

**VIRGINIA DEQ STORMWATER  
DESIGN SPECIFICATION No. 15****EXTENDED DETENTION (ED) POND****VERSION 1.9****March 1, 2011****SECTION 1: DESCRIPTION**

An Extended Detention (ED) Pond relies on 12 to 24 hour detention of stormwater runoff after each rain event. An under-sized outlet structure restricts stormwater flow so it backs up and is stored within the basin. The temporary ponding enables particulate pollutants to settle out and reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on banks of the receiving stream. ED differs from stormwater detention, since it is designed to achieve a minimum drawdown time, rather than a maximum peak rate of flow (which is commonly used to design for peak discharge or flood control purposes and often detains flows for just a few minutes or hours). However, detention used for channel protection, may result in extended drawdown times. Therefore, designers are encouraged to evaluate the detention drawdown as compared to the ED requirements in order to meet both criteria. ED ponds rely on gravitational settling as their primary pollutant removal mechanism. Consequently, they generally provide fair-to-good removal for particulate pollutants, but low or negligible removal for soluble pollutants, such as nitrate and soluble phosphorus. The use of ED alone generally results in the lowest overall pollutant removal rate of any single stormwater treatment option. As a result, ED is normally combined with wet ponds (Design Specification No 14) or constructed wetlands (Design Specification No 15) to maximize pollutant removal rates. Designers should note that an ED pond is the final element in the roof to stream runoff reduction sequence, so one **should be considered *only* if there is remaining Treatment Volume or Channel Protection Volume to manage after all other upland runoff reduction practices have been considered and properly credited.** Designers may need to submit documentation to the local plan review authority showing that all other runoff reduction opportunities have been

exhausted and were found to be insufficient, leaving additional water quality or Channel Protection Volume to manage.

## SECTION 2: PERFORMANCE

**Table 15.1. Summary of Stormwater Functions Provided by ED Ponds**

Stormwater Function	Level 1 Design	Level 2 Design
Annual Runoff Volume Reduction (RR)	0%	15%
Total Phosphorus (TP) EMC Reduction <sup>1</sup> by BMP Treatment Process	15%	15%
Total Phosphorus (TP) Mass Load Removal	15%	31%
Total Nitrogen (TN) EMC Reduction <sup>1</sup> by BMP Treatment Process	10%	10%
Total Nitrogen (TN) Mass Load Removal	10%	24%
Channel Protection	Yes; storage volume can be provided to accommodate the full Channel Protection Volume (CP <sub>V</sub> )	
Flood Mitigation	Yes; flood control storage can be provided above the maximum extended detention volume	
<sup>1</sup> Change in event mean concentration (EMC) through the practice. The actual nutrient mass load removed is the product of the removal rate and the runoff reduction rate (see Table 1 in the <i>Introduction to the New Virginia Stormwater Design Specifications</i> ).		

Sources: CWP and CSN (2008); CWP (2007)

