WET PONDS

Definition

A wet pond is a stormwater facility constructed through filling and/or excavation that provides both permanent and temporary storage of stormwater runoff. It has an outlet structure that creates a permanent pool and detains and attenuates runoff inflows and promotes the settlement of pollutants. A wet pond, also known as a retention basin, can also be designed as a multi-stage facility that also provides extended detention for enhanced stormwater quality design storm treatment and runoff storage and attenuation for stormwater quantity management. The adopted TSS removal rate for wet ponds is 50 to 90 percent depending on the permanent pool storage volume in the pond and, where extended detention is also provided, the duration of detention time provided in the pond.

Purpose

Wet ponds are used to address both the stormwater quantity and quality impacts of land development. A wet pond's permanent pool can retain runoff from the stormwater quality design storm, thereby promoting pollutant removal through sedimentation and biological processing. The permanent pool can also protect deposited sediments from resuspension. Higher stages in the basin can also be used to provide additional stormwater quality treatment through extended detention and/or attenuate the peak rates of runoff from larger storms through the use of multi-stage outlets for flood and erosion control. Wet ponds can also provide aesthetic and recreational benefits as well as water supply for fire protection and/or irrigation.

Conditions Where Practice Applies

Wet ponds require sufficient drainage area and, in turn, dry weather or base flow to maintain the volume and environmental quality of the permanent pool. Therefore, the minimum drainage area to a wet pond must be 20 acres.

Wet ponds should not be located within the limits of natural ponds or wetlands, since they will typically not have the full range of ecological functions as these natural facilities. While providing some habitat and aesthetic values, wet ponds are designed primarily for pollutant removal and erosion and flood control.

It is important to note that a wet pond must be able to maintain its permanent pool level. If the soil at the site is not sufficiently impermeable to prevent excessive seepage, construction of an impermeable liner or other soil modifications will be necessary.

Wet ponds may be limited by the potential for discharge water to be heated in the permanent pool during summer months and should not be used if the receiving waters are ecologically sensitive to temperature change.

Finally, a wet pond must also 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 parameter for a wet pond is the ratio of its permanent pool volume to the volume of runoff entering the pond. This ratio is used to determine the pond's TSS removal rate. This removal rate can be increased if extended detention storage is also provided above the permanent pool level. Details of these and other design parameters are presented below and summarized in Table 6.12-1. The components of a typical wet pond both with and without extended detention are shown in Figure 6.12-1.

A. Storage Volumes

Wet ponds should be designed to treat the runoff volume generated by the stormwater quality design storm. Techniques to compute this volume are discussed in Chapter 2: Computing Stormwater Runoff Rates and Volumes. The resultant TSS removal rate for a wet pond will depend on the ratio of its permanent pool volume to the stormwater quality design storm runoff volume. Figure 6.12-2 presents the range of approved TSS removal rates for various permanent pool to runoff volume ratios. As can be seen in the figure, the minimum required permanent pool volume in a wet pond is equal to the stormwater quality design storm runoff volume to the pond. At this 1:1 volume ratio, a wet pond would have a TSS removal rate of 50 percent. This removal rate increases to 80 percent for wet ponds with permanent pool volumes that are three times the stormwater quality design storm runoff volume (i.e., volume ratio of 3:1).

Also shown in Figure 6.12-2 are TSS removal rates in wet ponds that also provide extended detention above the permanent pool water surface. As shown in Figure 6.12-2, a wet pond with a permanent pool to runoff volume ratio of 3:1 that also provides 24 hours of extended detention would have a TSS removal rate of 90 percent. TSS removal rates for other combinations of permanent pool to runoff volume ratios for extended detention times of 12 and 18 hours are also shown in Figure 6.12-2. Definitions and details of extended detention are presented in Section 6.4: Extended Detention Basins.

B. Permanent Pool Depth

The depth of a wet pond's permanent pool is an important design parameter. The permanent pool should be shallow enough to avoid thermal stratification and deep enough to minimize algal blooms and resuspension of previously deposited materials by subsequent storms and strong winds. Prevention of thermal stratification will minimize short-circuiting and maintain aerobic bottom waters, thus maximizing pollutant uptake and minimizing the potential release of nutrients to the overlying waters. The mean depth of the permanent pool is obtained by dividing the storage volume by the pool surface area. A mean depth of three to six feet is normally sufficient to maintain a healthy environment within the permanent pool. The outlet structure or riser should be located in a relative deep area to facilitate withdrawal of cold

bottom water to help mitigate any downstream thermal impacts. If maintained at the recommended three to six foot depth, the permanent pool can better serve as an aquatic habitat.

