

BMP DESCRIPTIONS FOR STEPL AND REGION 5 MODEL

Animal Trails and Walkways.....	1
Animal Waste Management Systems	1
Bioretention Facility	2
Concrete Grid Pavement	2
Conservation Cover	3
Conservation Crop Rotation	3
Contour Farming.....	3
Cover and Green Manure.....	3
Critical Area Planting	3
Diversion.....	3
Dry Detention Basin	4
Extended Wet Detention Basin.....	4
Filter Strip.....	4
Grade Stabilization Structure.....	4
Grass Swale.....	4
Grassed Waterway	6
Hydromulch	6
Infiltration Basin	6
Infiltration Devices	6
Infiltration Trench.....	6
Oil/Grit Separator.....	7
Porous Pavement.....	7
Prescribed Grazing.....	7
Reduced Tillage Systems.....	8
Residue Management, Mulch Tilling	8
Road Dry Seeding and Hydraulic Seeding	8
Road Grass and Legume Seeding	9
Road Hydromulch (Hydromulch).....	9
Road Straw Mulch	9
Road Tree Planting	9
Runoff Management System.....	9
Sand Filter.....	9
Sand Filter/Infiltration Basin	10
Settling Basin.....	10
Soil Stabilization Measures (Forests Site Preparation).....	11
Hydromulch	11
Straw	11
Crimping	11
Seeding.....	11
Fertilizer.....	11
Transplanting	11
Net.....	11

Solids Separation Basin	11
Solids Separation Basin/Infiltration Bed	11
Straw Crimping.....	12
Stream Channel Stabilization.....	12
Streambank Protection	12
Streambank Fencing.....	13
Strip Cropping.....	13
Strip Cropping, Buffer	13
Strip Cropping, Contour.....	13
Strip Cropping, Field	14
Terrace	14
Vegetated Filter Strip.....	14
Waste Management Systems	14
Waste Storage Facility	14
Water and Sediment Control Basin.....	14
Weekly Street Sweeping.....	15
Wet Pond.....	15
Wetland Detention	15
Water Quality Inlets (Inlet Devices).....	16
References.....	16

Animal Trails and Walkways

Animal trails and walkways (Figure 1) are facilities designed to allow livestock or wildlife to move through difficult or ecologically sensitive terrain. They are intended to reduce erosion by providing or improving animals' access to forage, water, or shelter; improving grazing efficiency and distribution; and diverting travel away from ecologically sensitive or erosive sites.



Figure 1. Animal trails and walkways (USDA, Natural Resources Conservation Service).

Animal Waste Management Systems

Animal waste management systems comprise a variety of best management practices (BMPs) or combination of BMPs used at concentrated animal feeding operations (CAFOs) and farms to manage animal waste and related animal by-products. These systems include engineered facilities and management practices for the efficient collection, proper storage, necessary treatment, transportation, and distribution of waste. The BMPs are designed to reduce the discharge of nitrogen, phosphorus, pathogens, organic matter, heavy metals (such as zinc, copper, and occasionally arsenic, which are present in many animal rations), and odors. Example facilities and management methods are holding ponds, waste treatment ponds, composting, and manure management and land application.

Bioretention Facility

A bioretention facility or bioretention area consists of both a shallow depression or basin with a flow-regulating structure to control flow and a floor covered with specially engineered soil and plants to promote biological degradation of pollutants.

Concrete Grid Pavement

Concrete grid pavement (Figure 2) is a pavement surface that consists of strong structural materials having regularly interspersed void areas filled with pervious materials like sod, gravel or sand. The pervious materials enhance rainfall infiltration, reducing runoff.



Figure 2. Example of a concrete grid pavement used in an overflow parking area (ODNR 1992).

Conservation Cover

Conservation cover is the practice of establishing and maintaining perennial vegetative cover to protect soil and water resources on land that has been retired from agricultural production. It reduces soil erosion and sedimentation, improves water quality, and creates or enhances wildlife habitat.