## SECTION 3: LEVEL 1 AND 2 DESIGN TABLE

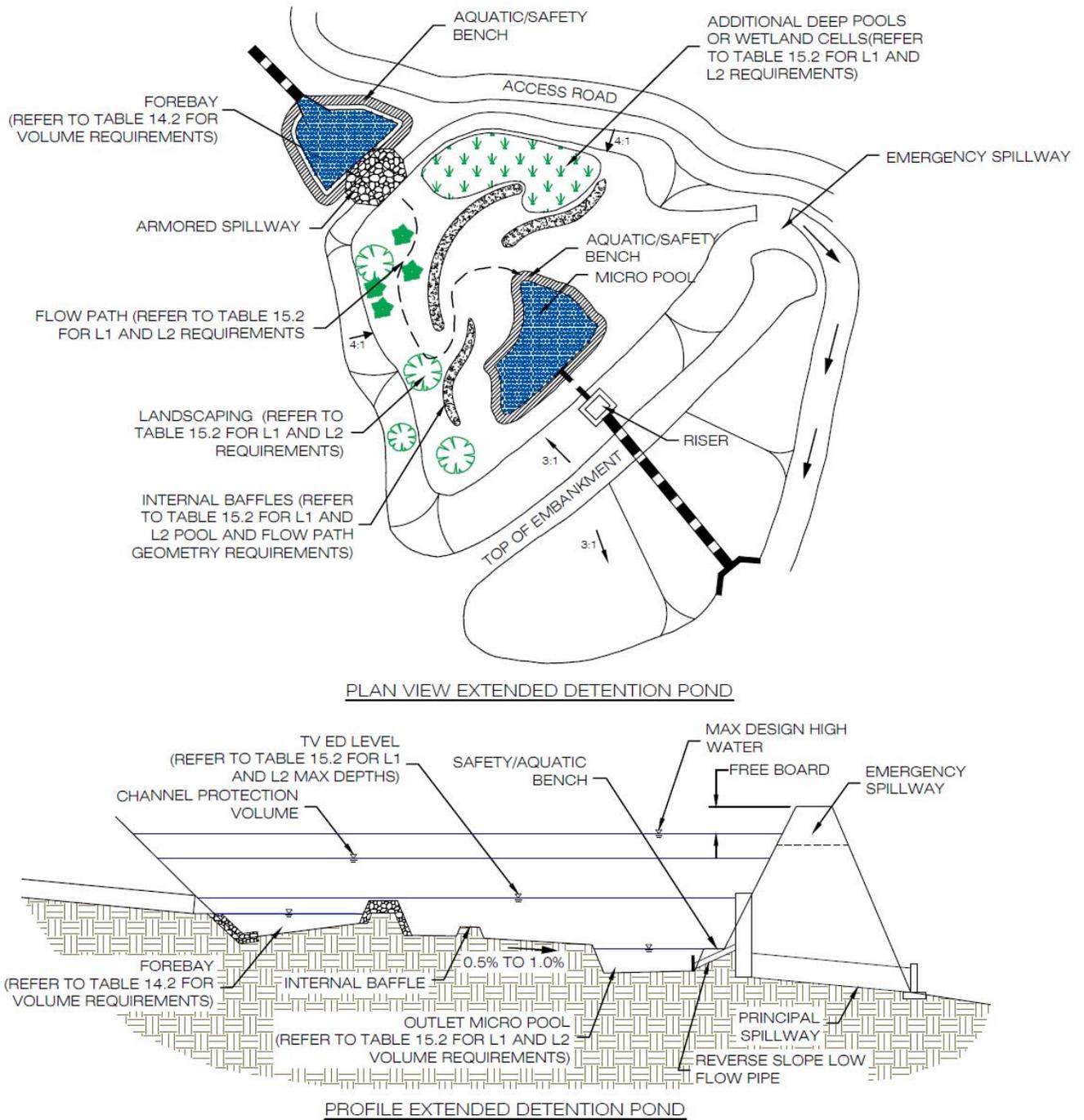
The major design goal for ED Ponds in Virginia is to maximize nutrient removal and runoff reduction. To this end, designers may choose to go with the baseline design (Level 1) or choose an enhanced design (Level 2) that maximizes nutrient removal and runoff reduction. To qualify for the higher nutrient reduction rates associated with the Level 2 design, ED ponds must be designed with a Treatment Volume equal to  $1.25(R_v)(A)$ . **Table 14.2** lists the criteria for the Level 1 and 2 designs. See **Section 6** for more detailed design guidelines.

**Table 15.2. Extended Detention (ED) Pond Criteria**

Level 1 Design (RR:0; TP:15; TN:10)	Level 2 Design (RR:15; TP:15; TN:10)
$T_v = [(1.0) (R_v) (A)] / 12$ – the volume reduced by an upstream BMP	$T_v = [(1.25) (R_v) (A)] / 12$ – the volume reduced by an upstream BMP
A minimum of 15% of the $T_v$ in the permanent pool (forebay, micropool)	A minimum of 40% of $T_v$ in the permanent pool (forebay, micropool, or deep pool, or wetlands)
Length/Width ratio OR flow path = 2:1 or more	Length/Width ratio OR flow path = 3:1 or more
Length of the shortest flow path / overall length = 0.4 or more	Length of the shortest flow path / overall length = 0.7 or more
Average $T_v$ ED time = 24 hours or less	Average $T_v$ ED time = 36 hours
Vertical $T_v$ ED fluctuation exceeds 4 feet	Maximum vertical $T_v$ ED limit of 4 feet
Turf cover on floor	Trees and wetlands in the planting plan
Forebay and micropool	Includes additional cells or features (deep pools, wetlands, etc.) Refer to Section 5
CDA is less than 10 acres	CDA is greater than 10 acres

**SECTION 4: TYPICAL DETAILS**

**Figure 15.1** portrays a typical schematic for an ED pond.



**Figure 15.1. Typical Extended Detention Pond Details**

## SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

The following feasibility issues need to be evaluated when ED ponds are considered as the final practice in a treatment train. Many of these issues will be influenced by the type of ED Pond being considered (refer to Design Applications at the end of this section).

**Space Required.** A typical ED pond requires a footprint of 1% to 3% of its contributing drainage area, depending on the depth of the pond (i.e., the deeper the pond, the smaller footprint needed).

**Contributing Drainage Area.** A minimum contributing drainage area of 10 acres is recommended for ED ponds, in order to sustain a permanent micropool to protect against clogging. Extended detention may still work with drainage areas less than 10 acres, but designers should be aware that these “pocket” ponds will typically (1) have very small orifices that will be prone to clogging, (2) experience fluctuating water levels, and (3) generate more significant maintenance problems.

**Available Hydraulic Head.** The depth of an ED pond is usually determined by the amount of hydraulic head available at the site. The bottom elevation is normally the invert of the existing downstream conveyance system to which the ED pond discharges. Typically, a minimum of 6 to 10 feet of head is needed for an ED pond to function.

