City of Cambridge, Massachusetts

Department of Public Works

147 Hampshire Street • Cambridge, MA 02139

APPENDIX A
Best Management Practices

Section 2

Version 04/10

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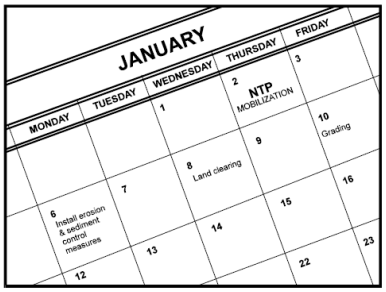
2. CONSTRUCTION CONTROLS

2.1. Construction Sequencing/Scheduling

DESCRIPTION

Scheduling is the development of a written plan that includes sequencing of construction activities and the implementation of BMPs such as erosion control and sediment control while taking local climate (rainfall, wind, etc.) into consideration. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule. Construction site sequencing involves disturbing only part of a site at a time to prevent erosion from dormant parts. Grading activities and construction are completed and soils are effectively stabilized on one part of the site before grading and construction commence at another part.



Source: California Stormwater BMP Handbook, January 2003.

DESIGN CONSIDERATIONS

- Locate temporary soil stockpiles and staging areas to prevent additional land disturbance.
- Establish a "trigger" for beginning a phase (e.g. percent of previous phase stabilized).
- Address both temporary and permanent stormwater management in each phase. Manage runoff separately in each phase.
- Ensure that later upstream phases address potential impacts to already completed downstream phases.
- Avoid rainy periods. Schedule major grading operations during dry months when practical. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means or to install sediment trapping devices.
- Plan the project and develop a schedule showing each phase of construction. Clearly show how the rainy season relates to soil disturbing and re-stabilization activities. Identify which measures should be installed before other activities are started.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Erosion Control
- Sediment Control
- Site Planning and Management

APPLICABILITY

- Should be incorporated into every construction project.

- Include on the schedule implementation and deployment of: erosion control BMPs, sediment control BMPs, tracking control BMPs, wind erosion control BMPs, and source control BMPs.
- Include dates for activities that may require non-stormwater discharges such as dewatering, sawcutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, pavement cleaning, etc.
- Work out the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, foundation pouring, utilities installation, etc., to minimize the active construction area at any given time.
- Sequence trenching activities so that most open portions are closed before new trenching begins.
- Incorporate staged seeding and re-vegetation of graded slopes as work progresses.
- Schedule establishment of permanent vegetation during appropriate planting time for specified vegetation.
- Non-active areas should be stabilized as soon as practical after the cessation of soil disturbing activities or one day prior to the onset of precipitation.
- Monitor the weather forecast for rainfall. When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment treatment controls on all disturbed areas prior to the onset of rain.
- Be prepared year round to deploy erosion control and sediment control BMPs. Erosion may be caused during dry seasons by un-seasonal rainfall, wind, and vehicle tracking. Keep the site stabilized year round, and retain and maintain sediment trapping devices in operational condition.
- Apply permanent erosion control to areas deemed substantially complete during the project's defined seeding window.
- Provide construction access in each phase separate from access for permanent residents to prevent conflicts between residents living in completed stages of the site and construction equipment working on later stages.
- Balance earthwork in each phase (e.g. "cut" and "fill" amounts are equal).

MAINTENANCE CONSIDERATIONS

ADVANTAGES

- Use of other, more costly yet less effective, erosion and sediment control BMPs may often be reduced through proper construction sequencing.

LIMITATIONS

- Environmental constraints such as nesting season prohibitions reduce the full capabilities of this BMP.
- Weather constraints, especially during the winter months.

REFERENCE

- California Stormwater BMP Handbook for Construction
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

If progress deviates, take corrective actions. Amend the schedule when changes are warranted and prior to the rainy season to show updated information on construction site BMPs.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspectors should verify that work is progressing in accordance with schedule.

CONSTRUCTION SCHEDULING IN CAMBRIDGE

- A construction schedule is required for all construction activities as part of an approved Erosion and Sediment Control Plan.

2.2. ♦ Preservation of Natural Vegetation

DESCRIPTION

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.

DESIGN CONSIDERATIONS

- Provide for preservation of existing vegetation prior to the commencement of clearing and grubbing operations or other soil disturbing activities in areas where no construction activity is planned or will occur at a later date. Consider tree vigor, age, species, and wildlife benefits when selecting trees for preservation.
- Clearly mark areas to be preserved with temporary fencing. Include sufficient setback to protect roots. Orange colored plastic mesh fencing works well. Use appropriate fence posts and adequate post spacing and depth to completely support the fence in an upright position. Extend and mark the boundaries around contiguous natural areas and tree drip lines to protect the root zone from damage.
- Prepare a site map with the locations of trees, boundaries of environmentally sensitive areas, and buffer zones to be preserved. Locate temporary roadways, stockpiles, and layout areas to avoid stands of trees, shrubs, and grass. Follow natural contours and maintain preconstruction drainage patterns – if grading is not done properly, it could result in hydrology changes that kill vegetation. Make sure vegetation to be preserved will not interfere with installation and maintenance of utilities.
- Clear only the land that is needed for building activities and vehicle traffic.
- Maintain existing irrigation systems where feasible. Temporary irrigation may be required.
- Use barriers to prevent equipment from approaching protected areas. Instruct employees and subcontractors to honor protective devices. Prohibit heavy equipment, vehicular traffic, or storage of construction materials within the protected area.
- Do not nail boards to trees.
- Do not cut roots inside the tree drip line.
- During final site cleanup, remove barriers from around

St. Peter's Field parking lot – Cambridge, MA.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Erosion Control
- Site Planning and Management

APPLICABILITY

- Suitable for use on most projects. Large projects often provide the greatest opportunity for use.
- Areas within the site where no construction activity occurs, or occurs at a later date. Especially suitable for multi-year projects.
- Areas where natural vegetation exists and is designed for preservation.
- Areas where local, state, and federal government require preservation, such as vernal pools, wetlands, etc.
- Where vegetation designated for

preserved areas and trees.

MAINTENANCE CONSIDERATIONS

- During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the Erosion and Sediment Control Plan.
- If fertilization is needed, apply fertilizer at the minimum rate and to the minimum area needed. Work fertilizer deeply into soil to reduce exposure of nutrients to stormwater runoff. Apply fertilizer at lower application rates with higher application frequency. Limit hydroseeding (simultaneously applies lime and fertilizer). Ensure that erosion and sediment controls are in place to prevent fertilizer and sediment from being transported off site.

If damage to protected vegetation still occurs, maintenance guidelines described below should be followed:

- Repair or replace damaged vegetation immediately to maintain the integrity of the natural system. Choose vegetation that enhances existing vegetation.
- If a tree or shrub is damaged, remove and replace it with a tree of the same or similar species with a 2-in or larger caliper width from balled and burlaped nursery stock when construction activity is complete.
- Serious tree injuries should be attended to by an arborist. Damage to the crown, trunk, or root system of a retained tree shall be repaired immediately.
- Trench as far from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching or tunneling near or under trees to be retained, place tunnels at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots. Fill trenches and tunnels as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots.
- Do not leave tree roots exposed to air. Cover exposed roots with soil as soon as possible. If soil covering is not practical, protect exposed roots with wet burlap or peat moss until the tunnel or trench is ready for backfill.
- Cleanly remove the ends of damaged roots with a smooth cut.
- If bark damage occurs, cut back all loosened bark into the ultimate removal can be temporarily preserved and be utilized for erosion control and sediment control.
- Especially beneficial for floodplains, wetlands, stream banks, steep slopes, and other areas where erosion controls would be difficult to establish, install, or maintain.

ADVANTAGES

- Protects desirable vegetation from damage during development.
- Saves money on site stabilization and landscaping.
- Moderates temperature changes and provides shade for land and surface water habitats.
- Natural vegetation can process higher quantities of runoff than newly seeded areas and has a higher filtering capacity.
- Does not require time to establish.
- Provides screening against noise and visual disturbance.
- Usually requires less maintenance than planting new vegetation.
- Enhances aesthetics.

LIMITATIONS

- Requires forward planning by the owner/developer, contractor, and design staff.
- Limited opportunities for use when project plans do not incorporate existing vegetation into the site design.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactory for the planned development.

REFERENCE

- California Stormwater BMP Handbook for Construction
- Massachusetts Erosion and

undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible.

- Aerate soil that has been compacted over a trees root zone by punching holes 12 in deep with an iron bar, and moving the bar back and forth until the soil is loosened. Place holes 18 in. apart throughout the area of compacted soil under the tree crown.
- Fertilize stressed or damaged broadleaf trees to aid recovery. Fertilize trees in late fall or early spring. Apply fertilizer to the soil over the feeder roots and in accordance with label instructions, but never closer than 3 ft. to the trunk. Increase the fertilized area by one-fourth of the crown area for conifers that have extended root systems.
- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup stabilization.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect preserved areas regularly to ensure barriers have not been removed or failed. Inspect vegetation to ensure it has not been damaged. Restore damaged protection measures and vegetation immediately.

PRESERVATION OF NATURAL VEGETATION IN CAMBRIDGE

- Cambridge has established a Tree Ordinance which affects development projects meeting certain criteria. Please visit http://www.cambridgema.gov/TheWorks/departments/parks/TreeOrdinanceLink.html for specific information.

Sediment Control Guidelines for Urban and Suburban Areas

- US EPA National Menu of Best Management Practices

2.3. Chemical Stabilization

Source: Erosion Control at www.forester.net.

DESCRIPTION

Chemical stabilizers, also known as soil binders or soil palliatives, provide temporary soil stabilization. Vinyl, asphalt, or rubbers are sprayed onto the surface of exposed soils to hold the soil in place and minimize erosion from runoff and wind. These materials are easily applied to the surface of the soil, can stabilize areas where vegetation cannot be established, and provide immediate protection.

DESIGN CONSIDERATIONS

- A chemical stabilizer must be environmentally benign (non-toxic to plant and animal life), easy to apply, easy to maintain, economical, and should not stain paved or painted surfaces. Chemical stabilizers should not pollute stormwater. Some chemical stabilizers may not be compatible with existing vegetation.
- Performance depends on temperature, humidity, and traffic across treated areas.
- Some chemical stabilizers reduce how pervious a soil is. Chemical stabilizers that reduce the soils capability to drain shall be used in limited quantities. Areas where the type of stabilizer is used shall have the top 4-inches of soil removed once stabilizer is no longer needed.

Selection: Factors to consider when selecting a chemical stabilizer include the following:

- Suitability to situation – Consider where the chemical stabilizer will be applied, if it needs a high resistance to leaching or abrasion, and whether it needs to be compatible with any existing vegetation. Determine the length of time soil stabilization will be needed, and if the chemical stabilizer will be placed in an area where it will degrade rapidly. In general, slope steepness is not a discriminating factor for the listed chemical stabilizers.
- Soil types and surface materials – Fines and moisture content are key properties of surface materials. Consider a chemical stabilizer's ability to penetrate, likelihood of leaching, and ability to form a surface crust on the surface materials.
- Frequency of application – The frequency of application can be affected by subgrade conditions, surface type, climate, and maintenance schedule. Frequent applications could lead to high costs. Application frequency may be minimized if the chemical stabilizer has good penetration, low evaporation and good longevity. Consider also that frequent application will require frequent

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Erosion Control

APPLICABILITY

- Typically applied to disturbed areas requiring short term temporary protection.
- Suitable for use on stockpiles.
- Good alternative to mulches in areas where grading activities will soon resume.
- Regional soil types will dictate appropriate chemical stabilizers to be used.
- Use chemical stabilizers alone in areas where other methods of stabilization are not effective because of

equipment clean up.

The table below lists types of chemical stabilizers and their general properties. For more information on specific chemical stabilizers, please visit: http://www.cabmphandbooks.com/Construction.asp

Table 1 Properties of Soil Binders for Erosion Control

Evaluation Criteria	Binder Type			
	Plant Material Based (Short Lived)	Plant Material Based (Long Lived)	Polymeric Emulsion Blends	Cementitious-Based Binders
Relative Cost	Low	Low	Low	Low
Resistance to Leaching	High	High	Low to Moderate	Moderate
Resistance to Abrasion	Moderate	Low	Moderate to High	Moderate to High
Longevity	Short to Medium	Medium	Medium to Long	Medium
Minimum Curing Time before Rain	9 to 18 hours	19 to 24 hours	0 to 24 hours	4 to 8 hours
Compatibility with Existing Vegetation	Good	Poor	Poor	Poor
Mode of Degradation	Biodegradable	Biodegradable	Photodegradable/ Chemically Degradable	Photodegradable/ Chemically Degradable
Labor Intensive	No	No	No	No
Specialized Application Equipment	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher
Liquid/Powder	Powder	Liquid	Liquid/Powder	Powder
Surface Crusting	Yes, but dissolves on rewetting	Yes	Yes, but dissolves on rewetting	Yes
Clean Up	Water	Water	Water	Water
Erosion Control Application Rate	Varies (1)	Varies (1)	Varies (1)	4,000 to 12,000 lbs/acre

Source: California Stormwater BMP Handbook, January 2003

Application: After selecting an appropriate chemical stabilizer, the untreated soil surface must be prepared before applying the stabilizer. The untreated soil surface must contain sufficient moisture to assist the agent in achieving uniform distribution.