Conservation Crop Rotation

Conservation crop rotation is the practice of growing different crops on the same piece of land in a planned sequence. This sequence might involve growing high-residue-producing crops such as corn or wheat in rotation with low-residue-producing crops such as vegetables or soybeans. The rotation might also involve growing forage crops in rotation with various field crops. Crop rotation can help reduce soil erosion and break insect, disease, and weed cycles.

Contour Farming

Contour farming includes tillage, planting, and other farming operations performed with the rows on or along the contour of the field slope. It helps to reduce sheet and rill erosion and the resulting transport of sediment and other waterborne contaminants.

Cover and Green Manure

Cover and green manure refers to a crop of close growing legumes or small grain grown primarily for seasonal protection and soil improvement. The crop is usually grown for one year or less, except where permanent cover is needed as in orchards. The crop controls erosion during periods when the major crops do not furnish adequate cover; and it adds organic material when it is plowed into the soil.

Critical Area Planting

Critical area planting is the planting of grasses, legumes, or other vegetation to stabilize slopes in small, severely eroding areas. The permanent vegetation stabilizes areas such as gullies, over-grazed hillsides and terraced backslopes. Although the primary goal is erosion control, the vegetation can also provide nesting cover for birds and small animals.

Diversion

Diversion is the redirection of a storm drain line or outfall channel so that it can temporarily discharge into a sediment trapping device. Its purpose is to prevent sediment

laden water from entering a watercourse, or public or private property through a storm drain system, or to temporarily provide underground conveyance of sediment laden water to a sediment trapping device. A diversion channel is constructed across a slope and has supporting earthen ridge on the lower side.

Dry Detention Basin

A dry detention basin is a storm water retention basin that remains dry except for short periods following large rainstorms or snowmelt events. Its main benefit is its moderating influence on peak flows, helping to control streambank erosion.

Extended Wet Detention Basin

An extended wet detention basin is a detention basin designed to increase the length of time that storm water is retained. This type of basin is typically configured in sections with a shallow forebay and a deeper permanent pool of water. The permanent pool of water provides a storage volume for pollutants to settle out. During large storm events, storm water temporarily fills the additional storage volume and is slowly released over a number of hours, reducing peak flow rates. Detention basins are often heavily vegetated so the vegetation can filter pollutants.

Filter Strip

A filter strip is a strip or area of vegetation for removing sediment, organic matter, and other pollutants from runoff and wastewater before they reach water bodies or water sources, including wells.

Grade Stabilization Structure

A grade stabilization structure is designed to reduce channel grade (steepness) in natural or constructed watercourses to prevent erosion of a channel that results from excessive grade in the channel bed (Figure 3). This practice allows the designer to adjust the channel grade to fit soil conditions.

Grass Swale

Grass swales (Figure 4) are elongated depressions in the land surface that are at least seasonally wet, usually heavily vegetated, and normally without flowing water. Swales direct storm water flows into primary drainage channels and allow some of the storm water to infiltrate into the ground surface. Swales are vegetated with erosion resistant,

and flood tolerant grasses. Sometimes check dams are strategically placed in swales to moderate flow, and an engineered soil mixture might underlie swales.

