

Section 3: Erosion and Sediment Control Best Management Practices

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3.1. Introduction

Temporary erosion and sediment controls whether structural or passive are collectively termed “Best Management Practices” or BMPs. When discussing erosion and sediment controls it is important to draw a distinction between permanent and temporary erosion and sediment controls. Permanent erosion control for most all situations involves reestablishing a vegetative cover of native and adapted species of grasses, forbs, and other herbaceous materials. Permanent structural erosion controls are only required when changes are made to the existing natural systems that require reinforcing or armoring of the surface to prevent erosion. Common examples of conditions that require some type of permanent structural erosion control are:

- bridge approaches and abutments that must resist high tractive forces,
- constructed or modified channels that have tractive forces greater than those recommended for vegetated channels,
- structures in or crossing streams that are actively migrating, and
- cut or fill slopes that have long, steep slopes of unstable or highly erosive materials.

Conditions other than those above rarely need any treatment other than reestablishment of vegetative cover.

Temporary erosion control methods and materials have two purposes:

1. To protect the surface from erosive forces until permanent vegetative cover is established.
2. To foster the establishment and growth of permanent vegetative cover by moderating soil temperatures, conserving soil moisture, and protecting the developing seedlings.

Permanent sediment controls are structures used to treat storm water runoff from transportation facilities. These include a wide range of structural types such as: extended detention ponds, wet ponds, constructed wet lands, bio-retention areas, porous pavements, filters, etc. Temporary sediment controls used for construction sites are usually simple detention structures, filters, and traps made of synthetic materials and products such as sediment bags.

There are numerous methods, materials and technologies to assist with accomplishing temporary erosion and sediment controls for transportation construction sites. Each material, method or combination of methods must be selected based on a thorough knowledge of the site, its soils, hydrologic and hydraulic properties, and climate.

3.2. Permanent Erosion Control

Permanent erosion control reestablishes vegetative cover with native or adapted species appropriate to the geographic region and includes any structural modifications needed to ensure long term sustainability. For a majority of transportation sites, reestablishment of adapted grass species is the primary means of permanently controlling both erosion and sediment. However, in some cases, additional controls may be needed to permanently control erosion of stream beds and banks, cut or fill embankments, or where special soil conditions are encountered.

Under the National Pollutant Discharge Elimination System (NPDES) rules, it is often difficult to separate permanent erosion and sediment controls from storm water quantity and quality controls. Erosion control is really the first line of defense in ensuring good water quality. Other controls tend to be downstream practices to control runoff or remove materials that become suspended in storm water runoff. Storm water controls range from simple grass-lined channels or earth-formed extended detention basins to very sophisticated wetlands, wet ponds, and filters.

The following subsections briefly discuss some of the permanent erosion control and storm water quality measures in common use. This discussion is intended as a guide only and not intended to be an exhaustive discussion of all the available storm water quality and permanent erosion and sediment control technologies.

3.2.1. *Vegetation*

Vegetation is the primary means of controlling erosion and sedimentation on all unpaved surfaces of the roadside. For roadsides, unpaved shoulders, in-slopes, back slopes, borrow ditches, and cut and fill embankments; the preferred vegetative cover is made up of herbaceous species, grasses, forbs, wildflowers, etc.

Woody species are generally confined to use in very specialized situations where stronger, deeper rooted plants are needed to increase the structural integrity of the native soil conditions. On the roadside, woody species should not be used or allowed to colonize within the clear zone recommended for the design speed and road edge conditions. In most cases, trees with woody trunks are considered a hazard when they encroach on the clear zone. In addition, most grasses and herbaceous species are not shade tolerant and will not survive under a tree canopy.

3.2.2. *Native and Adapted Vegetation Species*

There has been a great deal of discussion about using native grass species on the roadside to replace what are often called exotic or invasive species. Anytime native grass species are considered, there are significant issues that must be considered also. Many parts of the roadside are an integral part of the highway structure, shaped, compacted and sealed to prevent moisture from entering the road base materials. In the areas immediately adjacent to the pavement, many native species are not well adapted to these droughty, compacted soil conditions. In these situations, the preferred species are those adapted to those conditions and quite frequently these adapted species are not natives.

