STORMWATER MANAGEMENT

Stormwater management is the effort to reduce runoff of rainwater or melted snow into streets, lawns and other sites and the improvement of water quality, according to the United States Environmental Protection Agency (EPA). When stormwater is absorbed into the soil, it is filtered and ultimately replenishes aquifers or flows into streams and rivers. However, when heavy rainwater hits, ground saturated by water creates excess moisture that runs across the surface and into storm sewers and road ditches. This water often carries debris, chemicals, bacteria, eroded soil, and other pollutants, and carries them into streams, rivers, lakes, or wetlands.

In urban and developed areas, impervious surfaces such as pavement and roofs prevent precipitation from naturally soaking into the ground. Instead, water runs rapidly into storm drains, sewer systems and drainage ditches and can cause flooding, erosion, turbidity (or muddiness), storm and sanitary sewer system overflow, and infrastructure damage. However, stormwater design and "green infrastructure" capture and reuse stormwater to maintain or restore natural hydrologies. Detaining stormwater and removing pollutants is the primary purpose of stormwater management.

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STORMWATER RUNOFF CONTROL

CATCH BASIN & CLEANING

DEFINITION

Catch basins collect water from roads and parking lots and convey it to an underground storm drain system. Catch basins incorporated into a curb and gutter system are called curb inlets.

PURPOSE

Catch basins have minimal water quality benefit alone; however, in a developed watershed they are often a necessary component of a drainage system that have a water quality benefit. There are design elements that can be incorporated into a catch basin to achieve some water quality benefit.

PLANNING CRITERIA & IMPLEMENTATION

Catch basins are suitable along paved roads, parking lots, paved swales, or rock-lined ditches where permanent storm drain systems are currently installed or planned to be and should be designed by a licensed professional civil engineer. Design basin spacing to prevent water from overtopping the curb and gutter or drainage ditch. Size the basins based on the size of the drainage area, the amount of sediment expected from the discharging waters, the size and frequency of runoff events, and the amount of maintenance expected, recognizing that an undersized system will require more frequent maintenance.

Determine if a catch basin will be pre-cast or cast-in-place, choosing among concrete, prefabricated metal, or prefabricated concrete pipe materials. The diameter of circular basins should be twice that of the culvert or storm drain. The length of a rectangular basin should be twice that of the culvert or storm drain and the width equal to the pipe diameter. Include water treatment when basins will receive pollutant or sediment laden runoff, choosing among a variety of basin inserts that are available to treat and filter pollutants. Determine the level of needed treatment from the type and amount of pollutants in the drainage area. Weep holes may be incorporated to infiltrate a small amount of water. Check with jurisdiction requirements prior to designing them into the system.

MAINTENANCE

Advantages include prevention of discharge of degraded runoff water from roadside ditches and adjacent slopes, reduction in discharge velocity from culverts/curbs by dissipating energy, and the structure can be designed to trap sediment, grease, and debris before discharging to other facilities. Disadvantages include accumulation of sediment and debris, requiring frequent maintenance, and – unless frequently maintained – captured sediment may become re-suspended during subsequent flows. Catch basins should be inspected at least semiannually, in the spring after snowmelt and in the fall as well as during storms. Inspect for sediment and debris build up in the drain inlet as well as on the grate. Other maintenance actions include vactoring of catch basins to remove accumulated sediment and debris, sweeping streets regularly, and not storing snow directly over a catch basin.

ROCK-LINED DITCH OR SWALE

DEFINITION

Rock-lined ditches or drainage swales are shallow ditches that blend in with surrounding landscape design, facilitate water management, and encourage natural irrigation. Ditches and swales take advantage of natural slopes in the land to direct water downward into all the soil as opposed to letting it pool above ground or waterlog a specific region. Property owners can make use of these self-sufficient, permaculture storm drains, particularly if they live in wetland areas.

PURPOSE

The primary function is to convey stormwater runoff and there is minimal water quality benefit; however, rock-lined and drainage swales may decrease the velocity of water and facilitate some infiltration.

PLANNING CRITERIA & IMPLEMENTATION

Swales are suitable in all drainage systems which collect, concentrate, and convey stormwater at the ground surface. Swales can be used to convey runoff both to and from underground storm drain systems.

MAINTENANCE

Special design consideration should be given for ditches and swales adjacent to plowed snow areas, snow storage areas, or areas receiving runoff from snow that has accumulated significant amounts of sand or other winter abrasives. Sand and abrasives applied during the winter months can quickly fill rock-lined ditches and drainage swales, which are difficult to maintain.

ROOF RUNOFF MANAGEMENT

DEFINITION

Rooftop runoff generally has low pollutant concentrations compared to other urban sources. Practices that store rooftop runoff, such as cisterns and rain barrels, are the simplest of the on-lot treatment systems. Cisterns and rain barrels can be particularly valuable where rainfall is infrequent, and reuse for irrigation can save homeowners money. Down spouts can be disconnected from the storm drain system and rainfall can instead be collected and stored on site.

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies as a result of residential runoff.

PLANNING CRITERIA & IMPLEMENTATION

Rain barrels and cisterns capture and store stormwater runoff from rooftops and other impervious catchment areas, providing water for non-potable uses such as landscape irrigation. The difference between a barrel and a cistern relates to their size and application. Barrels are smaller and typically used in residential applications, whereas cisterns store larger volumes of water and are more applicable for larger drainage areas and structures.

