

# Permanent Seeding

## Benefits:

- *Permanent seeding provides long-term stabilization of soils. Permanent seeding is a low-cost low-maintenance method. Permanent seeding can reduce erosion, slow runoff velocities, increase infiltration, reduce runoff volumes, and filter sediments. Permanent seeding is suitable for a wide range of sites and conditions.*

## Limitations:

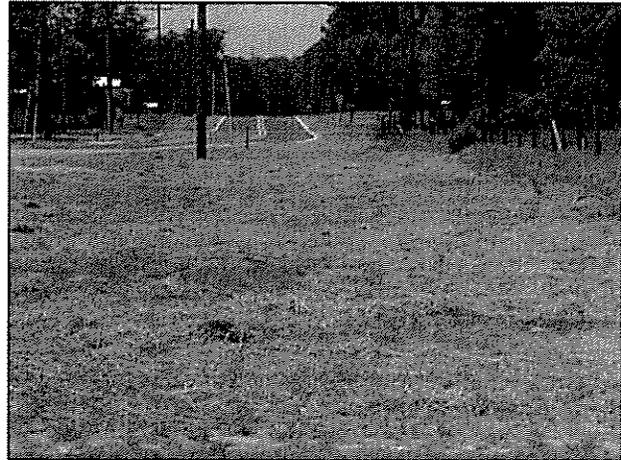
- *Permanent seeding does not immediately stabilize soils and erosion during seed establishment. Additional stabilization methods and runoff controls may be necessary during establishment. Seed selection and effectiveness are dependant on the seasons and may not be effective during parts of the year. Additional time and labor may be required to prepare the seed bed and to reseed patches where establishment was unsuccessful.*

## Costs:

- *USEPA reports costs for seeding to range from \$200 to \$1,000 per acre and average \$400 per acre. Estimates for maintenance costs range from 15 to 25 percent of the capital costs and average 20% (USEPA, 1993).*

## Effectiveness:

- *USEPA reports that permanent vegetative cover can reduce the amount of suspended solids in runoff by between 50 and 100 % with an average of 90%.*



## Discussion:

Permanent seeding is the establishment of perennial vegetation from seed to control erosion from runoff on recently disturbed soils. Permanent seeding is a useful method for erosion control in areas where permanent vegetative cover is the most practical or effective method of stabilizing soils. This measure is economical and adaptable to different site conditions. Permanent seeding provides a wide range of options for plant materials and methods of establishment. Careful planning is vital to the success of permanent seeding. Proper planning includes identifying plant materials best suited to the site and soil conditions, proper seed bed preparation, timely planting, and proper maintenance to ensure establishment and survival.

# Riprap

### Benefits:

- Riprap stabilizes soils in areas that receive concentrated flows and provides for reduction of runoff velocity. Riprap has a wide range of applications and is typically a low cost material.

### Limitations:

- Riprap is typically not recommended for slopes greater than 2:1. Proper design to ensure the correct size of stones for the application is critical to the success.



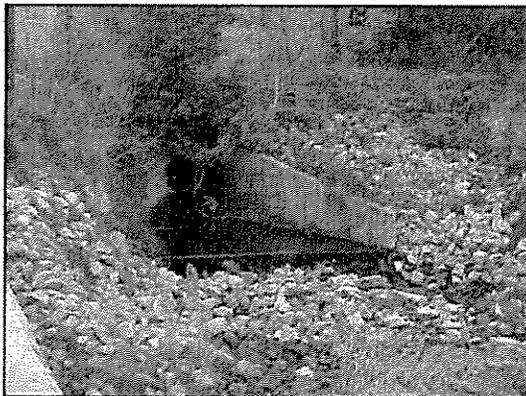
### Costs:

- Cost for riprap depends on availability, amount, method of delivery, and stone size.

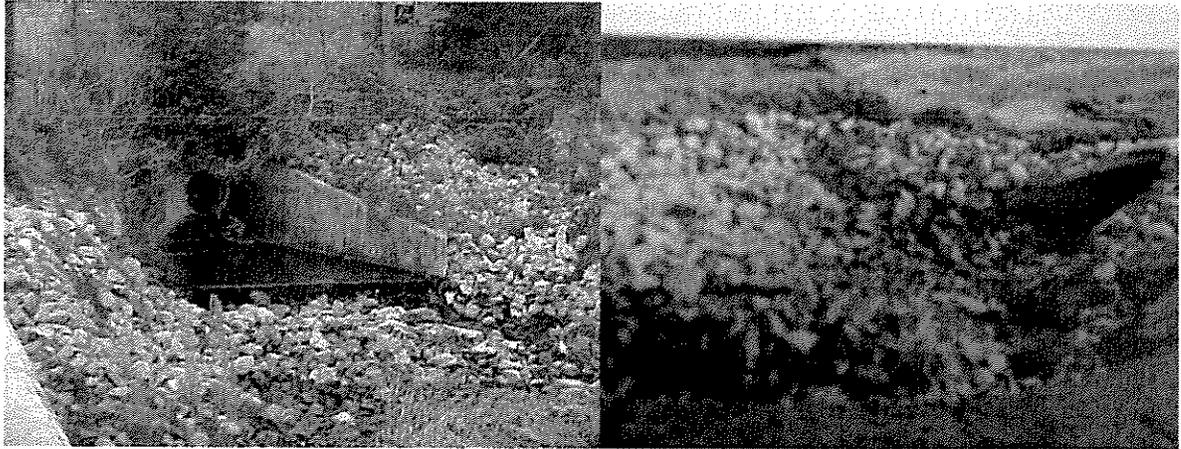

(Source- Mayo et al., 1993)

### Discussion:

Riprap is a permanent layer of stones designed to stabilize banks and protect soil from erosion in areas of concentrated flows. Examples of common places to use riprap include outlet structures, slope drains, channel bottoms and side slopes, temporary check dams, and grade stabilization structures. Riprap can reduce stormwater velocities in channels by providing angular surfaces, and riprap can protect underlying soils from the forces of stormwater runoff. However, riprap should be limited to slopes of less than 2:1, and measures using riprap should be carefully designed and inspected to ensure proper function.



