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CHAPTER 3: EROSION & SEDIMENT CONTROL MEASURES & BMP’s

3.1 Erosion Prevention

This chapter presents best management practices for erosion and sediment control. The discussion for each best management practice includes typical applications and design criteria. Additional information such as the advantages, disadvantages, maintenance requirements and common failures of each BMP are also included, and should help the designer to choose the most appropriate measure or control and to develop special provisions.

The details of installation can and should vary in the field depending on the site conditions. Field variations for each type of measure are encouraged. The substitution of other cost-effective products or methods that provide substantially equivalent or superior performance is allowed if approved by the Agency.

As implied by their name, BMP’s are stabilization methods and structural erosion control measures that represent commonly accepted practices. Table 3-1 presents ratings for basic applications of commonly used erosion control measures.

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Table 3-1 Matrix of temporary and permanent erosion control measures and estimated effectiveness ratings: E = Excellent, M = Moderate, P = Poor
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3.1 Erosion Prevention

Erosion prevention is the most effective and inexpensive method for reducing pollution associated with construction activities. Limiting the amount of exposed soil and directing surface water runoff away from exposed soil are two excellent ways to minimize erosion during construction. Erosion control practices primarily involve preserving natural vegetation when possible or stabilizing exposed soils with temporary covers or permanent vegetation. Reducing the erosion associated with construction vehicular traffic is also covered in this section. Many of these techniques can reduce erosion by 80 to 95 percent compared with exposed soils.

3.1.1 Best Management Practices

1. Preserve Natural Vegetation
2. Buffer Zone
3. Temporary and Permanent Seeding
4. Hydraulic Seeding
5. Mulch
6. Sod
7. Matting
8. Plastic Sheeting
9. Dust Control
CHAPTER 3: EROSION & SEDIMENT CONTROL MEASURES & BMP’s

3.1.1.1 Preserve Natural Vegetation

This BMP involves preserving natural vegetation to the greatest extent possible during the construction process and after construction where appropriate. Maintaining natural vegetation is the most inexpensive form of erosion prevention control. This method is particularly important in sensitive areas such as wetlands, stream corridors, lakes, and near steep slopes. The project manager, inspector and contractor should address and discuss preserving natural vegetation during the Pre-construction Conference.

Applications

- Flood plains, wetlands, stream banks, steep slopes and other areas where erosion controls would be difficult to install and maintain.

Advantages

- Helps reduce soil erosion and runoff while beautifying an area.
- Saves landscaping costs, provides areas for wildlife, and provides visual screening.
- Helps maintain water temperature. Temperature moderation is especially important when detention ponds drain to salmonid-bearing streams.
- Retains existing shade and cover habitat.

Disadvantages

- Retaining older trees could create a safety hazard.
- May constrict area available for construction activities.

Special Considerations

- Requires coordination with Environmental Professionals, Landscape Professionals and the construction Project Manager’s office.
- Requires the Inspector or Contractor to fence or flag the clearing limits.
- Requires the Inspector or Contractor to fence or flag outside tree and shrub driplines.

Design Criteria

- Coordinate with the Landscape Architect and Environmental Professionals assigned to the project when determining what to save and how to save it.
• Vegetation can be preserved in natural clumps or as individual trees, shrubs and vines.

• Clearly flag or mark the ground disturbance limits outside the dripline of preserved trees.

• Protect vegetation from:
  • Construction equipment injury above or below the ground level. Injury occurs from scarring, cutting roots, or compaction.
  • Grade changes, which affect the plants’ ability to obtain air, water or minerals. Placing a layer of gravel and a tile system over the roots before a major fill allows air to circulate and protects the plant from the fill.

• Terracing the area around the plant, or leaving the plants on an undisturbed mound can increase the plants’ survival chances.
  • Root exposure.
  • Damage caused by excavations for tile, water and sewer lines.

Maintenance

• Inspect and repair flagging or fencing.
• Re-cover and/or seal exposed plant roots.

Common Failures

The most common problem with this BMP is non-observance of clearing limits and clearing of the entire site prior to construction. If possible, work with the contractor to establish a phased clearing and grading schedule at the beginning of the project.
3.1.1.2 Buffer Zone

A buffer zone consists of an undisturbed area or strip of natural vegetation or an established suitable planting adjacent to a disturbed area that reduces erosion and runoff.

Applications

- Between disturbed areas and streams or other water bodies.
- Along natural swales and wetlands.

Advantages

- Filters Sediment.
- Promotes infiltration.
- Provides habitat.
- Reduces velocity and quantity of runoff, dissipates energy.
- Provides visual screening.
- Can be used to stabilize stream banks.
- Low maintenance.

Disadvantages

- Requires keeping all construction equipment, debris and soils out of the natural areas.
- Extensive buffers can cover large areas of land that are not available for project development.

Special Considerations

- Constrains work area and equipment movement.
- Requires the Inspector or Contractor to fence or flag the clearing limits.
- Requires the Inspector or Contractor to fence or flag outside tree and shrub driplines.

Design Criteria

- Preserve natural vegetation in clumps, blocks or strips.
- Preserve natural vegetation on unstable, steep slopes.
Vegetative buffer zones for streams, lakes or other waterways should be 100 ft wide on each side of the feature. The width can increase depending on other onsite conditions, existing vegetative conditions and erosion potential.

Maintenance

- Inspect flagging and fencing frequently and repair as needed.

Common Failures

The most common problem with this BMP is non-observance of buffer zone delineation and clearing of the entire site prior to construction. If possible, work with the contractor to establish a phased grading plan that includes buffer zones.
3.1.1.3 Seeding

A well-established vegetative cover is one of the most effective methods of preventing erosion. The most effective practice is to establish vegetation on most construction sites as the slopes are finished, rather than waiting until all the grading is complete. This and other requirements are described in Section 01030 of the *Oregon Standard Specifications For Highway Construction*.

**Applications**

- On disturbed areas that require seeding either because the area has reached final grade (permanent seeding) or because the area will remain undisturbed for over 2 months (temporary seeding). Refer to Section 01030, or Chapter 6 of this manual for soil exposure limitations and seeding dates.
- In vegetation-lined channels, seed and then protect with matting.
- In retention/detention ponds.

**Advantages**

- Prevents erosion and also traps sediment.
- Promotes infiltration.
- Improves appearance of the site.
- Reduces runoff.
- Provides excellent stabilization.
- Relatively inexpensive erosion control measure.

**Disadvantages**

- Needs sufficient time for seed to establish.
- Requires mulch or other cover to keep soil in place until vegetation is established.
- May require fertilizer and lime to establish on poor soils.
- May require irrigation.
- Must be removed prior to applying fill material.

**Design and Selection Criteria**

Typical grass and legume seed mixes for erosion control are developed by the ODOT Geo/Environmental Section. The erosion control designer of record is normally responsible for specifying seed mixes and seeding rates, which are shown in the project Special Provisions.
mix of several plant species is typically used to increase the chance that at least one species will do well, given the extreme seasonal fluctuations that occur in nature. When developing an erosion control mix, seeds are selected for specific plant characteristics that will result in optimal erosion protection. Grass and similar species are normally used rather than other plant species because of their rapid establishment, fibrous root system, and potential for long term stabilization.

Seedling vigor is an important plant characteristic to consider for erosion control seeding because the goal is to have rapid establishment and a dense fibrous root system. This holds the soil in place and provides a thick canopy over the soil to break the raindrop velocity. Some grasses do well early in the season and can act as nurse or cover crops until the slower growing species can establish. Seed mixes are developed for specific climatic zones around the state to match the optimum growing conditions for each species.

Other characteristics that are important for erosion control are the methods by which the grass develops, grows and spreads. Grasses can be rhizomatous, where the plant sends out runners that start new growth; a bunch grass; or a sod-forming grass. Rooting depth is important and for erosion control purposes grasses are characterized as being deep, moderate or shallow rooting. Selection of seeds for a mixture of rooting depths provides optimum support for soils and best enables the removal of water by the roots at the various zones in the soil.

**Seed Qualities and characteristics**

Agriculturally-produced seed is normally specified by Pure Live Seed (PLS) weight. Pure live seed refers to the portion of a seed lot that is live seed of the desired kind. The purpose of measuring seed on a PLS basis is so that trash and empty seeds do not confuse seeding rate calculations for the application.

Seed furnished for a project must meet or exceed the requirements of the Standard Specifications. Most important is meeting the requirements of state and federal seed law which, among other things, spells out exact seed labeling requirements. (See Oregon Revised Statute 633.520 for the exact requirements). For a brief summary of typical information that must be on the seed label, see Construction subsection 7.3.2.

The label must be correct and the purity, germination and other information on the tag must be backed by a seed lab analysis report. High quality seed germinates well, has a high purity percentage, and is free of noxious weeds or unintended species. The identity, purity and uniformity of the seed must be maintained at all times by continuing to monitor seed delivered to the project for proper labeling.
Certified Seed is a special category of seed with very high quality standards. This program assures seed growers and the industry that a named seed variety is true to its original type so the type can be successfully kept true when grown for production by grass seed growers. The Oregon Certified Seed program is administered by the Oregon Department of Agriculture and Oregon State University. A list of seed varieties that are currently certified can be found in the Oregon Seed Certification Service Handbook. Certified seed is specified for highway projects when the highest level of assurance is needed that seed will be free from weeds or unintended species.

Native seed is another category of seed which will be used on projects. The two major distinctions for native seed are agriculturally-produced seed and collected seed. The definition of “native” can vary, so be sure the desired definition is being used because this can have a large effect on seed availability and cost. It is quite normal for the native seed market to experiences severe fluctuations.

**Timing of Seeding**

- Apply permanent seeding on areas to be left dormant for 1 year or more.
- Apply permanent seeding when no further disturbances are planned.
- Seed immediately after seedbed preparation while the soil is loose and moist.
- Seed before applying mulch.
- To determine optimum dates for seeding, consult a local agronomist or erosion control specialist.
- Generally, the best time to apply seed is early spring or late fall depending on site conditions. Irrigation may be required for areas seeded during the hot summer months.
- Seed applied during the winter may take several months to develop a dense ground cover due to cold temperatures. The application and maintenance of mulch is critical for winter seeding. Additional erosion control measures may need to be applied to provide temporary stabilization.
- Apply temporary seeding to temporarily stabilize disturbed soils and slopes that are not at finished grade and which will be exposed for 2 months or longer before being disturbed again.

**Site Preparation**

- Prepare site according to Sections 01030 and 01040.
• Bring the seed bed to final grade, remove all rocks and debris, and smooth surface undulations larger than 2 inches.
• Divert concentrated flows away from the seeded area.
• For optimum seeding conditions salvage and stockpile topsoil until final grades are established. Spread topsoil over new grades or:
  • Conduct soil test to determine pH and nutrient content.
  • Roughen the soil by harrowing, tracking, grooving and furrowing.
  • Apply soil amendments as needed to adjust pH to 6.0-7.5. Incorporate these amendments into the soil.
• The seedbed should be firm but not compact. The top 1 to 2 inches of soil should be loose, moist and free of large clods and stones.
• If the seedbed has been idle long enough for the soil to become compact, the topsoil should be harrowed with a disk, spring tooth drag, spike tooth drag, or other equipment designed to condition the soil for seeding.
• Harrowing, tracking or furrowing should be done horizontally across the face of the slope, so ridges are along the slope contour.
• The topsoil surface should be in reasonably close conformity to the lines, grades and cross sections shown on the construction plans.
• Consult a Geotechnical Engineer prior to placing topsoil on slopes 1:2 or steeper.