Rain barrel and cistern installation should be done according to manufacturer's specifications. Grade a level footing for placement of a barrel or cistern to connect to a gutter downspout. Connect the downspout to the barrel or cistern. Several types of gutter adapters are available to direct water into the barrel or cistern, such as flexible hoses or downspout redirectors. Position the rain barrel or cistern at an elevation above the location of the desired use of the captured water (e.g., vegetation/landscaping, rain garden, etc.) to gravity feed rather than pump whenever possible.

MAINTENANCE

Rain barrels and cisterns require minimal maintenance, but the homeowner needs to ensure that the hose remains elevated during the winter to prevent freezing and cracking. In addition, the tank needs to be cleaned out about once per year. Rain barrels and cisterns should be checked periodically to ensure that they are properly sealed to prevent mosquito breeding.

STORMWATER PONDS VS. STORMWATER WETLANDS

DEFINITION: STORMWATER POND

A stormwater pond is a constructed, shallow stormwater retention basin or landscaped area with a permanent pool of water. Stormwater runoff collected in the pool is treated through settling. In addition, the aquatic bench (fringe wetlands), safety bench, side slopes, and shallow areas of the pond include plants to aid in the filtration and infiltration of the stormwater runoff flowing through the practice.

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies as a result of property development and natural or human-induced erosion.

PLANNING CRITERIA & IMPLEMENTATION

While vegetation in the stormwater pond is important, the primary purpose of a stormwater pond is to act as a water quantity and quality device, and introducing fertilizers into the stormwater pond introduces nutrients such as phosphorus and nitrogen that can pollute downstream waters. In addition, stormwater ponds should already be nutrient rich environments that do not require fertilization. To control animal nuisances and invasive species, pesticides (including herbicides, fungicides, insecticides, or nematode control agents) should be used sparingly and only if necessary.

It is important that the embankment for a pond be inspected regularly for trees and animal activity. Trees growing on the top or sides of the embankment should be removed. The roots of trees grow into the embankment and will weaken the structure of the embankment by creating passageways that allow water to flow through the embankment. Trees that are blown over or damaged by storms can loosen or remove soil which weakens the strength of the embankment. In the same way animals can burrow holes weakening the structure of the embankment. These holes act as a passageway for the water to travel through the embankment, increasing the potential for the embankment to fail.

MAINTENANCE

There are some common problems to be aware of when maintaining a stormwater pond. They include, but are not limited to, the following: sediment build-up, clogging in the inlet and outlet structure, establishing vegetation within the stormwater pond, pruning and weeding to maintain appearance, eutrophic conditions indicated by excessive algae growth or fish kills, creating a mosquito habitat. Routine inspection and maintenance should be performed on stormwater ponds to ensure that the structure is functioning properly. Note that during the first year the stormwater pond is built, maintenance may be required at a higher frequency to ensure the proper establishment of vegetation in the practice.

DEFINITION: STORMWATER WETLAND

Stormwater wetlands are constructed wetland systems built for stormwater management purposes. They typically consist of a combination of open water, shallow marsh and semi-wet areas that are located just above the permanent water surface. As stormwater runoff flows through a wetland, it is treated primarily through gravitational settling and biological uptake.

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies as a result of property development and natural or human-induced erosion.

PLANNING CRITERIA & IMPLEMENTATION

While vegetation in the stormwater wetland is important, the primary purpose of a stormwater wetland is to act as a water quantity and quality device, and introducing fertilizers into the stormwater wetland introduces nutrients such as phosphorus and nitrogen that can pollute downstream waters. In addition, stormwater wetlands should already be nutrient rich environments that do not require fertilization. To control animal nuisances and invasive species, pesticides (including herbicides, fungicides, insecticides, or nematode control agents) should be used sparingly and only if necessary.

It is important that the embankment for a wetland be inspected regularly for trees and animal activity. Trees growing on the top or sides of the embankment should be removed. The roots of trees grow into the embankment and will weaken the structure of the embankment by creating passageways that allow water to flow through the embankment. Trees that are blown over or damaged by storms can loosen or remove soil which weakens the strength of the embankment. In the same way animals can burrow holes weakening the structure of the embankment. These holes act as a passageway for the water to travel through the embankment, increasing the potential for the embankment to fail.

MAINTENANCE

There are some common problems to be aware of when maintaining a stormwater wetland. They include, but are not limited to, the following: sediment build-up, clogging in the inlet and outlet structure, establishing vegetation within the wetland area. maintaining the proper pH levels for plants, pruning and weeding to maintain appearance, mosquitoes breeding in the practice. Routine maintenance should be performed on the stormwater wetlands to ensure that the structure is properly functioning. Note that during the first year the stormwater wetland is built, maintenance may be required at a higher frequency to ensure the proper establishment of vegetation in the practice.

STORM DRAIN

DEFINITION

A storm drain is a pipe or other conduit used to collect and convey surface runoff from paved streets and parking lots to a stable discharge point, preferably a treatment and/or infiltration facility. Storm drains alone have no water quality benefit and tend to increase stormwater runoff velocity and erosion potential at discharge locations. However, in a developed watershed they are often a necessary component of a drainage and treatment system that as a whole improves water quality.

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies as a result of property development and natural or human-induced erosion.

PLANNING CRITERIA & IMPLEMENTATION

Storm drains are applicable to sites with curb and gutter systems, drainage ways, and other small runoff collection structures; however, they are most commonly installed on a neighborhood scale in densely developed commercial/residential areas. Unless otherwise justified, use storm drainpipe having a diameter of at least 18 inches. Design pipe systems with a minimum of 1 percent slope to prevent the water from freezing. The pipe may also be surrounded with gravel to provide insulation. Do not design transitions from larger to smaller diameter pipes. Protect inlets and outlets with outlet protection to prevent scouring. Design debris control devices at each pipe inlet, such as a trash rack, to prevent clogging and resultant damage from flooding or erosion. Incorporate sediment traps and basins in storm drain systems to reduce peak flows, trap sediment, and prevent clogging of downstream drainage or infiltration structures by sediment. Size storm drains based on the assumption that they will flow full or partially full under the design discharge but will not be subjected to head pressure from impoundment upstream of inlets. Consider debris blockage potential, maintenance issues, cost implications, and physical constraints in designing the number of inlets that are connected in a series.

