determined for the design capacity of the pipe. Manning's Equation may be used to determine that 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 and the table at the end of this section may be used. If the tailwater depth is greater than half the diameter of the outlet pipe, then another engineering method needs to be utilized. Pipes which outlet onto an area with no defined channel may be assumed to have a minimum tailwater condition.

**Apron Length:** The apron length shall be determined from the enclosed table.

**Apron width:** If the pipe discharges directly into a well-defined channel, the apron shall extend across the channel bottom and 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:

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

**Note:** Consult with IF&W for sizing criteria if the apron is so wide that the depth of water from the base flow of the stream is too shallow to allow fish passage.

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

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

**Materials:** The apron may be lined with vegetation, riprap, grouted riprap, or concrete. The median sized stone for riprap shall be determined from the included table. If concrete is used in a stream, it must be air dried for 21 days and rinsed prior to contact with water.

Aprons made up of riprap shall be designed and installed in accordance with the RIPRAP BMP.

Aprons made up of gabions shall be designed and installed in accordance with the GABION BMP. Both will have piping protection provided by either a gravel filter or appropriate geotextile.

When gabion mats are used, the rock filling the baskets shall contain no rock smaller than the mesh of the baskets.

## Plunge Pools

Refer to the detail drawings at the back of this section for the proper design of a plunge pool.

**"Hanging" culverts:** "Hanging" culverts (culverts with a significant drop from the outlet to the stream) with plunge pools will not be allowed on streams with fish migration.

**Culvert sizes of 36 inch diameter or less:** An outlet pool lined with 6 to 12 inch stone constructed one diameter deep, two diameters wide and four diameters long will provide adequate outlet protection. For example, a 12-inch diameter culvert would require a stone-lined outlet pool 12 inches deep, 24 inches wide and 48 inches long.

**Culverts greater than 36 inches** A professional engineer should design these. The installation of riprap shall conform to the RIPRAP BMP. Rock riprap on the sides of the pool shall taper from the top of the pipe at the outlet down to the level of the design high water elevation of the receiving channel for the design storm. A gravel filter or appropriate geotextile shall be used to protect against piping of soil fines from beneath the rock.

## MAINTENANCE

Periodically check all aprons, plunge pools and structural outlets for damage and repair them as needed. If any evidence of erosion or scouring is apparent, modify the design as needed to provide long term protection (keeping in mind fish passage requirements if applicable).

**OUTLET PROTECTION  
FOR A PIPE FLOWING FULL WITH LOW TAILWATER**

**RIPRAP SIZE - D50 (inches)**

**PIPE DIAMETER**

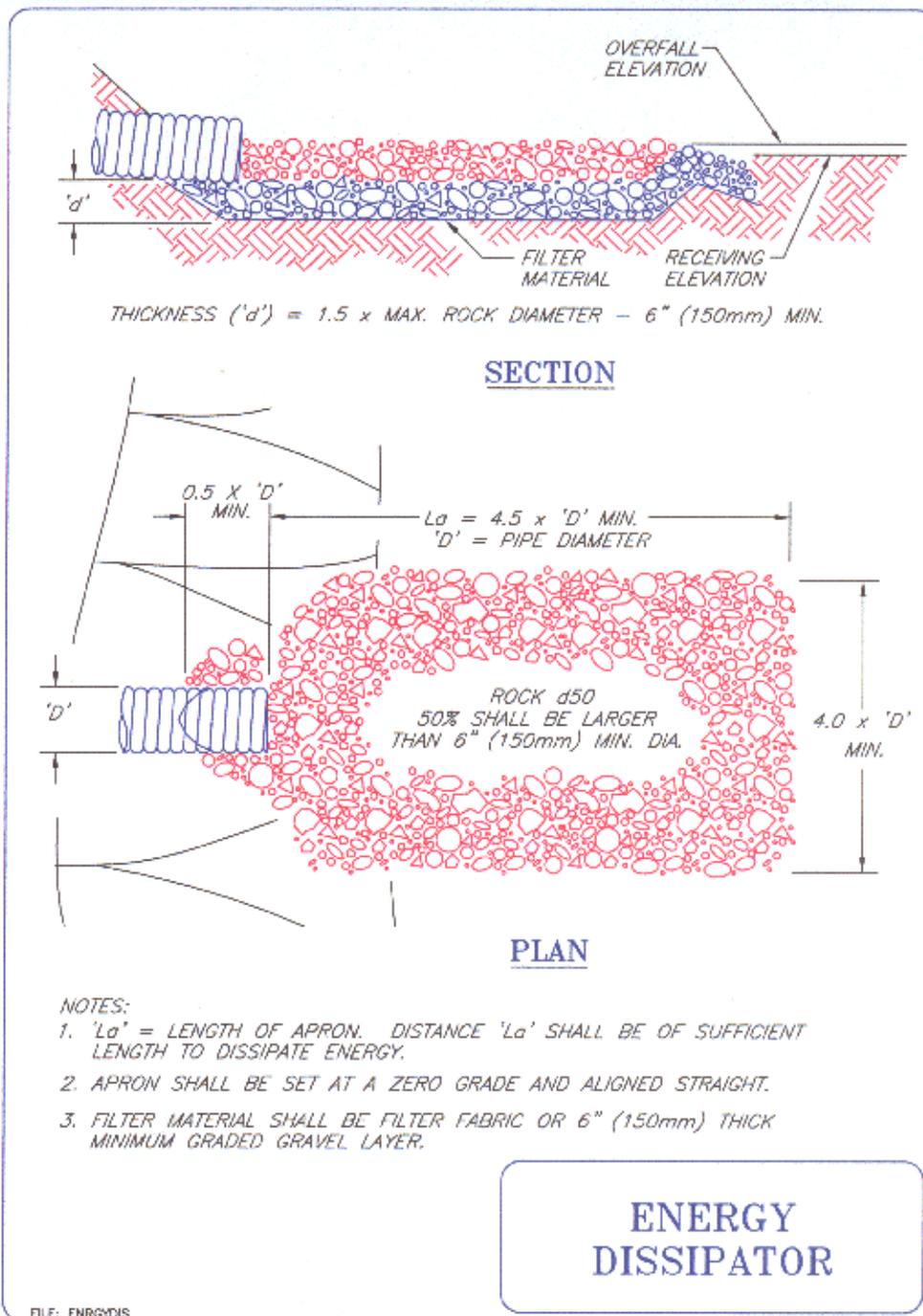
	12"	15"	18"	21"	24"	27"	30"	36"	42"	48"	54"	60"
<b>3cfs</b>	4											
<b>5cfs</b>	4											
<b>8cfs</b>	5	4										
<b>10cfs</b>	6	5	4									
<b>12cfs</b>	8	6	6									
<b>15cfs</b>	8	6	8	5								
<b>17cfs</b>		8	8	5								
<b>20cfs</b>		10	10	6	5							
<b>25cfs</b>		12	12	6	6							
<b>30cfs</b>				8	8	6						
<b>40cfs</b>				12	10	8	6					
<b>50cfs</b>				16	12	10	8	6				
<b>60cfs</b>				18	16	12	10	8				
<b>70cfs</b>					18	15	12	8				
<b>80cfs</b>					20	16	15	10	8			
<b>90cfs</b>						18	16	12	10			
<b>100cfs</b>						20	18	12	10			
<b>125cfs</b>						24	20	16	12	10		
<b>150cfs</b>							24	20	16	12	10	
<b>200cfs</b>								24	20	18	15	12

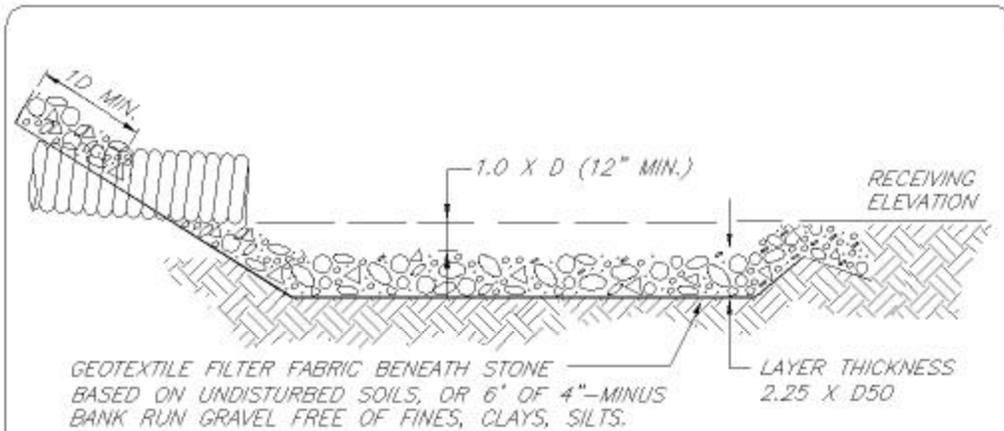
**MINIMUM LENGTH OF APRON (FEET)**

**PIPE DIAMETER**

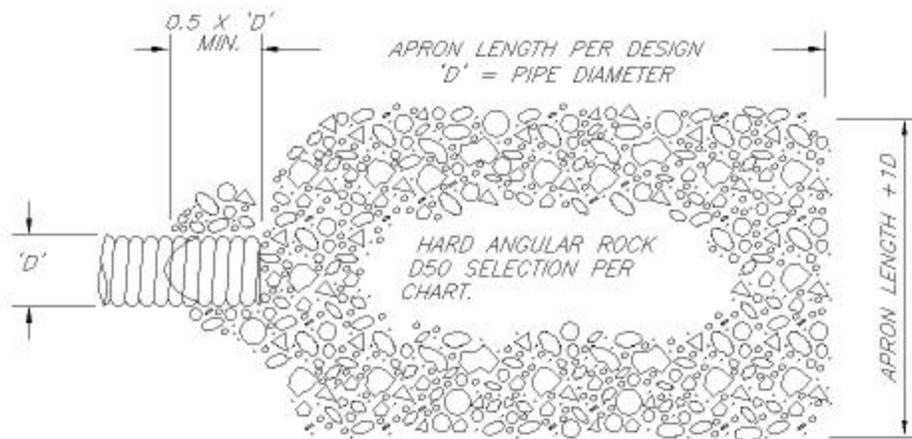
	12"	15"	18"	21"	24"	27"	30"	36"	42"	48"	54"	60"
<b>3cfs</b>	8											
<b>5cfs</b>	8											
<b>8cfs</b>	11	10										
<b>10cfs</b>	14	12	10									
<b>15cfs</b>	18	16	14	12								
<b>20cfs</b>		18	18	16	12							
<b>30cfs</b>			22	20	18	16						
<b>40cfs</b>			26	24	24	20	18					
<b>50cfs</b>				26	26	24	22	18				
<b>70cfs</b>					30	30	28	25				
<b>100cfs</b>						36	36	33	27			
<b>150cfs</b>						42	42	42	38	33	28	
<b>200cfs</b>								48	45	42	37	32

From USDA Soil Conservation Service





**SECTION**



**PLAN**

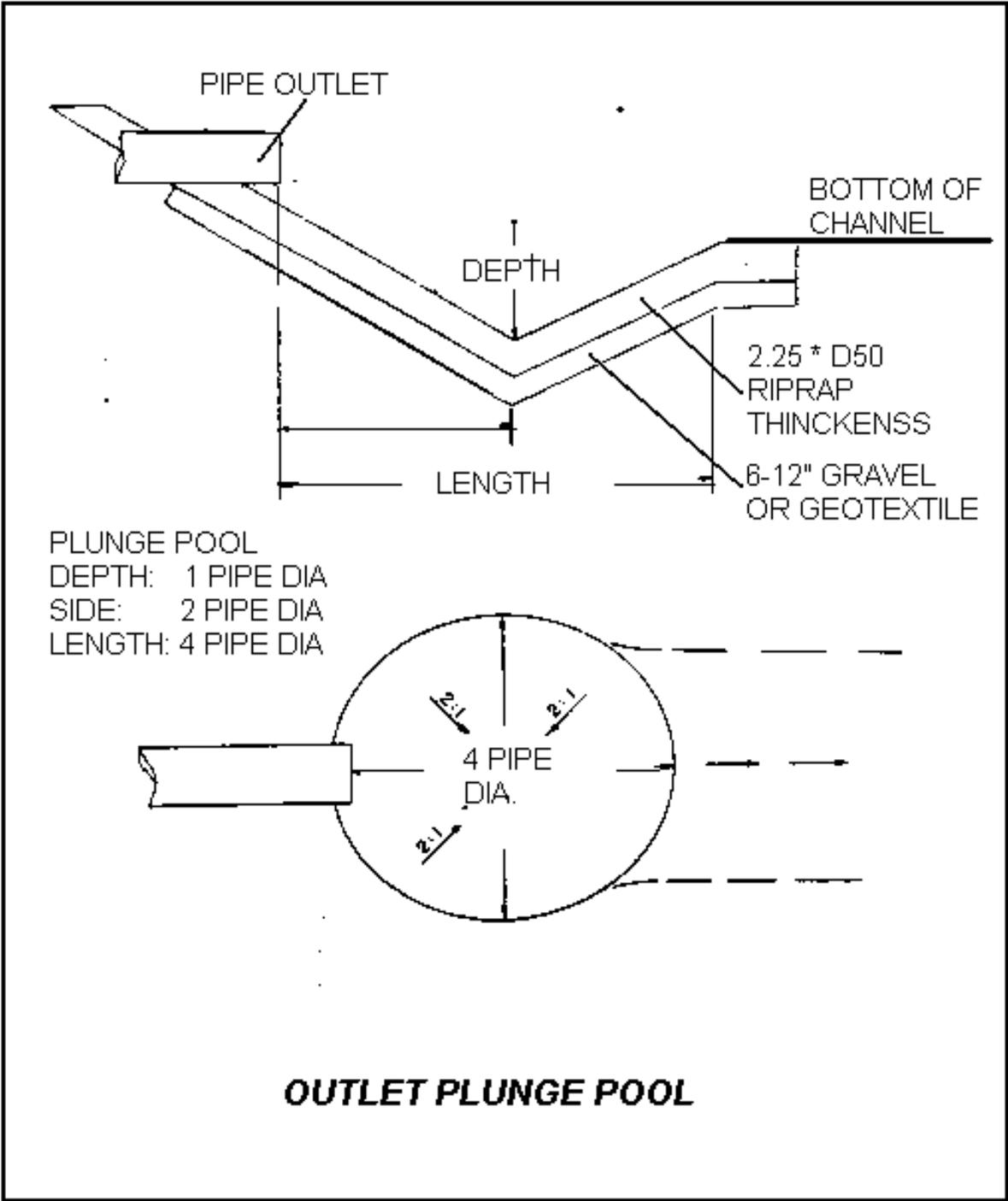
**NOTES:**

1. CONSULT WITH IF&W IF FISH PASSAGE WILL BE INHIBITED DURING LOW FLOWS.
2. REFER TO DESIGN NOTES AND LIMITATIONS IN TEXT ON PIPE OUTLET PROTECTION.
3. IN DEFINED CHANNELS, APRON SHALL EXTEND FULL WIDTH OF BOTTOM AND ONE FOOT ABOVE MAX. TAILWATER OR UP TO BANK FULL, WHICHEVER IS LESS.

**PIPE OUTLET  
PROTECTION**

1984 JOHN McCULLAH ME DEP 2003

FILE: OUTLETAPRON



**E-4 LEVEL SPREADERS****PURPOSE & APPLICATIONS**

A level spreader is an outlet constructed at zero grade across the slope consisting of a vegetated or mechanical structure used to disperse or "spread" concentrated flow thinly over a receiving area. Its purpose is to spread collected water over a wide enough area so that erosion of the receiving area does not result. It can reduce erosion and the movement of sediment. An additional benefit of a level spreader is to remove other pollutants from runoff by filtration, infiltration, absorption, adsorption, decomposition, and volatilization.

This practice applies:

- Where concentrated water is dispersed within wooded buffers or on fields adjacent to streams, ponds, and lakes; and
- In areas requiring a filter strip such as a buffer to treat runoff.

This practice shall not be used:

- Where drainage areas above it are greater than 10 acres. For greater drainage areas, use vegetated waterways, lined waterways, or grade control structures.
- Where the water discharge will cross an adjoining property line unless it can be intercepted by a stable drainageway capable of handling the added volume.

**CONSIDERATIONS**

- A level spreader must be installed correctly with 0% grade on the spreader lip to ensure a uniform distribution of flow; otherwise water will channelize below the structure and become a source of erosion.
- Consider the time of year available for proper establishment of vegetation prior to construction of the level spreader. If a grass cover needs to be installed in the receiving area, construction will be limited to the growing season. Final seeding should be completed by September 1. Otherwise, refer to the OVERWINTER STABILIZATION AND CONSTRUCTION BMP.
- Stable receiving swales should exist below the receiving area as concentrated flow can be expected to start occurring within about 300 feet. Evaluate slopes and soil material, vegetative species and their condition on the receiving area before constructing a level spreader.
- Provisions for mowing and otherwise managing the vegetation on the receiving area shall be planned to maintain the effectiveness of the filter area.

**SPECIFICATIONS****Design Criteria**

Refer to detail drawings found at the back of this section for the proper design of a level spreader.

**Capacity:** The capacity of each level spreader shall be based on the allowable velocity of the soil. The minimum length shall be 12 feet. Typically, a level spreader should be sized to transfer 0.25 cfs per linear foot of spreader during the 10-year storm.

**Receiving Area:** Each level spreader shall have a vegetated receiving area with the capacity to pass the flow without erosion. The receiving area shall be stable prior to the construction of the level spreader.

The receiving area shall have a regular topography to prevent undue flow concentration before entering a stable watercourse. If the receiving area is not presently stable, then the receiving area shall be stabilized according to the PERMANENT VEGETATION BMP prior to the level spreader being built. This will limit construction to the growing season.

**Approach Velocity:** The flow area upstream of the level spreader shall be sufficient to ensure a low approach velocity to the level "lip." The minimum flow area of level spreader shall be equal to four times the flow of the delivery channel. The lip shall be installed at a 0% grade (level).

### **Construction Specifications**

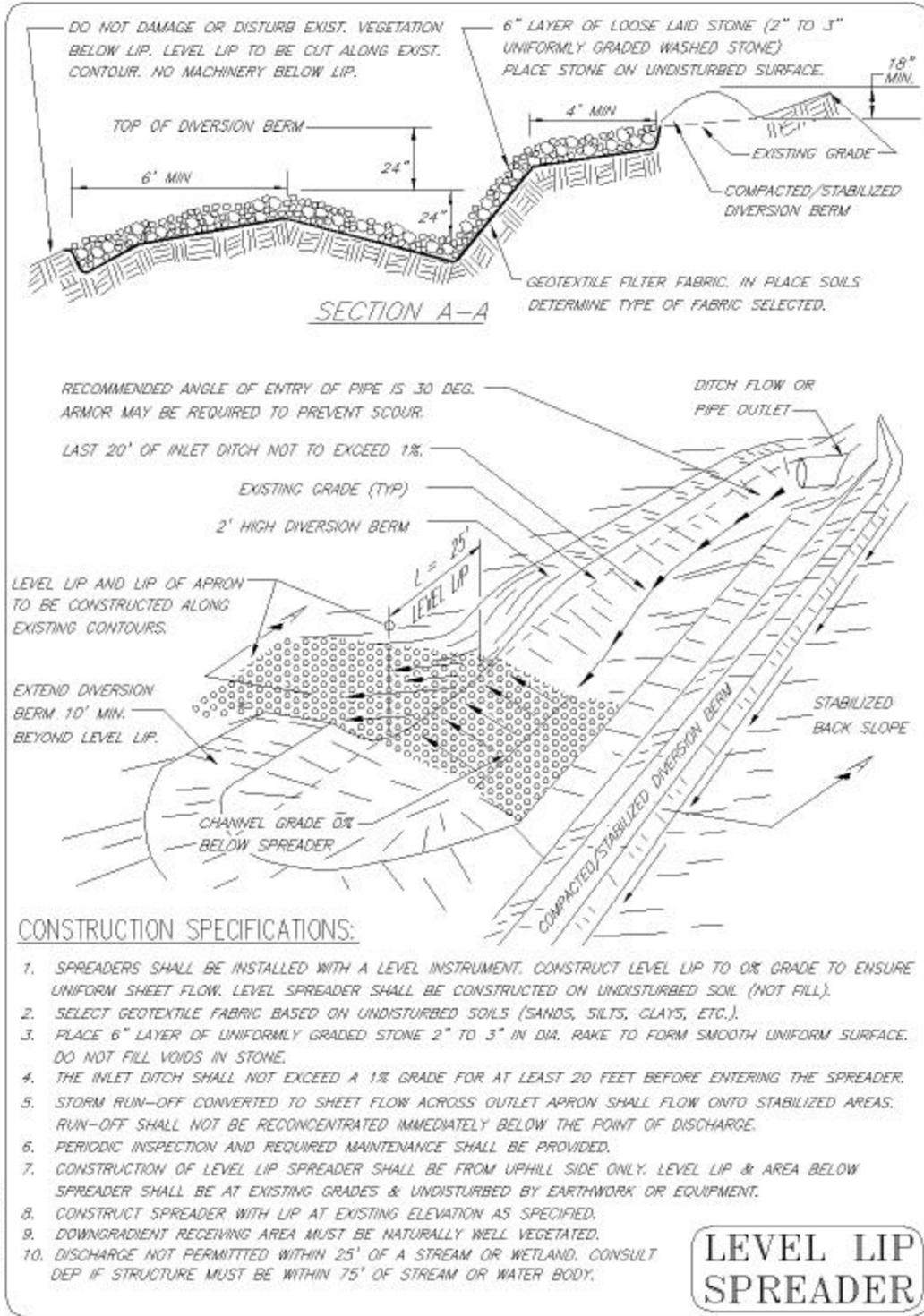
The receiving area below the level spreader shall be protected from harm during construction. Minor disturbed areas shall be stabilized with vegetative measures. A temporary stormwater diversion may be necessary until the level spreader has fully stabilized.

Level spreaders must blend smoothly into the downstream receiving area without any sharp drops or irregularities, to avoid channelization, turbulence and hydraulic "jumps."

Level spreaders shall be constructed on undisturbed soil where possible. If fill is used, it shall be constructed of material compacted to 95% of standard proctor test levels prior to seeding for that area not considered the seedbed.

### ***MAINTENANCE***

After construction and until fully revegetated, the level spreaders need to be carefully inspected for any signs of channelization and immediately repaired. The structure will fail if water exits from it in channelized flow. Vegetated level spreaders may require periodic mowing. Spreaders constructed of wood, asphalt, stone or concrete curbing also require periodic inspection to check for damage and to be repaired as needed. Over time, the level spreader may fill with sediment and will need to be cleaned out to maintain its capacity.



**E-5 VEGETATED WATERWAYS****PURPOSE & APPLICATIONS**

A vegetated waterway is an artificial channel, ditch or outlet, shaped or graded and established with suitable vegetation. It does not include natural stream channels. The waterway channel may must have a parabolic or trapezoidal cross-section. It reduces gully erosion and provides limited filtering of sediment and pollutants.

This practice is applicable at all sites where concentrated runoff needs to be conveyed and controlled without causing erosion (roadside ditches, drainage easements, etc.). Stone centered waterways are also practical where machinery will need to cross them.

**CONSIDERATIONS**

- Lack of established vegetation in late fall may result in spring erosion and water quality deterioration. Refer to the OVERWINTER STABILIZATION AND CONSTRUCTION BMP.
- Areas with seepage (high water table) may be regulated wetlands and a NRPA permit may be required.
- The selection of vegetative seed mixtures must consider the local wildlife and fishery needs. If shading is required to keep low water temperatures for fisheries, trees and shrubs should be planted to shade the waterway.

**SPECIFICATIONS****Design Specifications**

Refer to the detail drawing found at the back of this section for the proper design and construction of a vegetation swale.

**Capacity:** The minimum capacity of the swale must be sufficient to confine the peak runoff expected from a storm of 10-year frequency, 24-hour duration at a minimum. On slopes of less than 1 percent, out-of-bank flow may be permitted if such flow will not cause erosion, property damage, or threaten life.

**Velocity:** Velocities shall not exceed the maximum permissible velocity values for vegetated soils as listed in APPENDIX B.

**Slope:** The vegetation within a ditch line with a slope greater than 8 % will not hold or remain healthy. Thus, ditches with a slope steeper than 8% will need to be ripraped. See the RIPRAP WATERWAYS BMP.

**Drainage:** A stone center drain or another suitable reinforcement drainage measure shall be provided for swales having continuous flows, a high water table, or seepage problems. Stone sizing for stone-centered waterways should be no larger than 2-3 inches (D50). Sites with flatter slopes (less than 2%) where water-tolerant vegetation, such as reed canarygrass, can be grown and erosion will not occur may not require additional reinforcement. NOTE: This condition is indicative of a wetland area and a NRPA permit would be required.

**Outlet:** All grassed waterways shall have a stable outlet with adequate capacity for the design flow. The outlet can be another vegetated channel, an earth ditch, a natural channel, or other suitable outlet. The bank-full discharge from the new channel shall flow smoothly into the existing channel without any velocity increase or depth loss.

**Erosion Control Blanket:** The placement of one strip of erosion control blanket at the base of a ditch or swale is an excellent way to protect the newly excavated ditch from erosion until vegetation is established. This is especially beneficial when the swale has a slight slope. However, the manufacturer's specification for stapling must be followed.

**Vegetative Specifications**

Special emphasis will be given to the proper installation and maintenance of vegetative practices during planning, design, and construction.

- Upon final grading, the disturbed areas shall be immediately seeded to permanent vegetation and mulched and will not be used as outlets until a dense, vigorous vegetative cover has been obtained. Refer to the PERMANENT VEGETATION BMP. See APPENDIX A for suitable seed mixtures for the purpose and site conditions.
- Seeded areas need protection during establishment and will be treated in accordance with the MULCHING BMP. Note that netting or excelsior mesh should be installed in the base of all vegetated channels until vegetation is well established (75% surface cover at a minimum).

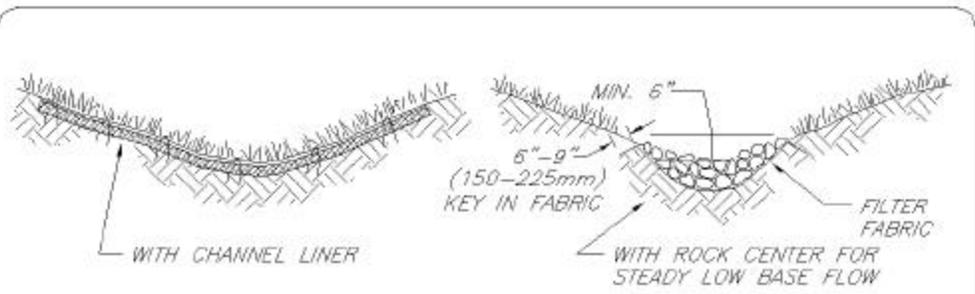
### **Schedule of Installation**

Once soil is exposed for waterway construction, it should be immediately shaped, graded and stabilized.

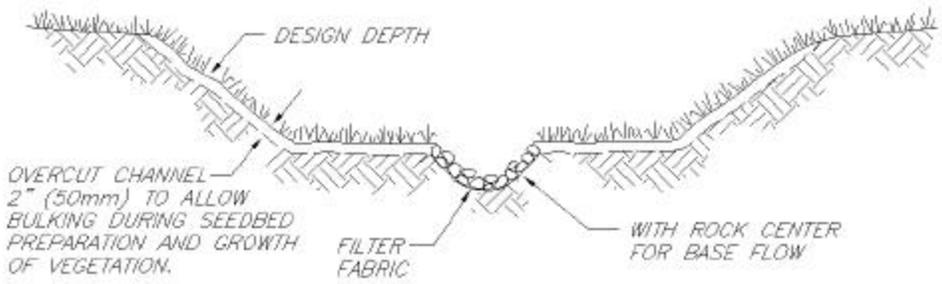
Vegetated waterways need to be stabilized early during the growing season (prior to September 15). If final seeding of waterways is delayed past September 15, emergency provisions such as sod or riprap may be required to stabilize the channel. Waterways should be fully stabilized prior to directing runoff to them.

### ***MAINTENANCE***

A maintenance program should be established to maintain waterway capacity, vegetative cover, and the outlet. The need for periodic liming and fertilizing shall be based on soil tests or visual observation. Mow waterway at least once annually. When practical, delay mowing until after July 15 to accommodate ground nesting wildlife. Mow to a height of 4 to 6 inches to help maintain good surface protection. Excessive growth shall be removed. Do not mow later than 30 days prior to the first killing frost (average date).



**TYPICAL PARABOLIC CHANNEL  
CROSS-SECTION**



**TYPICAL TRAPEZOIDAL CHANNEL  
CROSS-SECTION**

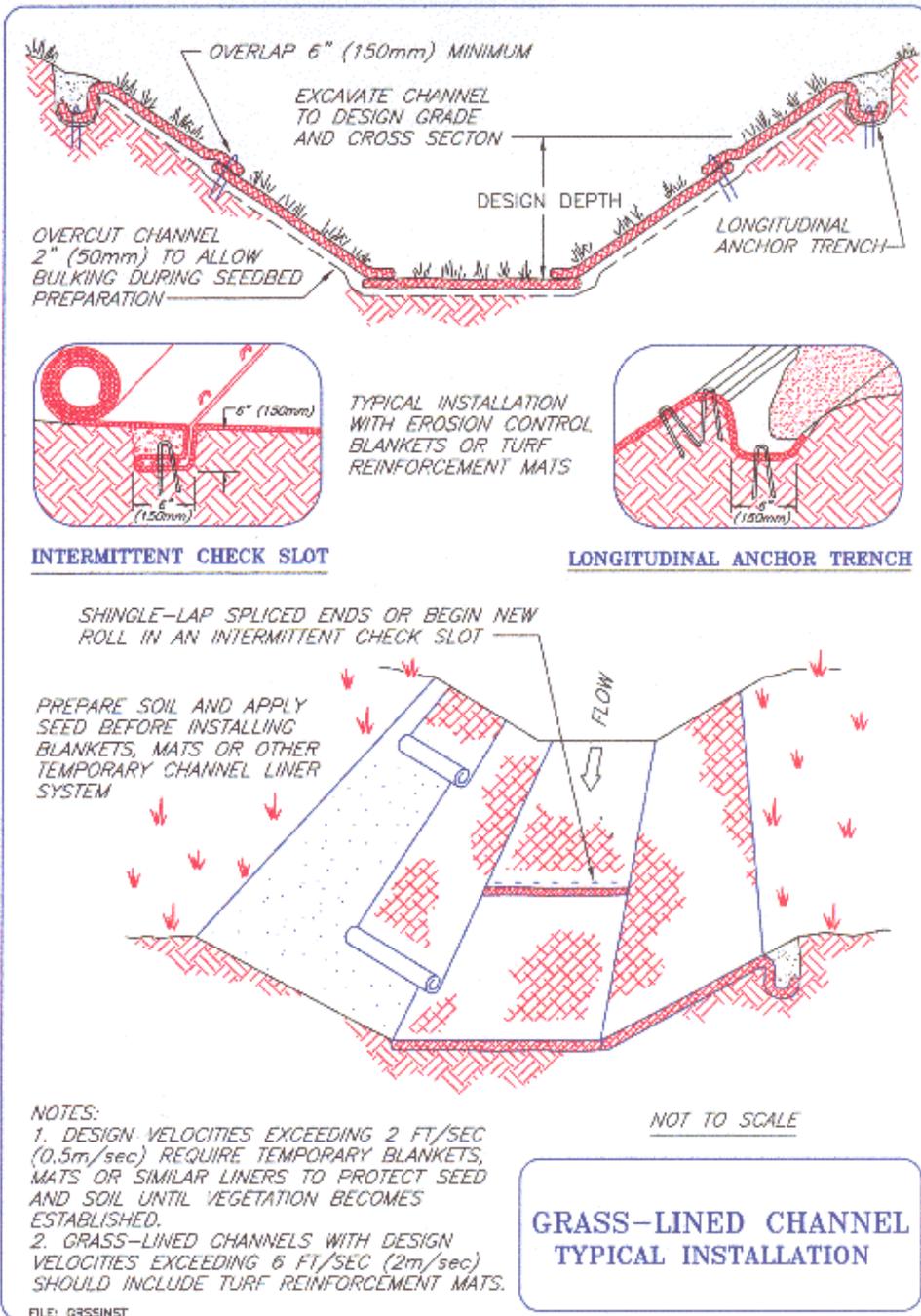
**NOTES**

1. CHOOSE FABRIC BASED ON SOILS PRESENT, I.E., COARSE OR CLAYS/SILTS.
2. ROCK SIZE IN CHANNEL CENTER BASED ON VELOCITY, SEE ROCK SIZING.
3. USE TURF REINFORCEMENT MATS IF VELOCITY EXCEEDS 3 FPS. REFER TO APPROPRIATE CHAPTER IN MANUAL.