Figure 6.12-1: Wet Pond Components

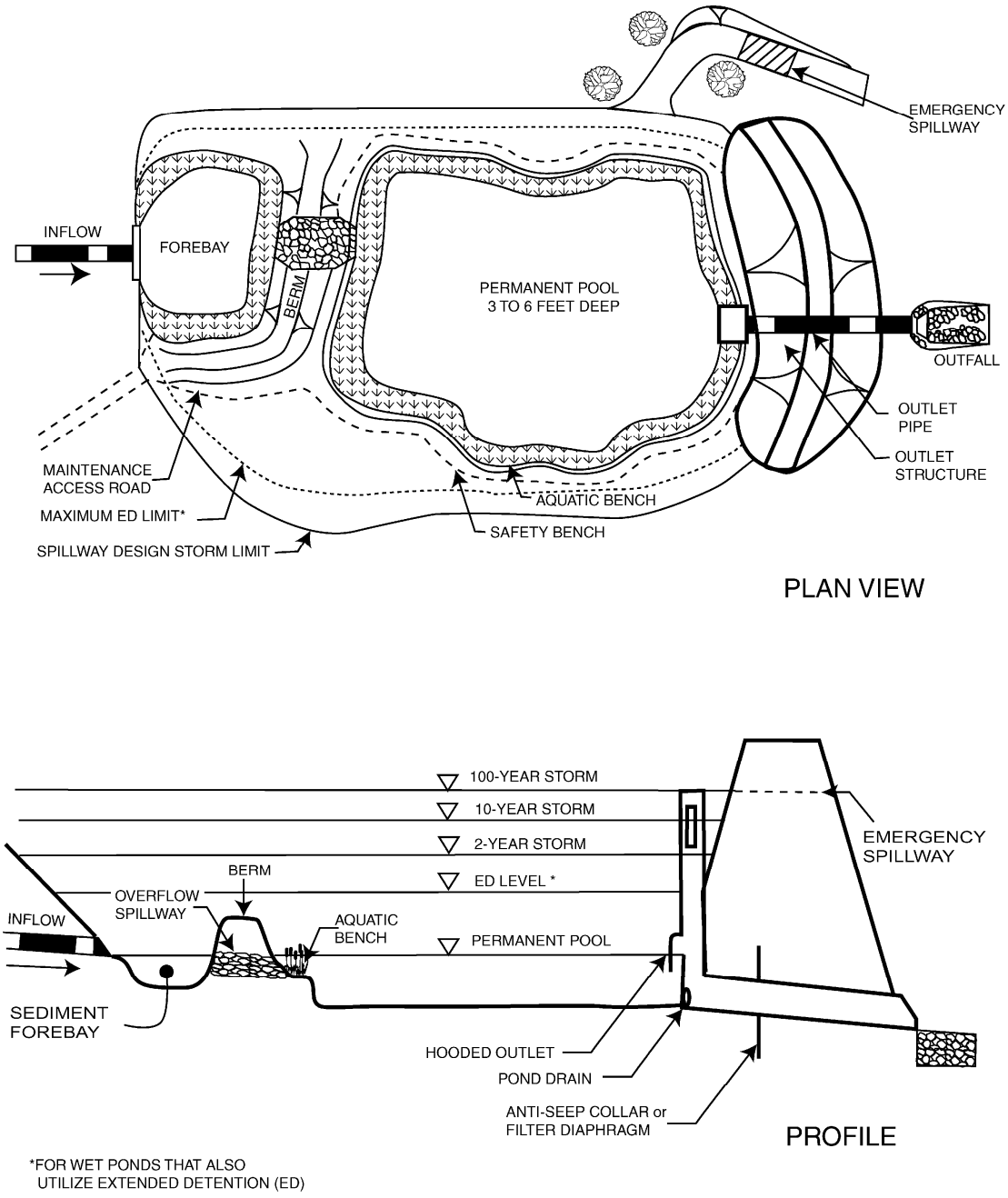
