Stormwater BMPs for Basins

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Section One Introduction to Basin BMP Types and Selection Guidance

Introduction

This course provides guidance on the design of best management practices (BMPs) for the mitigation of the environmental impacts to receiving waters associated with urban runoff. It presents general design considerations associated with the selection and use of BMPs, and design considerations related to the use of vegetative biofilters. This material provides design guidelines for a group of stormwater management (SWM) BMPs broadly referred to as basins or ponds. The objectives of this course is to provide practical design guides that when followed, result in SWM BMPs facilities that maximize pollutant removal and flood control.

Basin or pond BMPs are the mainstay of SWM. Water resources engineers have designed small and large ponds for many years for a wide range of applications, including farm ponds, recreational ponds, water supply reservoirs, flood control reservoirs and multiple uses reservoirs. Our collective knowledge of ponds, their design, construction, operation and maintenance is extensive. However, their use for environmental protection purposes including stream channel protection, water quality treatment and protection of receiving waters is a recent development, and in many instances requires reassessing the traditional applications of pond design techniques to meet these new objectives. This course provides this type of assessment and guidance related to the design of pond BMPs for environmental protection purposes.

This course provides an introduction to various pond BMP types and the selection of the appropriate pond BMP type. Selection guidance is provided with respect to a number of selection factors that include: 1) impact area, 2) watershed factors, 3) terrain factors, 4) stormwater treatment suitability, 5) physical suitability factors and 6) community and environmental factors.

Section 2 provides criteria for designing dry detention BMPs. Criteria are provided for sizing the required pond volume, basin configuration, outlet protection, vegetative cover and other considerations.

Section 3 provides criteria for the design of wet retention ponds. Guidance is provided for the following design parameters: pool volume, pool depth, surface area of permanent pool, minimum drainage area and pond volume, side slopes, pond configuration, outlets, and other considerations. Criteria are also provided for the design of wetland ponds. These criteria include: general feasibility, conveyance, pretreatment, treatment and maintenance.

Section 4 provides criteria for the design of infiltration ponds. Design criteria are provided for the following elements: general feasibility, conveyance, pretreatment, treatment and maintenance. In addition design procedures address the following elements: soil texture, hydrologic design methods and sizing procedures for infiltration pond design.

Section 5 provides construction specifications for pond BMPs. The specifications address the following elements; embankments, spillways, pipes, valves, plant materials and riprap.

Section 6 provides guidance regarding inspection and maintenance considerations for pond BMPs. The following topics are described: inspection responsibility and contents of inspection reports, aesthetic and functional maintenance requirements, and access requirements. In addition, some guidance is provided relating how to design pond BMPs to minimize the maintenance requirements.

Background

For the purposes of this course, pond BMPs are grouped into three types: 1) dry basins, including detention ponds and extended detention basins, 2) wet ponds, including both wet detention basins and retention ponds and 3) infiltration basins.

Detention and Extended Detention Basins

Detention of urban stormwater runoff began appearing as an urban SWM practice in the late 1960s in North America, to control runoff peaks from new land development sites. Figure 1-1 shows a typical detention basin. While many jurisdictions initially applied this approach to control the 10-, 25-, 50-, or 100-yr storm flow rates, a small number of jurisdictions, including Montgomery County and Prince George's County, Maryland, also mandated detention to control the 2-yr peak flow rate for stream bank erosion control purposes (as discussed in Volume 1, this policy has not been able to achieve the objective of stream channel protection). Extended detention for stormwater quality began to be used for new installations of extended detention ponds or as retrofits of old dry ponds. By the late 1980s, sufficient empirical data were available to design extended detention basins for water quality purposes with reasonable confidence in their performance. Extended detention refers to a basin designed to *extend* detention beyond that required for stormwater control to provide some water quality affect.

Extended detention basins are viable and effective treatment facilities. When properly designed, significant reductions are possible in the total suspended sediment load and of constituents associated with these sediments. Typically these basins are less effective in removing soluble solids. Figure 1-2 illustrates the elements of a typical extended detention basin. The amount of reduction depends on a wide variety of factors, including:

- surface area of the basin
- peak outflow rate
- size distribution of the particles
- specific gravity of particles
- fraction of the sediment that is active clay
- type of associated pollutant concentrations
- fraction of influent solids that are colloidal, dissolved and or unsettleable.

The manner in which these characteristics impact performance is described in Section 2.

Extended detention basins will sometimes have a small permanent pool below the invert of the low flow outlet. This is normally so small that it does not materially impact trapping of sediment and chemicals, and is typically included for aesthetics or to cover deposited sediments.

Figure 1-1 Typical Dry Basin

Regional facilities often offer economies of scale and greater reliability in capturing stormwater, while on-site facilities offer institutional and fiscal advantages of implementation as the land is urbanized. Other advantages and disadvantages of regional and on-site facilities are described in Section 5 of Volume 1.

Because of the poorly documented stormwater pollutant control effectiveness of detention basins designed for flood control, these basins cannot themselves be recommended as viable water quality control measures (Moffa et al., 2000). However, detention basins can be effective when used in conjunction with other upstream stormwater control practices such as swales, filter strips and biofiltratrion BMPs covered in Volume 2.