**GRASS-LINED CHANNEL  
TYPICAL CROSS SECTIONS**

1996 JOHN McCULLAH ME DEP 2003

FILE: GRASS-XS



## E-6 RIPRAP WATERWAYS

### PURPOSE & APPLICATIONS

Riprap is a permanent, erosion-resistant ground cover constructed of large, loose, angular or sub-angular (rounded) stone. Riprap may be used, as appropriate, at storm drain outlets, on channel banks and/or bottoms, roadside ditches, drop structures, at the toe of slopes or to stabilized streams, etc. This practice is applicable where the soil conditions, water turbulence and velocity, expected vegetative cover, etc., are such that the soil may erode under the design flow conditions. Its purpose is:

- To protect the soil surface from the erosive forces of concentrated runoff.
- To slow the velocity of concentrated runoff while enhancing the potential for infiltration.
- To stabilize slopes with seepage problems and/or fine textured non-cohesive soils.

### CONSIDERATIONS

Since riprap is used where erosion potential is high, construction must be sequenced so that the riprap is put in place without delay. Disturbance of areas where riprap is to be placed should be undertaken only when final preparation and placement of the riprap can follow immediately behind the initial disturbance. Where riprap is used for outlet protection, the riprap should be placed before or in conjunction with the construction of the pipe or channel so that it is in place when the pipe or channel begins to operate.

### SPECIFICATIONS

#### Design Criteria

Refer to the detail drawing located at the back of this section for the proper construction of a riprapped channel. Also refer to the RIPRAP SLOPE STABILIZATION BMP.

**Types of Riprap:** Refer to MDOT specifications for information about standard types of riprap.

**Gradation:** Since graded riprap consists of a variety of stone sizes, the average size of stone in a mixture is described as the D<sub>50</sub>. In other words, it is specifying a diameter of stone in the mixture for which 50 percent, by weight, will be smaller and 50 percent will be larger.

A mixture composed primarily of the larger stone size but with a sufficient mixture of other sizes filling the progressively smaller voids between the stones is described as a well-graded mixture. The diameter of the largest stone size in such a mixture should be 1.5 times the D<sub>50</sub> size.

The designer, after determining the riprap size that will be stable under the flow conditions, shall consider that size to be minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size.

**Roughness coefficient:** The most significant effect on the retardance of flow velocity is from the friction that occurs along the flow channel. For riprap, Manning's n is calculated as follow:

$$n = \frac{y^{1/8}}{[21.6 \log_{10}(y/D_{50}) + 14.0]} \quad \text{where: } y = \text{depth of water in feet}$$

$$D_{50} = \text{riprap diameter in feet}$$

**Thickness:** The minimum thickness of the riprap layer shall be 2.2 times the maximum stone diameter (for a D<sub>50</sub> of 12" or smaller), but not less than 6 inches. For D<sub>50</sub> specified greater than 12 inches, the riprap layer thickness shall be 2 times the D<sub>50</sub>.

**Quality of Stone:** Stone for riprap shall consist of sub-angular field stone or rough unhewn quarry stone of approximately rectangular shape. The stone shall be hard and of such quality that it will not disintegrate on exposure to water or weathering, be chemically stable and it shall be suitable in all other respects for the purpose intended. The bulk specific gravity (saturated surface-dry basis) of the individual stones shall be at least 2.5.

**Riprap at Outlets:** Design criteria for sizing the stone and determining the dimension of riprap pads used at the outlet of drainage structures are contained in the PIPE OUTLET PROTECTION BMP.

### **Riprap for Channel Stabilization**

Riprap for channel stabilization shall be designed to be stable for the condition of bank-full flow in the reach of channel being stabilized. Riprap shall extend up the banks of the channel to a height equal to the maximum depth of flow for a 10-year storm event or to a point where vegetation can be established to adequately protect the channel bottom width. The riprap shall extend across the bottom and up both sides of the channel.

**Bank Protection:** Where riprap is used only for bank protection and does not extend across the bottom of the channel, riprap shall be keyed into the bottom of the channel. The minimum depth of the key must equal to 2.25 times the  $D_{50}$  and must extend across the bottom of the channel for the same distance.

**Flow Velocity:** The  $D_{50}$  of the riprap should be designed for the maximum velocity as follow:

<b>FLOW VELOCITY(cfs)</b>	<b>RIPRAP D50</b>
16	36 inch
13	24 inch
11	18 inch
10	15 inch
8	10 inch
6	6 inch
4	3 inch

Other methods for determining  $D_{50}$  sizes may be used but need to be documented.

**Filter Blankets:** A filter blanket is a layer of material that prevents soil movement into or through the riprap. A filter blanket can be either a gravel layer or geotextile filter cloth. The need for a filter blanket is determined by comparing the particle sizes of the overlying material and the base material in accordance with the criteria below:

**Filter Blankets:** A filter blanket is a layer of material placed between the riprap and the underlying soil surface to prevent soil movement into or through the riprap. The need for a filter blanket is determined by comparing the particle sizes of the overlying material and the base material. Refer to the GEOTEXTILES and RIPRAP SLOPE STABILIZATION BMPs.

**Flow Depth:** The riprap rock size should be determined for maximum anticipated flow depth within the channel as follow:

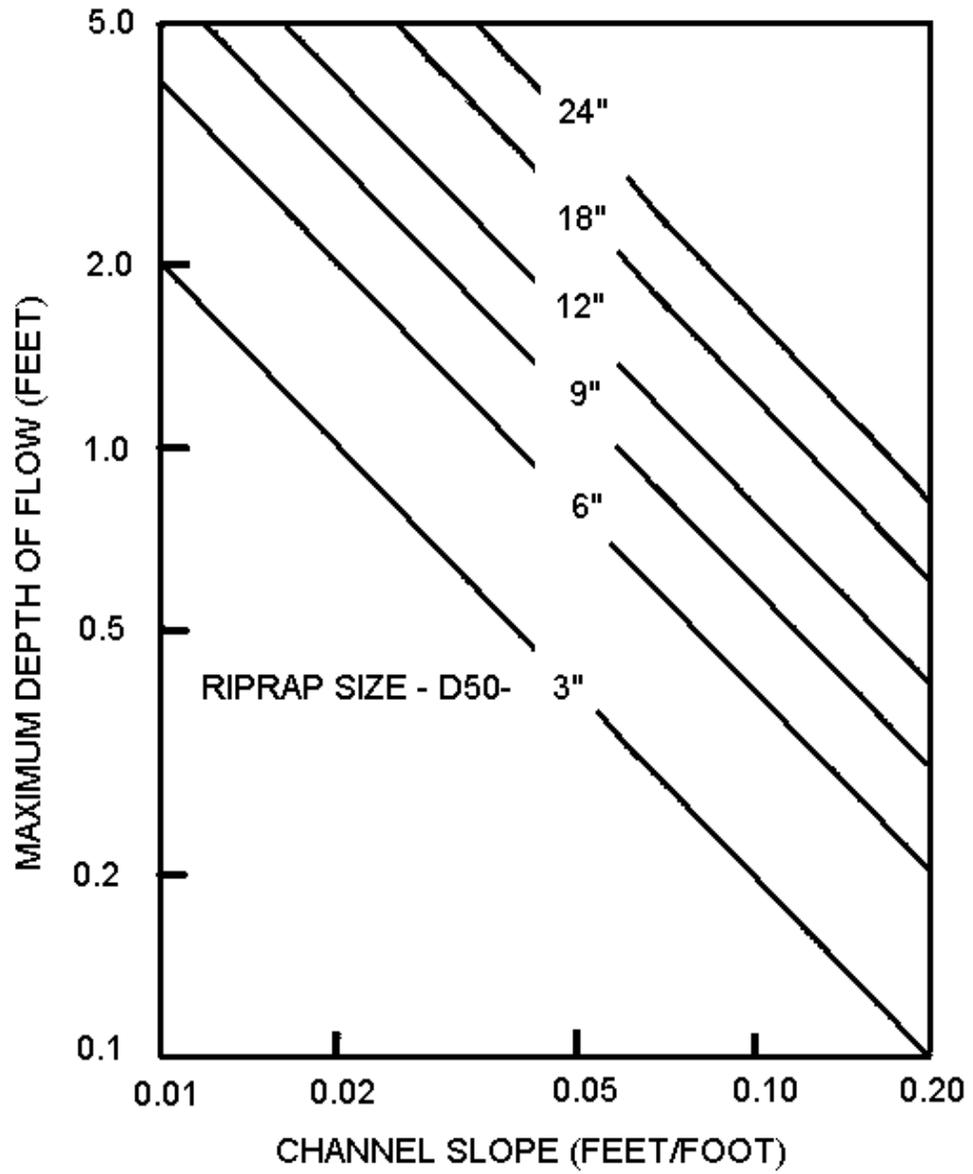
### **Installation Requirements**

**Subgrade Preparation:** The subgrade for the riprap or filter shall be prepared to the required lines and grades. Any fill required in the subgrade shall be compacted to a density approximating that of the surrounding undisturbed material and to a 95% compaction as determined by Standard Proctor Density. All brush, trees, stumps and other objectionable material (i.e., organic matter) shall be removed.

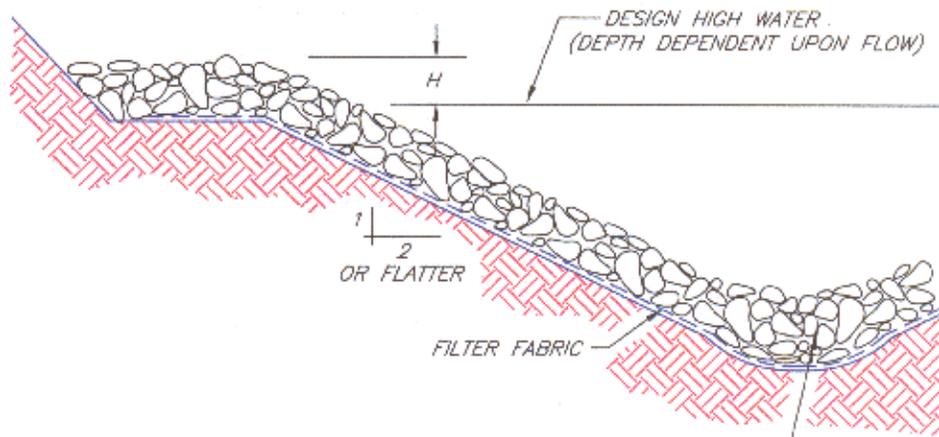
**Filter Blanket:** The placement of the filter blanket should be done immediately after the slope preparation. For geotextile filter cloths, the cloth should be placed directly on the prepared slope, installed and anchored according to the manufacturer's recommendations. Refer to the GEOTEXTILE BMP

**Stone Placement:** The placement of riprap should follow immediately after placement of the filter. The riprap should be placed so that it produces a dense well-graded mass of stone with a minimum of voids. Refer to the RIPRAP SLOPE STABILIZATION BMP.

**Maintenance:** Once a riprap installation has been completed, it should require very little maintenance. It shall, however, be inspected periodically to determine if high flows have caused scour beneath the riprap or dislodged any of the stone. If repairs are needed, they should be accomplished immediately.



DESIGN HEIGHT (H), WIDTH AND STONE SIZE SHALL  
BE DETERMINED BY THE ENGINEER



MINIMUM 6" (150mm) THICK LAYER OF 2" (50mm) MINIMUM  
DIAMETER DRAIN ROCK. LARGER STONE SHALL BE USED  
DEPENDENT UPON GRADIENT, SOIL TYPE, AND DESIGN FLOW.

TYPICAL SECTION

**ROCK LINED  
CHANNEL**

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FILE: ROKCHNEL

**E-7 REINFORCED WATERWAYS****PURPOSE & APPLICATIONS**

A reinforced waterway is a permanently lined channel constructed down a slope having an erosion-resistant lining of concrete, stone, or other permanent material. The earth above the structure must be permanently vegetated or otherwise protected. Its purpose is to provide for safe disposal of runoff without damage by erosion or flooding and where unlined or grassed waterways would be inadequate. Properly designed linings may also control seepage, piping, and sloughing or slides and they reduce gully erosion.

This standard applies to waterways or outlets having linings reinforced and non-reinforced cast in-place concrete; flagstone mortared in place, or similar permanent linings other than riprap.

Other permanent linings that can be considered are gabion mats or other durable manufactured erosion reinforcement mats. But it does not apply to stream channels or streambanks.

This practice applies if the following or similar conditions exist:

- Concentrated runoff, wetness, prolonged base flow or seepage is such that a lining is needed to control erosion.
- Steep grades, greater than 8 %, which would cause high velocity and erosion.
- The location is such that use by people or animals preclude the use of vegetated waterways or outlets.
- Highly erosive soils or other soil conditions which preclude using vegetation.
- Climatic conditions precluding using vegetation (construction past the growing season).

**CONSIDERATIONS**

- Water temperatures may be altered due to the changes in shading of natural and man-made channels.
- Wildlife habitats in the riparian zone will deteriorate by the change of water temperature and quality as discharged from lined waterways.

**SPECIFICATIONS****Design Criteria**

Reinforcement of a waterway may consist of asphalt, concrete, corrugated metal pipe, grouted riprap, or gabions. It should be noted here that paved and rigid flumes are susceptible to cracking unless placed on well compacted fill (95% of Standard Proctor as determined by ASTM D-698), and are securely tied in to prevent frost heaving and undercutting of the structure by water. An alternative would be to use a flexible geomembrane under the riprap so it can move and not crack.

- Reinforcement must be added to waterways that are steeper than 8 %. The maximum slope of the channel shall be 1.5:1 or 67 percent.
- Curtain walls may be provided at the beginning and the end of a reinforced waterway to retard seepage. The curtain wall shall be as wide as the channel, extend at least 18 inches into the soil below the channel and have a minimum thickness of 6 inches.
- Concrete flumes shall have expansion joints at a maximum spacing of 90 feet. Eighteen inch long dowels of #4 reinforcing steel placed on 5-inch centers shall be located at all required joints

**Capacity:** The minimum capacity shall be adequate to carry the peak rate of runoff from a 10-year frequency, 24-hour duration storm at a minimum.

**Velocity:** Maximum design velocity shall be as shown below. Except for short transition sections, flow in the range of 0.7 to 1.3 fps of the critical slope must be avoided unless the channel is straight. Extra precautions shall be taken where high velocities are in other than straight reaches. Waterways or outlets with high velocities shall discharge into an energy dissipator.

DEPTH OF FLOW	MAXIMUM VELOCITY
2.3 ft	10 fps
2.0 ft	10 fps
1.0 ft	15 fps
0.3 ft	30 fps
0.0 ft	30 fps

**Cross section:** The cross section shall be parabolic, or trapezoidal. Cross sections made of monolithic concrete may be rectangular.

**Side slope:** The steepest allowable side slopes, horizontal to vertical, are:

- Rock riprap:** 2 to 1
- Non-reinforced Formed concrete:** 1.5 ft up vertical embankment sides
- Slip-form concrete:** 1 to 1 for less than 3-ft high embankments
- Screened concrete or mortared flagstone:** 1 to 1 for embankments less than 2 feet  
2 to 1 for embankments 2 feet or more high

**Note:** *Non-reinforced concrete or mortared flagstone linings shall be used only on low shrink-swell soils that are well drained or where subgrade drainage facilities are installed.*

**Lining thickness:** The minimum lining thickness shall be:

- **Rock riprap:** Riprap channels shall have a minimum thickness of 2.25 times the maximum stone diameter but not less than 8 inches (plus thickness of filter or bedding).
- **Concrete:** 4 inches (In problem areas, minimum thickness shall be 5 inches reinforced with welded wire fabric)
- **Flagstone:** 4 inches, including mortar bed

**Related structures** Side inlets, drop structures, and energy dissipators shall meet the hydraulic and structural requirements for the site.

**Geotextile or Gravel Filters or bedding:** Filters or bedding shall be used to prevent piping. Drains shall be used to reduce uplift pressure and to collect water, as required. Filters, bedding, and drains shall be designed according to the RIPRAP SLOPE STABILIZATION and GEOTEXTILES BMPs. Weep holes may be used with drains if needed.

**Contraction joints:** Contraction joints in concrete linings, if required, shall be formed transversely to a depth of about one-third the thickness of the lining at a uniform spacing in the range of 10 to 15 feet. Provide for uniform support to the joint to prevent unequal settlement.

**Rock riprap or flagstone:** Stone used for riprap shall be dense, angular and hard enough to withstand exposure to air, water, freezing, and thawing. Flagstone shall be flat for ease of placement and have the strength to resist exposure and breaking. Refer to the RIPRAP BMP for additional information.

### Construction Specifications

The foundation area shall be cleared of trees, stumps, roots, sod, loose rock, or other objectionable material.

The cross section shall be excavated to the neat lines and grades as shown on the plans. All soft sections and unsuitable material shall be removed and replaced with suitable material. The subgrade shall be thoroughly compacted and shaped to a smooth, uniform surface. For concrete channels, the subgrade shall be moist at the time the concrete is placed.

No abrupt deviations from design grade or horizontal alignment shall be permitted.

Concrete lining shall be placed to the required thickness. Provisions shall be made to protect freshly placed concrete from temperature variation and drying to ensure proper curing.

Filter, bedding, and rock riprap shall be placed to line and grade and in the manner specified. Riprap shall be placed so that it does not reduce the designed cross-section more than 10 percent.

Construction operations shall be done to minimize erosion and water pollution. All disturbed areas shall be vegetated or protected with a cover against soil erosion.

### **Material Specifications**

**Concrete:** Concrete used for lining shall be proportioned so that it is plastic enough for thorough consolidation and stiff enough to stay in place on side slopes. A dense, durable product shall be required.

**Mortar:** Mortar used for mortared in-place flagstone shall consist of a workable mix of cement, sand, and water with a water-cement ratio of not more than 6 gallons of water per bag of cement.

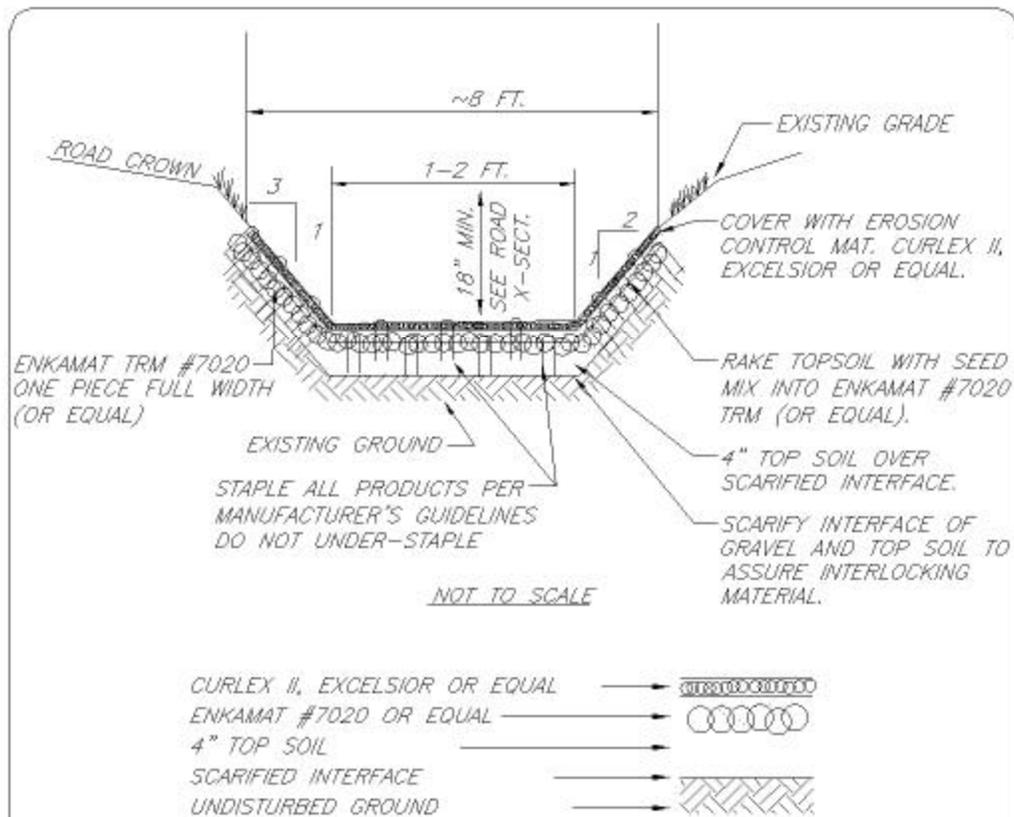
**Rock for Riprap:** Rock shall be durable, and have the desired shape and size distribution to meet the design's needs.

### **Schedule of Installation**

Once soil is exposed for waterway construction, it should be immediately shaped, graded and stabilized. Lined waterways should be completely stabilized prior to directing runoff to them.

### ***MAINTENANCE***

Before permanent stabilization of the slope, the structure shall be inspected after each rainfall and damages to the slope or the paved flume repaired immediately. After the slope is stabilized, little maintenance should be required.



EXPANDED CROSS SECTION

## REINFORCED VEGETATED DITCH TURF REINFORCEMENT MAT (TRM)

TRMs SHOULD NOT BE USED:

1. TO PREVENT DEEP-SEATED SLOPE FAILURE DUE TO CAUSES OTHER THAN SURFICIAL EROSION.
2. WHEN ANTICIPATED HYDRAULIC CONDITIONS ARE BEYOND THE LIMITS OF TRMs AND NATURAL VEGETATION.
3. DIRECTLY BENEATH DROP OUTLETS TO DISSIPATE IMPACT FORCES (ALTHOUGH THEY MAY BE USED BEYOND THE IMPACT ZONE).
4. WHERE WAVE HEIGHT MAY EXCEED 12 INCHES (ALTHOUGH THEY MAY BE USED TO PROTECT AREAS UP-SLOPE OF THE WAVE IMPACT ZONE).
5. FOR COLD WEATHER SEEDING (DORMANT SEEDING) APPLY SEEDING AT TWICE THE SPECIFIED RATE. SPRING OVERSEEDING MAY BE DONE DIRECTLY OVER MATS.

**REINFORCED  
VEGETATED  
DITCH (TRM)**

ME DEP 2003

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## E-8 WATER DIVERSION

### **PURPOSE & APPLICATIONS**

A diversion is a channel constructed across the slope to divert excess concentrated and sheet surface water, and possibly subsurface water, from areas under construction or development, to sites where it can be used or disposed of. This practice applies to sites where:

- A diversion is required to control erosion and runoff on construction sites.
- Concentrated runoff from higher lying areas is potentially damaging to a developing area.
- Overland (sheet) surface flow and shallow subsurface flow caused by seepage is potentially damaging to areas under construction.
- Runoff is in excess and a diversion is required as part of a pollution abatement system.
- Diversions shall not be substituted for terracing or land grading where such practices are more appropriate for erosion control.

### **CONSIDERATIONS**

Every effort should be made to incorporate the diversion into the plans for parking lots, ball fields, recreation areas, and back yards in such a way that maintenance will be enhanced and multiple use of the area made possible. The diversion may be planned to provide grasses and legumes as an element in wildlife upland habitat management.

- Diversions should not be substituted for terracing or land grading where such practices are more appropriate for erosion control. Diversions shall not be used below high sediment-producing areas unless land treatment practices or structural measures, designed to prevent damaging accumulations of sediment in the channels, are installed with or before the diversions. The exceptions are where a diversion is used to divert sediment-laden water to a sedimentation facility.
- In sensitive watersheds it will be necessary for temporary diversions to have a temporary mulch liner (erosion control blanket) and where feasible, to empty into a sediment trap or basin prior to emptying into a stable outlet. Refer to the TEMPORARY MULCHING BMP. Temporary diversions can deteriorate water quality if they are left bare for extended periods of time.
- Where diversions carry concentrated flow, their outlets may require treatment or a structure to dissipate energy and re-disperse the flow or re-create sheet flow into areas of undisturbed forest floor where sediment can be filtered and runoff absorbed.

### **SPECIFICATIONS**

#### **Design Specifications**

Refer to the detail drawing located at the back of this section for the proper design of a water diversion.

- **Cross section:** The channel may be parabolic, V-shaped, or trapezoidal. The diversion must be designed to have stable side slopes. The ridge height must include a reasonable settlement factor (10% is recommended). The ridge should have a minimum top width of 4 ft at the design elevation. The top of the constructed ridge shall not be lower at any point than the design elevation plus the specified overfill for settlement.
- **Grade and velocity:** Channel grades may be uniform or variable. Channel velocity shall not exceed what is considered non-erosive for the soil and planned vegetative treatment.
- **Location:** The condition of the outlet area, site topography, land use, soil type, and length of slope should determine the location of the diversion.
- **Outlets:** Each diversion must have an adequate outlet. The outlet must convey runoff to a point where outflow will not cause damage. The vegetative outlets should be installed and stabilized before the construction of the diversion to ensure establishment of vegetative cover

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

- **Capacity:** Diversions designed to protect urban areas, buildings, and roads shall have enough capacity to carry the peak runoff expected from a storm frequency consistent with the hazard involved of a 10-year frequency at a minimum. For higher risk areas, the design storm may need to be greater (i.e. 100-year storm for the potential loss of life).
- **Vegetation:** Disturbed areas shall be established to grass immediately after construction. If the soils or winter conditions preclude the use of vegetation and protection is needed, non-vegetative means, such as erosion control mats or gravel may be used. Seedbed preparation, seeding, fertilizing, and mulching shall comply with recommendations in the PERMANENT VEGETATION BMP. Seeding should be completed by September 1st to assure good cover over fall and winter months.

### **Construction Specifications**

All ditches or gullies shall be filled, and trees and other obstructions shall be removed before construction begins or shall be part of the construction.

If underground conduits are located under diversion ridges, mechanical compaction, water packing, and installation and backfill of conduit trenches shall be made in advance to allow adequate settlement. The materials used for the inlet and conduit shall be suitable for the purpose intended. Diversion ridges constructed across gullies or depressions shall be compacted to ensure proper functioning of the diversion.

Seeded areas need protection during establishment and will be mulched in accordance to the TEMPORARY MULCHING BMP.

Diversions must be completely stabilized prior to directing runoff to them.

### **Schedule of Installation**

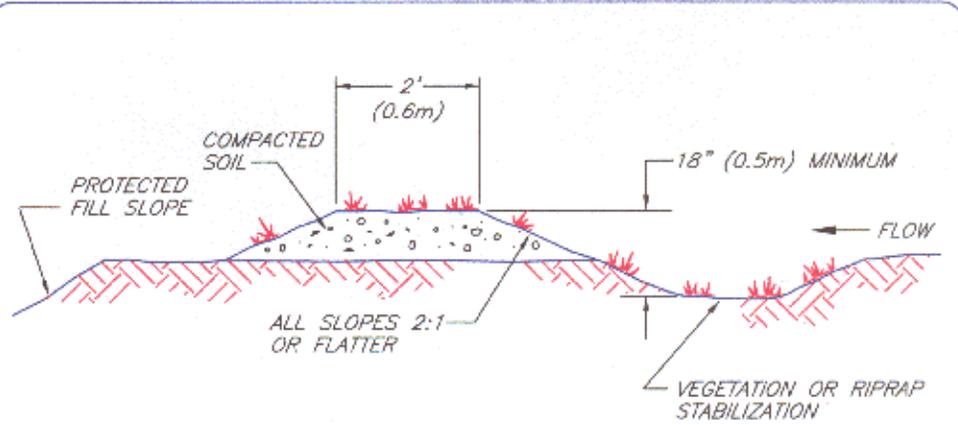
Once soil is exposed for a diversion channel, it should be immediately shaped, graded and stabilized.

Vegetated diversions need to be stabilized early during the growing season (prior to September 1st). If final seeding of diversions is delayed past September 1st, emergency provisions such as sod or riprap may be required to stabilize the channel.

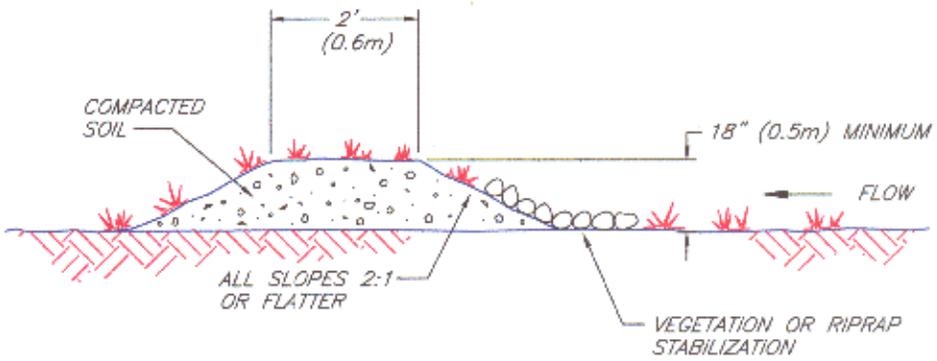
### **MAINTENANCE**

A maintenance program should be established to maintain diversion capacity, storage, ridge height, vegetative cover, and the outlets. Diversion ridges can be hazardous to mow. Any hazards must be brought to the attention of the responsible person.