# *Rock Outlet Protection*



**Benefits:**

- *Good energy dissipater*
- *Easy installation*

**Costs:**

- *Low costs.*

**Discussion:**

Erosion at the outlet of channels, culverts, and other structures is common and can cause structural failure with serious downstream problems. It is necessary that exit velocities into streams be nonerosive for site conditions. Rock outlet protection is often installed to provide the necessary energy dissipation. A riprap-lined apron is the most commonly used structure for this purpose, because it has relatively low cost and can be installed easily on most sites. Other types of outlet protection include concrete impact basins and paved outlets.



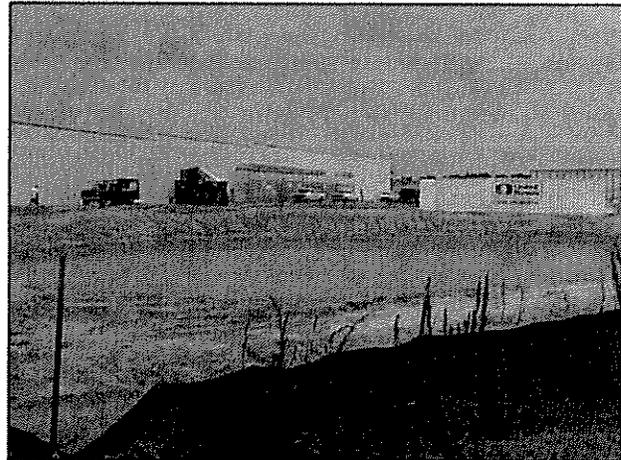
## *Sediment Basins and Rock Dams*

### **Benefits:**

- *Sediment basins and rock dams can reduce runoff velocities and reduce levels of suspended solids in runoff by intercepting stormwater flow leaving a site and allowing time for sedimentation.*

### **Limitations:**

- *Sediment basins and rock dams should not be used in locations where failure would threaten human life or property including roads and utilities. Sediment basins and rock dams should never be used in live streams. Sediment basins and rock dams have demonstrated little or no effectiveness at removing dissolved pollutants from runoff. Some land loss is associated with sediment basins.*



### **Costs:**

- *USEPA (1993) reports costs for basins with less than 50,000 ft<sup>3</sup> storage volume to average \$0.60/ft<sup>3</sup> and for basins with greater than 50,000 ft<sup>3</sup> storage volume an average of \$0.30/ft<sup>3</sup>.*

### **Costs:**

- *USEPA estimates removal efficiency rates of suspended solids for sediment basins to average 70%. One study (Barfield and Clar, in Smolen et. al., 1988) reported that for sediment basins in southeastern coastal plain areas that used the design  $A=0.01q$ , where  $A$  is basin surface area and  $q$  is peak inflow rate in ft<sup>3</sup>/second, an average sediment removal efficiency rate of greater than 75% was observed.*

### **Discussion:**

Sediment basins and rock dams are two separate yet similar practices that both provide for temporary capture of stormwater and controlled release stormwater to allow for settling of suspended sediments. Sediment basins can be constructed using earthen berms, shallow excavation, or a combination of both. Sediment basins can be designed as either temporary or permanent measures. Basin designs typically employ a riser or culvert drain and designs range from dry pools to wet permanent pools. Rock dams use an embankment of rock and gravel to provide gradual drainage from the pool. Proper design is crucial to successful operation in order to ensure the appropriate size pool for the drainage area. Improper design can result in rupture of the embankment walls creating a greater input of sediments into the runoff. Both practices should be sited in drainage swales or low areas that receive runoff from the site, but neither should ever be placed in a live stream. Embankments and excavations should be vegetated immediately following their construction. Regular inspection and maintenance is essential to ensure effectiveness of sediment basins and rock dams.

# Sediment Filters and Sediment Chambers

## Benefits:

- Sediment filters can remove many pollutants from stormwater runoff. Sediment filters can be modified in a wide range of design variations to suit site conditions and desired applications. Sediment filters can use various filter materials in order to target specific pollutant types.

## Limitations:

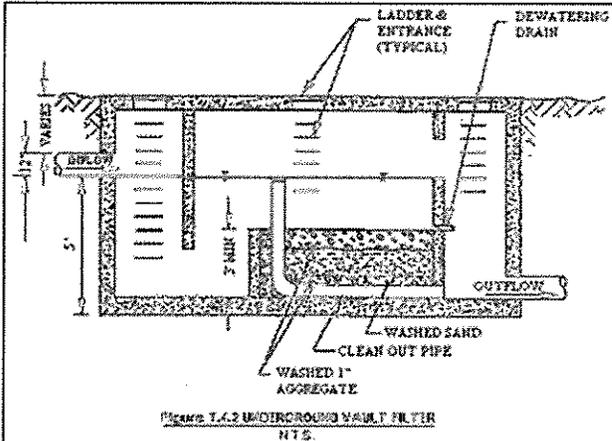
- Sediment filters provide little or no reduction in stormwater volumes or velocities. Sediment filters require frequent inspection and regular maintenance. Sediment filters should not be used for sites with a drainage area greater than 10 acres.

