BUREAU OF WATERSHED MANAGEMENT
PROGRAM GUIDANCE

Watershed Management Team
Storm Water Runoff Program

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Modeling Post-Construction Storm Water Management Treatment

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This document is intended solely as guidance and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

APPROVED:

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Jill Schoen, Director Date

Bureau of Watershed Management

A. Statement of Problem Being Addressed

This document is intended to clarify how to model post-construction stormwater management treatment to comply with the post-construction performance standards of subchs. III (Non-Agricultural) and IV (Transportation) of ch. NR 151, Wis. Adm. Code. Modeling is not required, as compliance may also be demonstrated through hand calculations and or in combination with DNR technical standards developed under subch. V of ch. NR 151, Wis. Adm. Code. However, given the efficiency of models, they are commonly used to estimate runoff volumes and rates, treatment efficiency, infiltration rates and volumes, etc. Each model has certain assumptions and/or limitations that need to be accounted for in order for the treatment practice to achieve the model's predicted treatment efficiency. Accounting for such issues might be through treatment design and or adjustment to the model's pollutant removal assumptions.

The DNR's Runoff Management staff recognize the methods set forth in this document as appropriate for meeting modeling requirements in applicable parts of ss. NR 151.121-128 or ss. NR 151.241-249, Wis. Adm. Code. However the procedures in this document are not mandatory, as other modeling approaches may also be used to satisfy these requirements, so long as they meet the applicable requirements in ch. NR 151, Wis. Adm. Code, and related regulatory standards.

This guidance also applies to modeling Municipal Separate Storm Sewer Systems (MS4s) to show compliance with the developed urban area standard under s. NR 151.13, Wis. Adm. Code, and Total Maximum Daily Load (TMDL) requirements for Total Suspended Solids (TSS) and Total Phosphorus (TP). Additional MS4 modeling guidance documents are available via: http://dnr.wi.gov/topic/stormwater/standards/ms4_modeling.html

Additionally, there are references to Technical Standards and related formal documents throughout this guidance. These are references to the formal technical standards developed under subch. V of ch. NR 151, Wis. Adm. Code. This information is generally available at: http://dnr.wi.gov/topic/stormwater/standards/postconst_standards.html
Please contact DNR Storm Water Program staff if you are unable to locate or need assistance with interpretation of a Technical Standard.

B. Guidance

Model Versions & Model Specific Issues

1. Pervious area soil type is generally based on the NRCS mapped soil layer unless site-specific conditions dictate otherwise. In WinSLAMM, Type A soils are considered sandy soils, type B soils are considered silty soils, and type C and D soils are considered clayey soils.

2. As noted under s. NR 151.122 (3), Wis. Adm. Code, use the most current model version of WinSLAMM or P8. Benefits of this include: (1) older versions of WinSLAMM do not have as many model warnings to notify a user about model limitations, (2) newer versions may provide more options to appropriately model treatment and (3) new versions may provide additional treatment credit. The DNR storm water runoff modeling web page for WinSLAMM and P8 is: http://dnr.wi.gov/topic/stormwater/standards/slamm.html

3. WinSLAMM 9.4 and earlier versions of WinSLAMM result in double counting of pollutant removal for most treatment practices modeled in series. This will result in impermissible

overestimation of pollutant removal for modeling treatment practices. Beginning with version 9.2, warnings were added to WinSLAMM to help alert modelers of this issue. The modeler will need to adjust to ensure that the results do not include double credit for removal of the same particle size. PV & Associates has created a document titled 'Modeling Practices in Series Using WinSLAMM' which helps guide users on how certain practices can be modeled in series. The document is available at: http://winslamm.net/Select_documentation.html Note: This is being offered only for informational purposes so that you may find this information and is not an endorsement of PV & Associates or its products or services.

4. In WinSLAMM, when modeling a wet pond, if the "Initial Stage Elevation" is not changed from "0" to the outlet elevation, the model starts running with an empty pond. This must be changed as an empty pond does not represent a wet pond condition. Therefore, the "Initial Stage Elevation" of a wet pond must be set equal to the invert elevation of the lowest outlet.

