Module 3: Onsite Practices

ESC Practices & Minimum Standards

Chapter 3 in the 1992 ESCHB is organized in such a way that it groups certain structural practices (as shown below).

Road stabilization practices prevent the tracking of dirt onto public roads, while sediment barriers filter sediment laden water. Dikes and diversion either: split up drainage area, reduce them in size, or prevent stormwater from entering an area. Sediment traps and basins filter water prior to discharge. Flumes allow stormwater to safely

flow down slopes. Waterway, outlet and stream protection protect onsite channels, outlets and off-site channels, respectively. Finally, excess water on a site can also be removed by subsurface drain.

Each chapter (practice) in Section 3 of the ESCHB is organized into a number of sections:

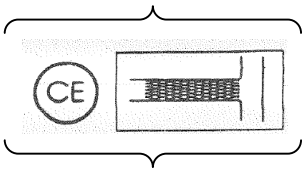
1. Definition
2. Purpose
3. Condition where practice applies
4. Planning considerations
5. Design criteria
6. Construction specifications
7. Maintenance

http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx

DEQ realizes that there are many more sediment control measures on the market; however, the practices in the 1992 ESCHB are generic and non proprietary. If a proponent of a project wishes to use a proprietary practice, this practice will need to be approved for use in that locality. Approval is done at the locality level, often in consultation with the local DEQ representative.

The following is a brief review of some selected sediment control practices.

3.02 Temporary Stone Construction Entrance (CE)



Construction entrances are stone "runways" located at the points of vehicular ingress and egress on a construction site.

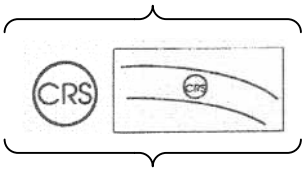
- Meant to reduce soil the transport onto public roads & paved areas.
- 6 inch thick – 12 feet wide & 70 feet long
- Must use filter cloth underneath VDOT #1 stone
- Wash rack may be used if water is carried to settling area
- MS-17

TAKE AWAY POINTS:

- Street requires frequent cleaning - Mud must be removed from paved area at the end of each day by shovel & broom
- Stone must be replaced or cleaned frequently

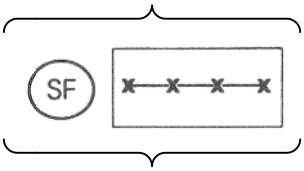
3.03 Construction Road Stabilization (CRS)

During wet weather, temporary stabilization with stone will reduce the mud and potential erosion



- 14 feet wide – one way; 20 feet wide two way traffic
- MS-17 & MS-1

3.05 Silt Fence (SF)



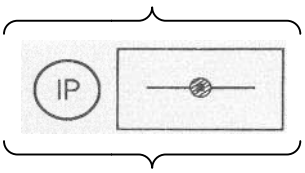
A silt fence is a temporary sediment barrier constructed of filter fabric and supported by pests and sometimes wire. As perimeter control they often installed as a first step measure (MS-4) and placed across or at the toe of a slope.

- Used to intercept sheet and rill flow; not concentrated. (i.e. flow must be ≤ 1 CFS)
- Drainage area limited to ¼ acre for 100 linear feet of barrier (total drainage area behind a silt fence cannot be wider that 100 feet).
- Height above ground; Min=16" & Max= 34

TAKE AWAY POINTS:

- Sheet flow only
- 4" deep and 4" wide trench on upslope side ➔ 8" of fabric in ditch
- Cleanout (½ barrier height)
- Check Stake spacing
- Must be removed at the end of a project per MS-18.

3.07 Storm Drain Inlet Protection (IP)



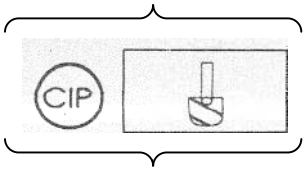
The 1992 ESCHB shows several types of storm drain inlet protection including drop inlets and curb inlets. Drainage area size limitation is 1 acre.

- Silt fence Type: 2 X 4 stakes for vertical and horizontal; spaced 3 feet apart
  Entrench fabric 12 inches around inlet
- Gravel and Wire: ½" wire mesh over inlet; place at least 12 inches of stone over the wire
- Concrete Block: ½" wire mesh over inlet; place at least 12 inches of stone over the wire
- MS-10 requires that inlet protection is provided on all inlets that are operational before final/permanent stabilization of the area.

TAKE AWAY POINTS:

Purpose – keep sediment out of storm sewer & prevent the need to vacuum and/or flush after construction

3.08 Culvert Inlet Protection (CIP)



Culvert inlet protection prevents sediment from entering into the culvert.