Seeding

• Apply seed as specified in Section 01030.
• Seed to soil contact is the key to good germination.
• Apply seed at the rates specified using calibrated seed spreaders, cyclone seeders, mechanical drills, or hydroseeder so the seed is applied uniformly on the site.
• Broadcast seed should be incorporated into the soil by raking or chain dragging, and then lightly compacted to provide good seed-soil contact.
• Apply mulch and tackifier or matting, as specified, over the seeded areas.
• To prevent seed from being washed away, confirm installation of all required surface water control measures.
• Double the rate of seed application when mulch and seed is applied in a single application.
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- When hydroseeding, a mulch or green dye tracer is required as a visual application aid.
- On slopes steeper than 1:2, hydroseeding requires an increased rate of tackifier to be applied.
- For additional discussion of hydroseeding, refer to subsection 3.1.1.5. in this Chapter.

Fertilizer

- Apply fertilizer as specified in Section 01030.
- Slow-release fertilizers are more efficient and have fewer environmental impacts. Areas being seeded for final landscaping may require soil tests to determine the exact type and quantity of fertilizer needed to prevent the over-application of fertilizer. Use non-phosphorus fertilizer on disturbed areas near water bodies and wetlands.
- The use of stockpiled topsoil or compost can reduce the need for fertilizer and improves the overall soil quality.
- Provide project-specific application rates in Specifications, Section 01030.

Mulching

- Refer to Section 3.1.1.5 of this Chapter.
- Straw mulch in loose conditions is preferred for seeding during the wet season on slopes 1:2 or flatter.
- Straw mulch may be required during the dry season if:
  - Grass growth is expected to be slow;
  - The soils are highly erodable;
  - There is a water body close to the disturbed area; or
  - Significant precipitation is anticipated before the grass will provide effective cover.
- The straw mulch shall not be moldy, caked, decayed or of otherwise low quality. Submit verification from the supplier that the straw is free of noxious weeds. Acceptable documentation submitted shall show whether (1) the straw is from an “Oregon Certified Seed” field or (2) the seed lab results of the seed harvested from the straw meet minimum Oregon Certified Seed quality for weed seed content (refer to Appendix D).
• Apply mulch on top of the seed or, in some situations as specified or approved, apply mulch with the seed during hydroseeding. The application rate of seed should be increased if seed and mulch are applied in a single application.

Maintenance

• Newly seeded areas need to be inspected frequently to ensure the grass is growing.
• If the seeded area is damaged due to runoff, additional storm water management measures may be needed. Re-seed and mulch damaged areas.
• Spot seeding can be done on small areas to fill bare spots where grass did not grow properly.
• If spot seeding is ineffective, use an alternate method, such as sodding or matting.
• Re-seed and protect with mulch any areas affected by erosion. If the erosion is caused by concentrated runoff, fix the runoff problem and then re-seed and mulch the area.

Common Failures

The most common problems with seeding are failure of the seed to grow and erosion of seedbed soils before plants becomes established. Common causes are seeding outside of the optimum growing season and poor seed quality. Other problems include improper selection of seed, using the wrong seeding method for the site; inadequate coverage of mulch and tackifier, substitution of seed variety without prior approval by the Agency, and erosion of seeded areas without immediate repair.
3.1.1.4 Mulch

Mulching is the application of a protective layer of straw or other suitable mulch material to the soil surface. Straw mulch and/or hydromulch are also used in conjunction with seeding of critical areas for the establishment of temporary or permanent vegetation. Mulching soils provides immediate temporary protection from erosion. Mulch also enhances plant establishment by conserving moisture, holding fertilizer, seed, and topsoil in place, and moderating soil temperatures.

Applications

- Seed cover.
- Dust control
- Soil cover on areas that can’t be seeded or are otherwise unfavorable for plant growth.
- As temporary stabilization on bare soils exposed by construction activities. Refer to Section 00280, for specific requirements.
- On slope greater than 1:2, or where the mulch is susceptible to movement by wind or water, the mulch material should be hydraulically applied with a tackifier or the straw mulch should be anchored mechanically.

Advantages

- Provides rapid protection.
- Conserves moisture.
- Allows vegetation growth through the mulch.
- Protects seeding from heat, moisture loss and transport due to runoff.

Disadvantages

- Thick mulches can delay germination.
- Can be blown or washed away if not adequately tackified.
- Must be removed prior to applying fill material.
- May provide road hazard if cattle begin grazing on straw mulch applied to roadsides.

Design Criteria

- Divert concentrated runoff from mulched areas.
• Specific material and application criteria are included in Section 00280 and 01030. The following discussion contains general information regarding mulches.
• Refer to Appendix D for Mulch Application Rate Worksheet.

Organic Mulches

• Straw mulch provides immediate protection lasting approximately three months. Straw can be spread mechanically or by hand and may require anchoring for wind protection. Common anchoring methods include crimping, disk, rolling; covering with netting; spraying with a tackifier; or keeping it moist. The combination of hydroseed slurry and straw mulch is well suited to steep slopes, critical areas and severe climate conditions.

• The straw mulch shall not be moldy, caked, decayed or of otherwise low quality. Submit verification from the supplier that the straw is free of noxious weeds. Acceptable documentation submitted shall show either (1) that the straw is from an “Oregon Certified Seed” field or (2) the seed lab results of the seed harvested from the straw meet minimum Oregon Certified Seed quality for weed seed content (refer to Appendix D). The minimum requirements of Oregon Certified Seed are as published in the current year’s Oregon Certified Seed Handbook. The Oregon Certified Seed Handbook and lists of farms with certified fields that sell to the public are available from County Extension Offices or Oregon State University.

• Wood cellulose, grass straw cellulose and paper fiber products are commonly applied hydraulically.

• Wood chips are suitable for areas that will not be closely mowed and areas around ornamental plantings. Chips decompose slowly and require nitrogen application to prevent nutrient deficiency in plantings. Both wood and bark chips tend to wash down slopes greater than 6%.

• Corn stalks, which decompose slowly and are resistant to wind blow, should be shredded into 4 to 6 in. lengths.

• Manure mulches should be well aged and are not suitable for use near water bodies, or when low weed seed content is required.

• Leaf compost, available in some areas of the state, is suitable for flat areas.
Synthetic Mulches

- Synthetic, spray-on mulches and soil binders can seal the soil surface, but may cause adverse effects on water quality. Therefore, they are not recommended for use as mulch.

Maintenance

- Maintain the thickness of the cover in all areas.
- Re-mulch and/or protect with a net or blanket any areas that experience erosion. If the erosion problem is drainage related, fix the drainage problem and re-mulch the eroded area.
- Hydraulically treated areas shall be inspected and monitored after installation and periodically thereafter.
- Hydraulic mulches and tackifiers shall provide the necessary erosion protection until permanent erosion-resistant cover is established. If sheet or rill erosion is evident, then prompt re-application of treatments shall be necessary.
- If hydraulic mulch or tackifiers were applied without seed for erosion and dust control, the product must remain effective for the length of time the soil will remain bare or until revegetation occurs. Periodic inspections will assure the intended purposes will be met.
- Areas that fail to establish cover adequate to prevent erosion shall be re-mulched as soon as such areas are identified.
- If mulched areas are damaged by concentrated runoff, the prompt implementation of additional practices and BMP’s may be necessary.

Common Failures

The most common problems with mulches are poor installation and maintenance. Other problems include improper selection of mulch material and tackifier, inadequate coverage of mulch and tackifier, deterioration, wind or water removal of hydraulic application without replacement.
3.1.1.5 **Hydraulic Application**

Hydraulic application is a method of application for certain BMPs. Hydraulic equipment such as hydroseeders and hydromulchers can be used to uniformly apply materials onto slopes such as mulch, tackifier, dust control chemicals, soil amendments, and others.

**Applications**

- For applying seed, fertilizer, mulch, tackifier, soil amendments, bonded fiber matrix, and chemical stabilization.
- Slopes steeper than 1:3 that cannot receive adequate seedbed preparation and where mulch would be difficult to otherwise anchor.
- On sites where the application of a hydraulically applied bonded fiber matrix (mat) system is desirable.
- On sites where other soil stabilization, seeding, and mulching practices would result in unacceptable levels of ground disturbance.
- Where site conditions, such as irregular soil surfaces, existing vegetation, and shallow soils preclude the installation of erosion blankets and mats.
- On sites where straw mulch has been applied and the straw needs to be anchored (tacked) with tackifiers or hydraulic mulches.
- On sites where dust control is desired.
- Please refer to Appendix D for the Hydroseeding Mixture Worksheet.

**Advantages**

- Provides rapid installation.
- Generally requires less seedbed preparation, the surface soil may be left irregular with large clods, stones, or rock outcropping exposed.
- Uniformly distributes seed and mulch material.
- Increases favorable conditions for quick germination and growth.
- Can be used effectively on steep slopes and other areas where access is limited.

**Disadvantages**

- Generally less expensive than broadcast or seed drilling operations.
- Thick mulch applications can delay germination.
- Can be blown or washed away if not adequately tackified.
• Required application rates can vary significantly dependant on site preparation.
• Limitations on application reach of equipment
CHAPTER 3: EROSION & SEDIMENT CONTROL MEASURES & BMP’s

3.1.1.6 Sod

Establishes permanent turf for immediate erosion protection and stabilizes drainageways.

Applications

- Disturbed areas requiring short-term or long-term cover.
- Disturbed areas requiring immediate vegetative cover.
- Waterways carrying intermittent flow (except biofiltration swales) and requiring immediate stabilization or aesthetic mitigation.
- Around inlets located off roadways.

Advantages

- Provides immediate, effective protection, and is aesthetically pleasing.
- Provides high-density vegetation, which is superior to a recently seeded area.
- Placement can occur any time that soil moisture is adequate and the ground is not frozen.

Disadvantages

- Expensive.
- Availability is seasonal.
- Difficult to find sod free of weeds.
- Irrigation may be required if installed in summer.
- Difficult to mow if installed on slopes steeper than 1:3.
- Installation in grassed waterways may roll up if not anchored or drained properly.
- Time necessary for root establishment may be lengthy.

Design Criteria

- Use sod that is weed free, has uniform thickness (approximately 1 in. thick) and dense root mat for mechanical strength.
- Generally inappropriate for bioswales. Sod can be used for lining ditches to prevent erosion, but will provide little water quality benefit during the wet season.
- The following steps are general recommendations for sod installation. Refer to Specification Section 01040 for specific installation criteria.
CHAPTER 3: EROSION & SEDIMENT CONTROL MEASURES & BMP’s

- Shape and smooth the surface to final grade in accordance with the approved grading plan.
- Fertilize as per supplier’s recommendations. Non-phosphorous fertilizer is required near water bodies and wetlands.
- Work lime and fertilizer into soil 1-2 in. deep and smooth the surface.
- Lay sod strips perpendicular to the direction of water flow, beginning at the lowest area to be sodded. Wedge strips securely into place and square the ends of each strip to provide for a close, tight fit. Stagger joints at least 1 ft. Staple sod onto 1:3 and steeper slopes.
- Roll the sodded area and irrigate.
- When sodding is carried out in alternating strips or other patterns, seed the areas between the sod immediately after sodding.

Maintenance

- Inspect sodded area frequently for soil moisture content and root establishment.
- Re-tack, re-sod, or re-seed as necessary.
- If it is impossible to establish a healthy ground cover due to frequent saturation, instability, or some other cause; remove the sod, seed the area with an appropriate mix, and protect with matting.

