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First Half Inch Infiltration Standard

Waukesha County Storm Water Management and Erosion Control Ordinance

Background and Standards:

Infiltration Standards. The 2005 update to the Waukesha County Storm Water Management and Erosion Control Ordinance contains the following standards for storm water infiltration:

Land Use	Minimum Infiltration Volumes (%)		Maximum Required "Effective Infiltration Area"
	Option #1 Percent of Annual Predevelopment Runoff	Option #2 Percent of 2-Year, 24-hr. Storm Runoff	
Residential	90%	25%	1% of Site
Nonresidential	60%	10%	2% of Site

The ordinance requires that modeling involving average annual rainfall or runoff volumes shall use rainfall data from the Milwaukee area between March 28 and December 6, 1969. It also requires that separate runoff curve numbers be used for pervious and impervious surfaces, rather than composite curve numbers, when calculating runoff from the 2-year storm event.

Water Quality Standards. By design, each storm water management plan must meet the following post-development total suspended solids (TSS) reduction targets, based on average annual rainfalls, as compared to no runoff management controls:

A. For new land development, 80% TSS reduction;
B. For redevelopment, 40% TSS reduction;
C. For in-fill development prior to October 1, 2012, 40 % TSS reduction;
D. For in-fill development after October 1, 2012, 80% TSS reduction.

First Half-Inch Alternative. To meet these requirements it is normally necessary to utilize modeling tools such as SLAMM or a TR-55-based program. Modeling is a time-consuming and expensive process. As an alternative to modeling the hydrology, the Land Resources Division will presume that any site complies with both the infiltration and water quality requirements of the ordinance if the first ½ inch of runoff from the site is infiltrated. The purpose of the following discussion is to show that infiltrating the first half-inch of runoff meets or exceeds the ordinance infiltration and water quality requirements.

Infiltration

Volume Calculation for ½ Inch of Runoff. Calculation of the runoff volume is simply the area of the site multiplied by the runoff depth (1/2 inch). For example:

(11 acres)(43,560 sq. ft./acre)(1/2 inch)(1 foot/12 inches) = 19,965 cubic feet

To meet the infiltration requirement, an infiltration basin with 19,965 cubic feet of dead storage (storage below the outlet) must be constructed. This assumes there is no infiltration in dynamic routing (of water passing through basin). A half-acre basin one foot deep would meet this requirement. Construction details, soils, and peak discharge must still be addressed, but the infiltration dead storage sizing has been determined in two minutes, as opposed to eight hours.

Comparison with Ordinance Standards. Infiltration of the first ½ inch of runoff meets and exceeds the ordinance standards for infiltration based on the two-year storm. The attached spreadsheet and graph illustrate that, for the two-year storm:

- For residential development, where the percent impervious surface is typically about 25-38% (and a composite TR-55 runoff curve number (RCN) on a site with type B soils is typically about 70-75), 25% of the runoff is 0.20-0.28 inches. This is 40-56% of the first ½ inch of runoff.
- For commercial development, it is impossible for 10% of the 2-year storm runoff to exceed the first ½ inch of runoff. The 2-year storm is 2.7 inches of rain, per Natural Resources Conservation Service (NRCS) Technical Publication 40. Even if 100% of the storm runs off, 10% of 2.7 inches is only 0.27 inches, which is less than 0.50 inches. At 50-65% impervious surface (typical for commercial, and comparable to a composite RCN of 80-85 in B soils), the runoff depth is 1.4-1.7 inches, of which 10% is 0.14-0.17 inches.

Water Quality

Treatment Through Infiltration. Similarly, it is assumed that the water quality requirement is met if the first ½ inch of runoff is infiltrated. The rationale for this assumption is that the vast majority of rain events are relatively small storms, that these storms remove the bulk of the TSS from the surfaces, and infiltration of the first ½ inch of runoff will result of the deposition of the TSS in the infiltration basins.

Comparison with NRCS Methodology. A review of the 1969 Milwaukee rain file indicates that, of the 116 recorded rain events, none had a depth greater than 2 inches, 3 were between 1.5 and 2 inches, 6 were between 1 and 1.5 inches, 11 were between 0.5 and 1 inches, and the rest were all smaller. The largest event is 1.96 inches of rain, which is smaller than the NRCS 1-year design storm (2.3 inches) for Waukesha County.

Using the NRCS curve number methodology, if a site has a composite curve number of 70, the initial abstraction is 0.86 inches, and the greatest predicted runoff depth is 0.23 inches. If the composite curve number is 80, the initial abstraction is 0.5 inches, and the greatest predicted runoff depth is 0.54 inches. For the 1969 rain year, then, a basin or system of BMPs designed to infiltrate the first ½ inch of runoff would discharge the equivalent of 0.04 inches of runoff depth in a single event, and no more for the remainder of the year. Assuming that TSS is uniformly distributed in the runoff and that there is no re-suspension of particles, 99.8% of the TSS would therefore be removed, exceeding the 80% requirement.

Comparison with SLAMM Methodology. The NRCS methodology is criticized for underpredicting runoff in small storm events. Use of the Source Loading and Management Model (SLAMM) is an alternate method of simulating infiltration and sediment removal performance that is designed to give a more accurate prediction of small storm hydrology.

WinSLAMM does not permit the specification of infiltration basin dead storage. Infiltration basins are described solely as a function of area and infiltration rate. Therefore, it is not possible to directly describe an infiltration basin that has dead storage equal to ½ inch of runoff from the site. However, by post-processing the output files in a spreadsheet, it is possible to determine the volume of runoff that, on an average annual basis, would exceed the dead storage capacity of the basin. The assumptions made in this modeling and processing include:

- No infiltration by dynamic routing (only the water in the dead storage is infiltrated).
- All pervious areas are silty soil.
- All impervious areas are directly connected to the drainage system, and do not drain to previous areas, first.
- All TSS in the infiltrated/stored water is removed and TSS in the excess water is discharged.

The results of this analysis show that, for a basin designed to dead-store the first ½ inch of runoff, for the 1969 Milwaukee rain file:

Percent Impervious Surface	Percent TSS Removal On Average Annual Basis	Equivalent B Soil Composite CN
0	100	61
26	100	71
57	80	82
100	62	98

As some infiltration does occur in dynamic routing, these percent removal numbers are likely conservative.

Conclusions

1. For residential development, infiltration of the first ½ inch of runoff infiltrates about 3 times as much water as is required by the 25% of the 2-year storm runoff criterion.
2. For commercial development, infiltration of the first ½ inch of runoff exceeds the 10% of the 2-year storm runoff criterion for all levels of imperviousness.
3. For the rain file prescribed by the ordinance, infiltration of the first ½ inch of runoff meets the water quality requirement of 80% TSS removal up to 57% impervious surface.