- Follow manufacturer's written recommendations for application rates, pre-wetting of application area, and cleaning of equipment after use.
- Prior to application, roughen embankment and fill areas.
- Consider the drying time for the selected chemical stabilizer and apply with sufficient time before anticipated rainfall. Chemical stabilizers should not be applied during or immediately before rainfall. Generally, chemical stabilizers require a minimum curing time of 24 hours before they are fully effective. Refer to manufacturer's instructions for specific cure time.

environmental constraints, or use them in combination with vegetative or perimeter practices to enhance erosion and sediment control.

ADVANTAGES

- Provides temporary dust, wind, and soil stabilization.

LIMITATIONS

- Temporary in nature and may need reapplication.
- Require a minimum curing time until fully effective, as prescribed by the manufacturer. Curing time may be 24 hours or longer, and some chemical stabilizers may not cure if low temperatures occur within 24 hours of application.
- Generally experience spot failures during heavy rainfall events.
- Do not hold up to pedestrian or vehicular traffic across treated areas.
- May not penetrate soil surfaces made up primarily of silt and clay, particularly when compacted.
- May not perform well with low relative humidity. Under rainy conditions, may become slippery or leach out of the soil.
- If improperly applied, can pool and create impervious surfaces where water cannot infiltrate and could increase stormwater runoff.
- Generally more expensive than vegetative practices.
- Water quality impacts of chemical stabilizers are relatively unknown.
- Reduces soils ability to drain.

- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.
- Chemical stabilizers should not be applied to frozen soil, areas with standing water, under freezing or rainy conditions, or when the temperature is below 40°F during the curing period.
- More than one treatment is often necessary, although the second treatment may be diluted or have a lower application rate.

For liquid agents:

- Crown or slope ground to avoid ponding
- Uniformly pre-wet ground at 0.03 to 0.3 gal/yd^2 or according to manufacturer's recommendations.
- Apply solution under pressure. Overlap solution 6 to 12 in.
- Allow treated area to cure for the time recommended by the manufacturer – typically at least 24 hours.
- Apply second treatment before first treatment becomes ineffective, using 50 percent application rate.
- In low humidity, reactivate chemicals by re-wetting with water at 0.1 to 0.2 gal/yd^2.

REFERENCE

- California Stormwater BMP Handbook for Construction
- US EPA National Menu of Best Management Practices

MAINTENANCE CONSIDERATIONS

Areas where erosion is evident should be repaired and chemical stabilizers reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication. Reapply the selected chemical stabilizer as needed to maintain effectiveness.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect for exposed soil.

CHEMICAL STABILIZERS IN CAMBRIDGE

- A sampling and analysis plan must be incorporated into the SWPPP as chemical stabilizers could be a source of non-visible pollutants.

2.4. Geotextiles and Mats

Source: Stony Brook-Millstone Watershed Association, New Jersey

DESCRIPTION

Geotextiles are porous fabrics also known as filter fabrics, road rugs, synthetic fabrics, construction fabrics, or simply fabrics. Geotextiles and mattings of natural materials are used to cover the soil surface to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, matting may be used to stabilize soils until vegetation is established.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Erosion Control
- Runoff Control

APPLICABILITY

- Commonly applied on short, steep slopes (generally steeper than 3:1), where erosion potential is high and vegetation will be slow to establish.
- Stream banks where moving water at velocities between 3 ft/s and 6 ft/s is likely to wash out new vegetation, channels with flows exceeding 3.3 ft/s, and channels to be vegetated. Also used on slopes adjacent to water bodies of environmentally sensitive areas.
- When seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season).
- Should be considered when the soils are fine grained and potentially erosive.
- Slopes and disturbed soils where mulch must be

DESIGN CONSIDERATIONS

- The choice of matting should be based on the size of area, side slopes, surface conditions such as hardness, moisture, weed growth, and availability of materials. For more information on material selection, visit: http://www.cabmphandbooks.com/Construction.asp
- **Site Preparation:** Proper site preparation is essential to ensure complete contact of the blanket or matting with the soil. Grade and shape the area of installation. Remove all rocks, clods, vegetation or other obstructions so that the installed blankets or mats will have complete, direct contact with the soil. Prepare the seedbed by loosening 2 to 3 in. of topsoil.
- **Seeding:** Seed the area before blanket installation for erosion control and revegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket installation, all check slots and other areas disturbed during installation must be re-seeded. Where soil filling is specified, seed the matting and the entire disturbed area after installation and prior to filling with the mat and soil. Fertilize and seed in accordance with seeding specifications or other types of landscaping plans. When using jute matting on a seeded area, apply approximately half the seed before laying the mat and remainder after laying the mat. The protective matting can be

laid over areas where grass has been planted and the seedings have emerged. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

- **Check Slots:** Check slots are made of glass fiber strips, excelsior matting strips or tight folded jute matting blanket or strips for use on steep, highly erodible watercourses. The check slots are placed in narrow trenches 6 to 12 in. deep across the channel and left flush with the soil surface. They are to cover the full cross section of designed flow.
- **Laying and Securing Matting:** Before laying the matting, all check slots should be installed and the friable seedbed made free from clods, rocks, and roots. The surface should be compacted and finished according to the requirements of the manufacturer's recommendations. Mechanical or manual lay down equipment should be capable of handling full rolls of fabric and laying the fabric smoothly without wrinkles or folds. The equipment should meet the fabric manufacturer's recommendations or equivalent standards.
- **Anchors:** U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats and blankets to the ground surface. Wire staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown. Metal stake pins should be 0.188 in. diameter steel with a 1.5 in. steel washer at the head of the pin, and 8 in. in length. Wire staples and metal stakes should be driven flush to the soil surface.
- **Installation on Slopes:** Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows. Begin at the top of the slope and anchor the blanket in a 6 in. deep by 6 in. wide trench. Backfill trench and tamp earth firmly. Unroll blanket down slope in the direction of water flow. Overlap the edges of adjacent parallel rolls 2 to 3 in. and staple every 3 ft. When blankets must be spliced, place blankets end over end (shingle style) with 6 in. overlap. Staple through overlapped area, approximately 12 in. apart. Lay blankets loosely and maintain direct contact with the soil. Do not stretch. Staple blankets loosely and maintain direct contact with the soil. Do not stretch. Staple blankets sufficiently to anchor blanket and maintain contact with the soil. Staples should be placed down the center and staggered with the staples placed along the edges. Steep slopes, 1:1 to 2:1, require a minimum of 2 staples/yd^2. Moderate slopes, 2:1 to 3:1, require a anchored and disturbed areas where plants are slow to develop.
- Can be used on stockpiles.
- Generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (since staples and netting can catch in mowers).
- Not suitable for areas that have heavy foot traffic (tripping hazard).
- Can be used as a separator between riprap and soil. This "sandwiching" prevents the soil from being eroded beneath the riprap and maintains the riprap base.

ADVANTAGES

- Fabrics are relatively inexpensive for certain applications.
- A wide variety of geotextiles to match specific needs is available.

LIMITATIONS

- Mattings are more costly than other BMPs, limiting their use to areas where other BMPs are ineffective (e.g. channels, steep slopes).
- Installation is critical and requires experienced contractors.
- May delay seed germination due to reduction in soil temperature.
- Must be removed and disposed of prior to application of permanent soil stabilization measures.
- Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill. Plastic results in 100% runoff, which may cause

minimum of 1 ½ staples/yd^2.

- **Installation in Channels:** Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows. Dig initial anchor trench 12 in. deep and 6 in. wide across the channel at the lower end of the project area. Excavate intermittent check slots, 6 in. deep and 6 in. wide across the channel at 25 to 30 ft. intervals along the channels. Cut longitudinal channel anchor trenches 4 in. deep and 4 in. wide along each side of the installation to bury edges of matting, whenever possible extend matting 2 to 3 in. above the crest of the channel side slopes. Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 12 in. intervals (note: matting will initially be upside down in anchor trench). In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 3 in. Secure these initial ends of mats with anchors at 12 in. intervals, backfill and compact soil. Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 3 in. overlap. Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 12 in. intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench. Alternate method for non-critical installations: Place two rows of anchors on 6 in. centers at 25 to 30 ft. intervals in lieu of excavated check slots. Staple shingled lap spliced ends a minimum of 12 in. apart on 12 in. intervals. Place edges of outside mats in previously excavated longitudinal slots; anchor using prescribed staple pattern, backfill, and compact soil. Anchor, fill, and compact upstream end of mat in a 12 in. by 6 in. terminal trench. Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes. Seed and fill turf reinforcement matting with soil, if specified.
- **Soil filling (if specified for turf reinforcement):** Always consult the manufacturer's recommendations for installation. Do not drive tracked or heavy equipment over mat. Avoid any traffic over matting if loose or wet soil conditions exist. Use shovels, rakes, or brooms for fine grading and touch up. Smooth out soil filling just exposing top netting of mat. Temporary soil stabilization removed from the site of the work must be disposed of if necessary.

serious erosion problems in the areas receiving the increased flow.

- Geotextiles, mats, plastic covers, and erosion control covers have maximum flow rate limitations; consult the manufacturer for proper selection.

REFERENCE

- California Stormwater BMP Handbook for Construction
- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

MAINTENANCE CONSIDERATIONS

Areas where erosion is evident should be repaired and geotextiles reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication. If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Make sure matting is uniformly in contact with the soil at all times. Check that all the lap joints are secure. Check that staples are flush with the ground. Check that disturbed areas are seeded.

2.5. Mulching

DESCRIPTION

Mulches, which are chopped up organic material, have two purposes on construction sites. They are used to protect seeds from erosion, moisture loss and animals (e.g. birds and small mammals) and are used alone when seeds cannot be established, such as outside the growing season. Mulches are one of the most important, effective, and economical erosion control practices.

Grass mulching is applied to stabilize exposed soils and to reduce stormwater runoff velocity

Source: US EPA National Menu of Best Management Practices

DESIGN CONSIDERATIONS

- There are many types of mulches. Selection of the appropriate type of mulch should be based on the type of application, site conditions, and compatibility with planned or future uses.
- Green Material: This type of mulch is produced by the recycling of vegetation trimmings such as grass, shredded shrubs, and trees. Methods of application are generally by hand although pneumatic methods are available. Green material can be used as a temporary ground cover with or without seeding and should be evenly distributed on site to a depth of not more than 2 in.
- Shredded Wood: Suitable for ground cover in ornamental or revegetated plantings. Shredded wood/bark is conditionally suitable – see applicability. Distribute by hand or use pneumatic methods. Evenly distribute the mulch across the soil surface to a depth of 2 to 3 in.
- Hydraulic Mulch: Hydraulic mulch consists of applying a mixture of shredded wood fiber or a hydraulic matrix, and a stabilizing emulsion or tackifier with hydro-mulching equipment, which temporarily protects exposed soil from erosion by raindrop impact or wind.
- Prior to application, after existing vegetation has been removed, roughen embankment and fill areas by rolling with a device such as a punching type roller or by track walking. The construction application procedures for mulches vary significantly depending upon the type of mulching method specified.
- Avoid mulch placement onto roads, sidewalks, drainage channels, existing vegetation, etc.
- Organic mulch materials such as straw, wood chips, bark, and wood fiber have been found to be the most effective, although straw is preferred.
- On steeper slopes and critical areas such as waterways, use netting or anchoring with mulch to hold it in place.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Erosion Control

APPLICABILITY

- Suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established.
- Not suitable for use on slopes steeper than 3:1 (H:V). Best suited to flat areas or gentle slopes or 5:1 (H:V) or flatter.
- Not suitable for areas exposed to concentrated flows.

ADVANTAGES

- Instant protection of exposed areas.
- Conserves moisture and

- For more information on mulch materials and installation, please visit: http://mass.gov/dep/water/esfull.pdf

MAINTENANCE CONSIDERATIONS

Areas where erosion is evident should be repaired and mulch reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication. Regardless of the mulching technique selected, the key consideration in inspection and maintenance is that the mulch needs to last long enough to achieve erosion control objectives. If the mulch is applied as a standalone erosion control method over disturbed areas (without seed, it should last the length of time the site will remain barren or until final re-grading and revegetation. Where vegetation is not the ultimate cover, such as ornamental and landscape applications of bark or wood chips, inspection and maintenance should focus on longevity and integrity of the mulch. Reapply mulch when bare earth becomes visible. If netting used to anchor, care should be taken during mowing to keep the mower height high.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspection procedures should focus on longevity and integrity of the mulch. Inspect for movement of mulch and bare areas.

reduces the need for irrigation.

- Extremely effective at reducing suspended solids, with efficiencies in the 80% and 90% range.
- Low cost and easy to apply.

