BMP DESCRIPTIONS FOR STEPL AND REGION 5 MODEL

Contents

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.

Bioreactor

A bioreactor (Figure 2) is an edge of field treatment process used to reduce the nitrogen in runoff, typically coming from a tile line. A denitrifying bioreactor is a buried trench filled with a carbon source – usually wood chips – installed at the edge of a field. Tile drains from the field carry excess water from the plant root zone, and divert a portion of the drainage water into the bioreactor. Microorganisms on the wood chips consume the nitrates in the water and expel it as nitrogen gas. Performance varies based United States Department of Agriculture Excavating the pit for bioreactor installation. Helping People Help the Land on size, location, and a variety of other factors, but the average bioreactor can be expected to remove up to half of the nitrates in water flowing through it.

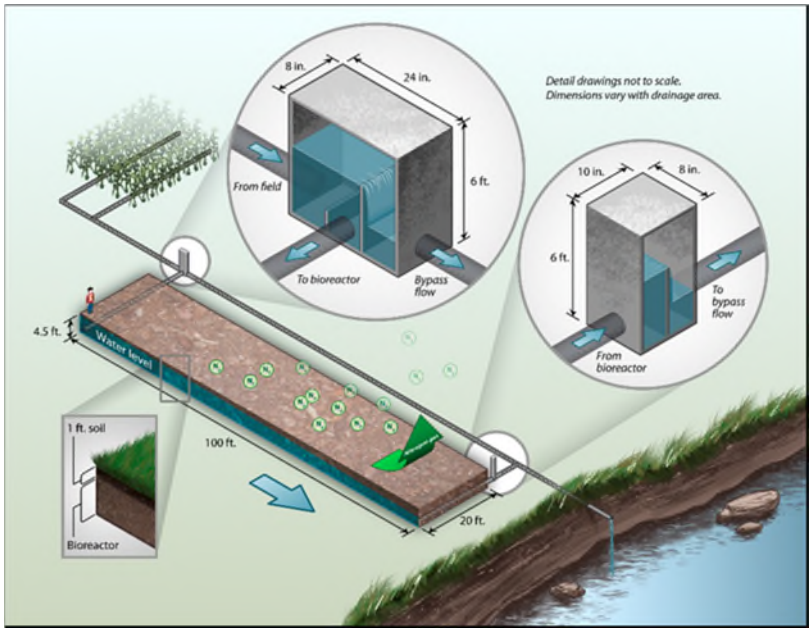


Figure 2. Bioreactor [Source: Christianson and Helmers (2011)]

Buffer - Forest (100ft wide)

An area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies. The riparian area serves to create shade to lower or maintain water temperatures to improve habitat for aquatic organisms; create or improve riparian habitat and provide a source of detritus and large woody debris; reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow; reduce

pesticide drift entering the water body; restore riparian plant communities; and increase carbon storage in plant biomass and soils. Figure 3 shows a forested buffer.

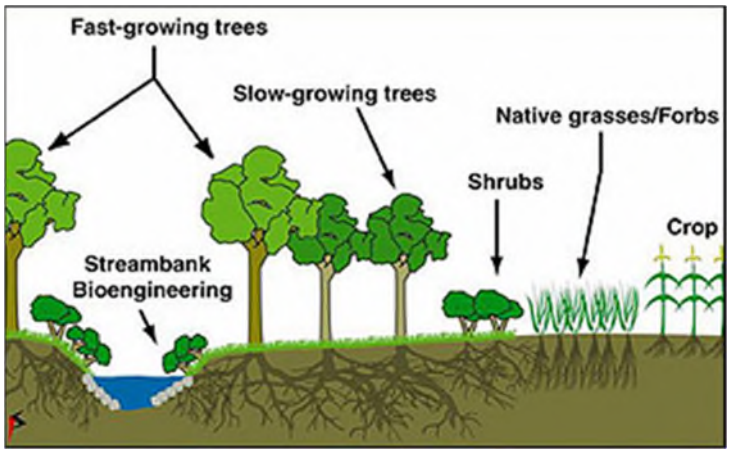


Figure 3. Forest Buffers (Source: University of Missouri Extension, http://extension.missouri.edu/p/AF1009)