Mow the diversion at least once annually. Mow to a height of 4-6 inches to help maintain good surface protection.



**TYPICAL FILL DIVERSION**



**TYPICAL TEMPORARY DIVERSION DIKE**

- NOTES:
1. THE CHANNEL BEHIND THE DIKE SHALL HAVE POSITIVE GRADE TO A STABILIZED OUTLET.
  2. THE DIKE SHALL BE ADEQUATELY COMPACTED TO PREVENT FAILURE.
  3. THE DIKE SHALL BE STABILIZED WITH TEMPORARY OR PERMANENT SEEDING OR RIPRAP.

**TEMPORARY  
DIVERSION DIKE**

1996 JOHN McCULLAH

FILE: TEMPODIKE

**E-9 TEMPORARY SLOPE DRAINS**

**PURPOSE & APPLICATIONS**

A slope drain is a flexible tubing or conduit extending from the top to the bottom of a cut or fill slope. Its purpose is to temporarily conduct runoff safely down the disturbed face of an embankment without causing erosion. It significantly reduces rill and gully erosion on slopes during construction.

**CONSIDERATIONS**

There is often a significant time lag between when a cut or fill slope is completed and when a permanent drainage system can be installed and during this period, the slope is usually particularly vulnerable to erosion. The maximum drainage area per drain should be relatively small and much less than 5 acres.

When used in conjunction with diversion dikes, temporary slope drains can be used to convey stormwater from the entire drainage area above a slope to the base of the slope without erosion. It is very important that these temporary structures be installed properly since their failure will often result in severe gully erosion. The conduit inlet section must be securely entrenched, all connections must be watertight, and the conduit must be staked securely.

**SPECIFICATIONS**

**Design Criteria**

Refer to the detail drawings located at the back of this section for the proper design of a temporary slope drain.

- The slope drain shall consist of heavy-duty flexible material designed for this purpose. The diameter of the slope drain shall be equal over its entire length. Reinforced hold-down grommets must be spaced at 10 foot (or less) intervals.
- Slope drains shall be sized according to the following table:

Drainage Area (Acres)	Pipe Diameter, D (Inches)
0.5	12
1.5	18
2.5	21
3.5	24
5.0	30

- The entrance to the slope drain shall consist of a standard MDOT Flared End-Section for Metal Pipe Culverts. Extension collars shall consist of 12-inch long corrugated metal pipe. Watertight fittings shall be provided.
- An earthen dike shall be used to direct stormwater runoff into the temporary slope drain and shall be constructed according to the WATER DIVERSION BMP.
- The height of the dike at the centerline of the inlet shall be equal to the diameter of the pipe (D) plus 6 inches. Where the dike height is greater than 18 inches at the inlet, it shall be sloped at the rate of 3:1 or flatter to connect with the remainder of the dike.
- The outlet of the slope drain shall be protected from erosion according to the PIPE OUTLET PROTECTION BMP.

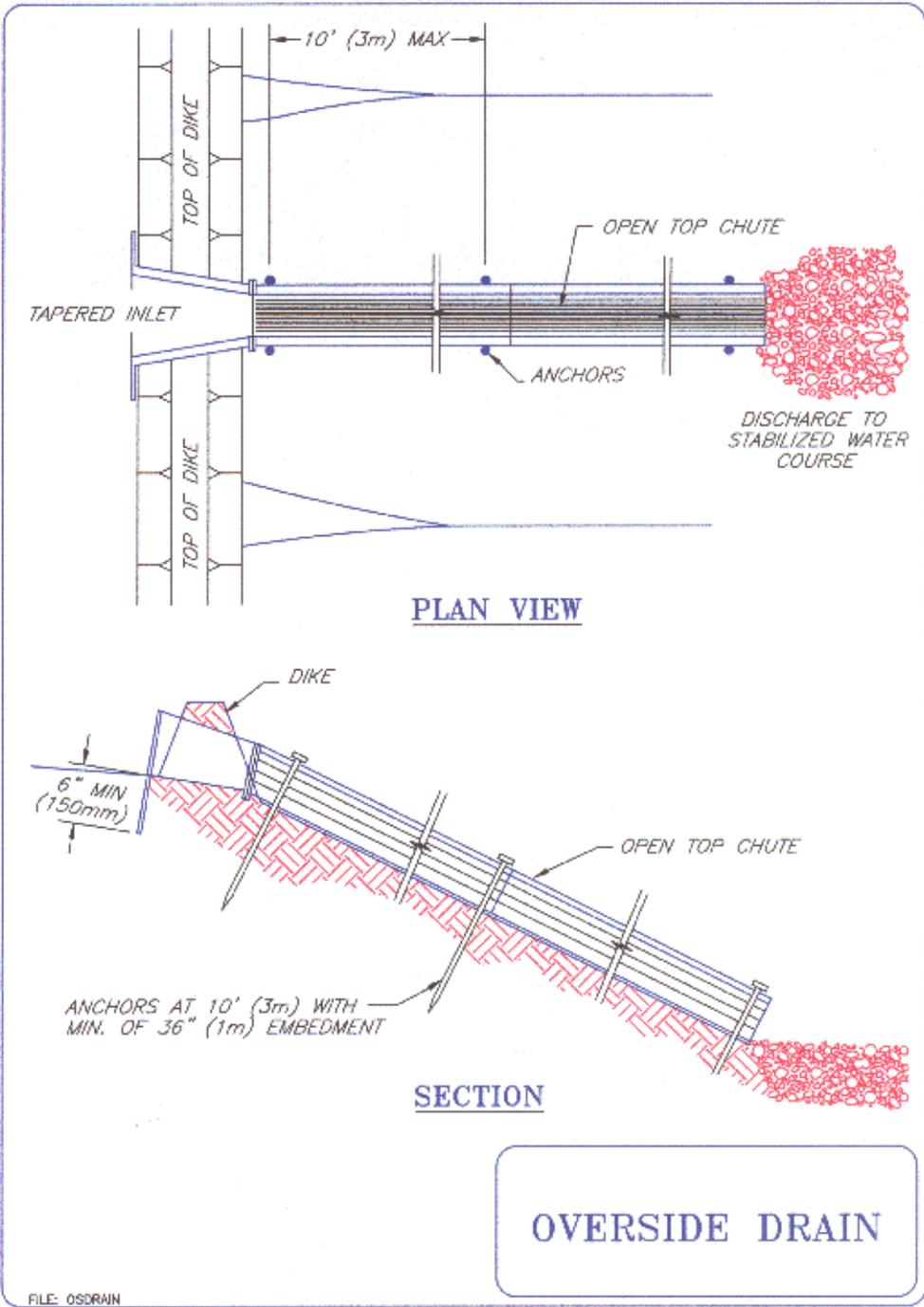
**Construction Specifications**

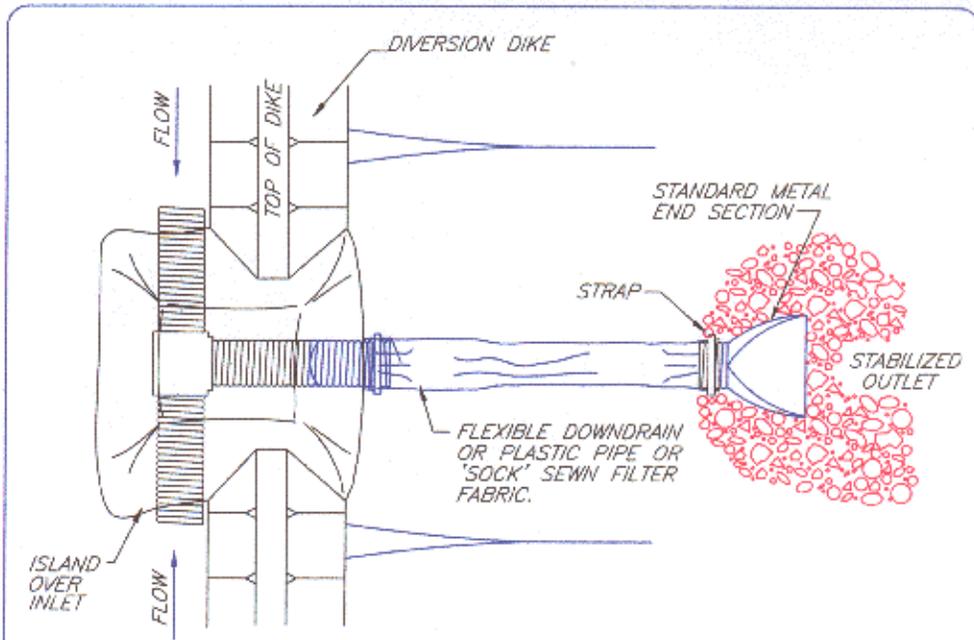
- The temporary slope drain shall be placed on undisturbed soil or well-compacted fill.
- The entrance section shall slope toward the slope drain at the minimum rate of 1/2 inch per foot.

- The soil around and under the entrance section shall be hand-tamped in 8 inch lifts to the top of the dike to prevent piping failure around the inlet.
- The slope drain shall be securely staked to the slope at the grommets provided.
- The slope drain sections shall be securely fastened together and have watertight fittings.
- Installation of temporary slope drains should be completed and their outlets protected before runoff is diverted to them.

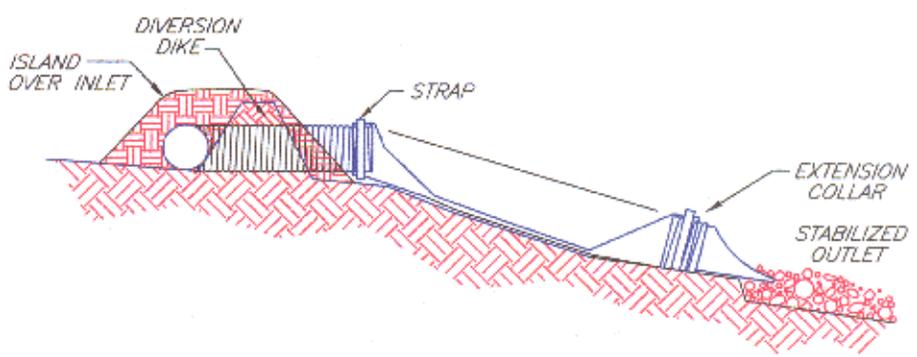
### ***MAINTENANCE***

The slope drain structure shall be inspected weekly, and after every storm and repairs shall be made as necessary. The entrance should be kept clear of sediment and debris. The contractor should avoid the placement of any material on and prevent construction traffic across the slope. Upon stabilization of the slope, the slope drain shall be removed.





PLAN VIEW



SECTION

**SLOPE DRAIN**

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FILE: SLOPEDRN

**F-1 TEMPORARY STREAM DIVERSION****PURPOSE & APPLICATIONS**

A temporary stream diversion is the diverting of the base flow of a perennial stream around a construction site by use of a conduit (pipe) or small diversion ditch.

Its purpose is:

- To maintain stream flow continuity, quality and habitat and provide a dry working environment for the construction activities.
- To allow the installation of a structure in a perennial stream with minimal impacts on stream turbidity. By temporarily diverting the stream's base flow away from the construction areas and into a stable pipe or channel system, clean water is kept out of the active construction area.

This practice applies where flows are low enough and/or the watershed is small enough to allow normal base flows to be handled practically in a conduit (pipe) or small diversion ditch. It is intended for those situations where the temporary stream diversion will only be needed during the summer-fall months of low stream flow, where the time of construction can be minimized, and the site can be stabilized before winter. For projects involving large streams or rivers that are expected to be under construction for a long period of time, more permanent engineered structures will be needed.

**CONSIDERATIONS**

Any work with a stream is subject to the rules and regulations of the U.S. Army Corps of Engineers for in-stream modifications (404 permits), the Maine DEP, and the Land Use Regulation Commission regulations.

**Timing:** Timing the installation of this measure is critical to minimize impacts on fisheries.

**Phasing:** To minimize the impact to the stream, phasing the operations must be considered before the stream is diverted. This measure needs to be quickly and carefully installed, well maintained and removed as soon as possible when the construction area is stable.

**Constriction of the channel:** These practices will increase the velocity of flow due to constriction of the channel and will create a higher potential for erosion and movement of sediments in the stream channel.

**Flooding:** Any flood flows during the construction period can be expected to damage or destroy this practice. It may contribute to the flooding effects.

**Maintenance:** This practice is a high maintenance item, and should be considered for use in a cautious manner. The impact of failure on downstream facilities should be carefully considered. In addition, aquatic needs such as fish passage may preclude the use of this practice.

**DESIGN CRITERIA**

Refer to the guidelines and graphics of the TEMPORARY SLOPE DRAIN BMP.

The construction of any specific temporary stream diversion shall not cause a significant water level difference between the upstream and downstream water surface elevations (not to exceed 1%) and the velocity should be maintained at a rate similar to existing flow conditions.

**Fish Passage:** Consult with the Inland Fish and Wildlife Department for dates of fish spawning or migration within the waterway the work is to occur. Standard blocked out dates are from October 1 to April 30 for some streams and from March 15 to June 15 for other streams.

**Water Fluctuation:** The base flows of all streams must be maintained at all time. In addition, for bass and warm water species, the water level fluctuation should be no greater than one (1) foot during the time period from May 1st - July 1st.

**Time of Operation:** All temporary stream diversions shall be removed within 2 calendar days after the structure is no longer needed. Unless prior written approval is obtained, all structures shall be removed and the area stabilized before winter.

**Aggregate:** There shall be no earth, sands, silts, clays or organic material used for construction within the waterway channel. Washed coarse aggregate (3/4 inch to 4 inches) referenced, as AASHTO designation No. 1 shall be the minimum acceptable aggregate size for temporary stream diversions. Larger clean aggregates will be allowed.

**Sandbags:** Sandbags shall consist of materials, which are resistant to ultra-violet radiation, tearing and puncture, and woven tightly enough to prevent leakage of fill material (i.e., sand, fine gravel, etc.).

### **Planning Criteria**

Select a design method that will least disrupt the existing terrain for the stream reach. Consider the effort that will be required to restore the area after the temporary stream diversion is removed. The following criteria must be considered when selecting a temporary stream diversion method:

**Time of year:** The time of year may preclude the selection of one or more of the standard methods due to fish spawning or migration restrictions.

**Site Location:** Locate the temporary stream diversion where there will be the least disturbance to the soils of the existing waterway banks.

**Removal of the structure:** Ease of removal and subsequent damage to the waterway should be primary factors in considering the choice of a design of the stream diversion.

**Maintenance:** This is a high maintenance item. Weather reports need to be monitored and the structure prepared for anticipated storm events.

### **Design Criteria**

Provisions for temporary stabilization of the inlet, outlet, and return channel shall be included in the design. The materials used in construction must be sound, and capable of withstanding the loads applied. The materials must also be durable and maintain their integrity for the life of the project.

- Excavation of the channel shall begin at the downstream end and proceed upstream. All excavated materials shall be stockpiled outside of the floodplain and temporarily stabilized to prevent re-entry into the stream channel.
- The height of the diversion structure shall be one half the distance from the streambed to stream bank plus one foot.
- All dewatering of the construction area shall be pumped to a dewatering basin prior to re-entering the stream.
- All excavation materials shall be disposed of in an approved disposal area outside the 100-year floodplain unless otherwise approved.
- The downstream and upstream connection to the natural channel shall be constructed under dry conditions. Sandbags shall contain the stream.
- The process of excavation and stabilization shall be a continuous (uninterrupted) operation. All materials shall be on-site prior to channel construction.
- Periodic inspection and maintenance shall be performed as needed to ensure that the diversion, streambed and streambanks are maintained and not damaged. Maintenance shall include removal and disposal of any trapped sediment or debris. Sediment shall be disposed of outside of the flood plain and stabilized.

### **Sandbag-Conduit Diversion**

This practice should be limited to streams, which drain less than 1 square mile. It should be used only for very short time duration. Because the potential for wash out is high, it must be carefully monitored. It should not be left unattended for any 24-hour period. If a major storm event is expected, the site must be stabilized in preparation for it. The conduit shall have the hydraulic capacity to handle the flow rate of 30 cubic feet per second per square mile of drainage area above the site.

### **Sandbag-Stone Diversion**

This practice should be limited to streams, which drain less than 5 square miles. The temporary channel should be able to convey the 2-year storm event. The diversion structure shall be installed from upstream to downstream. Sheeting shall be overlapped such that the upstream portion covers the downstream portion with at least an 18-inch overlap.

### **Fabric Based Channel Excavation**

This practice should be limited to streams, which drain less than one (1) square mile. The temporary channel should be sized to convey the 2-year storm event. All debris (rocks, sticks, etc.) shall be removed and the channel surfaces made smooth so that the fabric will rest flush with the channel sides and bottom.

#### **Stabilization with Geotextile Fabric**

- The fabric shall have a minimum width such that it is keyed in and anchored at the top of the stream bank.
- The fabric shall be placed so that it rests flush with the channel at all points of contact.
- The fabric shall be placed such that one piece will line the entire channel. If this is not possible, the fabric shall be placed so that it overlaps along the channel's transverse. Longitudinal overlaps shall not be allowed. Upstream sections shall overlap downstream sections. The overlap shall equal 2 feet minimum.
- The fabric shall be keyed into 2 x 2-foot trenches located at the upstream edge and at 50 foot intervals (the overlap nearest to each 50-foot increment). The key-in shall be from top of channel to top of channel. Riprap shall be carefully placed into the trench (without dropping onto the fabric).
- The fabric sections shall be secured with pins (length of 18 inches minimum) and washer (diameter 1 inch minimum). Overlaps shall be pinned along transverse and longitudinal axes with spacing equal to 3 feet maximum.
- The spacing of the pins must follow the manufacturer's specification and is dependent on the anticipated velocities and thickness and type of geotextile fabric.
- The entire bottom of the channel could be riprapped if high velocities were anticipated. When the area is riprapped, it is not required that the geotextile fabric underneath the riprap be pinned.
- An impervious plastic lining can be used in lieu of geotextile fabric. The plastic liner shall be 6 mil or thicker and shall be capable of maintaining strength against the effects of ultraviolet light for a period of at least 60 days.

#### **Removal of the Diversion**

- Water shall not be allowed through the natural stream until all construction is completed.
- When the diversion is no longer needed, all structures shall be removed within 2 calendar days.
- After diversion of the stream back to the natural streambed, the temporary diversion channel shall be backfilled and stabilized. Points of tie-in to the natural channel shall be stabilized in accordance with the STREAMBANK STABILIZATION BMP

### **MAINTENANCE**

**Inspection:** Periodic inspection must be performed to ensure that the structure is maintained and not damaged, that sediment is not entering the stream or blocking fish passage or migration.

**Maintenance:** Maintenance shall be performed, as needed, to ensure that the structure complies with the standards and specifications. This shall include removal and disposal of any trapped sediment or debris. Sediment shall be disposed of outside of the floodplain and stabilized.

**Storm Events:** Anticipate major storm events. If a major storm is predicted, emergency measures must be taken to minimize damage.

**F-2 STREAM CROSSING****PURPOSE & APPLICATIONS**

A stream crossing is a structure placed across or in a waterway to provide access for a period of less than one year. Temporary access crossings shall not be utilized to maintain traffic for the general public. The purpose of a stream crossing is to provide safe, pollution-free access across a waterway by establishing minimum standards and specifications for the construction and maintenance of the project. Temporary stream crossings are necessary to prevent construction equipment from damaging the waterway, blocking fish migration, and tracking sediment and other pollutants. They should be planned to be in service for the shortest practical period of time and removed as soon as their function is completed.

This measure is applicable in non-tidal waterways. These standards and specifications provide designs based on waterway geometry rather than the drainage area contributing to the point of crossing. Structural utility and safety must also be considered when designing waterway crossings to withstand expected loads and standard accepted engineering design should be used to size these structures.

**CONSIDERATIONS**

The specifications contained in this practice pertain primarily to flow capacity and resistance to washout of the structure. From a safety and utility standpoint, the designer must also be sure that the span is capable of withstanding the expected loads from heavy construction equipment, which will cross the structure.

The designer must also be aware that such structures are subject to the rules and regulations of the U.S. Army Corps of Engineers for in-stream modifications (404 permits) and the Maine DEP under the Natural Resources Protection Act.

These structures should not become a channel constriction, which can cause flow backups or washouts during periods of high flow. They should be planned to be in service for the shortest practical period of time and to be removed as soon as their function is completed. It should not be in place during the spring thaw and rains unless sized accordingly.

- Care must be taken to minimize erosion and movement of sediment due to disturbance of stream banks and bottom substrate.
- Timing the installation of this measure is critical to minimize impacts on fisheries.
- Arch culverts are preferred to standard culverts for the preservation of fish habitat because they are easier to embed and backfill with natural material.
- A regional biologist from the Department of Inland Fisheries and Wildlife should be consulted to determine the timing of local fisheries spawning and migration patterns so impact is minimized to fisheries.
- Overall road planning and design should be carefully considered to minimize the number of stream crossings required.
- If undersized, it may contribute to a flooding hazard.

**SPECIFICATIONS**

Additional information and guidance may be available from the Maine Forest Services.

**Planning Criteria**

**In-Stream Excavation:** In-stream excavation shall be limited to only that necessary to allow installation of the standard measures as presented in this specification.

**Elimination of Fish Migration Barriers:** The construction of any specific crossing method shall not cause a significant water level difference between the upstream and downstream water surface elevations that could effect fish passage and bridges pose the least potential for creating barriers to aquatic migrations.

**Crossing Alignment:** The temporary waterway crossing shall be at right angles to the stream. Where approach conditions dictate, the crossing may vary 15% from a line drawn perpendicular to the centerline of the stream at the intended crossing location.

**Road Approaches** The centerline of both road approaches shall coincide with the crossing alignment centerline for a minimum distance of 50 feet from each bank of the waterway being crossed. Based on the slope of the approaches, additional distance may need to be added on. When a physical or right-of-way restraint precludes the 50 feet minimum may need the evaluation from a professional.

**Surface Water Diverting Structure:** A water diverting structure such as a swale shall be constructed (across the roadway on both roadway approaches) 50 feet (maximum) on either side of the waterway crossing. This will prevent roadway surface runoff from directly entering the waterway. The 50 feet is measured from the top of the waterway bank. Design criteria for this diverting structure shall be in accordance with the "Standard and Specification" for the individual design standard of choice. If the roadway approach is constructed with a reverse grade away from the waterway, a separate diverting structure is not required. Additional information may be available from the Maine forest Services.

**Back-up erosion control devices:** Streams are considered to be highly sensitive areas and all construction work around waterways should have a back-up set of erosion control measures installed to protect the stream should the first set of measures fail. For example, silt fencing can be installed along the stream perimeter to protect the stream from sedimentation and as a back-up measure, temporary mulch such as erosion control mix can be applied on disturbed areas at the end of each day or prior to anticipated storm events. Combinations of accepted measures can be used along streams.

**Road Width:** Temporary crossings shall have one traffic lane. The minimum width shall be 12 feet with a maximum width of 20 feet.

**Fisheries Restrictions and Permits:** A permit from the Maine DEP will be needed to install and remove temporary access culverts in streams. Installation and removal may not be permitted during the period of time from the start of trout spawning until the eggs have hatched. In some instances, restrictions may also be applied to bass spawning waters. Check with the Inland Fish and Wildlife Department.

**Water Fluctuation:** The base flows of all streams must be maintained during spawning time. In addition, for bass and warm water species, the water level fluctuation should be no greater than one (1) foot during the time period from May 1st - July 1st.

**Time of year:** The construction must be timed to take advantage of seasons with low or no stream flow (generally late summer months) to minimize downstream impacts from sedimentation.

**Soil Aggregate:** There shall be no sands, silts, clays or organic materials used for construction within the waterway channel. Washed coarse aggregate (3/4" to 4") referenced as AASHTO designation No. 1 shall be the minimum acceptable aggregate size for temporary crossings. Larger clean aggregates will be allowed.

**Geotextile:** Geotextile fabric is either woven or nonwoven plastic, polypropylene, or nylon used to distribute the load, retain fines, allow increased drainage of the aggregate and reduce mixing of the aggregate with the subgrade soil.

### **Design Criteria**

The following criteria for erosion and sediment control shall be considered when selecting a specific temporary access water crossing standard method:

**Site Location:** Locate the temporary crossing where there will be the least disturbance to the soils of the existing waterway banks. When possible, locate the crossing at a point receiving minimal surface runoff.

**Vehicular loads and traffic patterns:** Vehicular loads, traffic patterns, and frequency of crossings should be considered in choosing a specific method.

**Maintenance of crossing:** The standard methods will require various amounts of maintenance. The bridge method should require the least maintenance, whereas the ford method will probably require the more intensive maintenance. Maintenance activities may require new permits.

**Temporary Stream Diversions:** Where sedimentation is expected to cause major damage downstream, temporary stream diversions shall be installed. Refer to the TEMPORARY STREAM DIVERSION BMP for information.

**Culvert Inlets & Outlets:** Reinforcement of culvert headwalls and outlets is generally required to protect the stream from chronic erosion and sedimentation. Refer to the PIPE INLET PROTECTION BMP and the PIPE OUTLET PROTECTION BMP for information.

**Site aesthetics:** Select a standard design method that will least disrupt the existing terrain of the stream reach. Consider the effort that will be required to restore the area after the temporary crossing is removed.

**Stabilization:** All areas disturbed during installation shall be stabilized within 14 calendar days of that disturbance in accordance with the STREAMBANK STABILIZATION BMP, PERMANENT VEGETATION BMP, TEMPORARY MULCHING BMP, or any other appropriate structural BMP. If vegetative stabilization is required, the project needs to be timed to use the growing season.

**NOTE:** *All mulching along streams requires anchoring with erosion control nets or mats.*

### **Temporary Access Culvert**

A temporary access culvert consists of a section(s) of circular pipe, pipe arches, or oval pipes of reinforcing concrete, corrugated metal, or structural plate with compacted backfill, which is used to convey slow moving water through the crossing.

#### **Considerations**

- The bank slopes and stability must be taken into consideration when selecting the method of stream crossing.
- Alignment of the culvert should follow the alignment of the stream channel.
- Culverts should be installed at or below streambed elevation.
- This temporary waterway crossing method is normally preferred over a ford type of crossing since disturbance to the waterway is only during construction.
- Temporary culverts can be salvaged and reused.

#### **Construction Specifications**

**Culvert strength:** All culverts shall be strong enough to support their cross sectional area under the expected maximum loads.

**Culvert Size:** The cross sectional area of the culvert pipe shall be the largest pipe diameter equal to the undisturbed cross sectional area of the bank full condition of the stream. It should fit into the existing channel without major excavation of the waterway channel or without major approach fills. If a channel width exceeds 3 feet, additional pipes may be used until the cross sectional area of the pipes approaches that of the existing channel. The minimum size culvert that may be used is an 18-inch diameter pipe.

Where watersheds are larger than 1 square mile (640 acres), then the culvert may have to be sized for a larger storm event such as the 100-year storm to comply with federal regulations.

**Culvert Length:** 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 temporary culvert exceed the width needed to access the work location with a single lane.

**Geotextile Fabric:** Geotextile fabric shall be placed on the streambed and streambanks prior to placement of the pipe culvert(s) and aggregate. The filter fabric shall cover the streambed and extend a minimum six inches and a maximum one-foot beyond the end of the culvert and bedding material. Geotextile fabric reduces settlement and improves crossing stability.

**Culvert Placement:** The invert elevation of the culvert shall be installed at or below the natural streambed grade to minimize interference with fish migration (free passage of fish).

**Culvert Protection:** The culvert(s) shall be covered with a minimum of one foot of aggregate. If multiple culverts are used, they shall be separated by at least 12 inches of compacted aggregate fill. At the minimum, the bedding and fill material used in the construction of the temporary access culvert crossings shall conform to the aggregate requirements cited above.

### **Temporary Access Ford**

A temporary access ford is a shallow structure placed in the bottom of a waterway over which the water flows while still allowing traffic to cross the waterway. Where fish passage is a concern, at least one portion of the ford shall have 6 inches of flow depth over the top of the ford, or equal to the minimum flow depth at all time.

#### **Considerations**

Temporary fords may be used when the streambanks are less than three (3) feet above the invert of the stream, and the streambed is armored with naturally occurring bedrock, or can be protected with an aggregate layer in conformance with these specifications.

- The approaches to the structure shall consist of a stone pad constructed to comply with the aggregate requirements of the General Requirements section. The entire ford approach (where banks were cut) shall be covered with filter cloth and protected with aggregate to a depth of four (4) inches.
- The approach roads at the cut banks shall be no steeper than 5H: 1V. Spoil material from the banks shall be stored out of the flood plain and stabilized.
- One layer of geotextile fabric shall be placed on the streambed, streambanks and road approaches prior to placing the bedding material on the stream channel or approaches. The fabric will be a minimum of six (6) inches and a maximum one-foot beyond the bedding material.
- The bedding material shall be coarse aggregate or gabion mattresses filled with coarse aggregate. If gabion mattresses are used, they will be of plastic, weighted, screen type.
- All fords shall be constructed to minimize the blockage of stream flow and shall allow free flow over the ford. The placing of any material in the waterway bed will cause some upstream ponding. The depth of this ponding will be equivalent to the depth of the material placed within the stream and therefore should be kept to a minimum height. However, in no case will the bedding material be placed deeper than 12 inches or one-half (1/2) the height of the existing banks which ever is smaller.

### **Access Bridge**

A temporary access bridge is a structure made of wood, metal, or other material, which provides access across a stream or waterway.

#### **Considerations**

- This is the preferred method for temporary access waterway crossings. Normally, bridge construction causes the least disturbance to the waterway bed and banks when compared to the other access waterway crossings.
- Most bridges can be quickly removed and reused.
- Temporary access bridges pose the least chance for interference with fish migration when compared to the other temporary access waterway crossings. Bridge use and removal should not significantly affect the stream or its banks.

#### **Construction Specifications:**

**Bridge Placement:** A temporary bridge structure shall be constructed at or above bank elevation to prevent the entrapment of floating materials and debris.

**Abutments:** Abutments shall be placed parallel to and at the top of stable banks.

**Bridge Span:** Bridges shall be constructed to span the entire channel. The span is dependent upon loading and material used. Consult a qualified engineer for the design. No footing, pier or bridge support will be permitted within the channel for waterways less than 8 feet wide.

**Stringers:** Stringers shall either be logs, sawn timber, pre-stressed concrete beams, metal beams, or other approved materials.

**Deck Material:** Decking shall be of sufficient strength to support the anticipated load. All decking members shall be placed perpendicular to the stringers, butted tightly and securely fastened to the stringers. Decking materials must be butted tightly to prevent any soil material tracked onto the bridge from falling into the waterway below.