LIMITATIONS

- Care must be taken to apply mulch at the specified thickness, as thick mulches can reduce soil temperatures and delay seed germination.
- Wood mulch and compost may introduce unwanted species.
- May need to be removed prior to further earthwork and either composted or landfilled.
- Can be easily blown or washed away by runoff if not secured.
- Some mulch materials such as wood chips may absorb nutrients necessary for plant growth.

REFERENCE

- California Stormwater BMP Handbook for Construction
- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

2.6. Temporary Seeding

DESCRIPTION

Temporary seeding is used to establish a cover on a disturbed area that will grow rapidly by using annual plants. A temporary vegetative cover is used for areas that have been disturbed and remain untouched for more than 14 calendar days. A temporary vegetative cover will help to reduce damage caused by erosion to a disturbed area by hindering sediment to be transported downstream or to off-site areas. Temporary vegetative covering should also be used when a site is ending construction due to winter conditions. The contractor should place the temporary seed early enough so that it can properly grow before winter. Placing temporary seeding can greatly reduce the cost of other erosion and sediment control devices since the seeding will help reduce the amount of sediment transport greatly.

Source: Love the Garden website. www.lovethegarden.com

DESIGN CONSIDERATIONS

- Prior to seeding taking place necessary erosion and sediment control devices such as inlet protection, diversion channels or filter berms should be installed around the area when necessary.
- Plant selection should be based on time of year and site conditions. Refer to the below table for examples of plants that can be used.

Planting Dates	Species	Rate (lbs./ac.)
Aug 15 – Oct. 31	Cereal Rye (Winter Rye)	120
Apr 1 – June 1 Aug 15 – Sept 15	Annual Ryegrass	40
May 1 to June 30	Foxtail Millet	30
Aug 15 to Oct 31	Oats	80

- **Annual Ryegrass and Cereal Rye**-Annual Ryegrass and Cereal Rye should be used for fall and spring seeding since it tolerates cold temperatures and low moisture.
- **German Millet**-Foxtail Millet should be used in the summer months. Foxtail Millet will die from frost and does not tolerate cold weather. This is a summer time planting only.
- **Oats**-Oats should be used as a fall seeding since it tolerates cold temperatures and low moisture
- Seeding that is placed in fall, winter and during hot and dry days

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Erosion Control
- Runoff Control

APPLICABILITY

- Well-suited in areas where permanent, long-lived vegetative cover is the most practical or most effective method of stabilizing soil.
- Use on roughly graded areas that will not be regraded for at least a year.
- Effective on areas where soils are unstable because of their texture or structure, high water table, winds, or steep

should be covered with straw. Hay should not be used since it contains the seeds and maybe considered invasive.

- Areas that fail to establish proper seeding should be re-seeded or another type of ground cover should be selected.
- Hydro-seeding applications with appropriate seed-mulch-fertilizer mixtures may also be applies as temporary seeding.
- Liming maybe used when applied uniformly. Lime should be applied at 2 tons of ground limestone per acre or according to soil test.
- A 10-10-10 fertilizer can be applied to the area at a rate of 400 lbs per acre or as indicated by soil test. Forty percent of the nitrogen should be in organic form.
- Lime and fertilizers should be worked in to a depth of 4 inches using any suitable equipment.

MAINTENANCE CONSIDERATIONS

Maintenance for seeded areas will vary depending on the level of use expected.

Grasses should emerge within 4-28 days and legumes 5-28 days after seeding, with legumes following grasses. A successful stand has the following characteristics: vigorous dark green or bluish (not yellow) seedlings; uniform density, with nurse plants, legumes, and grasses well intermixed; green leaves that remain green throughout the summer – at least at the plant bases.

If a stand has inadequate cover (less than 40% cover), reevaluate the choice of plant materials and quantities of lime and fertilizer. Reestablish the stand following seedbed preparation and seeding recommendations. Depending on the condition of the stand, repair by overseeding or reseeding after complete seedbed preparation. If timing is bad, overseed with rye grain or Foxtail millet to thicken the stand. If vegetation fails to grow, test the soil to determine if low pH or nutrient imbalances are responsible. Use soil tests to determine if more fertilizer needs to be added. Do not fertilize cool season grasses in late May through July. Grass that looks yellow might be nitrogen deficient. Do not use nitrogen fertilizer if the stand contains more than 20 percent legumes.

slope.

- Especially important for filter strips, buffer areas, vegetated swales, steep slopes and stream banks.
- Major factors that dictate the suitability of plants for a site include climate, soils, and topography.

ADVANTAGES

- Lower initial costs and labor needs.
- Well established grass and ground covers can give an aesthetically pleasing, finished look to a development.
- Usually the most economical way to stabilize large areas.
- Wide variety of grasses and legumes available.
- Ease of establishment in difficult areas, and once established, vegetation will prevent erosion and slow runoff velocities.

LIMITATIONS

- Effectiveness can be limited by high erosion during establishment, the need to reseed areas that fail to establish, limited seeding times, or unstable soil temperature and soil moisture content during germination and early growth.
- Does not immediately stabilize soils – temporary erosion and sediment control measures will be necessary.
- Vegetation and mulch cannot prevent soil slippage and erosion if soil is not inherently stable.
- Coarse, high grasses that aren't mowed can create a fire hazard in some places. Very short mowed grass,

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect seeded areas for failure. Conduct a follow-up weekly survey to ensure the area has been seeded correctly and replace all failed plants.

however, provides less stability and filtering capacity.

- Grass planted to the edge of a watercourse may encourage fertilization and mowing near water's edge and increase nutrient and pesticide contamination.
- May require regular irrigation to establish and maintain.
- Depends initially on climate and weather for success.

REFERENCE

- California Stormwater BMP Handbook for Construction
- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- US EPA National Menu of Best Management Practices

2.7. Permanent Seeding

DESCRIPTION

Seeding is used to control runoff and erosion on disturbed areas by establishing perennial vegetative cover from seed. It reduces erosion and sediment loss and provides permanent stabilization. Vegetation controls erosion by protecting bare soil surfaces from displacement by raindrop impacts and by reducing the velocity and quantity of overland flow. This practice is economical, adaptable to different site conditions, and allows selection of a variety of plant materials.

Source: Love the Garden website. www.lovethegarden.com

DESIGN CONSIDERATIONS

- Seed or plant permanent vegetation in areas 1 to 4 months after the final grade is achieved unless temporary stabilization measures are in place.
- Selection of the right plant materials for the site, good seedbed preparation, timing, and conscientious maintenance are important.
- Prepare and amend the soil on a disturbed site to provide sufficient nutrients for seed germination and seedling growth.
- Loosen the soil surface enough for water infiltration and root penetration.
- If soils are too acidic, increase the pH to between 6.0 and 6.5 with liming or choose plants that are appropriate for the soil characteristics at your site. Protect seeds with mulch to retain moisture, regulate soil temperatures, and prevent erosion during seedling establishment.
- Use long-lived grass perennials that form a tight sod and are fine-leaved for areas that receive extensive use, such as homes, industrial parks, schools, churches, and recreational areas.
- Whenever possible, choose native species that are adapted to local weather and soil conditions to reduce water and fertilizer inputs and lower maintenance overall.
- If non-native plant species are used, they should be tolerant of a large range of growing conditions, as low maintenance as possible, and not invasive.
- Low-maintenance areas are mowed infrequently or not at all and do not receive lime or fertilizer regularly. Plants must be able to persist with minimal maintenance over long periods of time. Use grass and legume mixtures for these sites because legumes fix nitrogen from the atmosphere. Sites suitable for low-maintenance vegetation include steep slopes, stream or channel

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Erosion Control
- Runoff Control

APPLICABILITY

- Well-suited in areas where permanent, long-lived vegetative cover is the most practical or most effective method of stabilizing soil.
- Use on roughly graded areas that will not be regraded for at least a year.

banks, some commercial properties, and "utility" turf areas such as road banks.

- Consider the microclimate within the development area. Low areas may be frost pockets and require hardier vegetation since cold air tends to sink and flow towards low spots. South-facing slopes may be more difficult to re-vegetate because they tend to be sunnier and drier.
- Divert as much surface water as possible from the area to be planted.
- Remove seepage water that would continue to have adverse effects on soil stability or the protecting vegetation. Subsurface drainage or other engineering practices may be needed and might require permits.
- Provide protection from equipment, trampling and other destructive agents.
- Vegetation cannot be expected to supply an erosion control cover and prevent slippage on a soil that is not stable due to its texture, structure, water movement, or excessive slope.
- Install necessary surface runoff control measures such as gradient terraces, berms, dikes, level spreaders, waterways, and sediment basins prior to seeding or planting.
- Seedbed Preparation: If infertile or coarse-textured subsoil will be exposed during land shaping, it is best to stockpile topsoil and respread it over the finished slope at a minimum 2 to 6 in. depth and roll it to provide a firm seedbed. If construction fill operations have left soil exposed with a loose, rough, or irregular surface, smooth with blade and roll. Loosen the soil to a depth of 3 to 5 in. with suitable agricultural or construction equipment. Areas not to receive top soil should be treated to firm the seedbed after incorporation of the lime and fertilizer so that it is depressed no more than ½ to 1 in. when stepped on with a shoe. Areas to receive topsoil should not be firmed until after topsoiling and lime and fertilizer are applied and incorporated, at which time it should be treated to firm the seedbed as described above. This can be done by rolling or cultipacking.
- Apply lime and fertilizer according to soil test recommendations. In absence of a soil test, apply lime (a pH of 5.5 – 6.0 is desired) at a rate of 2.5 tons per acre and 10-20-20 analysis fertilizer at a rate of 500 pounds per acre (40% of N to be in an organic or slow release form). Incorporate lime and fertilizer into the top 2 to 3 in. of soil.

- Effective on areas where soils are unstable because of their texture or structure, high water table, winds, or steep slope.
- Especially important for filter strips, buffer areas, vegetated swales, steep slopes and stream banks.
- Major factors that dictate the suitability of plants for a site include climate, soils, and topography.

ADVANTAGES

- Lower initial costs and labor needs.
- Well established grass and ground covers can give an aesthetically pleasing, finished look to a development.
- Usually the most economical way to stabilize large areas.
- Wide variety of grasses and legumes available.
- Ease of establishment in difficult areas, and once established, vegetation will prevent erosion and slow runoff velocities.

LIMITATIONS

- Effectiveness can be limited by high erosion during establishment, the need to reseed areas that fail to establish, limited seeding times, or unstable soil temperature and soil moisture content during germination and early growth.
- Does not immediately stabilize soils – temporary erosion and sediment control measures will be necessary.
- Vegetation and mulch cannot prevent soil slippage and erosion if soil is not inherently stable.

- Seeding operations should be performed within one of the following periods: April 1 – May 31, August 1-September 10, or November 1-December 15 as a dormant seedling (seedling rates should be increased by 50% for dormant seedings.
- Seeding should be performed by one of the following methods: Drill seedings; Broadcast and rolled, cultipacked or tracked with a small track piece of construction equipment; Hydroseeding, with subsequent tracking.
- Seed should be planted to a depth of ¼ to ½ in.
- Mulch the seedings with straw applied at the rate of ½ tons per acre. Anchor the mulch with erosion control netting or fabric on sloping areas.

MAINTENANCE CONSIDERATIONS

Maintenance for seeded areas will vary depending on the level of use expected.

Grasses should emerge within 4-28 days and legumes 5-28 days after seeding, with legumes following grasses. A successful stand has the following characteristics: vigorous dark green or bluish (not yellow) seedlings; uniform density, with nurse plants, legumes, and grasses well intermixed; green leaves that remain green throughout the summer – at least at the plant bases.

If a stand has inadequate cover (less than 40% cover), reevaluate the choice of plant materials and quantities of lime and fertilizer. Reestablish the stand following seedbed preparation and seeding recommendations. Depending on the condition of the stand, repair by overseeding or reseeding after complete seedbed preparation. If timing is bad, overseed with rye grain or German millet to thicken the stand until a suitable time for seeding perennials. If the season prevents resowing, mulch or jute netting is an effective temporary cover. Consider seeding temporary, annual species if the season is not appropriate for permanent seeding. If vegetation fails to grow, test the soil to determine if low pH or nutrient imbalances are responsible. On a typical disturbed site, full plant establishment usually requires refertilization in the second growing season. Use soil tests to determine if more fertilizer needs to be added. Do not fertilize cool season grasses in late May through July. Grass that looks yellow might be nitrogen deficient. Do not use nitrogen fertilizer if the stand contains more than 20 percent legumes. Seeded areas should be fertilized during the second growing season. Lime and fertilize thereafter at periodic intervals.

- Coarse, high grasses that aren't mowed can create a fire hazard in some places. Very short mowed grass, however, provides less stability and filtering capacity.
- Grass planted to the edge of a watercourse may encourage fertilization and mowing near water's edge and increase nutrient and pesticide contamination.
- May require regular irrigation to establish and maintain.
- Depends initially on climate and weather for success.