Common Failures

The most common problem with this BMP is poor installation, inadequate establishment, poor soil contact and insufficient maintenance. Other problems include improper selection of sod type, poor soil fertility, and inadequate soil moisture.
3.1.1.7 Matting

There are numerous erosion control products available that can be described in various ways, such as matting, blankets, fabric and nets. We will call them all matting. A wide range of materials and combination of materials are used to produce matting including, but not limited to: straw, jute, wood fiber, coir (coconut fiber), plastic netting, and Bonded Fiber Matrix.

The selection of matting materials for a site can make a significant difference in the effectiveness of the BMP. ODOT accepts matting materials that have been tested and approved by the Texas DOT/TTI Hydraulics and Erosion Control Laboratory meeting performance criteria for the following categories:

- Type A – Slope protection mat for slopes 1:3 or flatter – clay soils.
- Type B – Slope protection mat for slopes 1:3 or flatter – sandy soils.
- Type C – Slope protection mat for slopes steeper than 1:3 – clay soils.
- Type D – Slope protection mat for slopes steeper than 1:3 – clay soils.
- Type E – Flexible channel liner for shear stress from 0-96 Pascal.
- Type F – Flexible channel liner for shear stress from 0-192 Pascal.
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- Type G – Flexible channel liner for shear stress from 0-287 Pascal.
- Type H – Flexible channel liner for shear stress from 0-383 Pascal.
- The current list of approved matting materials is available from the ODOT GEO-ENVIRONMENTAL section or on the TXDOT website: http://www.odot.state.tx.us/insdtdot/orgchart/cmd/erosion/contents.htm
- Refer to detail: RD 1055 Matting, located at the end of this section.

Applications

- On disturbed areas that require cover for more than 30 days.
- For permanent stabilization of slopes 1:2 or steeper and with more than 10 ft. of vertical relief.
- For permanent reinforcement of turf to protect drainageways during high flows.
- For permanent stabilization of channels, possibly providing a cost-effective, environmentally preferable alternative to riprap.
- For drainage ditches and swales. The appropriate netting or blanket applied to drainage ditches and swales can protect bare soil from channelized runoff while vegetation is established.
- On steep slopes and in channels to prevent erosion and hold seed and mulch in place.

Advantages

- Immediate cushioning against splash erosion from raindrop impact.
- Does not generate high-velocity runoff and, therefore, offers temporary slope protection, which is superior to plastic sheeting.
- Captures a great deal of sediment due to its open, porous structure.
- Usually easy to install.

Disadvantages

- Correct installation is critical to the effectiveness of these products. Good ground contact during installation prevents runoff concentrating under the blanket and causing significant erosion (tenting).
- Soil surface must be graded smooth with no surface irregularities.
- Limited protection capabilities when used as flexible channel liner.
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Design Criteria

- Apply seed and fertilizer prior to matting
- Apply as temporary slope stabilization according to Section 00280.
- Remove all debris and undulations larger than 2 in. in any dimension.
- When selecting matting consider the following questions:
  - How long will the matting be required to provide protection?
  - How steep is the slope?
  - What is the soil type?
  - What is the shear stress on the channel bottom?
- Add check slots on long slopes to control rilling under matting.
- Organic matting materials (excelsior, jute and coir) biodegrade and are useful for applications requiring stabilization for up to three months. Use organic blankets, which retain moisture and provide organic matter to the soil, for slope protection and short-term waterway protection and to improve the speed and success of revegetation.
  - Jute netting must be used in conjunction with mulch in order to prevent erosion that could result from the net’s open structure.
  - Excelsior brand (aspen wood fiber), woven straw, and coir (coconut fiber) blankets may be installed without mulch because they provide complete surface protection.
- Synthetic mats are made from non-biodegradable material and will remain in place for years (some photodegeneration does occur). Use purely synthetic blankets for long-term stabilization of waterways.
  - Turf Reinforcement Mats (TRM) are made from polymer netting or monofilaments formed into a mat. TRM’s protect seed and increase germination and also acts as part of the root structure; giving the turf higher strength.
  - Erosion Control and Revegetation Mats (ECRM), composed of heat-fused monofilaments or monofilaments stitched between netting act as permanent mulch. ECRM allow growth through the mat.
- Channel or swale applications:
  - Lengthwise overlap: Min. 1 ft.
• Crosswise overlap: Min. 6 in.
• Anchor upstream end of mat in check slot.
• Avoid joining material in center of ditch or swale.

• Slope application:
  • Lengthwise overlap: Min. 1 ft.
  • Crosswise overlap: Min. 6 in.
  • At top of slope, entrench material in a 6 in. X 6 in. trench and staple at 1 ft. intervals.
  • At bottom of slope, extend mat 2 ft. beyond the toe of the slope, turn material under 4 in. and staple at 1 ft. intervals.
  • On slopes flatter than 1:3, roles can be placed in horizontal strips.
  • Mats must be stapled in place as they are installed down the slope face. The mat should have intimate contact with the soil surface.

Maintenance

• Inspect periodically, especially following severe storms.
• Repair any damaged areas of the net or blanket and staple into the ground any areas not in close contact with the ground surface.
• If erosion occurs, repair and protect the eroded area.

Common Failures

The most common problem with matting is poor installation, not following the manufacturer specifications and insufficient maintenance. Other problems include improper blanket selection, improper placement of soil staples, and poor site preparation which leads to a failure to provide intimate contact with the soil surface. Subsurface flows (seeps) causing erosion under matting. Bonded fiber matrix may fail if installed during cold and wet weather or not including a high enough tackifier to wood fiber ratio.
3.1.1.8 Plastic Sheeting

Plastic sheeting provides immediate, short-term protection to slopes and disturbed areas that cannot be mulched. Plastic sheeting has been known to transfer erosion problems because water will sheet flow off the plastic at high velocity. This is usually attributable to poor application, installation and maintenance. Use alternatives to plastic covering whenever possible.

- Refer to detail: NDET407 Plastic Sheeting Temporary, located at the end of this section.

Applications

- On disturbed areas that require cover for less than 30 days.
- On cut and fill slopes and stockpiles.
- Use when vegetation cannot be established to protect soil during rainy season on small areas only, for larger areas consider matting (Section 3.1.1.7 of this Chapter).
- Can be used alone or in conjunction with sediment fences, and/or diversion dikes.

Advantages

- Provides immediate, short-term erosion protection to slopes and disturbed areas.
- Fairly quick and easy to install.

Disadvantages

- Plastic sheeting may concentrate sunrays and burn the vegetation beneath it.
- Material generates high velocity runoff.
- Plastic breaks down quickly when exposed to ultraviolet radiation.
- Plastic, when it is not completely removed, can clog drainage system inlets and outlets.
- If not properly anchored, wind may transport plastic onto roadways and create traffic hazard.

Design Criteria

- Do not use plastic covering upslope of areas such as steep and/or unstable slopes that might be adversely affected by concentrated runoff.
- When possible, install an inceptor dike at the toe of the plastic to divert flows away from the plastic.
• Toe-in the top of the sheeting in a 6 in. x 6 in. trench backfilled with compacted native material.
• Install a gravel berm, riprap, or other suitable protection at the toe of slope in order to dissipate runoff velocity.
• Anchor the plastic using sandbags or other suitable tethered anchoring system spaced on a 10 ft. grid spacing.
• Overlap seams 1 ft. to 2 ft.; tape, roll and stake the seams and then weigh down the entire length.

**Maintenance**

• Replace torn sheets and repair open seams.
• Completely remove and replace plastic when it begins to deteriorate.
• Completely remove all plastic once it is no longer needed.
• Check anchoring system and repair or add anchors.

**Common Failures**

The most common problem with plastic sheeting is poor installation and maintenance. Other problems include improper plastic sheeting selection, failure to anchor plastic sheeting into place, and improper placement of suitable protection at the slope toe.
Figure 3-2 Plastic Sheeting
3.1.1.9 Dust Control

Preventative measures to minimize wind transport of soil, prevent traffic hazards and reduce sediment transported by wind and deposited in water resources.

Applications

- On construction routes and other disturbed areas subject to surface dust movement and where off-site damage may occur if dust is not controlled.

Advantages

- Reduces movement of soil to offsite areas.
- Increases visibility.

Disadvantages

- Over watering may cause erosion.
- Most methods require immediate reapplication if disturbed.

Design Criteria

- Dust control is covered in Sections 00280 and 00340 of the ODOT Specifications; the designer can provide project-specific dust control specifications for the contractor to apply. Measures include:
  - Seeding
  - Mulching
  - Matting
  - Water
  - Tackifier
  - Chemical Soil Stabilizers – see ODOT Qualified Product List. In some areas, these must be approved prior to use.
  - Installation construction entrances and stabilizing construction haul roads with crushed rock.
  - Schedule construction operations so that the least amount of project area is disturbed at one time.
  - Install temporary or permanent surface stabilization measures immediately after completing land grading.
Maintenance

- Maintain dust control measures through dry weather periods until all disturbed areas have been stabilized.
- Re-stabilize areas disturbed by contractor’s operations or other activities (wind, water, vandalism, etc.) within 2 days of disturbance.

Common Failures

The most common problem with this BMP is over watering; water may cause erosion when over applied and failure to re-apply dust control measures after initial application is disturbed.
3.2 Runoff Control Practices

The greater the volume and velocity of surface water runoff on construction sites, the more sediment and other pollutants are transported to streams, wetlands, and lakes. Diverting runoff away from exposed soils can greatly reduce the amount of soil eroded from a site. Decreasing runoff velocities reduces erosion and the amount of pollutants carried off-site.

Runoff controls divert runoff from exposed areas and reduce runoff velocities. Runoff control BMP’s that divert runoff from exposed areas include pipe slope drains and diversion swales. Runoff control BMP’s that reduce runoff velocities include check dams and sediment traps.

Best Management Practices

1. Construction Entrance
2. Tire Wash Facility
3. Construction Road/Parking Area Stabilization
4. Slope Drain
5. Outlet Protection
6. Surface Roughening
7. Check Dam
8. Interceptor Dike and Interceptor Swale
9. Grass-lined Swale
3.2.1.1 Construction Entrance

A stabilized aggregate pad, placed at construction site ingress/egress locations, that reduces the amount of sediment transported onto paved roads by vehicles or runoff.

- Refer to detail: RD1000 Construction Entrance Temporary, located at the end of this section.

Applications

- Wherever traffic will be leaving a construction site at a rate of at least 25 trips per day and traveling on paved roads or other paved areas located within 100 ft. of the site.
- The 1200-CA Permit (Schedule A. Subsection 8c) requires that each site shall have graveled, paved or constructed entrances, exits and parking areas to reduce the tracking of sediments onto public or private roads.
Advantages

- Reduces traffic hazards caused by debris on public roadways.
- Reduces sediment on roadways that can wash into the storm sewer system.

Disadvantages

- Only effective if erosion and sediment control employed elsewhere onsite.
- Only works if installed at every location where significant construction traffic leaves the site.
- Fills with sediment quickly and requires frequent maintenance and/or replacement of rock.