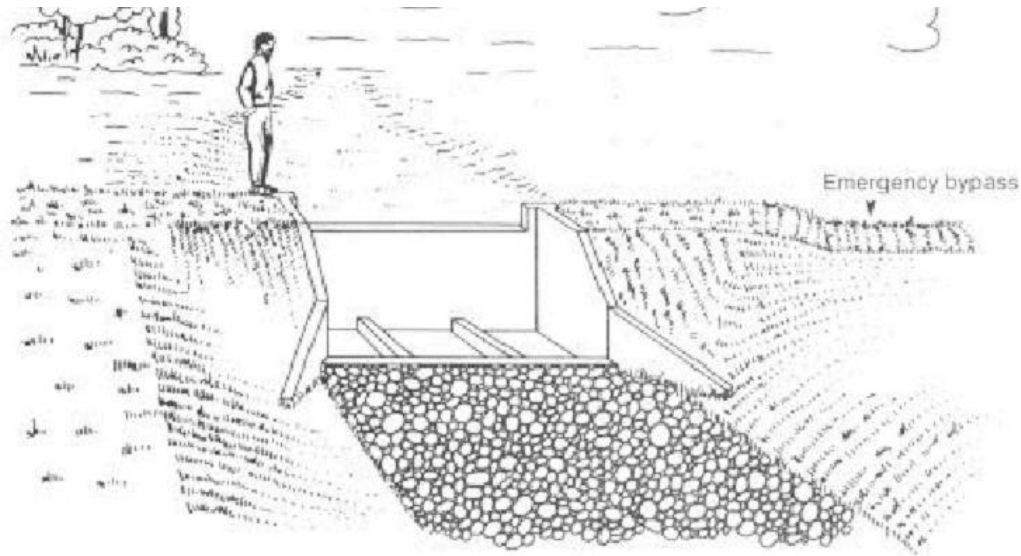


Figure 3. A reinforced concrete drop spillway for grade stabilization with emergency bypass and downstream protection (Mississippi State University Department of Agricultural and Biological Engineering).



Figure 4. A grass swale.

Grassed Waterway

A grassed waterway is a natural or constructed channel that is shaped or graded and planted with suitable vegetation for the stable conveyance of runoff without causing erosion of the channel.

Hydromulch

Hydromulch is a mixture of fiber mulch, grass seed, fertilizer, or other agriculture approved additives (including a tactifier or bonding agent such as guar gum) and water. This mix is placed in a machine to form a homogeneous slurry. The slurry is sprayed under pressure to achieve a uniform application over the soil. *Hydromulching* is a term used to describe the process of applying hydromulch.

Infiltration Basin

An infiltration basin is a facility constructed in highly permeable soil that provides temporary storage of runoff during rain events. Over a period of several hours or days, the basin allows the water to discharge primarily by infiltration through the surrounding soil. It might have an outlet for overflow discharge to surface water.

Infiltration Devices

Infiltration devices capture a portion of runoff, and retain it onsite, allowing it to infiltrate into the soil. If properly sited, designed, constructed, and regularly maintained, these devices can be very effective in reducing peak discharge rates and storm water volumes and removing pollutants from the first flush of runoff. Infiltration trenches, infiltration basins, dry wells, leaching catch basins, porous pavement/blocks, and infiltration islands within parking areas are examples of infiltration devices.

Infiltration Trench

An infiltration trench is basically an excavated ditch that has been lined with filter fabric and backfilled with stone to form an underground basin. Runoff is diverted into the trench through a grass area or pretreatment device. It then exfiltrates into the soil to provide groundwater recharge or enters a perforated pipe underdrain through which it is routed to an outflow facility. Infiltration trenches can handle only small amounts of runoff and are often used in conjunction with other BMPs.

Oil/Grit Separator

An oil/grit separator (Figure 5) consists of a series of three or four concrete chambers connected to a storm drain system. Runoff passes through the chambers, settling sediment and particulate matter, screening debris, and separating free surface oils from storm water runoff before the water passes to a storm drain. An oil/grit separator is used primarily to treat water to remove contaminants from small areas where activities contribute large loads of grease, oil, mud, sand, and trash to storm water runoff. Such areas include automotive work areas, loading areas, gas stations, parking areas, and roads, which have a heavy amount of motor vehicle traffic.