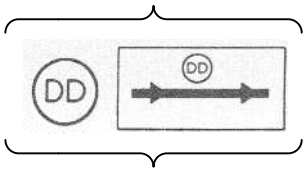
Types of culvert inlet protection include:

- Silt Fence:
  - Maximum life = 3 months
  - Minimum height = 16"; maximum height = 34"
- Sediment Trap:
  - Constructed per approved plan and specifications
  - Toe of riprap no closer than 24" from opening

TAKE AWAY POINTS:

- Culvert inlet protection is required by MS-10 & must be removed at the project's end (MS-18).

3.09 Temporary Diversion Dike (DD)



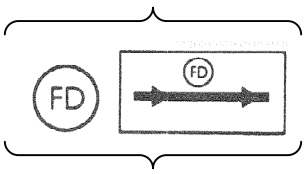
This is a ridge of compacted soil which is either used to divert water away from the project area, or divert water on-site to sediment trapping devices, water conveyances, or stabilized outlets (MS-11).

- Often constructed as first step measure (MS-4) or later on when site conditions change.
- They have a maximum drainage area size of 5 acre.

TAKE AWAY POINTS:

- Must be stabilized immediately after construction (MS-5)
- They have a maximum life of 18 months.

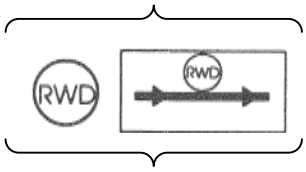
3.10 Temporary Fill Diversions (FD)



This is a diversion used for active (earth) fill areas. They address MS-7 in requiring stable fill slopes that are non-erodible and MS-8 which requires any concentrated runoff be directed down a slope in a controlled manner.

- Typically constructed at the end of the work day.
- Minimum height = 9 inches
- They have a maximum life span of one week; thus, do NOT need to be stabilized.
- Constructed to divert water from the slope to a stable outfall (MS-11).

3.11 Temporary Right-of-Way Diversions (RWD)



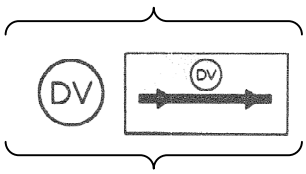
This is a ridge of compacted soil or loose gravel placed across a disturbed right-of-way. Practice is often seen on utility projects in hilly terrain.

- Constructed to reduce the flow length and divert the water to a stable outlet (MS-11).
- Min height 18 inches
- Needs proper spacing (p.63 of ESCH)
- Mountable by vehicles

TAKE AWAY POINTS:

- Remember Module 1 regarding slope steepness and length.
- If you see rills or small gullies forming, consider using this "speed bump"

3.12 Diversion (DV)



This is a permanent channel with a ridge on the lower (downslope) side. They are constructed to reduce slope length, divert stormwater runoff and are sometimes used as perimeter control.

- They must terminate in a stabilized outlet (MS-11)
- They must be designed to convey the runoff from a 10-year storm (MS-19).

TAKE AWAY POINTS:

- Must be stabilized immediately (MS-5) and prior to being made operational
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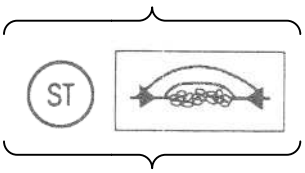
3.13 Temporary Sediment Trap (ST)



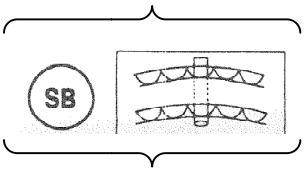
This is a small ponded area usually formed by constructing an earthen embankment along a slope or small drainage area. A stone weir/outlet is used to drain to drain this pond over a defined time. They are generally used as part of the perimeter controls for the project (MS-4).

- Per MS-6, traps can only treat runoff from less than 3 acres
- Storage capacity = 134 cubic yds./acre
- Must include 50% dry storage & 50% wet storage volume.

TAKE AWAY POINTS:

- Minimum Standard 5 requires they be **stabilized immediately**
- They have a maximum life of 18 months.
- Cleaned out when sediment reaches half the volume of the wet storage
- Determine a mark/measurement = half the wet storage volume
- Place sediment where it will NOT run back into the trap.

3.14 Temporary Sediment Basin (SB)



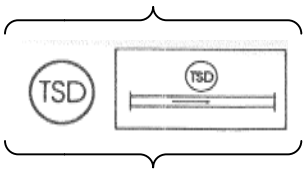
Sediment basins consist of a temporary barrier or dam with an engineered outfall structure that releases the water in a controlled manner. The structure is usually constructed across a drainage way at the low end of the project and must be designed by a qualified professional. They are generally used as part of the perimeter controls for the project (MS-4) and need to be stabilized before made functional (MS-5).

- Per MS-6, must be used to treat stormwater runoff from areas that are 3 acres or more
- Storage capacity = 134 cubic yds./acre
- Must include 50% dry storage & 50% wet storage volume.

