TECHNICAL MEMORANDUM

Ohio Environmental Protection Agency

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Date: October 15, 2019

Subject: Revision to minimum filter bed size and ponding depth in Rainwater & Land Development Practice Standard 2.10 - Bioretention

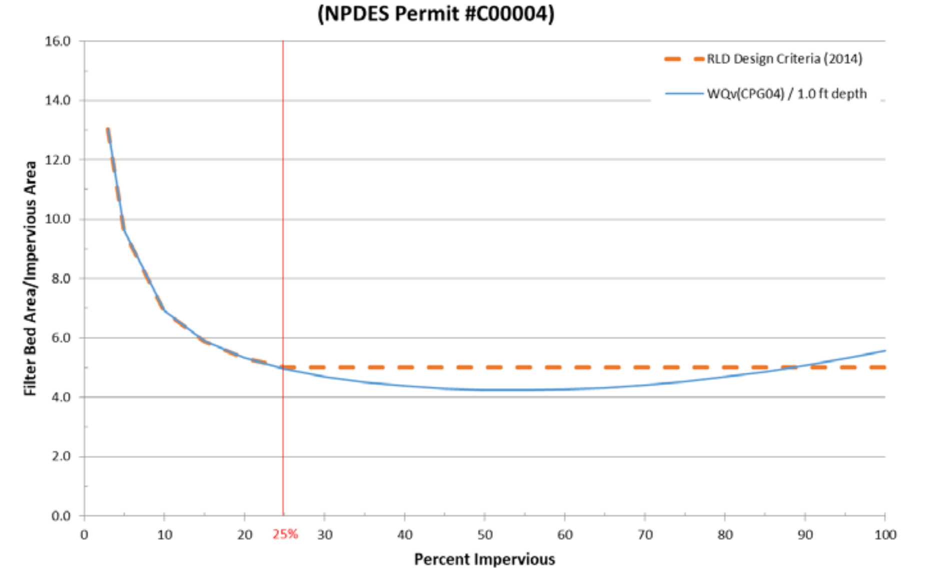
This technical memo provides interim technical guidance until the *Rainwater & Land Development* (RLD) manual is revised and republished.

For all bioretention practices, the minimum size of the filter bed shall be at least equal to the Water Quality Volume (WQv) divided by the ponding depth to a maximum depth of 18 inches.

The minimum filter bed area for a bioretention practice as specified in the current RLD manual, Chapter 2.1 is contingent upon the impervious percentage of the contributing drainage area. For a drainage area exceeding 25% impervious, the minimum filter bed area is 5% of the contributing impervious drainage area and for a drainage area less than 25% impervious, the minimum filter bed area is the WQv divided by the maximum 1 ft ponding depth (ODNR, 2006).

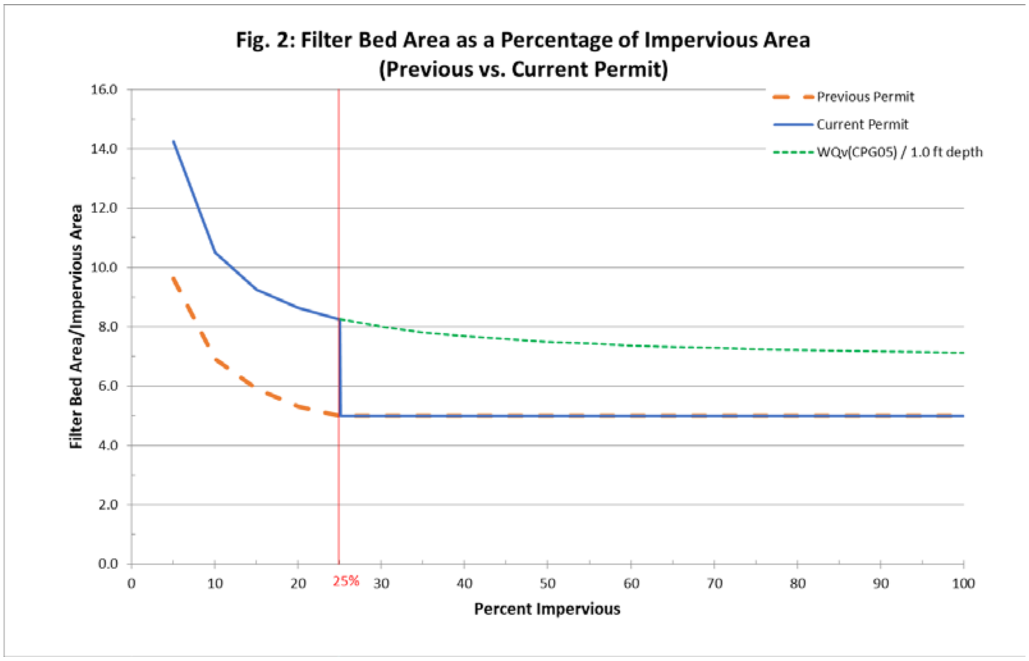
According to the current RLD standard, “the ponding depth for the WQv should be less than or equal to 12 inches to ensure the WQv drains in a timely fashion (<24 hrs.) in preparation for the next runoff event.” When designed to 5% of the contributing impervious drainage area and a 12-inch ponding depth, the storage volume developed above the filter bed approximates the WQv as calculated in the previous permit when drainage areas is greater than 25% impervious and removes the dip in sizing that would occur if designed only to the WQv (due to formula for the Runoff Coefficient, C). However, designing to the WQv rather than the 5% criterion when the drainage area is less than 25% impervious prevents the use of exceedingly small practices with storage less than the WQv. This dual design criteria, split at 25% of the contributing imperious drainage area, as applied to the WQv under the previous (OHC00004) version of the Construction General Permit (CGP) is depicted in Figure 1.