**Minimum Setbacks.** Local ordinances and design criteria should be consulted to determine minimum setbacks to property lines, structures, and wells. Generally, ED ponds should be set back at least 10 feet from property lines, 25 feet from building foundations, 50 feet from septic system fields, and 100 feet from private wells.

**Depth-to-Water Table and Bedrock.** ED ponds are not allowed if the water table or bedrock will be within 2 feet of the floor of the pond.

**Soils.** The permeability of soils is seldom a design constraint for micropool ED ponds. Soil infiltration tests need to be conducted at proposed pond sites to estimate infiltration rates, which can be significant in Hydrologic Soil Group (HSG) A soils and some group B soils. Infiltration through the bottom of the pond is encouraged unless it will impair the integrity of the embankment. Geotechnical tests should be conducted to determine the infiltration rates and other subsurface properties of the soils underlying the proposed ED pond. If the site is on karst topography, an alternative practice or combination of practices should be employed at the site, if possible. See Technical bulletin No. 1 (CSN, 2008) for guidance on stormwater design in karst terrain. The Extended Detention Basin should be the option of last resort and, if used in karst, must have an impermeable clay or (preferably) geosynthetic liner in accordance with Stormwater Design Specification No. 13 (Constructed Wetlands).

**Trout Streams.** Pond practices have a tendency to raise the water temperature in receiving streams. Therefore, the use of ED ponds in watersheds containing trout streams is restricted to situations where upland runoff reduction practices cannot meet the full Channel Protection Volume requirement. In these instances, a micropool ED pond must (1) be designed with a maximum 12 hour detention time, (2) have a minimum pool volume sufficient to prevent

clogging, (3) be planted with trees so it becomes fully shaded and (4) be located outside of any required stream buffers.

***Perennial Streams.*** Locating dry ED ponds on perennial streams is strongly discouraged and will require both a Section 401 and Section 404 permit from the appropriate state or federal regulatory agency.

### **Design Applications**

Extended Detention is normally combined with other stormwater treatment options within the stormwater facility (e.g., wet ponds, and constructed wetlands) to enhance its performance and appearance. Other design variations are also possible where a portion of the runoff is directed to bioretention, infiltration, sand filters, etc., that are within the overall footprint but housed in a separate cell, where the ponding depth of the  $T_v$ , channel protection storage, and/or flood protection storage is limited by the criteria of that particular practice. In such cases, the designer may need to develop a concept design and “hybrid” performance for review by the plan approving authority (or the Virginia BMP Clearinghouse, for broader application).

The typical design applications for ED include:

- Micropool Extended Detention
- Wet Extended Detention Pond (covered in Stormwater Design Specification No.14, Wet Ponds)
- Limited ED above Wetlands (covered Stormwater Design Specification No. 13, Constructed Wetlands)

**Figure 15.1** above illustrates several ED pond design variations. While ED ponds can provide for channel and flood protection, they will rarely provide adequate runoff volume reduction and pollutant removal to serve as a stand-alone compliance strategy. Therefore, designers should always maximize the use of upland runoff reduction practices, (e.g., rooftop disconnections, small-scale infiltration, rainwater harvesting, bioretention, grass channels and dry swales) that reduce runoff at its source (rather than merely treating the runoff at the terminus of the storm drain system). Upland runoff reduction practices can be used to satisfy most or all of the runoff reduction requirements at most sites. However, an ED pond may still be needed to provide any remaining channel protection requirements. Upland runoff reduction practices will greatly reduce the size, footprint and cost of the downstream ED pond.

## **SECTION 6: DESIGN CRITERIA**

### **6.1. Overall Sizing**

Designers can use a site-adjusted  $R_v$  or CN to reflect the use of upland runoff reduction practices to compute the remaining treatment, channel protection, and/or flood protection volumes that must be treated by the ED pond, using the accepted applicable method. ED ponds are then designed to capture and treat the remaining runoff volume as necessary. Runoff treatment ( $T_v$ ) credit may be taken for the entire water volume below the normal pool elevation of any

micropools, forebays and wetland areas (minimum of 15% for ED Level 1, and 40% for Level 2), as well as the temporary extended detention above the normal pool. To qualify for the higher nutrient reduction rates associated with the Level 2 design, the ED pond must be designed with a Treatment Volume that is 25% greater than the  $T_v$  for the Level 1 design [i.e.,  $1.25(R_v)(A)$ ], but not any additional Channel Protection Volume.

## 6.2. Treatment Volume Drawdown and Detention Design

Methods for calculating the required orifice size for achieving the target drawdown of the Treatment Volume for the Level 1 (24 hours) and Level 2 (36 hours) design can be found in the Engineering Calculations chapter of the current Virginia Stormwater Management Handbook. Similarly, the hydraulic design of the multi-stage riser to meet the channel protection and flooding protection design goals can also be found in the Virginia Stormwater Management Handbook.