TAKE AWAY POINTS:

- They have a maximum life of 18 months.
- Cleaned out when sediment reaches half the volume of the wet storage
- Mark the riser pipe at the clean out volume
- Make sure the low flow orifice is blocked during construction if structure will be converted permanent SWM pond after construction

3.15 Temporary Slope Drain (TSD)



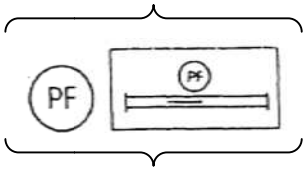
Temporary slope drains consist of flexible tubing that are installed on slopes and conduct concentrated runoff safely from the top to the bottom of the slope without causing erosion on or below the slope.

- They are required per MS-8.
- Maximum Drainage area is 5 acres
- Need to be sized according to table 3.15-A of ESCH

TAKE AWAY POINTS:

- Entrance of the drain is located at a low point
- Slope drain (pipe) must be properly anchored
- Outlet protect must be installed at the bottom

3.16 Paved Flumes (PF)



Paved flumes are permanently concrete lined channels constructed to conduct concentrated stormwater runoff from the top to the bottom of a slope without causing erosion on or below the slope.

- They are required per MS-8.
- Must have curtain walls top and bottom
- Expansion joints are required every 90 feet

TAKE AWAY POINTS:

- Outlet protection & energy dissipater
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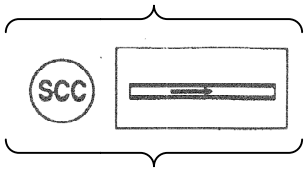
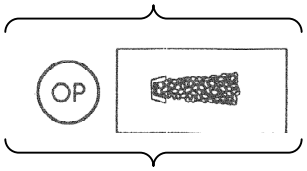


3.17 Stormwater Conveyance Channels (SCC)

These are permanent channels which can be grass, rip-rap, or concrete and are designed to carry concentrated flow without erosion. They may be used in combination with (permanent) diversions (3.12).

- Required to convey flows as per MS-19 and must be stabilized before operational (MS-5).
- Manmade must handle peak flow of 10 yr. storm
- Natural must handle peak flow of 2 yr. storm
- Must include outlet protection and discharge into an adequate channel

3.18 Outlet Protection (OP)



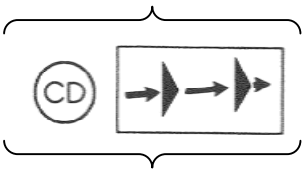
In order to reduce the erosive forces, MS-11 requires outlet protection in areas where stormwater either: a) leaves the project site or b) exits channels, stilling basins and/or storm drain outlets.

- Filter cloth under rock
- Provides a smooth transition with natural channel

TAKE AWAY POINTS:

- Installed at 0% grade
- Excavate, lay filter cloth, then install rock to design elevation, length and width

3.20 Rock Check Dam (CD)



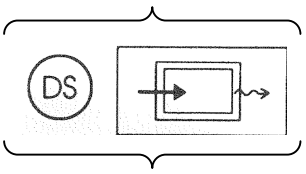
These are small temporary stone dams constructed across drainage ditches to reduce the velocity of concentrated flows; thus reducing the potential for erosion in swales and ditches.

- Two stone sizes depending on drainage area
- Max. height is 3 feet and middle should be 6 inches lower

TAKE AWAY POINTS:

- Remove accumulated sediment when it exceeds half the height of the dam
- Dispose/spread sediment proper
- Check dams are removed at the end of a project (MS 18).

3.26 Dewatering Structure (DS)



These are temporary settling and filtering devices for water that is discharged from dewatering (pumping) activities. Installed as per MS-11 & MS-16c.

- Storage capacity ($ft.^3$) should = 16 x pump discharge capacity (GPM)
- Clean-out at 1/3 the capacity