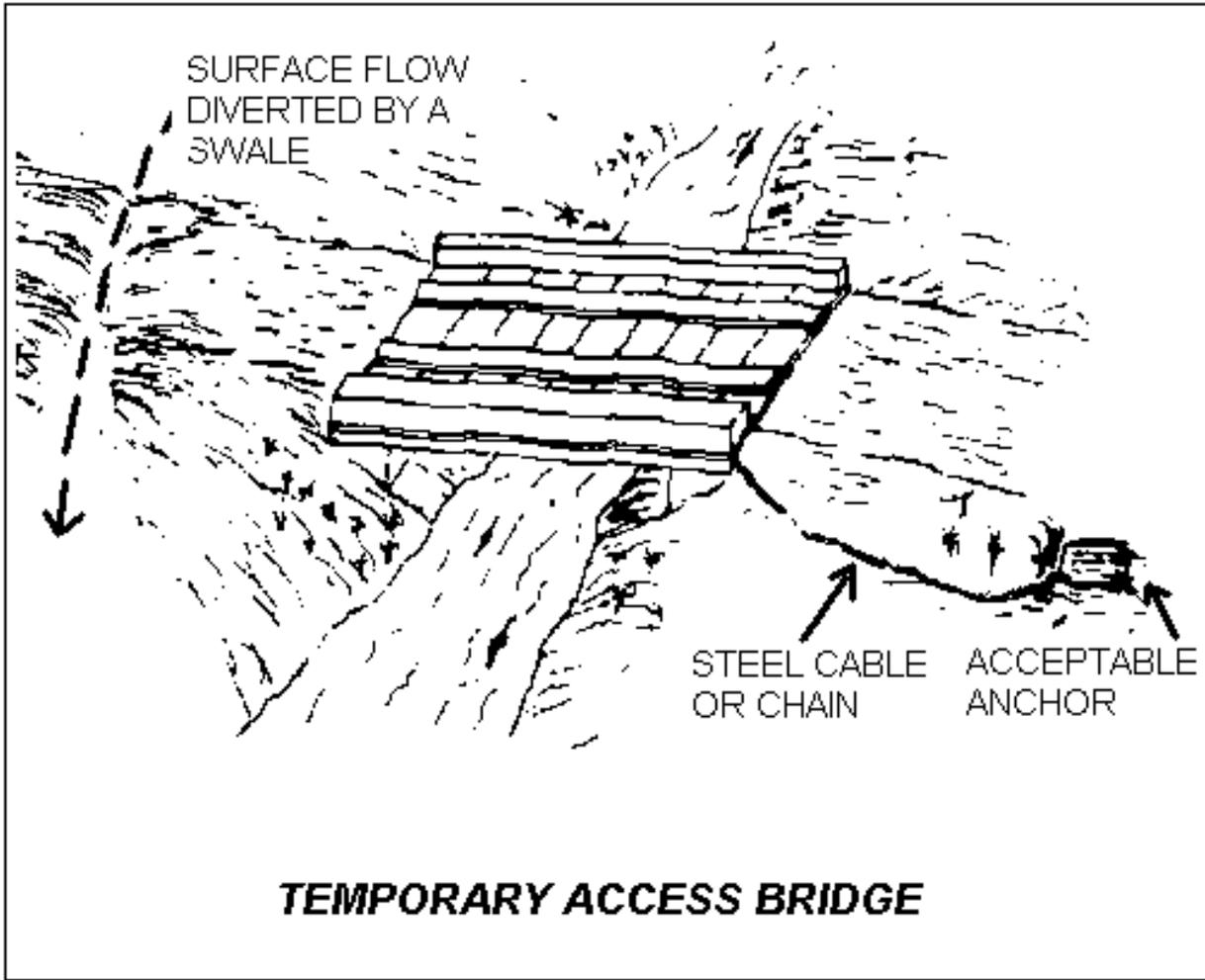
**Run Planks** (optional): Run planking shall be securely fastened to the length of the span. Run planks shall be provided for each track of the equipment wheels. Although run planks are optional, they may be necessary to properly distribute loads.

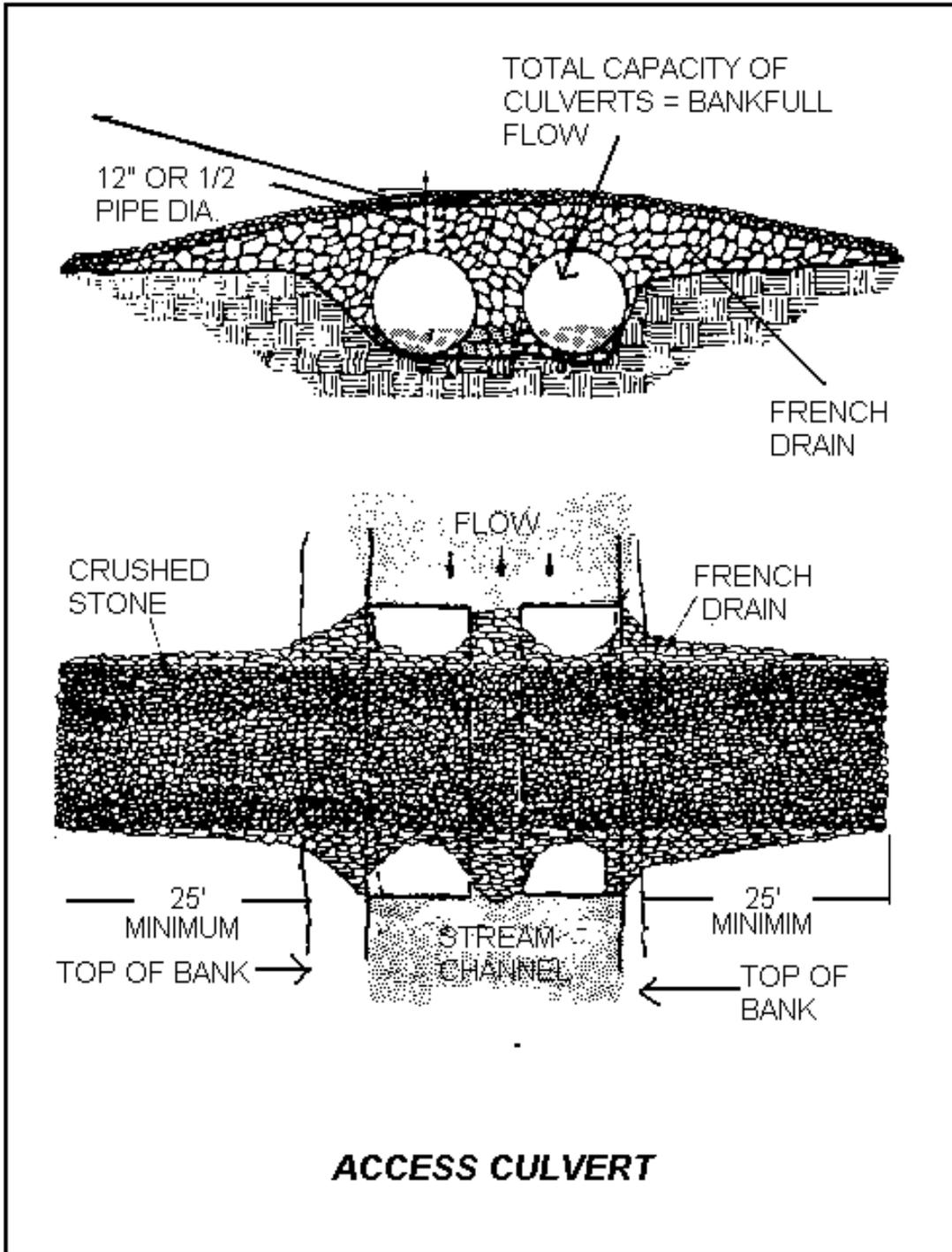
**Curbs or Fenders:** Curbs or fenders must be installed along the outer sides of the deck. Curbs or fenders are an option, which will provide additional safety.

**Bridge Anchors:** Temporary bridges shall be securely anchored at one end using steel cable or chain. Anchoring at only one end will prevent channel obstruction in the event that floodwaters float the bridge. Acceptable anchors are large trees, large boulders, or driven steel anchors. Anchoring shall be sufficient to prevent the bridge from floating downstream and possibly causing an obstruction to the flow.

## **MAINTENANCE**

- **Time of Operation:** All temporary crossings shall be removed within 14 calendar days after the structure is no longer needed. All structures shall be removed within one year from the date of installation.
- **Stabilization:** All areas disturbed during ford installation shall be stabilized immediately in accordance with the STREAMBANK STABILIZATION BMP.
- **Inspection:** Periodic inspection must be performed to ensure that the bridge, culverts, fords, streambed and stream banks are maintained and not damaged, that sediment is not entering the stream or blocking fish passage or migration.
- **Maintenance:** Maintenance shall be performed, as needed to ensure that the structure complies with the standard and specifications for each BMP. This shall include the removal and disposal of any trapped sediment or debris. Sediment shall be disposed of outside of the flood plain and stabilized.
- **Removal:** When the temporary structure has served its purpose, including bridge abutments or culverts and other bridging materials shall be removed within 14 calendar days. Care should be taken so that any aggregate left does not create an impoundment or restrict fish passage.
- **Final Clean up:** Final clean up shall consist of removal of excess materials from the waterway and protection of banks from erosion. All materials shall be stored outside the waterway flood plain. Clean up shall be accomplished without construction equipment working in the stream channel.
- **Approach Disposition:** The approach slopes of the cut banks shall not be backfilled.
- **Final Stabilization:** All areas disturbed during ford removal shall be stabilized immediately in accordance with the STREAMBANK STABILIZATION BMP.





**G-1 SEDIMENT TRAPS****PURPOSE & APPLICATIONS**

A sediment trap is a small, temporary ponding area to intercept sediment-laden runoff from small disturbed areas long enough to allow the coarser sediment particles to settle out. A sediment trap is usually installed in a drainageway, at a storm drain inlet or culvert inlet, or other points of discharge from a disturbed area.

**SPECIFICATIONS**

**Location:** Sediment traps shall be located so that they can be installed prior to disturbing the area they are to protect. Traps must not be located any closer than 20 feet from a proposed building foundation if the trap is to function during construction. Locate traps to obtain maximum storage benefit from the terrain, for ease of cleaning out and disposal of the accumulated sediment.

**Trap Clean out:** Sediment shall be removed and the trap restored to its original dimension when the sediments have accumulated to 1/2 of the trap's design depth. Sediment removed from the trap shall be deposited in a protected area and in such a manner that it will not erode.

**Excavation:** All excavation operations shall be carried out in such a manner that erosion and water pollution shall be minimal. Excavated sediment traps shall have 1:1 or flatter slopes.

**Outlet:** The outlet shall be designed, constructed and maintained in such a manner that sediment does not leave the trap and that erosion at or below the outlet does not occur. Sediment traps must outlet onto stabilized (preferably undisturbed) ground, into a watercourse, stabilized channel, or into a storm drain system.

**Pipe Outlet Sediment Trap**

See the detail drawings at the back of this section for the proper construction of a pipe outlet sediment trap. A pipe outlet sediment trap consists of a trap formed at the outlet of a detention pond used for water quantity control and the water shall be discharged to a well-vegetated receiving area to be filtered by natural or well-established vegetation.

**Construction Sequence:** The outlet trap is installed before the construction of the project begins and is to remain operational until the site is fully stabilized. Sediment traps with pipe outlet structures may be fitted with a temporary perforated riser, surrounded by a gravel cone.

**Riser:** The outlet for the trap is through a perforated riser pipe through the embankment. The outlet pipe and riser shall be made of corrugated metal and its top 2/3 must be perforated with (1) inch nominal diameter holes or slits spaced six (6) inches vertically and horizontally placed into the concave portion of the corrugated pipe. No holes or slits will be allowed within six (6) inches of the top of the horizontal barrel.

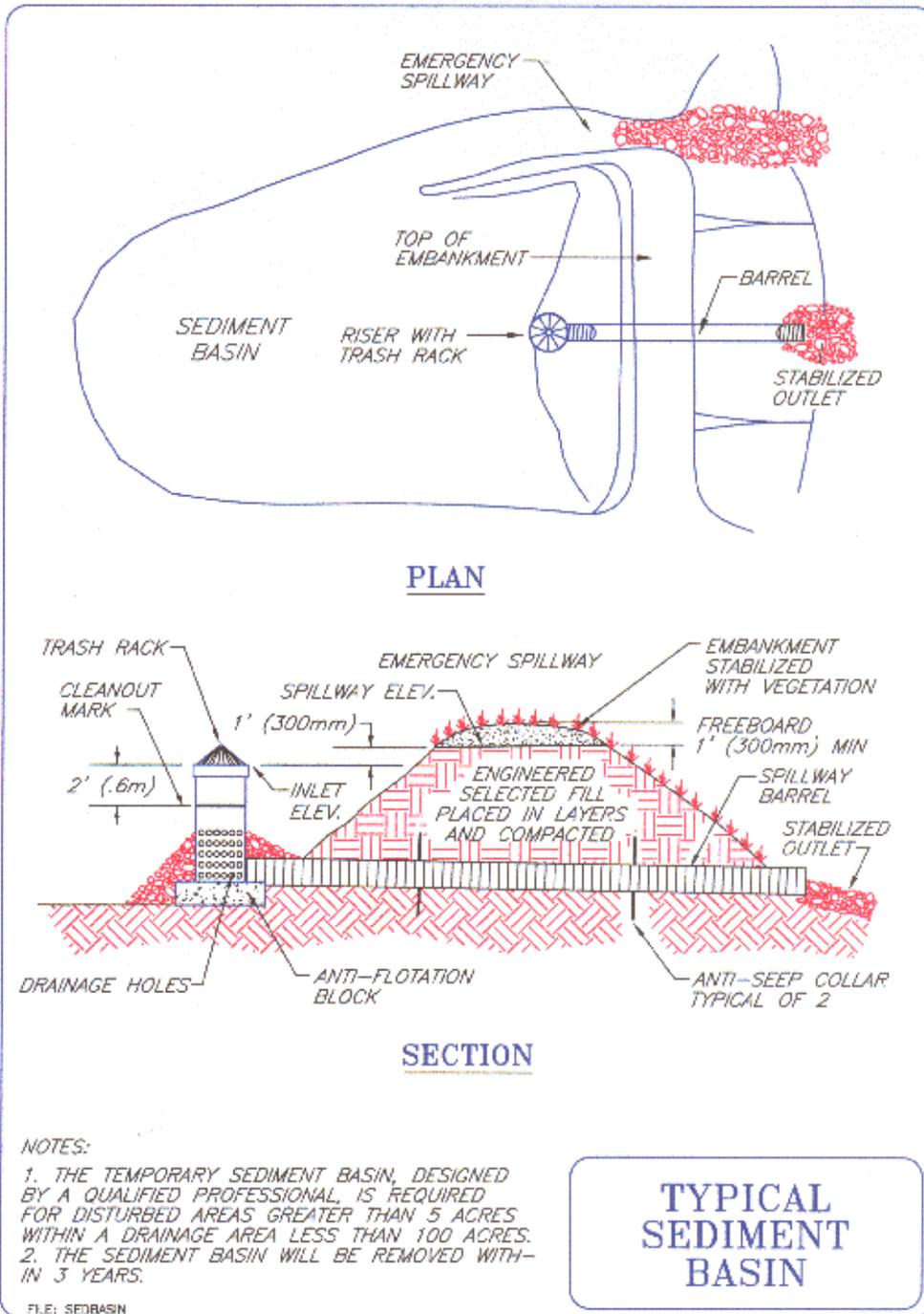
**Filter Fabric:** A geotextile filter shall be installed around the riser. The riser shall be wrapped with a geotextile or filter cloth (Mirafi 100 X, Poly Filter GB or a filter cloth with an equivalent sieve size between #40-80) and secured with strapping or connecting band at the top and bottom of the cloth. The cloth shall cover an area at least six (6) inches above the highest hole and six (6) inches below the lowest hole. The top of the riser pipe shall not be covered with filter cloth.

**Embankment:** The top of the embankment shall be at least 1 1/2 feet above the crest of the riser. The embankment shall be fully stabilized with either riprap or vegetation and mulch.

**Anchoring Weight:** The riser shall have a base with sufficient weight to prevent flotation of the riser. Two approved bases are: (1) A concrete base 12 inches thick with the riser embedded 9 inches into the concrete base, or (2) 1/4" minimum thickness steel plate attached to the riser by a continuous weld around the circumference of the riser to form a watertight connection. The plate shall have 2.5 feet of stone, gravel, or earth placed on it to prevent flotation. In either case, each side of the square base measurement shall be the riser diameter plus 24 inches.

**Riprap Outlet Sediment Trap and Energy Dissipator:** A Riprap Outlet Sediment Trap consisting of a trap formed by an excavation and embankment. The outlet for this trap shall be

through a partially excavated channel lined with riprap. This outlet channel shall discharge onto a stabilized area or to a watercourse. The riprap outlet sediment trap may be used for drainage areas of up to a maximum of 15 acres. Refer to PIPE OUTLET PROTECTION BMP.



**G-2 SEDIMENT POND CONSTRUCTION****PURPOSE & APPLICATIONS**

A sediment basin is a water impoundment constructed to collect and store sediment and/or debris made by constructing a dam or embankment or by excavating a pit or dugout pond for water storage. Its purpose is:

- Detain stormwater volume and slowly releasing it to the downstream waterways
- To prevent undesirable deposition on downstream drainage waterways
- To trap sediment originating from construction sites
- To provide a basin for deposition and storage of sediments and debris.

This specification applies if the following conditions exist:

- Failure of the dam will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.
- A sediment basin must be more than 100 feet away from a Resource Protection Area as defined by the Maine DEP.

**PLANNING CONSIDERATIONS**

**Water Quantity:** By impounding water, ponds create a new surface and ground water regime.

The peak discharge downstream may be reduced, and in dry weather the downstream flow may go to zero. Depending on the site, there may be an increased flow to the ground water. With some seepage the base flow may be extended over a longer period of time.

**Water Quality:** Ponds may trap nutrients and sediment, which wash into the basin, removing substances from downstream. Chemical concentrations in the pond may be higher during the summer months. By reducing the amount of water that flows in the channel downstream, the frequency of flushing of the stream is reduced and there is a temporary collection of substances held temporarily within the channel. A pond may cause more leachable substances to be carried into the ground water

**CONSIDERATIONS**

Sediment basins are a flow through type structure and are designed to retard the time it takes the runoff from reaching the downstream areas without long-term storage. There may be an increased recharge to ground water; but if the basin bottom is nearly impermeable, only a small amount of water may percolate beneath the basin.

- Ponds mostly trap coarse-grained sediments, which wash into the basin. Fine-grained sediments such as silts and clays will remain suspended in the water and will travel off-site unless the water is detained for an extended period of time.
- Water temperatures may be altered due to changes in shading of man-made channels and ponds.
- Ponds must not be constructed in or directly discharging to an existing stream channel as they cause thermal pollution - raising water temperatures high enough to damage Maine's cold water fisheries.
- Pond locations and construction activities may affect downstream water quality, wetlands and water-related wildlife habitats.
- Overall planning and design should be carefully considered to minimize the number of ponds required.

## **SPECIFICATIONS**

Sediment ponds must be constructed and stabilized prior to disturbing the watershed above them. If sediment ponds will be stabilized with vegetation, they must be installed early in the growing season.

### **Design Criteria**

**Capacity:** The capacity of the sediment basin shall equal to the stormwater volume to be detained plus the volume of sediment expected to be trapped. Periodic removal of sediment will be necessary to maintain the pond's capacity.

**Temporary basins:** Temporary basins having drainage areas of 5 acres or less and a total embankment height of 5 feet or less may be designed with less conservative criteria. The embankment shall have a minimum top width of 4 feet and side slopes of 2:1 or flatter. An outlet shall be provided of earth, pipe, stone, or other devices adequate to handle the 10-year frequency discharge without failure or significant erosion.

**Site investigations:** Test pits, dug prior to design preparation, are necessary to determine foundation conditions and to evaluate borrow sources for embankment pond construction. Soil auger information may be sufficient for excavated pond construction. In general soil information shall be gathered under the dam and principal spillway to a depth at least equal to the maximum dam height.

**Site Conditions:** Site conditions shall be such that runoff from the design storm can be safely, and in a non-erosive manner, passed through a natural or constructed emergency spillway and/or a principal spillway.

**Number of ponds:** Efforts should be made to minimize the number of ponds required.

**Drainage area:** The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded at flood stage against the embankment at the emergency spillway elevation is 3 ft or more. Excavated ponds must be designed to be drained within a 10-day period.

**Stabilization:** All areas disturbed during construction shall be stabilized within 7 calendar days of that disturbance in accordance with the PERMANENT VEGETATION BMP, TEMPORARY MULCHING BMP, or other appropriate structural BMP. All construction of sediment basins must be completed and seeded by September 15th if vegetative measures will be used for final stabilization. Otherwise, erosion control blankets, erosion control mix will be required on side slopes as specified with the WINTER CONSTRUCTION AND STABILIZATION BMP. If structural measures such as riprap will be used for final stabilization, this time limit will not apply. Water shall not be channelized to the sediment basin until the basin is stabilized with vegetative or structural measures.

**Removal of fine sediment particles:** Sediment basins with pipe outlet structures shall be fitted with a temporary perforated riser surrounded by a gravel cone. This will serve to filter fine colloidal material. In sensitive watersheds where additional protection should be provided (lake watersheds, sensitive streams), a geotextile filter shall be installed around the riser as well. Additionally, the water shall be discharged to a well-vegetated receiving area to be filtered by natural or well-established vegetation.

### **Design Criteria for Embankment Ponds**

**Foundation cutoff:** A cutoff of relatively impervious material shall be provided under the dam if necessary. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than one horizontal to one vertical.

**Earth embankment:** The minimum top width for a dam is shown as follows. If the embankment top is to be used as a public road, the minimum width shall be 16 ft for one-way traffic. Guardrails

or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority.

<b>Minimum top width for dams</b>	
<b>Embankment</b>	<b>Top width</b>
10 or less	6
10-15	8
15-20	10
20-25	12
25-35	14
35 or more	15

**Embankment Slope:** The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical, and neither slope shall be steeper than two horizontal to one vertical. All slopes must be designed to be stable, even if it requires flatter side slopes.

**Slope Protection:** If needed to protect the slopes of the dam, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided.

**Height requirements:** The design height of the dam shall be increased by the amount needed to insure that after settlement the height of the dam equals or exceeds the design height. The minimum elevation of the top of the settled embankment shall be 1 ft above the water surface in the reservoir with the emergency spillway flowing at design depth. The minimum difference in elevation between the crest of the emergency spillway and the settled top of the dam shall be 2 ft for all dams having more than a 20-acre drainage area or more than 20 ft in effective height.

**Excavated pond:** Any excavated pond with a drainage area in excess of five acres, or spring flow in excess of 100 gallons per minute must be designed to accordance with embankment pond criteria.

**Principal spillway:** A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of mechanical spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway. The spillway elevation shall be no less than 0.5 ft below the crest of the emergency spillway for dams having a drainage area or 20 acres or less, and no less than 1 ft for those having a drainage area of more than 20 acres.

When design discharge of the principal spillway is considered in calculating the peak outflow through the emergency spillway, the crest elevation of the inlet shall be such that the full flow will be generated in the conduit before there is discharge through the emergency spillway. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the emergency spillways. The diameter of the pipe shall not be less than 4 in. If the pipe conduit diameter is 10 in. or greater, its design discharge may be considered when calculating the peak outflow rate through the emergency spillway.

The pipe shall be capable of withstanding external loading without yielding, buckling, or cracking. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection. The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe. All pipe joints shall be made watertight by the use of couplings, gaskets, caulking, or by welding.

The maximum height of fill over any principal spillway steel or aluminum pipe must not exceed 25 ft. The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Concrete pipe shall have concrete bedding or a concrete cradle, if required. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load.

**Cathodic protection** is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need.

**Antiseep collar:** Seepage control along an outlet pipe shall be provided if any of the following conditions exist:

- The effective height of dam is greater than 15 ft.
- The conduit is of smooth pipe larger than 8 in. in diameter.
- The conduit is of corrugated pipe larger than 12 in. in diameter.

When antiseep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. Collar material shall be compatible with pipe materials. The antiseep collar(s) shall increase by 15% the seepage path along the pipe.

**Seepage control:** Seepage along pipes extending through the embankment shall be controlled by use of a filter and drainage diaphragm, unless it is determined that antiseep collars will adequately serve the purpose.

The drain is to consist of sand, meeting fine concrete aggregate requirements (at least 15% passing the No. 40 sieve but no more than 10% passing the No. 100 sieve). If unusual soil conditions exist, a special design analysis shall be made. The drain shall be a minimum of 2 ft thick and extend vertically upward and horizontally at least three times the pipe diameter, and vertically downward at least 18 in beneath the conduit invert. The drain diaphragm shall be located immediately downstream of the cutoff trench, approximately parallel to the centerline of the dam.

The drain shall outlet at the embankment downstream toe, preferably using a drain backfill envelope continuously along the pipe to where it exits the embankment. Protecting drain fill from surface erosion will be necessary.

**Antivortex devices:** Closed conduit spillways designed for pressure flow must have adequate antivortex devices.

**Trash guard:** To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser.

**Pond drainage:** A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

**Emergency spillways:** An emergency spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for the acceptable use of closed conduit principal spillways without an emergency spillway: a conduit with a cross-sectional area of 3 sq.ft. or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed emergency spillway shall require to pass the peak flow expected, less any reduction creditable to conduit discharge and detention storage.

The emergency spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days' drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the emergency spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Emergency spillways shall provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

Constructed emergency spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth. The side slopes shall be stable for the material in which the spillway is to be constructed. For dams having an effective height exceeding 20 ft, the emergency spillway shall have a bottom width of not less than 10 ft.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed emergency spillway shall fall within the range established by discharge requirements and permissible velocities.

**Structural emergency spillways:** If chutes or drops are used for principal spillways or principal emergency or emergency spillways, they shall be designed according to the principles set forth

by the USDA for chute spillway. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table 4, less any reduction creditable to conduit discharge and detention storage.

**Vegetated emergency spillway:** An embankment pond with a vegetated or earth emergency spillway and no principal spillway must satisfy all of the following conditions.

- The effective height of dam does not exceed 20 feet.
- The drainage area does not exceed 20 acres.
- The ratio of drainage area to pond surface area does not exceed 24.
- Surface runoff and/or ground water flow will not cause long duration, continuous or frequent flow.

**Visual resource design:** The visual design of ponds shall be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

### **Design Criteria for Excavated Ponds**

Any excavated pond with a drainage area in excess of five acres, or spring flow in excess of 100 gallons per minute must be designed to accordance with embankment pond criteria.

**Runoff:** Provisions shall be made for a pipe and emergency spillway if necessary. Runoff flow patterns shall be considered when locating the pit and placing the spoil.

**Side slopes:** Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical.

**Perimeter form:** If the structures are to be used for recreation or are highly visible to the public, the perimeter or edge should be curvilinear.

**Inlet Protection:** If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

**Excavated material:** The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and so that it will not be washed back into the pond by rainfall. It shall be disposed of in one of the following ways:

- Uniformly spread to a height that does not exceed 3 ft, graded away from the pond.
- Uniformly placed and shaped with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 ft from the edge of the pond.
- Shaped to a designed form that blends visually with the landscape.

### **Construction Specifications**

It is essential to use erosion control measures during the construction of a pond to protect downstream waterbodies from sedimentation. The following criteria for erosion and sediment control shall be considered when constructing a pond structure:

**Site Location:** Locate the permanent pond where there will be the least disturbance to the soils of the existing site. Ponds should not be located in stream or wetlands.

**Timing:** Whenever possible, install ponds during periods of low rainfall (generally late summer) to minimize downstream impacts from sedimentation.

**Foundation preparation:** The foundation area shall be cleared of trees, logs, stumps, roots, brush, boulders, sod, and rubbish. If needed to establish vegetation, the topsoil and sod shall be stockpiled and spread on the completed dam and spillways. Foundation surfaces shall be sloped no steeper than a ratio of one horizontal to one vertical. The foundation area shall be thoroughly scarified before placement of the fill material. The surface shall have moisture added, or it shall be compacted if necessary so that the first layer of fill material can be compacted and bonded to the foundation.

**Cutoff Trench:** The cutoff trench and any other required excavations shall be dug to the lines and grades shown on the plans or as staked in the field. If they are suitable, excavated materials may be used in the permanent fill. Existing stream channels in the foundation area shall be sloped no steeper than a ratio of one horizontal to one vertical. They shall be deepened and widened as necessary to remove all stones, gravel, sand, stumps, roots, and other objectionable material and to accommodate compaction equipment.

**Fill Placement:** The material placed in the fill shall be free of detrimental amounts of sod, roots, frozen soil, stones more than 6 in. in diameter (except for rockfills), and other objectionable material.

**Drainfill:** Drainfill shall be kept from being contaminated by adjacent soil materials during placement by either placing it in a cleanly excavated trench or by keeping the drain at least 1 ft above the adjacent earthfill. Selected drainfill and backfill material shall be placed around structures, pipe conduits, and antiseep collars at about the same rate on all sides to prevent damage from unequal loading.

Fill material shall be placed and spread beginning at the lowest point of the foundation and then bringing it up in horizontal layers thick enough that the required compaction can be obtained. The fill shall be constructed in continuous horizontal layers. If openings or sectionalized fills are required, the slope of the bonding surfaces between the embankment in place and the embankment to be placed shall not be steeper than a ratio of three horizontal to one vertical. The bonding surface shall be treated the same as that specified for the foundation to insure a good bond with the new fill.

The distribution and gradation of materials shall be such that no lenses, pockets, streaks, or layers of material shall differ substantially in texture or gradation from the surrounding material. If it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and upstream parts of the fill. If zoned fills of substantially differing materials are specified; the zones shall be placed according to lines and grades shown on the drawings. The complete work shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

**Stabilization:** All areas disturbed during installation shall be stabilized within 7 days of that disturbance in accordance with the PERMANENT VEGETATION BMP or other appropriate structural BMP. If vegetative stabilization is required, the project needs to be timed to use the growing season. All construction of ponds must be completed and seeded by September 15th if vegetative measures will be used for final stabilization. Final stabilization will include seeding, mulching and anchoring with netting or mats. If structural measures such as riprap will be used for final stabilization, this time limit will not apply. Water shall not be directed to the pond until the pond is stabilized with vegetative or structural measures.

**Temporary Diversions:** Where sedimentation is expected to cause major damage downstream, temporary diversions shall be installed to direct water around the pond construction area. Refer to the WATER DIVERSION BMP.

**Culvert Inlets & Outlets:** Reinforcement of culvert headwalls and outlets in pond structures is generally required to protect downstream areas from chronic erosion and sedimentation. Refer to the PIPE INLET PROTECTION BMP and the PIPE OUTLET PROTECTION BMP for information.

**Riprap Outlet Sediment Trap and Energy Dissipator:** A Riprap Outlet Sediment Trap consisting of a trap formed by an excavation and embankment. The outlet for this trap shall be through a partially excavated channel lined with riprap. This outlet channel shall discharge onto a stabilized area or to a watercourse. The riprap outlet sediment trap may be used for drainage areas of up to a maximum of 15 acres. Refer to PIPE OUTLET PROTECTION BMP.