REFERENCE

- California Stormwater BMP Handbook for Construction
- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- US EPA National Menu of Best Management Practices

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect seeded areas for failure. Conduct a follow-up survey after 1 year and replace all failed plants.

2.8. Dust Control

DESCRIPTION

Dust control is used to reduce the surface and air movement of dust and other fine particles during land disturbing activities, demolition and other construction activity. Dust control should be important part of all construction activities. Dust control will help prevent airborne substances that may present a health hazard, safety problems or harm animal or plant life throughout the course of construction. Dust control should be applied to all surfaces that are exposed to elements and can become dry quickly. This includes but is not limited to construction access roads, denuded areas and stockpiles.

Source: www.jericoservices.com/images/DustControlPage

DESIGN CONSIDERATIONS

- There are many forms of dust control that can be picked. The Engineer/Contractor should choose the appropriate method that correlates to the site and also type of use.
- Types of temporary methods of dust controls are vegetative cover, mulching, tillage, irrigation, spray-on adhesives, stone, barriers, and Calcium Chloride.
- Types of permanent methods of dust control are, permanent vegetation, and stone.
- A contractor shall only expose areas that are currently being worked on. A contractor should never de-nude an entire site at the beginning of a project. Limiting the amount of soil disturbance at one time should be a key objective to reducing the cost of dust control and also maintaining a better site environment.
- Dust Control should be performed when necessary. At no time should visible dust particle be seen in the air around a construction site.
- A contractor should develop a proper site plan that reduces the amount of area needed to be used to lay-down, access roads and other activities that disturb soils.
- Stockpiles should have dust control applied to them daily and should be permanently vegetated if left untouched for 14 days. Stockpiles may be covered with plastic provided they are not greater than 20' in diameter. The plastic should be properly secured at all times and should not move during high wind events.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (M)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Control
- Erosion Control

APPLICABILITY

- On all sites where bare soils will be exposed and dust can be transported by wind, traffic and other methods.

ADVANTAGES

- Reduce the amount of sediment pollution that can enter the air and effect air quality in nearby areas.
- Site remains clean and free of airborne dust particles

MAINTENANCE CONSIDERATIONS

Depending on the phasing plan, soil type and dust control selection, dust control can either require extensive maintenance or very little maintenance. The contractor should decide on a practice that is best suited for the project. The basic rule is, once dust is starting to be seen in the air either from wind, truck traffic, or other forces a re-application of the dust control measure should be applied.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Dust control should re-applied immediately once the appearance of dust has occurred.

LIMITATIONS

- Depending on type of dust control my require daily application and constant maintenance.
- Can be costly if not done properly.
- Contractor can reduce the pervious characteristics of the soil if some types of dust control are applied to heavily.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Virginia Erosion and Sediment Control Handbook.
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

2.9. Construction Safety Fence

DESCRIPTION

The purpose of safety fence around a site and within a site is to protect the general public and also the workers on site from entering an area with an apparent danger. The safety for the general public and workers must be considered at both the planning and implementation phases of any and all land disturbing activities. Generally speaking safety fence shall be placed around the entire site to control access by not allowing the public into the area. In addition safety fence should also be considered around large trenching operations, overhead dangers and any other danger that poses a threat to workers on site. In general there are two type of construction fence, chain link fencing and plastic (Polyethylene) fence.

Source: www.shawnee.edu/off/com/uc/TL%20Photos

DESIGN CONSIDERATIONS

- Safety fences should be placed at locations so that a formidable barrier is created to prevent undesirable access, while allowing for construction activities to continue.
- The height of fencing should be 5 feet for plastic fence and 8 feet for all metal (chain link) fencing. A fence should be tall enough to prevent children from climbing over it.
- Signs shall be posted every 50 feet along the fence line warning anyone approaching the area that a danger lies ahead. Signs can read "DANGER-KEEP OUT", "HAZARDOUS AREA", or any other warning.
- Plastic fencing may be used as a safety fence, primarily in temporary situation. The fencing should be meet the physical requirements in the table below:
- Plastic fencing shall be secured to a metal "T" or "U" post driven into the ground to a minimum depth of 18". Post shall be placed 6 feet on center.
- Metal fencing should be placed when a hazard will be created for an extend period of time, i.e. site work for a construction project last more than 3 months, when the general public is exposed to a risk and unwanted entry is undesired. The metal fencing should be the requirements in the table below.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (NR)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Access Control

APPLICABILITY

- Typically installed around all construction site and in areas of danger.

ADVANTAGES

- Can improve both the appearance and the public perception of the construction project.
- Help keep out unwanted persons from entering the construction site and rick being injured.
- Help works onsite from entering any areas that may be deemed a hazard within the projects limits.

- Metal safety fence posts shall be installed at 10 feet on center. When determining spacing, the measurement will be made parallel with the ground surface.
- Post shall be set in concrete, backfilled or anchored by other acceptable means. When set in concrete the post shall be placed at least 18" below the surface with 6" of concrete on all sides. When backfilled the post shall be placed at least 24" below grade and the area backfilled with common burrow and compacted to at least 95%. Any other acceptable methods of anchoring shall be constructed so the fence does not fall during wind events.
- Wind screen shall not be placed on a fence until at least 7 days has passed from the time of installation. Wind screen shall be securely fastened by means of clips at the post intervals every 15" and at least every 2 feet on the top on bottom rails. Wind holes shall be placed in the screen as deemed necessary by the contractor or resident engineer.

MAINTENANCE CONSIDERATIONS

Maintain safety fences until the construction site has been fully stabilized. Safety fences shall be checked regularly for any weather or other type of damage. Sections should be replaced within 24 hours once damage is discovered. Care and maintenance attention should be given to all access points (gates) at the end of the work day. All locking devices shall be repaired if broken and be in working order throughout the life of the fence.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect fence for tears, rips or any other structural abnormality. Repairs should be made with 24 hours.

LIMITATIONS

- Design of safety fence is often looked past due diligence must be placed on the contractor to ensure proper site safety.
- High winds can blow fences over possible injuring those near the fence, extreme care must be used to ensure the fence is properly anchored.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Virginia Erosion and Sediment Control Handbook.
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

2.10. Construction Entrance Stabilization

DESCRIPTION

The purpose of stabilizing entrances to a construction site is to minimize the amount of sediment leaving the area as mud and sediment attached to vehicles. Installing a pad of gravel over filter cloth where construction traffic leaves a site can help stabilize a construction entrance. As a vehicle drives over the pad, the pad removes mud and sediment from the wheels and reduces soil transport off the site. The filter cloth separates the gravel from the soil below, keeping the gravel from being ground into the soil. The fabric also reduces the amount of rutting caused by vehicle tires. It spreads the vehicle's weight over a soil area larger than the tire width. In addition to using a gravel pad, a vehicle washing station can be established at the site entrance. Using wash stations routinely can remove a lot of sediment from vehicles before they leave the site. Diverting runoff from vehicle washing stations into a sediment trap helps to make sure the sediment from vehicles stays onsite and is handled properly. Stabilized construction entrances should be used in conjunction with stabilized construction roads to reduce the amount of mud picked up by vehicles.

DESIGN CONSIDERATIONS

Entrance Design

- Stabilize all entrances to a site before construction and further site disturbance begin. Make sure the stabilized site entrances are long and wide enough to allow the largest construction vehicle that will enter the site to fit through with room to spare.
- If many vehicles are expected to use an entrance in any one day, make the site entrance wide enough for two vehicles to pass at the same time with room on either side of each vehicle.
- If a site entrance leads to a paved road, make the end of the entrance flared so that long vehicles do not leave the stabilized area when they turn onto or off the paved roadway.
- If a construction site entrance crosses a stream, swale, or other depression, provide a bridge or culvert to prevent erosion from unprotected banks.
- Avoid locating at curves in public roads or on steep slopes.

Preparation

- A filter fabric should be installed down-gradient from the

Source: The Northern Virginia Soil and Water Conservation District - Fairfax County, Virginia.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Control

APPLICABILITY

- Typically installed where construction traffic leaves or enters an existing paved road.
- Should be extended to any roadway or entrance where vehicles enter or leave the site.

ADVANTAGES

- Can improve both the appearance and the public perception of the construction project.
- Mud on vehicle tires is significantly reduced which

construction entrance in order to contain any sediment-laden runoff from the entrance.

- Remove all vegetation and other objectionable material from foundation area. Grade and crown foundation for positive drainage.
- A geotextile filter fabric should be placed between the stone fill and the earth surface below the pad to reduce the migration of soil particles from the underlying soil into the stone and vice versa. Filter cloth is not required for a single family residence lot.
- If the slope toward the road exceeds 2%, construct a ridge 6 to 8 in. high with 3:1 side slopes, across the foundation approximately 15 ft from the entrance to divert runoff away from the public road.
- All surface water that is flowing to or diverted toward the construction entrance should be piped beneath the entrance. If piping is impractical, a berm with 5:1 slopes that can be crossed by vehicles may be substituted for the pipe.

Gravel Pad

- Stone for a stabilized construction entrance must be 1 to 3 in. stone, reclaimed stone, or recycled concrete equivalent placed on a stable foundation as specified in the approved Erosion and Sediment Control Plan.
- Make sure stone and gravel used to stabilize the construction site entrance area large enough so that they are not carried offsite by vehicles.
- Avoid sharp-edged stone to reduce the possibility of puncturing tires.
- Minimum length of the gravel pad should be 50 ft, except for a single residential lot where a 30 ft minimum length may be used. Longer entrances will provide better cleaning action. The pad should extend the full width of the construction access road or 10 ft whichever is greater. The aggregate should be placed at least 6 in. thick.
- Install stone or gravel at a depth of at least 6 in. for the entire length and width of the stabilized construction entrance.

Washing

- If gravel pad is not sufficient to remove majority of mud from vehicle tires, tires must be washed before vehicle enters public road.

avoids hazards caused by depositing sediments on public roadways.

- Sediment, which is otherwise contained on site, does not enter stormwater runoff elsewhere.

LIMITATIONS

- Some soil might still be deposited from vehicle tires onto paved surfaces.
- A reliable water source to wash vehicles before leaving the site might not be initially available. Trucking water to the site creates an additional cost.
- This practice will only be effective if sediment controls are used throughout the rest of the construction site.
- Effective only if installed at every entrance/exit.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

- The wash area should be a level area with 3 in. washed stone minimum, or a commercial rack. Wash water should be directed into a sediment trap, vegetated filter strip, or other approved sediment trapping device. Sediment should be prevented from entering any watercourses.

MAINTENANCE CONSIDERATIONS

Maintain stabilization of the site entrance(s) until the rest of the construction site has been fully stabilized. All temporary erosion and sediment control measures should be removed within 30 days after final site stabilization is achieved or after the temporary practices are no longer needed. Addition of stone and gravel periodically to each stabilized construction site entrance might be necessary to keep the entrance effective. If entrance becomes clogged with mud, stones should be replaced. Sweep up soil tracked offsite immediately for proper disposal. For sites with wash racks at each site entrance, construct sediment traps and maintain them for the life of the project. Periodically remove sediment from the traps to make sure they keep working. To further reduce the chance of sediments polluting stormwater runoff, sweep the paved area adjacent to the stabilized site entrance.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect gravel for clogging and the pad for bare spots. Inspect roadways and adjacent paved areas for tracked sediments.

2.11. Filter Berm

DESCRIPTION

A gravel or stone filter berm is a temporary ridge made up of loose gravel, stone, or crushed rock. It slows and filters flow and diverts it from an open traffic area. It acts as an efficient form of sediment control. One type of filter berm is the continuous berm, a geosynthetic fabric berm that captures sand, rock, and soil.

Source: US EPA website.

DESIGN CONSIDERATIONS

- Use well-graded gravel or crushed rock to build the berm, with rock size ranging from ¾ in. to 3 in. in diameter and containing less than 5 percent fines.
- Space berms according to the steepness of the slope. Space them closer together as the slope increases.

Berm dimensions:

- 1 ft high
- 3:1 side slopes
- 8 linear ft per 1 cfs of runoff based on the 10 yr 24 hr design storm.

Spacing of berms:

- Every 300 ft on slopes less than 5%.
- Every 200 ft. on slopes between 5% and 10%.
- Every 100 ft. on slopes greater than 10%.

MAINTENANCE CONSIDERATIONS

It is important to make repairs at the first sign of deterioration to keep the berm functioning properly. Accumulated sediment should be removed and properly disposed of and the filter material replaced as necessary. Regular inspection should indicate how often sediment needs to be removed.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect for accumulated sediments and deterioration of the berm. Inspect and repair immediately if damaged by construction traffic.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (M)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Control
- Runoff Control

APPLICABILITY

- Where a temporary measure is needed to retain sediment from the right-of-way or in traffic areas on construction sites.
- Intended to be used only in gently sloping areas (less than 10 percent).

ADVANTAGES

- Reduces speed of runoff.
- Efficient method of sediment control.

LIMITATIONS

- Do not last very long unless they are maintained regularly because they are prone to

clogging with mud and soil.