Refer to Table 15.2 for the Level 1 and Level 2 maximum ponding depths and other criteria.

## 6.3. Required Geotechnical Testing

Soil borings should be taken below the proposed embankment, in the vicinity of the proposed outlet area, and in at least two locations within the proposed ED pond treatment area. Soil boring data is needed to (1) determine the physical characteristics of the excavated material, (2) determine its adequacy for use as structural fill or spoil, (3) provide data for structural designs of the outlet works (e.g., bearing capacity and buoyancy), (4) determine compaction/composition needs for the embankment, (5) determine the depth to groundwater and bedrock and (6) evaluate potential infiltration losses (and the potential need for a liner).

## 6.4. Pretreatment Forebay

Sediment forebays are considered to be an integral design feature to maintain the longevity of ED ponds. A forebay must be located at each major inlet to trap sediment and preserve the capacity of the main treatment cell. Other forms of pre-treatment for sheet flow and concentrated flow for minor inflow points should be designed consistent with pretreatment criteria found in Design Spec No. 9: Bioretention. The following criteria apply to forebay design:

- A major inlet is defined as an individual storm drain inlet pipe or open channel serving at least 10% of the ED pond's contributing drainage area.
- The forebay consists of a separate cell, formed by an acceptable barrier. (e.g., an earthen berm, concrete weir, gabion baskets, etc.).
- The forebay should be at least 4 feet deep and must be equipped with a variable width aquatic bench for safety purposes. The aquatic benches should be 4 to 6 feet wide at a depth of 18 inches below the water surface.
- The total volume of all forebays should be at least 15% of the total Treatment Volume (inclusive – and thereby satisfying the Level 1 permanent pool volume requirement – however, a micro pool outlet is still encouraged for maintenance benefits). The relative size of individual forebays should be proportional to the percentage of the total inflow to the

wetland. Similarly, any outlet protection associated with the end section or end wall should be designed according to state or local design standards.

- The forebay should be designed in such a manner that it acts as a level spreader to distribute runoff evenly across the entire bottom surface area of the main treatment cell.
- The bottom of the forebay may be hardened (e.g., concrete, asphalt, or grouted riprap) in order to make sediment removal easier.
- The forebay should be equipped with a metered rod in the center of the pool (as measured lengthwise along the low flow water travel path) for long-term monitoring of sediment accumulation.

## 6.5. Conveyance and Overflow

**No Pilot Channels.** Micropool ED ponds shall not have a low flow pilot channel, but instead must be constructed in a manner whereby flows are evenly distributed across the pond bottom, to promote the maximum infiltration possible.

**Internal Slope.** The maximum longitudinal slope through the pond should be approximately 0.5% to 1% to promote positive flow through the ED pond.

**Primary Spillway.** The primary spillway shall be designed with acceptable anti-flotation, anti-vortex, and trash rack devices. The spillway must generally be accessible from dry land.

**Appendix B: Principal Spillways** of the *Introduction to the New Virginia Stormwater Design Specifications*, as posted on the Virginia Stormwater BMP Clearinghouse web site, at the following web site:

<http://www.vwrrc.vt.edu/swc/NonProprietaryBMPs.html>

**Non-Clogging Low Flow Orifice.** ED Ponds with drainage areas of 10 acres or less, where small diameter pipes are typical, are prone to chronic clogging by organic debris and sediment. Orifices less than 3 inches in diameter may require extra attention during design to minimize the potential for clogging. Designers should always look at upstream conditions to assess the potential for higher sediment and woody debris loads. The risk of clogging in outlet pipes with small orifices can be reduced by:

- Providing a micropool at the outlet structure:
  - Use a reverse-sloped pipe that extends to a mid-depth of the permanent pool or micropool.
  - Install a downturned elbow or half-round CMP over a riser orifice (circular, rectangular, V-notch, etc.) to pull water from below the micropool surface.
  - The depth of the micropool should be at least 4 feet deep, and the depth may not draw down by more than 2 feet during a 30 day summer drought (for a water balance calculation method, see Section 6.2 of Stormwater Design Specification No 13: Constructed Wetlands).
- Providing an over-sized forebay to trap sediment, trash and debris before it reaches the ED pond's low-flow orifice.
- Installing a trash rack to screen the low-flow orifice.

- Using a perforated pipe under a gravel blanket with an orifice control at the end in the riser structure to supplement the primary outlet.

**Emergency Spillway.** ED ponds must be constructed with overflow capacity to pass the 100-year design storm event through either the Primary Spillway or a vegetated or armored Emergency Spillway. **Appendix C: Emergency Spillways** of the *Introduction to the New Virginia Stormwater Design Specifications*, as posted on the Virginia Stormwater BMP Clearinghouse web site (the URL is on the previous page).