## Costs:

- MWCOC (1992) estimates construction costs for sand filters to range from \$3.00 to \$10.00/ft<sup>2</sup> of runoff treated. The same report estimates annual maintenance costs at about 5% of construction costs.

## Effectiveness:

- Effectiveness will depend greatly upon the types of pollutants, the volume of runoff, and the design of the filter.



Schematic representation of a sediment filter

## Discussion:

Sediment filters and sediment chambers involve the use of a filter medium to remove suspended sediments and other particulate matter from stormwater runoff. Sediment chambers are one particular type of sediment filter and are often used as one stage in a sediment filter system. Sediment filters are typically composed of four basic parts: inflow regulation, pretreatment, filter bed, and outflow mechanism. Sediment filters can be designed in a variety of ways from confined systems to unconfined, on-line or off-line, and aboveground or below. Sediment filters have applications for construction and post-construction sites. Sediment filters should not be used for sites with a drainage area greater than 10 acres. Maintenance is an important aspect of proper function. Maintenance should include inspection and cleaning, and depending on the source and nature of the runoff the filter receives, may require annual replacement of the filter media at a minimum. If the potential for regulated pollutants is high at a site, sediments may need to be tested to ascertain the appropriate disposal method.



## Sediment Trap

### Benefits:

- Sediment traps are similar to sediment basins on a smaller and temporary scale, and can be used with other temporary practices to slow runoff and reduce suspended solids.

### Limitations:

- Sediment traps should not be used for drainage areas greater than 5 acres. Sediment traps are temporary measures and should not be used for longer than 2 years. Sediment traps do not maintain a lengthy detention time compared to other similar methods and often provide less effective removal of fine sediments such as silts and clays.



Sediment traps are used to collect sediment-laden runoff from disturbed areas on construction sites

### Costs:

- USEPA (1993) estimates average construction costs for sediment traps at \$0.60 per ft<sup>3</sup> of storage volume.

### Effectiveness:

- USEPA estimates removal efficiency rates of suspended solids for sediment basins to average 60%. One study (Barfield and Clar, in Smolen et al., 1988) reported that for sediment basins in southeastern coastal plain areas that used the design  $A=0.01q$ , where  $A$  is basin surface area and  $q$  is peak inflow rate in ft<sup>3</sup>/second, an average sediment removal efficiency rate of greater than 75% was observed.

### Discussion:

Sediment traps are small impoundments formed by excavation of a depression or placement of an earthen berm across a drainage way or at a point of discharge. Sediment traps are used to detain stormwater runoff and allow sediments to settle. Sediment traps are typically temporary measures (~24 months) and are often used along with other BMPs such as entrance/exit wash stations and outlets to diversion channels to achieve an effective stormwater management system. Sediment traps typically use a rock spillway or outlet point to slow the release of stormwater runoff. Sediment traps should not be used for drainage areas greater than 5 acres and should allow at least 1,800 ft<sup>2</sup>/acre of drainage area. Regular inspection and maintenance should be conducted to ensure proper function. Inspection for proper drainage and erosion of banks should be conducted, and maintenance should include removal of accumulated sediments.

## Silt Fence

### Benefits:

- *Silt fences reduce the offsite transport of sediments in stormwater runoff. Silt fences are generally low cost and widely applicable. Silt fences do not require a lot of clearing and grubbing before installation.*

### Limitations:

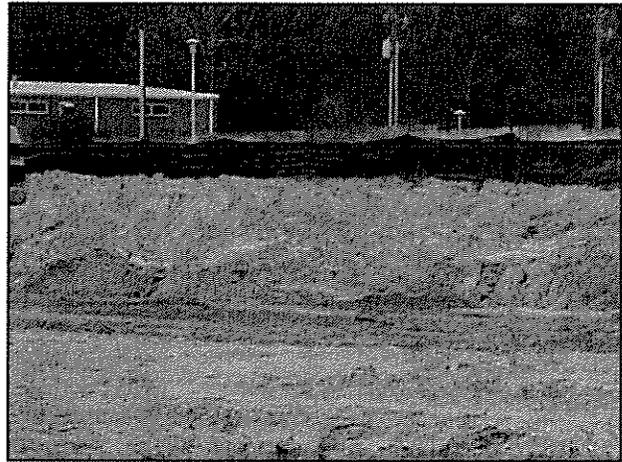
- *Silt fences are not recommended for managing high velocities, concentrated flows. Obstructions to adequate installation such as boulders or roots can hinder the effectiveness of silt fences. Silt fences require regular inspection and maintenance.*

### Costs:

- *USEPA (1992) estimates installation costs for silt fence at \$6.00 per linear foot. SWRPC (1991) estimates installation costs to range from \$2.30 to \$4.50 per linear foot.*

### Effectiveness:

- *USEPA reports that properly installed and maintained silt fences constructed of filter fabric have an average removal efficiency rate of 70% for suspended solids, 80 to 90% for sand, 50 to 80% for silt-loam, and 0 to 20% for silt-clay-loam soils.*



### Discussion:

Silt fences are temporary structural controls designed to intercept stormwater and prevent or minimize sediment and debris in runoff, especially from rill or sheet erosion. Silt fences are most effective for a drainage area of no more than  $\frac{1}{4}$  acre per 100 feet of fence with a maximum gradient of 50% and in ditches or swales where drainage area is no more than 2 acres and where flow velocity will not exceed 1 ft<sup>3</sup>/second. Silt fences are inexpensive, easily constructed, and effective for sediment removal from runoff. Silt fences require regular inspections and may require regular maintenance. Silt fences have a life span of approximately 6 months at most. Silt fences require proper design and installation for effective erosion control.