Buffer - Grass (35ft wide)

A newly established area along a waterbody that intercepts overland flow and is used to maintain bank stabilization, reduce the impacts of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals to supply food, cover and thermal protection to fish and other wildlife. To achieve these results the recommended minimum width is 35 feet wide and should include native grass(es). Figure 4 shows a grass buffer.

Figure 4. Grass buffers (Source: USDA NRCS, Pennsylvania) https://www.nrcs.usda.gov/wps/portal/nrcs/detail/pa/newsroom/releases/?cid=NRCSEPRD1192216

Concrete Grid Pavement

Concrete grid pavement (Figure 5) 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.

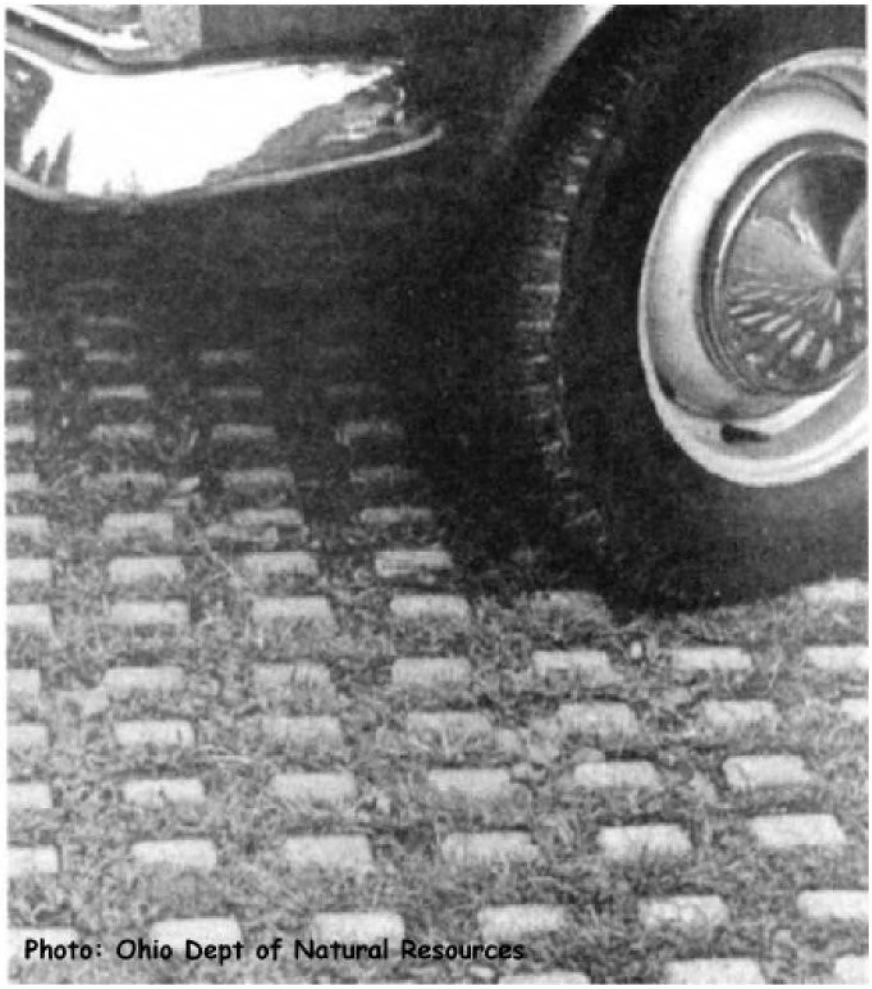


Figure 5. Example of a concrete grid pavement used in an overflow parking area (ODNR 1992).