- Can be difficult to maintain because of clogging from mud and soil on vehicle tires.
- Gravel filter berm is more expensive to install than other practices which use materials found on-site.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- US EPA National Menu of Best Management Practices

2.12.Silt Fence

DESCRIPTION

Silt fences remove sediment partially by filtering runoff and partially by slowing it down, providing opportunity for settling. Silt fences are geotextile, semi-permeable sheets supported by posts and anchored in the ground to intercept sediment-laden runoff. Silt fences are used as temporary perimeter controls around sites where construction activities will disturb the soil. They can also be used around the interior of the site. When installed correctly and inspected frequently, silt fences can be an effective barrier to sediment leaving the site in stormwater runoff.

Source: Lake County Ohio Stormwater Management Department.

DESIGN CONSIDERATIONS

- The material for silt fences should be a pervious sheet of synthetic fabric such as polypropylene, nylon, polyester, or polyethylene yarn. Choose the material based on the minimum synthetic fabric requirements shown in the table below.

Minimum Requirements for Silt Fence Construction:

Physical property	Requirements
Filtering efficiency	75%-85% (minimum): highly dependent on local conditions
Tensile strength at 20% (maximum) Elongation	Standard strength: 30 lb/linear in. (minimum) Extra strength: 50 lb/linear in. (minimum)
Ultraviolet radiation	90% (minimum)
Slurry flow rate	0.3 gal/ft^2/min (minimum)
Tensile Strength	124 LBS
Elongation	15%
Puncture	65 LBS
Mullen Burst	300 PSI
Trapezodail Tear	65 LBS
UV Resistance	70%
Apperent Opening Size	30 US sieve
Water Flow Rate	10 GPM/FT^2

Source: US EPA National Menu of Best Management Practices

- If a standard-strength fabric is used, it can be reinforced with wire mesh behind the filter fabric. This increases the effective life of the fence. The maximum life expectancy for synthetic fabric silt fences is about 6 months, depending on the amount

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (H)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Control

APPLICABILITY

- Construction sites with relatively small drainage areas. Drainage area for silt fences should not exceed 0.25 acre per 100 ft. fence length.
- Appropriate for areas where runoff will occur as low-level flow, not exceeding 0.5 cfs.
- The slope length above the fence should not exceed 100 ft.
- Do not install across streams, ditches or waterways.
- Where there is no concentration of water in a channel or other drainage

of rainfall and runoff. Burlap fences have a much shorter useful life span, usually up to 2 months.

- The stakes used to anchor the filter fabric should be wood or metal. Wooden stakes should be at least 5 ft. long and have a minimum diameter of 2 in. if a hardwood like oak is ued. Stakes from soft woods like pine should be at least 4 in. in diameter. When using metal posts in place of wooden stakes, they should weigh at least 1.00 to 1.33 lb/linear ft. If metal posts are used, attachment points are needed for fastening the filter fabric with wire ties.

- Erect silt fence in a continuous fashion from a single roll of fabric to eliminate gaps in the fence. If a continuous roll of fabric is not available, overlap the fabric from both directions only at stakes or posts. Overlap at least 6 in. Excavate a trench to bury the bottom of the fabric fence at least 6 in. below the ground surface. This helps to prevent gaps from forming near the ground surface. Gaps would make the fencing useless as a sediment barrier.

- Consider installing an orange mesh fence adjacent to the silt fence to alert construction equipment and other vehicles of the location.

- The height of the fence posts should be 30 to 36 in. above the original ground surface. If standard-strength fabric is used with wire mesh, space the posts no more than 10 ft. apart. If extra-strength fabric is used without wire mesh reinforcement, space the posts no more than 6 ft. apart.

- The fence should be designed to withstand the runoff from a 10-year peak storm event. Once installed, it should remain in place until all areas upslope have been permanently stabilized by vegetation or other means.

- The fence should be located where it will trap sediment; that is, where there will be contributing runoff. A silt fence located along the top of a ridge or at the upper end of a drainage area serves no useful purpose, except as it may be used to mark the limits of a construction area.

- Silt fences have a low permeability to enhance sediment trapping. This will create ponding conditions behind the fences, so they should not be located where ponding will cause property damage or a safety hazard. The sedimentation pool behind the fence is very effective and may reduce the need for sediment basins and traps.

- May be designed to store all the runoff from the design storm, above the fence, and drainage area is usually not more than 1.5 acres.

- Flow should not be concentrated, it should be spread out over many linear ft. of silt fence.

- Mainly used as a perimeter control.

ADVANTAGES

- Reduces the speed of runoff flow.

- Removes sediments and prevents downstream damage from sediment deposits.

- Minimal clearing and grubbing required for installation.

- Trap a much higher percentage of suspended sediments than straw bales.

LIMITATIONS

- Problems may arise from incorrect selection of filter fabric or from improper installation.

- Not an adequate method of runoff control for anything deeper than sheet or overland flow.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas

- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net

- US EPA National Menu of Best Management Practices

or located to allow bypass flow when temporary sedimentation pool reaches a predetermined level.

- Fence should be located so that water depth does not exceed one half of the silt fence height above the surface.
- Provide access to the location where sediment accumulates and provide reinforced, stabilized outlets for emergency overflow.
- Silt fence is most effective when used in conjunction with other practices such as perimeter dikes or diversions.

- Silt fence may be attached to permanent construction fencing as long as the post are metal with a weight at least 1.00 to 1.33 lb/linear ft. and are set 18" below grade and anchored by concrete.
- It is not necessary to used straw or hay bales together with silt fence.

MAINTENANCE CONSIDERATIONS

A silt fence requires a great deal of maintenance. Remove sediment deposits promptly to provide adequate storage volume for the next rain and to reduce pressure on the fence. Take care to avoid undermining fence during cleanout. If fabric tears, decomposes, or in any way becomes ineffective, replace it immediately. Replace burlap used in sediment fences after no more than 60 days. Remove all fencing materials after the contributing drainage area has been properly stabilized. Sediment deposits remaining after the fabric has been removed should be graded to conform with the existing topography and vegetated.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect fence for gaps, tears in fabric, and broken posts.

2.13.Inlet Protection Interior Devices

DESCRIPTION

Inlet protection systems are structures designed to filter sediment from runoff as it flows into an inlet device such as a catchbasin. Inlet protection is often a filtering device that is constructed on, around or near an inlet device. Inlet protection is used as a temporary filter for sediment laden runoff entering the storm drain system. Inlet protection should be located on all existing and proposed drainage structures. Additional protection will be need if the catchbasin has a curb inlet as well as a grate. When installed correctly and inspected frequently inlet protection can be an effective filter for removing sediment before it enters the storm drain system.

Source: http://www.acfenvironmental.com/images/SiltSack.jpg

DESIGN CONSIDERATIONS

- Inlet protection that is placed within a catchbasin shall be used for all roadways and areas associate with bikes, pedestrians and automobile use.
- The material for Inlet Protection should be a pervious material of synthetic fabric such as polypropylene, nylon, polyester, or polyethylene yarn. Choose the material based on the minimum synthetic fabric requirements shown in the table below.
- The Inlet Protection for roadways and traffic areas should be selected based on flow entering the catchbasin structure.
- Inlet Protection that is placed inside of a catchbasin or drop inlet shall meet the following requirements;
    - Dump Straps at bottom of device
    - Lifting loops at the top of the device
    - A restrain cord/rebar located half way up the device
    - Sewn edges using high strength nylon thread.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (H)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Control

APPLICABILITY

- Construction areas with relatively small drainage areas. Drainage area shall not exceed 1 acre without additional protection
- Should be sized according to flow
- Install in all catchbasins unless otherwise noted.
- Mainly used on all downstream catchbasins and selected upstream catchbasins.

Minimum Requirements for catch basin protection:

Regular Flow Inlet Protection	
Physical property	**Requirements**
Filtering efficiency	75%-85% (minimum): highly dependent on local conditions
Grab Tensile	390 LBS
Grab Elongation	30% (minimum)
Puncture	120 LBS
Mullen Burst	600 PSI
Trapezoid Tear	120 LBS
UV Resistance	90%
Apparent Opening	40 US Sieve
Flow Rate	40 Gal/Min/ft^2
Permittivity	0.55 Sec^-1

High Flow Inlet Protection	
Physical property	**Requirements**
Filtering efficiency	75%-85% (minimum): highly dependent on local conditions
Grab Tensile	390 LBS
Grab Elongation	30% (minimum)
Puncture	140 LBS
Mullen Burst	400 PSI
Trapezoid Tear	120 LBS
UV Resistance	90%
Apparent Opening	40 US Sieve
Flow Rate	175 Gal/Min/ft^2
Permittivity	1.5 Sec^-1

- The inlet protection device should be designed to withstand the runoff from a 10-year peak storm event. Once installed, it should remain in place until all areas upslope have been permanently stabilized by vegetation or other means.
- Inlet protection should be located in areas that receive runoff from any disturbed area including any catchbasin that collect runoff from truck traffic associated with

ADVANTAGES

- Removes sediments and prevents downstream damage from sediment deposits.
- Minimal clearing and grubbing required for installation.

LIMITATIONS

- Problems may arise from incorrect selection of filter fabric or from improper installation.
- Not installing over a curb inlet will greatly reduce the amount of TSS removed.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

construction.

- The inlet protection shall have an interior overflow in the material to allow for high flow events to by-pass device and enter the catchbasin without the device being removed.
- If a curb inlet is present then a sediment filtering/blocking fabric or material shall be placed in front of the inlet so that runoff is treated or blocked before entering the catchbasin.
- Provide access to the location where inlet protection has been placed. Do not place trailers, storage containers of stockpiles over the catchbasin.

MAINTENANCE CONSIDERATIONS

An inlet protection requires a great deal of maintenance. Remove sediment deposits promptly to ensure that runoff will flow through the catchbasin. If inlet protection device tears, decomposes, or in any way becomes ineffective, replace it immediately. Remove all inlet protection devices after the contributing drainage area has been properly stabilized.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect inlet protection devices for gaps, tears in fabric, and excessive debris build-up.

2.14.Inlet Protection Exterior Devices

DESCRIPTION

Inlet protection systems are structures designed to filter sediment from runoff as it flows into an inlet device such as a catchbasin. Inlet protection is often a filtering device that is constructed on, around or near an inlet device. Inlet protection is used as a temporary filter for sediment laden runoff entering the storm drain system. Inlet protection should be located on all existing and proposed drainage structures. When installed correctly and inspected frequently inlet protection can be an effective filter for removing sediment before it enters the storm drain system.

Source: Lake County Ohio Stormwater Management Department.

DESIGN CONSIDERATIONS

- Inlet devices that are placed on the exterior of a catchbasin should be designed to maximize longevity, maintenance and inlet protections.
- There are several different methods to protect inlets with exterior controls. These controls include but are not limited to; silt fence placed on the outside edges, block and gravel, filter fabric and gravel, etc….
- The exterior Inlet Protection shall be placed around a catchbasin that is not located in a roadway or an area that receive bicycle, pedestrian or any other traffic of that nature.
- The inlet protection device should be designed to withstand the runoff from a 10-year peak storm event. Once installed, it should remain in place until all areas upslope have been permanently stabilized by vegetation or other means.
- Inlet protection should be located in areas that receive runoff from any disturbed area including any catchbasin that collect runoff from truck traffic associated with construction.
- An exterior device can allow for some ponding to occur as long as there is no damage to surrounding properties and no pedestrian, bicycle or automobile traffic is affected.
- If a curb inlet is present then a sediment filtering/blocking fabric or material shall be placed in front of the inlet so that runoff is treated or blocked before entering the catchbasin.
- Provide access to the location where inlet protection has been placed. Do not place trailers, storage containers of stockpiles over the catchbasin.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (H)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Control

APPLICABILITY

- Construction areas with small or large drainage areas. Drainage area shall not exceed 2 acres without additional protection
- Should be sized according to flow
- Install in all catchbasins unless otherwise noted.
- Mainly used on all downstream catchbasins and selected upstream catchbasins.

MAINTENANCE CONSIDERATIONS

An inlet protection requires a great deal of maintenance. Remove sediment deposits promptly to ensure that runoff will flow through the catchbasin. If inlet protection device tears, decomposes, or in any way becomes ineffective, replace it immediately. Remove all inlet protection devices after the contributing drainage area has been properly stabilized.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect inlet protection devices for gaps, tears in fabric, and excessive debris build-up.

ADVANTAGES

- Removes sediments and prevents downstream damage from sediment deposits.
- Minimal clearing and grubbing required for installation.

LIMITATIONS

- Problems may arise from incorrect selection of material or from improper installation.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

2.15. Culvert Inlet Protection

DESCRIPTION

The purpose of Culvert Inlet Protection is to reduce the amount of sediment that can be transported directly in to a drainage system. Though there are few Culvert Inlets in Cambridge it is imperative that these structures be protected properly so that sediment does not flow into the City's drainage system. Culvert Inlet Protection is used as either a temporary or permanent solution to remove sediment and other debris before it enters the drainage system. There are several ways that culverts can be protected to reduce sediment load to the City's system.