Design Criteria

- Minimum length:
  - 50 ft. for drainage areas having less than 1 acre of exposed soil.
  - 100 ft. for drainage areas having more than 1 acre of exposed soil
- Minimum width: 20 ft.
- Minimum Aggregate Depth: 8 in.
- Install at construction entrances before beginning grading.
- Whenever possible, construct the pad on a firm, compacted subgrade.
- Place a geotextile under the aggregate when fine sediment under the pad could “pump” up and into the pad.
- Do not install aggregate on paved surfaces.
- Install fencing as necessary to restrict construction vehicle traffic to the construction entrance.
- Include a tire wash if the entrance does not prove effective in retaining sediment onsite.

Maintenance

- Immediately sweep up and remove or stabilize onsite any sediment that is tracked onto pavement.
• If the sediment poses a threat to public safety and street sweeping proves ineffective, consider washing the street and collecting the water in a sediment pond or sump before it leaves the site.

• Add aggregate as needed to maintain the specified dimensions.

• Immediately remove any aggregate, which gets carried from the pad to the roadway.

• Maintain fencing installed as traffic control.

Common Failures

The most common problem with this BMP is the failure to include adequate depth and length of rock, failure to replace rock when voids are filled with sediment, and poor installation.
3.2.1.2 Tire Wash Facility

Two types of tire wash facilities are available depending on the severity of sediment tracking and the size of the project. Type 1 is a stabilized gravel pad similar to a stabilized construction entrance that is graded or otherwise constructed to collect wash water and convey it to a sediment trap, basin, or other suitable treatment facility. Type 2 consists of a shallow concrete lined basin partially filled with water, through which exiting vehicles drive.

- Refer to detail: Rd1060 Tire Wash Facility, located at the end of this section.

Applications

- Wherever traffic will be leaving a construction site and traveling on paved roads or other paved areas located within 100 ft. of the site. Where sediment removal on a stabilized construction entrance alone is inadequate to prevent tracking.

Advantages

- Reduces traffic hazards caused by debris on public roadways.
- Reduces sediment on roadways, which can wash into the storm sewer system.
- Type 1 is easy to construct and is relatively inexpensive.
- Type 2 is useful for high traffic volumes or large projects of long duration.

Disadvantages

- Only works if installed at every location where construction traffic leaves the site.
- Fills with sediment quickly and requires frequent maintenance.
- Requires a source of wash water.
- Requires a turnout or doublewide exit to avoid entering vehicles having to drive through wash area.
- Type 1 requires labor to wash the tires of all vehicles exiting the site.
- Type 2 is costly to construct.
- Type 2 will generate large volumes of sediment-laden water, requiring treatment elsewhere on site.

Design Criteria

- Type 1
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- Minimum length: 50 ft.
- Minimum width: 20 ft.
- Minimum Aggregate Depth: 8 in.
- Place geotextile under the aggregate when fine sediment under the pad could “pump” up and into the aggregate pad.
- Install fencing as necessary to restrict existing construction vehicle traffic to the tire wash.
- Grade the pad to drain to suitable collection and treatment facility.

Type 2

- Basin dimensions 40 ft. long by 10 ft. wide with sloping ingress and egress, and 50 ft. long impervious runout area at ingress, which drains into basin.
- Line bottom of basin with geotextile and 1 ft. of aggregate base coarse.
- Construct basin out of 1 ft. concrete with steel reinforcement.
- Provide water supply.
- Provide outlet for sediment-laden water discharge to treatment facility or provide pumps and tanks for water treatment.

Maintenance

Type 1

- Wash pad when sediment clogs aggregate.
- Add or re-grade aggregate as needed.
- Immediately remove any aggregate that gets carried from the pad to the roadway.
- Ensure that wash water drainage, collection and treatment system is functioning.

Type 2

- Remove/discharge wash water as needed.
- Remove accumulated sediment from bottom of basin.
- Ensure that wash water collection and treatment system is functioning.

Common Failures

The most common problem with this BMP is failure to use or maintain the facility.
Figure 3-4 Tire Wash Facility
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3.2.1.3 Construction Road/Parking Area Stabilization

Stabilized parking areas and onsite vehicle transportation routes reduce erosion caused by construction traffic or runoff.

Applications

- Permanent or temporary roads or parking areas used by construction traffic.
- The 1200-CA Permit requires that all unpaved roads located onsite shall be graveled. Other effective erosion and sediment control measures either on the road or down gradient may be used in place of gravel.

Advantages

- Reduces onsite erosion, dust, and offsite tracking of soils.
- Can speed and enhance efficiency of onsite work.

Disadvantages

- Temporarily stabilized construction roads can be expensive to install and maintain.

Design Criteria

- Road and parking area stabilization may not be necessary during the dry season (unless dust is a concern) or if the site is underlain by coarse-grained soils.
- ODOT usually leaves temporary road locations and construction criteria to the contractor’s discretion. The following is general information regarding road and parking stabilization:
  - Stabilize roads and parking areas immediately after initial grading.
  - Whenever possible, construction roads and parking areas should be placed on firm, compacted subgrade.
  - Temporary road gradients shouldn’t exceed percent.
  - Grade roadways to encourage sheet flow runoff to a roadside ditch or to a heavily vegetated area, except vegetated wetlands or landscaped areas, with a well-developed topsoil and at least 50 ft. of vegetation to treat the sheet flow runoff. Treating sheetflow runoff from temporary roads is preferred to using a sediment pond or trap.
• Immediately following grading, apply crushed rock, gravel base or crushed surfacing base course. A course of asphalt-treated base (ATB) or cement may also be used.

• Install fencing, if necessary, to limit vehicle access to stabilized roads and parking areas.

Maintenance

• Add crushed rock, gravel base, as required to maintain a stable driving surface and to stabilize any eroded areas.

Common Failures

The most common problem with this BMP is the failure to include adequate depth and length of rock, failure to maintain the rock depth for supporting heavy vehicles, and poor installation.
3.2.1.4 Temporary Slope Drain

Figure 3-5 Temporary Slope Drain

A pipe extending from the top to the bottom of a cut or fill and discharging into a stabilized watercourse, sediment trapping device or onto a stabilized area. The pipe slope drain carries concentrated runoff down steep slopes without causing gullies, erosion, or saturation of slide-prone soils.

- Refer to details: RD1045 Temporary Slope Drain, and Flume Application, located at the end of this section.

Applications

- On any slope where a large amount of flow must be collected and conveyed to avoid erosion.
- Areas where clean water should be kept separate from sediment-laden water.
• If a permanent measure is needed, it should be designed as part of the roadway drainage facilities.

Advantages

• Effective method of conveying water down steep slopes.
• Reduces or eliminates erosion.
• Easy installation and little maintenance.

Disadvantages

• Drain can be under-designed or incorrectly located.
• Area cleared for drain installation requires stabilization to prevent erosion occurring under the pipe.
• Outfall systems constructed of pipe segments, which are banded and/or gasketed together, could develop leaks causing erosion and failure of the system. Failures on erodible or steep slopes can cause downstream sedimentation or even mudflows.
• Adjustment of pipe lengths is necessary as cut and fill slopes are extended.

Design Criteria

• Size and space pipe slope drains to convey the peak flow from a 2-year design storm using the rational method found in ODOT Hydraulics Manual. Inlet control is a critical factor when sizing pipes. Estimate pipe diameter from the following table.

Table 3-2 Slope drain sizes

<table>
<thead>
<tr>
<th>Contributing Drainage Area (Maximum)</th>
<th>Pipe Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>½ acre</td>
<td>12 in.</td>
</tr>
<tr>
<td>1 ½ acre</td>
<td>18 in.</td>
</tr>
<tr>
<td>3 ½ acre</td>
<td>24 in.</td>
</tr>
</tbody>
</table>
• Consider using continuously fused, welded or flange-bolted mechanical joint systems with proper anchoring or HDPP (high-density polyethylene pipe) for outfalls on steep slopes.

• Show the entrance sloped toward the pipe inlet.

• At the inlet, show interceptor dikes that are at least 1 ft. higher at all points than the top of the inlet pipe and placed to direct water into the pipe.

• If the pipe slope drain will convey sediment-laden runoff, direct the runoff to a sediment retention facility.

• In the runoff is not from a disturbed area or is conveyed from a sediment trap or pond, convey the runoff to a stabilized discharge point.

• Energy Dissipation – Scour holes or riprap-lined stilling basins prevent most scour problems at outfalls (refer to Section 3.2.1.5 of this chapter).

• Consider site conditions to determine if a more complex energy dissipater may be required. Consult the ODOT Hydraulics Manual.

• The special provisions and typical notes should include the following installation directions:
  • Minimize disturbance during installation. In some circumstances this requires HDPP installed by hand.
  • Slope anchor details.
  • Immediately stabilize any area disturbed during installation or maintenance.
  • Securely connect the standard flared end section at the entrance to the slope drain, using watertight connecting bands.

• Pipe should be staked securely to prevent movement.
  • Securely fasten together the slope drain sections with gasketed watertight fittings, and securely anchor the sections into the soil.
  • Stabilize the area below the outlet following the energy dissipater.

Maintenance

• Adjust lengths of pipe when cut and fill slopes are extended.

• Regularly check the inlet and outlet points, especially following heavy rains. If there are signs of undercutting or water is going around the point of entry, reinforce the head wall with compacted earth or sand bags.
• Regularly check connection points for signs of erosion. Tighten fittings and repair erosion as needed.

• Immediately repair and install appropriate protection if erosion occurs at the outlet.

Common Failures

Common problems occur when connections are not watertight and stabilization along the slope at the inlet or outlet was incorrectly installed. Problems may also result from pipes that are undersized or incorrectly located for flow actually occurring onsite.
3.2.1.5 Outlet Protection

Outlet protection reduces the speed of concentrated flow, thereby preventing scour at conveyance outlets. By dissipating energy, outlet protection lowers the potential for downstream erosion. Outlet protection includes riprap-lined basins, concrete aprons, and settling basins. Outlet protection prevents scour at storm water outlets, and minimizes the potential for downstream erosion.

- Refer to details: RD1050 Temporary Scour Basin and NDET446 Sediment Control at Pipe Inlet/Outlet, located at the end of this section.

Applications

- At the outlets of ponds, pipe slope drains, ditches, or other conveyances, and where runoff is conveyed to a natural or man-made drainage feature such as a stream, wetland, lake, or ditch.

Advantages
• Many techniques are effective, relatively inexpensive, and easy to install.
• Removes sediment and reduces velocity.

Disadvantages

• Can be unsightly.
• May be difficult to remove sediment without removing and replacing the structure itself.
• Rock outlets with high velocity flows may require frequent maintenance.

Design Criteria

• Use the standard detail for outlet protection as a minimum. Consider site conditions to determine if a more complex energy dissipater may be required.
• Refer to the ODOT Hydraulics Manual for specific criteria.

Maintenance

• If there is scour at the outlet, protect the eroded area by increasing the size of the energy dissipater facility.
• Remove accumulated sediment frequently.

Common Failures

The most common problem with outlet protection is underdesign, failure to remove accumulated sediment, and rock that is too small and/or is not angular enough for the runoff velocities (river run or rounded rock is not adequate).
3.2.1.6 Surface Roughening

Figure 3-7 Surface Roughening

Leaving the slopes in a roughened condition after clearing or creating a rough soil surface with horizontal depressions or grooves will trap seed and reduce runoff velocity. Roughening can be accomplished by ‘track walking’ slopes with tracked equipment, by using a serrated wing blade attached to the side of a bulldozer, or by other agricultural equipment such as spike-toothed harrows.

Applications

- All slopes to be seeded.
- All slopes steeper than 1:3 having a vertical rise of 5 ft. or greater.
- On areas that can’t be seeded or are otherwise unfavorable for plant growth.
- As a temporary stabilization on bare soils exposed by construction activities.

