EXTENDED DETENTION BASINS

Definition

An extended detention basin is a facility constructed through filling and/or excavation that provides temporary storage of stormwater runoff. It has an outlet structure that detains and attenuates runoff inflows and promotes the settlement of pollutants. An extended detention basin is normally designed as a multi-stage facility that provides runoff storage and attenuation for both stormwater quality and quantity management. The adopted TSS removal rate for extended detention basins is 40 to 60 percent, depending on the duration of detention time provided in the basin.

Purpose

Extended detention basins are used to address both the stormwater runoff quantity and quality impacts of land development. The lower stages of an extended detention basin can detain runoff from the stormwater quality design storm for extended periods of time, thereby promoting pollutant removal through sedimentation. Higher stages in the basin can also attenuate the peak rates of runoff from larger storms for flood and erosion control. Extended detention basins are designed for complete evacuation of runoff and normally remain dry between storm events. However, to enhance soluble pollutant removal, the lower stages of an extended detention basin may also be designed with a permanent pool and partially function as either a wetland or wetpond (see *Chapter 6.2: Constructed Stormwater Wetlands* and *Chapter 6.12: Wet Ponds*).

Conditions Where Practice Applies

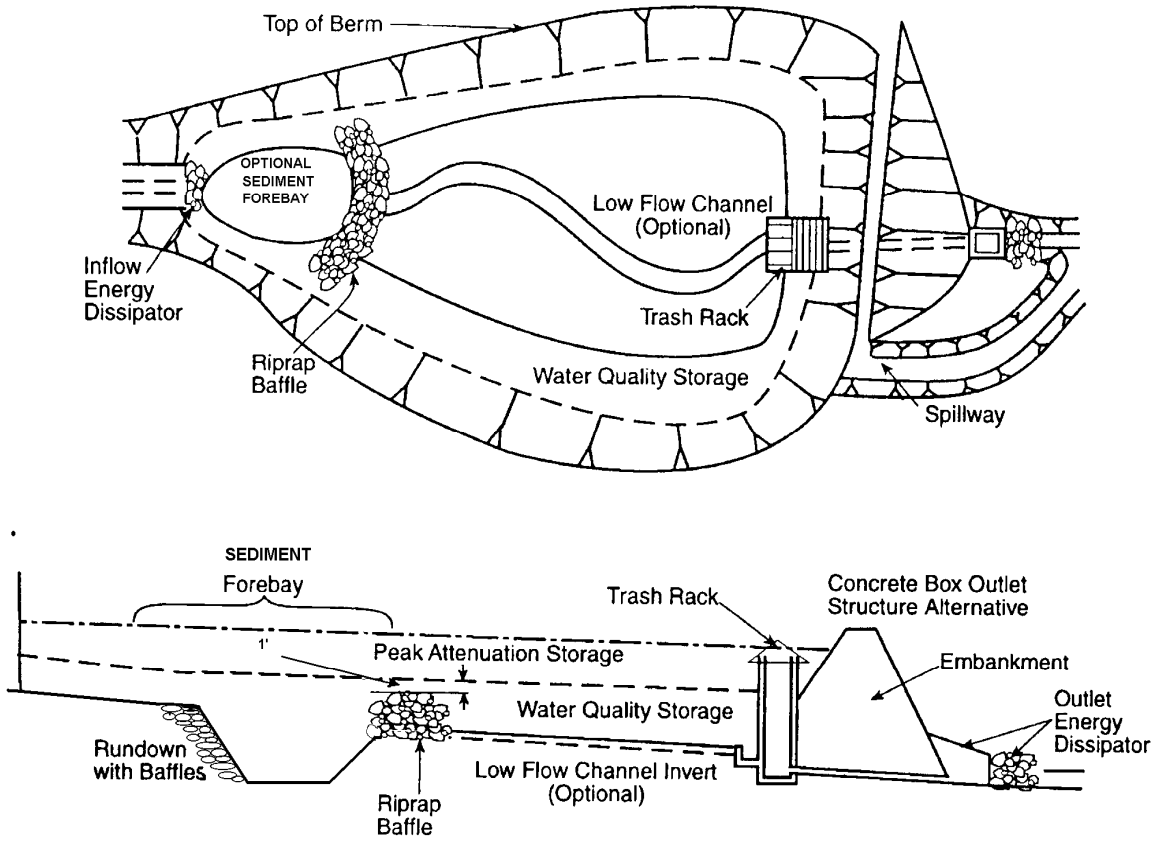
Extended detention basins may be used at sites where significant increases in runoff are expected from site development. In addition, standard detention basins may be retrofitted or converted to extended detention by increasing the time over which the basin releases the stormwater quality design storm runoff volume, provided that erosion and flood control volumes and outflow rates are not adversely altered.
Extended detention basins can be used at residential, commercial, and industrial development sites. However, their limited effectiveness in removing both particulate and soluble pollutants may limit their use for water quality treatment.