# *Slope Drain*

**Benefits:**

- *Temporary slope drains can prevent erosion from concentrated flows on unstabilized slopes. They can provide protection during slope stabilization or until other permanent practices are in place.*
- *Easy installation and low maintenance costs.*

**Limitations:**

- *Temporary slope drains must be sized to accommodate the anticipated runoff from the drainage area and are not recommended for areas greater than 5 acres. Failures can result from blockage*



**Costs:**

- *Low maintenance costs.*

**Discussion:**

Temporary slope drains are used as conduits for conveyance of runoff across slopes subject to erosion. Temporary slope drains can be used to provide drainage down slopes until permanent drains or soil stabilization measures have been established. Temporary slope drains can provide an effective means of discharging concentrated stormwater flow; therefore, gully erosion is avoided. Design of temporary slope drains should consider the size of the conduit used versus the area drained and should provide stabilized inlet and outlet areas.



# Sodding

## **Benefits:**

- *Sodding can provide immediate vegetative cover and erosion control. Sodding is an effective method of soil stabilization and erosion control. Sod can provide cover in many situations where seeding may fail.*
- *Can be used to establish vegetation where other methods are unacceptable.*

## **Limitations:**

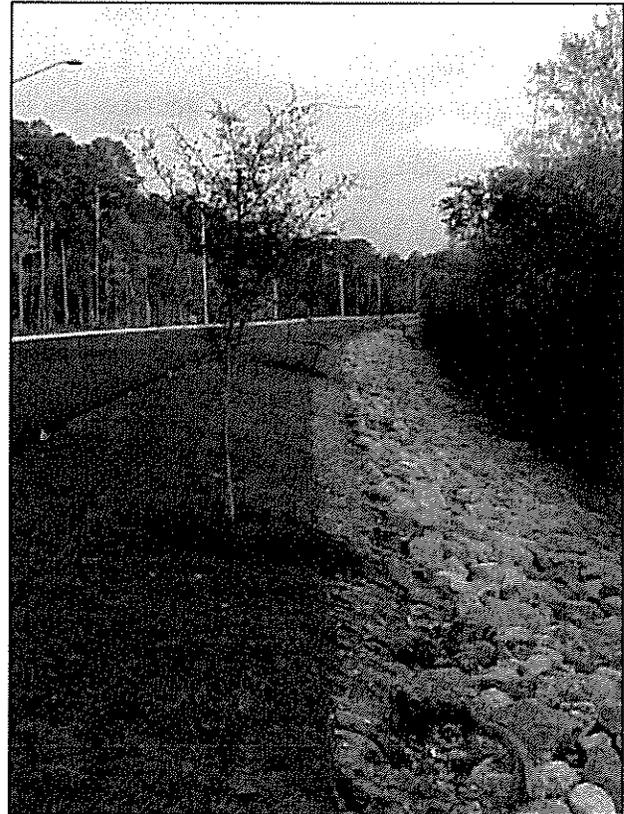
- *Sodding is typically more expensive than other methods of establishing vegetation. Sodding requires well prepared soils, transportation and installation costs, and often watering during establishment. High installation costs and early maintenance demands are associated with sodding.*

## **Costs:**

- *USEPA reports costs for sodding range from \$0.10 to \$1.10 per ft<sup>2</sup> and average \$0.20 per ft<sup>2</sup>. Annual maintenance costs are estimated at 5% of the capital costs (USEPA, 1993).*

## **Effectiveness:**

- *USEPA reports sodding can reduce total suspended solids in runoff by as much as 99%. Individual rates may vary depending on installation and site soils.*



## **Discussion:**

Sodding is a useful method of rapidly stabilizing crucial areas such as channels and areas where aesthetics are important such as residential areas. Sodding typically provides more reliable results and less maintenance than seeding. Sod can be applied to areas where seeding is difficult, such as steep slopes and can be applied during times of the year when seeding is not a practical option. Sod is more expensive than seeding, and costs include purchase, transportation, installation, and maintenance.



# Soil Retention

## Benefits:

- *Soil retention structures are useful for sandy or rocky soils with steep slopes that may not allow for other methods of stabilization. Retention structures can be used to provide slope reduction for steep slopes.*

## Limitations:

- *Retention structures should be designed by a professional engineer.*



## Costs:

- *Costs for slope reduction are similar to those for grading. Structural retention methods are often moderately to very expensive and include costs for design, materials, and construction.*



## Discussion:

Soil retention involves structures or practices designed to hold soil in place or keep contained within a sited boundary. Methods of soil retention range from grading slopes to shoring excavated areas with structural supports. Soil retention methods include structural methods using wood, steel, or concrete. Soil retention is useful in areas where other measures such as vegetative practices are ineffective. Proper design of soil retaining structures is essential to the proper function and should consider such factors as site drainage patterns and expected soil loads. A professional engineer should be consulted for the design, and regular inspections and maintenance should be conducted to ensure proper function.