Advantages

- Grooves trap seed.
- Increased vegetation establishment.
- Reduces runoff velocity, increases infiltration.
• Provides some instant protection from sheet erosion.
• Traps soil eroded from the slopes above.

Disadvantages

• Vegetated slopes cannot always be easily maintained by mowing.
• Tracking with a bulldozer/heavy equipment may compact the soil.
• May increase time to finish slopes.
• Should not be relied upon as sole means of erosion control.

Design Criteria

• Immediately seed and mulch roughened areas to obtain optimum seed germination and growth.
• Height of track grousers shall be 1.5 in. or greater.
• Tracking should be accomplished by driving equipment up and down slope to create horizontal depression/grooves.

Cut Slope Roughening

• Stair-step grade or groove the cut slopes that are steeper than 1:3.
• Use stair-step grading on all erodible material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with the same subsoil are particularly suited to stair-step grading.
• Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" in toward the vertical wall.
• Do not make individual vertical cuts more than 2 ft. high in soft materials or more than 3 ft. in rocky materials.
• Groove the slope using machinery to create a series of ridges and depressions that run across the slope, on the contour.

Fill Slope Roughening

• Place fill slopes with a gradient steeper than 1:3 in lifts not to exceed 8 in., and make sure each lift is properly compacted.
• Ensure that the face of the slope consists of loose, uncompacted fill 4 to 6 in. deep.
Use horizontal grooving along the contour or tracking to roughen the face of the slopes, if necessary.

Apply seed, fertilizer and straw mulch, and then track or punch the mulch with a bulldozer.

Do not blade or scrape the final slope face.

### Cuts, Fills, and Graded Areas

- Make mowed slopes no steeper than 1:3.
- Roughen these areas to shallow grooves by normal tilling, diskng, harrowing, or use a cultipacker-seeder. Make the final pass of any such tillage on the contour.
- Make grooves formed by such implements close together, 12 in. maximum spacing, and not less than 1 in. deep.
- Excessive roughness is undesirable where mowing is planned.

### Maintenance

- Periodically inspect the seeded slopes for rills and washes. Fill these areas slightly above the original grade, then re-seed and mulch as soon as possible.

### Common Failures

The most common problem with surface roughening can occur from excessive soil compaction, inadequate vegetation establishment, high velocity runoff causing rill or gully erosion, and tracking in wrong direction.
3.2.1.7 Check Dam

Small dams constructed across a swale or ditch to reduce velocities of concentrated flows, thereby reducing erosion in the swale or ditch. Check dams not only prevent gully erosion from occurring before vegetation is established, but also allow a significant amount of suspended sediment to settle out.

- Check Dams can be constructed from a variety of materials.
  - Type 1 – Aggregate: Aggregate material only.
  - Type 2 – Straw Bales: Entrenched straw bales staked to the ground with an aggregate weir.
  - Type 3 – Bio-filter Bags: Bio-filter bags staked to the ground with or without an aggregate weir.
  - Type 4 – Sand Bags: Sand bags with or without an aggregate weir.
• Type 5 – Pre-fabricated Check Dam System: A manufactured system specifically designed to slow water so that suspended particles settle out. Field-fabricated systems are not allowed.

• Refer to details RD1005 - Check Dam located at the end of this section.

Applications

• In temporary or permanent channels not yet vegetated when installing channel lining is not feasible.
• In small open channels that drain 10 acres or less.
• Do not place check dams in streams or rivers.

Advantages

• Prevent erosion and promote settling of sediment in runoff.
• When carefully located and constructed, check dams may function as permanent installations.
• Inexpensive and easy to install.
• May aerate water as it passes the check dams.
• Aggregate can be spread into ditch and used as a channel lining when the check dam is no longer necessary.
• Some pre-fabricated check dams are reusable.

Disadvantages

• Measures may be unsightly.
• Removal may be costly for some types of check dams.
• Suitable only for a limited drainage area.
• May reduce hydraulic capacity of the channel.
• May create turbulence downstream, causing erosion of the channel banks.
• Ponded water may kill grass in grass-lined channels.
• May be an obstruction to construction equipment.

Design Criteria

• Space check dams according to the following table.
CHAPTER 3: EROSION & SEDIMENT CONTROL MEASURES & BMP’s

Table 3-3 Spacing for check dams

<table>
<thead>
<tr>
<th>Ditch Grade</th>
<th>Minimum Weir Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 in.</td>
</tr>
<tr>
<td>6%</td>
<td>**</td>
</tr>
<tr>
<td>5%</td>
<td>**</td>
</tr>
<tr>
<td>4%</td>
<td>**</td>
</tr>
<tr>
<td>3%</td>
<td>17 ft. sp.</td>
</tr>
<tr>
<td>2%</td>
<td>25 ft.sp.</td>
</tr>
</tbody>
</table>

** Not Allowed

- Construct rock check dams of rock or aggregate sized to stay in place given the expected design flow velocity, typically 3 in. to 6 in. diameter. Place rock or aggregate by hand or by mechanical means rather than dumping the rock.
- Completely cross the ditch or swale width and ensure the center of the dam is 6 in. lower than the upper ends.
- Remove check dams from grass-lined ditches and swales once the grass is established.
- Seed and mulch the area where the check dams were immediately following removal.

**Maintenance**

- Periodically inspect check dams for performance and sediment accumulation.
- Remove sediment once it reaches one-third the depth of the rock weir.
- Replace aggregate weir when filtering capacity is reduced by one-half.

**Common Failures**

The most common problem with check dam performance results from incorrect spacing and installation (inadequate rock size or angularity, or the low point of weir not centered), inadequate sediment removal, undercutting, scouring around the sides of the weir and not maintaining check dam integrity.
3.2.1.8 Diversion Dike/Diversion Swale

A ridge of compacted soil or a lined swale with vegetative lining located at the top, base or somewhere along a sloping disturbed area. The dike or swale intercepts and conveys smaller flows along low-gradient drainage ways to larger conveyances such as ditches or pipe slope drains or to a stabilized outlet. Dikes and swales may be used alone or in combination with each other.

- Refer to details: NDET434 Diversion Dike/Swale (Type 1), NDET435 Diversion Dike/Swale (Type 2), NDET436 Diversion Dike/Swale (Type 3), NDET437 Diversion Dike/Swale (Type 4), NDET438 Diversion Dike/Swale (Type 5), NDET439 Diversion Dike/Swale (Type 6), NDET440 Diversion Dike/Swale (Type 7), located at the end of this section.

**Applications**

- Install above a disturbed slope to intercept runoff and reduce runoff volume on the disturbed area.
- Install below a disturbed area to divert runoff to a sediment-trapping device.
• Install across a disturbed slope to reduce runoff velocity.

Advantages

• Provides a practical, inexpensive method to divert runoff.
• Can handle flows from large drainage areas.
• Use onsite material and equipment to construct.

Disadvantages

• If improperly constructed, can contribute to erosion caused by concentrating the flow.
• High flow velocity can damage vegetation.

Design Criteria

• Refer to Table 3-4 Dike Design Criteria and Table 3-5 Swale Design Criteria.
• Install the dike and/or swale horizontally at intervals across a disturbed slope.
• Space horizontal interceptor dikes and swales according to Tables 3-4 and 3-5.
• For slopes of erodible soils, steeper than 1:2 with more than 10 ft. of vertical relief, construct benches or shorten distance between dikes and swales.
• If the dike or swale intercepts runoff from disturbed areas, discharge the runoff to a stable conveyance that routes the runoff to a sediment trap or basin.
• If the dike or swale intercepts runoff that originates from undisturbed areas, discharge the runoff to a stable conveyance that will route the runoff downslope of any disturbed areas and release the water at a stabilized outlet.
• Pipe collected flow under roads.
### Table 3-4 Diversion dike design criteria

| Top Width | 24 in. minimum |
| Height | 20 in. minimum  
Measured from upslope toe and at a 90% standard proctor compaction ASTM D698. |
| Side Slopes | 1:2 or flatter |
| Grade | Topography Dependent |
| Dike Grade | Between 0.5-1% |
| Slope of Disturbed Area vs. Horizontal Spacing |  
| <5% | 300 ft. |
| 5-10% | 200 ft. |
| 10-25% | 100 ft. |
| 25-50% | 50 ft. |
| Slope Stabilization |  
| <5%  
Seed and mulch within 5 days of dike of disturbed construction area. |
| 5-40%  
Stabilize immediately using either sod or riprap. |
| Outlet | Upslope side of dike provides positive drainage to the outlet.  
Provide energy dissipation as necessary to prevent erosion.  
Release sediment-laden runoff to a sediment trapping facility. |
### Table 3-5 Diversion swale design criteria

| Bottom Width | 24 in. minimum. The bottom should be level across the swale. |
| Depth | 12 in. |
| Side Slopes | 1:2 or flatter |
| Grade | Maximum 5% with positive drainage to a suitable outlet. |
| Slope of Disturbed Area vs. Horizontal Spacing | Slope Stabilization |
| 3 – 5% | Temporarily seed or line with riprap 12 in. thick and press into the bank approximately 3 in. to 4 in. |
| 5 – 10% | |
| 10 – 25% | |
| 25 – 50% | |
| Outlet | Level spreader or riprap to stabilize outlet/sedimentation pond. |

### Table 3-6 Diversion swale spacing design criteria

| Slope | Swale Spacing |
| 3 – 5% | 300 ft. |
| 5 – 10% | 200 ft. |
| 10 – 25% | 100 ft. |
| 25 – 50% | 50 ft. |

### Maintenance

- Immediately repair damage resulting from runoff or construction activity.
- If the dike or swale regularly overflows, increase the capacity and/or frequency of the dikes/swales.
- Inspect and repair as necessary after every major storm.
- Minimize construction traffic over temporary dikes and swales.
- Clean out clogged pipes (as part of the swale system) under roads.

### Common Failures

The most common problems with diversion dikes and swales result from inadequate stabilization causing erosion along the base of a dike or the bottom of a swale, and from undersized construction for flows actually occurring onsite.
3.2.1.9 Grass-lined Swale

A channel with vegetative lining constructed to convey and dispose of concentrated surface runoff without damage from erosion, deposition, or flooding.

Applications

- Areas where concentrated runoff will cause damage from erosion or flooding.
- In channels where a vegetative lining can provide sufficient stability for the channel cross section and grade.
- On projects where slopes are generally less than 5%.
- Where space is available for relatively large cross section.

Advantages

- Does not generate high velocity runoff and offers temporary slope protection, which is superior to plastic sheeting.
- Capture a great deal of sediment due to the filtering effect of vegetation.
- Usually easy to install.

Disadvantages

- May require temporary irrigation to establish vegetation.
- Cannot be used until vegetation is established.

Design Criteria

- As a minimum, grass-lined channels should carry a peak runoff from a 10-year storm even without eroding. Where flood hazards exist, increase the capacity according to the potential damage. The allowable design velocity for grassed-lined channels is based on soil conditions, type of vegetation, and the method of establishment. The channel shape may be parabolic, trapezoidal, or v-shaped, depending on the need and site conditions. Small check dams or flow spreaders may be necessary to minimize channelization. See Section 3.1.1.3 – Seeding for details on vegetation establishment. Refer to ODOT Hydraulics Manual for additional design information.

Maintenance

- During the initial establishment, grass-lined channels should be repaired and grass re-established if necessary.
After grass has become established, the channel should be checked periodically to determine if the channel is withstanding flow velocities without damage.