Source: USDA-Natural Resources Conservation Service - Illinois

DESIGN CONSIDERATIONS

- There are two types of culver inlet protection that the City approves of, Silt Fence, Culvert Inlet Sediment Traps.
- The general design for both shall be constructed so that the clean out and disposal of trapped sediment minimizes interference with construction activities.
- The inlet protection be constructed so that any resulting ponding of stormwater will not cause excessive inconvenience or damage to adjacent areas or structures.
- Each culvert protection shall be designed for that specific inlet.

Silt Fence Culvert Inlet protection

- Silt fence shall be placed so that no runoff can enter the culvert untreated and is at least 6 feet away from the culvert opening,
- Silt fence shall be wire supported to promote strength of the material.
- The silt fence shall be place per the silt fence detail.
- The silt fence should be placed so that no concentrated flow is directed towards the fence, a level spreader should be used to promote sheet flow if necessary. If concentrated flow is anticipated than a Culvert Inlet Sediment Trap should be used.

Culvert Inlet Sediment Trap

- Rip-rap shall be placed and sized so that erosion does not occur around the area. The minimum mean size of the rip-rap should be no smaller than 6".

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (H)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Control

APPLICABILITY

- Should be used on all culver inlets located near a construction site
- Should be sized correctly to reduce the amount of total suspended solids in the runoff.

ADVANTAGES

- Able to handle large amounts of flow when constructed correctly
- If maintained properly the culvert inlet protection should have a fairly long life span 1-2 years.
- Removes sediments and prevents downstream damage from sediment deposits.

- An energy diffuser should be constructed no greater than 6 feet away from the from the culvert opening.

MAINTENANCE CONSIDERATIONS

A Culvert inlet protection requires a great deal of maintenance. Remove sediment deposits promptly to ensure that runoff will flow to the culvert. If inlet protection device tears, decomposes, or in any way becomes ineffective, replace it immediately. Remove all inlet protection devices after the contributing drainage area has been properly stabilized.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect silt fence for tears, rips or any other structural abnormality. Inspect Rip-rap for excess sediment build-up and any rocks that are out of place. Repairs should be made with 24 hours.

LIMITATIONS

- Significant ponding can occur around the culvert
- A large amount of clearing and grading maybe needed to be done to install proper inlet protection
- Problems may arise from incorrect selection of material or from improper installation.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Virginia Erosion and Sediment Control Handbook.
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

2.16. Culvert Outlet Protection (Rip-Rap Protection)

DESCRIPTION

The purpose of culvert outlet protection is to prevent erosion and scour occurring downstream from an outlet point. Culvert outlet protection also prevents scour and erosion to occur further downstream by reducing velocity levels, energy levels and stabilizing the flow from a concentrated flow. The outlet of pipes and structurally lined channels are critical erosion points. Stormwater that is transported through a conveyance system usually has a high velocity and a large energy capacity that needs to be reduced before the flow can be introduced into the receiving channel or body. Most culvert outlet protection has an energy dissipater at the end to absorb the impact and reduce the energy and velocity from stormwater discharge.

The most common form of culvert outlet protection is rip-rap, however concrete, asphalt and grass can also be used in limited areas. Culvert outlet protection is related to the outlet flow and the tail water level. In some cases where outlet protection is not feasible due to space, flows or financial reasons a stilling basin can be used. Acceptable designs can be found:

Hydraulic Design of Energy Dissipaters for Culvert and Channels, Hydraulic Engineering Circular No. 14, U.S. Dept. of Transportation, Federal Highway Administration, (83).

Hydraulic Design of Stilling Basins and Energy Dissipaters, Engineering Monograph NO. 25, U.S. Dept. of the Interior – Bureau of Reclamation, (74).

DESIGN CONSIDERATIONS

- All culvert outlet protections should be set at a zero grade for the entire distance of the outlet protection. The protection should be design to withstand all flow, velocity and energy associated with a 25-year storm event.
- Culvert outlet protection is directly associated with the tail water depth immediately below the pipe outlet. A manning equation may be used to determine tail water depth.
  - If the tail water is less than half the diameter of the outlet pipe, it shall be classified as a **Minimum Tail Water Condition.** If the tail water is greater than half the pipe diameter is shall be classified as a **Maximum Tail Water Condition.**
- Apron Length shall be determined from the curves according to

Source: USDA-Natural Resources Conservation Service - Illinois

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (M)
- Trash (M)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Control
- Erosion Control

APPLICABILITY

- At all downstream culverts that are directly affected by construction run off from the site-this will be at the discretion of the City Engineer.
- At any downstream culvert where erosion can take place.

ADVANTAGES

- Able to handle extremely small and large flows.
- Reduce the amount of scour and erosion that can occur downstream of the culvert.
- Once constructed can be left

tail water conditions

1. Minimum Tail Water – Use Plate 3.18-3
2. Maximum Tail Water – Use Plate 3.18-4

- The width of the apron shall extend along the bottom of the existing channel is one exists. The apron should extend up the channel banks to an elevation one foot above the maximum tail water depth of the top of bank, whichever is less.
- For outlets that do not flow into an existing channel, a channel should be constructed with a width that is at least equal to the pipe diameter plus 0.40 times the length of the apron.
- The side slopes for all types of outlet protections should be no steeper than 2:1 (horizontal: vertical)
- Culvert outlet protection should contain no bends, however if bends are necessary proper rip-rap sizing should be done around the edges of the corner to prevent scour from velocity changes. The bends should be design to have a Froude number of 1.0 or less.
- Rip-rap gradation should be done for all channels by calculating the D 50 stone size. The rip rap shall be composed of a well graded mixture down to one-inch size particles such that 50% of the mixture by weight shall be larger than the D 50 size as determined by the design procedure. The design mixture should be design primarily of larger stones but with a sufficient amount of smaller stones to fill voids and "lock" the rip-rap together. The largest diameter stone size should be no greater than 1 ½ times the size of the D 50 size. Refer to the chart for rip-rap weights and sizing.

in place for many years with limited maintenance

LIMITATIONS

- Can require a large footprint to be properly constructed.
- If the rip-rap is sized incorrectly it can wash out and significant damage to the channel and outlet can occur.
- Velocities need to be small enough so a hydraulic jump is not created.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Virginia Erosion and Sediment Control Handbook.
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices
- USDA-SCS

Size of Rip-Rap	
Weight (lbs)	**Mean Spherical Diameter (D 50) (feet)**
50	0.80
100	1.10
150	1.30
300	1.60
500	1.90
1,000	2.20
1,500	2.60
2,000	2.75
4,000	3.60
6,000	4.00
8,000	4.5
20,000	6.1

Source: VDOT Drainage Manual

- The depth of the rip-rap shall be at least 2 times the maximum stone diameter but not less than 6 inches.
- The stone should be roughed quarried and approximately rectangular. No stone shall appear smooth. The stone shall be hard and angular and should not weather or degrade over time. The stone should have a specific gravity of at least 2.5. Concrete rubble maybe used provided it has a density of at least 150 pounds per cubic foot and meets the above mentions conditions.
- Filter fabric or a granular filter should used to reduce the possibility of soil movement beneath the rip-rap lining.
- The end of the channel should have an energy dissipater to reduce the velocity and energy of the runoff before it enters the receiving channel. The flow out of the energy dissipater should be calculated so that it is below the permissible velocity of the receiving waters.

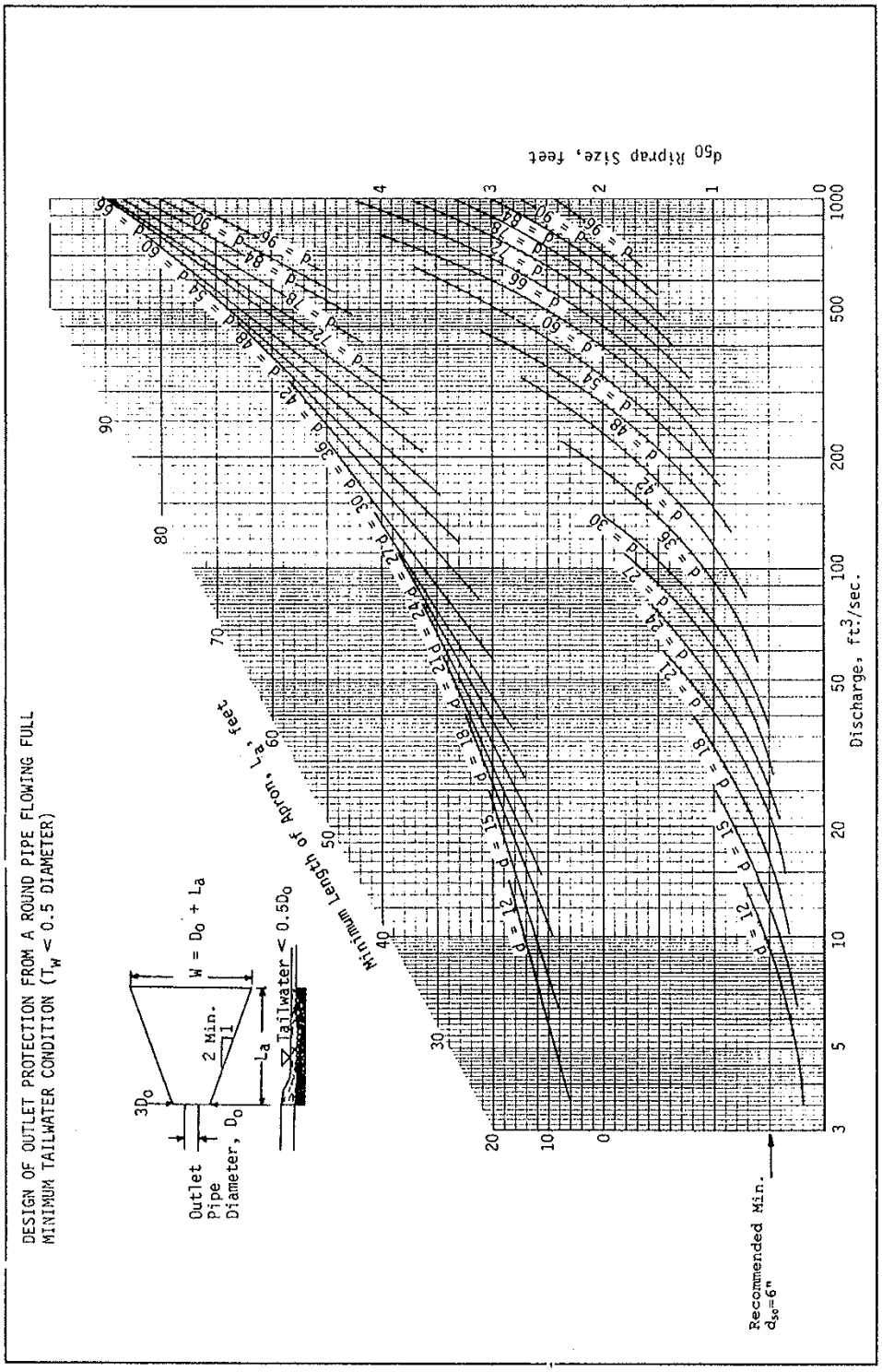
MAINTENANCE CONSIDERATIONS

Once installed completely there should be very little maintenance to the rip-rap. Rip-rap should be replaced once it appears that the stones have moved or area starting to become dislodged. Maintenance at the end of the rip-rap may need to occur if evidence of erosion of scour has appears.

