Post-Construction Storm Water Questions and Answers
Water Quality Volume Drawdown

The NPDES construction general permit (CGP) requires a post-construction storm water best management practice (BMP) on all disturbed areas one acre or larger. The post-construction BMP must be designed to meet a required minimum drain time at a measured release rate over the full drawdown curve to optimize water quality treatment.

What are the discharge requirements for extended detention BMPs?

For dry extended detention basins, the water quality volume (WQv) is detained and released over 48 hours. For wet extended detention basins and wetland basins, the WQv is detained and released over 24 hours. The release period (24 or 48 hours) is the drawdown time from a brimful WQv; that is, with discharge beginning from storage of the full WQv until the entire WQv drains out of the basin.

The water quality outlet must be sized such that no more than one-half of the WQv is released in the first one-third of the required drawdown time (the first 16 hours for dry basins, the first 8 hours for wet basins and wetland basins). A greater release rate will reduce the pollutant removal efficiency and increase the hydraulic impacts to receiving streams.

How do you determine the water quality outlet (orifice) size to meet the WQv drawdown requirements?

A shortcut method is presented here for sizing the water quality outlet based on the drawdown requirements and the average hydraulic head associated with the storage volume. This simplified method will provide a starting point from which to design a vertical, circular orifice, but may be adapted for other water quality outlet configurations.

Step1. Determine the WQv for the drainage area to the BMP (see Equation 1; p21, CGP)

Step 2. Determine the average release rate for the WQv:

$$Q_{avg} = WQv/t_d$$

where:

t_d = minimum drain time (hr)

t_d = 48 hr for dry extended detention basin

t_d = 24 hr for wet extended detention basin or wetland basin

Step 3. Using average hydraulic head (Havg) equal to one-half the maximum hydraulic head (Hmax), estimate the required outlet orifice area by rearranging and solving the orifice equation:

$$A_{orifice} = Q_{avg}/[C*(2*g*H_{avg})^{0.5}]$$

where:

$A_{orifice}$ = area [ft^2]

Q_{avg} = average discharge rate (ft^3/s)

C = coefficient of discharge (0.6 for sharp-edge orifice)

g = acceleration of gravity (32.2 ft/s^2)

$H_{avg} = H_{max}/2$ = average hydraulic head (ft)

H_{max} = brimful WQv elevation – water quality outlet elevation or tailwater elevation

Step 4. Based on orifice area, determine the dimensions for the orifice. For a circular orifice:

$$A_{orifice} = \pi*d_{orifice}^2/4$$

$$d_{orifice} = [(4*A_{orifice})/\pi]^{0.5}$$

where:

d is orifice diameter

Step 5. Verify the drawdown rate.

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How is the drawdown rate verified?

Though orifices larger than that calculated by the above method may meet the target drawdown period for the WQv basin, they may not meet the CGP requirement to discharge no more than the first half of the WQv in less than one-third of the drawdown time. To verify drawdown is acceptable, you must either (A) use a spreadsheet [see Figure 1] or (B) route the WQv (pull the plug from a full WQv) through the basin outlet to ensure the actual drawdown curve meets requirements.

To account for discharge occurring during the drawdown period, can I route the WQv through the BMP?

No. Ohio EPA understands that basin discharge will begin before the basin fills the full WQv. Routing of storm water runoff through post-construction BMPs was accounted for in the selection of the PWQv, reducing the water quality event depth from 1.10 inches to 0.90 inches.

How is compliance with the required drawdown documented?

To demonstrate compliance with the post-construction sizing requirements when designing extended detention basins, calculations to determine orifice size must be clearly indicated in the Storm Water Pollution Prevention Plan (SWP3). Ohio EPA recommends including stage-storage data or elevation-area-capacity tables indicating the elevation at which the WQv is achieved. This data must match the elevations indicated on the profile view of the outlet structure. Ohio EPA recommends including a graph (see Figure 1) that shows the post-construction BMP achieves the desired WQv release rate.

What if the outlet needed to produce the required water quality volume drawdown is smaller than the minimum allowable under local ordinance?

The minimum WQv drain time required by CGP Table 4A must be still be met. The BMP must be configured to comply with both the required drawdown time and the local minimum orifice size. This is often achieved by increasing the practice's surface area. If the resulting surface area is not feasible, the designer may need to consider another practice.

Example Calculation

A wet extended detention basin was selected as the post-construction practice for a 16.5-acre residential development with 6.8 acres of impervious area. A circular orifice will be used as the outlet, and the proposed WQv depth (H_{max}) is 1.5 ft.