The scale of the seeding operation must be considered because this often impairs using all native species on the roadside. The revegetation of a roadside may involve several hundred acres, and native seed is seldom available in quantities sufficient to meet these needs. For this reason, available commercial seed sources must be used.

Eventually, more native seed may become available at reasonable cost. However, until seed sources are developed and varieties are developed that tolerate the harsh growing conditions of the roadside, non-invasive adapted species provide the most environmentally sound approach to permanent erosion control and maintaining water quality.

3.2.3. Soils and Soil Testing

There is no substitute for soil tests conducted on areas to be revegetated. Once again it is important to understand that the roadside is part of a structure and in no way related to the adjacent farm field, wood lot, or pasture, although they are neighbors, and the vegetation community of the roadside must be sensitive to that.

For the most part, the soils that compose the roadside are, by design, non-organic. Therefore, additional basic plant nutrients are necessary to achieve a suitable vegetation cover. In order to know what nutrients are actually needed, soil tests are recommended for at least, Nitrogen (N), Phosphorous (P), Potassium (K) and soil pH.

Simply looking at the soil does not tell how much and what type of nutrients need to be added. The soils at the surface of the roadside may have been transported to the site from some distance; likewise the lower horizons of the soil profile do not necessarily match the properties of the surface soil. It is not at all uncommon to encounter extreme changes in pH or unusually high levels of either potassium or phosphorous and only soil testing will identify these differences.

Nutrients are one of the leading pollutants in storm water and contribute significantly to conditions including low available oxygen. Therefore, adding the right nutrients is an important consideration in managing water quality. If soils are already rich in potassium or phosphorous, adding more by simply specifying a balanced fertilizer may result in increases in the chemical nutrient pollutant loading of receiving waters.

Commercial fertilizers are often cited as a culprit in contributing to nutrient pollution. However because of the scale of roadside planting, commercial fertilizers are the effective means of supplying these nutrients. The key to proper use of commercial fertilizers is to use soil tests to select the appropriate fertilizer analysis for specific site conditions.

An alternative method that has been gaining wide spread popularity is the use of organic compost. Composts have been demonstrated to provide some nutrient benefits depending on the type of composted material. However, composts do not provide the control of nutrient amounts that can be achieved with chemical fertilizers and it has been demonstrated that some types of compost, particularly animal manures, can have very high concentrations of phosphorous and ammonia that will create nitrogen spikes in the runoff. In most cases the nitrogen is not a major concern, but the phosphorous can be a problem in areas that have high background phosphorous levels in the soil. The most beneficial use of compost seems to be in helping replenish the organic content of the topsoil and in helping rebuild mature topsoil. This is a major benefit, particularly in areas of very shallow, rocky soils.

3.3. Matching Vegetation to Soils and Climate

It is important to match the seed mixes to the season and the climatic conditions of the region. The Department has developed six (6) standard seed mixes for South Dakota. Two (2) seed mixes are designated for use east of a line through Huron, approximately the Highway 37 corridor. Two (2) more seed mixes are designated for the lands west of Huron. In each case, there is a mix for newly graded areas within the project limits, excluding the top of the

roadway and any temporary easements. The second mix is for temporary easements, not under cultivation and other areas outside the right-of-way that may require seeding. The other two (2) mixes are for more urban applications. The first is a mixture for replacing ornamental lawns and the second is for projects with sites less than 5 acres.

These seed mixes have recently been revised to meet changing perceptions of acceptable revegetation practice. Deviations from these recommended mixes should only occur in extreme circumstances where special soil conditions are encountered or where extreme climatic differences such as high elevation are encountered.