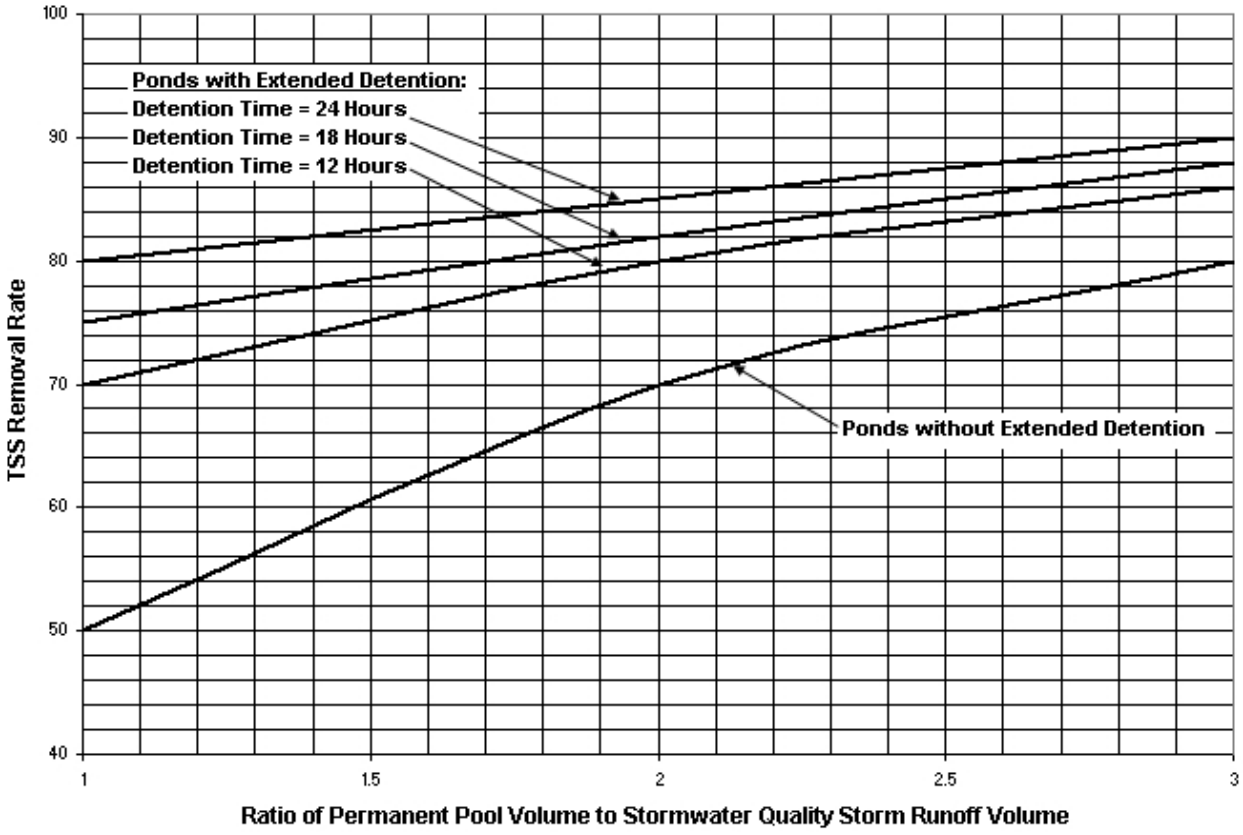