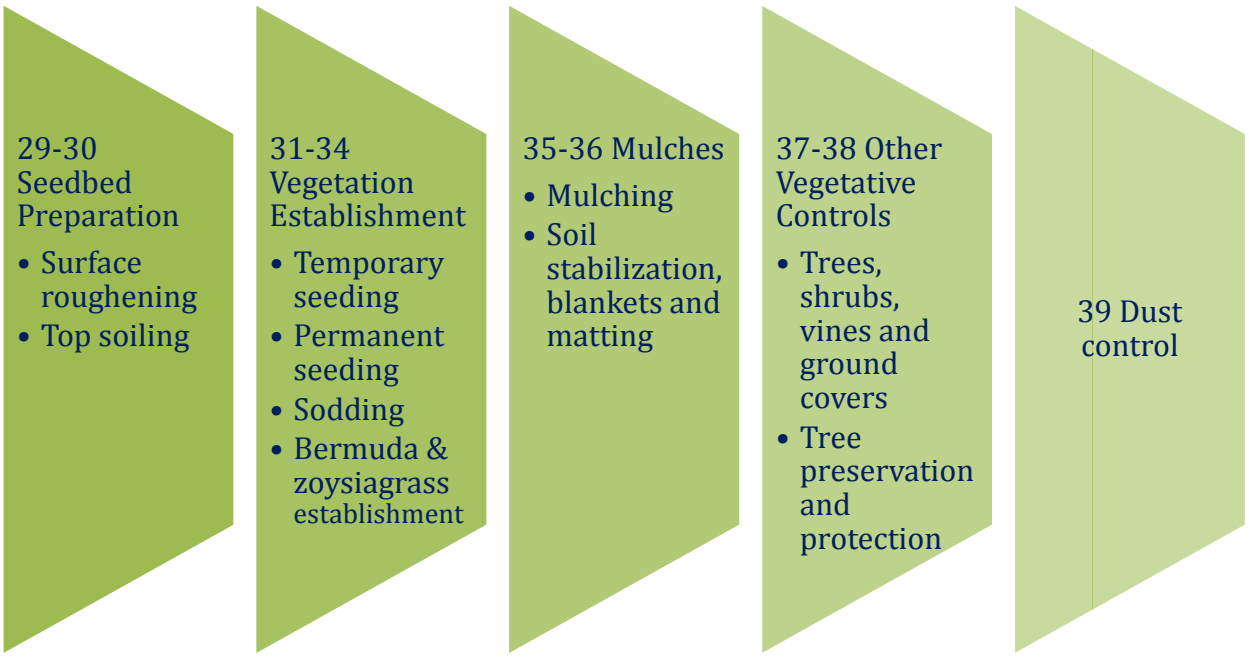
3.27 Turbidity Curtain (TC) -This is a floating geo-textile material which minimizes sediment transport from a disturbed area adjacent to or within a body of water. Installed as per MS-12 and MS-14.

Stablization & Vegetation

As we learned in module 1, good vegetation is 90+% effective in preventing erosion by protecting against raindrop impact. It also slows the runoff velocity and filters stormwater. Lastly, in the long run, it is less costly then structural practices, due to both capital and maintenance costs.

The ESC Plan should also consider preservation of existing vegetation, as it will serve to do the following:

- lessen construction costs,
- provide existing/native vegetation, and
- reduce the area disturbed (important for infiltration & SWM practices).

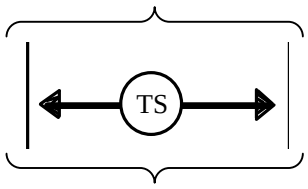


3.30 Topsoil (TO)

Topsoiling is the method of stripping, storing and spreading the surface layer of disturbed soil in order to obtain a more desirable planting and growing medium after a project area has been completed.

- Stockpiles must be stabilized (sediment barrier and/or seeding) in accordance with MS2.
- Any stockpiles off-site must be inspected and stabilized as well.
- topsoil is spread to a minimum depth of 2" on 3:1 or steeper slopes and 4" on flatter slopes
- A soil test is an inexpesive way to determine the proper amounts of nutrients need for plant establishement

3.31 Temporary Seeding (TS)

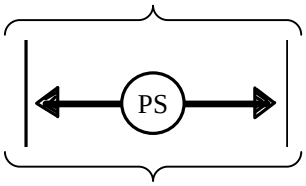


A good vegetative cover is approximately 90% to 100% efficient in reducing erosion and is by far the least expensive method in erosion and sediment control. This practice includes the establishment of a temporary vegetative cover on disturbed areas by seeding appropriate, rapidly growing annual plants

- As per MS-1, temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 14 days.
- Permanent stabilization shall be applied to areas that are to be left dormant for more than one year.

TAKE AWAY POINTS: Money spent on temporary seeding can pay for itself by reducing maintenance costs of the yemporay sediment control practices and can prevent damage on or off-site from sediment deposition.

3.32 Permanent Seeding (PS)



As inspectors we are concerned about the proper execution of the erosion and sediment control plan including: a) proper site preparation, b) the seeding process, c) mulching, d) plant establishment and maintenance, and e) any ongoing erosion during the plant establishment phase.

- soil should does not contain large amounts of rocks, woody materials, or construction debris
- Only, certified seed should be used
- seed is spread uniformly over the site; an
- site should be properly mulched (see 3.35).

TAKE AWAY POINTS:

- Permanent vegetation shall not be considered established until a ground cover is achieved that is uniform (e.g., evenly distributed), mature enough to survive, and will inhibit erosion
- Individuals lots in residential construction have 2 options:

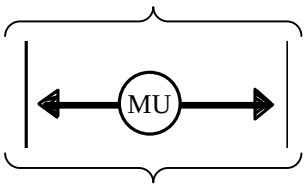
3.33 Sodding (SO)

Sodding is a specialty installation where establishment of vegetation is critical (such as high maintenance or slopes). When installed, inspections should ensure:

- Sod is laid in staggered rows
- Sod is tightly butted against each other
- Sod installed on steep slopes is anchored

TAKE AWAY POINTS:

- If sodding occurs during very dry weather, subsurface must be sprayed/wetted before installation
- Sod must be installed within 36 hours of harvesting



3.35 Mulch (MU)

Mulches are generally used in combination with permanent seeding or during periods when the area cannot be seeded (but a ground cover is required). The two major purposes for using mulch are to:

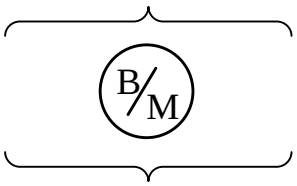
- protect the soil from raindrop impacts and
- provide a favorable microclimate for seed germination and plant establishment.