3.3.1. Seeding

Seeding is covered by [Section 730](#) of the SDDOT Standard Specification for Roads & Bridges. The specifications cover the materials and methods to be used for seeding including the planting seasons, bed preparation and planting methods. These specifications are supplemented by the standard notes pages for erosion and sediment control which are available on-line.

3.3.2. Sodding

Sodding, or solid sodding, is an effective way of achieving immediate, permanent erosion control. Depending on the location of a project and the soil and slope conditions, sod can often provide a cost-effective alternative to the use of seeding with erosion control blankets. The primary consideration is the availability of a suitable water supply, which may be a municipal water supply, an available well, or an accessible surface water body of sufficient size to supply the establishment irrigation needs for the required four (4) week watering period. Sod quality, site preparation, and laying sod are covered in [Section 733](#), Sodding in the Standard Specifications for Roads & Bridges.

3.4. Woody Materials in Erosion Control

Woody plant materials are primarily used in biotechnical stabilization applications or in areas where reforestation is to be used (usually on back slopes), as the primary erosion control or in ornamental planting. Ornamental planting is not usually part of a permanent erosion control plan and will not be discussed further here. The two types of woody material used in erosion control are tree or shrub seedlings and live cuttings or live stakes.

Seedlings are planted bare root, and planting should conform to the same planting season as for grasses and herbaceous materials. Live cuttings and stakes must be harvested while the parent plants are fully dormant. The cuttings and stakes must be stored in a moist condition and planted prior to the cuttings or stakes breaking dormancy.

3.5. Structural Supplemental Controls

Structural supplemental controls are any devices or materials used with or without vegetation to prevent surface, bank, channel or stream bed erosion. Permanent controls are only necessary where natural conditions have been modified to the point that the pre-existing vegetative cover will no longer prevent erosion or where natural processes or upstream modifications have created unstable conditions that cannot be mitigated by vegetation alone. Examples of supplemental erosion and sediment controls include:

- [concrete riprap and energy dissipaters](#)
- [gabions and gabion mattresses](#),
- [rock riprap](#),
- [turf reinforcement mats](#) (TRMs).

When the need for permanent structural controls arises, the selection and design of permanent structural erosion and sediment controls must be based on good engineering practice. Preparation usually involves hydrologic, hydraulic and geotechnical analysis of the site as the basis for determining the design of permanent controls. One size does not fit all, and over-design in an effort to be on the safe side, can sometimes lead to unforeseen downstream consequences. Therefore, no further discussion of permanent structural controls is appropriate in this context.

3.6. Biotechnical controls

Biotechnical is a term applied to the use of live vegetation to achieve permanent structural erosion controls. These solutions have the greatest applications where unstable slopes are encountered such as in rock cuts and cut slopes in mountainous terrain, steep fill slopes, and for the stabilization of rapidly eroding stream banks. The most common types of biotechnical stabilization techniques include:

- branchpacking,
- brushmattress,
- brushlayering,
- coconut fiber rolls,
- dormant post plantings
- joint planting,
- live cribwalls,
- live fascines,
- live stakes,
- log and root wad revetment,
- tree revetment, and
- vegetated geogrids.

A more detailed discussion of these methods and their applications is provided in a special section on biotechnical techniques.

3.7. Temporary Erosion and Sediment Control for Construction

This discussion of temporary erosion and sediment control is divided into subsections that cover basic categories of temporary controls used in construction based upon their function:

- surface protection for slopes and channels,
- velocity reduction,
- sediment capture, and
- run-on management.

Erosion controls are placed on the surface to dissipate the energy of rainfall and minimize soil particle detachment. Sediment controls are corrective measures that trap sediment and other suspended materials carried in runoff before it can enter an adjacent water body. Sediment controls are backup measures and should never be used in lieu of good erosion control measures. Good erosion control will minimize the need for sediment controls.

However, even the best erosion controls are only about 80%-85% efficient; therefore, some sediment control backup is needed for every site. Regulations currently require that a sediment capture volume equivalent to 3600 cubic feet, or one acre inch, for every disturbed acre of contributing drainage area be provided ahead of the downstream discharge point(s). It is recommended that the required volume be viewed as insurance and that more localized sediment controls be provided up stream of the required sediment catchment(s).