Step 1. Determine the WQv

Area draining to BMP, A_{total} = 16.5 ac
Impervious area draining to BMP, A_{imp} = 6.8 ac
Impervious fraction, i = A_{imp}/A_{total} = (6.8 ac)/(16.5 ac) = 0.41 [41% impervious]
Volumetric runoff coefficient, Rv = 0.05 + 0.9*i = 0.05 + 0.9*(0.41) = 0.42
Water quality volume, WQv = Rv*P*A/12 = 0.42*(0.90 in)*(16.5 ac)/(12 in/ft) = 0.52 ac-ft = 22,640 ft^3

Step 2. Determine the average release rate for the WQv

Qavg = WQv/t_d = 22,640 ft3/ (24 hr) (3600 s/hr) = 0.262 ft^3/s

Step 3. Using average hydraulic head (H_{avg}) equal to one-half the maximum hydraulic head (H_{max}), estimate the required outlet orifice area by rearranging and solving the orifice equation

$A_{orifice} = Q_{avg}/[C*(2*g*H_{avg})^{0.5}] = (0.262\ ft^3/s)/[0.6*(2*32.2\ ft/s^2*0.75\ ft)^{0.5}] = 0.0628\ ft^2$

where:
C = coefficient of discharge (0.6 for sharp-edge orifice)
g = acceleration of gravity (32.2 ft/s^2)
$H_{avg} = H_{max}/2$ = (1.5 ft)/2 = 0.75 ft (average hydraulic head)

Step 4. Based on orifice area, determine the dimensions for the orifice. For a circular orifice:

$d_{orifice} = [(4*A_{orifice})/\pi]^{0.5} = [(4*0.0628\ ft^2)/\pi]^{0.5} = 0.282\ ft = 3.40\ in$

Step 5. Verify the drawdown rate.

Volume @ $T_{8\ hours}$ = 13,173 (≥22,640/2, OK)
Volume @ $T_{24\ hours}$ =2,540 (≥ 0, OK)

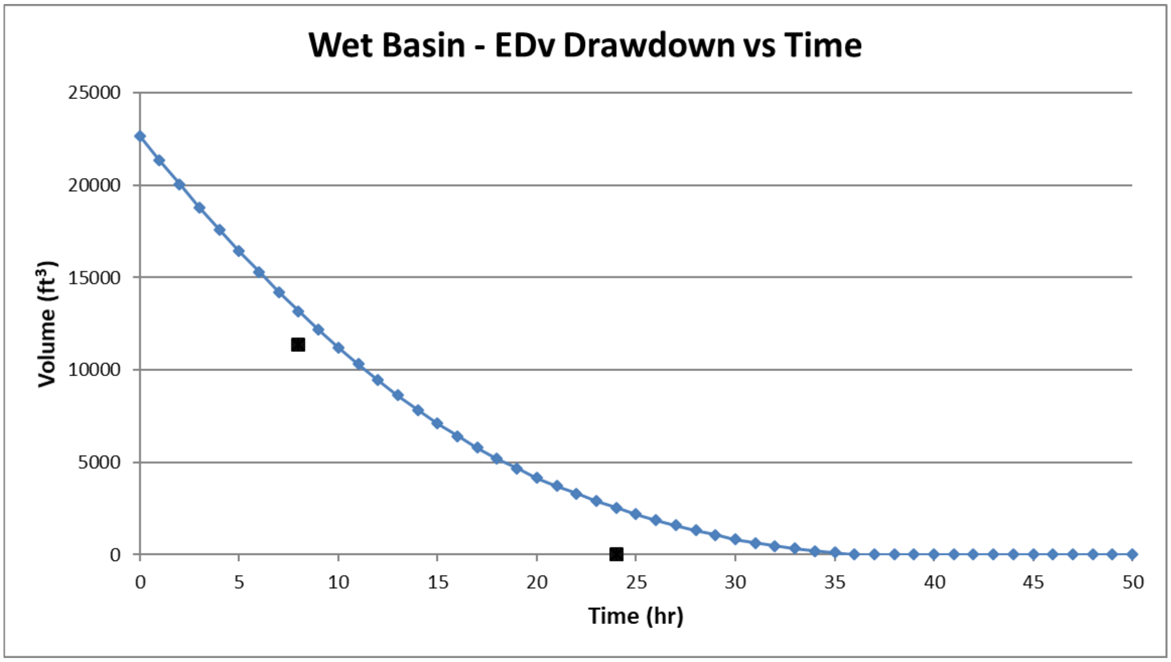

Figure 1 - Spreadsheet designed to show drawdown from brimful WQv in the above example.

Contact

For more information, contact Justin Reinhart at ***justin.reinhart@epa.ohio.gov*** or 614) 705-1149.