Wet/Retention Ponds

A retention pond is a small artificial lake with emergent wetland vegetation around the perimeter, designed to remove pollutants from stormwater. This BMP is sometimes referred to as a "wet pond" or a "wet detention basin". In This course, it is referred to as a retention pond to distinguish it from the extended detention basin described in the previous section. Removal rates of solids by retention ponds, tend to outperform detention basins. The larger permanent pool of retention basins allows water to reside in the interval between storms, when further treatment occurs. A retention pond can be sized to remove nutrients and dissolved constituents, while any pool that may be associated with an extended detention basin is smaller and is provided for aesthetics, as discussed under the extended detention discussion above. Figure 1-3 illustrates the elements of a wet/retention pond.

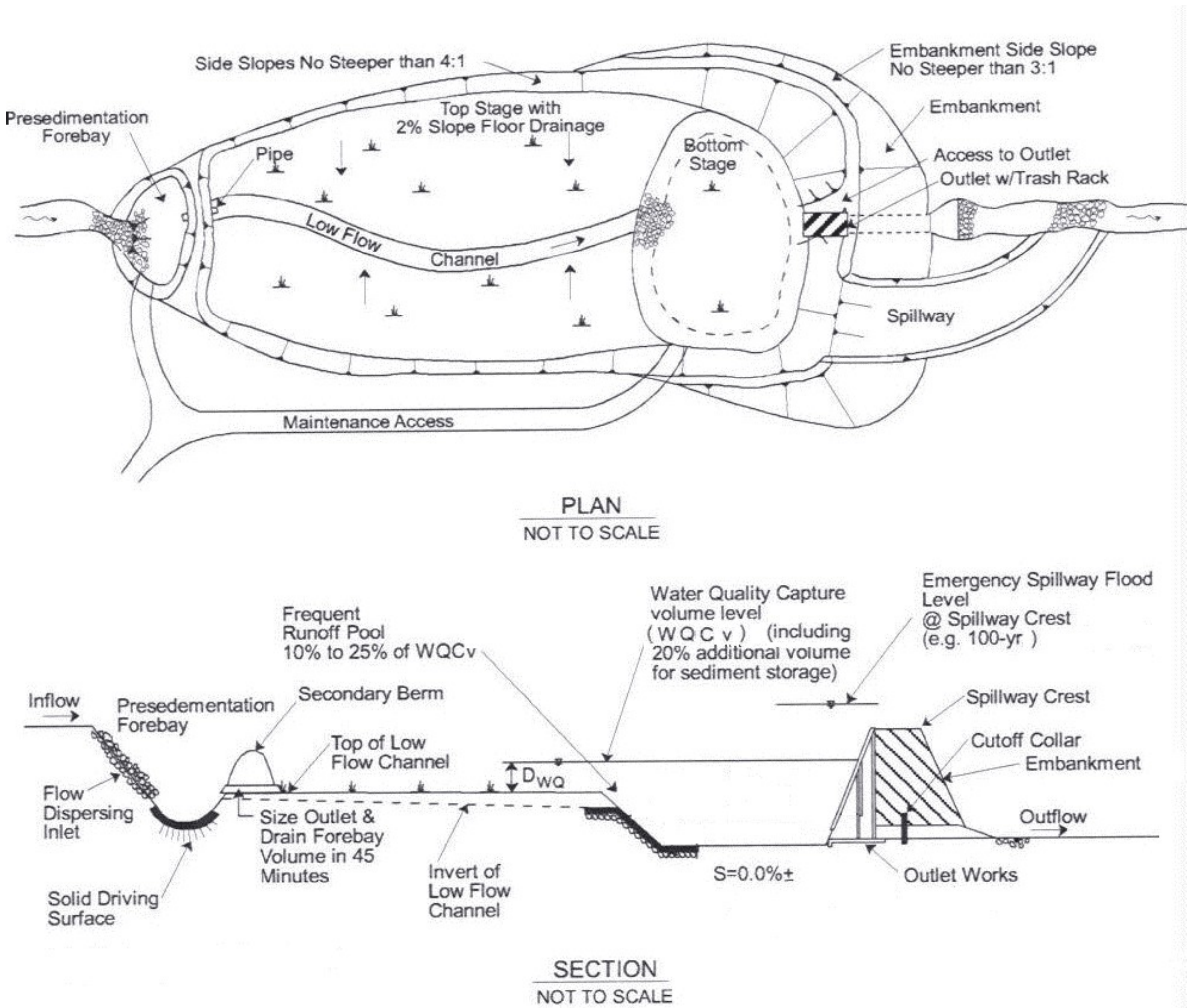

Figure 1-2 Extended Detention Basin, Typical Detail (modified from UDFCD, 1999)

Infiltration Basins

Infiltration basins are detention ponds constructed to allow infiltration to occur simultaneously with other treatment processes. Figure 1-3 provides a typical detail for an infiltration basin. The operating characteristics of infiltration basins are essentially the same as for dry detention, with a few significant exceptions:

- Infiltration basins also remove dissolved solids in the volume of infiltrated water, whereas dry detention basins do not remove dissolved solids.
- The settling velocities of the particles are increased by a value equal to the infiltration rate in the basin. The impact would, of course be more important for the clay-sized particles than for silt, sand, and small or large aggregates.
- Infiltration practices differ from typical dry basins because they have the ability to meet the groundwater recharge requirements (V_R) (described in Appendix C Volume 1), and therefore provide an additional element of control or performance.