The BMP data sheets provide descriptions of the wide range of sediment controls that are available and the wide variety of applications. For convenience they have been grouped into five broad categories:

- perimeter protection;
- in-channel detention materials and methods;
- in-stream detention materials;
- drainage inlet; and
- drainage outlet protection.

To avoid repetition, some methods and materials have been placed in the group that characterizes the most common application even though they may have application in more than one category.

A group of BMP data sheets occurring within each category describe the various methods and materials used to achieve a particular type of erosion control. Each BMP sheet includes the information outlined below.

Material Name

The material or method name used is the term generally accepted by erosion and sediment control professionals and the industry. The two organizations cited as the authority for terms used, are the [International Erosion Control Association](#) (IECA) and the [Erosion Control Technology Council](#) (ECTC). The IECA is an international trade organization of erosion and sediment control professionals. The ECTC is an association of manufacturers and other erosion and sediment control professionals whose purpose is developing, marketing and establishing quality standards for the industry. ECTC receives most of its support from material manufacturers and suppliers.

Other terms

Other terms lists any names or titles that may also be used regionally for a material or method name listed.

Inspection Form Number

The construction site inspection form lists BMPs by number for reference within the document. If there is a coinciding number, it is listed on the BMP sheets.

SDDOT Specification

If there is a standard SDDOT specification for the application of the material, a hyperlinked reference to that specification is provided. Simply click the highlighted link and the document will go to that specification.

SDDOT Standard Plate

If there is a standard SDDOT plate for the application of the material, a hyperlinked reference to that plate is provided. Simply click the highlighted link and the document will go to the appropriate plate.

Description

This section includes a general description of the BMP, its function as a BMP, and other descriptive information that would assist a designer with choosing the proper BMP.

Applications

This section briefly lists the site conditions and situations where the material or method has application. Other sections of the manual will provide more detail about the design criteria for specific situations.

Considerations

The design considerations provide a brief synopsis of the things that should be considered when selecting the material or method. For example, many rolled erosion control products have different longevity characteristics that will be magnified by climatic conditions. Therefore, regional climatic variables might be listed as a design consideration.

Where temporary erosion control materials and methods are concerned, one size does not fit all. This section will list the limitations of use.

Any specific training needs, equipment or any special skills needed to design or specify a particular material or method will be discussed. For example, gabions and stone riprap must be designed for specific flow conditions. Therefore, design should be handled by an engineer qualified to estimate flow characteristics and the resulting stresses that would have to be resisted by the materials used.

Inspection and Maintenance

This section discusses the quality control issues associated with a proper application of a material or method, such as proper depth of cover or lack of bare spots, etc. Issues related to periodic inspections and special maintenance considerations are also noted.

Common Problems

Most all materials and methods have weaknesses or common problems in their installation. This includes issues such as materials not being properly anchored or healed in, non-uniformity of cover, or migration of cover material in a blanket or mat. For each material, common problems will be noted to facilitate selection and inspection.

BMP Ratings

The BMP data sheet will also have indicators that include the following:

- Effectiveness Index – rates BMP performance relative to bare soil;
- Functional Longevity – rates BMP longevity from one season to over three years or duration of project with consideration of factors such as weather, material degradability and consistent material quality;
- Ease of Installation – rates BMP based upon labor, necessary equipment and mobilization, access and availability; and
- Ease of Maintenance – rates BMP based upon frequency, labor, equipment and mobilization, repair and replacement, access and availability.

Some ratings may indicate that there is no data available (NDA) or not applicable (N/A).

3.7.1. Surface Protection - Slopes

Slope surface protection methods and materials are intended to perform four functions:

- protect the soil surface from forces that will detach soil particles and make them available for transport in wind or water,
- preserve soil moisture to foster seed germination and vegetation establishment,
- moderate soil temperatures to foster seed germination and vegetation establishment, and
- reduce runoff velocities to capture and hold detached soil particles.