**Sequence of installation:** Sediment basins must be installed and stabilized with either vegetation or structural measures prior to disturbing the land that will produce the sediment. Water shall not be channelized to the sediment basin until the basin is stabilized.

**Moisture control:** The moisture content of the fill material shall be adequate for obtaining the required compaction. Material that is too wet shall be dried to meet this requirement, and material that is too dry shall be wetted and mixed until the requirement is met.

**Compaction:** Construction equipment shall be operated over each layer of fill to maximize compaction. Special equipment shall be used if needed to reach the required compaction. If a minimum required density is specified, each layer of fill shall be compacted as necessary to

obtain that density.

Fill adjacent to structures, pipe conduits, and drainfill or antiseep collars shall be compacted to a density equivalent to that of the surrounding fill by hand tamping or by using manually directed power tampers or plate vibrators. Fill adjacent to concrete structures shall not be compacted until the concrete has had time to gain enough strength to support the load.

**Protective Cover:** A protective cover of vegetation shall be established on all exposed surfaces of the embankment, spillway, and borrow area if soil and climatic conditions permit. If soil or climatic conditions preclude the use of vegetation and protection is needed, nonvegetative cover such as mulches or gravel may be used. In some places, temporary vegetation may be used until permanent vegetation can be established. The embankment and spillway shall be fenced if necessary to protect the vegetation.

**Principal spillway:** Pipe materials shall conform to appropriate specifications. Antiseep collars shall be of materials compatible with that of the pipe and shall be installed so that they are watertight. The pipe shall be installed according to the manufacturer's instructions. It shall be firmly and uniformly bedded throughout its length and shall be installed to the line and grade shown on the drawings.

**Concrete:** The mix design and testing of concrete shall be consistent with the size and requirements of the job. Mix requirements or necessary strength shall be specified. The type of cement, air entrainment, slump, aggregate, or other properties shall be specified as necessary. All concrete is to consist of a workable mix that can be placed and finished in an acceptable manner. Necessary curing shall be specified. Reinforcing steel shall be placed as indicated on the plans and shall be held securely in place during concrete placement. Subgrades and forms shall be installed to line and grade, and the forms shall be mortartight and unyielding as the concrete is placed.

**Foundation and embankment drains:** Foundation and embankment drains, if required, shall be placed to the line and grade shown on the drawings. Detailed requirements of drain material and any required pipe shall be shown in the drawings and specifications for the job.

**Excavated ponds:** The completed excavation shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

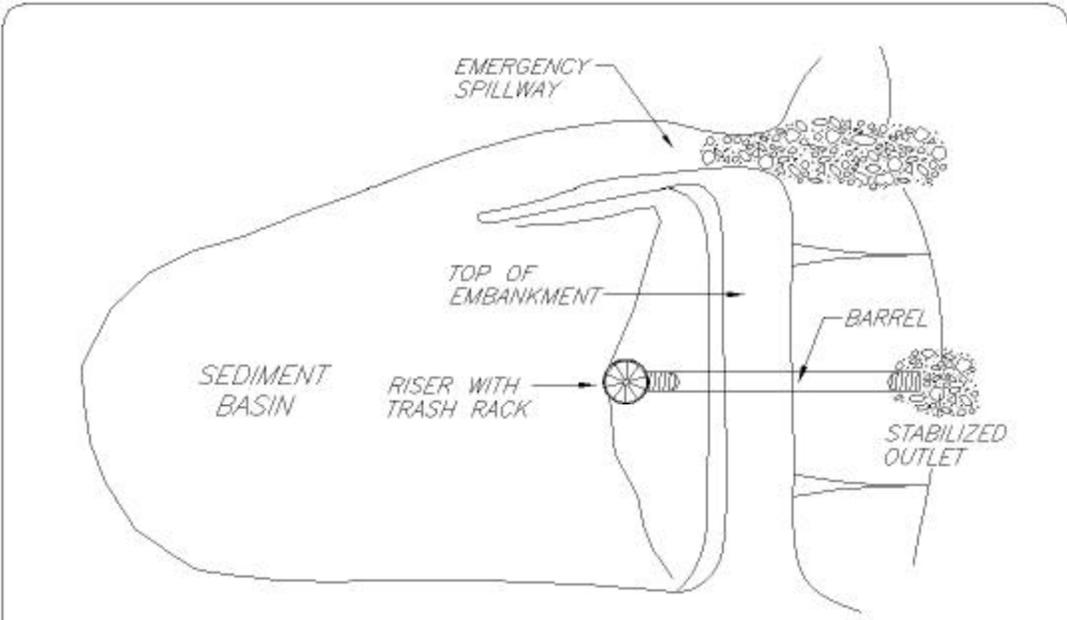
**Embankment and excavated ponds:** Construction operations shall be carried out so that erosion and air and water pollution are minimized and held within legal limits. All work shall be conducted in a skillful and workmanlike manner. The completed job shall present a workmanlike appearance.

Measures and construction methods that enhance fish and wildlife values shall be incorporated as needed and practical. Fencing and cover to control erosion and pollution shall be established as needed. Appropriate safety measures, such as warning signs, rescue facilities and fencing, shall be provided as needed.

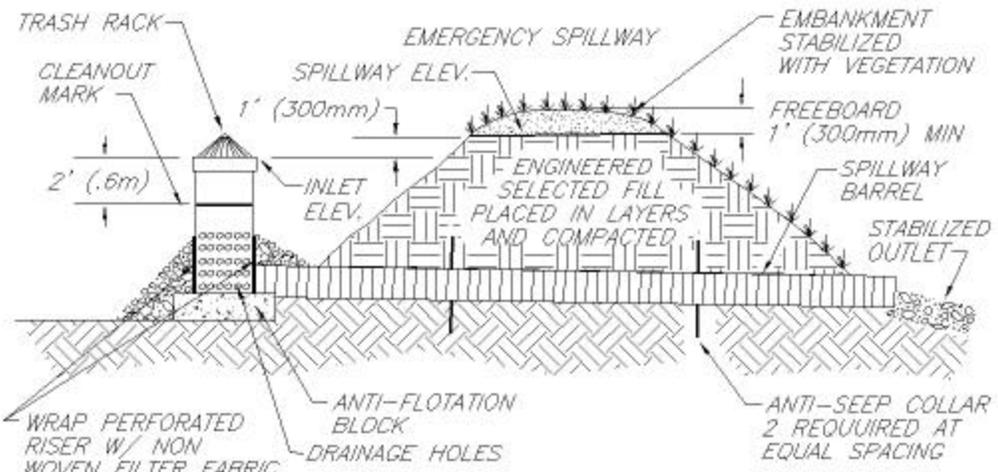
## ***MAINTENANCE***

Pond installations need to be regularly inspected during their installation. If there is any evidence of siltation, corrective measures need to be installed to keep sediment from entering downstream areas.

The basin shall be maintained as needed to maintain its function. Clean out of sediment from the basin shall be determined based on the design criteria. The water discharged from sediment basins shall be monitored during storm events to determine how well they are functioning and if sedimentation is apparent, additional erosion control measures shall be applied to eliminate the source of sedimentation.



**PLAN**



**SECTION**

- NOTES:**
1. THE SEDIMENT BASIN WILL BE REMOVED WITHIN 3 YEARS.
  2. EMERGENCY SPILLWAY CAPACITY DESIGNED FOR 25 YEAR STORM FLOW (INCLUDING STONE APRON).
  3. POND CAPACITY DESIGNED FOR 25 YEAR STORM BEFORE ACTIVATING EMERGENCY SPILLWAY.

**TYPICAL  
SEDIMENT  
BASIN**

1994 JOHN McCULLAH  
 ME DEP 2003  
 FILE: SEDBASIN

**G-3 CONSTRUCTION DEWATERING****PURPOSE & APPLICATIONS**

Construction dewatering is a necessary operation on most construction sites in the Northeast. Excavations that do not result in a daylight drain, or have insufficient slope onsite to easily provide daylight drains, trap either rainwater or groundwater within the excavation. Similarly, cofferdams collect rain, ground or seepage water within the work area. For construction projects, this water needs to be removed before certain operations can be performed or to keep work conditions safe. It is typical for contractors to use ditch pumps to dewater these enclosed areas, but pay little attention to the location of the outlet and where the pumped water goes. Often, the pumped water finds its way to a downgradient natural resources like a lake, wetland, or a stream that is sensitive and needs to be protected. This practice examines the best ways to deal with this discharge of collected water and is designed to:

- Prevent the discharged water from eroding soil on the site.
- Choose the best location for discharge.
- Remove sediment from the collected water.
- Preserve downgradient natural resources and property.

**CONSIDERATIONS**

- The discharge areas should be chosen with careful consideration to the downgradient water resources and the landscape ability to treat water flows from the dewatering process. A wooded buffer is best. All buffer requirements are found in the VEGETATED BUFFER BMP section. The discharge should be stopped immediately if the receiving area is showing any sign of instability or erosion.
- If the collected runoff is contaminated with oil, grease, or other petroleum products, oil/water separator or a filtration mechanism may be necessary prior to the discharge. Another method of disposal such as containment and trucking away by a Maine DEP licensed transporter will need to be implemented if the water has been contaminated by toxic and hazardous materials.
- All requirements of state law and permit requirements of local, state, and federal agencies must be met.

**SPECIFICATIONS**

Dewatering excavated areas must be in two distinct phases. The removal of the collected water within the excavation and the treatment of the collected water.

**Physical Dewatering**

The removal of water from the excavated area can be accomplished by numerous methods. The most common of these are: gravity drain through daylight channels, mechanical pumping, siphoning, and using the bucket of construction equipment to scoop and dump water from the excavation.

- Channels dug for discharging water from the excavated area need to be stable. If flow velocities cause erosion within the channel then a ditch lining should be used.
- Bucketed water should be discharged in a stable manner to the sediment removal area. A splash pad of riprap underlain with geotextile may be necessary to prevent scouring of the soil in the basin.
- Dewatering in periods of intense, heavy rain, when the infiltrative capacity of the soil is exceeded, should be avoided.

**Sediment Removal**

Many methods of settling or filtering sediment are available for the contractor to consider.

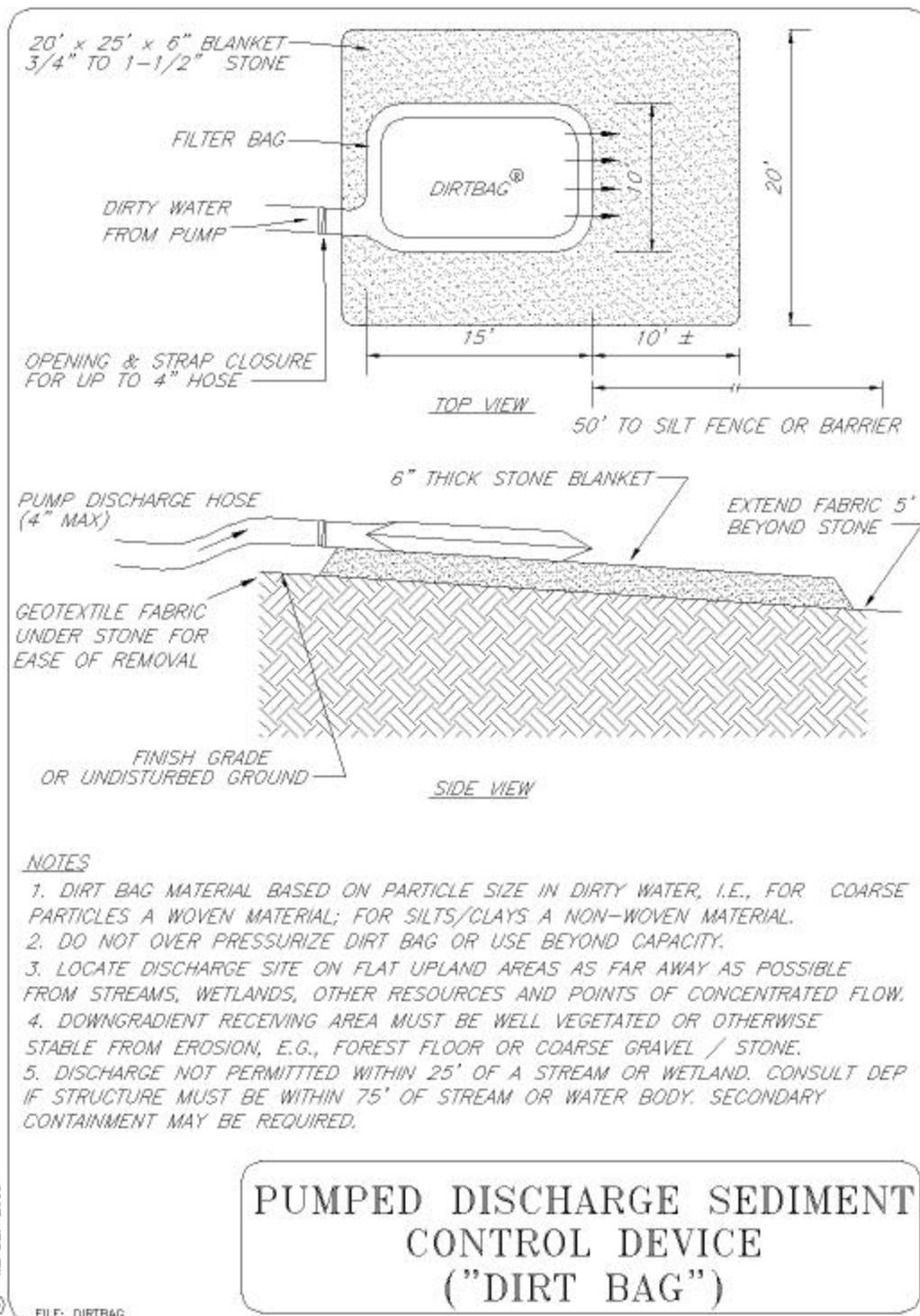
- Flow to the sediment removal structure may not exceed the sediment removal structure's capacity to settle and filter flow or the structure's volume capacity.
- Sediment Removal Basins should discharge wherever possible to a well-vegetated buffer through sheet flow and should maximize the distance to the nearest water resources and minimizing the slope of the buffer area.
- Various basin designs have been proposed in past projects.
  - An enclosure of Jersey Barriers lined with a large piece of slit tape geotextile.
  - A temporary enclosure constructed with hay bales, silt fence, or both. Erosion control mix also may be incorporated with silt fence or hay bales.
  - Direct discharge of lightly sediment bearing water may be able to go directly into well-buffered areas with 0-2% slope as long as a method of spreading flow into sheet flow is available.
  - Discharge to a manufactured / pre-made structure specifically designed for sediment removal, like a Silt Sak, Silt Bag, or other similar product.
  - Concrete or steel settling chambered systems for sediment removal.
  - Excavated or bermed sedimentation ponds or structures. Side slopes no greater than 2 to 1, or with a combined interior and exterior slope of no greater than 5 to 1. See the SEDIMENT TRAP BMP section.
  - A stormwater detention pond may be used as a stilling basin during construction. However, a sediment barrier needs to be installed to the outlet structure to prevent the discharge of sediment. See the SEDIMENT POND CONSTRUCTION BMP section.

#### **Installation Requirements**

- For trench excavation, limit the trench length to 500 feet and place the excavated material on the up gradient side of the trench.
- Install diversion ditches or berms to minimize the amount of clean stormwater runoff allowed into the excavated area.
- Never discharge to areas that are bare or newly vegetated.

#### ***MAINTENANCE***

During the active dewatering process, inspection of the dewatering facility should be reviewed frequently. Special attention should be paid to the buffer area for any sign of erosion and concentration of flow that may compromise the buffer area. Observe where possible the visual quality of the effluent and determine if additional treatment can be provided.



**H-1 ROAD CONSTRUCTION AND STABILIZATION****PURPOSE & APPLICATIONS**

Most of gravel roads' erosion and sedimentation problems originate with improper construction and maintenance. These erosion problems also create ruts, pumps and potholes that can destroy the suspension of a vehicle or construction equipment.

**CONSIDERATIONS**

Effective drainage is critical to road longevity and stability. Good drainage requires removing runoff from the road surface and preventing groundwater from infiltrating the road base. These two distinct drainage problems require an understanding of the difference between surface water and groundwater.

**Surface Water**

Surface water is water that is flowing or standing on the top of the ground. On gravel roads, the biggest concern is to get water off the road surface as quickly as possible and to direct it to a natural or constructed drainage channel that is capable of handling the flow without eroding. When surface water is not drained off the road, it can lead to washouts, muddy conditions, and potholes.

The following measures are used to help drain water off the road surface:

- a well-constructed road with proper crowning and grading;
- stable road ditches;
- diversions (e.g., water bars); and
- turnouts and buffers that return runoff as sheet flow to natural drainage areas, but well away from any surface waterbodies.

Any road (even properly constructed ones) will alter the natural surface water drainage pattern. The trick is to recognize these changes and to prevent them from causing problems.

**Groundwater**

Groundwater (subsurface water) flows and is stored under the earth's surface. With roads, the biggest concern is to keep groundwater out of the road base. Groundwater in the road base will make it soft (potentially impassable) and susceptible to tire rutting. Ideally, subsurface water should be drained from the road base and directed to a natural or constructed channel capable of handling the flow without eroding. Types of subsurface drainage include:

- Stable ditches that are dug sufficiently deep (below the water table) to drain water from the road base
- A well-constructed road foundation of coarse soil materials (i.e., sand and gravel with few fines to allow subsurface water to drain efficiently).
- And subsurface drains of either pervious (slotted) pipe or permeable soil material.

**SPECIFICATIONS****Road Material**

The specific composition of soil materials used in road construction will make a big difference in terms of performance and durability. Good road material should contain portions of the three basic types of soil that have specific properties that make it best for different aspects of road building: gravel, sand, and fines (silts and clays which are generally comprised of particles too small for the eye to see). Gravel is very durable and drains freely. Sand also drains efficiently. Fines pack and bind well, helping shed water as they do not drain well. Some general guidelines are as follows.

**Road base material** needs to be sturdy and drain freely. The gravel must be somewhat coarser than the road surface material (3"-4" maximum particle size); and have 0 to 7 percent fines (to subsurface drainage). The base layer should be 18 inches or thicker.

**Road surface material** needs to pack well, be durable, and shed water. It should have gravel with a maximum particle size of 2 inches (for a smooth ride) and 7 to 12 percent fines (to pack well and shed water). The surface layer should be about 4 to 6 inches thick. Loose surface material generally indicates a lack of fines. Soft roads are generally indicative of too many fines in the base material, or a base layer that is not thick enough to support the road.

### Alternative Road Surfacing Materials

There are certain situations where a typical gravel surface may not be sufficient to resist erosion or traffic wear such as in areas of steep slopes, sharp corners, or intersections with heavy volumes of turning traffic. Alternative materials generally cost more up front, but can be more cost effective, given their longer life cycle. Alternative materials can also lessen or eliminate some chronic maintenance problems.

**Reclaimed Pavement/Recycled Asphalt:** Reclaimed pavement is old pavement that has been ground up. It looks similar to road gravel, but it is more granular and darker because of the residual asphalt. The most common and effective use of this material is on steep road segments that have had problems with surface erosion. The residual asphalt in this material acts as a binder, which makes it more resistant to erosion.

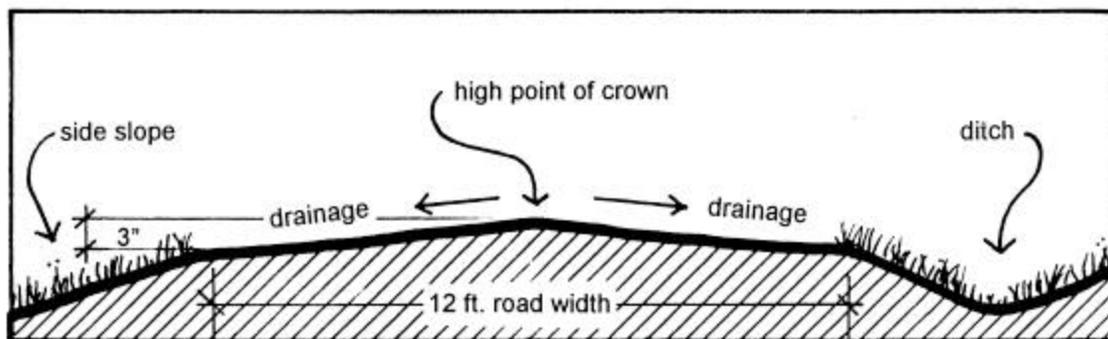
- Reclaimed pavement can be spread in the same way as gravel; no special equipment is required.
- When placing on problem slopes, start from just beyond the crest (top) of the hill and work down.
- The recommended depth is 3-4 inches. Anything less may be prone to erosion.
- Compact the recycled pavement, particularly on areas that are heavily traveled. Compacting with a roller or whacker is preferred.
- Verify the quality of the product before delivery so that it does not contain any waste products such as sheet rock and gravel making it less likely to bind together.

### Road Level

Properly constructed roads are built above the natural ground. This creates a high point, which is essential for effective surface drainage. Unfortunately, many older roads were built by pushing material away from the roadway, resulting in a road surface that is lower than the surrounding land, which is hard to drain and heavy runoff will tend to overflow and run over the road. This type of road is also prone to subsurface drainage problems, because the road base often consists of poor (native) soil materials that may be in the local water table.

### Crowning

Road crowning and grading are the primary means by which surface water is drained off a road surface. To crown a road means to create a high point that runs lengthwise along the center of the road. Either side of this high point is sloped gently away from the center toward the outer edge of the road. Crowning is the quickest way to get water off the road, preventing significant erosion of the road surface.



**Crown profile:  $\frac{1}{4}$ " of crown per foot of road width (e.g.,  $\frac{1}{4}$ " x 12' road = 3" crown).**

An insufficient crown will allow water to puddle on the road surface creating potholes or eroding the road surface. The potholes will continue to grow each time a vehicle splashes through them, resulting in the loss of fine clay particles that are necessary for a good road surface. Standing water will also seep into the roadbed, weakening the road and making it susceptible to tire rutting. Proper grading will prevent potholes from forming and provide a safer surface for travel. A general rule for level or gently sloping gravel roads is ¼-inch of crown per foot of total road width. A crown of ½-inch per foot of road width may be necessary for steeper sections to counteract the tendency of water to travel downhill over the road surface. Crowns greater than ¾-inch per foot are not generally recommended, as they can be difficult to maintain and difficult to drive over. Crowning should be done annually on gravel roads because snow plowing and normal use flattens the road over the course of a year.

### **Grading**

Grading is the process of smoothing and crowning a gravel road using a grader with a steel cutting blade to redistribute soil material. The grader is the most frequently used piece of equipment for general gravel road maintenance. It can be very versatile when used by an experienced operator.

In general, roads receiving heavier use will require more frequent grading. Trucks carrying heavy loads will flatten the crown and create wheel ruts much faster than typical passenger vehicle traffic. Cars traveling too fast will blow away light soil particles from the road surface causing wash boarding.

Regular grading of gravel roads or shoulders is an effective means of removing and redistributing ridges of road winter sand or material that has either been washed to the road edge or has been pushed to the edge by vehicle traffic. These little ridges will catch water before it can drain off the road, channeling it along the outer edge of the road surface potentially causing severe damage to a road surface during periods of heavy rain.

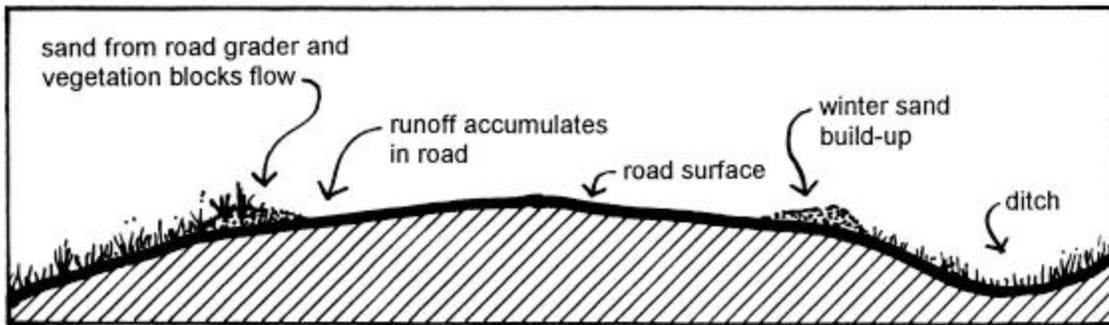
- Always make sure that water can get off the road by smoothing the edge of the road with the grading blade.
- Usually, gravel roads are regraded by scraping this material from the outer edge of the road, and pulling it back into the center.
- Bulldozers are not generally recommended for road grading as they tend to flatten the crown, which restricts effective surface drainage.
- Proper grading is also the most effective means of removing potholes. The grader should cut to the full depth of the potholes. Otherwise, they will tend to reform very quickly.

Grading is typically done at least once a year on seasonal roads and more often on year-round roads. The best time to grade a road is when the road is moist (in the spring, or after a rain). Water helps to loosen the gravel and fines and makes the road easier to reshape.

**Steel Tine Rake:** One affordable and effective piece of maintenance equipment is a steel tine rake, or York rakes. This device consists of a row of strong metal tines that work in much the same manner as a grader blade. It is made to be towed behind, or mounted in front of a pickup truck or tractor and can be used to:

- Remove potholes and washboarding;
- Maintain or establish proper road crown;
- Remove ridges of road material or vegetation from the road shoulder; and
- Mix road materials to achieve proper distribution of particle sizes.

### Sand and vegetation build-up prevent drainage to side of road



### **MAINTENANCE**

Effective erosion control and maintenance can be best accomplished by:

- Monitor and maintain the road on a regular basis. The best time to inspect a gravel road is on or following a rainy day.
- Thoroughly plan the construction and maintenance before starting the project.
- Keep runoff velocities slow
- Avoid concentrating runoff (promote dispersion).
- Discharge stormwater runoff into vegetated areas.
- Minimize areas of exposed soil on side slopes and ditches
- Stabilize and cover bare soils with vegetation or other protection (i.e., mulch or riprap).

Keep in mind that refilling a road that continues to wash out is a waste of time and money and does not effectively address the problem. Effective maintenance should prevent or minimize recurring problems.

## H-2 ROAD SURFACE DRAINAGE

### **PURPOSE & APPLICATIONS**

Effective drainage is critical to the stability and longevity of a gravel road. Good drainage requires removing runoff from the road surface and get it off as quickly as possible otherwise it can lead to washouts, muddy conditions and potholes. Besides a well-constructed road with proper crowning and grading and stable road ditches, road surface diversion or waterbars are needed to direct the runoff off the road surface.

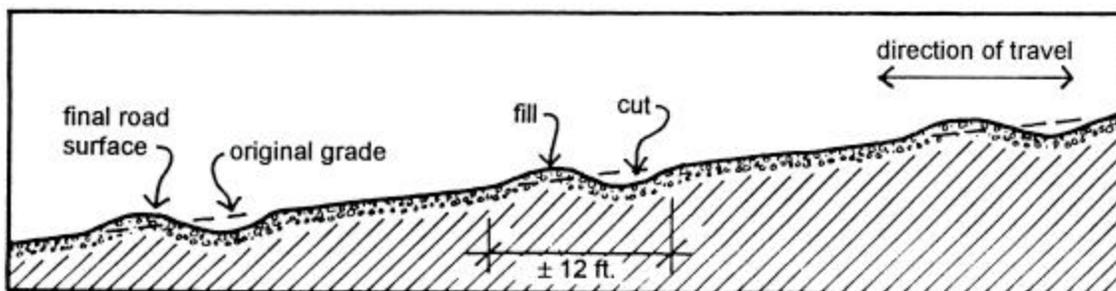
Ideally, road runoff should be discharged uniformly off the road surface, resulting in sheet flow into a grassed or wooded area where it will gradually percolate into the ground without creating channels or causing erosion. The main purpose of waterbars is to reduce the quantity of stormwater flowing over the road and reaching the bottom of the hill. Waterbars should be located so that they gradually transfer stormwater from the road surface to a side ditch and buffer following the contours of the land. These should be installed frequently enough to prevent large volumes of runoff and more water bars are necessary on steeper slopes to counteract the effect of fast-moving water.

### **CONSIDERATIONS**

If no ditch is present, the waterbars should have a flared end section that is level and lined with rock to spread out the flow. The level lip of this device converts the channeled flow from the water bar into shallow sheet flow just before it discharges into the vegetated area. (Sheet flow has far less erosive potential than channeled flow, because the water is moving more slowly.) Waterbars are beneficial, because they disperse runoff before it can cause erosion (if located frequently enough).

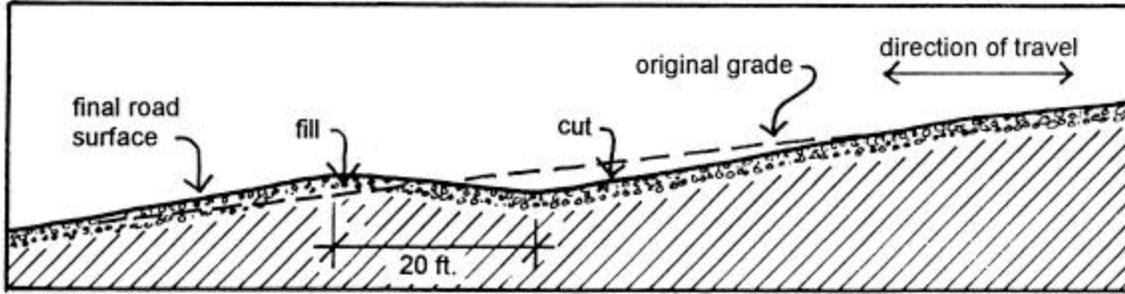
### **Water Bars and Broad-Based Dips**

Water bars and broad-based dips can be used on roads and driveways to divert water off the road surface during a storm. A water bar is a ridge (like a speed bump) that runs diagonally across the road, typically at a 30-degree angle. The ridge stops water from running down the road, and diverts it to the side. Place water bars at frequent intervals to prevent significant water flow on the road.



**WATER BARS**

A broad-based dip accomplishes the same result as a waterbar by using a shallower depression. These devices can be an economical means of getting water to drain off the road. Water bars are easy to construct, but may be inappropriate for roads with frequent daily traffic. Broad-based dips are more appropriate for use on year-round roads but they can't be used on steep slopes. Broad-based dips may however cause safety concerns if sufficient water accumulates that they result in ice formation on the road surface.