Figure 6.12-2: TSS Removal Rates for Wet Ponds



C. Permanent Pool Surface Area

The surface area of a wet pond's permanent pool is also an important design parameter as it directly affects the settling rate of particulate solids in the runoff to the pond. The surface area of a permanent pool will depend on site topography, minimum and maximum pool depths, and the desired settling rate. The minimum permanent pool surface area is 0.25 acres.

D. Drainage Area And Water Budget

As noted above, wet ponds require sufficient drainage area and dry weather base flow to function properly. A reliable base flow must be available to maintain the volume and quality of the permanent pool. Therefore, the minimum drainage area to a wet pond is 20 acres. Smaller drainage areas may be permissible if detailed analysis indicates that sufficient base or groundwater inflow is available. The detailed analysis must include a water budget demonstrating the availability of water to sustain the 3 to 6 feet permanent pool depth. The water budget must demonstrate that the water supply to the wetpond is greater than the expected loss rate.

E. Pond Configuration

The length to width ratio of a wet pond should as large as possible to simulate conditions found in plug flow reaction kinetics. Under ideal plug flow conditions, a plug or pulse of runoff enters a pond and is treated by chemical reactions as well as the physical processes of dispersion and settlement as the pulse travels the length of the wet pond. Therefore, the pond's length to width should be at least 3:1 to maximize these treatment processes. In cases where it is impractical to construct wet ponds with these lengths, internal baffles or berms may be added within the pond to the increase the travel length and residence time.

F. Safety Ledges

Safety ledges must be constructed on the slopes of all wet ponds with a permanent pool deeper than three feet. Two ledges must be constructed, each 4 to 6 feet in width. The first or upper ledge must be located between 1 and 1.5 feet above the permanent pool level. The second or lower ledge must be located approximately 2.5 feet below the permanent pool level.

G. Outlet Structure

The riser structure should be equipped with a bottom drain pipe, sized to drain the permanent pool within 40 hours so that sediments may be removed mechanically when necessary. The drain pipe should be controlled by a lockable valve that is readily accessible from the top of the outlet structure. Additional information regarding outlet structures can be found in N.J.A.C.7:8-6, Soil Erosion and Sediment Control Standards for New Jersey and the NJDEP Stormwater Management Facilities Maintenance Manual.

H. Overflows

All wet ponds 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. Wet ponds 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, including safe conveyance of the wet pond's spillway design storm.

I. Tailwater

The hydraulic design of the outlet structure, outlet pipe, and emergency spillway in a wet pond must consider any significant tailwater effects of downstream waterways or facilities. This includes instances where the permanent pool level is below the flood hazard area design flood elevation of the receiving stream.

J. Other Components

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

Table 6.12-1: Summary of Design Parameters

Design Parameter
Minimum Permanent Pool Volume = Stormwater Quality Design Storm Runoff Volume
Mean Permanent Pool Depth = 3 to 6 Feet
Minimum Permanent Pool Surface Area = 0.25 Acres
Minimum Drainage Area Size = 20 Acres
Maximum Permanent Pool Drain Time = 40 Hours
Recommended Minimum Pool Length to Width Ratio = 3:1

Maintenance

Effective wet pond performance requires regular and effective maintenance. *Chapter 8: Maintenance and Retrofit of Stormwater Management Practices* provides information and requirements for preparing a maintenance plan for stormwater management facilities, including wet ponds. Specific maintenance requirements for wet ponds are presented below. These requirements must be included in the pond's maintenance plan.

A. General Maintenance

All wet pond components expected to receive and/or trap debris and sediment must be inspected for clogging and excessive debris and sediment accumulation at least four times annually as well as after every storm exceeding one inch of rainfall. The primary location for debris and particularly sediment accumulation will be within a wet pond's permanent pool. Additional components may include forebays, inflow points, trash racks, outlet structures, and riprap or gabion aprons.

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.

Studies have shown that readily visible stormwater management facilities like wet ponds receive more frequent and thorough maintenance than those in less visible, more remote locations. Readily visible facilities can also be inspected faster and more easily by maintenance and mosquito control personnel.

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 also 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 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 season. The vegetative cover should be maintained at 85 percent. If vegetation has greater than 50 percent damage, the area should 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 ensure optimum vegetation health must not compromise the intended purpose of the wet pond. 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. All outlet valves are to be inspected and exercised at least four times 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 and return the pond to its permanent pool level. This normal drain time should then be used to evaluate the pond's actual performance. If significant increases or decreases in the normal drain time are observed, the pond's outlet structure and both groundwater and tailwater levels must be evaluated and appropriate measures taken to comply with the maximum drain time requirements.

Note: The Considerations section below is provided to assist the designer in enhancement of wet ponds. However, consistency with these considerations is not required in order to receive the TSS removal rate for this BMP.

Considerations

A. Permanent Pools

The primary component of a wet pond is its permanent pool. To maintain water quality, oxygen levels, control mosquito breeding, and prevent stagnation, an adequate and regular inflow of surface and/or ground water is necessary. Where sufficient oxygen levels and mixing will be difficult to achieve, a fountain or aerator may be included. However, such conditions may be indicative of larger site suitability problems that must be thoroughly investigated before a wet pond is selected for use at a land development site. The potential effects of sediment loading on the permanent pool must also be considered when determining whether a site is suitable for a wet pond. The use of existing lakes and ponds as wet ponds for treatment of stormwater is prohibited.