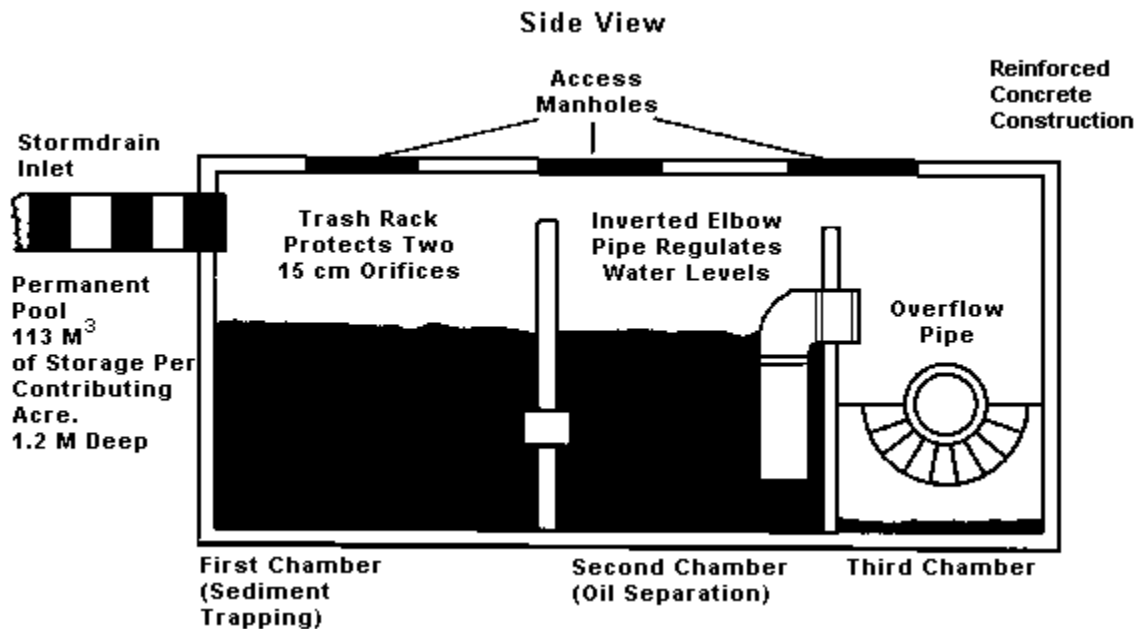


Figure 5. Schematic of an oil/grit separator (Mississippi State University Center for Sustainable Design).

Porous Pavement

An alternative to conventional asphalt, porous pavements uses a variety of porous media, often supported by a structural matrix, concrete grid, or modular pavement. The media allow water to percolate through the pavement to a subbase for gradual infiltration into the underlying soil.

Prescribed Grazing

Prescribed grazing is the controlled harvest of vegetation with grazing or browsing animals, managed with the intent to maintain or improve water quality and quantity. For example, on grazed forest, native pasture, or rangeland, grazing is limited so that the

grazing animals will consume no more than 50 percent (by weight) of the annual growth of high or medium preferred grazing species.

Reduced Tillage Systems

Reduced tillage refers to any system that is less intensive and aggressive than conventional tillage. The number of operations is decreased compared to conventional tillage, or a tillage implement that requires less energy per unit area is used to replace an implement typically used in conventional tillage system. The term is sometimes used to imply conservation tillage; however, for a system to be considered a conservation tillage system, 30 percent of the soil surface must be covered with residue after planting.

Residue Management, Mulch Tilling

Mulch tilling (Figure 6) is the practice of tilling crop residue from the previous harvest into the soil as mulch by using non-inversion tillage methods such as chiseling and disk harrowing to partially incorporate organic material left on the soil surface.



Figure 6. Residue management, mulch till (USDA, Natural Resources Conservation Service)

Road Dry Seeding and Hydraulic Seeding

Two basic methods for spreading seed are dry seeding and hydraulic seeding. Dry seeding is a method the U.S. Forest Service uses to revegetate inactive roads to provide long-term erosion control. In dry seeding, seeds are broadcast or planted without mixing them with water or other liquid. Dry seeding and fertilizing along roads are usually done with cyclone-type rotary seeders. In hydraulic seeding (hydroseeding), a wet slurry of seed, mulch, and fertilizer is typically applied from a pump truck or portable trailer to steep slopes or areas where erosion rates are high.

