Stormwater Best Management Practice

Dry Detention Ponds

Minimum Measure: Post Construction Stormwater Management in New Development and Redevelopment
Subcategory: Retention/Detention

Description

Dry detention ponds (also called dry ponds, extended detention basins, detention ponds and extended detention ponds) are basins that detain stormwater for some minimum time (e.g., 24 hours) to allow particles and pollutants to settle and reduce peak flow rates. They do not have large permanent pools of water—unlike wet ponds—though they often have small pools at the inlet and outlet of the basin. Although dry detention ponds were once popular for flood control, they are less so now, given their limited ability to provide water quality treatment.

Dry detention pond with security fencing.
Credit: Jared Richardson for USEPA, 2012

Applicability

Dry detention ponds have traditionally been one of the most widely used stormwater controls. They are appropriate for detaining stormwater from large drainage areas (typically 10 or more acres). They require a large area to construct, so other stormwater controls are more appropriate for smaller sites (see Grassed Swales, Infiltration Basin, Infiltration Trench, Bioretention (Rain Gardens), Permeable Pavements, or Green Roofs). If pollutant removal efficiency is an important consideration, dry detention ponds may not be the most appropriate choice.

Common Terms

Stormwater hot spots are areas where land use or activities generate highly contaminated stormwater discharges, with pollutant concentrations exceeding those typically found in stormwater. Examples include gas stations, vehicle repair areas and waste storage areas.

A **stormwater retrofit** is a stormwater management practice (usually structural) put into place after development or construction of a stormwater control to improve water quality, protect downstream channels, reduce flooding or meet other specific objectives that did not exist at the time of original construction.

Regional Applicability

Dry detention ponds can work in all regions of the United States. Design engineers might need to make minor changes in cold or arid climates or in regions with karst (i.e., limestone) topography.

Stormwater Hot Spots

Dry detention ponds can accept flow from stormwater hot spots, but to do so need a liner or significant separation from groundwater.

Stormwater Retrofit

As noted above, dry detention ponds were common stormwater controls in the past but have become less popular given their limited ability to address water quality concerns (see "Limitations" below). They can be useful stormwater retrofit options, though, given their existing prevalence and the fact that they already offer certain stormwater management benefits such as flood control. In retrofit scenarios, it is possible to modify these facilities to incorporate features that address additional objectives such as water quality treatment and channel protection. This could be a more cost-effective option than constructing an entirely new stormwater control—as could combining a dry detention basin with other stormwater treatment options to address water quality impacts.

Cold Water (Trout) Streams

Dry detention ponds can increase the temperature of stormwater they receive (UNHSC, 2011). Generally, the only way to mitigate this effect is to decrease the detention time. Alternative stormwater controls may therefore be more appropriate in areas discharging to cold water streams.

Siting Considerations

Designers need to ensure that the dry detention pond is feasible at the site in question. This section provides basic guidelines for siting dry detention ponds.

Drainage Area

In general, dry detention ponds are appropriate for sites with a minimum area of 10 acres. On smaller sites, it can be challenging to provide proper discharge control because the orifice diameter at the outlet needed to control relatively small storms becomes very small and thus prone to clogging (City of Portland, 2016). For smaller sites, green infrastructure practices and on-lot treatment controls are better options given their smaller footprint and effectiveness.

Slope

Dry detention ponds can operate at sites with slopes up to about 15 percent. The local slope needs to be relatively flat: this allows the pond's side slopes to be reasonably flat, which keeps safety risks low.

There is no minimum slope requirement, though there needs to be enough elevation drop from the pond inlet to the pond outlet to ensure that flow can move through the system.

Soils

Dry detention ponds can function with almost all soils and geology, with minor design adjustments for karst areas or in rapidly percolating soils such as sand. In such areas, extended detention ponds need impermeable liners to prevent groundwater contamination or sinkhole formation.

Standing Water

To limit standing water, the base of the extended detention facility should not intersect the groundwater table. The persistence of standing water for more than 3 days in dry detention facilities makes them ideal breeding grounds for mosquitoes (Metzger et al., 2002).