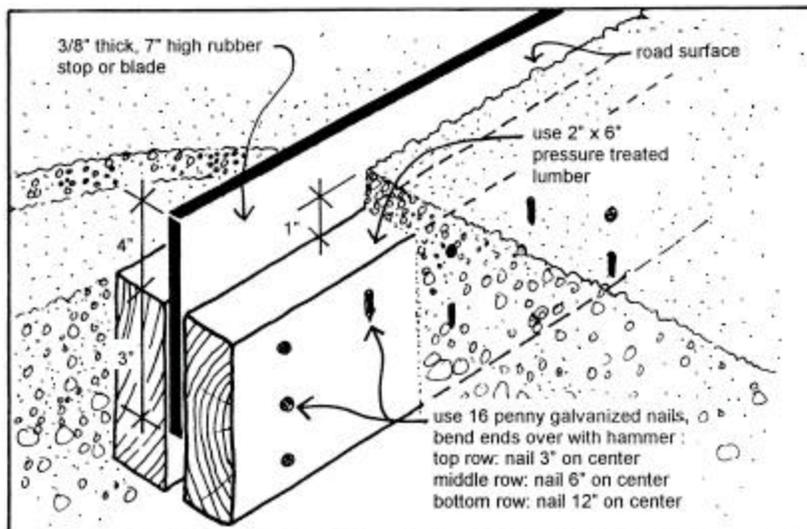


**BROAD-BASED DIP**

Spacing For Water Bars And Broad-based Dips	
Road/Trail Grade (%)	Water Bar Spacing (feet)
2	250
5	135
10	80
15	60
20	45
30	35

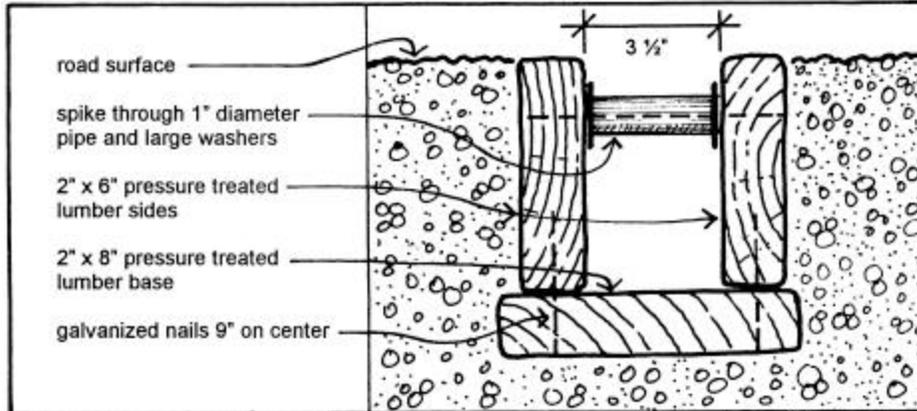
**Rubber Bars**

Rubber bars can also be used to divert water off sloping sections of a road and can take the place of a water bar. The rubber bar protrudes above the road surface high enough to intercept and collect water, while allowing traffic to pass over it. This device is used generally on seasonal roads or driveways because the bars are prone to snowplow damage. The rubber for this type of device can be found in some hardware stores and is typically cut from an old conveyor belt.



## Open-top Culverts

Open-top culverts are an alternative often used in logging operations, but can also be used on camp roads. These box-like structures collect and divert road surface runoff away from the road. They are seldom recommended for year-round roads due to the likelihood of snowplow damage. Open-top culverts can be constructed of logs or from sawn lumber and if constructed of pressure treated lumber, they can last for many years. Open-top culvert must be set 30° downslope perpendicular from the road cross-section and must drain into a stable vegetated buffer. They need to be cleaned regularly to remove sediments, gravel, leaves, and twigs; but winter snowplowing can easily destroy this type of culvert.



## H-3 ROAD DITCH TURNOUTS

### **PURPOSE & APPLICATIONS**

A ditch turnout consists of a stable ditch, a turnout berm and a trench outlet used to store and release road runoff into existing stable natural vegetated buffer area. The outlet, a level spreader, is constructed with the natural topography in mind, across the slope, consisting of a combination of stone and existing natural vegetation used to disperse, filter and spread concentrated flow over a receiving area. See the LEVEL SPREADER BMP for its design.

Turnouts reduce the amount of water in a long ditch and the movement of sediment by filtering out sediment, soluble pollutants and sediment attached pollutants by filtration, infiltration, absorption, adsorption, decomposition, and volatilization.

- Use only where drainage areas being treated are less than 2 acres. For greater drainage areas, use vegetated waterways, lined waterways, or grade control structures.
- Obtain an easement for flows that will cross an adjoining property before being intercepted by a stable drainageway capable of handling the added flow.

### **CONSIDERATIONS**

- If grass cover needs to be installed in the ditch and/or the receiving area, construction will be limited to the growing season. Final seeding should be completed by September 15.
- The receiving area must maintain the natural contour across the slope to insure uniform distribution of flow, otherwise water will channelize and the structure will fail.
- Stable receiving swales should exist below the receiving area as concentrated flow can be expected to start occurring within 300 feet.
- Provisions shall be made to maintain the undisturbed nature of the vegetation in the filter area as it can aid in slowing and dispersing flows.

### **SPECIFICATIONS**

#### **Design Criteria**

**Ditch Section:** The ditch that conveys the road runoff to the turnout berm and trench must be stabilized with either vegetation or riprap. Refer to the VEGETATED WATERWAYS BMP or RIPRAP REINFORCED BMP.

**Turnout Berm Section:** The turnout berm that directs the ditch flows to the trench receiving area shall be stabilized in conjunction with ditch stabilization. The side slopes of the berm shall be 2H:1V at the maximum. The minimum height shall be 2 feet.

**Trench Receiving Area:** The trenches shall be constructed along the existing contour. It shall be 15-20 feet long, at least 7 feet wide across the top and a least 2 feet deep. The trench shall be filled with 4-6 inch clean stone.

**Natural Vegetated Buffer Area:** The receiving area shall have a regular topography to allow the conversion of surface flows into subsurface flows through infiltration and to prevent undue flow concentration before entering a stable watercourse. And the receiving area shall be stable prior to the construction of the ditch turnout.

**Uphill Runoff:** Runoff from uphill side slopes of road shall not be allowed to drain into ditch turnouts. These are only appropriate for use in controlling road runoff in small sections of roadway. The intent of ditch turnouts is to remove sediment from road runoff through infiltration into a vegetated buffer. It was not originally designed as an erosion control BMP.

**Turnout Berm and Trench Spacing:** Spacing shall be based on the road grade as shown below:

Road Grade	Spacing between Turnouts
1-2%	200 feet
3-10%	150 feet
10%	100 feet

### **Construction Specifications**

The receiving area below the ditch turnout trench shall be protected from harm during construction. The area must be revegetated before any flow is directed into it. A temporary diversion may be necessary in this case.

Ditch turnouts shall blend smoothly into the downstream receiving area via a level spreader without any sharp drops or irregularities, to avoid channelization, turbulence and hydraulic "jumps". Refer to the LEVEL SPREADER BMP for design

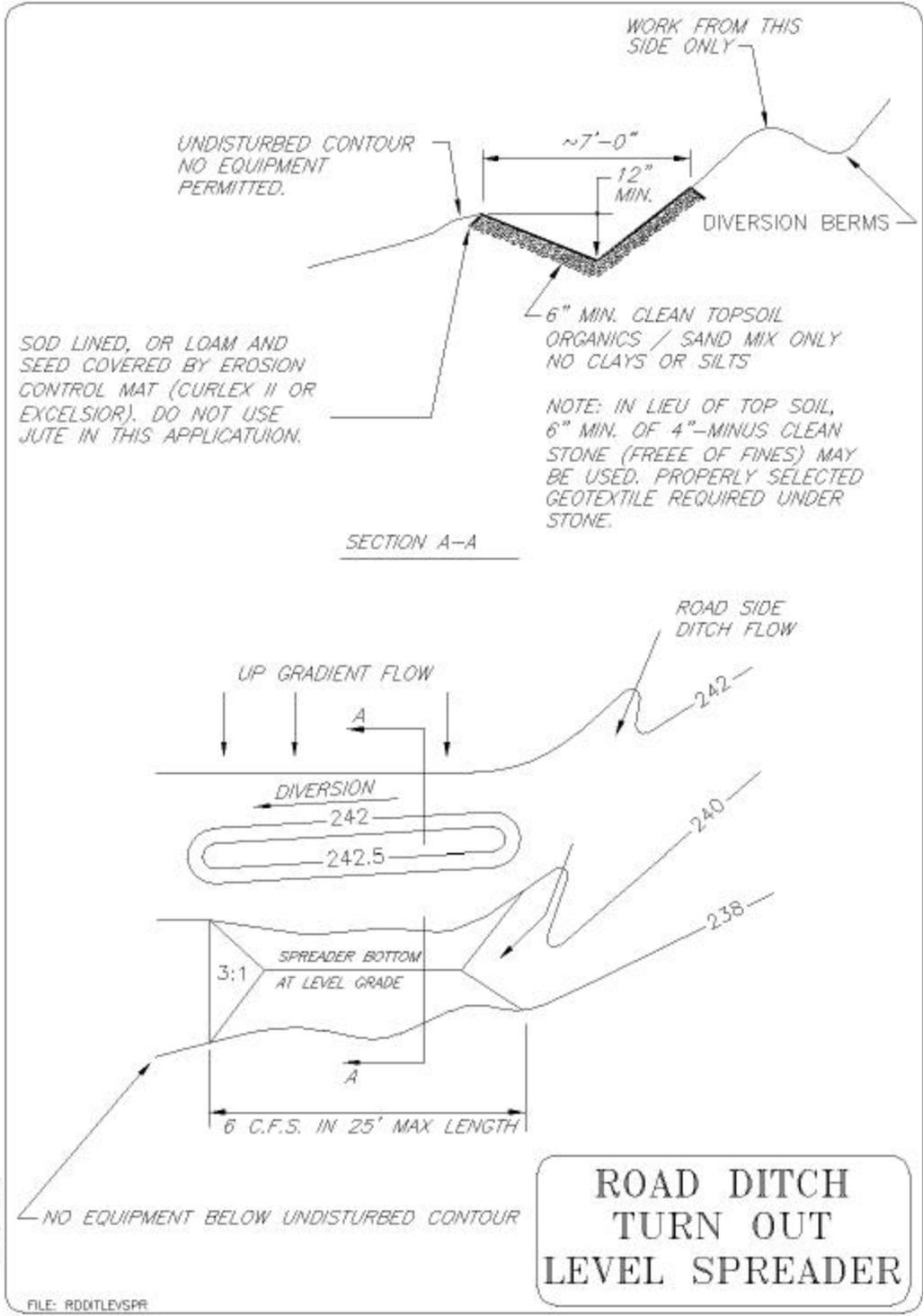
Ditch turnouts shall be constructed on undisturbed soil where possible. If fill is used it shall be constructed of material compacted to 95% of standard proctor test levels prior to seeding for that area not considered the seedbed.

### **Schedule of Installation**

Ditch turnouts should be installed in conjunction with the ditch construction. Once soil is exposed, the turnouts should be immediately constructed and stabilized.

### ***MAINTENANCE***

After construction, ditch turnouts need to be carefully inspected for any signs of channelization and immediately repaired. It will be necessary to remove sediment from the ditch turnout trench when the swale is full and the structure is no longer functioning properly.



**I-1 GRAVEL PIT RECLAMATION****PURPOSE & APPLICATIONS**

Gravel pit reclamation is the stabilization of inactive borrow areas with herbaceous perennial plants. The purpose is to stabilize the soil, preventing wind or water erosion from causing on-site or off-site damage and to improve the aesthetic appeal and the ability of the site to support wildlife. This practice is applicable to sand and gravel borrow areas which have had the soil profile replaced to approximate original conditions or where the soil profile has been removed.

**CONSIDERATIONS**

- Gravel pit reclamation provides an excellent opportunity to use recyclable organic residuals rather than mining topsoil from prime farmland areas.
- Gravel pits should be revegetated with a diversity of grasses, shrubs and trees to provide improved wildlife habitat.
- Nutrients and pesticides used to establish and maintain vegetation must be managed to protect surface and ground water quality.
- Late fall seeding may fail and cause water quality deterioration in spring runoff events.
- Sand and gravel pits are difficult sites to permanently vegetate. The difficulty can almost always be attributed to one factor: the topsoil is usually sold and is not stockpiled for reclamation. To re-establish vegetation, save enough topsoil on-site to allow for a 4-inch cap over the whole area. This is usually sufficient for establishing selected vegetation compatible with the site conditions.

**SPECIFICATIONS****Engineering Considerations**

Each site should be evaluated to determine if engineering practices are needed to help maintain soil stability and prevent erosion. While some sites require specific and detailed engineering plans, there are general guidelines that can be considered on all sites. The following guidelines can ease the task of establishing vegetation:

**Slope stability:** Cut and fill slopes should not exceed 2:1 (2 horizontal feet for 1 vertical foot) to provide stability. Flatter slopes (3:1) are preferred to facilitate seeding efforts.

**Slope length:** Avoid long slopes to help prevent erosion and to allow access for seeding, mulching, and maintenance. Refer to the LAND GRADING AND SLOPE PROTECTION BMP for information about modifying slope lengths.

**Diversions:** Construct diversions at tops of slopes to divert runoff away from the slope banks to a stable outlet. Refer to the WATER DIVERSION BMP.

**Chutes** Construct rock lined chutes or equivalent to conduct concentrated flow of water to stable outlets. Refer to the RIPRAP REINFORCED WATERWAYS BMP or REINFORCED WATERWAYS BMP.

**Grass and Legume Species****Preparation for Seeding**

Remove large stones, boulders, and other debris that will hinder the seeding process and establishment of vegetation.

Spread a minimum depth of 4 inches of topsoil over the site; but topsoil substitutes may be used instead. The topsoil should be mixed with the subsoil to a depth of 6 inches minimum. This helps roots to penetrate into the less fertile subsoil and helps prevent slippage of the grass layer in the future.

Sample and test the topsoil: Obtain samples by collecting 6 to 8 small samples (1 or 2 handfuls) of soil material from the upper 4 inches of the area to be seeded. Mix the small samples to obtain one composite sample.

Use part of the sample for a soil test to determine lime and fertilizer needs. Run the balance of the sample(s) through a sieve analysis to determine the percent by weight passing a 200-mesh sieve. Sieve analyses can be requested from the University of Maine Soil Analytical Lab in Orono (581-2917).

**Seeding Procedures**

Select one of the following grass/legume mixes as described for gravel pits. These mixes are recommended because they are better adapted to gravel pit sites and require little maintenance during and after establishment. Additional guidance on species substitutes and available seed sources may be obtained from NRCS field offices and local Soil and Water Conservation Districts.

**MIX 1**

SPECIES	VARIETY (select one)	Lb Per Acre
Switchgrass	Blackwell, Shelter, Cave-in-Rock	4.0
Big Bluestem	Niagara, Kaw	4.0
Little Bluestem	Camper, Aldous, Blaze	2.0
Sand Lovegrass	NE-27, Bend	1.5
Coastal Panicgrass	Atlantic	2.0

**MIX 2**

SPECIES	VARIETY (select one)	Lb Per Acre
Flatpea*	Lathco	10.0
Perennial Pea*	Lancer	2.0
Crownvetch*	Penngift, Chemug	10.0
Tall Fescue	Ky-31, Rebel, Ken-Hi	10.0

**MIX 3**

SPECIES	VARIETY (select one)	Lb Per Acre
Orchardgrass	Pennlate, Kay, Potomac	5.0
Tall fescue	Ky-31	10.0
Redtop	Streeker, Common	2.0
Birdfoot trefoil	Viking, Empire	5.0

\* These legumes must be inoculated at time of seeding. If seeding by hand, use a sticking agent, such as cola or milk to stick inoculant to seed. If seeding with hydroseeder, use 4 times the recommended rate of inoculant.

Based on the percent weight passing a 200-mesh sieve, select one of the three grass/legume mixes described above. Use:

- Mix 1:               Where percent by weight passing a 200 sieve is less than 15
- Mix 2:               Where percent by weight passing a 200 sieve is between 15 and 20
- Mix 1, 2 or 3:    Where percent by weight passing a 200 sieve is above 20

***The standard soil conservation mix available from local suppliers is not recommended. This mix usually provides a green cover very quickly, but the plant species begin to die out in 2-4 years on sterile and droughty sites if fertilizing is not done on a regular basis***

(b) The primary seeding dates begin as soon as the snow melts in the spring and ends May 15. The importance of early seeding cannot be overemphasized. Depending on weather conditions, substantial failure can be expected if seeding is done later.

Fertilize and lime based on soil test results.

### **Tree and Shrub Species**

Gravel pits can be landscaped to provide screening and to improve wildlife habitat. This is especially important in larger pits where habitat has been lost. The following species can be used in gravel pit reclamation:

**Primarily for cover on sand and gravel sites:** Bristly locust, rugosa rose, seabuckthorn, and common juniper. Of these, bristly locust is the best where rapid spread and development is needed to provide cover on steep banks or gullies. Rugosa rose and seabuckthorn also spread by suckering, but are not as vigorous as bristly locust. Sweetfern can be used, if local transplant material is available. Overseeding shrub plantings with perennial ryegrass at 10 to 15 pounds per acre will provide some protection against erosion while the shrub planting is developing. Spacing of shrubs should be 4 feet x 4 feet, or 4 feet x 6 feet.

**Primarily for wildlife food and cover:** Use any of the above plants or crabapples, red osier dogwood, highbrush cranberry, sumac species, thornapple, and mountain ash.

**Primarily for screening:** Eastern red cedar, crabapples, European and Japanese larch, American arborvitea, red spruce, white spruce, Norway spruce, red pine and jack pine.

*Note: Avoid exotic invasive species including Autumn Olive, Russian Olive and Honeysuckle.*

### **MAINTENANCE**

Substantial stand vigor can be achieved if the site is topdressed with fertilizer one year after planting between June 15 and July 15. The timing of this topdressing is important. If mowing is desired to suppress woody growth, mow about mid-July leaving a stubble height of 6-8 inches. A good cover of flatpea will prevent invasion of woody species.

**I-2 STREAMBANK STABILIZATION****PURPOSE & APPLICATIONS**

Streambank stabilization consists of using vegetation or structural materials to stabilize and protect banks of streams, brooks, rivers, or excavated channels against scour and erosion from flowing water. Streambank vegetation that is sufficiently developed contributes large woody material to streams, creates critical structural elements of habitats for many different species. Still streambanks stabilized with shrub and tree vegetation provides excellent habitat for fish and wildlife species. Maine's fisheries rely on a combination of shading and leaf drop by the plants. Shading protects fish species from "thermal pollution" -- when the water heats up too much for fish to thrive. Leaf litter provides the first link in the food chain -- a food source for the insects that young fish feed on. The purpose of streambank stabilization is:

- To prevent stream damage due to utilities, roads, buildings, or other facilities adjacent to the banks,
- To maintain the capacity of the channel,
- To control channel meander that would adversely affect downstream facilities,
- To reduce sediment loads causing downstream damages and pollution,
- To improve the stream as a habitat for fish and wildlife.

Good planning before construction normally requires staying away from streams but these measures are used to stabilize and protect the banks of streams, brooks, rivers, and excavated channels that are influenced by or influence a developing area. It pertains to natural or excavated channels where the streambanks are susceptible to erosion from the action of water, ice, debris, or to damage from livestock, pedestrian, or vehicular traffic.

**CONSIDERATIONS**

Streambank stabilization requires the understanding of both channel formation processes and engineering applications. For many projects, engaging the services of a competent fluvial geomorphologist should be considered.

All permit requirements of local, state, and federal agencies must be obtained.

- Structural measures may be necessary to stabilize the embankments and if extensive reconstruction is required, other engineering practices should be used.
- It is far better to minimize cutting and disturbance of existing vegetation rather than to replant.
- Tree and shrub plantings are beneficial for fish habitat since they shade the water (counter acting thermal heating) and provide leaf litter (a food source). This protects fish productivity.
- Avoid using riprap as much as possible because it promotes thermal pollution. Heating occurs when stormwater runoff washes over sun-baked stone riprap. In cases where riprap is required for streambank stability, combine it with vegetative plantings to maintain good habitat.
- Pesticides and fertilizers should not be used next to streams. It is preferable to use mulch to prevent competing vegetation from killing introduced vegetation and to add organic matter.
- There may not be any increased erosion and sediment yield from the channel and surrounding areas during and immediately after construction.
- Late fall construction and seeding may fail and cause water quality deterioration in spring runoff events and these areas need to be stabilized accordingly.

**SPECIFICATIONS**

Any work performed within a stream or adjacent to it will need a DEP permit under NRPA (Natural Resource Protection Act). LURC permits are required in the unorganized areas of Maine. Contact the Department of Inland Fisheries and Wildlife for more information. See the detail drawings at the back of this section for the proper biostabilization methods of streambanks.

## Design Criteria

- Because each reach of a stream, brook, or river is unique, measures for streambank protection must be installed according to a plan and adapted to the specific site.
- The grade must be controlled, either by natural or artificial means, before any permanent type of bank protection can be considered feasible, unless the protection can be safely and economically constructed to a depth well below the anticipated lowest depth of bottom scour.
- Streambank protection shall be started at a stabilized or controlled point and ended at a stabilized or controlled point on the stream.
- Woody debris in stream channels shall be preserved to provide fish habitat where possible and clearing of debris should be minimized since this debris provides habitat for fish species.
- Changes in channel alignment shall be made only after an evaluation of the effect on the land use, interdependent water disposal systems, hydraulic characteristics, and existing structures. Curves and meanders, deflectors and gabion wingwalls can be installed to increase fish habitat.
- Structural measures must be effective for the design flow and be able to withstand greater floods without serious damage. They shall also be designed to avoid an increase in erosion downstream of planned measures. This is accomplished by not changing the direction of flood flows and not increasing velocities by use of protective armor that is too smooth (Low "n" value).
- Vegetative protection shall be considered on the upper parts of eroding banks, especially on areas that are susceptible to infrequent inundation.

### Bank protection with riprap

Refer to the RIPRAP SLOPE STABILIZATION BMP. The following is a partial list of elements that may be included in a plan for streambank protection:

- If tree removal is needed to promote the growth of desirable bank vegetation, leave root systems intact.
- Reduction of the slope of streambanks to provide a suitable condition for vegetative protection or for the installation of structural bank protection.
- Placed or dumped heavy stone, properly underlaid with a filter blanket, if necessary, to provide protection for streambanks.
- Deflectors constructed of posts, piling, fencing, rock, brush, or other materials that project into the stream to protect banks at curves and reaches subjected to impingement by high velocity currents.
- Pervious or impervious structures built on or parallel to the stream to prevent scouring streamflow velocities adjacent to the streambank.
- Artificial obstructions, such as fences to protect vegetation needed for streambank protection or to protect critical areas from damage from stock trails or pedestrian and vehicular traffic.

**Construction Specifications:** Measures and construction methods that enhance fish and wildlife values shall be incorporated as needed and practical. Special attention shall be given to protecting and maintaining key shade, food, den trees, and visual resources and to stabilizing disturbed areas.

**Material Specifications:** Refer to the RIPRAP SLOPE STABILIZATION, GABION and PERMANENT VEGETATION BMPs for this information.

### Bank protection with vegetation

Stands of full-grown trees protect streambanks from erosion through the binding of soil with their roots. Shrubs provide even better erosion protection, and riverside stands of willow trees are often replaced naturally by colonies of shrub-like willows. These plants hold the soil with their root systems and reduce water velocities. They also protect tree trunks from damage caused by breaking ice and help to prevent the formation of strong eddies around large trees during flood flows. Shrub vegetation is particularly beneficial along the impact bank of a stream meander, where maximum scouring tends to occur.

**Planting individual shrubs:** Streambanks are often difficult to plant, even when they are well

sloped. Where mattocks or shovels are unsatisfactory tools, the planting dibble, which is a heavy metal tool with a blade and a foot pedal is the best tool. It is thrust into the ground to make a hole for the plant.

Shrub can be put into the soil as cuttings, slips or stems. Fresh cuttings should be 3/8- to 1/2-inch thick and 12 to 18 inches long. They should be kept moist. If not used at once, they should be stored in cool moist sand. Rooted cuttings should be planted vertically in the bank with 1 or 2 inches of wood protruding above the ground surface. Plantings should be made early in the spring to ensure adequate moisture for growth. For further information about general planting, consult the PERMANENT VEGETATION BMP.

Since shrubs are generally not effective for the first two years, grasses must be seeded immediately following shrub planting to provide initial streambank protection. Annual ryegrass can be immediately seeded and will sprout up within days. See the TEMPORARY VEGETATION BMP for seeding information. Mulch and an erosion control blanket such as jute netting or excelsior must be installed as well to protect bare soil on the stream banks. Refer to the TEMPORARY MULCHING BMP for more information about both.

**Fascine Rolls:** Willows and other softwoods can also be bound together in various ways in order to ensure immediate protection of the streambank. Fascine rolls (also known as wattles) are bundles of willow, dogwood or poplar whips that are placed across the slope on the contour. They are set against the bank so that the parts, which are to take root, touch the ground above the water level and are able to get sufficient moisture. Covering them with earth improves the contact with the ground and retards their loss of moisture.

**Brush Layering:** Brush layering uses the same planting materials as fascine rolls, however they are not tied together in bundles. They consist of layers of loose branches interlayered with soil. Generally longer branches are used and a greater volume of planting material is required. Fascine rolls and brush layering can be installed to deflect water away from eroding banks. The branches are set parallel to the direction of the current or at an angle of 30 to 45 degrees.

**Willow Mattresses:** The degree of streambank protection can be increased by using willow mattresses or packed fascine work. Willow mattresses consist of 4-to-8-inch-thick layers of growing branches set perpendicular to the direction of the current or sloping downstream, with the broad ends of the branches oriented downwards. The branches are held together with interweaving wire or other branches at intervals of 24 to 32 inches, set parallel to the direction of the current or at an angle of 30 degrees. If several layers of mattress are necessary, the tops of the lower layers should cover the bases of the upper layers. The bottom layer is fixed at the base in a trench previously dug at the base of the softwood zone. The whole mattress structure should be covered with 2 to 10 inches of earth or fine gravel.

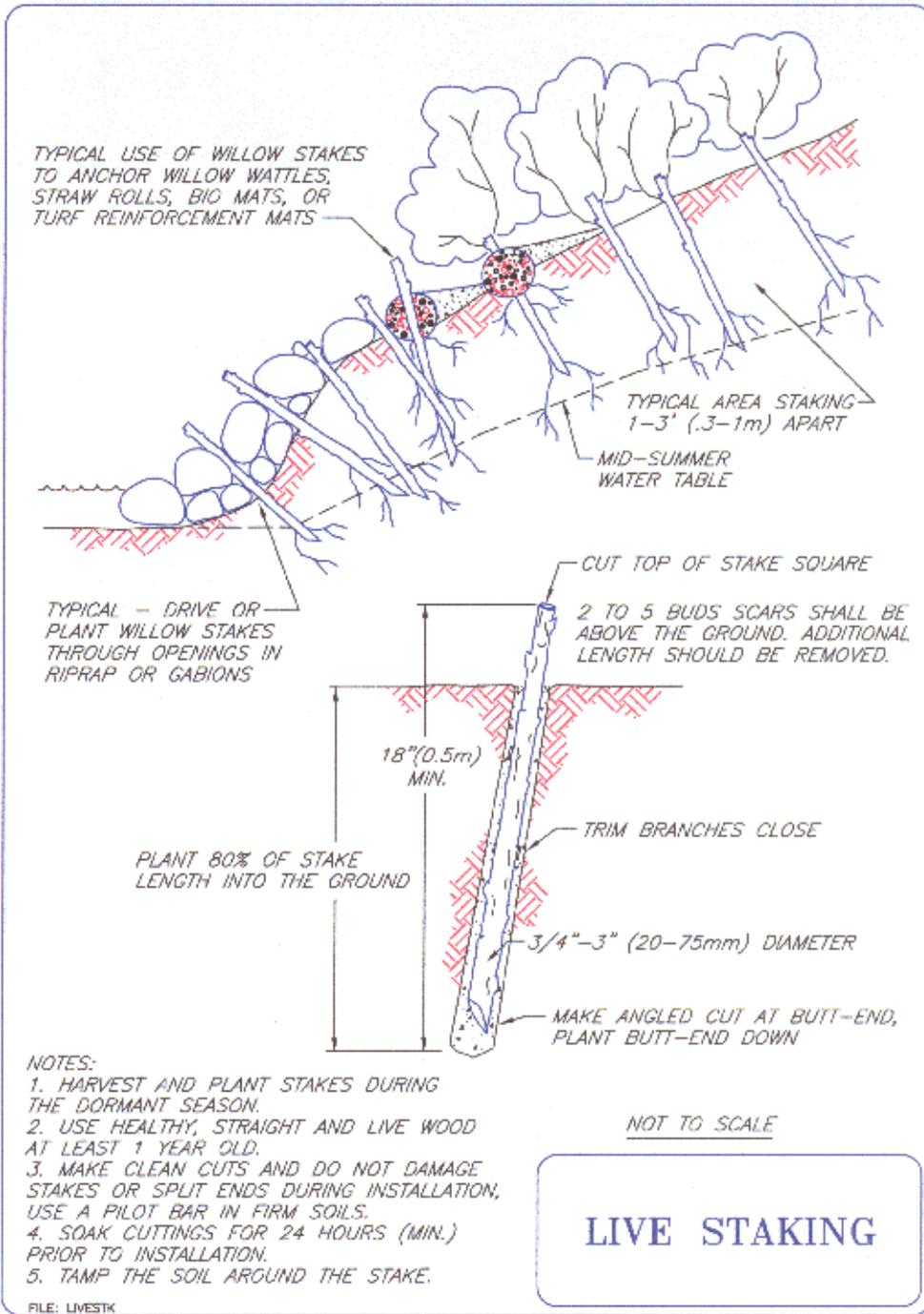
**Packed Fascine-Work:** Packed fascine-work consists essentially of layers of branches laid one across the other to a depth of 8 to 12 inches and covered with fascine rolls. The spaces between the fascine rolls are filled with gravel, stones and soil so that no gaps remain; and a layer of soil and gravel 8 to 12 inches thick is added on top. Packed fascine-work is particularly suitable for repairing large breaches in the banks of streams.