Finally, an extended detention basin must have a maintenance plan and, if privately owned, should be protected by easement, deed restriction, ordinance, or other legal measures that prevent its neglect, adverse alteration, and removal.

Design Criteria

The basic design parameters for an extended detention basin are its storage volume and detention time. An extended detention basin must have the correct combination of storage volume and outflow capacity to contain and slowly discharge the design runoff volume over a prescribed period of time. Details of these and other design parameters are presented below. The components of a typical extended detention basin are shown in Figure 6.4-1.

Figure 6.4-1: Extended Detention Basin Components



(Adapted from *Dam Design and Construction Standards*, Fairfax County, Virginia, 1991)

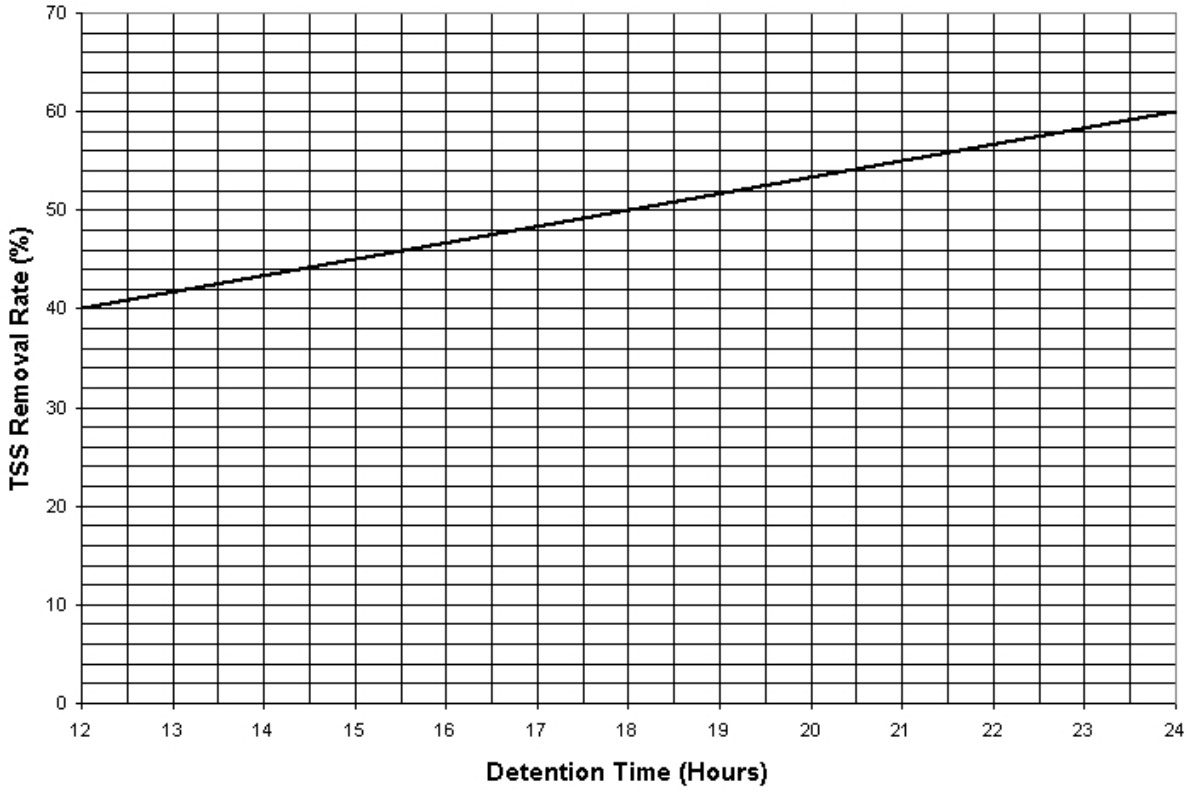
A. Storage Volume, Depth, and Duration

Extended detention basins are designed to provide treatment of runoff volume generated by the stormwater quality design storm. Techniques to compute this volume are discussed in *Chapter XX: Computing Stormwater Runoff Rates and Volumes*.