INSPECTION CONSIDERATIONS

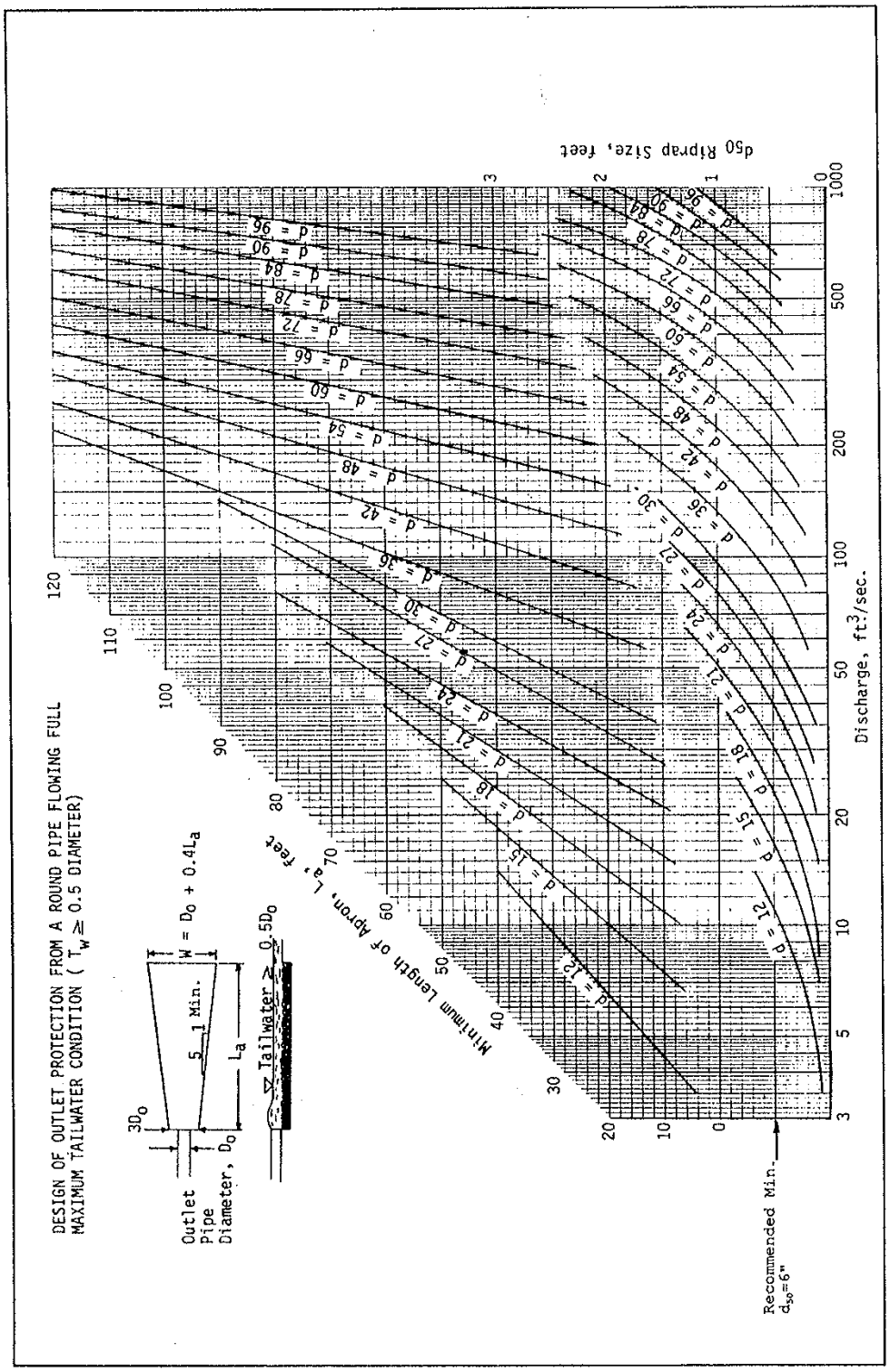
The rip-rap culvert protection should be inspected after all storm events that are greater than the 25-year design storm. Attention

should be placed on the side of the channel and also the bed to see if scour of erosion has taken place. Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect Rip-rap for excess sediment build-up and any rocks that are out of place. Repairs should be made with 24 hours.



Source: USDA-SCS

Plate 3.18-3



Source: USDA-SCS

Plate 3.18-4

2.17. Dewatering Devices

DESCRIPTION

There are several different types of dewatering practices that can be used for construction sites depending on the amount of groundwater, the size of your site and also the size available for dewater devices. Dewatering the act of removing water from an area and treating the water to remove a certain amount of sediment before discharging it back into the ground or the stormwater system. Most projects located within the limit of the City will need to do some dewatering due to high groundwater levels and rainfall and runoff entering a trench or work zone.

Source: www.syntexgeo.com/dewater.html

DESIGN CONSIDERATIONS

- A dewatering device should be sized appropriately so that the water does not overtop the structure.
- A dewatering device must be designed so that it removes at least 80% of all sediment in the water before it is discharged into the ground or a storm water collection system.
- At no time shall water from a dewatering device enter a body of water directly unless at least a 75 foot wide buffer zone is provided between the device and body of water.
- There are several types of dewater devices
- Dewatering bags are an allowable method of dewatering provided that the bag is properly designed and the sediment laden runoff is being treated.
- Chemical dewatering is acceptable provided the water is treated with an environmentally friendly, non-toxic, flocculation agent.
- Pump discharge can also be discharge through drilled holes or other methods of release.

Portable Sediment Tank (large sediment amounts)

- A portable sediment tank also known as a frac tank should be movable.
- The tank should be at least two feet deep and have at least two baffles within the tank. The baffles should be evenly spaced apart and be constructed out of metal, plastic or a geo-textile fabric that filters sediment.
- The tank shall be located in a location where it can be cleaned and maintained easily and also collect the most amount of sediment laden water.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Removal

APPLICABILITY

- For sites that have sediment laden discharge from dewatering activities

ADVANTAGES

- Can be small foot print depending on the type of unit selected.
- Removes a large amount of TSS from sediment laden runoff.
- Depending on the application can be relatively inexpensive.

LIMITATIONS

- May need a large foot print

- The tank should be sized accordingly:

  Pump Discharge (gpm) x 16 = cubic feet of storage required

- If the outfall is still sediment laden the size of the tank, the number of baffles, or the settling time should be increased to achieve the proper amount or sediment removal.
- The tank should be cleaned once sediment reach a quarter of the way up the tank or blocks any outlets.

Silt Fence Pit (medium sediment amounts)

- A silt fence pit is a de-watering device that allows sediment laden runoff to be filtered through silt fence and allowed to discharge onto the surrounding vegetated ground.
- The tank should be sized accordingly:

  Pump Discharge (gpm) x 16 = cubic feet of storage required

- A pervious filter fabric can be placed on the bottom of the storage area so water can be infiltrated back into the ground.
- The storage area can be excavated up to three feet below the toe of the silt fence provides the area is excavated at least 1 foot away from the silt fence.
- The storage area should not exceed 10 feet by feet.
- Pumps should be shut off once the water level has reached three fourths the way up on the silt fence.
- Sediment should be removed when it reaches a quarter the way up the silt fence or when the capacity of the area is less than 50% the designed amount.

Filter Box (small sediment amounts)

- A filter box should be made up of a sturdy material such as wood, metal or plastic.
- The filter box should be able to hold no more than 200 gpm.
- The tank should be sized accordingly:

  Pump Discharge (gpm) x 16 = cubic feet of storage required

- The Box should be lined with a geo-textile fabric similar to silt fence and also filled with clean crushed stone.
- The sediment laden runoff should not overtop the structure.
- The treated runoff can spill onto a vegetative surface, recharge into the ground or be pumped into the storm drainage system.

depending on the application

- Can be maintenance intensive is runoff is laden with high amounts of sediment.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Virginia Erosion and Sediment Control Handbook.
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

MAINTENANCE CONSIDERATIONS

Maintenance of these dewater devices should occur every time sediment laden runoff is entering the devices. The devices should be cleaned and maintained on a regular basis. If any damage occurs to the systems the dewatering devices should be taken off line immediately and all dewatering activities should stop until they are repaired or replaces. When draining a dewatering device the water should be removed from the top water surface elevation to the bottom to ensure that the sediment has been left undisturbed.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect the dewatering devices at every use. Dewatering devices should be cleaned once sediment reaches manufacturer, engineered, or required amounts. Repairs should be made immediately and all dewatering activities to the devices should be stopped while repair is being made.

2.18. Runoff Diversion

DESCRIPTION

Runoff diversion is meant to transport runoff to a catch basin, dewatering device, around a site and many other reasons. There are several types of diversion devices that can be used in coordination with other erosion and sediment control measures. A contractor should always keep sediment laden runoff on site to be treated, this may require a diversion structure to be built along the property line so that runoff can flow to a treatment area (dewatering, catchbasin that is protected, etc.). Diversion structures are often dug into the existing soil or a berm constructed on top the existing surface that allows runoff to be directed into another structure. A diversion structure can also be used to keep offsite watering from entering by diverting it around the site into a drainage structure, permanent or temporary.

DESIGN CONSIDERATIONS

- Diversion structures should be stabilized immediately with temporary or permanent vegetation to prevent erosion.
- Diversion structures should be one of the first erosion and sediment control devices put in on site to unsure once the area is disturbed no sediment laden runoff leaves the site view over land relief.
- The diversion structure should have a positive pitch from bottom to top to ensure that the area will properly drain to the drainage structure.
- A diversion structure can be constructed as a berm that is 18 inches high and a minimum of 4.5 feet wide with slopes no greater than 1 ½:1.
- A diversion structure can also have a ditch associated with it that is the shape of a trapezoid or smoothed channel. The excess fill can be used as berm.
- The diversion structure should have a channel slope that is less than or equal to 2% for the entire length. For slopes greater than 2% stabilization methods should be used.
- All diversion structures placed at the top of a slope shall be placed at least 2 feet from the top of the slope.
- The design channel should be able to pass the 10-year storm without over topping or erosion taking place.

Source: The Northern Virginia Soil and Water Conservation District - Fairfax County, Virginia.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (L)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Control
- Runoff Control

APPLICABILITY

- Should be placed in areas where runoff needs to be diverted to a dewatering structure.

ADVANTAGES

- Relatively easy to install, can be constructed using stabilized fill from site work
- Effective way to convey runoff to dewater structures.

MAINTENANCE CONSIDERATIONS

It is important to make repairs at the first sign of deterioration to keep the berm and channel functioning properly. At the first sign of the erosion the area should be removed and new material should be placed and compacted properly. Accumulated sediment should be removed and properly disposed of. Regular inspection should indicate how often sediment needs to be removed.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. The berm and channel should be inspected after every ½ inch rain event with in any given 24 hour period. Inspect for accumulated sediments and deterioration of the berm and channel. Inspect and repair immediately if damaged has occurred.

- Ensures that no runoff will leave the site and enter other properties.

LIMITATIONS

- Need to be properly stabilized before runoff conveyance is introduced.
- Maintenance can be extensive depending on the type of stabilization.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Virginia Erosion and Sediment Control Handbook.
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

2.19. Stream Bank Stabilization

DESCRIPTION

There are two types of stream bank stabilization that can be utilized, one being structural stream bank stabilization and the other being vegetative stream bank stabilization. Structural stream bank stabilization should consist of placed rip-rap, gabions or other means of a structural device such as a grid paver. Vegetative stabilization should utilize living plants to stabilize the stream banks. The vegetative stabilization methods should be used in areas where a natural looking design is needed and can also be used with bio-degradable mats to protect the areas from being eroded prematurely.

Source: The Northern Virginia Soil and Water Conservation District - Fairfax County, Virginia.

DESIGN CONSIDERATIONS

- Since each stream bank is different and sometimes sections of stream banks are different the engineer should review each section and place the appropriate stabilization method.
- Bottom scour should be controlled, by either structural stabilization or vegetative stabilization before any type of bank stabilization is constructed.
- Stabilization should be started and ended at stabilized or controlled points
- Special attention should be given to maintaining and improving habitat for fish, wild life, and other aquatic life.
- The design of stabilization should be based off the 10-year event for the body of water and the stabilization should withstands the velocities from these events with minimum damage,.
- All requirements to state, local and federal laws and permit should be met.
- Stabilize all areas as soon as the structural measures are complete.

Structural Stream Bank Stabilization

- Used when velocities along the stream bank exceed 5 ft/s or when substantial erosion and sediment control is needed.
- **Rip-rap**-heavy angular stone placed or dumped onto the stream bank to provide protection form erosive forces. Rip-rap sizing should be based on the velocity that is being exerted on the rip-rap. The
- **Gabions**-rectangular rock-filler wire baskets that are pervious, semi-flexible building blocks that can be connected to each other to for a armored wall for the stream bank.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (M)
- Trash (L)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Removal
- Erosion Control
- Site Planning and Management

APPLICABILITY

- For all stream, culvert, or water conveyance channels where erosion has been significant and needs to be addressed to reduce the loss of property, wildlife or other natural resources.

ADVANTAGES

- Depending on the type of application can be made to mimic the natural

- Gabions should be at a minimum designed with a hexagonal triple twist mesh of heavy galvanized wire that can be poly coated.
- The design of gabions should follow the below chart.

Gabion Thickness (inches)	Maximum Velocity(fps)
6”	6 fps
8”	11 fps
12”	14 fps

- **Reinforced Concrete-**maybe used when velocities are to erosive for other methods. Reinforced Concrete is very esthetically unappealing and should be considered a final option.
- **Grid Pavers-**modular concrete or plastic units that have spaced voids to allow for vegetative growth to take root. For use in areas that have high velocities and need a vegetative appearance.
- **Rolled Mats-**fiber rolled mats that staked into the current stream bank. Rolled mats should be made out off biodegradable material and should be used in correspondence with vegetative stabilization.

Vegetative Stream Bank Stabilization

- Used when velocities along the stream bank are below 5 ft/s and when a vegetative stream bank is desired.
- The following items should be considered when utilizing a vegetative stream bank stabilization approach.
  - The frequency of bank full flow based on anticipated watershed development.
  - The channels slope and flow velocity.
  - The antecedent soil conditions
  - Present and anticipated channel roughness
  - The location of bends along with current condition
  - The location of unstable terrain upslope from the stream bank.
  - Pollutants currently found in the water, a high pollutant load my inhibit plant growth
  - The presence of brackish water.
- The following items should be considered when utilizing a vegetative stream bank stabilization approach.

environment and create a channel that is environmentally friendly.