**Adequate Outfall Protection.** The design must specify an outfall that will be stable for the 10-year design storm event. The channel immediately below the pond outfall must be modified to prevent erosion and conform to natural dimensions in the shortest possible distance. This is typically done by placing appropriately sized riprap, over filter fabric, which can reduce flow velocities from the principal spillway to non-erosive levels (3.5 to 5.0 fps depending on the channel lining material). Flared pipe sections that discharge at or near the stream invert or into a step pool arrangement should be used at the spillway outlet.

**Inlet Protection.** Inlet areas should be stabilized to ensure that non-erosive conditions exist during storm events up to the overbank flood event (i.e., the 10-year storm event). Inlet pipe inverts should generally be located at or slightly below the forebay pool elevation.

**On-Line ED Ponds** must be designed to detain the required  $T_v$  and either manage or be capable of safely passing larger storm events conveyed to the pond (e.g., 1-year channel protection detention, 10-year flood protection, and/or the 100-year design storm event). Adequate design freeboard between the maximum design water surface elevation and the top of the embankment must be provided in accordance with Design Specification **Appendix A: Earthen Embankments** of the *Introduction to the New Virginia Stormwater Design Specifications*, as posted on the Virginia Stormwater BMP Clearinghouse web site, at the following web site:

<http://www.vwrrc.vt.edu/swc/NonProprietaryBMPs.html>

**Dam Safety Permits.** ED ponds with high embankments or large drainage areas and impoundments may be regulated under the Virginia Dam Safety Act (§ 10.1-606.1 et seq., Code of Virginia) and the Virginia Dam Safety Regulations (4 VAC 50-20 et seq.). Refer to Design Specification Appendix A: Earthen Embankments for additional information.

## 6.6. Internal Design Features

**Side Slopes.** Side slopes leading to the ED pond should generally have a gradient of 4H:1V to 5H:1V. The mild slopes promote better establishment and growth of vegetation and provide for easier maintenance and a more natural appearance.

**Long Flow Path.** ED pond designs should have an irregular shape and a long flow path from inlet to outlet to increase water residence time, treatment pathways, and pond performance. In terms of flow path geometry, there are two design considerations: (1) the overall flow path through the pond, and (2) the length of the shortest flow path (Hirschman et al., 2009):

- The overall flow path can be represented as the length-to-width ratio *OR* the flow path ratio (see the *Introduction to the New Virginia Stormwater Design Specifications*, as posted on the Virginia Stormwater BMP Clearinghouse web site for diagrams and equations). These ratios must be at least 2L:1W for Level 1 designs and 3L:1W for Level 2 designs. Internal berms, baffles, or topography can be used to extend flow paths and/or create multiple pond cells.
- The shortest flow path represents the distance from the closest inlet to the outlet (the *Introduction to the New Virginia Stormwater Design Specifications*, as posted on the Virginia Stormwater BMP Clearinghouse web site). The ratio of the shortest flow to the overall length must be at least 0.4 for Level 1 designs and 0.7 for Level 2 designs. In some cases – due to site geometry, storm sewer infrastructure, or other factors – some inlets may not be able to meet these ratios. However, the drainage area served by these “closer” inlets should constitute no more than 20% of the total contributing drainage area.

***Treatment Volume (water quality) Storage.*** The total  $T_v$  storage may be provided by a combination of the permanent pool (in the form of forebays, deep pools, and/or wetland area) and extended detention storage in accordance with the Level 1 and Level 2 design volume allocations.

***Vertical Extended Detention Limits.*** The maximum  $T_v$  (1 inch) ED water surface elevation may not extend more than 5 feet above the basin floor or normal pool elevation for a Level 1 design, or 4 feet for a Level 2 design.. The maximum vertical elevation for ED and channel protection detention over shallow wetlands is 1 foot. The bounce effect is not as critical for larger flood control storms (e.g., the 10-year design storm), and these events can exceed the 5 foot vertical limit if they are managed by a multi-stage outlet structure.

***Safety Features.***

- The principal spillway opening must be designed and constructed to prevent access by small children.
- End walls above pipe outfalls greater than 48 inches in diameter must be fenced to prevent a hazard.
- An emergency spillway and associated freeboard must be provided in accordance with applicable local or state dam safety requirements. The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges.
- Both the safety bench and the aquatic bench should be landscaped with vegetation that hinders or prevents access to the pool.

## **6.7. Landscaping and Planting Plan**

A landscaping plan must be provided that indicates the methods used to establish and maintain vegetative coverage within the ED pond and its buffer. Minimum elements of a plan include the following:

- Delineation of pondscaping zones within both the pond and buffer
- Selection of corresponding plant species
- The planting plan