The time from when the maximum runoff storage volume is achieved in the basin until only 10 percent of that volume remains in the basin is defined as the basin's detention time. Figure 6.4-2 below must be used to determine the TSS removal rates for extended detention basins with detention times of 12 to 24 hours. For example, to achieve a 60 percent TSS removal rate, atleast 10 percent of the maximum runoff storage volume achieved in the basin must remain in the basin 24 hours after the peak elevation is achieved. This applies to all types of land developments. The minimum diameter of any outlet orifice must be 2.5 inches.

The lowest elevation in an extended detention basin, excluding low flow channels, must be at least 1 foot above the seasonal high groundwater table. The lowest elevation in any low flow channel, including any underdrain pipes and bedding material, must be at or above the seasonal high groundwater table.

Figure 6.4-2: TSS Removal Rate vs. Detention Time



B. Overflows

All extended detention basins must be able to safely convey system overflows to downstream drainage systems. The capacity of the overflow must be sufficient to provide safe, stable discharge of stormwater

in the event of an overflow. Extended detention basins that are classified as dams under the NJDEP Dam Safety Standards at N.J.A.C. 7:20 must also meet the overflow requirements of these Standards.

C. Tailwater

The hydraulic design of the outlet structure, outlet pipe, emergency spillway, and underdrain systems in an extended detention basin must consider any significant tailwater effects of downstream waterways or facilities. This includes instances where the lowest invert in the outlet or overflow structure is below the flood hazard area design flood elevation of a receiving stream.

D. Other Components

Information regarding outlet structures, bottom and side slopes, trash racks, low flow channels, conduit outlet protection, and vegetative cover can be found in N.J.A.C.7:8-6 and Soil Erosion and Sediment Control Standards for New Jersey and the NJDEP Stormwater Management Facilities Maintenance Manual.

E. Subsurface Extended Detention Basins

A subsurface detention basin is located entirely below the ground surface. Runoff may be stored in a vault, perforated pipe, and/or stone bed. If a stone bed is utilized for any part of the storage volume, all runoff to the subsurface basin must either be pretreated or the basin's storage volume increased to account for the loss of volume in the stone bed due to sediment accumulation. This loss must be based upon the expected life of the basin. This increase is due to the impracticality of removing this sediment from the stone storage bed. This pretreatment must remove at least 50 percent of the TSS in the runoff from the basin's maximum design storm.

Following pretreatment, additional TSS removal can then be provided by the subsurface extended detention basin as the secondary BMP in a treatment train. Computation of the total TSS removal rate is described in *Chapter XX: Stormwater Pollution Removal Criteria.* See *Recommendations* below for additional information on runoff pretreatment.

Maintenance

Effective extended detention basin performance requires regular and effective maintenance. *Chapter XX: Maintenance and Retrofit of Stormwater Management Measures* provides information and requirements for preparing a maintenance plan for stormwater management facilities, including extended detention basins. Specific maintenance requirements for extended detention basins are presented below. These requirements must be included in the basin's maintenance plan.

A. General Maintenance

All extended detention basin components expected to receive and/or trap debris and sediment must be inspected for clogging and excessive debris and sediment accumulation twice annually and as needed. Such components may include basin bottoms, trash racks, low flow channels, outlet structures, riprap or gabion aprons, and inlets.

Sediment removal should take place when the basin is thoroughly dry. Disposal of debris, trash, sediment, and other waste material should be done at suitable disposal/recycling sites and in compliance with all applicable local, state, and federal waste regulations.

B. Vegetated Areas

Mowing and/or trimming of vegetation must be performed on a regular schedule based on specific site conditions. Grass should be mowed at least once a month during the growing season. Vegetated areas must be inspected at least annually for erosion and scour. Vegetated areas should also be inspected at least annually for unwanted growth, which should be removed with minimum disruption to the bottom surface and remaining vegetation.