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.

Conservation Tillage (30-59% Residue)

Managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round while limiting soil-disturbing activities used to grow and harvest crops in systems where the field surface is tilled prior to planting with 30-59 percent crop residue prior to planting. This will reduce sheet, rill, and wind erosion and excessive sediment in surface waters (soil erosion); reduce tillage-induced particulate emissions (air quality impact); improve soil health and maintain or increase organic matter content (soil quality degradation); and reduce energy use (inefficient energy use).

Conservation Tillage (≥60% Residue)

Limiting soil disturbance to manage the amount, orientation and distribution of crop and plant residue on the soil surface year around. This will reduce sheet, rill and wind erosion and excessive sediment in surface waters; reduce tillage-induced particulate emissions; maintain or increase soil health and organic matter content; increase plant-available moisture; reduce energy use; and provide food and escape cover for wildlife.

Contour Farming

Aligning ridges, furrows, and roughness formed by tillage, planting and other operations to alter velocity and/or direction of water flow to around the hillslope. This practice is applied to achieve one or more of the following: reduce sheet and rill erosion; reduce transport of sediment, other solids and the contaminants attached to them; reduce transport of contaminants found in solution runoff; or increase water infiltration. Figure 6 shows an example of contour farming.

Figure 6. Contour farming (Source: USDA NRCS, New Jersey, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/nj/technical/cp/?cid=nrcs141p2_018675)

Controlled Drainage

Water control structures that are installed in drainage tile lines to allow the water table in a field to be raised or lowered as needed (Figure 7 and Figure 8); this allows the manager to manage the drainage volume and water table elevation by regulating the flow from a surface or subsurface agricultural drainage system. This can reduce nutrient, pathogen, and pesticide loading from drainage systems into downstream receiving waters; improve productivity, health, and vigor of plants; and reduce oxidation of organic matter in soils.

Example 1: Flashboard Riser

Figure 7. Flashboard riser (Source: http://www.soil.ncsu.edu/publications/BMPs/drainage.html)

Example 2:

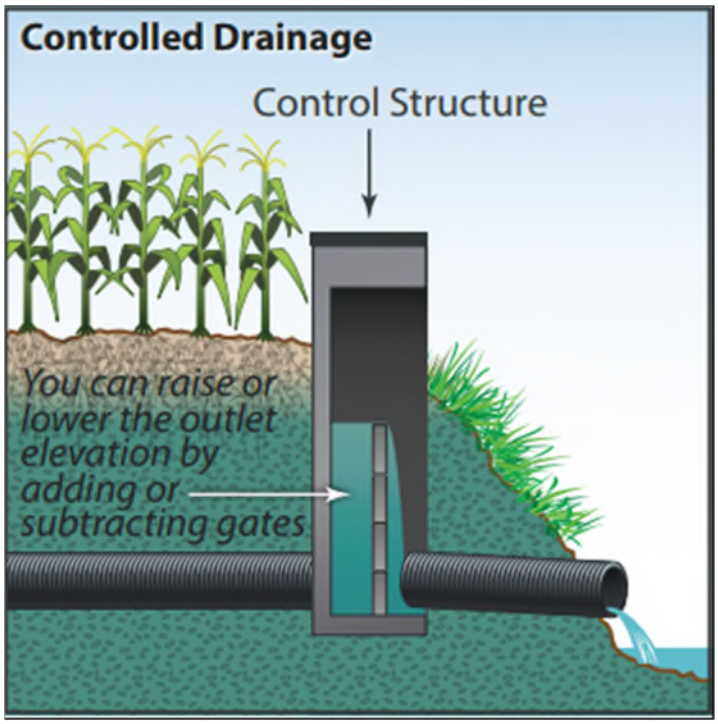


Figure 8. Water control structure [Source: Christianson, et. al. (2016)]

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 need 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.