MAINTENANCE

Storm drains are effective at conveying stormwater if designed and installed properly. Effectiveness is lost once clogged with sediment and debris so a regular street sweeping program is critical and will reduce overall maintenance costs. Storm drains need to be part of an associated hydrologic source control BMP system in order to reduce pollutant loads.

OUTLET PROTECTION

DEFINITION

Outlet protection structures prevent scour and erosion at discharge outlets by dissipating the energy and reducing velocities. Typical applications include an apron lined with rock riprap, concrete, or vegetation.

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies as a result of property development and natural or human-induced erosion.

PLANNING CRITERIA & IMPLEMENTATION

All outlet protection structures should be designed by a licensed professional civil engineer. Select the most appropriate materials for outlet protection. A rock-lined apron is commonly used because it is stable and durable, requires little maintenance, and blends in with the natural environment. Consider using vegetation for outlet protection in channels subject to low volumes and velocities. For outlets on slopes steeper than 10 percent, provide additional protection using larger rock to accommodate higher flow energies. Base the design of an outlet protection structure on the size of the channel and peak flow volume, and on the peak shear stress of discharging water during the design runoff event.

Construct discharge aprons subject to smaller flows by hand as follows:

- Place a 3 inch to 6-inch filter layer of sand or gravel in a trapezoidal-shaped apron. Filter fabric or an erosion control blanket can be substituted for the filter layer of sand or gravel.
- Construct the apron width at the culvert outlet to be 3 times the culvert diameter.
- Flare the apron out at a ratio of 1 foot laterally for each 2 feet of length, until the apron is 3 times the width of the culvert.
- Manually place a base layer of rocks on top of the apron. The size of the rock is a function of the discharge velocity.

MAINTENANCE

Inspection should include identifying erosion problems, documenting sediment accumulation, and identifying blocked or obstructed stormwater flow. The inspection crew may want to install a staff plate or ruler to monitor sediment accumulation if not already installed. Chronic sediment accumulation indicates a significant sediment source upstream in need of stabilization. Maintenance crews should be prepared to replace riprap to provide erosion protection and remove accumulated sediment and debris to ensure unobstructed flow. Removal of trash and debris is another common maintenance practice.

GRASSED WATERWAYS AND OUTLETS

DEFINITION

A shaped or graded channel that is established with suitable vegetation to convey surface water at a nonerosive velocity using a broad and shallow cross section to a stable outlet. This practice is applied in areas where added water conveyance capacity and vegetative protection are needed to prevent erosion and improve runoff water quality resulting from concentrated surface flow.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding,
- Prevent gully formation,
- Protect/improve water quality.

PLANNING CRITERIA & IMPLEMENTATION

Prepare plans and specifications for a grassed waterway that describe the requirements for applying the practice according to this standard. As a minimum, include:

- A plan view of the layout of the grassed waterway.
- Dimensions of the waterway, including length, grade, top width, bottom width, depth, and side slopes as applicable.
- Disposal requirements for excess soil material.
- Site-specific construction specifications that describe in writing the installation of the grassed waterway. Include specification for control of concentrated flow during construction and vegetative establishment.
- Vegetative establishment requirements.

Where environmentally sensitive areas need to be protected from dissolved contaminants, pathogens, or sediment in runoff, consider establishment of an increased width of vegetation on the waterway above the flow area. Increasing the width of the established vegetation above the flow area will increase filtering of sediment and pathogens, and it will increase infiltration of runoff and nutrient removal. Where sediment control is the primary concern, consider using vegetation in the waterway that can withstand partial burial and adding sediment control measures above the waterway, such as residue management. Consider increasing the channel depth and/or designing areas of increased width or decreased slope to trap and store sediment to reduce the amount of sediment that leaves a field. Provide for regular cleaning out of the waterway when trapping sediment in this manner.

Implement best management practices and use a system of additional conservation practices or a soil health management system in conjunction with the grassed waterway to minimize upstream runoff and concentrated flow. Tillage and crop planting often takes place parallel to the waterway, resulting in preferential flow paths and erosion along the edges of the waterway. Consider installation of measures that ensure the runoff from adjacent areas will enter the waterway. Measures such as directing spoil placement or small swales can direct this preferential flow into the grassed waterway.

Livestock and vehicle crossings should occur perpendicular to the waterway. Consider locating crossings to minimize potential damage to the waterway. Crossing design must not interfere with design-flow capacity. Avoid areas where unsuitable plant growth-limiting subsoil and/or substratum material, such as salts, acidity, root restrictions, etc., may be exposed during implementation of the practice. Where areas cannot be avoided, seek recommendations from a soil scientist for improving the condition; or, if not feasible, consider over-cutting the waterway and add topsoil over the cut area to facilitate vegetative establishment. Avoid or protect, if possible, important wildlife habitat, such as woody cover or wetlands, when determining the location of the grassed waterway.