Design Considerations

Specific designs may vary considerably, depending on site constraints, preferences of the designer or community, or local regulations. Common recommended features fall into five basic categories: pretreatment, treatment, conveyance, maintenance reduction and landscaping. For any project, design engineers should follow local requirements.

Pretreatment

Removing coarse sediment particles from stormwater before they reach the large permanent pool reduces a pond's maintenance burden. Pretreatment features help settle out these particles. For a pond, the appropriate pretreatment feature is a sediment forebay, a small pool at the entrance to the pond (typically about 10 percent of the volume of water that the pond will treat for pollutant removal).

Treatment

Treatment design features enhance a stormwater control's ability to remove pollutants. To allow for enough settling time, the pond should be large enough to detain the volume of stormwater it treats for between 12 and 48 hours. Designing dry ponds with a high length-to-width ratio (i.e., at least 1.5:1) and incorporating other design features to maximize the flow path effectively increases the detention time in the system by keeping flow from short-circuiting the pond. Designing ponds with relatively flat side slopes can also help to lengthen the effective flow path. Last, as dry detention ponds alone do not provide a high degree of pollutant removal, adding filtration at the outlet improves water quality before discharging to receiving waters.

Conveyance

The conveyance system should carry stormwater to and from dry ponds safely, in a manner that minimizes erosion potential. It is also important to stabilize the outfall of pond systems to prevent scouring. To convey low flows through the system, designers should incorporate a small, shallow pilot channel, as well as an emergency spillway to safely convey water from large floods. To help mitigate the warming of water at the outlet channel, designers should provide shade around the channel at the pond outlet, if possible.

Maintenance Reduction

Stormwater controls need regular maintenance. Design features can ease this maintenance burden. In a dry detention pond, a micropool at the outlet can prevent resuspension of sediment and outlet clogging. A good design includes maintenance access to the forebay and micropool.

Another design feature that can reduce maintenance needs is a non-clogging outlet. Typical examples include a reverse-slope pipe or a weir outlet with a trash rack. A reverse-slope pipe draws from below the permanent pool, extending in a reverse angle up to the riser, and determines the water elevation of the micropool. Because these outlets draw water from below the level of the permanent pool, floating debris is less likely to clog them.

Landscaping

Designers should maintain a vegetated buffer around the dry detention pond and should select plants within the detention zone (i.e., the portion of the pond up to the elevation where it detains stormwater) that can withstand both wet and dry periods.

Storage Pipes and Tanks

Another variation of the dry detention pond design is the use of storage tanks, storage pipes or underground vaults. This approach is most common in urban environments on small sites with limited opportunity to provide flood control—where underground storage for a large drainage area would generally be costly. Because the drainage area contributing to tank or pipe storage is typically small, the outlet diameter needed to reduce the flow from very small storms would be very small. A very small outlet diameter, along with the underground location of the tanks or pipes, creates the chance that debris will build up in the outlet and cause maintenance problems.

Arid or Semiarid Climates

In arid and semiarid regions, design engineers might need to make changes to conserve scarce water resources. Any landscaping plans should prescribe drought-tolerant vegetation wherever possible. In addition, the design engineer can replace the wet forebay with an alternative dry pretreatment, such as a detention cell. In regions with distinct wet and dry seasons—as in many arid regions—detention ponds can have recreation uses in the dry season (e.g., as ball fields).

Cold Climates

In cold climates, some additional design features can help to treat spring snowmelt. One such modification is to increase the volume available for detention to help treat this relatively large flow event. As well, it may be necessary to remove sediment from the forebay more often than in warmer climates (see “Maintenance Considerations” below for guidelines) to account for sedimentation due to road sanding.

Maintenance Considerations

In addition to incorporating features into the dry detention pond design to minimize maintenance, site operators will need to carry out some regular maintenance and inspection practices. Table 1 outlines some of these practices.