Cover Crops*

Cover crops are crops that are grown to provide soil cover and prevent erosion (Figure 9). Cover crops are used to fill in bare soil when a main crop has been harvested, when there is a niche in a season's crop rotation, or when there is a need to interplant a cover crop with a cash crop. They provide ground cover, reduce erosion, suppress weeds, reduce insect pests and diseases, absorb excess fertilizer, reduce nutrient leaching, and enrich soil with organic matter. Important elements of the practice and its effectiveness include selection of the cover crop species, previous crop, the planting time, and the seeding method. There are two basic categories of cover crops: (1) a traditional cover crop may be neither fertilized nor harvested, and (2) a commodity cover crop may receive nutrient applications in late winter or spring of the following year after establishment.

Cover Crop (Traditional, Early Planting Time)

- Traditional crops include rye, legume/grass mixture with at least 50% of the full rate of the grass component, triticale, barley and/or wheat that are not harvested
- Early planting time: more than 2 weeks before average frost date

Cover Crop (Traditional, Normal Planting Time)

- Traditional crops include rye, legume/grass mixture with at least 50% of the full rate of the grass component, triticale, barley and/or wheat that are not harvested
- Normal planting time: the average between the frost date and two weeks before frost date

Cover Crop (Commodity)

- Commodity cover crops include rye, legume/grass mixture with at least 50% of the full rate of the grass component, triticale, barley and/or wheat that are planted for harvest.

*If cover crops are implemented with reduced tillage/conservation tillage practices, use cover crop and conservation tillage efficiency values.

Figure 9. Rye cover crop seeded into corn residue. (Photo courtesy of USDA)

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 10 and Figure 11) 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.

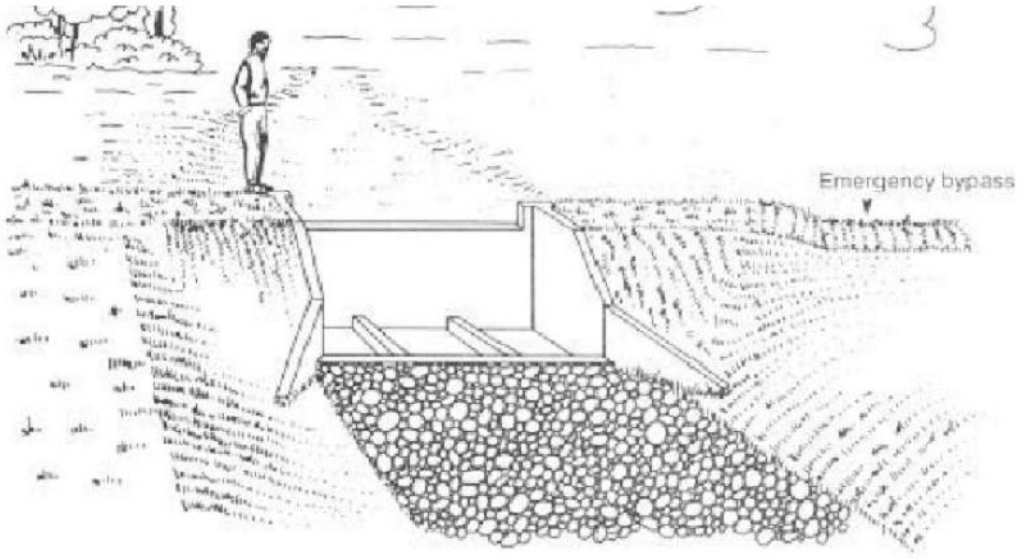


Figure 10. A reinforced concrete drop spillway for grade stabilization with emergency bypass and downstream protection (Mississippi State University Department of Agricultural and Biological Engineering).

Figure 11. 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.

Land Retirement

The process of taking land out of production and replacing with permanent vegetative cover such as shrubs, grasses, and/or trees.