When establishing or restoring vegetation, biweekly inspections of vegetation health should be performed during the first growing season or until the vegetation is established. Once established, inspections of vegetation health, density, and diversity should be performed at least twice annually during both the growing and non-growing seasons. The vegetative cover must be maintained at 85 percent. If vegetation has greater than 50 percent damage, the area must be reestablished in accordance with the original specifications and the inspection requirements presented above.

All use of fertilizers, mechanical treatments, pesticides, and other means to assure optimum vegetation health must not compromise the intended purpose of the extended detention basin. All vegetation deficiencies should be addressed without the use of fertilizers and pesticides whenever possible.

C. Structural Components

All structural components must be inspected for cracking, subsidence, spalling, erosion, and deterioration at least annually.

D. Other Maintenance Criteria

The maintenance plan must indicate the approximate time it would normally take to completely drain the maximum design storm runoff volume from the basin. This normal drain time should then be used to evaluate the basin's actual performance. If significant increases or decreases in the normal drain time are observed, the basin's outlet structure, underdrain system, and both groundwater and tailwater levels must be evaluated and appropriate measures taken to comply with the maximum drain time requirements and maintain the proper functioning of the basin.

Note: The Considerations and Recommendations sections below are provided to assist the designer in enhancement of extended detention basins. However, consistency with these recommendations and considerations is not required in order to receive the TSS removal rate for this BMP.

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Considerations

A typical extended detention basin will range from 3 to 12 feet in depth. Depth is often limited by groundwater conditions or the need for positive drainage from excavated basins. If the basin intercepts

the groundwater, it may result in a loss of runoff storage volume, mosquito breeding, and difficulty maintaining the basin bottom. Hence, it is important to accurately determine the depth to seasonal high groundwater table (SHWT). Please refer to *Chapter XX: Groundwater Recharge* for more information on establishing the SHWT.

When designing an extended detention basin, bottom soils should be examined. If soils are relatively impermeable (USDA Hydrologic Soil Group "D"), a dry extended detention basin may exhibit problems with standing water. Conversely, if soils are very permeable (Group "A") the effects on groundwater should be considered. If bedrock lies close to the surface of the soil, excavation for necessary storage volume may be too costly and difficult. In Karst landscapes, other alternatives to detention basins should be examined.

Recommendations

A. Pretreatment

As with all other best management practices, pretreatment can extend the functional life and increase the pollutant removal capability of an extended detention system. Pretreatment can reduce incoming velocities and capture coarser sediments, which will extend the life of the system. This is usually accomplished through such means as vegetative filters, a forebay, or a manufactured treatment device. Information on vegetative filters and manufactured treatment devices is presented in Chapters 6.11 and 6.7, respectively.

Forebays can also be included at the inflow points to an extended detention basin to capture coarse sediments, trash, and debris, which can simplify and reduce the frequency of system maintenance. A forebay should be sized to hold the sediment volume expected between clean-outs.

B. Sediment Accumulation

A properly designed extended detention basin will accumulate considerable amounts of sediment over time, leading to the loss of the detention volume and, thus, both runoff quality and quantity control effectiveness. Therefore, depending on the clean-out intervals, an increase in an extended detention basin's maximum design storm storage volume should be considered to compensate for this expected loss of storage volume. See *E. Subsurface Extended Detention Basins* in *Design Criteria* above for more information on required volume increases in subsurface basins.

C. Flow Paths

An extended detention basin relies on the process of sedimentation for removal of runoff pollutants. Therefore, the basin should be designed to maximize the degree of sedimentation. Flow path lengths should be maximized and long, narrow basin configurations with length to width ratios from 2:1 to 3:1 should be utilized. Basins that are shallow and have larger surface area to depth ratios will provide better pollutant removal efficiencies than smaller, deeper basins.

D. Wetland Creation

It may be possible to establish a wetland area in the bottom stage of an extended detention basin to increase the pollutant removal rate. See *Chapter 6.2: Constructed Stormwater Wetlands* for more information.

E. Water Depth

To enhance safety by minimizing standing water depths, the vertical distance between the basin bottom and the elevation of the first stormwater quantity control outlet (normally set equal to the maximum stormwater quality design storm water surface) should be no greater than 3 feet wherever practical.

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