Fig. 1: Filter Bed Area as a Percentage of Impervious Area (NPDES Permit #C00004)



When the dual design criterion, split at 25% of the contributing impervious drainage area is applied to the WQv as revised in the current CGP (OHC00005), the bioretention practice size becomes greatly disjointed at 25% impervious and the 5%

criteria (at a maximum ponding depth of 1 ft) fails to approximate the WQv for drainage areas exceeding 25% impervious. This effect is shown in Figure 2.



The filter bed area is an important aspect of a bioretention practice. Sized properly, the hydraulic and pollutant loading will be equally and safely distributed over the practice area to percolate through the full soil media and, if possible, into the surrounding soil - maximizing treatment performance and reducing the risk of failure. The specification to size the bioretention filter bed area to at least 5% of the contributing impervious drainage area is simply an analytical determination of the area needed given a coefficient of permeability (k) of 1.0 ft/day and a filter time of 48 hours (Claytor, 1996) as shown in Figure 3 below.

This design was later shown by Claytor (1996) to drain a 6-inch deep ponding volume within 30 hours (Claytor, 1996) and has become the accepted design criteria (USEPA, 1999). However, more recent evaluation of practices and anecdotal evidence supports a ponding depth of up to 18 inches (Minton, 2011). Most storm water manuals continue to recommend a maximum ponding depth of 6 to 12 inches. West Virginia DEP has adopted a maximum ponding depth of 18 inches.

Derivation of bioretention facility sizing criteria:

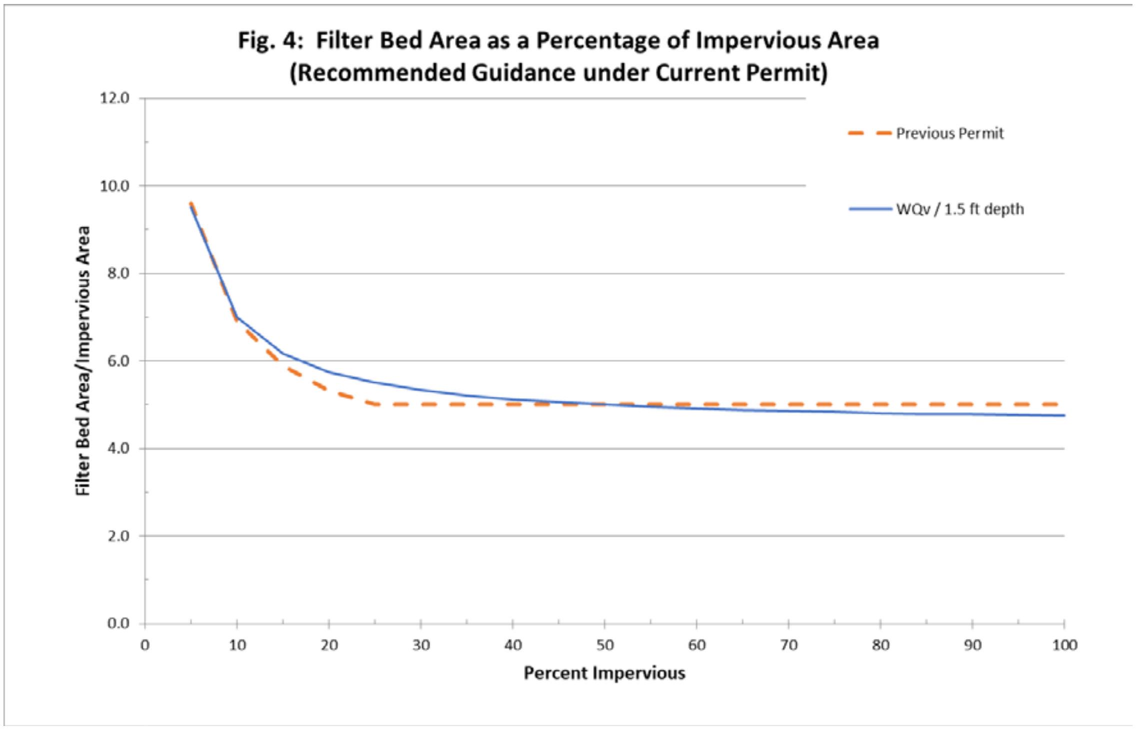
For a one (1) acre site which is 100% Impervious (R_v = 0.95)
WQV = [1.0"• •(0.95)/ (12"/ft)]• •(43,560 ft²/ac) = 3,449 ft³
k = 1.0 ft/day
d_f = 5' (4' soil + 1' sand bed)
h = 3" = 0.25'
t_f = 2 days
A_f = 3,449 ft³• •5' /[(0.5 ft/day)• •(5.25 ft)• •(3 days)] = 2,190 ft²
% of site area = 2,190/43,560• •100 = 5.0

Therefore, use the following equation for sizing the bioretention surface area:

A_f = D.A. • •5.0% • •R_v **Equation 6.1**
where,

Fig. 3: Basis for 5% criterion in Claytor (1996).

A filter bed area equal to or exceeding the current WQv divided by a maximum design ponding depth of 18 inches (1.5 feet) results bioretention practices of similar size to those designed under to the previous RLD guidance and the old WQv calculation. As shown in Figure 4, bioretention practices on drainage areas 60% to 100% impervious will be slightly smaller in area than previously designed while practices on drainage areas 10% to 40% will be slightly larger, with both capturing a higher net volume of runoff.



This guidance provides a minimum bed area and maximum ponding depths. Some situations may merit larger filter beds and shallower ponding depths. The designer will need to evaluate if a maximum ponding depth of 18 inches, coupled with any freeboard, will result in safety, survival of plantings, or side slope erosion issues.

REFERENCES

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