Check the channel for debris, scour, or erosion and immediately make repairs. It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes and make repairs immediately.

Remove all significant sediment accumulations to maintain the designed carrying capacity.

Keep the grass in a healthy, vigorous condition at all times, since it is the primary erosion protection for the channel.

Permanent grassed waterways should be seasonally maintained by mowing and/or irrigating, depending on the type of vegetation selected.

Newly seeded areas need to be inspected frequently to ensure the grass is growing.

If the seeded area is damaged due to runoff, additional storm water measures such as check dams or matting may be needed.

Spot seeding can be done on small areas to fill in bare spots where grass did not grow properly.

Common Failures

Improper seed selection and site preparation are the most common problems with grass lined swales. Major reconfiguration of the drainage system often results in increased maintenance and risk of failure. Allowing water to flow through the facility prior to adequate vegetation establishment may also increase the risk of failure.
3.3 Sediment Control Practices

 Once soil erosion occurs, sediment trapping or removal techniques can reduce the amount of sediment and associated pollutants that leave the site, thus protecting nearby streams, wetlands, and lakes. Sediment controls are usually placed around the perimeter of a disturbed area and where concentrated water leaves the site. Sediment control BMP’s should be in place before land clearing and grading begins. It is important to note that sediment controls, if poorly maintained, can become sources of sediment and other pollutants during larger storms.

 Best Management Practices
  1. Sediment Barrier
     a. Straw Bales
     b. Biofilter Bags
     c. Straw Rolls (Wattles)
     d. Sand Bags
     e. Brush Barrier
     f. Filter Berm
     g. Pre-fabricated Barrier System
  2. Sediment Fence
  3. Inlet Protection
  4. Sediment Trap
  5. Sediment Basin
3.3.1.1 Sediment Barrier

Sediment barriers can be constructed from a variety of materials. A listing of barrier types according to ODOT specifications and drawings follows:

- Type 1 – Straw Bales: Entrenched straw bales staked to the ground.
- Type 2 – Biofilter Bags: Entrenched biofilter bags staked to the ground.
- Type 3 – Straw Rolls (Wattles): Entrenched straw rolls staked to the ground.
- Type 4 – Sand bags: Bags filled with sand or gravel.
- Type 5 – Brush Barrier: Entrenched and mounded woody materials or strippings.
- Type 6 – Filter Berm: Entrenched aggregate, mounded.
- Type 7 – Pre-fabricated Barrier System: A manufactured system specifically designed for temporary erosion control applications. Field fabricated systems are not allowed.

Table 3-7 Barrier spacing for general application

<table>
<thead>
<tr>
<th>% SLOPE</th>
<th>SLOPE (V:H)</th>
<th>MAXIMUM SPACING ON SLOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10%</td>
<td>&lt; 1:10</td>
<td>300 ft.</td>
</tr>
<tr>
<td>10 &gt; % ≥ 15</td>
<td>1:10 &gt; X ≥ 1:7.5</td>
<td>150 ft.</td>
</tr>
<tr>
<td>15 &gt; % ≥ 20</td>
<td>1:7.5 &gt; X ≥ 1:5</td>
<td>100 ft.</td>
</tr>
<tr>
<td>20 &gt; % ≥ 30</td>
<td>1:5 &gt; X ≥ 1:3</td>
<td>50 ft.</td>
</tr>
<tr>
<td>&gt;30%</td>
<td>&gt; 1:3</td>
<td>25 ft.</td>
</tr>
</tbody>
</table>
3.3.1.1.1 Straw Bale – Sediment Barrier Type 1

Figure 3-10 Straw Bale – Sediment Barrier Type 1
A temporary sediment barrier consisting of a row of entrenched and anchored straw bales with check dams at low points. Straw bale sediment barriers trap small amounts of sediment by decreasing sheet flow and low-moderate channel flow velocities. Water is channeled through the aggregate weir, and a sediment fence is used to trap sediment that has moved through the weir.

- Refer to the detail: RD1025 Sediment Barrier (Type 1), located at the end of this section.

Applications
- Below areas subject to sheet and rill erosion.
- 1:2 slopes or flatter.
- Swales or ditches with maximum 2 acres drainage contributing.

Advantages
- Relatively inexpensive method of sediment control.

Disadvantages
- Effective approximately 3 months.
- Misuse or incorrect installation can contribute to sediment loading.
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- Difficult to tell if bales are properly installed.
- Improper applications; installations in drainageways and swales where high water volumes and velocities, destroys effectiveness.
- Improper placement and/or installation can allow undercutting and end-flow.
- Inadequate maintenance can greatly reduce effectiveness of sediment removal.
- Heavy and hard to move when wet.

Design Criteria

- Contributing drainage should be less than ¾ acres per 330 ft. of bale length.
- Check dams should be used when the barrier crosses a ditch, swale, or low point in the barrier system and the system requires relief from water impoundment, typically every 100 ft. maximum.
- Rock and/or filter fabric placed immediately downstream of the rock spillway will dissipate the energy of the falling water and reduce downstream erosion.
- Place bales in a single row, lengthwise, oriented perpendicular to the flow, and with ends of adjacent bales tightly abutting one another.
- Each bale shall be embedded in the soil a minimum of 4 in. Use straw, rocks, or filter fabric to fill any gaps between the bales and tamp the backfill material to prevent erosion under or around the bales.
- If the bales are wire bound, they should be oriented so the bindings are around the sides rather than along the top and bottom. Wire bindings that are placed in contact with the soil soon disintegrate and may allow the bale to fall apart.
- The bales shall be securely anchored in place by two wooden stakes or rebar driven through the bales. The first stake in each bale shall be driven toward the previously laid bale to force the bales tightly together. Drive the stakes at least 20 in. into the ground.
- The straw bales shall not be moldy, caked, decayed or of otherwise low quality. Submit verification from the supplier that the straw is free of noxious weeds. Acceptable documentation submitted shall show either (1) that the straw is from an “Oregon Certified Seed” field or (2) the seed lab results of the seed harvested from the straw meet minimum Oregon certified seed quality for weed seed content (refer to Appendix D). The minimum requirements of Oregon Certified Seed are as published in the current year’s Oregon Certified Seed Handbook. The Oregon Certified Seed Handbook and lists of farms with certified fields that sell
to the public are available from County Extension Offices or Oregon State University.

**Maintenance**

- The barriers shall be inspected periodically during the winter and after each significant storm. Repairs and/or replacement shall be made promptly.
- Sediment shall be removed when it has reached 1/3 the height of the barrier.
- Replace deteriorated bales.

**Common Failures**

The most common problems with this BMP include straw bales not placed in excavated trench, installation where flow is excessive, undercutting around bales, and poor maintenance such as ignoring degraded bales, ties, gaps between bales, or not adding check dams at release points.
3.3.1.1.2 Biofilter Bags – Sediment Barrier Type 2

Biofilter bags are manufactured from 100% recycled wood-product waste placed in plastic mesh bags. They are typically 30 in. long by 18 in. wide and weigh approximately 45 lb.

- Refer to detail: RD1030 Sediment Barrier, (Type 2 & 4) Biofilter or Sandbags.

Applications

- To capture and retain sediment on slopes.
- To capture sediment around drain inlets (see Inlet Protection, Type 4).
- To capture sediment and reduce water velocity on paved streets.
- To capture sediment and reduce water velocity in unlined and lined channels, swales or ditches.
- Can be staked in developing rills or gullies to capture sediment and reduce water velocity.

Advantages

- Relatively low cost.
- Can be used in place of sediment fences or straw bales on slopes.
- Wood-product can be recycled or used onsite when no longer needed.
- Installation is simple, can be done by hand.
- Bags are easy to move, replace and reuse on paved surfaces.
- Are good short-term solution in situations where concentrated flows are causing erosion (can be stuffed or staked in developing rills).

Disadvantages

- Generally effective for only a few months.
- Can be easily damaged by construction equipment or by traffic in paved areas.
- Can become clogged with sediment and cease to filter runoff.
- If not properly staked, will fail on slope applications.
- If improperly installed can allow undercutting or end-flow.
- Not effective where water velocities or volumes are high.
- Lightweight results in higher buoyancy if not properly installed.
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• Low sediment retention capacity may require frequent maintenance.

Design Criteria

• On slope applications should be installed on contour.
• See table for slope spacing at the beginning of Section 3.3.1.1.
• Ends of bags must be tightly abutted and overlapped to direct flow away from bag joints.
• Install two stakes per bag.
• Stakes not needed in paved areas.

Maintenance

• Inspect biofilter bag installations after storms. Check that stakes are secure and ends of bags are tightly abutted. Check that undercutting or end-flow is not occurring.
• Check that flow is not becoming channeled behind bags (parallel to row of bags).
• Inspect plastic mesh bags for tears.
• Remove sediment when 1/3 height of bag has accumulated.
• Replace damaged bags as needed.

Common Failures

Failures most commonly result from biofilter bags not being tightly abutted together, which allows flow between or under the bags and causes rilling. This also occurs when bags are not properly staked. Another common failure is caused when the bags are not installed on contour and water flow becomes channeled behind the bags.
3-11 Biofilter Bags
3.3.1.1.3 Straw Rolls (Wattles) – Sediment Barrier Type 3

Figure 3-12 Straw Rolls (Wattles) – Sediment Barrier Type 3

Straw rolls are manufactured from straw that is wrapped in tubular plastic netting. They are approximately 8 in. in diameter by 25 ft. to 30 ft. long. Straw rolls are placed in shallow trenches and staked along the contour of newly constructed or disturbed slopes.

- Refer to detail: RD 1035 Sediment Barrier (Type 3), located at the end of this section.

Applications

- To capture and retain sediment on slopes.
- To temporarily stabilize slopes by reducing soil creep and sheet and rill erosion until permanent vegetation is established.
- Installed on unvegetated slope areas above concrete v-ditches.
- To control erosion from entering paved areas; installed behind sidewalk or curb.

Advantages

- They can often replace sediment fences or straw bales on steep slopes.
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- Rolls are a short-term solution to help establish native vegetation.
- Rolls store moisture for vegetation planted immediately upslope.
- May be left in place to biodegrade and/or photodegrade.
- Straw becomes incorporated into the soil with time, adding organic material to the soil and retaining moisture for vegetation.
- Reduces runoff velocity.
- Requires minimal ground disturbance to install.
- Lightweight and easy to install.

**Disadvantages**

- Rolls only function for one or two seasons.
- If not installed properly with sufficient trench, rolls may fail during the first rain event.
- Straw rolls may require maintenance to ensure that the stakes are holding and the rolls are still in contact with the soil. This is especially true on steep slopes in sandy soil.
- Low sediment retaining capacity may require frequent maintenance.

**Design Criteria**

- Prepare the slope before the wattle installation is started.
- Rills and shallow gullies should be smoothed as work progresses.
- Dig small trenches across the slope on contour to place rolls in. Space trenches in accordance with the table at beginning of Section 3.3.1.1. The trench should be deep enough to accommodate half the thickness of the roll. When the soil is loose and uncompacted, the trench should be deep enough to bury the roll 2/3 of its thickness because the surrounding ground may settle.
- Start building trenches and install rolls from the bottom of the slope and work up.
- It is critical that rolls are installed perpendicular to water movement, parallel to the slope contour.
- Lay the roll along the trenches fitting it snugly against the soil. Make sure no gaps exist between the soil and the straw wattle.
- Use a straight bar to drive holes through the wattle and into the soil for the willow or wooden stakes.
• Drive the stake through prepared hole into soil. Drive a minimum of 12 in. into undisturbed material.