Nutrient Management (Determined Rate)

Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments to budget, supply, and conserve nutrients for plant production; to minimize agricultural nonpoint source pollution of surface and groundwater resources; to properly utilize manure or organic byproducts as a plant nutrient source; to protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates; and/or to maintain or improve the physical, chemical, and biological condition of soil.

Nutrient Management (Determined Rate Plus Additional Considerations)

Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments to budget, supply, and conserve nutrients for plant production; to minimize agricultural nonpoint source pollution of surface and groundwater resources; to properly utilize manure or organic byproducts as a plant nutrient source; to protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates; and/or to maintain or improve the physical, chemical, and biological condition of soil. Additional considerations include, but are not limited to, the following: nitrogen management, nitrification inhibitors, and cases where manure is used as a nutrient source, the manure holding areas may need to provide capability to avoid application to frozen soil.

Oil/Grit Separator

An oil/grit separator (Figure 12) 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.

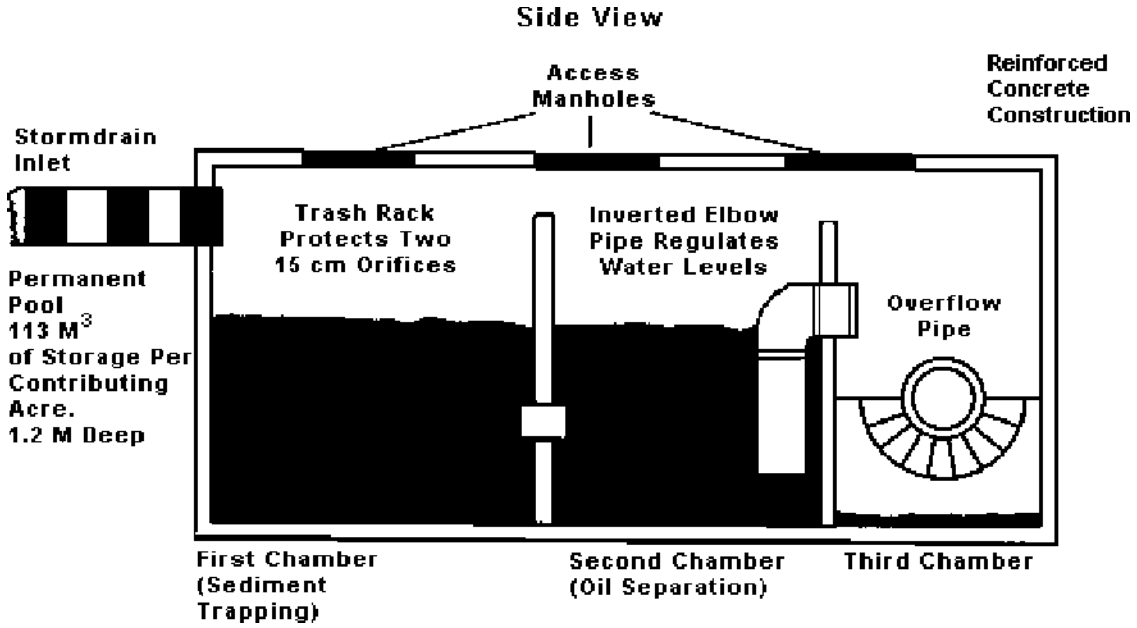


Figure 12. Schematic of an oil/grit separator (Mississippi State University Center for Sustainable Design).