Avoid placing trees and shrubs in or near the grassed waterway so they do not interfere with hydraulic functions or send roots into associated subsurface drainage. Medium or tall bunch grasses and perennial forbs may also be planted along waterway margins to improve wildlife habitat. Waterways with these wildlife features are more beneficial when connecting other habitat types (e.g., riparian areas, wooded tracts, and wetlands). When possible, select plant species that can serve multiple purposes, such as benefiting wildlife, while still meeting the basic criteria needed for providing a stable conveyance for runoff. Water-tolerant vegetation may be an alternative to subsurface drains or stone center waterways on some wet sites. Use irrigation in dry regions or supplemental irrigation as necessary to promote germination and vegetation establishment.

Wildlife habitat benefits can be provided by adding width of appropriate vegetation to the sides of the waterway. Care should be taken to avoid creating small isolated planting zones for wildlife. These can become population sinks where wildlife attracted to an area experience reproductive loss due to predation. Mowing may be appropriate to enhance wildlife values, but should be conducted to avoid peak nesting seasons and reduced winter cover whenever possible. Consider planting diverse legumes, forbs, and flowering plants, such as milkweeds, that provide pollen and nectar for native bees and other pollinators adjacent to the waterway. In dry regions, these sites may be able to support flowering forbs with higher water requirements and thus provide bloom later in the summer. For all organic or transitioning-to-organic operations, follow all National Organic Program rules.

MAINTENANCE

Provide an operation and maintenance plan to review with the landowner. Include the following items and others as appropriate in the plan:

- Establish a maintenance program to maintain waterway capacity, vegetative cover, and outlet stability. Vegetation damaged by machinery, herbicides, or erosion must be repaired promptly.
- Protect the waterway from concentrated flow by using diversion of runoff or mechanical means of stabilization, such as silt fences, mulching, hay bale barriers, etc., to stabilize grade during vegetation establishment as necessary.
- After vegetation is established, remove any temporary measures, such as diversions or silt fences, that were installed so as to not interfere with design flow.
- Minimize damage to vegetation by excluding livestock whenever possible, especially during wet periods. Permit grazing in the waterway only when a controlled grazing system is being implemented.
- Inspect grassed waterways regularly, especially following heavy rains. Fill, compact, and reseed damaged areas immediately. Remove sediment deposits to maintain capacity of

the grassed waterway.

- Control noxious weeds. Avoid use of herbicides or pesticides that would be harmful to the vegetation or pollinating insects in and adjacent to the waterway area.
- Avoid using waterways as turn rows during tillage and cultivation operations. Mow or periodically graze vegetation to maintain capacity, reduce sediment deposition, and maintain suitable plant composition and vigor.
- Apply supplemental nutrients as needed to maintain the desired species composition and stand density of the waterway. Do not use waterways as a field road. Avoid crossing with heavy equipment when wet.
- Lift tillage equipment and turn off chemical application equipment when crossing the waterway.

WATERSPREADING

DEFINITION

A system of diverting or collecting runoff from natural watercourses and spreading the runoff over relatively flat areas.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Reduce the potential for flooding and ponding.
- Reduce the potential for gully formation.
- Manage natural precipitation more efficiently.
- Facilitate ground water recovery.

Waterspreading is timed by the availability of natural runoff flow and applies to all land uses. Although applicable to any climatic condition, areas with an average annual precipitation of 8 to 25 inches show the greatest benefit from waterspreading.

Waterspreading applies to areas where the following conditions are all present:

- Soils have suitable intake rates and adequate water-holding capacities for the type of system;
- Topography is suitable for the diversion or collection and the benefited area allows uniform spreading of water to achieve the desired result; and
- Flows can be collected or diverted, spread and excess water returned without causing excessive erosion. This standard does not apply to irrigation systems.

PLANNING CRITERIA & IMPLEMENTATION

Prepare plans and specifications for waterspreading that describe the requirements for installing the practice to achieve its intended purpose. As a minimum, include the following:

- Design map showing the vicinity location, location of diversions, ditches, spreading area, elevations, north arrow, and scale.
- Detail drawings of the diversions and outlets, and other structural components.
- Written specifications that describe the site-specific details of installation.

The landowner must obtain all necessary permissions from regulatory agencies, or document that no permits are required. The landowner and/or contractor is responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

Diversion works must require no manual controls to divert the stream into the conveyance system or onto the spreading areas, except on watercourses with expected flow durations of more than 24 hours. Include erosion control at the diversion works, within the spreading area, and at the outlet facilities as an integral part of the waterspreading system. Provide suitable diversion controls so that only the desired rate of flow enters the conveyance system. Install a low-flow bypass to exclude bedload from the system where inflows contain sediment in amounts that will either reduce the life of the system or damage soil characteristics. Design inlet controls to be adjustable to exclude flow from the spreading areas at undesirable times, such as when crops are to be mechanically harvested. Protect the diversion works, conveyance system, or the spreading area from the diverted flow to prevent undue maintenance problems.

Design the conveyance system to safely convey the design flow from the diversion works to the spreading area. For earthen channels use relevant criteria found in NRCS Conservation Practice Standard (CPS) Open Channel (Code 582). For pipe conveyance use criteria from NRCS CPS Irrigation Pipeline (Code 430). Spreading area Arrange and locate ditches, dikes, diversions, conduits, and similar structures to spread diffused flow over the land surface or to pond water over the land, depending on the type of system selected. Grade and shape all slopes to facilitate management and harvesting operations.

Outlet works shall include provisions for returning excess water from the system to the stream channel or other parts of the system without causing excessive erosion and in time to prevent crop damage by ponded water. The flow line of the structure used for this purpose should be below ground level to improve flow characteristics.

When multiple basins are used in a spreading area, design the basins to be as parallel to one another as practicable. Space basins to permit use of modern farming equipment.