Types of mulch include: straw, hay, corn stalks, wood chips, bark, and fiber mulch.

- #1 choice of mulch is straw – applied at 2 tons/acre
- Fiber mulch – applied at 500-750 lbs/acre over straw mulch

TAKE AWAY POINTS: Mulch can also be used as a temporary ground cover to reduce erosion

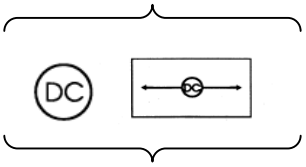
3.36 Blankets & Matting (BM)



Soil stabilization blankets are protective coverings or mat that are placed on top of planting areas located on steep slopes, channels or shorelines. They are generally divided into two classes:

- Treatment 1 is a (bio) degradable blanket used to protect the soil from raindrop impacts on slopes steeper than 3:1.
- Treatment 2 mats are non-degradable plastic structures which can be filled and planted. These mats become part of the soil surface and are resistant to the high energy generated by stormwater

3.39 Dust Control (DC)



Fugitive dust can be a significant cause in air pollution and it's important to control emissions. Excessive dust can contribute to health problems of neighbors, especially if they have pre-existing respiratory problems. Dust can also lead to complaints from deposits on cars, houses and other property. Major sources of dust are bare areas, haul roads, and general construction activities.

Dust Control Measures:

- Irrigation (water)
- Mulch
- Vegetative cover
- Tillage
- Spray on adhesives

ESC Practice & Minimum Standard (MS) Reference Guide				
Practice#	Description	Type	Primary MS	Other MS
3.01	Safety Fence*			
3.02	Construction Entrance*	S	MS 17	
3.03	Construction Road Stabilization*	S	MS 17	
3.04	Sediment Barrier-Straw*	S	MS 4	MS 3
3.05	Sediment Barrier-Fabric*	S	MS 4	MS 8
3.06	Brush Barrier*	S	MS 4	MS 8
3.07	Storm Inlet Protection*	S	MS 10	
3.08	Culvert Inlet Protection*	S	MS 10	
3.09	Temporary Diversion Dike*	S	MS 4	MS 5
3.10	Temporary Fill Diversion*	S	MS 8	MS 7
3.11	Temporary ROW Diversion*	S	MS 10	MS 11
3.12	Diversion	S	MS 4	
3.13	Sediment Trap*	S	MS 4 & 6a	MS 5
3.14	Sediment Basin	S	MS 4 & 6b	MS 5
3.15	Concentrated Slope Runoff - Temp	S	MS 8	MS 10 & 11
3.16	Concentrated Slope Runoff - Paved	S	MS 8	MS 10 & 11
3.17	SW Channel Lining	S	MS 11 & 19	MS 5 & 14
3.18	Outlet Protection	S	MS 11	
3.19	RipRap	S	MS 11 & 19	MS 7 & 9
3.20	Rock Check Dams*	S	MS 4 & 5	MS 3
3.21	Level Spreader	S	MS 11	
3.22	Immediate Stabilization-Earthen	V	MS 5	MS 15
3.23	Immediate Stabilization-Structural/Streambank	V	MS 15	MS 5
3.24	Vehicular Stream Crossing	S	MS 13	MS 14
3.25	Utility Stream Crossing	S	MS 12 & 13	MS 14
3.26	Dewatering (Utility Lines, etc.)	S	MS 16c & 19	MS 11
3.27	Turbidity Curtain*	S	MS 12	MS 14
3.28	Slope Water Seeps	S	MS 9	MS 9
3.29	Surface Roughening	V	MS1	MS 2
3.30	Topsoiling	V	MS 2	MS 3
3.31	Temporary Seeding (inc. soil stockpiles)	V	MS 1	MS 2 & 5
3.32	Permament Seeding (inc. soil stockpiles)	V	MS 3	MS2
3.33	Sodding	V	MS 1	MS 3
3.34	Bermudagrass & Zoysiagrass	V	MS 1 & 3	
3.35	Mulching	V	MS 1 & 3	MS 2 & 5
3.36	Soil Stabilization Blankets & Matting	V	MS 1 & 3	MS 7 & 19
3.37	Trees, Shrubs, Vines & Ground Cover	V	MS 1 & 3	MS 5
3.38	Tree Protection/Preservation	V	NA	
3.39	Dust Control	V	MS 1	MS 3
NA	Cut & Fill Slopes		MS 7	
NA	*Removal of Temporary Measures		MS 18*	