5. WinSLAMM version 10.3.2 will give some credit for a "dry pond" or extended detention pond, which will be considerably less than a pond with a 3-foot deep permanent pool. The DNR will allow credit to be taken at the level calculated in WinSLAMM with the following conditions:

    a) Energy dissipation is provided at inlets within the basin to prevent scour.
    b) A stone weeper, gabion, or similar structure is provided around the primary outlet within the basin to reduce scour and limit sediment movement to the outlet.
    c) The pond does not have a paved low flow channel.
    d) The pond vegetation is maintained in good condition.
    e) The maximum water surface water rise in the pond during the 1-yr/24-hr design storm event does not exceed 5 feet.
    f) The pond has a maximum drawdown time of 24 hours from the end of a single 1-yr/24-hr rainfall event, and no more than 72 hours for drawdown from a 100-yr/24-hr rainfall event.
    g) For modeling, enter the bottom area of the pond at stage 0.01 feet.

6. WinSLAMM version 10.5 and subsequent versions include several new features associated with the biofilter device, which allow and/or require more user input.
    a) The 'media data' button is used to enter the 'Soil , Media Mixtures and Components Table'. For DNR Bioretention Standard 1004, engineered soil mixture of 70-85% sand (ASTM C33 or concrete sand) and 15-30% compost, the 'composite soil mixtures properties' values for porosity, field capacity and wilting point may be applied.
    b) A maximum infiltration rate of 3.6 in/hr shall be used for DNR's engineered soil media specified in Bioretention Technical Standard 1004.
    c) A 'Percent solids reduction due to Engineered Media' value of 80% may be used for DNR's engineered soil media specified in Bioretention Technical Standard 1004.
    d) WinSLAMM Output Summary will give 'A biofilter will clog' warning if the model predicts that biofilter to clog in less than 10 years. To reduce maintenance and potential for clogging, a design should reduce the sediment load per unit area of the filter.
    e) Unless more site-specific evapotranspiration (ET) data is used, monthly average potential ET rates in inches/day of 0.10 (Apr), 0.14 (May), 0.15 (June), 0.15 (July), 0.12 (Aug), 0.09 (Sept), 0.07 (Oct), and 0.03 (Nov) may be used.

7. WinSLAMM version 10.5 allows a percent of tree canopy cover to be added for parking, streets, driveways/sidewalks source areas. The street source areas already include the effects of an average tree canopy cover. There would need to be a baseline average tree canopy cover established and only a street source area that exceeds a municipal average tree canopy cover should be given any additional credit for tree canopy cover. However, the canopy effects on other impervious areas have not been accounted for and may potentially be added for parking lots, driveways/sidewalks and roofs.

8. The WinSLAMM 'Freeway' land use file has Freeway Areas, Paved Lane/Shoulder Areas (sources areas 1-10) and Urban Highways, High Traffic Urban (source areas 11-18). The High Traffic Urban (source areas 11-18) should be used for urban highways as they are based on the latest USGS monitoring of runoff from urban highways. The High Traffic Urban source areas have more pollutant load and runoff volume than the Paved Lane/Shoulder Area source areas.

9. Starting in version 10.5, WinSLAMM defines streets in terms of edge-miles rather than curb-miles. This change was made to reflect the fact that pollutant loads from streets are generated regardless of whether or not a curb is present. The distinction between curbed streets (or urban cross sections) and non-curbed streets (or rural cross sections) is necessary because although both conditions generate loads, street cleaning should only be applied when there are curbed streets because all the studies that evaluate street cleaning performance used in WinSLAMM have been done on curbed streets.

10. P8 does not account for scour or sediment resuspension for any of its modeled treatment devices and this is identified within the P8 help menu, model limitation section. Ponds need to be designed to prevent resuspension to obtain the efficiency predicted by P8. DNR recommends that a 3-foot minimum permanent pool depth be maintained over the sediment storage area to help prevent sediment resuspension. The DNR allows using a straight-line depreciation such that a pond with a 1.5-foot deep permanent pool would be eligible for 1/2 the pollutant removal efficiency that would be credited due to settling. The sediment storage depth should not count toward the permanent pool depth.