# *Spill Prevention and Control Plans*

## **Benefits:**

- *Spill prevention and control plans can reduce the amount of exposure of hazardous materials to ground and surface water. An effective plan can result in cost savings in the event of an accidental spill.*

## **Limitations:**

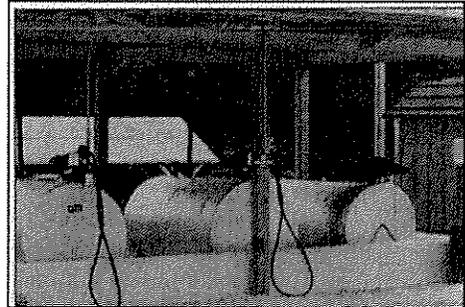
- *Time will be required for employee training and preparation of the response plan and materials.*

## **Costs:**

- *Relatively low costs associated with creating plan. Some cost associated with training employees*

## **Effectiveness:**

- *Prevention is an effective measure.*



## **Discussion:**

Spill prevention and control plans involve written instructions for preventing, responding to, stopping, containing, cleaning up, and disposing of wastes generated by an accidental spill of hazardous material. Spill prevention and control plans should provide measures for training employees in the proper methods of preventing and responding to spills, and written step-by-step instructions should be maintained at the site. Spill prevention and control plans are applicable to sites where hazardous materials are used or stored. Plans should identify the presence and locations of any hazardous materials used or stored on site as well as identifying the location and procedures for use of appropriate emergency spill response equipment. Plans should identify individuals responsible for implementing the plan, give the proper safety measures for each type of waste, and identify the appropriate authorities to contact such as fire department, HAZMAT response teams, and hospitals. Plans must be kept current to meet changing site conditions and personnel. Mock response practice situations are useful methods for evaluating the preparedness of personnel and the effectiveness of the spill prevention and control plan.

# *Storm Drain Inlet Protection*

## **Benefits:**

- *Prevent soil and debris from entering a storm drain. Can reduce clogging of storm drains during construction.*

## **Limitations:**

- *Storm drain inlet protection measures are intended to provide temporary protection during construction. They should be used in combination with additional measures such as sediment traps. Storm drain inlet protection measures are not intended for drainage areas greater than 1 acre. Frequent inspection and maintenance are necessary.*



## **Costs:**

- *USEPA (1993) estimates costs for installing storm drain inlet protection to average \$100 per inlet. Maintenance costs can be as much as installation costs. The SWRPC (1991) estimates installation costs of inlet protection measures to range from \$106 to \$154.*

## **Effectiveness:**

- *USEPA reports low effectiveness for erosion and sediment control, long-term pollutant removal, and habitat and stream protection.*

## **Discussion:**

Storm drain inlet protection measures are designed to prevent suspended particles from entering storm drain inlets. Several methods are available such as excavation around the perimeter of drop inlets, fabric or hay bales, block and gravel, or other materials such as straw booms or sock barriers around inlets. Use of storm drains during construction can provide a useful method of temporary diversion around disturbed soils, and inlet protection measures can prevent sediments and other suspended particles from entering the drains. Inlet protection measures should not be used for drainage areas greater than one acre and are most effective when used in combination with other practices to create a stormwater management system. Frequent inspection and maintenance is necessary to ensure proper function and detect failures early.

# *Straw Bale Barrier*

**Benefits:**

- *Reduces the velocity of flow*
- *Allows deposition*
- *Retains sediment*
- *Diverts small volumes of flow to protected outlets*

**Limitations:**

- *Cannot be placed across concentrated flow areas such as streams and ditches*
- *Need to be replaced every 3 months.*



**Costs:**

- *Low costs.*

**Discussion:**

Straw bale barriers are a temporary sediment barriers consisting of a row of entrenched and anchored straw bales erected on small disturbed areas to capture sediment from sheet flow. Because straw bale barriers are not designed to withstand high heads, the drainage area must be restricted and the barrier located so that the water depth does not exceed 1 foot at any point. In the design of straw bale barriers, exercise care to prevent failure from undercutting, overtopping, or end running. Check straw bale barriers after each significant rainfall, remove the necessary sediment, and make repairs promptly.



## Stream Crossing (temporary)

### Benefits:

- Allow full stream flow
- Allow site access with out harming water sources

### Limitations:

- Certain construction vehicles may be too heavy to use.

### Costs:

- Can be very expensive to construct.



### Discussion:

Stream crossings are direct sources of water pollution. They cause flooding and safety hazards. If washed out or damaged, they can also cause construction delays. Plan the development to complete work on each side separately to minimize stream crossings. Stream crossings are of three types: bridges, culverts, and fords. In selecting a stream crossing practice consider: frequency and kind of use, stream channel conditions, overflow areas, potential flood damage, surface runoff control, safety requirements and installation and maintenance costs. Temporary crossings may overflow during peak storm periods, however, the structure and approaches must remain stable.

## *Subsurface Drain*

### **Benefits:**

- *Improve soil-water conditions for vegetative growth*
- *Prevent sloughing of steep slopes due to groundwater seepage*
- *Stabilize wet foundation conditions*

### **Costs:**

- *Costs vary due to various climatic and geographic conditions which a site can experience.*

### **Discussion:**

A subsurface drain is often needed in construction operations and in developing areas to remove excess water from the soil. Drains usually consist of perforated, flexible conduit installed in a trench at a designed depth and grade. The conduit is often placed in a sand-gravel filter or gravel envelope and sized to carry the design flow. Backfill over the drain should be an open, granular soil of high permeability. Make sure the soil to be drained has sufficient depth and permeability to permit proper installation of an effective drainage system. An adequate outlet must be available. Properly designed and installed drains require little maintenance.