Road Grass and Legume Seeding

Grass and legume seeding is a form of revegetation of bare soils used to prevent erosion. Native plants, domesticated native plants, and introduced agronomic species are all useful for rehabilitation and revegetation.

Road Hydromulch (Hydromulch)

Hydraulic mulching is a process by which wood fiber mulch, processed grass, hay or straw mulch is applied with a tacking agent in a slurry with water to provide temporary stabilization of bare slopes or other bare areas. This mulching method provides uniform, economical slope protection. It may be combined with hydroseeding as a revegetation method.

Road Straw Mulch

Straw mulch is applied on slopes to hold the soil and prevent loss of grass seed. Straw mulch provides erosion control and moisture conservation, and it prevents soil crusting.

Road Tree Planting

Tree planting is used for erosion control on permanently closed or decommissioned forest roads to return the site to forest and timber production. Where necessary, compacted or rock-surfaced roads are loosened to reduce surface runoff and promote seedling survival.

Runoff Management System

A runoff management system controls excess runoff caused by construction operations at development sites, changes in land use, or other land disturbances. A settling basin (see *Settling Basin*) is a type of runoff management system.

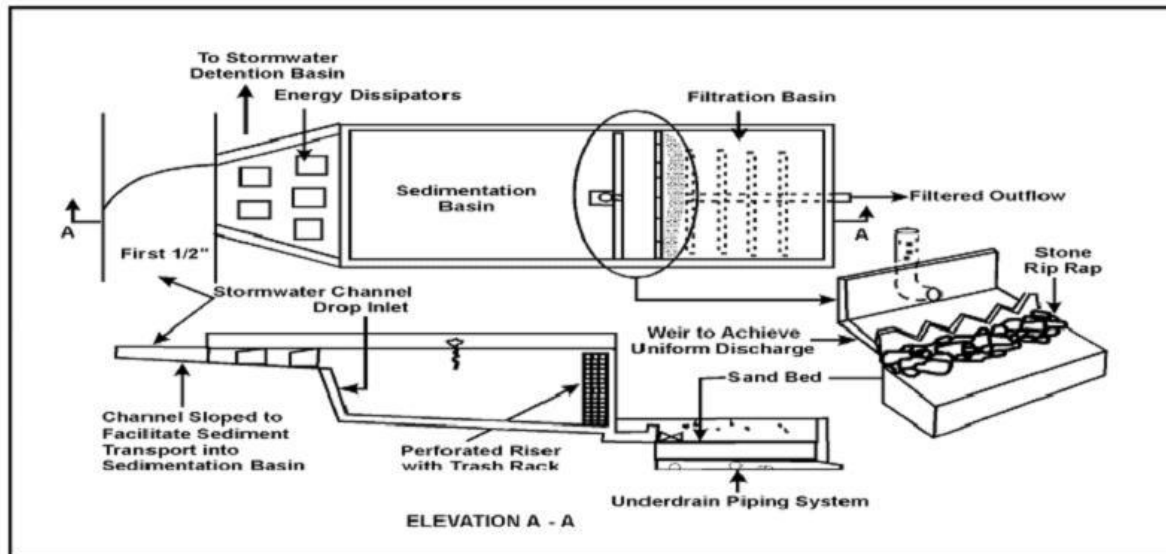
Sand Filter

Sand filters (Figure 7) are self-contained, compartmented treatment systems designed to catch runoff from highly impervious areas with relatively high total suspended solids, heavy metal, and hydrocarbon loadings, such as roads, driveways, drive-up lanes, parking lots, and urban areas. The compartments consist of a forebay that removes trash, debris, and coarse sediment, and a sand bed that allows solids settling and uses filtering and adsorption processes to reduce pollutant concentrations in storm water. The sand filter

compartments are usually constructed of concrete, and they may be set above or below ground.