- The sequence for preparing the wetland bed, if one is incorporated with the ED pond (including soil amendments, if needed)
- Sources of native plant material
- The landscaping plan should provide elements that promote diverse wildlife and waterfowl use within the stormwater wetland and buffers.
- The planting plan should allow the pond to mature into a native forest in the right places, but yet keep mowable turf along the embankment and all access areas. The wooded wetland concept proposed by Capiella *et al.*, (2005) may be a good option for many ED ponds.
- Woody vegetation may not be planted or allowed to grow within 15 feet of the toe of the embankment nor within 25 feet from the principal spillway structure.
- A buffer should be provided that extends
- A vegetated buffer should be provided that extends at least 25 feet outward from the maximum water surface elevation of the ED pond. Permanent structures (e.g., buildings) should not be constructed within the buffer area. Existing trees should be preserved in the buffer area during construction.
- The soils in the stormwater buffer area are often severely compacted during the construction process, to ensure stability. The density of these compacted soils can be so great that it effectively prevents root penetration and, therefore, may lead to premature mortality or loss of vigor. As a rule of thumb, planting holes should be three times deeper and wider than the diameter of the rootball for ball-and-burlap stock, and five times deeper and wider for container-grown stock.
- Avoid species that require full shade, or are prone to wind damage. Extra mulching around the base of trees and shrubs is strongly recommended as a means of conserving moisture and suppressing weeds.

For more guidance on planting trees and shrubs in ED pond buffers, consult Capiella et al (2006) and **Appendix E: Landscaping** of the *Introduction to the New Virginia Stormwater Design Specifications*, as posted on the Virginia Stormwater BMP Clearinghouse web site.

## 6.8. Maintenance Reduction Features

Good maintenance access is needed so crews can remove sediments from the forebay, alleviate clogging and make riser repairs. The following ED pond maintenance issues can be addressed during design, in order to make on-going maintenance easier:

- Adequate maintenance access must extend to the forebay, micropool, any safety benches, riser, and outlet structure and must have sufficient area to allow vehicles to turn around.
- The riser should be located within the embankment for maintenance access, safety and aesthetics. Access to the riser should be provided by lockable manhole covers and manhole steps within easy reach of valves and other controls.
- Access roads must (1) be constructed of load-bearing materials or be built to withstand the expected frequency of use, (2) have a minimum width of 12 feet, and (3) have a profile grade that does not exceed 15%. Steeper grades are allowable if appropriate stabilization techniques are used, such as a gravel road.
- A maintenance right-of-way or easement must extend to the ED pond from a public or private road.

- The designer should check to see whether sediments can be spoiled (deposited) on-site or must be hauled away.

## 6.9. ED Pond Material Specifications

ED ponds are generally constructed with materials obtained on-site, except for the plant materials, inflow and outflow devices (e.g., piping and riser materials), possibly stone for inlet and outlet stabilization, and filter fabric for lining banks or berms.

The basic material specifications for earthen embankments, principal spillways, vegetated emergency spillways and sediment forebays shall be as specified in **Appendices A through D** of the *Introduction to the New Virginia Stormwater Design Specifications*, as posted on the Virginia Stormwater BMP Clearinghouse web site, at the following URL:

<http://www.vwrcc.vt.edu/swc/NonProprietaryBMPs.html>

When reinforced concrete pipe is used for the principal spillway to increase its longevity, “O”-ring gaskets (ASTM C-361) should be used to create watertight joints, and they should be inspected during installation.

## SECTION 7: REGIONAL & SPECIAL CASE DESIGN ADAPTATIONS

### 7.1. Karst Terrain

Karst regions are found in much of the Ridge and Valley province of the Virginia. The presence of karst complicates both land development in general and stormwater design in particular. Designers should always conduct geotechnical investigations in karst terrain to assess this risk during the project planning stage. Because of the risk of sinkhole formation and groundwater contamination in karst regions, *use of ED ponds is highly restricted there* (see CSN Technical Bulletin No. 1, 2008, and Appendix 6-C of Chapter 6 of the Virginia Stormwater Management Handbook, 2010). If these studies indicate that less than 3 feet of vertical separation exists between the bottom of the ED pond and the underlying soil-bedrock interface, ED ponds should not be used. If ED ponds are used, they must have an acceptable liner in accordance with the guidance provided in Section 7.1 of Stormwater Design Specification No. 13 (Constructed Wetlands).

### 7.2. Coastal Plain

The lack of sufficient hydraulic head and the presence of a high water table of many coastal plain sites significantly constrain the application of ED ponds. Excavating ponds below the water table creates what are known as dugout ponds where the water quality volume is displaced by groundwater, reducing the pond’s mixing and treatment efficiency and creating nuisance conditions. In general, *shallow constructed wetlands are a superior alternative to ED ponds in coastal plain settings*.

### 7.3. Steep Terrain

The use of ED ponds is highly constrained at development sites with steep terrain.

### 7.4. Cold Climate and Winter Performance

Winter conditions can cause freezing problems within inlets, flow splitters, and ED outlet pipes, due to ice formation. The following design adjustments are recommended for ED ponds installed in higher elevations and colder climates:

- Do not submerge inlet pipes.
- Provide a minimum 1% slope for inlet pipes to discourage standing water and potential ice formation in upstream pipes.
- Place all pipes below the frost line to prevent frost heave and pipe freezing.
- Locate low flow orifices in the micropool so they withdraw at least 6 inches below the typical ice layer.
- Place trash racks at a shallow angle to prevent ice formation.
- If winter road sanding is prevalent in the contributing drainage area, increase the forebay size to 25% of the total Treatment Volume to accommodate additional sediment loadings.