# Surface Roughening

## **Benefits:**

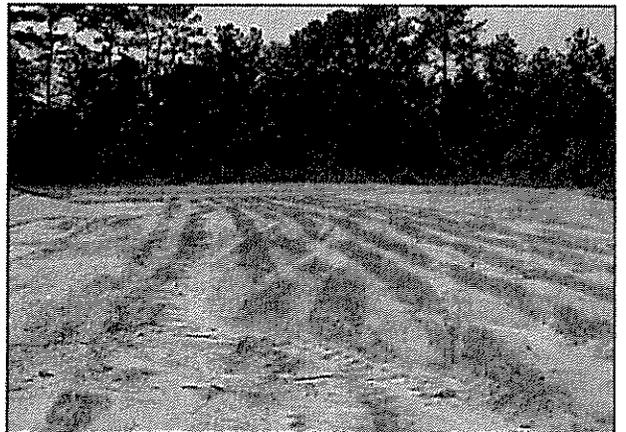
- *Soil roughening can slow runoff, increase infiltration, and help hold seeds from washing away.*
- *Soil roughening can be implemented on most sites where grubbing and clearing are conducted.*
- *Soil roughening can be used on all disturbed slopes and it has minimal costs.*
- *Soil roughening improves vegetation establishment and provides instant protection for bare soil.*

## **Limitations:**

- *Soil roughening provides only moderate erosion control.*
- *Soil roughening is not effective for substantial rainfall events.*
- *Roughening with heavy equipment may serve to compact soils and hinder seed establishment.*
- *Soil roughening is a temporary practice for freshly graded areas and is not intended to provide long term erosion control.*

## **Costs:**

- *Costs associated with soil roughening are primarily limited to the operation of equipment.*



## **Discussion:**

Soil roughening is a temporary erosion control measure used to create relief in recently disturbed soils. Soil roughening can be accomplished by several methods such as tracking construction equipment, disking, or harrowing to create horizontal grooves parallel to the contour of the land. Soil roughening can reduce the velocity of stormwater runoff allowing for better infiltration, and soil roughening aid in providing a place for seeds to take hold. Excessive roughening should be avoided in areas where mowing will be necessary for maintenance.

# Temporary Diversion Dikes

## Benefits:

- Diversion dikes can reduce pollutants in runoff by diverting runoff away from pollutant sources or by redirecting polluted runoff to other stormwater management practices.

## Limitations:

- Diversion channels are subject to concentrated flows that may lead to erosion of the channel and increased sediments in the runoff.



## Costs:

- Estimated costs for constructing diversion dikes involve site preparation and site development. The Southeastern Wisconsin Regional Planning Commission (SWRPC, 1991) estimated the total costs for a 100 ft. long, 1.5 ft. wide dike with 3:1 side slopes to cost between \$162 to \$500.

## Discussion:

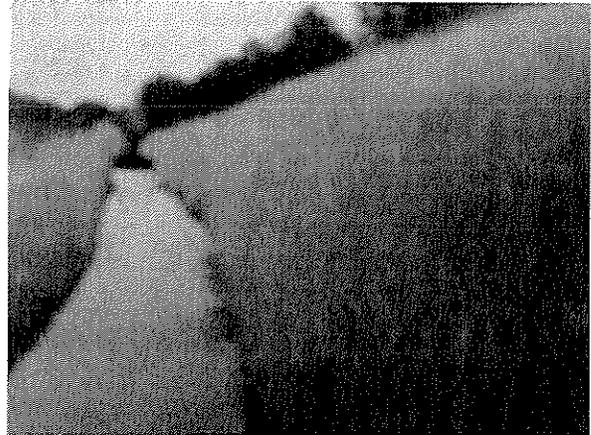
Temporary diversion dikes typically consist of compacted earthen dikes located at the top or at the bottom of a sloped area of disturbed soils. Temporary diversion dikes are designed to control the velocity and/or route of stormwater runoff. Up-slope placement serves to divert runoff away from disturbed areas and down-slope placement serves to redirect runoff from erosion prone areas towards sediment trapping measures. Diversion dikes are not meant to replace other practices such as vegetative cover, but instead are intended to be used where vegetative cover is not practical, such as in areas of constant disturbance that will not be brought to final grade for many months. Earthen diversion dikes may themselves require some form of stabilization to avoid erosion of the dike. Diversion dikes are intended for temporary use and require regular inspection and maintenance.



# *Temporary Seeding*

**Benefits:**

- *Protects earthen sediment control practices*
- *Stabilizes denuded areas that will not be brought to final grade for several weeks or months*
- *Provides nurse crop for permanent vegetation*
- *Provides residue for soil protection and seedbed preparation*
- *Helps prevent dust production during construction*



**Discussion:**

Protective cover must be established on all disturbed areas within 30 days after a phase of grading is completed. Temporary seeding and mulching are the most common methods used to meet this requirement. Annual plants that are adapted to site conditions and that sprout and grow rapidly should be used for temporary plantings. Proper seedbed preparation and the use of quality seed are also important. Because temporary seeding provides protective cover for less than one year, areas must be reseeded annually or planted with perennial vegetation.