• Install stakes at least every 4 ft. apart through the wattle. Additional stakes may be driven on the downslope side of the trenches on highly erosive or very steep slopes.

**Maintenance**

• Inspect the straw rolls and the slopes after significant storms. Make sure the rolls are in contact with the soil.

• Repair any rills or gullies promptly.

• Re-seed or replant vegetation if necessary until the slope is stabilized.

**Common Failures**

Failures most commonly result from straw rolls not being tightly abutted together, allowing water to easily pass between the rolls, resulting in rilling. Water can also scour beneath the rolls if they are not properly entrenched.
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3.3.1.1.4 Sand Bags – Sediment Barrier Type 4

Sandbags are manufactured from durable, weather resistant tightly woven material sufficient to prohibit leakage of the filler material. The bags should measure 24 in. by 12 in. by 6 in. and be filled with firmly packed sand weighing at least 75 lb.

- Refer to detail: RD1030 Sediment Barrier, (Type 2 & 4) Biofilter or Sandbags.

Applications

- To capture and retain sediment on slopes.
- To capture sediment around drain inlets.
- To capture sediment and reduce water velocity on paved streets.
- To capture sediment and reduce water velocity in unlined and lined channels swales or ditches.
- Can be placed in developing rills or gullies to capture sediment and reduce water velocity.
- Can be placed in streams for isolating work areas.

Advantages

- Relatively low cost.
- Installation is simple, can be done by hand.
- Bags are easy to move, replace and reuse on paved surfaces.
- Are good short-term solution in situations where concentrated flows are causing erosion (can be stuffed or staked in developing rills).
- Can be used to divert and slow velocity of small flows.
- Can be used in concrete lined ditches capture sediment and reduce water velocity.

Disadvantages

- Generally effective for only a few months.
- Can be easily damaged by construction equipment on paved surfaces.
- Can contribute sediment to runoff if bags rupture.
- Cannot be staked and are not appropriate on steep slope applications.
- Not effective in steep swales, channels or ditches.
- If improperly installed can allow undercutting or end-flow.
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- Not effective where water velocities or volumes are high, can get washed away.

Design Criteria

- On slope applications should be installed on contour.
- See table at beginning of Section 3.3.1.1 for spacing on slopes.
- Ends of bags must be tightly abutted and overlapped to direct flow away from bag joints.

Maintenance

- Inspect sandbag installations after storms. Check that ends of bags are tightly abutted. Check that undercutting or end-flow is not occurring.
- Check that flow is not becoming channeled behind bags (parallel to row of bags).
- Remove sediment accumulated behind bags when sediment reaches one-third of the barrier height.
- Replace damaged bags as needed.

Common Failures

Failures most commonly result from sandbags not being tightly abutted together, which allows flow between or under the bags causing rilling. Another common failure is caused when the bags are not installed on contour and water flow becomes channeled behind the bags. Sandbags can also be dislodged when placed in high velocity flows.
3-13 Sand Bags
3.3.1.1.5 Brush Barrier – Sediment Barrier Type 5

A brush barrier is a temporary sediment barrier constructed at the perimeter of a disturbed area using materials available from clearing and grubbing of the site. The barrier intercepts and retains sediments that are washed from disturbed areas.

- Refer to detail: NDET409 Sediment Barrier (Type 5), located at the end of this section.

Applications

- On gently sloped areas.
- Disturbed areas draining less than ¼ acre, where runoff is primarily sheet and rill erosion.
- Residual materials are available onsite for barrier construction.

Advantages

- Saves erosion control costs by utilizing materials onsite.
- Reduces velocity and quantity of runoff.

Disadvantages

- Only effective if erosion and sediment are controlled elsewhere onsite.
- Suitable for only a limited drainage area.
- Has limited life span.

Design Criteria

- The height should be between 45 in. – 5 ft.
- See table at beginning of Section 3.3.1.1 for barrier spacing.
- The width at the base should be between 5 ft. – 15 ft.
- Filter fabric anchored over the barrier can enhance the filtration capacity and effectiveness of the barrier.
- Fill barrier with 6 in. maximum diameter woody debris or topsoil strippings.

Maintenance

- Generally require little maintenance.
• Heavy buildup of sediment on the upslope side of the barrier should be removed when sediment reaches one-third of the barrier height.

• The barrier fabric should be inspected occasionally for tears and repaired as necessary.

• When the barrier is no longer needed, the fabric can be removed to allow natural establishment of vegetation within the barrier.

Common Failures

Failures most commonly result from loose construction, allowing water to easily pass through the vegetation. Improperly installed filter fabric can also be a problem.
3.3.1.1.6 Filter Berm – Sediment Barrier Type 6

Retains sediment in gravel or crushed rock berm.

- Refer to detail: NDET410 Sediment Barrier (Type 6), located at the end of this section.

Applications

- In traffic areas on construction sites.
- On gently sloped areas.
- Along roadway edges to dissipate sheet flow.

Advantages

- Very efficient method for sediment removal.
- Reduces runoff velocity.

Disadvantages

- More expensive than some other measures because it requires clean gravel or crushed rock rather than materials found onsite.
• Clogging from mud and soil may make maintenance difficult.
• Has a limited life span.

Design Criteria

• Use 2 in. maximum washed and well-graded gravel or crushed rock with less than 5% fines.
• Berm Dimensions:
  • Height and side slopes: 1 ft. high with 1:3 side slopes.
  • Length: 6 ft. 8 in. per 0.03 m³/s flow, based on the peak flow for the 10-year storm.
  • See table at the beginning of Section 3.3.1.1 for barrier spacing.

Maintenance

• Remove and replace gravel when filtering capacity is reduced by half to maintain performance.
• Removed sediment accumulation when it reaches one-third of the barrier height.
3.3.1.1.7 Pre-Fabricated Barrier System – Sediment Barrier Type 7

Pre-fabricated barrier systems typically consist of a triangular shaped dike, usually made of foam or other flexible, lightweight material. The dike is wrapped in geotextile, which extends from the bottom of the dike to provide aprons on the upslope and downslope sides of the dike. The dike is anchored by trenching and stapling the aprons. Barrier materials, section lengths and weights vary among manufacturers.

- Refer to detail: NDET 433 Pre-fabricated Sediment Barrier, located at the end of this section.

Applications

- To capture and retain sediment on slopes.
- To capture and direct water to a suitable conveyance or exit point, such as at the tops of slopes or at intermediate locations on cut-fill slopes.
• Diversion dike.
• Check dam.

Advantages

• Lightweight.
• Installation is relatively simple.
• Can be used to divert and slow velocities of small flows.
• Conforms to curves and rough terrain.
• Reusable.

Disadvantages

• Effective for unknown period of time (depends on material properties).
• Can be easily damaged by construction equipment.
• Not effective in steep swales, channels or ditches.
• If improperly installed can allow undercutting or end-flow.
• Not effective where water velocities or volumes are high.
• Installation must be done exactly as specified by manufacturer.
• May be difficult to install on steep slopes, trenching required.
• Can be easily damaged during sediment removal operations.

Design Criteria

• On slope applications should be installed on contour.
• Install in accordance with plans, special provisions and manufacturer’s recommendations.
• See table at the beginning of Section 3.3.1.1 for spacing of slopes.

Maintenance

• Inspect pre-fabricated barriers after storms. Check that undercutting or end-flow is not occurring.
• Check that barrier is not otherwise damaged.
• Check that aprons are securely anchored.
• Check that flow is not becoming channeled behind barrier (parallel to barrier).
Common Failures

Failures most commonly result from improper installation (not anchoring the aprons correctly) which allows flow under or around the barrier.
3.3.1.2 Sediment Fence

Temporary sediment trap consisting of an entrenched geotextile stretched across and attached to supporting posts. Sediment fences are adequate to treat flow depths consistent with overland or sheet flow. Supported sediment fences consist of geotextile backed with wire mesh of equivalent strength supported by metal posts. Unsupported sediment fence does not have mesh backing and may be supported by wood stakes. Refer to Section 00280 for more specific information.

- Refer to detail: RD1040 Sediment Fence (Supported and Unsupported) located at the end of this section.

Applications

- Sediment fences can be used as the sole treatment when the area draining to the fence is less than ¾ acre per 300 ft. of sediment fence and the average slope (perpendicular to the fence) is 1:3 or flatter. Otherwise, use sediment fence in conjunction with other measures.
• Slopes flatter than 50%.
• Install downslope of disturbed areas and prior to upslope clearing and grading.
• Do not use sediment fences in v-ditches or streams.
• Around inlets in non-traffic areas.

Advantages

• Reduces runoff velocity.
• Requires minimal ground disturbance to install.
• Relatively inexpensive.

Disadvantages

• Applicable to small drainage areas and overland flow; not applicable to concentrated flows.
• Incorrect geotextile or installation decreases sediment fence performance.
• Requires frequent maintenance and inspection.

Design Criteria

• The height of a sediment fence should not exceed 3 ft. Storage height and ponding height should never exceed 20 in.
• Show sediment fence along ground contours according to the flow lengths given on the typical details.
• When sediment fence approaches a ditch or swale, end the fence on each side of the ditch or swale and install a check dam in the ditch or swale.
• If possible, the filter fabric should be cut from a continuous roll to avoid the use of joints. When joints are necessary, filter cloth should be spliced only at a support post, with a minimum 4 ft. overlap and both ends securely fastened to the post, or join the two end stakes by wrapping the two ends at least one and one-half turns and driving the joined stakes into the ground together.
• Posts should be spaced a maximum of 6 ft. apart and driven securely into the ground (minimum of 6 in.).
• Turn the ends of the sediment fence uphill.
• A trench should be excavated approximately 6 in. deep along the line of the posts and upslope from the barrier.
• When supported sediment fence is used, a wire mesh support shall be fastened securely to the upslope side of the posts using heavy-duty wire stables, tie wires, and hog rings.

• The standard-strength filter fabric shall be stapled or wired to the fence, and 6 in. of the fabric should extend into the trench.

• The trench should be backfilled and the soil compacted over the toe of the filter fabric. Sediment fences placed at the toe of a slope should be set at least 6 ft. from the toe in order to increase ponding volume.

Maintenance

• Inspect fences weekly and after each storm event. Immediately repair any damage.

• Remove accumulated sediment once it has reached 1/3 the height of the sediment fence or 1 ft. maximum.

• Inspect for channel formation parallel to the fence, which indicates the geotextile is acting as a flow barrier.

• Replace deteriorated or clogged geotextile.

• Check for undercutting or piping under fence.

Common Failures

Common problems with sediment fence are inadequate installation; fence posts are not driven deep enough or fabric is not trenched in at least 6 in.; poor compaction of backfill material in trench. Problems also arise when sediment fence is installed in areas where concentrated flow occurs or when they are not installed along contour.
3.3.1.3 Inlet Protection

Prevents coarse sediment from entering storm drainage systems by filtering runoff and retaining sediment before it reaches a drainage inlet or storm sewer system. There are many options and variations of inlet protection available.

- Refer to detail: RD1010 Inlet Protection (Type 1, 2, & 3).
- Refer to detail: RD1015 Inlet Protection (Type 4) Biobag.
- Refer to detail: RD1020 Inlet Protection (Type 5) Masonry Aggregate.
- Refer to detail: NDET425 Inlet Protection (Type 6) Sod, located at the end of this section.