Table 1. Typical maintenance activities for dry ponds

Activity	Schedule
▪ Note erosion of pond banks or bottom	Semiannual inspection
▪ Inspect for damage to the embankment ▪ Monitor for sediment accumulation in the facility and forebay ▪ Examine to ensure that inlet and outlet devices are free of debris and operational	Annual inspection
▪ Repair undercut or eroded areas ▪ Mow side slopes ▪ Manage pesticide and nutrients ▪ Remove litter and debris	Standard maintenance
▪ Seed or sod to restore dead or damaged ground cover	Annual maintenance (as needed)
▪ Monitor sediment accumulations in the forebay; remove sediment when the forebay capacity has been reduced by 50 percent	2- to 7-year maintenance
▪ Monitor sediment accumulations; remove sediment when the pond volume has been reduced by 25 percent	25- to 50-year maintenance

Source: Modified from MPCA, 2017

Limitations

Although dry detention ponds are widely applicable, they have some limitations that might make other stormwater controls preferable:

- Dry detention ponds have limited water quality treatment capacity compared to other structural stormwater controls and are ineffective at removing soluble pollutants (see “Effectiveness”).
- Dry extended detention ponds may become a nuisance due to mosquito breeding if improperly maintained or if shallow pools of water form for more than 3 days.
- Dry ponds may detract from the value of a home (see “Cost Considerations”).

Dry detention ponds on their own only provide peak flow reduction and do little to control stormwater volume, which could result in adverse downstream impacts.

Effectiveness

Structural stormwater controls can achieve four broad resource protection goals: flood control, channel protection, groundwater recharge and pollutant removal. Dry detention basins can provide flood control and channel protection, as well as some limited pollutant removal. They are not typically designed to provide groundwater recharge (for a similar control that does provide groundwater recharge, see Infiltration Basin). However, some infiltration to surrounding soils may occur, particularly in soils with high infiltration rates.

Flood Control

One objective of stormwater controls can be to reduce the flood hazard associated with large storm events by reducing the peak flow associated with these storms. One of the main purposes of dry detention basins is to slow stormwater and reduce peak flow rates. Dry detention ponds therefore provide effective flood control, especially in conjunction with other peak flow reduction controls throughout a watershed.

Channel Protection

One result of urbanization is the geomorphic changes that occur in response to modified hydrology. Traditionally, dry detention basins have provided control of the 2-year storm for channel protection. However, it appears that this control has been relatively ineffective for channel protection. Research suggests that control of a smaller storm, such as the 1-year storm, might be more appropriate (MacRae, 1996; Tillinghast et al., 2011). Most current channel protection standards are based on the 1-year storm event (e.g., MDE, 2009).

Pollutant Removal

Dry detention basins provide some pollutant removal, provided that the design features described in the "Siting Considerations" and "Design Considerations" sections are incorporated. Although they are effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. Pollutant loading information for dry detention basins provided by the New Hampshire Department of Environmental Services allows for an assumed removal efficiency of 80 percent for total suspended solids, 55 percent for total nitrogen removal and 68 percent for total phosphorus removal (NHDES, 2011).

Cost Considerations[1]

The construction costs associated with dry detention ponds can range considerably depending on the type of construction and size. Adjusted for inflation, a reported range for dry detention ponds and dry extended detention ponds is $45,000 to $80,000 per acre of impervious surface treated (King & Hagan, 2011). As with most other stormwater controls, economies of scale suggest that larger systems are at the lower end of this range.

Maintenance costs can be slightly higher than comparable wet ponds, mostly due to the greater area needing regular mowing. For ponds, the annual cost of routine maintenance is typically about 2 to 6 percent of the construction cost (King & Hagan, 2011). Alternatively, a community can estimate the cost of the maintenance activities outlined in the maintenance section.

Another economic concern associated with dry ponds is that they can detract from the value of adjacent properties, especially compared to wet ponds and mixed recreational use stormwater facilities (Lee & Li, 2009). One study found that dry ponds detract from the perceived value of adjacent homes by between 3 and 10 percent (Emmerling-Dinovo, 1995).

Additional Information

Additional information on related practices and the Phase II MS4 program can be found at EPA's National Menu of Best Management Practices (BMPs) for Stormwater website

[1] Prices updated to 2019 dollars. Inflation rates obtained from the Bureau of Labor Statistics CPI Inflation Calculator website: https://data.bls.gov/cgi-bin/cpicalc.pl.

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