- Once a system is installed maintenance can be limited
- Helps protect the natural environment while limiting the amount of damage to the channel and any aquatic life.

LIMITATIONS

- Can be expensive depending on the length and size of the project.
- Special designs need to be considered for each application to ensure it is the most environmentally sound practice.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Virginia Erosion and Sediment Control Handbook.
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

MAINTENANCE CONSIDERATIONS

Maintenance of a stabilized stream bank varies with each application depending on amount of vegetation, steam velocity and any storm intensity and frequency. At a minimum all newly stabilized stream banks showed be carefully maintained for at least two years past installation. The banks should be examined for any erosion, ripping, tearing or deformation. Repairs should be made immediately and the area should be properly marked as an area of concern. For any stabilization method that does not call for vegetation, any vegetation should be removed and the area should be inspected for damage and repairs should be made immediately.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Steam bank stabilization should be checked after all rainfall events of ½ inch of rain within any given 24 hour period. Stream bank stabilization should be inspected for at least two years to ensure proper stabilization. Stream bank stabilization devices should be cleaned once sediment reaches manufacturer, engineered, or required amounts. Repairs should be made immediately and all dewatering activities to the devices should be stopped while repair is being made.

2.20. Turbidity Curtain

DESCRIPTION

A turbidity curtain is designed to greatly reduce the flow of sediment into a waterway by trapping the sediment and allowing it to settle to the bottom of the waterway in a controlled area. There are few locations within the City of Cambridge that would require a Turbidity Curtain to be placed when doing work, near the Charles River, Little River, Alewife Brook or Fresh Pond. A turbidity Curtain is placed when sediment is forced to enter a waterway due to shore bank work, dredging or filling near the area. A turbidity Curtain may also be placed at the discretion of the engineer/owner if sediment is entering a waterway.

Source: bmpinstalls.com

DESIGN CONSIDERATIONS

- A turbidity curtain should be designed to withstand all current in the waterway. The curtain should also be designed to withstand all tidal action and wave action in the water caused by natural forces and human forces.
- Turbidity curtains should extend the entire depth of the waterway whenever the waterway is not subject to tidal action and/or significant wind and wave forces.
- In tidal and/or wind and wave action situations, the curtain should never be so long as to touch the bottom. A minimum 1-foot space should exist between the ballast and the bottom of the skirt at calculated mean low water mark.
- Turbidity curtains should be located parallel to the direction of flow of a moving body of water. Turbidity curtains should not be placed across the main flow of a significantly moving body of water.
- When sizing the length of the floating curtain, allow an additional 25% variance in the straight-line measurements. This will allow for measuring errors, reduce stress from potential wave action during high winds and ease of installation.
- When determining the length of a curtain the design should have a minimum amount of joints. Joints should be no closer than 50 feet apart and no further away than 100 feet apart. This should provide maximum stability for the curtain.
- The ends of the curtain, both floating upper and weighted lower, should extend well up into the shoreline, especially if high water conditions are expected. The ends should be secured firmly to the shoreline (preferably to rigid bodies such piles or other weighted structures) to enclose the area fully where sediment

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (H)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (H)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Control

APPLICABILITY

- For all work that is being done on a shore line of a lake, river or stream.
- Also for work that may directly discharge into a lake, river Reduce the amount of TSS that can directly enter a waterway due to construction activities.

ADVANTAGES

- Greatly reduce the amount of TSS that can enter a waterway by creating a nearly impervious barrier between clean water and soil laden water.

may enter the water.

- When there is a specific need to extend the curtain to the bottom of the watercourse in tidal or moving water conditions, a heavy woven pervious filter fabric may be substituted for the normally recommended impervious geotextile. This creates a by-pass for water that will reduces the pressure on the curtain and keep it in the same relative location and shape during the rise and fall of tidal waters. The engineer should monitor the curtain during high flow events to ensure enough water is passing through the curtain so that excess pressure does not develop.
- Barriers should be bright yellow or international orange so that they stand out in contrast with the water.
- The seams of the fabric should be vulcanized, welded or sewn and should develop full strength of the fabric.
- Floatation devices should be buoyant units contained in an individual sleeve or collar that is attached to the curtain. The floatation device should be buoyant enough to hold the weight of the curtain and any sediment that has a force on the curtain.

MAINTENANCE CONSIDERATIONS

A turbidity curtain requires a great deal of maintenance. The curtain should be checked delay to ensure it is still in working order and has not been dislodged. Joints should be checked for weakness, rips, tears or other defects. Sediment levels should be checked after all storms greater than a half inch in any given 24 hour period. Sediment levels should also be checked twice a week to ensure no excessive buildup has occurred. Sediment should be removed once it is half way to the mean water surface elevation. While removing sediment extreme care must be used to ensure no sediment enters the unprotected waterway.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Inspect the turbidity curtain for tears, rips or any other structural abnormality. Repairs should be made with 24 hours.

- Relatively inexpensive to install.

LIMITATIONS

- Required maintenance daily to ensure it is still properly placed.
- Removal sediment behind the turbidity curtain can be difficult to complete.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Virginia Erosion and Sediment Control Handbook.
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices

2.21. Fiber Logs

DESCRIPTION

Fiber logs (also called fiber rolls or straw wattles) are tube-shaped erosion control devices filled with straw, flax, rice, coconut fiber material, or composted material. Each roll is wrapped with UV-degradable polypropylene netting for longevity or with 100 percent biodegradable materials like burlap, jute, or coir. Fiber rolls compliment permanent best management practices used for source control and revegetation. When installed in combination with straw mulch, erosion control blankets, hydraulic mulches, or bounded fiber matrices for slope stabilization, these devices reduce the effects of long or steep slopes. Fiber rolls also help to sow, filter, and spread overland flows. This helps to prevent erosion and minimizes rill and gully development. Fiber rolls help reduce sediment loads to receiving waters by filtering runoff and capturing sediments. They can provide protection for 3 to 5 years, slowly decomposing into mulch with the netting breaking down into small pieces.

Source: US EPA National Menu of Best Management Practices.

DESIGN CONSIDERATIONS

- Should be prefabricated rolls or rolled tubes of geotextile fabric. When rolling the tubes, make sure each tube is at least 8 inches in diameter. Bind the rolls at each end and every 4 feet along the length of the roll with jute-type twine.
- On slopes, install fiber rolls along the contour with a slight downward angle at the end of each row to prevent ponding at the midsection. Turn the ends of each fiber roll upslope to prevent runoff from flowing around the roll. Install fiber rolls in shallow trenches dug 3 to 5 inches deep for soft loamy soils, and 2 to 3 inches deep for hard, rocky soils. Determine the vertical spacing for slope installations on the basis of the slope gradient and soil type. A good rule of thumb is:

Slopes	Feet Apart
1:1	10
2:1	20
3:1	30
4:1	40

- Fiber rolls at the toe of slopes greater than 5:1 should be a minimum of 20 inches in diameter or installations achieving the same protection (i.e. stacked smaller diameter fiber rolls, etc.).
- For soft, loamy soils, place the rows closer together. For hard, rocky soils, place the rolls further apart. Stake fiber rolls securely

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (H)
- Trash (L)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Sediment Control

APPLICABILITY

- Fiber rolls placed along the shorelines of lakes and ponds provide immediate protection by dissipating the erosive force of small waves.
- Not to be used on slopes that are subject to creep, slumping, or landslide.
- Avoid using in channels that are actively incising or in reaches with large debris loads or potential for significant ice buildup.
- Can be used in areas of low

into the ground and orient them perpendicular to the slope. Biodegradable wood stakes or willow cuttings are recommended. Drive the stakes through the middle of the fiber roll and deep enough into the ground to anchor the roll in place. About 3 to 5 inches of the stake should stick out above the roll, and the stakes should be spaced 3 to 4 feet apart. A 24-inch stake is recommended for use on soft, loamy soils. An 18-inch stake is recommended for use on hard, rocky soils. Note that installation techniques will vary by manufacturer.

- Fiber rolls can also be used at projects with minimal slopes. Typically, the rolls are installed along sidewalks, on the bare lot side, to keep sediment from washing onto sidewalks and streets and into gutters and storm drains. For installations along sidewalks and behind street curbs, it might not be necessary to stake the fiber rolls, but trenches must still be dug. Fiber rolls placed around storm drains and inlets must be staked into the ground. These rolls should direct the flow of runoff toward a designated drainage area. Place them 1 to 1 ½ feet back from the storm drain or inlet.

MAINTENANCE CONSIDERATIONS:

Repair or replace split, torn, unraveled, or slumping fiber rolls. Fiber rolls are typically left in place on slopes. If they are removed, collect and dispose of the accumulated sediment. Fill and compact holes, trenches, depressions, or any other ground disturbance to blend with the surrounding landscape.

INSPECTION CONSIDERATIONS: Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines. Monitor fiber rolls daily during prolonged rain events. The inspection requirements of fiber rolls are minimal, but short term inspection is recommended to ensure that the rolls remain firmly anchored in place and are not crushed or damaged by equipment traffic.

shear stress.

- Have been used in a variety of areas: along highways and at construction sites, golf courses, ski areas, vineyards, and reclaimed mines.
- Suitable along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
- Suitable at the end of downward slope where it transitions to a steeper slope, along the perimeter of a project, down slope of exposed soil areas, as check dams in unlined ditches, or around temporary stockpiles.

ADVANTAGES

- Installation is easy, particularly in shallow soils and rocky material.
- Readily molded to fit the bank line.
- Do not obstruct hydraulic mulch and seed applications.
- Can be removed or left in place after vegetation has established.
- More adaptable to slope applications and contour installations than other erosion and sediment control practices.
- Blend in with the landscape and are less obtrusive than other erosion and sediment control practices.

LIMITATIONS

- Not effective unless they are trenched.
- Can be difficult to move once they are saturated.
- Have a very limited sediment capture zone.

- If not properly staked and entrenched, fiber rolls can be transported by high flows.

REFERENCES

- Massachusetts Stormwater Handbook
- US EPA National Menu of Best Management Practices
- California Stormwater BMP Handbook for Construction

2.22. Concrete Washout

DESCRIPTION

Concrete Washouts are used to contain standard concrete and also other types of concrete such as flow fill, grout etc...The washout area concentrates the concrete into a large single area or several smaller areas that will help ease in maintenance and cleanup of the site. The washout areas shall also prevent contrite spoils from spilling into stormwater catchbasin and polluting the downstream environment. It will also reduce the possibility of concrete spoils from clogging catchbasins or drainage pipes which can be costly to repair.

Source: www.cfpub.epa.gov

DESIGN CONSIDERATIONS

- Concrete washout areas must be located at least 50' from all catchbasins, open channels or any other structure that receives drainage runoff.
- A washout area can be either man made or prefabricated.
- Prefabricated structures shall be leak free and be designed to be able to handle the amount of anticipated volume. Secondary controls such as hay bales or fiver rolled socks shall also be placed around the perimeter of the structure to ensure that no concrete spoils can enter the drainage system.
- A man made structure can be design numerous ways. The designer shall take into consideration ground topography, location of drainage structures, and ease of use. These structures should be placed below grade when possible to help reduce the amount of spillage that can occur. Manmade structures shall also be leak proof.
- When designing a prefabricated or manmade structure it can be assumed that 7 gallons of wash water (Concrete Washout Systems, Inc., (2006)) will be used to clean the chute and equipment.
- The washout structure should provide at least 12" of free board to also reduce the chance of spillage.
- For sidewalk work the contractor may clean concrete trucks in an area of sidewalk that has all ready been removed. The contractor shall ensure that no spoilage enters the drainage system and that they are 50' away from the nearest catchbasin.

TARGETED CONSTITUENTS

- Bacteria (NR)
- Metals (NR)
- Nutrients (NR)
- Oil and Grease (NR)
- Organics (NR)
- Oxygen Demand (NR)
- Sediment (NR)
- Trash (NR)

Estimated Removal Efficiencies Key	
(H) High	(L) Low
(M) Moderate	(NR) Not Removed

OBJECTIVES

- Concrete Control

APPLICABILITY

- On all sites where concrete placement will occur.

ADVANTAGES

- Reduce the amount of concrete washout that can enter the storm drain system
- Concentrate concrete spoils to a single/multiple locations for easier site cleanup
- Prevents runoff of concrete spoils that may contaminate the site.

MAINTENANCE CONSIDERATIONS

The contractor should decide on a practice that is best suited for the project whether it is a manmade or prefabricated structures. The structures should be cleaned and concrete washout should be removed once it reaches at least 12" from the top. If concrete is spilled outside of the washout structure it should be cleaned immediately and the area should be adjusted to properly contain the concrete washout.

INSPECTION CONSIDERATIONS

Inspections should be performed in accordance with Section 4 of the Cambridge Stormwater Management Guidelines.

REFERENCE

- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Virginia Erosion and Sediment Control Handbook.
- Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net
- US EPA National Menu of Best Management Practices