There are numerous materials and methods that are available to provide slope surface protection. Each material and method has specific applications depending on the site, soils, slope, climatic factors, and the length of the construction period. Refer to Section 3.5 [BMP Selection Tool](#).

3.7.2. Surface Protection - Channels

The level of surface protection in a channel or ditch is based upon the shear stress or tractive force of the water entering the channel. This can be calculated using the SDDOT [Chapter 9 Drainage Manual](#). Shear stress is rated in pounds per square foot (psf). The higher the psf, the more protection is needed. Channel protection is necessary in hydraulic applications where design discharges exert velocities and shear stresses that exceed the limits of mature, natural vegetation. In cases where there are deep, concentrated flows that may generate tractive forces of 1.5 psf and greater, a combination of surface protection and velocity reduction are needed. Refer to Section 3.5 [BMP Selection Tool](#).

3.7.3. Surface Protection – Outlets

Surface protection at an outlet may require the same shear stress calculations from [Chapter 9 Drainage Manual](#) as with channels. High velocity, high flow discharges exert tractive force on the soil surface that may require heavy reinforcement for protection. Refer to Section 3.5 [BMP Selection Tool](#).

3.7.4. Velocity Reduction – Slopes

Velocity reduction BMPs on slopes promote infiltration and thereby reduce runoff. They can break up a long slope length to reduce the sheet flow velocity, thereby reducing the possibility of it gathering into concentrated flows. Refer to Section 3.5 [BMP Selection Tool](#).

3.7.5. Velocity Reduction – Channels

Velocity reduction BMPs in channels are used to promote infiltration and lessen the quantity of runoff. Reducing the velocity decreases the destructive power of the flowing water. Refer to Section 3.5 [BMP Selection Tool](#).

3.7.6. Sediment Capture – Perimeter Protection

Perimeter protection includes those materials that can be used to prevent sheet flow sediment discharges from the site. The most common material used for perimeter protection is geotextile silt fence but there are some other effective alternatives that can be used in the appropriate conditions.

Another category of perimeter protection is sediment capture materials and methods that capture and hold runoff until materials settle out of suspension. These devices can be earthen structures, temporary holding tanks, or geosynthetic materials. Refer to Section 3.5 [BMP Selection Tool](#).

3.7.7. Sediment Capture – In-channel Detention

In-channel detention is a form of check that will detail a certain volume of flow providing sufficient residence time to remove some of the silt load from the flow. Many of these materials and methods also double as velocity controls as well. Refer to Section 3.5 [BMP Selection Tool](#).

3.7.8. Sediment Capture - In-stream Detention

In-stream sediment devices are used to contain sediment when working in water. These are in place to confine sediment suspended by activity in the water to a specific area. They are not to be used to capture upstream sediment-laden runoff. Upstream runoff must be captured with additional sediment controls such as silt fence prior to entering the receiving water. Refer to Section 3.5 [BMP Selection Tool](#).

3.7.9. Sediment Capture - Drainage Inlet Protection

During the course of construction, inlets to the storm sewer system and entrances to culverts should be protected to prevent siltation in the pipe which will be conveyed to the connecting water body during succeeding storm events. Some methods simply block the inlet allowing the storm water to pond temporarily around the inlet. However, care must be exercised when choosing this type of solution in order to be sure that water will not flood an active road or highway. Other inlet protection methods are essentially pervious barriers that use a combination of filtration and detention to remove suspended materials from the runoff. Refer to Section 3.5 [BMP Selection Tool](#).

3.7.10. Sediment Capture - Drainage Outlet Protection

Drainage outlets often have high velocity, high flow water. With this comes great erosion potential. Many BMPs serve to capture sediment from these discharge areas. Caution must be used in choosing and placing a BMP at a drainage outlet as to not block the outlet and create flooding upstream. Refer to Section 3.5 [BMP Selection Tool](#).