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 though 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 13) 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 13. 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

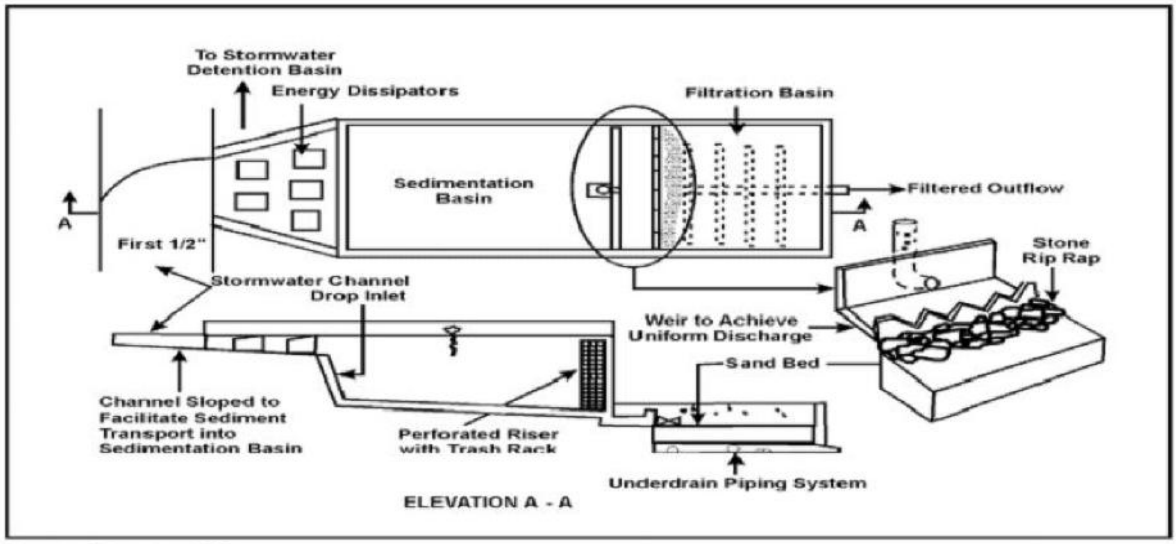
A runoff management system controls excess runoff caused by construction operations at development sites, changes in land use, or other land disturbances. A settling basin (see *Settling Basin*) is a type of runoff management system.

Sand Filter

Sand filters (Figure 14) 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 14) 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 14. 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
Hydromulch	Mix of cellulose fiber and water sprayed on slope
Straw	Straw hand-placed evenly on slope
Crimping	Rolling the placed straw with a sheepfoot roller
Seeding	Spreading grasses, alfalfa, or other legumes using a hand spreader or water mix
Fertilizer	Application of nitrogen, phosphorus, and potassium by hand spreader or water mix
Transplanting	Hand transplantation of locally grown plant species
Net	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 15), providing channel crossings for livestock, and seeding (vegetating or planting the channel to prevent erosion).

Figure 15. 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 16) 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.

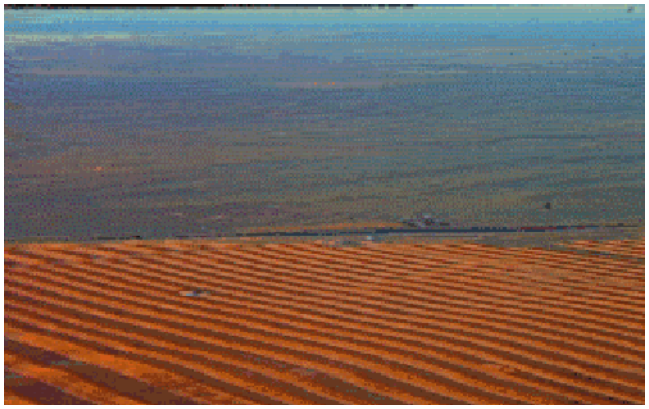


Figure 16. Field strip cropping (Purdue University).

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

A terrace is an earth embankment, or a combination ridge and channel, constructed across the field slope to enable water to be stored temporarily to allow sediment deposition and water infiltration (Figure 17). This practice is applied as part of a management system to either reduce erosion and trap sediment or retain runoff for moisture conservation.

Figure 17. Example of terraced cropland. (Source: USDA NRCS Iowa https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ia/newsroom/stories/?cid=nrcs142p2_008614)

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 18) 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 18. 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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