For water impounding dikes the maximum allowable depth of water impounded against dikes is 3 feet except across channels, sloughs, swales, or gullies less than 40 feet wide, where up to 5 feet of depth is allowed. If the water depth is greater than this, use the criteria in NRCS CPS Pond (Code 378) to design the embankment.

Minimum top width of dikes at design top elevation will be 3 feet. Include a minimum freeboard of 1.0 foot above the design water surface, or the wave height (from wind and fetch length calculations) above the design water surface, whichever is greater. Design dikes with side slopes no steeper than two horizontal to one vertical (2:1). Design flatter side slopes as needed for stability and 4:1 or flatter for safe mowing or other operations of farm equipment.

For outlet works the base the design of outlet(s) on the inflow from the 10-year 24-hour peak flow from the contributing area at minimum. Design at least one outlet or overflow section that is 1.0 ft or more below the design top elevation for each basin. The outlet must convey runoff water to a point where it will not cause damage. This may be a vegetated spillway, stable rock, weir overflow structure, pipe outlet, or some combination of these. Total capacity of the outlet must exceed the diverted design inflow to the impoundment.

For vegetative cover seed all areas where vegetation has been disturbed during construction following completion of construction. Use criteria from NRCS CPS Critical Area Planting (Code 342) for seedbed preparation, seeding, sodding, fertilizing, and/or mulching. If the soils or climatic conditions preclude the use of vegetation for erosion protection, nonvegetative linings such as concrete, gravel, rock riprap, cellular block, or other approved manufactured lining systems may be used.

MAINTENANCE

Provide an operation and maintenance (O&M) plan specific to the type of waterspreading installed. Include specific instructions for operating and maintaining facilities with the purposes of the practice, intended life, and the criteria for its design.

At a minimum, address the following:

- Specific instructions and operational requirements to safely divert the desired volume of water into the system, store as applicable, and release return flows.
- Average water yields by event, times to fill and empty the system, and any other hydrologic and hydraulic information needed to operate the system as designed.
- Soil infiltration and water-holding capacities, anticipated crops to be grown, effects of inundation, and any other information that will assist the operator in making sound economic and environmental decisions.
- Service, repair, or replacement of components as necessary to maintain their full function.
- Removal of debris and foreign material from structures, ditches, and other components that might hinder operation.
- Maintenance of good vegetative cover on all slopes and watercourses.

STORMWATER RUNOFF TREATMENT

INFILTRATION BASIN

DEFINITION & PURPOSE

An infiltration basin is a large, engineered structure designed to detain stormwater runoff and infiltrate the detained runoff over a period of days. Infiltration basins, while similar in design to a dry basin, do not include an outlet structure that is designed to slowly draw down the water quality storage volume of the basin. Infiltration basins designed as on-line facilities include a high-flow bypass or emergency spillway. Infiltration basins designed as off-line facilities may not have an emergency spillway, as runoff can be designed to bypass the facility based on the elevation of the water stored in the facility.

ADVANTAGES & DISADVANTAGES

Advantages:

- Reduces stormwater discharged to surface waters and can provide effective removal of pollutants of concern to lake clarity.
- When land area is adequate, an appropriately sized infiltration basin can replicate predevelopment runoff characteristics more closely than most other BMP's.
- Can provide stormwater volume reductions to prevent downstream channel erosion and can reduce potential downstream flooding.

Disadvantages:

- Applicability limited to sites with higher soil Ksat rates and low pollutant loads (unless pretreatment is provided). Depending upon inflowing pollutant loads, frequent maintenance may be necessary to maintain effectiveness.
- Siting is frequently constrained due to a lack of available land area and high seasonal groundwater elevations.

PLANNING CRITERIA & IMPLEMENTATION

The following guidelines are water quality design considerations for infiltration basins. Refer to applicable drainage design manuals within the responsible jurisdiction for requirements associated with structural integrity, drainage design, public safety, and other factors. Consider designing an accessible forebay or an equivalent pretreatment device at the inlet of an infiltration basin for removal of coarse sediments and debris. Accessible maintenance facilities, especially for subsurface infiltration basins, can markedly improve the ease of maintenance and contribute to extended effectiveness. A soils/hydrology investigation is typically necessary when siting an infiltration basin to determine soil permeability, depths to seasonal high groundwater, depths to restrictive layers, and any other potential impediments to successful infiltration. The bottom of an infiltration basin shall not be closer than 1 foot to high seasonal groundwater indicators. Where space is available, size the basin to retain at least the 20-yr/1-hr volume generated from the tributary impervious area.

Above ground infiltration basins shall be designed to infiltrate stormwater within 96 hours. An underdrain system may be used to increase infiltration through above ground systems during winter periods when soil is more likely to freeze. A minimum 8-inch diameter underdrain pipe, encased in gravel, can be used to drain the soils below infiltration basins. A valve attached to the underdrain system can be used to control the rate of draw down in the basin. The valve can either be actively managed or left open during the winter season to allow snowmelt to quickly move through the soils in the basin and reduce the potential for frozen soils to occur.

In areas where salt-based deicers are directed to infiltration basins, soil may become less fertile and less capable of supporting vegetation. Incorporating organic amendments such as dry wood chips or composted material can help to mitigate this potential problem.

Snow storage within infiltration basins may be acceptable if the following conditions are met:

- Drainage design standards for the responsible jurisdiction allow the practice.
- The limits of snow storage within the basin are clearly designated and do not encroach on the inlet and outlet structures of the basin.
- Basin capacity has been increased to accommodate expected snow storage amounts in addition to the design storm (typically the 20-yr/1-hr storm). The basin must retain the capacity to hold the design storm at all times during snow storage operations.
- Stabilized access for snow plowing equipment is provided.
- Maintenance is conducted annually after spring snowmelt to remove material and debris from the basin, rehabilitate the infiltration capacity of the basin, and to confirm conveyance facilities are functional.