### 7.5. Linear Highway Sites

ED ponds are poorly suited to treat runoff within open channels located in the highway right of way, unless storage is available in a cloverleaf interchange or in an expanded right-of-way. Guidance for pond construction in these areas is provided in VDOT's annually stormwater management specifications, as reviewed and approved annually by DEQ. Additional guidance can be found in Profile Sheet SR-5 in Schueler et al (2007).

## SECTION 8: CONSTRUCTION

### 8.1. Construction Sequence

The following is a typical construction sequence to properly install a dry ED pond. The steps may be modified to reflect different dry ED pond designs, site conditions, and the size, complexity and configuration of the proposed facility.

***Step 1: Use of ED pond as an E&S Control.*** An ED pond may serve as a sediment basin during project construction. If this is done, the volume should be based on the more stringent sizing rule (erosion and sediment control requirement vs. water quality treatment requirement). Installation of the permanent riser should be initiated during the construction phase, and design elevations should be set with final cleanout of the sediment basin and conversion to the post-construction ED pond in mind. The bottom elevation of the ED pond should be lower than the bottom elevation of the temporary sediment basin. Appropriate procedures should be implemented to prevent discharge of turbid waters when the basin is being converted into an ED pond.

**Step 2: Stabilize the Drainage Area.** ED ponds should only be constructed after the contributing drainage area to the pond is completely stabilized. If the proposed pond site will be used as a sediment trap or basin during the construction phase, the construction notes should clearly indicate that the facility will be dewatered, dredged and re-graded to design dimensions after the original site construction is complete.

**Step 3: Assemble Construction Materials** on-site, make sure they meet design specifications, and prepare any staging areas.

**Step 4: Clear and Strip** the project area to the desired sub-grade.

**Step 5: Install E&S Controls** prior to construction, including temporary de-watering devices and stormwater diversion practices. All areas surrounding the pond that are graded or denuded during construction must be planted with turf grass, native plantings, or other approved methods of soil stabilization.

**Step 6: Excavate the Core Trench and Install the Spillway Pipe.**

**Step 7: Install the Riser or Outflow Structure** and ensure the top invert of the overflow weir is constructed level at the design elevation.

**Step 8: Construct the Embankment and any Internal Berms** in 8 to 12-inch lifts and compact the lifts with appropriate equipment.

**Step 9: Excavate/Grade** until the appropriate elevation and desired contours are achieved for the bottom and side slopes of the ED pond.

**Step 10: Construct the Emergency Spillway** in cut or structurally stabilized soils.

**Step 11: Install Outlet Pipes**, including downstream rip-rap apron protection.

**Step 12: Stabilize Exposed Soils** with temporary seed mixtures appropriate for the pond buffer. All areas above the normal pool elevation should be permanently stabilized by hydroseeding or seeding over straw.

**Step 13: Plant the Pond Buffer Area**, following the pondscaping plan (see **Section 8.5** below).

## **8.2. Construction Inspection**

Multiple inspections are critical to ensure that stormwater ponds are properly constructed. Inspections are recommended during the following stages of construction:

- Pre-construction meeting
- Initial site preparation (including installation of E&S controls)
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure

- Implementation of the pondscaping plan and vegetative stabilization
- Final inspection (develop a punchlist for facility acceptance)

A construction phase inspection checklist for Extended Detention Ponds can be accessed at the CWP website at:

[http://www.cwp.org/Resource\\_Library/Controlling\\_Runoff\\_and\\_Discharges/sm.htm](http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm)

(scroll to Tool6: Plan Review, BMP Construction, and Maintenance Checklists)

For larger ED ponds, use the expanded construction inspection form provided in Appendix B of CWP (2004).

If the ED pond has a permanent pool, then to facilitate maintenance the contractor should measure the actual constructed pond depth at three areas within the permanent pool (forebay, mid-pond and at the riser), and they should mark and geo-reference them on an as-built drawing. This simple data set will enable maintenance inspectors to determine pond sediment deposition rates in order to schedule sediment cleanouts.

## SECTION 9: MAINTENANCE

### 9.1. Maintenance Agreements

Section 4 VAC 50-60-124 of the regulations specifies the circumstances under which a maintenance agreement ~~to~~ must be executed between the owner and the local program. This section sets forth inspection requirements, compliance procedures if maintenance is neglected, notification of the local program upon transfer of ownership, and right-of-entry for local program personnel. Access to ED ponds should be covered by a drainage easement to allow inspection and maintenance.

It is also recommended that the maintenance agreement include a list of qualified contractors that can perform inspection or maintenance services, as well as contact information for owners to get local or state assistance to solve common nuisance problems, such as mosquito control, geese, invasive plants, vegetative management and beaver removal. The *CWP Pond and Wetland Maintenance Guidebook* (2004) provides some excellent templates of how to respond to these problems.