Figure 3-17 Inlet Protection - Geotextile/Wire Mesh/Aggregate (Type 2)
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Figure 3-18 Inlet Protection - Geotextile/Wire Mesh/Aggregate (Type 2)

Figure 3-19 Inlet Protection – Biofilter Bags around Area Drain (Type 4)
Figure 3-20 Inlet Protection – Biofilter Bags around Catch Basin (Type 4)

Figure 3-21 Inlet Protection – Masonry/Aggregate (Type 5)
Applications

- At inlets which are ready for use before completion of final stabilization and that receive runoff from drainage areas less than 1 acre in size.
- At storm drain inlets downslope and within 500 ft. of a disturbed area or construction entrance.
- As a secondary measure downstream from erosion prevention and sediment trapping measures.

Advantages

- Prevents sediment from entering the storm drain system.
- Reduces amount of sediment leaving the site.

Disadvantages

- May result in ponding of water above the catch basin.
- Sediment removal may be difficult under high-flow conditions.
- May result in a traffic hazard.
- Short-circuiting of flow may occur if not properly installed.
- Useful only for low flows having low sediment loading.
- Improper installation, maintenance or removal may introduce sediment into the storm drain system.

Design Criteria

- Place inlet protection in areas where water can pond, and where ponding will not have adverse impacts.
- Inlet protection must allow for overflow in a severe storm event.
- Inlet protection types include:
  - Type 1 Sediment Fence
  - Type 2 Geotextile with Aggregate Filter
  - Type 3 Catch Basin Insert
  - Type 4 Biofilter Bags
  - Type 5 Masonry Aggregate
  - Type 6 Sod
Table 3-8 Inlet protection selection based on site conditions

<table>
<thead>
<tr>
<th>Site Conditions</th>
<th>Inlet Protection Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Area Drain, Soil</td>
<td>Y</td>
</tr>
<tr>
<td>Area Drain, Pavement</td>
<td>N</td>
</tr>
<tr>
<td>Ditch Inlet, Soil</td>
<td>Y</td>
</tr>
<tr>
<td>Ditch Inlet, Pavement</td>
<td>N</td>
</tr>
<tr>
<td>Grate Inlet Along Curb, Soil</td>
<td>N</td>
</tr>
<tr>
<td>Grate Inlet Along Curb, Pavement</td>
<td>N</td>
</tr>
<tr>
<td>Curb Opening Inlet, Soil</td>
<td>N</td>
</tr>
<tr>
<td>Curb Opening Inlet, Pavement</td>
<td>N</td>
</tr>
</tbody>
</table>

Maintenance

- Inspect and clean inlet protection during and after each significant storm and remove sediment from behind structure after every storm.
- If the aggregate becomes clogged with sediment, it must be carefully removed from the inlet and either cleaned or replaced.
- Assess the impacts of allowing water to pond at the inlet and provide an overflow weir or some other type of relief as needed.
- Consider the effect of placing obstructions at inlets on grade may have on their efficiency. Refer to the ODOT Hydraulics Manual or contact the Geo-Environmental Unit when placing protection at several inlets on grade along a roadway section.
- When possible, include a sediment sump 12 in. to 24 in. deep with 1:4 side slopes.
- Do not use water to remove sediment.
- Remove sediment accumulated on or around the protection as needed to maintain intended functions.
- Repair or replace materials as needed to ensure proper functioning.
Common Failures

The most common problem with this BMP include torn geotextile material, improperly sealed gaps in the inlet structure, and aggregate that becomes filled with sediment.
3.3.1.4 Sediment Trap

A sediment trap consists of a small, temporary ponding area, with a rock weir or perforated riser pipe at the outlet, formed by excavation or by constructing a weir. The sediment trap serves drainage areas 5 acres and smaller and has a design life of approximately six months.

- Refer to the detail: NDET414 Temporary Sediment Trap, located at the end of this section. Also refer to Chapter 6 Section 6.2.2.6.1 – Sediment Trap Sizing.

Applications

- Drainage areas that are 5 acres and smaller.
- Sites in proximity to salmonid streams, wetlands, or phosphorus-sensitive water bodies.
- Sites where major clearing and grading is likely to occur during the wet season.
- Sites with downstream erosion or sedimentation problems.
- Downslope of disturbed areas.
Combining with Permanent Drainage Facilities

- If a project includes a permanent storm water retention/detention pond, the rough-graded or final-graded facility could function as a trap during construction. Design features of the permanent structure, such as surface area, retention time and outlet control, should meet the design requirements of the temporary facility. Completion of the permanent facility should occur only when all upstream control structures are in place and stabilization of contributing drainage areas is complete.

- If a project includes an infiltration facility, the roughly excavated facility could be used as a trap or basin providing the facility provides the surface area and retention time required by the trap or basin. Excavate the sides and bottom of the facility to a minimum of 2 ft. bellow final grade with a backhoe working at “arms length” to minimize disturbance and compaction of the infiltration surface.

- Additionally, any required pretreatment facilities should be fully constructed prior to any release of sediment-laden water to the facility. Pretreatment and shallow excavations are intended to prevent the clogging of soil with fines.

Advantages

- Protect downstream riparian areas from sediment deposits.
- Prevent reduced downstream capacity due to sediment deposition in a stream channel.
- Prevents clogging of downstream facilities.
- Removes particles up to medium silt size (0.02 mm).
- Surface water conveyances can be connected to the facility as site development proceeds. The designer may want to route surface water collected from disturbed areas of the site through a sediment trap prior to release from the site.

Disadvantages

- May become an attractive nuisance. Care must be taken to adhere to all safety practices.
- Maintenance and sediment removal is essential for adequate performance.
- Serves limited areas.
- Does not reduce turbidity resulting from fine silts and clays in runoff. Traps are more effective when used in conjunction with other measures such as seeding and mulching.
Design Criteria

- See Chapter 6 Section 6.2.2.5.1 – Sediment Trap Sizing.
- Construct prior to any upslope clearing and grading.
- Locate in a low area where the trap will intercept all or most of the runoff from the disturbed area before it enters a waterway, considering safety in case structure fails.
- Locate the trap so that it is readily accessible for maintenance.
- Provide for diversion dikes and ditches, as needed, to collect and divert water toward the trap.
- Design the trap with a level bottom, 1:3 or flatter side slopes and a L:W ratio of 3. Because sediment traps are temporary, the sizing is less important to proper functioning than is constant maintenance.
- Construct the trap as the first step in the clearing and grading of the site.
- Form the trap by excavation or by construction of compacted embankment. If the trap is formed by embankment, the designer should note that dam safety regulation may apply to heights exceeding 5 ft. The embankment should be stabilized using a cover method such as seeding, mulching or erosion control matting.
- Do not drain traps directly into a stream, lake or other waterway. Water temperature in the trap may be too high for direct release. Always moderate the water temperature before it drains into a lake, stream, wetland or waterway. Whenever possible, release the trap discharge onsite onto a relatively level, densely grassed area at least 60 ft. from a waterway or wetland.
- Evaluate the release areas on a site-by-site basis in order to determine appropriate locations for and methods of releasing runoff. Do not use vegetated wetlands for this purpose. Refer to the ODOT Hydraulics Manual for design guidance on culverts and channels.

Maintenance

- Constant maintenance is essential for proper functioning.
- Remove sediment from the trap when it reaches one-third the storage capacity.
- Repair any damage to the trap, the embankments or the slopes.
Common Failures

Most sediment trap failures are related to poor location, incorrect sizing, and poor maintenance. If sediment is not removed from the trap on a regular basis, the sediment trap may become a source of sediment during large events.
3.3.1.5 Sediment Basin

Figure 3-23 Sediment Basin

A temporary sediment basin has one or more inflow points and baffles to spread the flow, wet storage and dry storage, a securely anchored riser pipe, a dewatering device and an emergency overflow spillway. The sediment basin serves drainage areas less than 10 acres and has a design life of approximately one-year.

Basins are large facilities that treat runoff from large drainage areas. Because of this, basins have limited application to highway construction projects. The applications, advantages and disadvantages of basins are included here for the designer’s edification.

- Refer to detail: NDET417 Temporary Sediment Basin (Type 1), located at the end of this section.

Applications

- Drainage areas from 5 to 10 acres.
CHAPTER 3: EROSION & SEDIMENT CONTROL MEASURES & BMP’s

- Sites in proximity to salmonid streams, wetlands, or phosphorus-sensitive water bodies.
- Sites where major clearing and grading is likely to occur during the wet season.
- Sites with downstream erosion or sedimentation problems.
- Downslope of disturbed areas. Install prior to any upslope clearing and grading.

Combining with Permanent Drainage Facilities

- If a project includes a permanent storm water retention/detention pond, the rough-graded or final-graded facility could function as a trap during construction. Design features of the permanent structure, such as surface area, retention time and outlet control, should meet the design requirements of the temporary facility. Completion of the permanent facility should occur only when all upstream control structures are in place and stabilization of contributing drainage areas is complete.

- If a project includes an infiltration facility, the roughly excavated facility could be used as a basin providing the facility provides the surface area and retention time required by basin. Excavate the sides and bottom of the facility to a minimum of 2 ft. above final grade with a backhoe working at “arms length” to minimize disturbance and compaction of the infiltration surface.

- Any required pretreatment facilities should be fully constructed prior to any release of sediment-laden water to the facility. Pretreatment and shallow excavations are intended to prevent the clogging of soil with fines.

Advantages

- Protect downstream riparian properties from sediment deposits.
- Prevent reduced downstream capacity due to sediment deposition in a stream channel.
- Prevents clogging of downstream facilities.
- Remove particles up to medium silt size (0.02 mm).
- Surface water conveyances can be connected to the facility as site development proceeds.

Disadvantages

- May become an attractive nuisance. Care must be taken to adhere to all safety practices.
• Failure of a basin that is not properly located could result in loss of life, damage to homes or buildings or interruption of services such as transportation or power.
• Maintenance and sediment removal is essential for adequate performance.
• Does not reduce turbidity resulting from fine silts and clays in runoff. Basins are more effective when used in conjunction with other measures such as seeding and mulching.

Design Criteria

• For best design information please refer to the ODOT Hydraulics Manual and Best Management Practices for Erosion and Sediment Control, Report No. FHWA-FLP-94-005 written by the U.S. Department of Transportation.
• Do not drain basins directly into a stream, lake, wetland or other waterway. Water temperature in the basin may be too high for direct release. Always moderate the water temperature before it drains into a lake, stream or waterway. Whenever possible, release the trap discharge onsite onto a relatively level, densely grassed area at least 60 ft. from a waterway or wetland.
• Require installation of a staff gauge to aid in determining sediment depth.
• The designer may want to route surface water collected from disturbed areas to a sediment basin prior to release from site.
• A qualified engineer should design temporary sediment basins.

Maintenance

• Inspect weekly and after each rain.
• All damages caused by soil erosion or construction equipment should be repaired before the end of each working day.
• Remove sediment when the sediment storage zone is half full. This sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the embankment or in or adjacent to a stream or floodplain.
• When temporary structures have served their intended purpose and the contributing drainage area has been properly stabilized, the embankments and resulting sediment deposit shall be leveled or otherwise disposed of in accordance with the approved erosion and sediment control plan.
Common Failures

Most failures with sediment basins are related to improper location, incorrect sizing and poor maintenance. If sediment is not removed from the basin on a regular basis, it may become a source of sediment during large events.