Remove and stockpile any native topsoil for use after rough grading basin dimensions. After completing basin grading activities, till back in topsoil or other soil amendments to improve infiltration capacity, which may be diminished by compaction from heavy equipment during grading. Tilling activities are typically at least 12 inches deep. The basin bottom shall be graded flat to provide uniform ponding and infiltration across the surface area of the basin.

MAINTENANCE

Inspect inlets and outlets to ensure stormwater is being properly conveyed and repair any blocked or diverted conveyances. Inspect forebays or pretreatment devices at the inlet of infiltration basin and remove accumulated sediment and debris. Inspect the basin for standing water 96 hours after a storm event. If water has not fully infiltrated, then infiltration drainage and rehabilitation are needed. Inspect for trash and debris especially at the inlet structures. Inspect for erosion, especially at the inlet locations. Inspect for invasive weeds and remove. Inspect site for unusual or unsafe conditions (snowplow damage, structural damage, dumping, vandalism, etc.). Repair structural components as necessary.

SEDIMENT BASIN

DEFINITION

A basin constructed with an engineered outlet, formed by constructing an embankment, excavating a dugout, or a combination of both.

PURPOSE

This practice is used to capture and detain sediment-laden runoff or other debris for a sufficient length of time to allow it to settle out in the basin.

PLANNING CRITERIA & IMPLEMENTATION

Prepare plans and specifications that describe the requirements for applying the practice according to this standard. As a minimum, include the following items:

- A plan view of the layout of the sediment basin, and typical profiles and cross sections of sediment basin.
- Details of the outlet system, including structural drawings adequate to describe the construction requirements.
- Requirements for vegetative establishment and/or mulching, as needed.
- Safety features and site-specific construction and material requirements.

Location:

- Sediment basins provide the last line of defense for capturing sediment when erosion has already occurred. When possible construct the basin prior to soil disturbance in the watershed. Choose the location of the sediment basin so that the basin intercepts as much of the runoff as possible from the disturbed area of the watershed. Choose a location that minimizes the number of entry points for runoff into the basin and interference with construction or farming activities. Do not locate sediment basins in perennial streams.

Storage Capacities:

- The sediment basin must have sediment storage, detention storage, and temporary flood storage capacities as follows: Design a minimum sediment storage capacity equal to the design life of the structure, or provide for periodic cleanout. For maximum sediment retention, design the basin so that the detention storage remains full of water between storm events. However, if site conditions, safety concerns, or local laws preclude a permanent pool of water, provide for dewatering of all or a portion of the detention and sediment storages between storm events. Design flood storage based on the required design storm for the auxiliary spillways. Provide a minimum of 1 foot in elevation between the principal and auxiliary spillways. Calculate the sediment storage volume from the bottom of the basin to the top of the sediment storage. Calculate the detention volume from the top of the sediment storage to the crest of the principal spillway. Calculate the flood storage between the crest of the principal spillway and the crest of the auxiliary spillway.

Principal Spillway and Auxiliary Spillway Design:

- Design the principal and auxiliary spillways as follows: Design the principal spillway to carry long-duration, continuous, or frequent flows without discharge through the auxiliary spillway. Design the principal spillway to drawdown the temporary flood storage within 24 hours. Use a principal spillway pipe 6-inches diameter or greater. Provide a stable outlet of the principal spillway for anticipated design flow conditions. Provide means such as perforations or small openings in the principal spillway riser when dewatering all or a portion of the detention and sediment storages. Design the auxiliary spillway to pass large storms without damage to the basin.

MAINTENANCE

As a minimum, include the following items in the operation and maintenance plan:

- Periodic inspections of all structures, earthen embankments, spillways, and other significant appurtenances.
- Prompt removal of trash from pipe inlets and trash racks.
- Prompt repair or replacement of damaged components.
- Prompt removal of sediment when it reaches predetermined storage elevations.
- Periodic removal of trees, brush, and undesirable species.
- Periodic inspection of safety components and immediate repair if necessary.
- Maintenance of vegetative protection and immediate seeding of bare areas as needed.

DRYWELL

DEFINITION

Drywells are vertical, underground infiltration systems that receive runoff from impervious surfaces via buried pipes.

PURPOSE

Drywells reduce the rate, volume and temperature of runoff by infiltrating, or allowing the water to slowly seep into the surrounding soils. Drywells also store a limited volume of runoff during storms.

PLANNING CRITERIA & IMPLEMENTATION

These systems provide fewer benefits than other low-impact development measures. They also tend to be expensive to build and involve complicated permit processes. Because of these factors, drywells are generally chosen as a last resort when other tools such as rain gardens, planters, and porous pavements are not practical.

Drywell construction should disturb as little of the surrounding soil as possible. To avoid clogging the drywell during construction, at no time should runoff from other areas be directed to the drywell until those areas have been stabilized or fully constructed.