Sand Filter/Infiltration Basin

Sand filters (see *Sand Filters*) are often coupled with infiltration basins (see *Infiltration Basin*). The sand filter (Figure 7) provides pretreatment of the runoff to reduce pollutant concentrations before the runoff passes into the infiltration basin, where it is allowed to infiltrate into the ground and recharge groundwater.



Source: Schueler, 1992.

FIGURE 1 TYPICAL AUSTIN SAND FILTER DESIGN

Figure 7. Schematic of a sand filter.

Settling Basin

A settling basin is a temporary basin with a controlled storm water release structure that releases flow at a very slow velocity, allowing the solids to settle out. Settling basins are used to collect and store sediment from sites cleared or graded during construction or for extended periods of time before permanent vegetation is established or structures are built. They are intended to help prevent the release of silt-laden runoff.

Soil Stabilization Measures (Forests Site Preparation)

The following measures can be used to stabilize soils for forest site preparation and road construction:

Measure	Description
<i>Hydromulch</i>	Mix of cellulose fiber and water sprayed on slope
<i>Straw</i>	Straw hand-placed evenly on slope
<i>Crimping</i>	Rolling the placed straw with a sheepfoot roller
<i>Seeding</i>	Spreading grasses, alfalfa, or other legumes using a hand spreader or water mix
<i>Fertilizer</i>	Application of nitrogen, phosphorus, and potassium by hand spreader or water mix
<i>Transplanting</i>	Hand transplantation of locally grown plant species
<i>Net</i>	Jute netting hand-placed on slope and pinned in place

Solids Separation Basin

A solids separation basin is a basin used for gravity settling of solids from liquid manure. A typical design for a solids separation basin is a 2- to 3-foot deep basin with concrete floor and walls and a porous dam or perforated pipe outlet that allows access by a front-end loader to remove solids every 1 to 2 months. Alternative earthen settling basins that allow for 6 to 12 months' storage of solids are also common. The basin contents should be thoroughly agitated and removed for land spreading by either a liquid manure spreader or slurry irrigation.

Solids Separation Basin/Infiltration Bed

See separate entries for *Solids Separation Basin* and *Infiltration Bed*.

Straw Crimping

Straw crimping is the practice of using a crimping disc, such as a sheepfoot roller, to place straw mulch on the ground. Crimping anchors the straw to the ground to hold it in place more securely.

Stream Channel Stabilization

Stream channel stabilization means stabilizing the channel of a stream with suitable structures to prevent erosion or siltation of the channel. A channel is considered stable if, the channel bottom remains essentially at the same elevation over long periods of time. Stream channel stabilization methods include modifying the channel capacity, channel armoring (riprap lining; see Figure 8), providing channel crossings for livestock, and seeding (vegetating or planting the channel to prevent erosion).



Figure 8. Riprap bank armoring for channel stabilization, Little Miami River, Ohio.

Streambank Protection

Streambank protection helps to prevent streambank erosion. Streambank protection methods are essentially the same as stream channel stabilization methods. They include modifying the channel capacity, channel armoring (riprap lining; see Figure 8), providing channel crossings for livestock, and seeding (vegetating or planting the channel to prevent erosion).

Streambank Fencing

Fencing is used to restrict livestock access to streambanks because animal traffic erodes streambanks, increases sediment load, and contributes animal waste in and near the stream, impairing water quality.

Strip Cropping

Strip cropping (Figure 9) is a technique in which alternate strips of different crops are planted in the same field. Contour strip cropping, field strip cropping, and buffer strip cropping are the three main types of strip cropping. Strip cropping is used to control both wind and water erosion. If the strips are planted along the contour of the land surface, water erosion can be minimized. In dry regions, if the strips are planted crosswise to the contour, wind erosion is also minimized.