Minimum Standard #	Summary Description & Purpose of Minimum Standards
MS 1	Addresses permanent and temporary soil stabilization: within 7 days when site is at final grade and on sites that are not at final grade but remain dormant for more than 14 days.
MS 2	Soil Stockpiles and borrow areas must be stabilized or protected with sediment trapping measures. This includes off site/remote areas. According to MS-1, piles dormant > 14 days should be temporary seeded.
MS 3	Permanent Stabilization: must be applied to areas not otherwise permanently stabilized. Ground cover needs to be uniform, mature enough to survive and inhibit erosion.
MS 4	Perimeter controls (sediment basins, traps, perimeter dikes, sediment barriers or etc) must be installed as first measures in any LDA and shall be made functional before upslope LDA occurs.
MS 5	Stabilization practice shall be applied immediately to earthen structures (such as dams, dikes & diversions) after installation.
MS 6	Sediment traps & basins shall be designed & constructed based on the total drainage area they serve.
MS 7	Cut and fill slopes shall be designed & constructed in a manner that will minimize erosion.
MS 8	Concentrated runoff shall not flow down a cut or fill slope unless contained in an adequate temporary or permanent channel, flume or slope drain structure.
MS 9	Where water seeps from a slope face, adequate drainage or other protection shall be provided.
MS 10	All storm inlet made operable during construction must be protected so sediment laden water cannot enter without first being filtered.

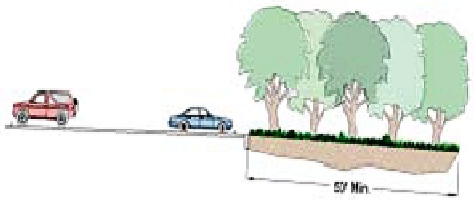
MS 11	**Before any newly constructed stormwater conveyance channel can be made operational, adequate protection and any required temporary or permanent channel lining shall be installed in both the conveyance channel & receiving channel.**
MS 12	**Minimize encroachment to live water course. Use non-erodible materials shall be used for constructing of causeways and coffer dams; earthen material may be used if armored by non-erodible material.**
MS 13	**When construction vehicles must cross a live water course more than twice in a 6 month period, a temporary stream crossing of non-erodible material must be provided.**
MS 14	**When working in a live water course, all applicable Federal, State and local regulations pertaining to the activity must be met.**
MS 15	**The bed and banks of a watercourse shall be stabilized immediately after work in the watercourse has been completed.**
MS 16	**Underground utility lines can have no more than 500 feet open trench and need to be stabilized as soon as possible. All dewatering operations shall be filtered before water leaves the site.**
MS 17	**Provisions shall be made to minimize the transport of sediment from the site onto paved surfaces.**
MS 18	**All temporary ESC measures shall be removed within 30 days of achieving a stabilized final grade or when the measure is no longer needed.**
MS 19	**Stormwater standard: Protect properties and waterways downstream of a LDA from erosion and sediment deposition due to increases in peak stormwater runoff.**

Design Specification No. 1: Rooftop (and impervious area) disconnection

This strategy involves managing runoff close to its source by intercepting, infiltrating, filtering, treating, or reusing it as it moves from the impervious surface to the drainage system. Two kinds of disconnection are allowed:

- Simple disconnection whereby rooftops and/or on-lot residential impervious surfaces are directed to pervious areas
- Disconnection leading to an alternative runoff reduction practice(s) adjacent to the roof

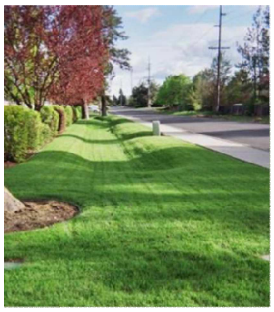
Design Specification No. 2: Sheet flow to a vegetated filter strip or conserved open space



Filter strips are vegetated areas that treat sheet flow delivered from adjacent impervious and managed turf areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. The two design variations are conserved open space and vegetated filter strips.

In both instances, stormwater must enter the filter strip or conserved open space as sheet flow. If the inflow is from a pipe or channel, an engineered level spreader must be designed in accordance with the DEQ criteria to convert the concentrated flow to sheet flow.

Design Specification No.3: Grass channels



Grass channels can provide a modest amount of runoff filtering and volume reduction within the stormwater conveyance system resulting in the delivery of less runoff and pollutants than a traditional system of curb and gutter, storm drain inlets, and pipes. The performance of grass channels will vary depending on the underlying soil permeability.

Grass channels can also be used to treat runoff from the managed turf areas of turf-intensive land uses, such as sports fields and golf courses, and drainage areas with combined impervious and turf cover (e.g., roads and yards).

Design Specification No. 4: Soil compost amendments

Soil restoration is an Environmental Site Design (ESD) practice applied after construction to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce the generation of runoff from compacted urban lawns and may also be used to enhance the runoff reduction performance of downspout disconnections, grass channels, and filter strips.