3.7.11. Sediment Capture – Construction Entrances

Loose soil on construction sites will adhere to vehicle tires and tracks and will be tracked onto adjacent streets and highways if some provision is not made to remove the loose material before the vehicle leaves the site. For this reason, it is important on linear projects, like highways, to limit ingress and egress to specific points along the route. At each point of egress there should be a means of removing the loose soil material from vehicles before they leave the site. Refer to Section 3.5 [BMP Selection Tool](#).

3.8. Run-on Management

Storm water flowing on a site consists of three parts: run-on, run across, and run-off. Management of the water that enters the construction site can minimize the amount of sediment-laden runoff. The BMPs linked below are designed to minimize concentrated flows and divert runoff away from denuded slopes or other critical areas. Runoff management techniques minimize slope steepness and length, and intercept and divert flows. It is an effective method to intercept clean run-on and divert it to a stabilized area before it become sediment laden. This protects the soil surface and assists in maintenance of sediment trapping devices by reducing the quantity of sediment-laden water. The key concept is to keep the clean water clean. Refer to Section 3.5 [BMP Selection Tool](#).

3.9. Biotechnical Techniques

The intent of this section is to introduce an environmentally sensitive approach to soil erosion control so that project designers can be aware of solutions that are not structurally based. Biotechnical control is a specialized field and requires a comprehensive knowledge of hydraulics, geotechnical engineering, horticulture, and fluvial geomorphology. Traditionally trained engineers would need additional training in order to apply this technique.

3.9.1. Material Properties

Biotechnical engineering or soil bioengineering is the use of live, woody cuttings combined with inert materials such as dead wood, rock or geosynthetics to stabilize slopes or streambanks. This application takes a great deal of coordination and scheduling because the effectiveness of stabilization depends highly on whether live cuttings are harvested and installed during dormant periods. Because vegetation is the primary stabilization material and mechanism, biotechnical controls are best used when environmental sensitivity is an issue. The selection of plant materials depends on local plant communities. Related information of plants should be available from local U.S. Department of Agriculture (USDA)-NRCS plant material centers. Biotechnical measures are good alternatives and can serve as both temporary and permanent BMPs. The combined use of different techniques on the same project site is common and encouraged.

Typical biotechnical techniques rely on woody plant materials by taking advantage of their deep root system, which reinforces the soil and other structures. Herbaceous plant materials such as grasses should also be included so that more fine soil particles can be held in place. The reinforcement strength increases over time, which is one of the benefits from the use of biotechnical stabilization.

Common slope and streambank erosion problems that can be stabilized by biotechnical methods include unstable slopes encountered such as in rock cuts and cut slopes in mountainous terrain, steep fill slopes, and rapidly eroding streambanks. USDA-NRCS lists 12 common types of biotechnical stabilization techniques including:

- [branch packing](#),
- [brush mattress](#),
- [brush layering](#),
- [coconut fiber rolls](#),
- [dormant post plantings](#),
- [joint planting](#),
- [live crib walls](#),
- [live fascines](#),
- [live stakes](#),
- [log and root wad revetment](#),
- [tree revetment](#), and
- [vegetated geogrids](#).

3.10. Endangered Species

3.10.1. *Provisions for the Topeka Shiner*

See the special provision for “[Construction Practices in Streams Inhabited by the Topeka Shiner](#)”. This special provision describes several conditions that are to be met by the project contractors during in-stream activities when the stream is inhabited by the Topeka Shiner.

3.11. BMP Selection Tool

This section provides a selection tool to guide the selection of an appropriate temporary sediment or erosion control BMP for a specific condition. The tool is essentially a decision tree that will guide the user through a series of site conditions. Simply follow the diagram below by clicking on the appropriate box. The process is repeated until you reach a list of appropriate BMPs for the site conditions cited. The list of BMPs is linked to the appropriate data sheet for each BMP type that can be used for the site conditions entered.