Follow these installation steps:

- Excavate a hole 2 feet larger in diameter than the outside diameter of the manhole rings. A clamshell is often used to excavate deep, narrow holes.
- Place the nonwoven geotextile fabric so that a continuous piece reaches the bottom and overlaps a minimum of 12 inches at the edges. It should be draped on all sides and to the bottom of the drywell. This geotextile will prevent fine sediments from migrating from the native soils to the surrounding drainage rock, and will help protect against long-term clogging.
- Place the solid, 3-foot-deep sump in the bottom and rearrange the geotextile if it has been pulled out of place. Position the rest of the specified number of perforated and nonperforated rings that will set the top ring at the correct finish grade.
- Install uniformly graded (that is, almost all the same size) drain rock between the outside walls of the drywell and the geotextile to the depth specified on plans. Dust or fine particles not washed away could clog the geotextile (Hicks and Lundy 1998), so not only should the base rock be delivered clean from the quarry, but it should also be washed carefully on site. One successful method is to hose the rock off in the delivery truck when it arrives. Another method might be to dump the rock and wash off the pile. In both instances, scooping of the rock should be done from the surface, and the rock should be closely monitored for fine sediments. As you work your way down the pile, fine sediments from above might only have been washed off partway through. If careful attention isn't paid to this step, the geotextile fabric could

become clogged with sediment, which would cause the drywell to fail.
- After rock has been placed a few inches above the highest perforated ring, lay the geotextile over the top of the rock and up the sides a few inches more, then trim it.
- Remove any debris that may have entered the drywell during construction.
- Install the lid and bolt it down.

Install inlet and outlet pipe by the same means used to connect pipes to standard manholes. Follow project specifications to backfill surface soil.

MAINTENANCE

Properly maintained drywells can last decades. But once a facility clogs, it must be replaced.

Some maintenance tips:

- Remove excess debris, control erosion and trash, and maintain inlets and outlets.
- Remove vegetation that could clog inlets or outlets.
- Schedule frequent inspections in smaller facilities, less frequent inspections in larger facilities.

We recommend a design with a 3-foot-deep solid sump at the bottom to make suctioning excess sediment easier.

FRENCH DRAIN

DEFINITION

A French drain is a type of subsurface drain that is a trench or system of trenches containing a perforated pipe surrounded by gravel.

PURPOSE

It is designed to collect stormwater runoff or groundwater and convey it from undesirable locations to a stable discharge point or hydrologic source control such as an infiltration basin or rain garden. While a perforated pipe may permit some infiltration, it is negligible and the primary purpose of a subsurface drain is conveying stormwater to a separate treatment and/or infiltration BMP in a more appropriate location.

PLANNING CRITERIA & IMPLEMENTATION

Subsurface drains should be designed in conjunction with an infiltration system so that there is no direct discharge to surface waters or groundwater. The discharge and infiltration of stormwater should be installed within the property boundaries and should not harm adjacent properties. Stormwater should not be discharged into the right of way or municipal storm drain system unless approval is obtained from the local governing authority. Maintain a pipe slope greater than 1 percent to promote constant flow and to prevent freezing. Surround perforated pipe with additional gravel for insulation.

MAINTENANCE

Subsurface drains are an effective conveyance when designed and installed properly. Effectiveness is lost if the system gets clogged with sediment and debris so maintenance is critical. Regular maintenance is critical to ensure proper functioning of this BMP.

T-SPREADER OR LEVEL SPREADER

DEFINITION

A level spreader is an excavated depression constructed at zero percent grade across a slope.

PURPOSE

The level spreader changes concentrated flow into sheet flow and then outlets it onto stable areas without causing erosion. It allows concentrated runoff to be discharged at non-erosive velocities onto natural or man-made areas that have existing vegetation capable of preventing erosion. An example would be at the outlet of a diversion or a waterway.

PLANNING CRITERIA & IMPLEMENTATION

Planning considerations:

- Diversions and waterways need a stable outlet for concentrated stormwater flows. The level spreader can be used for this purpose if the runoff is relatively free of sediment. If properly constructed, the level spreader will significantly reduce the velocity of concentrated stormwater and spread it uniformly over a stable undisturbed area.
- Placement of the level spreader must allow the water flowing over the level section to leave the structure as a uniform, thin film of water.
- The structure should outflow onto naturally vegetated areas whenever possible. The creation of a uniform level lip for the water to spread over is critical.
- Particular care must be taken during construction to ensure that the lower lip of the structure is level. If there are any depressions in the lip, flow will tend to concentrate at these points and erosion will occur, resulting in failure of the outlet. This problem may be avoided by using a grade board or a gavel lip over which the runoff must flow when exiting the spreader. Regular maintenance is essential for this practice.
- Water containing high sediment loads should enter a sediment trap before release in a level spreader.

Design recommendations:

- Drainage area should be limited to five acres.
- The grade of the channel entering the level spreader should be no steeper than 1 percent.
- The level spreader should be flat ("0 percent" grade) to ensure uniform spreading of storm runoff.
- The design length for a level spreader should be no more than 0.5 cfs per foot of level section, based on the peak rate of flow from the contributing erosion control or stormwater management practice.
- The width of the spreader should be at least 6 feet.
- The depth of the spreader as measured from the lip should be at least 6 inches and it should be uniform across the entire length.
- The spreader shall be stabilized with an appropriate grass mixture.
- The spreader should be mulched if necessary for the establishment of good quality vegetation.
- The level lip may be protected with an erosion stop and jute or excelsior matting. The erosion

stop should be placed vertically a minimum of six inches deep in a slit trench one foot back from the crest of the level lip and parallel to the lip. The erosion stop should extend the entire length of the level lip. Two strips of jute or excelsior matting can be placed along the lip. Each strip should overlap the erosion stop by at least six inches.

- The area downslope should have a complete vegetative cover sufficiently established to be erosion resistant.