Design Specification No. 5: Vegetated roofs

Vegetated roofs are alternative roof surfaces that typically consist of waterproofing and drainage materials and an engineered growing media that is designed to support plant growth. Vegetated roofs capture and temporarily store stormwater runoff in the growing media before it is conveyed into the storm drain system. A portion of the captured stormwater evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites.

There are two different types of vegetated roof systems. The first, *intensive* vegetated roofs have a deeper growing media layer that ranges from 6 inches to 4 feet thick, which is planted with a wider variety of plants, including trees. The second, *extensive* systems typically have much shallower growing media (2 to 6 inches), which is planted with carefully selected drought tolerant vegetation. Extensive vegetated roofs are much lighter and less expensive than intensive vegetated roofs and are recommended for use on most development and redevelopment sites.

Design Specification No. 6: Rainwater harvesting

Rainwater harvesting systems intercept, divert, store, and release rainfall for future use. The term rainwater harvesting is used in this specification, but it is also known as a cistern or rainwater harvesting system. Rainwater that falls on a rooftop is collected and conveyed into an above- or below-ground storage tank where it can be used for non-potable water uses and on-site stormwater disposal/infiltration. Non-potable uses may include flushing of toilets and urinals inside buildings, landscape irrigation, exterior washing (e.g. car washes, building facades, sidewalks, street sweepers, fire trucks, etc.), and fire suppression (sprinkler) systems.

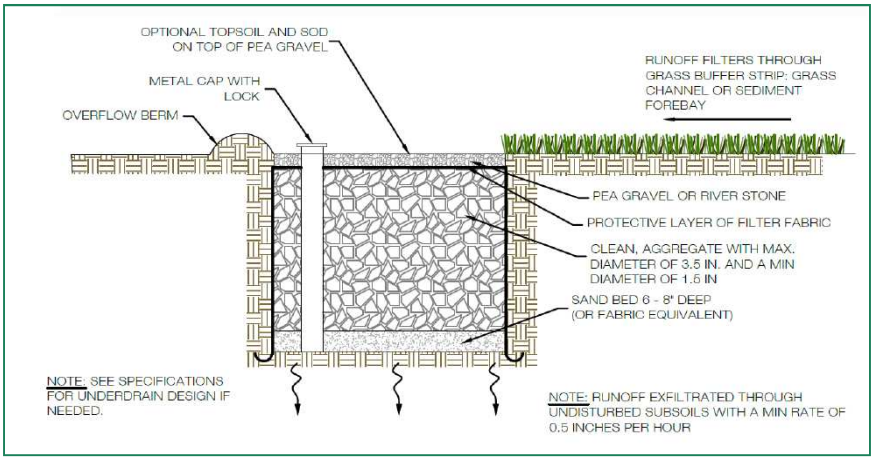
In many instances, rainwater harvesting can be combined with a secondary (down-gradient) runoff reduction practice to enhance runoff volume reduction rates and/or provide treatment of overflow from the rainwater harvesting system.

Design Specification No. 7: Permeable pavement

Permeable pavements are alternative paving surfaces that allow stormwater runoff to filter through voids in the pavement surface into an underlying stone reservoir, where it is temporarily stored and/or infiltrated. A variety of permeable pavement surfaces are available, including **pervious concrete**, **porous asphalt,** and permeable **interlocking concrete pavers**. While the specific design may vary, all permeable pavements have a similar structure, consisting of a surface pavement layer, an underlying stone aggregate reservoir layer and a filter layer or fabric installed on the bottom.

Design Specification No. 8: Infiltration

Infiltration practices use temporary surface or underground storage to allow incoming stormwater runoff to go into underlying soils. Runoff first passes through multiple pretreatment mechanisms to trap sediment and organic matter before it reaches the practice. As the stormwater penetrates the underlying soil, chemical and physical adsorption processes remove pollutants. Infiltration practices have the greatest runoff reduction capability of any stormwater practice and are suitable for use in residential and other urban areas where *measured* soil permeability rates exceed 1/2 inch per hour. To prevent possible groundwater contamination, infiltration should not be utilized at sites designated as stormwater hotspots.



Design Specification No. 9: Bioretention Basins

Individual bioretention areas can serve highly impervious drainage areas less than two acres in size. Surface runoff is directed into a shallow landscaped depression that incorporates many of the pollutant removal mechanisms that operate in forested ecosystems. The primary

component of a bioretention practice is the filter bed, which has a mixture of sand, soil, and organic material as the filtering media with a surface mulch layer. During storms, runoff temporarily ponds 6 to 12 inches above the mulch layer and then rapidly filters through the bed. Normally, the filtered runoff is collected in an underdrain and returned to the storm drain system. The underdrain consists of a perforated pipe in a gravel layer installed along the bottom of the filter bed. A bioretention facility with an underdrain system is commonly referred to as a *bioretention filter*. A bioretention facility without an underdrain system or with a storage sump in the bottom is commonly referred to as a b*ioretention basin*. Small-scale or micro-bioretention used on an individual residential lot is commonly referred to as a r*ain garden*.