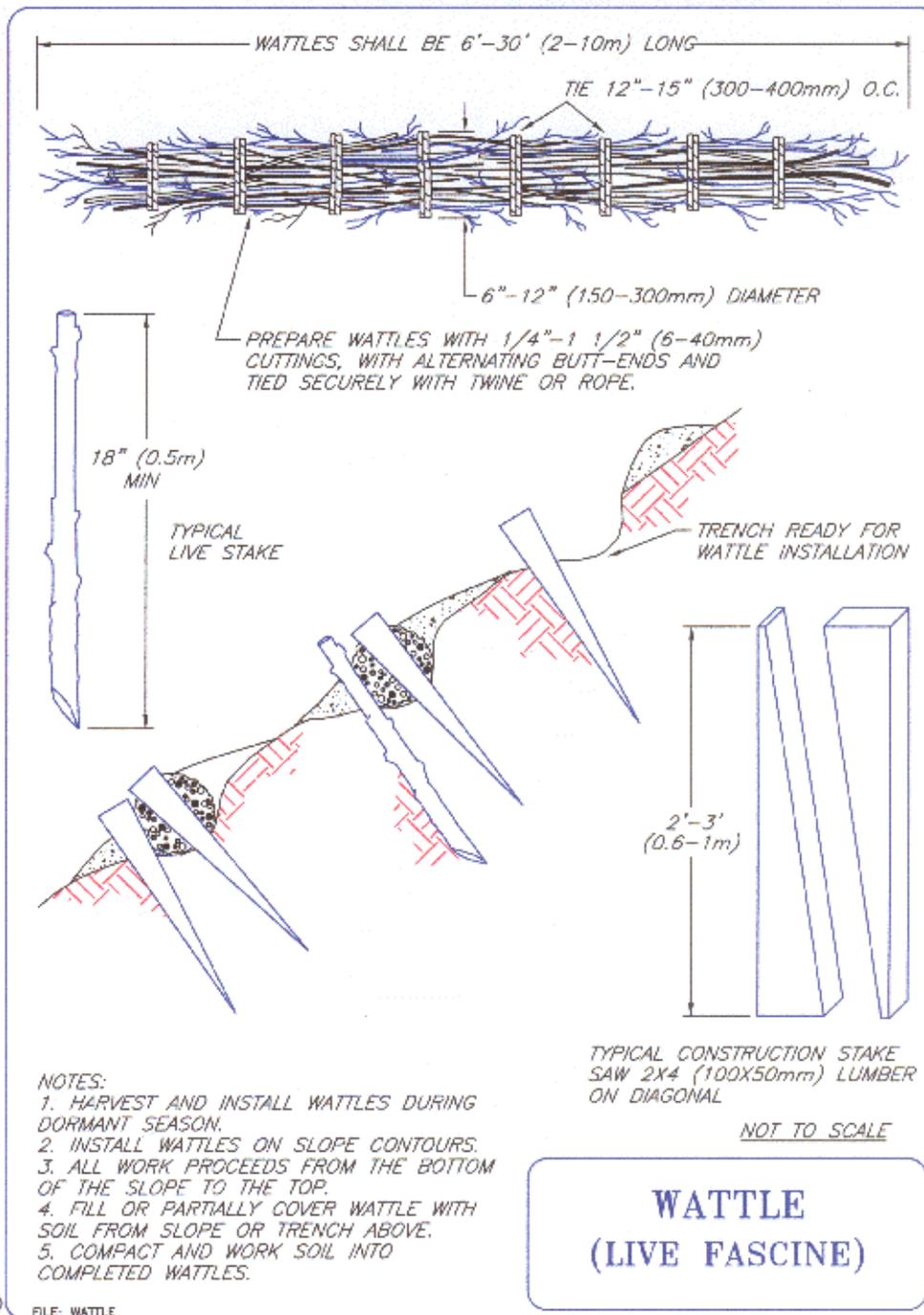
**Combination with Riprap Facing:** In many places, the bank is not adequately protected by vegetation until the roots are fully developed, and inanimate materials must provide temporary protection. There is a wide choice of methods, including the planting of woody plants in the crevices of stone facing. Generally a combination of vegetation with RIPRAP or GABIONS is preferred. Refer to the BMPs for each of these practices for more information.

**Establishing Tree Vegetation:** The presence of trees along streams is critical for maintaining good wildlife habitat, and provides the shade and leaf litter essential to Maine's fisheries. Tall trees should be planted along stream, especially on the southern side, to provide shade. In some cases, mature trees will be required for immediate shading.

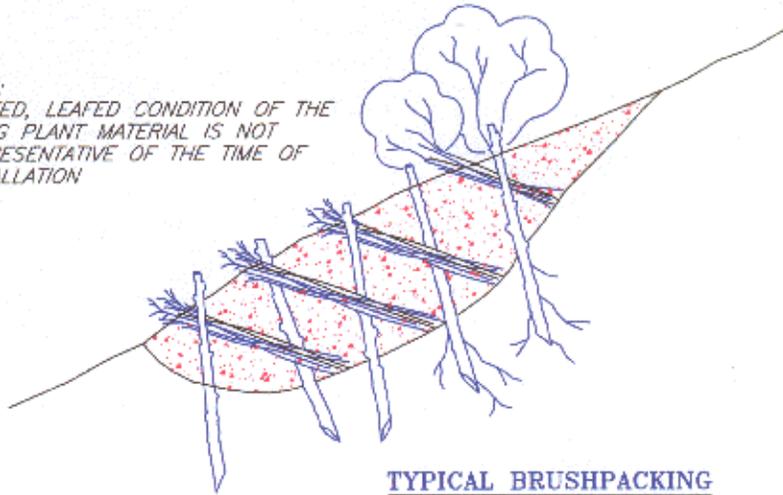
## **MAINTENANCE**

Streambanks are always vulnerable to new damage. Repairs are needed periodically. Banks should be checked after every high-water event is over. Gaps in the vegetative cover must be fixed at once with new plants, and mulched if necessary. Fresh cuttings from other plants on the bank can be used, or they can be taken from mother-stocked plantings if they are available.



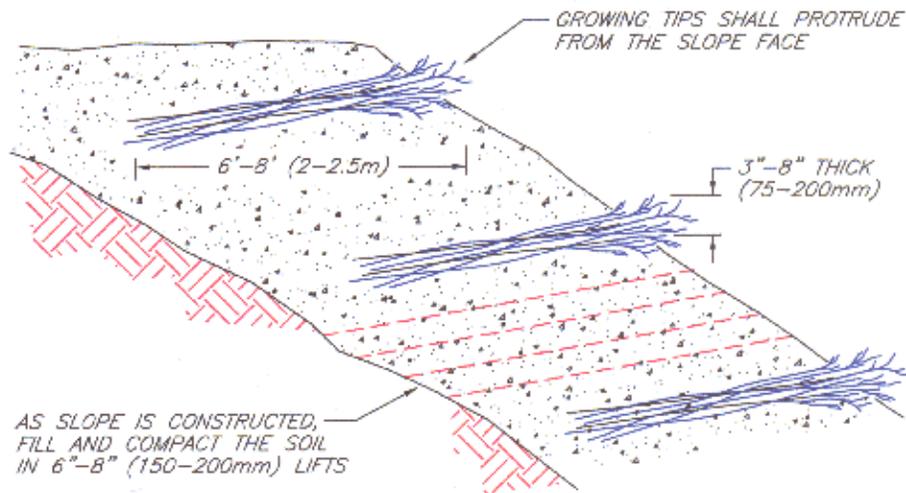


NOTE:  
 ROOTED, LEAFED CONDITION OF THE  
 LIVING PLANT MATERIAL IS NOT  
 REPRESENTATIVE OF THE TIME OF  
 INSTALLATION



**TYPICAL BRUSHPACKING**

COVER BRUSHLAYER IMMEDIATELY WITH  
 6" (150mm) OF FILL SOIL, WATER AND  
 COMPACT ACCORDING TO SPECIFICATIONS



GROWING TIPS SHALL PROTRUDE  
 FROM THE SLOPE FACE

6"-8" (2-2.5m)

3"-8" THICK  
 (75-200mm)

AS SLOPE IS CONSTRUCTED,  
 FILL AND COMPACT THE SOIL  
 IN 6"-8" (150-200mm) LIFTS

**TYPICAL BRUSHLAYERING  
 WITH SLOPE CONSTRUCTION**

**BRUSHLAYERING**

© 1998 JOHN McCULLAH

FILE: BRSH-LAYR

**I-3 SAND DUNE AND TIDAL BANK PROTECTION*****PURPOSE & APPLICATIONS***

It is important to establish and maintain vegetative cover on sand dunes and tidal banks to protect coastal shoreline. To stabilize and provide long term protection for sand dunes and tidal banks, it is necessary to protect dune vegetation from foot traffic and vehicles and to stabilize frontal sand dunes and provide for sand entrapment for dune building. This practice is applicable on any coastal shoreline where vegetation can be expected to effectively stabilize the site.

***CONSIDERATIONS***

- **Permits:** Any work carried out on coastal dunes will require a permit under the Natural Resources Protection Act (NRPA) from the DEP. Appropriate permits must be obtained prior to beginning work.
- Reducing the movement of sand may result in under-nourishment of nearby beaches.

***SPECIFICATIONS*****Stabilizing Existing Sand Dunes**

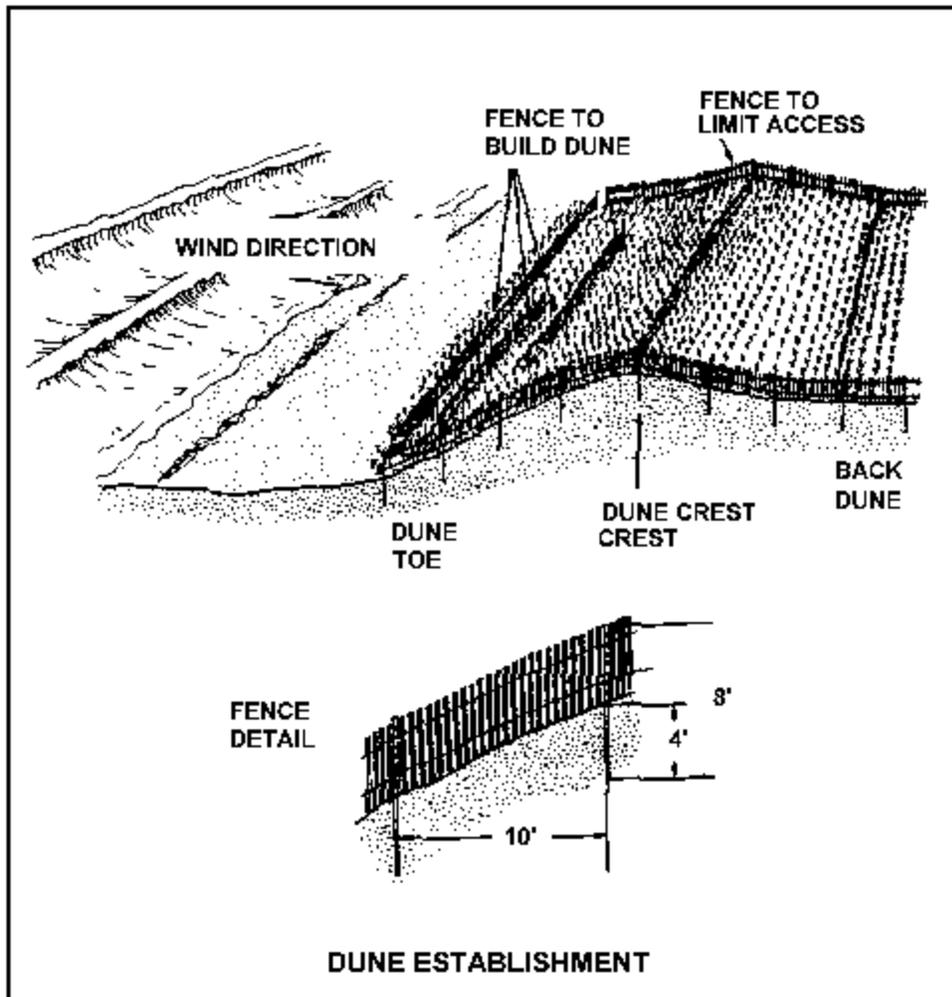
Where stabilization of existing sand dunes and/or re-establishment of beachgrass is needed:

- Certified "Cape" American beachgrass is most useful as an erosion control plant on non-dune areas where soils are very sandy and the site conditions make establishment of seeded species very difficult. It also can be used on soils high in salinity and is the best specie for the initial stabilization of frontal dunes. Planting shall be accomplished by April 30, following the planting recommendations found in USDA-SCS Conservation Plant Sheet No. 28 and 70.
- Smooth cordgrass is a long life perennial and is the dormant most productive marsh plant in the regularly flooded intertidal zone along the Atlantic coast. Smooth cord grass can grow to seven feet tall with stems up to ½ inch in diameter.
- Saltmeadow Cordgrass grows in salt marshes and sandy meadows along the coast. It occupies the area immediately above the intertidal zone. Mature plants are grayish green up to 3 feet tall.
- Certified "Atlantic" coastal panicgrass shall be planted on back dunes at 10 pounds, pure live seed, per acre. Plant from March 1 to June 15.
- Immediately after planting, a sand fence (snow fence) will be built to protect the beachgrass from vehicle and foot traffic. The fence shall surround the planted area at a distance of 15 feet from the planted area. Passageways should be provided to allow pedestrians to cross the planted area at 300-foot intervals. Boardwalks are desirable. Move the opening and boardwalk when beachgrass becomes weak.

**Sand Fence plus Vegetation**

Bands of vegetation should then be planted parallel to the fence on the landward and seaward. Each band of vegetation should be about 20 feet wide and placed 10 to 15 feet from the sand fence. As the sand fills between the two fences, additional fence can be erected or the area between the fences can be planted. Such a combination can trap

most of all the wind-blown sand crossing the dune area and produce a much broader-based dune than either approach alone.



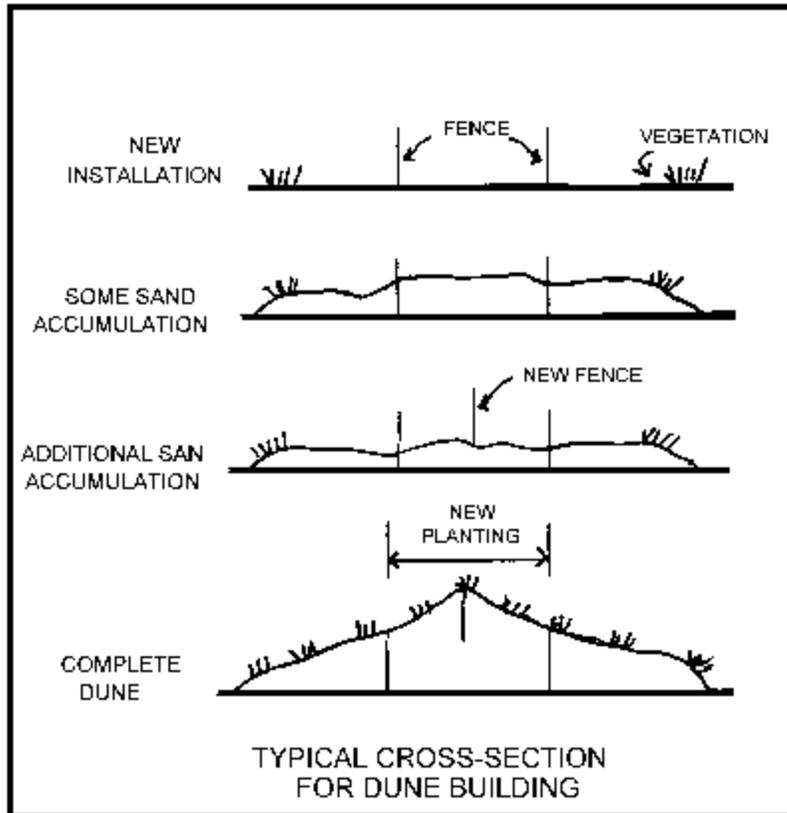
### Tidal Streams and Estuaries

The procedures to determine the effectiveness potential of stabilization of tidal streams and estuaries are found in the USDA-SCS Conservation Plant Sheet No. 28 and 70 for planting instruction. Plants to be used are the Certified "Cape" American beachgrass, smooth cordgrass, Certified "Avalon" and saltmeadow cordgrass.

Additional Reference: "Best of Beach Vegetation" by W. Curtis Sharp. Reprints from Parks and Recreation Resources, Vol. 1, Nos. 1, 2, 4 & 5, 7 & 8. Published in January, February, May/June, July/August 1982.

## Building, Planting and Maintaining Coastal Sand Dunes

Dune stabilization work must start at least one hundred (100) feet (horizontal distance) from the mean high tide (MHT) line as a minimum. Whenever feasible, leave room for two or more dune lines, a double layer of protection. Dunes grow toward the sand supply, which is the ocean.



### Building the Dune Vegetatively

Where blowing sand is available, a simple, relatively inexpensive and successful method exists for building dunes. It consists of planting American beachgrass strips parallel to the coastline. As the windblown sand moves off the beach landward it drops its load of sand, beginning the natural cycle of dune growth. The row closest to the ocean should be at least 100 feet (horizontal distance) from the MHT line. The plantings will trap most of the windblown sand, particularly during the growing season when the grass will continue to grow up through the newly trapped sand.

### Building the Dune using Sand Fences (snow fence material)

Use of sand fence is effective and it is readily available. It may be more expensive than building dunes vegetatively, but is less expensive than doing it with machinery. Normally it is also much faster than with vegetation alone.

To form a barrier dune, erect the sand fences, a minimum of 100 feet (horizontal distance) from the MHT line in two parallel rows (three or four rows may be used where sufficient land area and sand is available) 30 or 40 feet apart. The fences should be roughly parallel to the water line and yet be as nearly as possible at a right angle to the prevailing winds.

Where this is not possible, erect a single line of fence parallel with the sea at least 140 feet from the MHT line and space 30 foot long perpendicular spurs 40 feet apart along the seaward side to trap lateral drift. As the fences fill with sand, additional sets of fence can be placed over those filled until the barrier dune has reached a protective height. To widen an old dune, the fencing should be set seaward at a distance of 15 feet from its base.

**Materials:** Use standard 4-foot sand (snow) fence. The fence should be sound and free of decay, broken wire and missing or broken slats.

**Woods posts** for fence support should be black locust, red cedar, white cedar or other wood of equal life or strength. They do not need to be treated. They should be a minimum of 6 feet, 6 inches long and a minimum diameter of 3 inches. Standard fence post length is usually 7 - 8 feet and should be used where possible.

**Four (4) wire ties** should be used to fasten fence to wood posts. Weave fence between posts so that every other post will have fence on ocean side of posts. Tie wires should be no smaller than 12 gauge galvanized wire.

Posts are to be set no further than 10 feet apart. Posts will be set at least 3 feet deep. The bottom of the fence should be set about 3 inches into the sand, or a mechanical grader could be used to push some sand against the bottom of fence.

#### Establishing Shoreline planting:

Smooth Cordgrass is planted between the mean low water level and the mean high water level. Saltmeadow cordgrass is planted above the smooth cordgrass from mean high water to the top of the slope. If the distance from the mean high water to the top of the slope exceeds 10 feet. American beachgrass should also be planted in the upper part of the slope.

#### Establishment of the plants:

There are three types of plant materials that can be used for planting along the shoreline. One type is seedlings grown in peat pots, such plants should be about 12 inches tall with 3-5 stems per container before they are large enough for transplanting. The container is planted with the root mass.

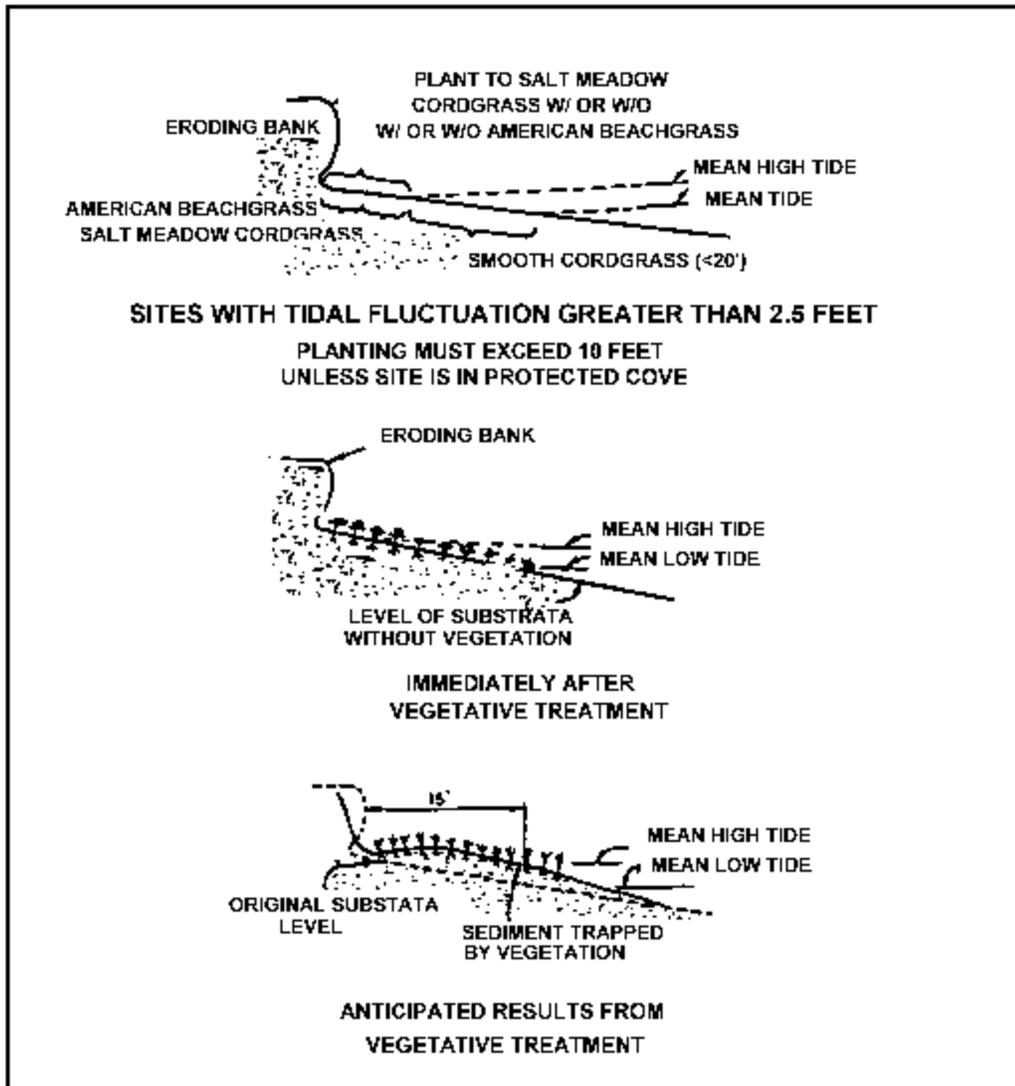
A second method is to grow the plants in containers, which allow the plants' root mass to slip out at the time planting. Their size, etc., is the same as above. The advantage of this method is that it eliminates the barrier occasionally created by the peat pots that may produce a slight turbulence around the plant and wash it out.

A third type is to harvest culms from natural or cultivated stands, which are then planted directly to the shoreline. If the plants are to be taken from natural stands they should be growing in sandy sub strata. The stands should be open and developing rather than dense and mature. The culms will be ready for digging and transporting when the top growth is six to ten inch tall. Each culm should have well-developed root.

Methods one, two and three are equally recommended for smooth cordgrass. Methods one and two are recommended for saltmeadow cordgrass, although method three can be used, but performance expectations will be less than with the other two methods.

When making plantings, place the hills 18 to 36 inches apart within and between rows. The spacing to be used is influenced by the severity of the site. On sites that have a high potential of being washed away, the spacing should be closer. In protected areas where there is little danger from the planting being initially destroyed, the spacing can be wider.

The hole made in the substrata should fully accommodate the plant roots. Be sure to seal the hole by pressing the soil around the roots with your heel. One or two ounces of fertilizer should be placed in the bottom of the planting hole or in a separate hole to one side of the plant. If this approach is used, a slow released fertilizer should be used. One ounce per hill is recommended. An alternate treatment is to broadcast about 500 lbs. of 10-10-10 fertilizer over the planted area at low tide about three weeks after planting time and some about 6 weeks after planting will give the most rapid growth to the new plantings.



Planting should be made between mid spring and July 1. The early spring plantings are more hazardous because of storms as less favorable soil temperatures. Actual dates are influenced by location. Late spring planting is preferred.

#### Management of Established Plantings

Plantings should be monitored frequently each year. Plants destroyed or washed out should be replanted as quickly as possible. Plant development and growth surrounding natural marshes must be fertilized in late May or June with 300-500 lbs., per acre of 10-10-10 fertilizer. All debris washed onto the plantings should be immediately removed to prevent smothering the plants.

#### Plant sources:

Smooth and saltmeadow cordgrasses are available commercially or can be dug locally from an existing marsh. Because commercial sources are subject to change, contact your local USDA Soil Conservation service office for sources closest to you.

#### ***MAINTENANCE***

Refer to the USDA Conservation Plant Sheet No. 28 and 70 for information about maintenance requirements.

**I-4 HOUSE LOT DEVELOPMENT*****PURPOSE AND APPLICATION***

Land grading a house lot development and house construction is a major source of sedimentation and must be carefully planned and carried out. The use of phasing, natural buffers, mulching, and temporary and permanent seeding should be the primary methods of addressing erosion control for land grading projects. Fall and winter erosion control measures must be upgraded and refined to protect the site from spring runoff and snowmelt.

**Plan the project to fit the site.**

Evaluate the site's strengths and weaknesses. Tailor the site layout and utilities to the topography and follow these general guidelines:

- Restrict construction activities to the least critical areas.
- Reduce impervious areas and thereby preserve existing native vegetation.
- Diffuse stormwater into buffers rather than concentrate it into channels.
- Align roadways following natural contours rather than up and down steep slopes.
- Cluster buildings to minimize the amount of earth movement needed.
- Divert clean water away from the immediate construction area to reduce the threat of erosion.

**Minimize the area of bare soil exposed at one time.**

- Sequence the construction of a project. Don't open up the whole site at one time. Build in phases.
- Preserve natural vegetation by flagging it and protecting it in the field.
- Create buffer strips of undisturbed vegetation between construction areas and environmentally vulnerable areas such as watercourses, ponds and wetlands.
- Lay down temporary mulching on any bare soil until final grade is reached.
- Immediately re-seed areas ready for revegetation.
- If construction extends into the fall and winter months, upgrade all erosion control measures to protect the site from spring runoff.

**SPECIFICATIONS****Grading Plan Design Specifications**

The plan shall include phasing of the following practices:

- Cut and fill slopes that are to be stabilized with grasses shall not be steeper than 2:1. Where the slope is to be mowed, the slope should be no steeper than 3:1; 4:1 is preferred because of safety factors related to mowing steep slopes. Slopes exceeding 2:1 shall require special design and stabilization considerations that shall be adequately shown on the plans.
- Surface water shall be diverted from the face of all cut and/or fill slopes by the use of diversions, ditches and swales or conveyed downslope by the use of a designed structure, except where:
  1. The face of the slope is or shall be stabilized and the face of all graded slopes shall be protected from surface runoff until they are stabilized.
  2. The face of the slope shall not be subject to any concentrated flows of surface water such as from natural drainageways, graded swales, downspouts, etc.
  3. Vegetation, gravel, riprap or other stabilization method must protect the face of the slope.
- On slopes with shallow sloughing, the soil should be removed to the depth of the slough or one and one half foot, whichever is greater, and filled with 6 inches of bank run gravel covered with one foot of field stone with an average size of at least 3 inches. Properly sized geotextile may be substituted for the gravel if desired. This stone should extend down the slope to a source of drainage, either a berm or a subsurface tile system.

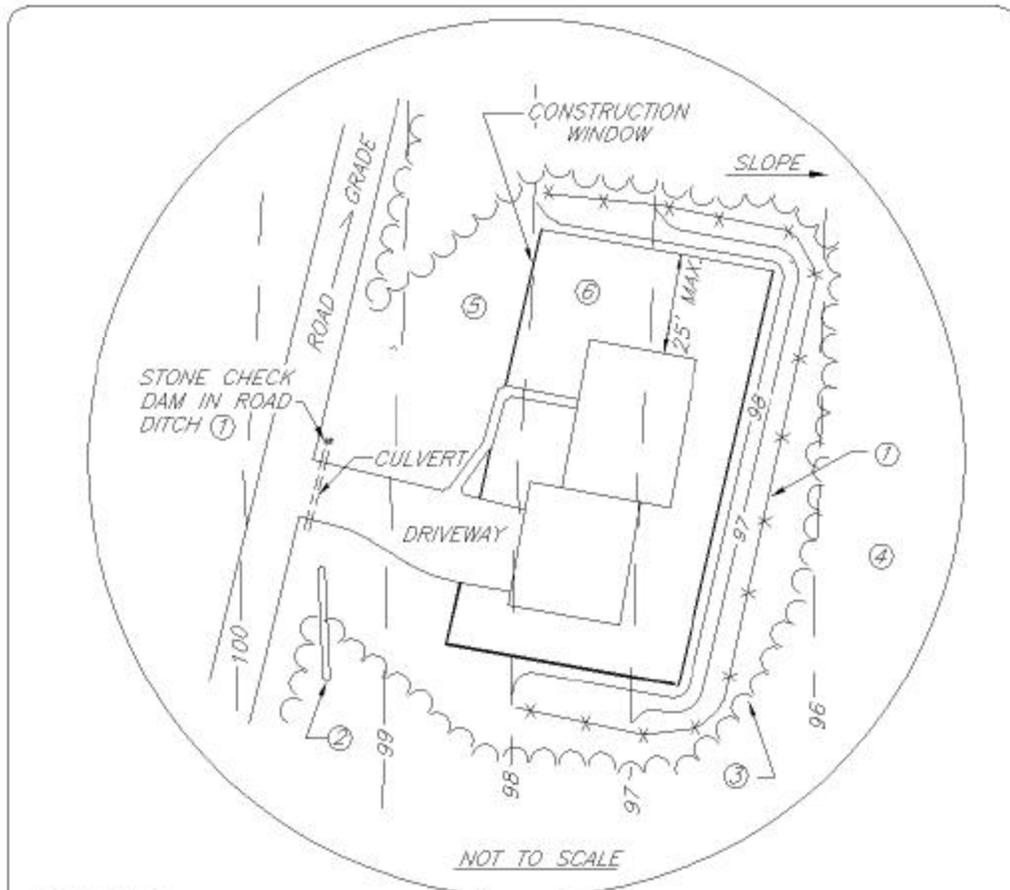
- Slopes shall not be created so close to property lines as to endanger adjoining properties without adequately protecting such properties against sedimentation, erosion, slippage, settlement, subsidence or other related damages.
- Fill material shall be free of brush, rubbish, rocks, logs, stumps, building debris, and other objectionable material. It should be free of stones over two (2) inches in diameter where compacted by hand or mechanical tampers or over eight (8) inches in diameter where compacted by rollers or other equipment. Frozen material shall not be placed in the fill nor shall the fill material be placed on a frozen foundation.
- All disturbed areas shall be stabilized structurally or with vegetation in compliance with the appropriate BMPs.

#### **Construction Specifications**

- All graded or disturbed areas including slopes shall be protected during clearing and construction in accordance with the approved erosion and sediment control plan until they are adequately stabilized.
- Any sign of rill or gully erosion shall be immediately investigated and repaired as needed.
- All graded areas shall be permanently stabilized immediately following finished grading.

#### **Timing and Phasing**

Grading shall be planned so as to minimize the length of time between initial soil exposure and final grading.