# *Top Soiling*

**Benefits:**

- *Higher organic matter present*
- *More friable consistency*
- *Greater available water holding capacity and nutrient content*

**Limitations:**

- *Subsoil could be as good as the top soil for seedbeds*
- *Needs to be on-site room for storage*



**Costs:**

- *Costs vary and in some cases, handling costs may be too high to make this practice cost effective*

**Discussion:**

Topsoil, which provides the major zone for root development and biological activities for plants, should be stockpiled and used wherever practical for establishing permanent vegetation. Topsoiling is a common practice where ornamental or high maintenance turf will be grown. It may be also required to establish vegetation on shallow soils, soils containing potentially toxic materials, very stony areas, and soils of critically low pH. Do not place top soil on slopes steeper than 2:1 to avoid slippage. The topsoil stockpile should be surrounded by silt fence.



# *Tree Preservation & Protection*

## **Benefits:**

- *Vegetation provides erosion control, reduction of runoff volumes and velocities, and infiltration. Existing vegetation can provide greater runoff management than newly seeded areas, has no lag time for establishment, has a higher filtering capability than newly seeded vegetation, typically requires less maintenance than newly landscaped areas, enhances aesthetics, and costs less than replanting.*

## **Limitations:**

- *Desirable natural vegetation may not exist at all sites. Planning is required to identify vegetation to be preserved. Design of site structures may not allow preservation of vegetation and equipment movement must have necessary room to maneuver.*

## **Costs:**

- *Costs may include increased labor for identifying vegetation to be preserved and for maneuvering around vegetated areas. Costs for clearing and grubbing can be reduced and costs for replanting and landscaping can be reduced. The efficient infiltration can produce cost savings by reducing the need for gutters and storm drains. This measure can also produce a more aesthetically desirable site, which can yield a more valuable property.*



## **Discussion:**

Preserving existing vegetation involves selective clearing during site development and is designed to incorporate existing desirable vegetated areas into the final site plan. Preserving the natural vegetation at a site is an effective measure when applicable. It is also often the most common sense approach to producing a finished site with vegetated areas. The only costs associated with this measure are additional planning prior to site preparation activities and the added time to maneuver around vegetation. Existing mature plant communities have the capacity to maximize infiltration of stormwater, and the organic soils associated with these mature plant communities can provide a measure of treatment for many common chemical pollutants. Preserving existing vegetation can result in actual cost savings.



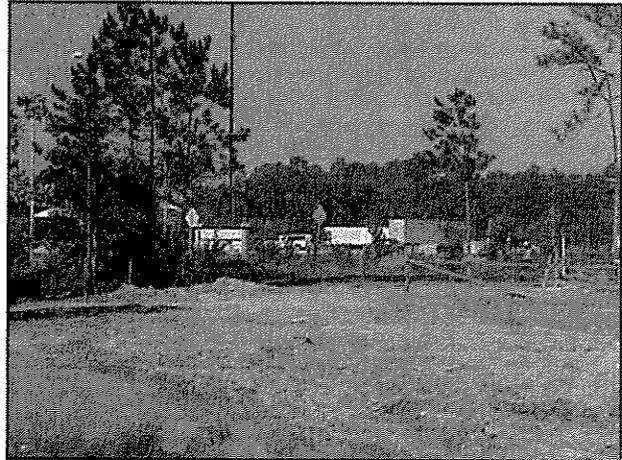
# *Vegetated Buffers*

## **Benefits:**

- *Vegetated buffers can reduce runoff velocity, increase infiltration, filter pollutants, separate areas that require protection from disturbance activities, and stabilize soils. They are particularly useful for providing protection to wetland areas, floodplains, and stream banks.*

## **Limitations:**

- *Vegetated buffers may not be cost effective if the cost of land is high. Adequate space is needed for effective function.*

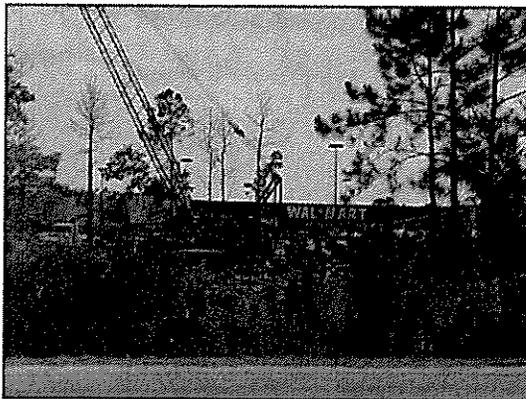


## **Costs:**

- *Costs vary with size of buffer. May not be cost effective if cost of land is high.*

## **Effectiveness:**

- *USEPA reports that several studies have demonstrated greater than 90% reductions in sediment and nitrate concentrations.*



## **Discussion:**

Vegetated buffers are areas of vegetation maintained to provide protection of neighboring areas from pollutants carried in stormwater runoff. The vegetated buffers are usually located along the perimeter of a construction site. Vegetated buffers that are properly designed and maintained can reduce the velocity of runoff, provide for infiltration, and act as filters to trap sediment. Vegetated buffers require adequate space to be effective stormwater management tools and the greater the slope, the greater the space required for the buffer. Vegetation in existing areas must be preserved, or bare areas revegetated with a mix of plant types to establish an effective buffer. Vegetated buffers have been shown to provide high levels of pollutant removal efficiencies, but may not provide much protection against concentrated flows.