MAINTENANCE

- The level spreader should be checked periodically and after every major storm.
- Any detrimental sediment accumulation should be removed.
- If rilling has taken place on the lip, the damage should be repaired and re-vegetated.
- Vegetation should be mowed occasionally to control weeds and encroachment of woody vegetation. Clippings should be removed and disposed of outside the spreader and away from the outlet area.
- Fertilization should be done as necessary to keep the vegetation healthy and dense.
- The spreader should be inspected after every runoff event to ensure that it is functioning correctly.

PRETREATMENT BMP'S: SEDIMENT FOREBAYS

DEFINITION

A sediment forebay is a small pool located near the inlet of a storm basin or other stormwater management facility. These devices are designed as initial storage areas to trap and settle out sediment and heavy pollutants before they reach the main basin.

PURPOSE

To remove sediment or floatables from stormwater prior to treatment.

PLANNING CRITERIA & IMPLEMENTATION

- The forebay can be a separate basin formed within the retention/detention basin.
- Should include sediment depth markers.
- Design to make maintenance accessible and easy.
- Design to dewater between storms.

MAINTENANCE

- Inspect at least once a month.
- Clean at least four times per year.
- Remove sediment to prevent resuspension.

PRETREATMENT BMP’S: VEGETATED FILTER STRIPS

DEFINITION

Uniformly graded vegetated surfaces, typically grass, that are intended to treat sheet flow from adjacent impervious surfaces by slowing runoff velocities and filtering out sediment and other pollutants and providing some infiltration. Often used as a buffer between agricultural land and surface waters as well.

PURPOSE

To slow runoff velocities, trap sediment, and promote infiltration.

PLANNING CRITERIA & IMPLEMENTATION

- Useful for small drainage areas.
- Requires 2% - 6% slope.
- Use with soils that have low clay content, poor soils that cannot sustain grass cover are also a limiting factor.
- Ground water separation of 2’ to 4’.
- Critical design features: pea gravel diaphragm at top of slope and pervious berm of sand and gravel at the toe of the slope 25’ minimum length

MAINTENANCE

- Inspect pea gravel diaphragm for clogging and remove built up sediment.
- Inspect vegetation for rills and gullies and correct.
- Inspect to ensure grass is established.
- Remove sediment build –up within bottom 25% original capacity.

MANUFACTURED TREATMENT DEVICES

DEFINITION

A manufactured treatment device is a structural alternative to treating water quality on a site. This approach to treatment can be used when space is limited.

PURPOSE

Manufactured treatment devices are designed to remove chemical contaminants and sediment from runoff through filtration, vortex separation, and/or other technologies.

PLANNING CRITERIA & IMPLEMENTATION

Manufactured treatment devices are most effective for small drainage areas. Separation from groundwater must be assessed. Different BMPs require varying distances to the seasonal highwater table. Manufactured treatment devices are typically more expensive to install and maintain than other BMPs that treat water quality. Capital costs vary based upon manufacturer, size of treatment area, and other design considerations. Cartridge replacement for MTDs is required regularly for the entire lifespan of the device.

MAINTENANCE

Regular maintenance activities include inspection of structural components, removal of sediment and debris, and cartridge replacement. See manufacturer guidelines for specific procedures.

FILTRATION BMP'S

DEFINITION

Filtration best management practices treat urban stormwater runoff as it flows through a filtering medium, such as sand or an organic material. Example filtration practices include biofiltration units, permeable pavement, and sand filters.

PURPOSE

Filtration practices treat stormwater by filtering pollutants. They are effective at attenuating suspended sediment and pollutants associated with that sediment. Most filtration practices utilize an underdrain and engineered soil media to attenuate pollutants and can be sized, in appropriate conditions, to treat the water quality volume. Some infiltration and/or loss of water through evapotranspiration occurs in most filtration practices. Filtration best management practices (BMP's) include, but are not limited, to:

- biofiltration (bioretention with an underdrain),
- permeable pavement with an underdrain,
- tree trenches and tree boxes with an underdrain,
- dry swale with an underdrain (with or without check dams),
- wet swales, and
- sand filters.

PLANNING CRITERIA & IMPLEMENTATION

Filtering practices are varied and include media filters (surface, underground, perimeter), vegetative filters (filter strips, grass channels), and combination media/vegetative filters (dry swales). Media and media/vegetative filters operate similarly and provide comparable water quality capabilities as bioretention. Vegetative filters are generally more suitable as pretreatment practices, but in some situations can be used on a standalone basis. Filtering practices have widespread applicability and are suitable for all land uses, as long as the contributing drainage areas are limited (e.g., typically less than 5 acres). Vegetative filters can be incorporated into landscaped areas, providing dual functionality.

Media filters are not as aesthetically appealing as bioretention, which makes them more appropriate for commercial or light industrial land uses or in locations that will not receive significant public exposure. Media filters are particularly well suited for sites with high percentages of impervious cover (e.g., greater than 50%). Media filters can be designed with an underdrain, which makes them a good option for treating potential stormwater hotspots. They can also be installed underground to prevent the consumption of valuable land space (often an important retrofit or redevelopment consideration).

MAINTENANCE

Depending on size of BMP filtration unit, maintenance of filtration BMP's involves handling of potentially hazardous material (oil sorbent material), which requires special disposal.

Additionally, maintenance may involve entry into the filtration BMP underground. Therefore the maintenance operator must be trained in handling and disposal of hazardous waste, and must also be certified for confined space entry if the maintenance will require entry into the filtration BMP. Therefore it is recommended that private BMP owners obtain a maintenance contract with a qualified contractor to provide inspection and maintenance. There are several cleaning service providers who are able to inspect and/or maintain filtration BMP's. Contact the manufacturer of the filtration system to find qualified service providers.