A well-designed wet pond will accumulate considerable quantities of sediment. The cleanout cycle for a wet pond in a stabilized watershed can vary, with an average cycle of approximately 10 years. Sediment removal at each cycle may cost as much as 20 to 40 percent of the initial construction cost. It should be noted that the exact cleanout cycle and cost will depend on the specific character of the wet pond and its watershed. Therefore, periodic inspections of sediment accumulation in a wet pond are vital to

determining how often and how much sediment must be removed. See *Maintenance* above for more information.

In cases where relatively permeable soils are encountered, the risk of seepage losses may be minimized by installing a clay or synthetic liner along the bottom of the pond.

B. Thermal Effects

Thermal effects of the wet pond must be considered since the permanent pool can act as a heat sink between storm events during hot weather. When the water is displaced from the pool, it may be as much as 10 degrees Fahrenheit warmer than the naturally occurring baseflow in the downstream waterway. Runoff to wet ponds from large impervious surfaces can also significantly raise the temperature of runoff during hot weather. The net result of elevated pool temperatures may have an adverse impact on downstream coldwater uses such as trout production.

Therefore, wet pond designers should pay special attention to the potential of thermal effects on downstream water bodies supporting cold water fisheries. Thermal impacts of wet ponds in such areas may be mitigated by:

- Using a deep permanent pool and positioning the outlet pipe to discharge the relatively colder water from near the bottom;
- Planting shade trees on the periphery of the pool to reduce solar warming; and
- Employing a series of pools in sequence rather than a single one.

C. Vegetation

Aquatic vegetation plays an important role in the pollutant removal dynamics of a wet pond. Soluble pollutants, especially nutrients, are removed through biological assimilation by both phytoplankton and macrophytes. Wetland plants can help keep algal proliferation in check by limiting the amount of nutrients available to the phytoplankton. In addition, an organically enriched wetland substrate will provide an ideal environment for bacterial populations to metabolize organic matter and nutrients. Aquatic vegetation may also aid in the regulation of pond water temperature.

Marsh vegetation can also enhance the appearance of the wet pond, stabilize the side-slopes, serve as wildlife habitat, and temporarily conceal unsightly trash and debris. As such, a wet pond may be designed to promote dense growth of appropriate wetland plant species along the banks. A 10 to 15 foot wide wetland vegetation bench starting one foot below the pool surface may be established along the perimeter of the pond. Water tolerant species of vegetative cover for wet pond surfaces should be used. To promote lasting growth, grasses and other vegetative covers should be compatible with prevailing weather and soil conditions and tolerant of periodic inundation and runoff pollutants. An adequate depth of topsoil should be provided below all vegetative covers in uplands. A minimum thickness of six inches is recommended.

D. Designing for Pollutant Removal

Two alternative approaches may be used to design wet pond pollutant removal. The first approach is based on solids settling and assumes that all pollutant removal within the pond occurs due to sedimentation. The Design Criteria section above is based primarily on this approach. The second approach treats the wet pond as a lake with controlled levels of eutrophication to account for the biological and physical/chemical processes that are principal mechanisms for pollutant removal. Both approaches relate the pollutant removal efficiencies to hydraulic residence time.

Design approach should be selected based on the target pollutants as well as site and economic constraints. The controlled eutrophication approach requires longer residence times and larger storage volumes comparable to those of the solids settling approach. However, where the chief concern is to control nutrient levels in waters such as lakes and reservoirs, it is advantageous to use the controlled eutrophication approach. If the major goal is the removal of a broad spectrum of pollutants, especially those adsorbed onto suspended matter (as discussed in Chapter 1: Stormwater Pollutant Removal Criteria), it is generally preferable to base the design on the sedimentation approach.

E. Pretreatment

As with all other best management practices, pretreatment can extend the functional life and increase the pollutant removal capability of a wet pond. 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 a vegetative filters and/or a manufactured treatment device. Information on vegetated filter strips and manufactured treatment devices is presented in Chapters 6.11 and 6.7, respectively.

As shown in Figure 6.12-1, forebays at the inflow points to a wet pond can capture coarse sediments, trash and debris, which can simplify and reduce the frequency of pond maintenance. A forebay should be sized to hold the sediment volume expected between clean-outs.

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