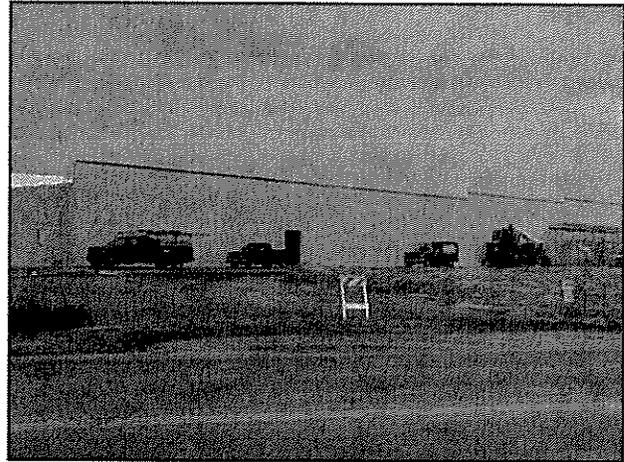
## *Vehicle Maintenance and Washing*

### **Benefits:**

- *Vehicle maintenance and washing practices at construction sites can reduce the amount of sediment tracked onto roads and exposed to stormwater. Also oil and water separators or other management practices are encouraged at a vehicle maintenance and washing area to capture contaminated washwater. Proper disposal of wastes and wastewater generated at the maintenance and wash areas is encouraged.*

### **Limitations:**

- *Costs will be associated with additional time it takes to wash trucks, management washwater, and dispose of water.*



### **Costs:**

- *Costs will be associated with additional time it takes to wash trucks, management washwater, and dispose of water.*

### **Discussion:**

The measure involves the use of designated areas specifically designed to reduce inputs of pollutants derived from the maintenance and washing of construction vehicles and equipment. Construction equipment and vehicles are potential sources of petroleum and lubricant products. Maintenance, parking and washing areas should be designed to minimize the threat from leaks, spills, and wastewater runoff. Methods can include designating covered and paved areas to conduct maintenance and washing, developing a spill prevention and control plan for maintenance areas, inspection and maintenance of equipment and vehicles, and written procedures for handling, storage, and disposal of wastes and wastewater. Wastewater from maintenance and washing areas should be treated as industrial process wastes and drains should be connected to a sanitary sewer system or other treatment facility and not connected to the storm drain system. Proper disposal of wastes generated from maintenance areas is an important component of this measure, and the local waste management authority should be consulted as to the proper disposal methods for each particular waste product.



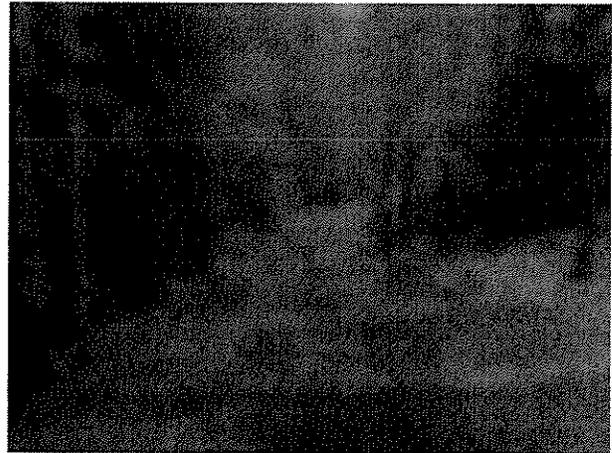
# Water Bar

**Benefits:**

- *Prevents erosion from long narrow slopes.*

**Costs:**

- *Usually low cost but dependent on usage and climate.*



**Discussion:**

Narrow rights-of-way, logging roads, etc., on long slopes used by vehicles can be subject to severe erosion. Surface disturbance and tire compaction promote gully formation by increasing the concentration and velocity of runoff. Water bars limit the accumulation of erosive volumes of water by diverting surface runoff at predesigned intervals. Water bars are constructed by forming a ridge and channel diagonally across the sloping right-of-way. Each outlet should be stable, considering the cumulative effect of upslope diversion outlets. The height and side slopes of the ridge and channel are designed to divert water and allow vehicles to cross.



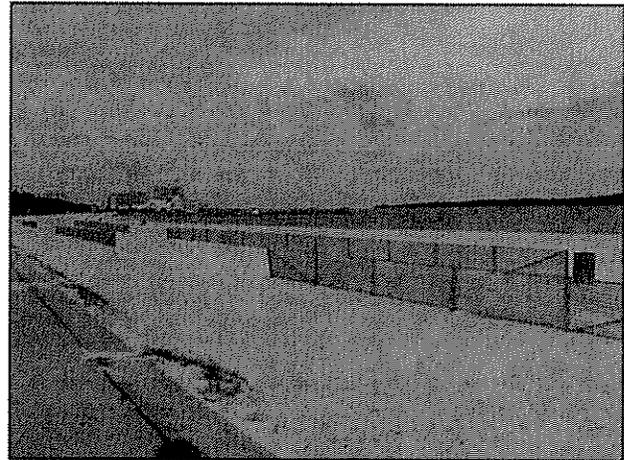
# *Wind Fences and Sand Fences*

**Benefits:**

- *Low cost and easy installation characterize wind and sand fences.*

**Limitations:**

- *Wind and sand fences are not to be used to control sediment transported in stormwater.*



**Costs:**

- *There are low costs associated with wind fences and sand fences.*

**Effectiveness:**

- *Wind and sand fences are not effective in controlling sediment in stormwater.*

**Discussion:**

Sand fences are barriers of small, evenly spaced wooden slats or fabric erected to reduce wind velocity and to trap blowing sand. The spaces between the fence slats allow wind and sediment to pass through but reduces the wind velocity, which causes sediment deposition along the fence. Wind fences are particularly useful for areas where dry arid conditions exist and for beachfront areas. Wind fences are most effective when placed perpendicular to the prevailing winds and are less effective in areas where wind directions are changing frequently. Wind fences do not control sediments transported in stormwater.