**INSTALLATION**

1. INSTALL SEDIMENT BARRIERS ON YOUR SITE BEFORE DISTURBING SOILS. SEE THE "SEDIMENT BARRIERS" MEASURE FOR DETAILS ON INSTALLATION AND MAINTENANCE.
2. CONSTRUCT A DIVERSION DITCH TO KEEP UPSLOPE RUNOFF OUT OF WORK AREA.
3. MARK CLEARING LIMITS ON THE SITE TO KEEP EQUIPMENT OUT OF AREAS WITH STEEP SLOPES, CHANNELIZED FLOW, OR ADJACENT SURFACE WATERS AND WETLANDS.
4. PRESERVE BUFFERS BETWEEN THE WORK AREA AND ANY DOWNSTREAM SURFACE WATERS AND WETLANDS. SEE THE "BUFFERS" MEASURE FOR BUFFER PRESERVATION.
5. USE TEMPORARY MULCH AND RYE-SEED TO PROTECT DISTURBED SOILS OUTSIDE THE ACTIVE CONSTRUCTION AREA. SEE THE "MULCHING" MEASURE AND "VEGETATION" MEASURE FOR DETAILS AND SPECIFICATIONS FOR THESE CONTROLS.
6. PERMANENTLY SEED AREAS NOT TO BE PAVED WITHIN SEVEN DAYS OF COMPLETING FINAL GRADING. SEE "VEGETATION" MEASURE FOR INFORMATION ON PROPER SEEDING.

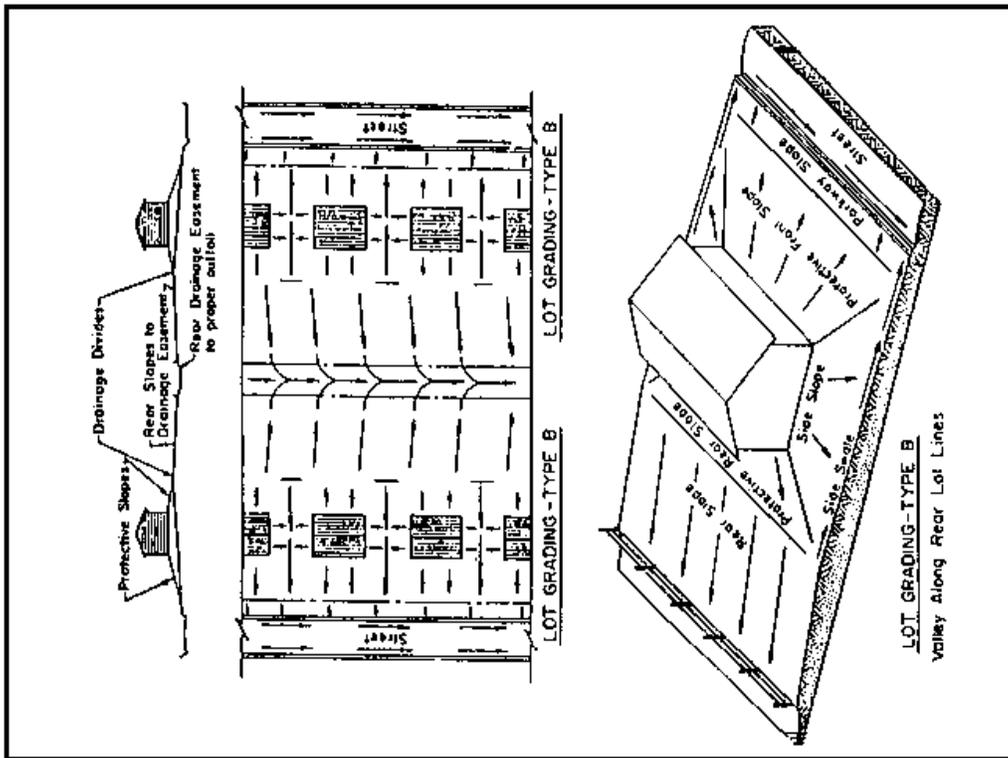
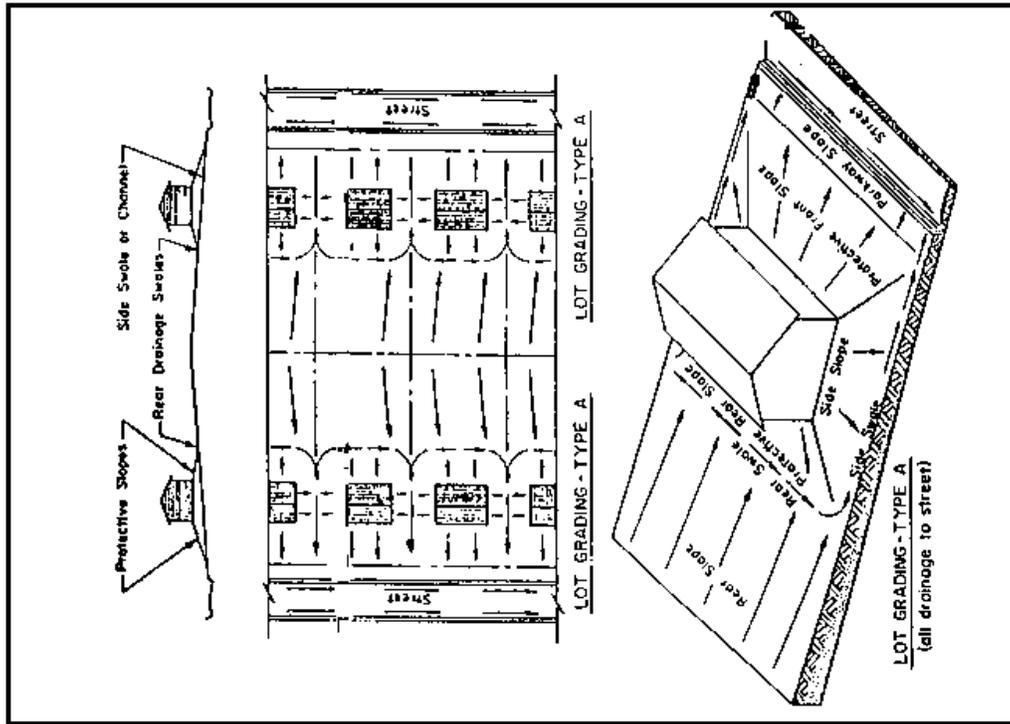
**MAINTENANCE**

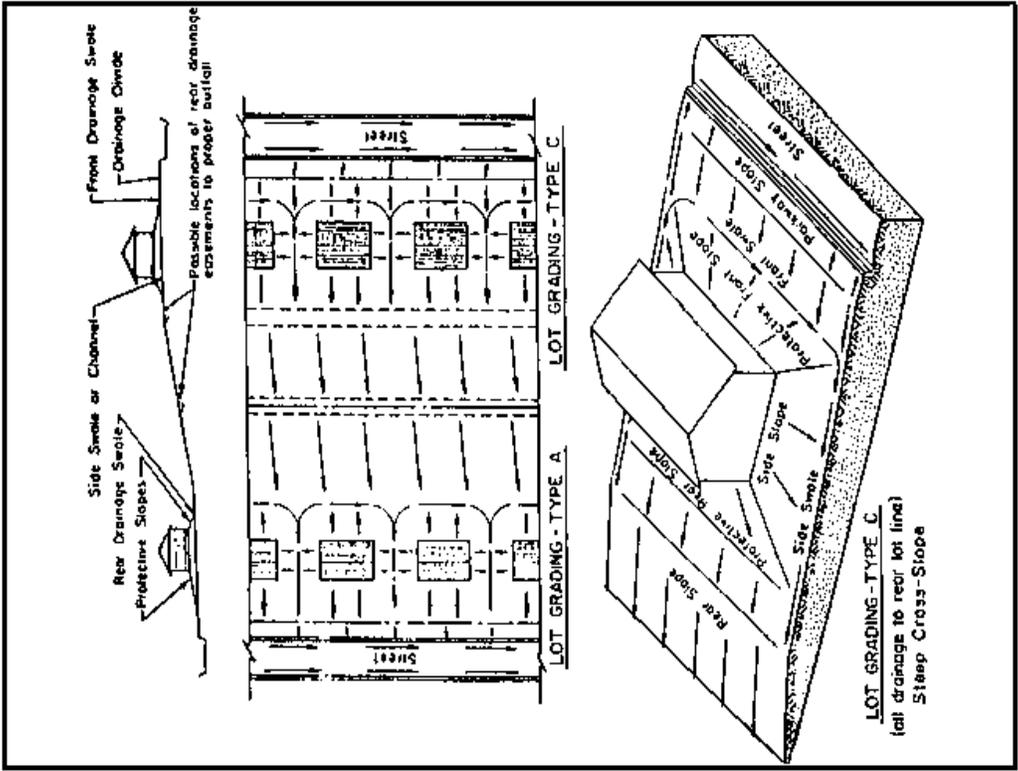
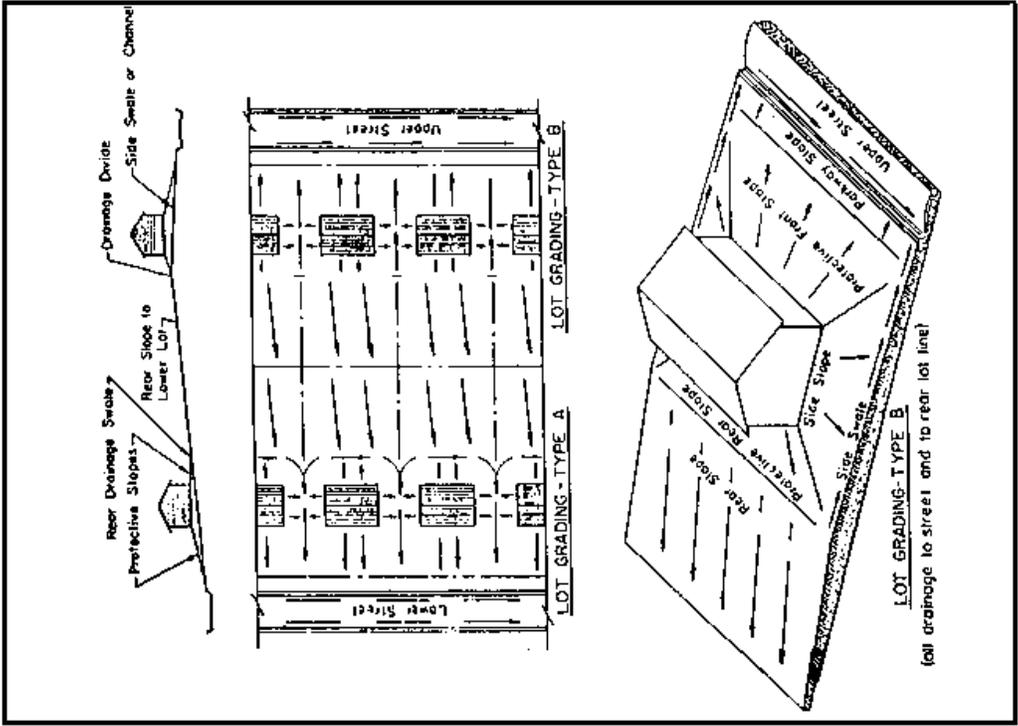
EVERY MONTH THE FIRST YEAR AFTER CONSTRUCTION AND YEARLY THEREAFTER, INSPECT FOR AREAS SHOWING EROSION OR POOR VEGETATION GROWTH. FIX THESE PROBLEMS AS SOON AS POSSIBLE. EACH SPRING REMOVE ANY ACCUMULATION OF DEBRIS OR WINTER SAND THAT WOULD IMPEDE RUNOFF FROM ENTERING A BUFFER OR DITCH.

**HOUSE SITE  
BMP**

ME DEP 2003

FILE: HOUSELOT





**APPENDIX A SEED MIXTURES**

**Table A.1 Seed Mixtures Recommended for Permanent Seedings**

<i>AREA</i>	<i>SEED MIXTURE (TABLE A.2)</i>
<b>BORROW AREAS, ROADSIDES, DIKES, LEVEES, POND BANKS AND OTHER SLOPES AND BANKS</b>	
Well or excessively drained soils*	1,2,3,4,5 or 8
Somewhat poorly drained soils*	2
Variable drainage soil*	2
<b>DRAINAGE DITCH AND CHANNEL BANKS</b>	
Well or excessively drained soils*	,2,3 or 4
Somewhat poorly drained soils*	2
Variable drainage soil *	2
<b>DIVERSIONS</b>	
Well or excessively drained soils*	2,3 or 4
Somewhat poorly drained soils*	2
Variable drainage soils*	2
<b>EFFLUENT DISPOSAL</b>	5 or 6
<b>GULLIED AND ERODED AREAS</b>	3,4,5,8,10,11 or 12
<b>MINESPOIL &amp; WASTE, AND OTHER SOIL BANKS</b> (If toxic substances & physical properties not limiting)	15,16,17 or 18
<b>FRESHWATER SHORELINES</b> (Fluctuating water levels)	5 or 6
<b>SKI SLOPES</b>	4 or 10
<b>SOD WATERWAYS AND SPILLWAYS</b>	1,2,3,4,6, 7, or 8
<b>GENERAL RECREATION SEEDINGS</b>	
<b>PICNIC AND PLAYGROUNDS OR DRIVING AND ARCHERY RANGES, NATURE TRAILS</b> (Not shaded)	1,2, or 23
<b>CAMPING AND PARKING, NATURE TRAILS</b> (Shaded)	19,20,21 or 23
<b>SAND DUNES</b> (Blowing sand)	24
<b>WOODLAND ACCESS ROADS, SKID TRAILS AND LOG YARDING AREAS</b>	9,10,16 or 22
<b>LAWNS AND HIGH MAINTENANCE AREAS</b>	1,19,20 or 21

\*See county soil survey for drainage class. Soil surveys are available from the County Soil and Water Conservation District Office.

Source: U.S. Department of Agriculture, Soil Conservation Service.

**RECOMMENDED VARIETIES**

Generally, native species are preferred.

- Creeping red fescue (Pennlawn, Ensylva, Wintergreen)
- Tall fescue (Kentucky 31)
- Coastal panicgrass (Atlantic)
- Little bluestem (Blaze, Aldous, Camper)
- Crownvetch (Chemung, Penngift)
- Cape Caucasian bluestem (Caucasian)
- Flat Pea (Lathco)
- Winter Rye (Aroostook inland, Wintergraze coastal)
- Reed canarygrass (Palaton, Venture) may be invasive in some areas
- Birdsfoot trefoil (Empire)
- Switchgrass (Blackwell, Shelter)
- Big bluestem (Niagra)
- American beachgrass
- Prennial ryegrass (Norlea, Manhattan)
- Deertongue (Tioga)

**Table A.2 Grass Type for Seed Mixtures**

<b>N0.</b>	<b>Seed Mixture</b>	<b>Lbs/Acre</b>	<b>Lbs/1,000 Sq. Ft.</b>
1.	Kentucky Bluegrass	20	.46
	Creeping red fescue	20	.46
	Perennial ryegrass	5	.11
	Total	45	1.03
2.	Creeping red fescue	20	.46
	Redtop	2	.05
	Tall fescue	20	.46
	Total	42	.97
3.	Creeping red fescue	20	.46
	Birdsfoot trefoil <sup>1/</sup>	8	.18
	Tall fescue	20	.46
	Total	48	1.10
4.	Creeping red fescue	20	.46
	Redtop	2	.05
	Birdsfoot trefoil <sup>1/</sup>	8	.18
	Total	30	.69
5.	Reed Canary Grass	20	.46
	Redtop	5	.11
	Total	25	.57
6.	Reed canary grass	15	.34
	Redtop	5	.11
	Birdsfoot trefoil <sup>1/</sup>	10	.23
	Total	30	.68
7.	Tall Fescue	15	.34
	Perennial ryegrass	5	.11
	Birdsfoot trefoil <sup>1/</sup>	10	.23
	Total	30	.68
8.	Switchgrass	10 (PLS) <sup>2/</sup>	.23
	Weeping lovegrass	3	.07
	Little bluestem	10 (PLS) <sup>2/</sup>	.23
	Total	23	.53
9.	Creeping red fescue	10	.23
	Crownvetch <sup>1/</sup> or	15	.34
	Flat pea	(30)	(.69)
	Tall fescue	15	.34
	Redtop	2	.05
	Total	42 - (57)	.96 - (1.31)
10.	Creeping red fescue	20	.45
	Redtop	2	.05
	Crownvetch <sup>1/</sup> or	15	.34
	Flat pea	(30)	(.69)
	Total	37 - (52)	.85 - (1.20)
11.	Birdsfoot trefoil <sup>1/</sup>	8	.18
	Crownvetch <sup>1/</sup>	15	.34
	Creeping red fescue	20	.46
	Total	43	.98

**Table A.2 Grass Type for Seed Mixtures (cont.)**

<b>NO.</b>	<b>Seed Mixture</b>	<b>Lbs/Acre</b>	<b>Lbs/1,000 Sq. Ft.</b>
12.	Tall fescue	15	.34
	Switchgrass	10 (PLS) <sup>2/</sup>	.23
	Perennial ryegrass	5	.11
	Crownvetch <sup>1/</sup>	15	.34
	Total	45	1.02
13.	Crownvetch <sup>1/</sup> or	10	.23
	Flat Pea	(30)	(.69)
	Switchgrass	5 (PLS) <sup>2/</sup>	.11
	Perennial ryegrass	5	.11
	Total	20 - (4)	.45 - (.91)
14.	Crownvetch <sup>1/</sup> or	15	.34
	Flat Pea	(30)	(.69)
	Perennial ryegrass	10	.23
	Total	25 - (40)	.57 - (1.03)
15.	Switchgrass	2 (PLS) <sup>2/</sup>	.05
	Big Bluestem	4 (PLS) <sup>2/</sup>	.09
	Coastal Panicgrass	2 (PLS) <sup>2/</sup>	.05
	Caucasian bluestem	2 (PLS) <sup>2/</sup>	.05
	Little Bluestem	2 (PLS) <sup>2/</sup>	.05
	Total	12	.29
16.	Tall fescue	20	.46
	Flat Pea	30	.69
	Total	50	1.15
17.	Deertongue	10 (PLS) <sup>2/</sup>	.23
	Birdsfoot trefoil <sup>1/</sup>	8	.18
	Perennial ryegrass	3	.07
	Total	21	.48
18.	Deertongue	10 (PLS) <sup>2/</sup>	.23
	Crownvetch <sup>1/</sup>	15	.34
	Perennial ryegrass	3	.07
	Total	28	.64
<b>SHADY SITES</b>			
19.	Creeping red fescue	50	1.15
	Canada bluegrass or	50	1.15
	Kentucky bluegrass		
	Total	100	2.30
20.	Creeping red fescue	100	2.30
21.	Creeping red fescue	50	1.15
	Tall fescue	30	.69
	Total	80	1.84
22.	Creeping red fescue	20	.46
	Flat Pea	30	.69
	Total	50	1.15
23.	Tall fescue	150	3.44

<sup>1/</sup> Inoculate legume seeds, use four times recommended rate of inoculante when hydroseeding.

<sup>2/</sup> Pure Live Seed (PLS): Warm season grass seed is sold and planted on the basis of pure live seed. An adjustment is made to the bulk pounds of seed to compensate for inert material and dead seed.

**TABLE A-3 TEMPORARY SEEDING (from USDA Soil Conservation services)**

<u>SEED</u>	<u>Lb/Ac</u>	<u>Lb/ 1,000SF</u>	<u>Recommended Seeding Dates</u>	<u>Remarks</u>
Winter Rye	112	2.6	8/15-10/1	Good for fall seeding. Select a hardy specie such as Aroostook Rye
Oats	80	1.8	4/1-7/1 8/15-9/15	Best for spring seeding. Early fall seedings will die with the winter but mulch will provide protection.
Annual Ryegrass	40	0.9	4/1-7/1	Grows quickly but is of short duration. Use where appearance is important. With mulch, seeding may be done throughout growing season.
Sudangrass	40	0.9	5/15-8/15	Good growth during periods of hot weather.
Perennial	40	0.9	8/15-9/15	Good cover, longer lasting than annual Ryegrass. Mulching will allow seeding throughout growing season.
Temporary mulch with/without seeding			0/1-4/1	Refer to TEMPORARY MULCHING BMP and PERMANENT VEGETATION BMP

**Tree and Shrub Species**

**Primarily for cover on sand and gravel sites:** Bristly locust, rugosa rose, seabuckthorn, and common juniper. Of these, bristly locust is the best where rapid spread and development is needed to provide cover on steep banks or gullies. Rugosa rose is non-native and may not be recommended and seabuckthorn spread readily and may be invasive. The most vigorous is the bristly locust. Sweetfern can be used, if local transplant material is available. Overseeding shrub plantings with perennial ryegrass at 10 to 15 pounds per acre will provide some protection against erosion while the shrub planting is developing. Spacing of shrubs should be 4 feet x 4 feet, or 4 feet x 6 feet.

**Primarily for wildlife food and cover:** Use any of the above plants or crabapples, red osier dogwood, highbrush cranberry, sumac species, thornapple, and mountain ash.

**Primarily for screening:** Eastern red cedar, crabapples, European and Japanese larch, American arborvitea, red spruce, white spruce, Norway spruce, red pine and jack pine.

*Note: Avoid exotic invasive species including Autumn Olive, Russian Olive and Honeysuckle.*

<b>APPENDIX B</b>	<b>MAINE HYDROGEOLOGIC SOIL GROUPS</b>
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**HYDROLOGIC SOIL GROUPS, MAXIMUM PERMISSIBLE VELOCITIES and SUBSURFACE INFLOW RATES FOR SOILS IN MAINE (USDA Soil Conservation Service)**

**Hydrologic Group A**

<i>Soil Name</i>	<i>K factor (10"-20")</i>	<i>Permissible Velocity Feet per second</i>		<i>Inflow Rate cfs/1000 ft. (where water table exists)</i>
		<i><u>Bare</u></i>	<i><u>Vegetated</u></i>	
Adams (Windsor)	.17	2.0	4.0	1.00
Colton (Hinckley)	.17	2.5	4.5	1.00
Dune Land	.10	2.0	4.0	1.00
Hermon (Gloucester)	.10	2.5	4.5	1.00
Masardis	.10	2.5	4.5	1.00
Pits, Gravelly	.02	2.5	4.5	1.00
Pits, Sandy	.15	2.0	4.0	1.00
Sunday (Suncook)	.15	2.5	4.5	1.00

**Hydrologic Group B**

Allagash	.28	1.5	3.5	1.00
Au Gres	.15	2.0	4.0	1.00
Bangor	.28	1.5	3.0	.15
Berkshire (Charlton)	.32	1.5	3.0	.15
Caribou	.24	1.5	3.0	.10
Croghan (Deerfield)	.17	2.0	4.0	.50
Danforth	.15	2.0	3.5	.15
Duane	.17	2.5	4.5	.50
Elliottsville	.24	1.5	3.0	----
Fryeburg (Hadley)	.49	1.5	3.0	.10
Groveton (Agawam)	.32	2.0	4.5	1.00
Lille	.43	1.5	3.0	.10
Linneus	.28	1.5	3.0	----
Lovewell (Winnooski)	.49	1.5	3.0	.10
Machias	.10	2.5	4.5	.50
Madawaska (Ninigret)	.28	1.5	3.5	.50
Monadnock	.28	1.5	3.5	.15
Ondawa	.37	2.0	4.0	.20
Penquis	.32	1.5	3.0	----
Perham	.32	1.5	3.0	.10
Podunk	.37	1.5	3.0	.15
Salmon (Hartland)	.64	1.0	2.5	.10
Sheepscot	.10	2.5	4.5	.50
Shirley	.15	2.0	3.5	.15
Skowhegan	.17	2.0	4.0	.50
Stetson (Merrimac)	.10	2.5	4.5	1.00
Waumbek	.17	2.5	4.5	1.00

**APPENDIX B (Continued)**

**Hydrologic Group C**

<i>Soil Name</i>	<i>K Factor (10" – 20")</i>	<i>Permissible Velocity Feet per second</i>		<i>Inflow Rate cfs/1000 ft. (where water table exists)</i>
		<i><u>Bare</u></i>	<i><u>Vegetated</u></i>	
Becket	.28	1.5	3.0	.10
Boothbay	.49	1.5	3.0	.05
Brayton (Ridgebury)	.32	1.5	3.0	.10
Buxton (Suffield)	.49	1.5	3.5	.05
Canaan	.17	2.0	3.5	----
Charles (Limerick)	.49	1.5	3.0	.10
Chesuncook	.32	1.5	3.0	.10
Colonel	.24	2.0	3.5	.10
Conant	.24	2.0	3.5	.15
Cornish	.49	1.5	3.0	.10
Crary	.64	1.0	2.5	.10
Daigle	.24	1.5	3.0	.10
Dixfield	.24	2.0	3.5	.10
Dixmont	.28	1.5	3.0	.15
Eldridge	.24	1.5	3.0	.05
Elmwood	.32	1.5	3.0	.05
Finch (Saugatuck)	.15	2.0	3.5	.15
Fredon	.24	2.0	3.5	.15
Howland	.24	2.0	3.5	.10
Kinsman	.17	2.0	4.0	.15
Mapleton	.20	2.0	3.5	----
Marlow (Paxton)	.32	2.0	4.0	.10
Melrose	.32	2.0	4.0	.10
Moosilauke (Walpole)	.24	2.0	4.0	.15
Naskeag	.10	2.5	4.5	.15
Naumburg	.17	2.0	4.0	.15
Nicholville (Belgrade, Scio)	.64	1.0	2.5	.10
Peru	.32	2.0	3.5	.10
Plaisted	.24	2.0	3.5	.10
Potsdam	.64	1.0	2.5	.10
Red Hook	.24	2.5	4.5	.15
Roundabout (Raynham)	.64	1.0	2.5	.05
Rumney	.37	1.5	3.0	.15
Skerry	.28	1.5	3.0	.10
Swanville (Canandaigua)	.49	1.5	3.0	.05
Telos	.32	1.5	3.0	.10
Tunbridge	.20	2.0	3.5	----
Westburry	.24	1.5	3.0	.10
Winnecook	.28	1.5	3.0	1.00

**APPENDIX B (Continued)**

**Hydrologic Group D**

<i>Soil Name</i>	<i>K factor (10" – 20")</i>	<i>Permissible Velocity Feet per second</i>		<i>Inflow Rate cfs/1000 ft. (where water table exists)</i>
		<i>Bare</i>	<i>Vegetated</i>	
Abram	----	2.0	3.5	----
Aurelie	.17	2.0	3.5	.10
Beaches	.05	2.5	4.5	1.00
Benson	.17	2.0	3.5	----
Biddeford	.32	1.5	3.0	.05
Burnham	.28	1.5	3.0	.10
Easton	.37	1.5	3.0	.10
Gouldsboro	.37	1.5	3.0	.05
Lamoine	.49	1.5	3.0	.05
Lyme (Leicester)	.32	1.5	3.0	.10
Medomak (Saco)	.49	1.5	3.0	.05
Monarda	.28	2.0	3.5	.10
Peacham (Whitman)	.28	2.0	3.5	.10
Scantic	.49	1.5	3.5	.05
Schoodic	.17	2.0	3.5	----
Searsport (Scarboro)	.17	2.5	4.5	.15
Washburn	.24	2.0	3.5	.10
Whately	.28	2.0	3.5	.05

**Hydrologic Group B/D**

(Atherton)	.28	2.0	3.5	.15
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**Hydrologic Group C/D**

Creasy	.28	1.5	3.0	----
Halsey	.24	2.0	3.5	.15
Lyman (Hollis)	.32	2.0	3.5	----
Mapleton, Stony	.20	2.0	3.5	1.00
Monson	.24	2.0	3.5	----
Swanton	.32	1.5	3.0	.05
Thorndike	.20	2.0	3.5	1.00

- Mesic soil names appear in parenthesis
- Miscellaneous land types are not assigned to a hydrologic group because of the soil's variability.
- Organic soils and those soils mapped above an elevation of 2300 feet (cryic soils) do not appear on this list as they will require special considerations.
- Soils with bedrock within 30" are not given inflow rates because of inadequate available cover for underground drainage conduits. Exceptions to this are Winnecook, Mapleton, and Thorndike, which are generally over bedrock that is rippable.

**Sources**

- Hydrologic Groups: Interpretation Record Sheets (SCS-SOI-5) SCS.
- Reference: Water Management Guide – Part 1 – Drainage (SCS 1976). Since 1976, values for new soils were established by comparing them to soils with similar properties.

**RESOURCES AND REFERENCES**

For more information about erosion control, contact the following agencies or use the following publications for reference.

- Soil and Water Conservation Districts. Check your local phone directory for SCS local offices (US Govt - USDA Soil Conservation Service).
- USDA Natural Resources Conservation Service - State Office: USDA Office Building, University of Maine, Orono 04473, Phone: 581-3446.
- Maine Department of Transportation, State House Station #16, Augusta, ME 04333, Phone: 289-3321.
- Maine Department of Environmental Protection, State House Station #17, Augusta, ME 04333.
- Water Bureau: Division of Environmental Evaluation & Lakes Studies, Phone: 289-3901.
- Land Bureau: Licensing and Review, Phone: 289-2111.
- Maine Department of Conservation, Land Use Regulation Commission (LURC), State House Station #22, Augusta, ME 04333, Phone: 289-2631 (for unorganized areas).
- Maine Department of Inland Fisheries and Wildlife, State House Station 41, Augusta, ME 04333, Phone: 289-3371.
- US Army Corps of Engineers, Maine Project Office, RR5 Box 1855, Augusta ME 04330, Phone: 623-8367 or 623-8124.
- "Erosion Control on Logging Jobs", The Land Use Handbook Section 6, Maine Department of Conservation, Land Use Regulation Commission, State House Station 22, Augusta, ME 04333, Phone: 289-2631.
- "Low Cost Shore Protection...a Property Owner's Guide", US Army Corps of Engineers, Maine Project Office, RR5, Box 1855, Augusta, Maine 04330, Phone: 623-8367.
- "Connecticut Guidelines for Soil Erosion and Sediment Control", Council on Soil and Water Conservation, Room 239, State Office Bldg., 165 Capitol Avenue, Hartford CT 06106, Phone: (203) 566-7234.
- "Best Management Practices for Forestry: Protecting Water Quality", Maine Forest Service, 2003.
- "Rhode Island Erosion and Sediment Control Handbook", Rhode Island State Conservation Committee, 9 Hayes Street, Providence, RI 02908, Phone: (401) 277-3162.
- Virginia Erosion and Sediment Control Handbook, Division of Soil and Water Conservation, Virginia Dept. of Conservation & Historic Resources, 203 Governor St., Suite 206, Richmond, VA 23219, Phone: (804) 786-2064.
- "Field Manual on Sediment and Erosion Control Best Management Practices for Contractors and Inspectors" by Jerald S. Fifield, Forester Press, 2001
- Linking Stormwater BMP Designs and Performance to Receiving Water Impact Mitigation" ASCE, 1801 Alexander Bell Drive, Reston, VA20191-4400.
- Erosion Draw, 3.0, Erosion Control standards and Construction Drawings, Salix-Applied Earthcare, 3141 Bechelli Lane, Redding, CA 96002, (530)224-0878.