Design Specification No. 10: Dry swales

Dry swales are essentially bioretention cells that are shallower, configured as linear channels, and covered with turf or other surface material (other than mulch and ornamental plants). They are a soil filter system that temporarily stores and then filters the desired treatment volume (Tv). Dry swales rely on a pre-mixed soil media filter below the channel that is similar to that used for bioretention. If soils are extremely permeable, runoff infiltrates into underlying soils. In most cases, however, the runoff treated by the soil media flows into an underdrain, which conveys treated runoff back to the conveyance system further downstream. The underdrain system consists of a perforated pipe within a gravel layer on the bottom of the swale, beneath the filter media. Dry swales may appear as simple grass channels with the same shape and turf cover, while others may have more elaborate landscaping. Swales can be planted with turf grass, tall meadow grasses, decorative herbaceous cover, or trees.

Design Specification No. 11: Wet swales

Wet swales can provide runoff filtering and treatment within the conveyance system and are a cross between a wetland and a swale. These linear wetland cells often intercept shallow groundwater to maintain a wetland plant community. The saturated soil and wetland vegetation provide an ideal environment for gravitational settling, biological uptake, and microbial activity. On-line or off-line cells are formed within the channel to create saturated soil or shallow standing water conditions (typically less than 6 inches deep).

Design Specification No. 12: Filtering practices

Stormwater filters are a useful practice to treat stormwater runoff from small, highly impervious sites. Stormwater filters capture, temporarily store, and treat stormwater runoff by passing it through an engineered filter media, collecting the filtered water in an underdrain, and then returning it back to the storm drainage system. The filter consists of two chambers: the first is devoted to settling, and the second serves as a filter bed consisting of sand or organic filter media.

Design Specification No. 13: Constructed wetlands

Constructed wetlands, sometimes called stormwater wetlands, are shallow depressions that receive stormwater inputs for water quality treatment. Wetlands are typically less than one-foot deep (although they have greater depths at the forebay and in micropools) and possess variable microtopography to promote dense and diverse wetland cover. Runoff from each new storm displaces runoff from previous storms, and the long residence time allows multiple pollutant removal processes to operate. The wetland environment provides an ideal environment for gravitational settling, biological uptake, and microbial activity. Constructed wetlands are the final element in the roof-to-stream runoff reduction sequence. They should only be considered for use after all other upland runoff reduction opportunities have been exhausted and there is still a remaining water quality or channel protection volume to manage.

Design Specification No. 14: Wet pond

Wet ponds consist of a permanent pool of standing water that promotes a better environment for gravitational settling, biological uptake, and microbial activity. Runoff from each new storm enters the pond and partially displaces pool water from previous storms. The pool also acts as a barrier to re-suspension of sediments and other pollutants deposited during prior storms. When sized properly, wet ponds have a residence time that ranges from many days to several weeks, which allows numerous pollutant removal mechanisms to operate. Wet ponds can also provide extended detention above the permanent pool to help meet channel protection requirements.

Design Specification No. 15: Extended detention (ED) pond

An Extended Detention (ED) Pond relies on 12 to 24 hour detention of stormwater runoff after each rain event. An under-sized outlet structure restricts stormwater flow so it backs up and is stored within the basin. The temporary ponding enables particulate pollutants to settle out and reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on banks of the receiving stream.

ED is normally combined with wet ponds (Design Specification No 14) or constructed wetlands (Design Specification No 13) to maximize pollutant removal rates. Designers should note that an ED pond is the final element in the roof to stream runoff reduction sequence, so one should be considered *only* if there is remaining treatment volume or channel protection volume to manage after all other upland runoff reduction practices have been considered and properly credited. Designers may need to submit documentation to the local plan review authority showing that all other runoff reduction opportunities have been exhausted and were found to be insufficient, leaving additional water quality or channel protection volume to manage.

Practice Number	BMP Practice
1	Rooftop disconnection
2	Sheet flow to vegetated filter or conserved open space 1
3	Grass channel
4	Soil amendments
5	Vegetated roof
6	Rainwater harvesting
7	Permeable pavement
8	Infiltration
9	Bioretention
10	Dry swale
11	Wet swale
12	Filtering practice
13	Constructed wetland
14	Wet pond
15	Extended detention pond

When these stormwater BMP's are being (or have been constructed), sediment is enemy. In order to ensure the enemy is kept at bay, the responsible land disturber/contractor can do thing so as the following:

- Perform maintenance on ESC practices as per the VESCP;
- Minimize the soils which will be compacted or disturbed;
- Install each BMP as per the approved plan;
- Follow the established construction sequence;
- Coordinate installation with the professional engineer.

The above is just a sampling of what module 4 will detail.