### 9.2. Maintenance Inspections

Maintenance of ED ponds is driven by annual inspections that evaluate the condition and performance of the pond, including the following:

- Measure sediment accumulation levels in forebay.
- Monitor the growth of wetlands, trees and shrubs planted. Record the species and their approximate coverage, and note the presence of any invasive plant species.
- Inspect the condition of stormwater inlets to the pond for material damage, erosion or undercutting.

- Inspect the banks of upstream and downstream channels for evidence of sloughing, animal burrows, boggy areas, woody growth, or gully erosion that may undermine embankment integrity.
- Inspect pond outfall channel for erosion, undercutting, rip-rap displacement, woody growth, etc.
- Inspect condition of principal spillway and riser for evidence of spalling, joint failure, leakage, corrosion, etc.
- Inspect condition of all trash racks, reverse sloped pipes or flashboard risers for evidence of clogging, leakage, debris accumulation, etc.
- Inspect maintenance access to ensure it is free of woody vegetation, and check to see whether valves, manholes and locks can be opened and operated.
- Inspect internal and external side slopes of the pond for evidence of sparse vegetative cover, erosion, or slumping, and make needed repairs immediately.

Based on inspection results, specific maintenance tasks will be triggered. Example maintenance inspection checklists for Extended Detention Ponds can be accessed in Appendix C of Chapter 9 of the *Virginia Stormwater Management Handbook* (2010) or at the CWP website at:

[http://www.cwp.org/Resource\\_Library/Controlling\\_Runoff\\_and\\_Discharges/sm.htm](http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm)  
(scroll to Tool6: Plan Review, BMP Construction, and Maintenance Checklists)

For a more detailed maintenance inspection checklist, see Appendix B in *CWP Stormwater Pond and Wetland Maintenance Guidebook* (2004).

### 9.3. Common Ongoing Maintenance Issues

ED ponds are prone to a high clogging risk at the ED low-flow orifice. This component of the pond's plumbing should be inspected at least twice a year after initial construction. The constantly changing water levels in ED ponds make it difficult to mow or manage vegetative growth. The bottom of ED ponds often become soggy, and water-loving trees such as willows may take over. The maintenance plan should clearly outline how vegetation in the pond and its buffer will be managed or harvested in the future. Periodic mowing of the stormwater buffer is only required along maintenance rights-of-way and the embankment. The remaining buffer can be managed as a meadow (mowing every other year) or forest.

The maintenance plan should schedule a shoreline cleanup at least once a year to remove trash and floatables that tend to accumulate in the forebay, micropool, and on the bottom of ED ponds.

Frequent sediment removal from the forebay is essential to maintain the function and performance of an ED pond. Maintenance plans should schedule cleanouts every 5 to 7 years, or when inspections indicate that 50% of the forebay capacity has been filled. As noted above, the designer should also check to see whether removed sediments can be spoiled (deposited) on-site or must be hauled away. Sediments excavated from ED ponds are not usually considered toxic or hazardous, and can be safely disposed by either land application or land filling.

## SECTION 10: COMMUNITY AND ENVIRONMENTAL CONCERNS

Extended Detention Ponds can generate the following community and environmental concerns that need to be addressed during design.

***Aesthetics.*** ED ponds tend to accumulate sediment and trash, which residents are likely to perceive as unsightly and creating nuisance conditions. Fluctuating water levels in ED ponds also create a difficult landscaping environment. In general, designers should avoid designs that rely solely on *dry* ED ponds.

***Existing Wetlands.*** ED ponds should never be constructed within existing *natural* wetlands, nor should they inundate or otherwise change the hydroperiod of existing wetlands.

***Existing Forests.*** Designers can expect a great deal of neighborhood opposition if they do not make a concerted effort to save mature trees during design and pond construction. Designers should also be aware that even modest changes in inundation frequency can kill upstream trees (Wright *et al.*, 2007).

***Stream Warming Risk.*** ED ponds have less risk of stream warming than other pond options, but they can warm streams if they are unshaded or contain significant surface area in shallow pools. If an ED pond discharges to temperature-sensitive waters, it should be forested, contain the minimum pools to prevent clogging, and have a detention time of no longer than 12 hours.

***Safety Risk.*** ED ponds are generally considered to be safer than other pond options, since they have few deep pools. Steep side-slopes and unfenced headwalls, however, can still create some safety risks. Gentle side slopes should be provided to avoid potentially dangerous drop-offs, especially where ED ponds are located near residential areas.

***Mosquito Risk.*** The fluctuating water levels within ED ponds have potential to create conditions that lead to mosquito breeding. Mosquitoes tend to be more prevalent in irregularly flooded ponds than in ponds with a permanent pool (Santana *et al.*, 1994). Designers can minimize the risk by combining ED with a wet pond or wetland.

## SECTION 11: REFERENCES

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