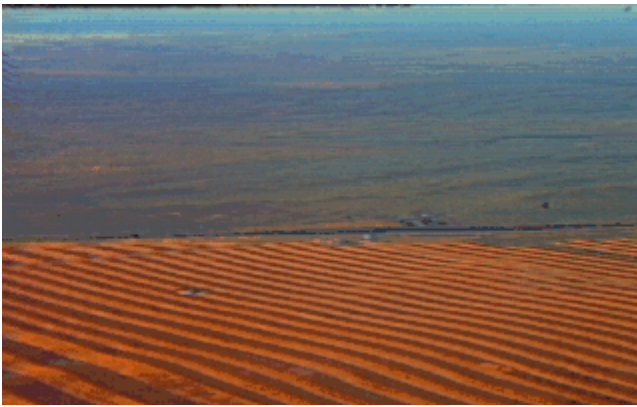


Figure 9. Field strip cropping (Purdue University).

Strip Cropping, Buffer

Buffer strip cropping can be employed by using strips of grass or legume crops laid out between contour strips of crops in irregular rotations. These strips may be even or irregular in width or placed on critical slope areas of the field.

Strip Cropping, Contour

In contour strip cropping, the crop strips follow the contours of the land. Both the crop stripping and the tillage are held closely to the contour of the field.

Strip Cropping, Field

In field strip cropping, strips of a uniform width are placed across the general slope of the land. With adequately grassed waterways, the strips may be used where topography is too irregular to make contour stripping practical.

Terrace

Terraces are constructed benches on slopes, which consist of level field or paddy areas held in place by embankments of soil or rock. Terraces enable water to be stored temporarily on slopes to allow sediment deposition and water infiltration; reduce slope length, erosion, and soil particle content in runoff water; improve water quality; retain runoff for moisture conservation; prevent gully development; and reduce flooding.

There are three types of terraces: bench terraces, contour terraces, and parallel terraces. Bench terraces are the type that most often comes to mind when the word *terrace* is used, and they are employed most often in mountain regions around the world.

Vegetated Filter Strip

See *Filter Strip*.

Waste Management Systems

See *Animal Waste Management Systems*.

Waste Storage Facility

A waste storage facility is an impoundment made by constructing an embankment or excavating a pit or dugout, or by fabricating a structure.

Water and Sediment Control Basin

A water and sediment control basin (Figure 10) is an earthen embankment or combination ridge and channel constructed across a slope and minor watercourse to form a sediment trap and water detention basin. Water collected in the basin is slowly released through an outlet structure.



Figure 10. Water and sediment control basin (USDA Natural Resources Conservation Service).

Weekly Street Sweeping

Weekly street sweeping is performed to remove contaminants, sediment, and debris from roadways before they have a chance to wash away in storm water runoff.

Wet Pond

A wet pond is a constructed basin that has a permanent pool of water throughout the year (or at least throughout the wet season). The primary removal mechanism is settling while the storm water runoff resides in the pool. Nutrient uptake also occurs through biological activity in the pond. Wet ponds are among the most cost-effective and widely used storm water treatment practices. Although there are several different versions of the wet pond design, the most common is the extended detention wet pond (see *Extended Wet Detention Basin*).

Wetland Detention

Wetland detention uses a detention basin planted with wetland vegetation. The wetland vegetation improves the quality of storm water released from the basin more effectively than dry detention and typical wet detention because the wetland vegetation reduces

nutrients like nitrate nitrogen and phosphorus by as much as 90 percent, and settling and mechanical filtration by wetland plants also reduce suspended solids and turbidity.

Water Quality Inlets (Inlet Devices)

Inlet devices are various types of inserts placed in water intakes to trap pollutants and floating trash. Some inlet devices, such as silt fences, culvert inlet sediment traps, and oil-skimming booms, are intended for temporary use to prevent sediment from entering storm drainage systems prior to permanent stabilization of a disturbed area, such as during construction. Other inlet devices, such as strainer baskets, are installed in storm water inlets permanently. The baskets sometimes incorporate an oil-skimming boom to collect hydrocarbons. These baskets must be cleaned out and the oil-absorbent material replaced periodically.

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