11. P8 gives pollutant removal credit for swales via infiltration and settling without accounting for sediment resuspension or scour. Swales are prone to scour and resuspension, which needs to be accounted for. DNR accepts the approach used in WinSLAMM to not give credit for trapping of particles smaller than 50 microns, without infiltration. WinSLAMM gives credit for trapping of sediment equivalent to the volume infiltrated plus removal of particles greater than 50 microns in runoff that drains through the swale. Based on the National Urban Runoff Program (NURP) particle size distribution, only about 16% of the particles (by mass) are larger than 50 microns. Whereas, about 11% of the Total Phosphorus (TP) is associated with the 16% of sediment (or TSS). If there were no infiltration, the maximum trapping efficiency for a grass swale would be about 16% of TSS and 11% of TP.
    Example: If a swale achieves infiltration of 40% of the annual average runoff volume and achieves 16% particle entrapment for the remaining runoff volume, then the total TSS and TP removal credit would be calculated as follows:

$$\text{Fraction infiltrated} + 0.16 \times \text{fraction not infiltrated} = \text{TSS removal}$$
$$0.40 + [0.16 \times (1 - 0.40)] = 0.496 \text{ or } 49.6\%$$
$$\text{Fraction infiltrated} + 0.11 \times \text{fraction not infiltrated} = \text{TP removal}$$
$$0.40 + [0.11 \times (1 - 0.40)] = 0.466 \text{ or } 46.6\%$$

    When taking credit for both infiltration and settlement in a swale, P8 can be run with the

"Particle Removal Scale Factor" set to zero in the swale device dialog box to obtain the TSS and TP remaining following swale treatment by infiltration only. The additional credit for settlement can be calculated by multiplying the TSS annual load remaining by the percent which is settled, such as 16% for TSS and 11% for TP. Subtract the settlement credit calculated from the TSS and TP load remaining to get the revised TSS and TP load remaining and adjust the percent removal accordingly. Note that additional credit for settlement may not be taken if the swale discharges to another treatment device which would result in double counting of particles removed.

12. P8 starts its model runs without an existing pollutant concentration in the storm water management system. P8 needs to be started long enough for the entire storm water system to be flushed and starting P8 a month early may not be adequate. To be safe, DNR recommends that P8 be started an extra year before the "keep dates".

13. A device, which may not be eligible for pollutant removal credit, may still be modeled if it is in series with other practices because of its benefit on runoff storage (detention) capacity, which may enhance the treatment efficiency of downgradient treatment devices (e.g., a dry detention pond upstream of a wet detention pond). Turn off the treatment efficiency of such practices in P8.

14. Models used to determine the pollutant removal efficiency of wet ponds can also be used for underground settling tanks (e.g., vaults, pipes or chambers). However, unlike typical wet ponds, the treatment surface area of circular pipes and arched chambers decreases as depth increases. For models that are not capable of directly evaluating this condition, an equivalent pipe/chamber width should be determined and multiplied by the pipe/chamber length to determine the treatment surface area (see Figure 1). The calculated treatment surface area should be used for each stage above the permanent pool elevation.

    A sediment storage depth should be specified for underground settling tanks. The depth between the bottom of the tank and the invert of the lowest outlet should be 3 feet plus the sediment storage depth (e.g., 3-ft + 0.5-ft sediment storage = 3.5-ft). If a model that considers particle resuspension is used (e.g., WinSLAMM), the depth between the top of the sediment storage and invert of the lowest outlet can potentially be less than 3 feet. The sediment storage depth indicated in the storm water management plan and/or used in modeling should be consistent with the sediment removal criteria specified in the long-term maintenance plan.

    The system should be designed such that water elevation during any event does not reach the top of the underground settling tank. Design should include appropriately spaced cleanouts for maintenance.

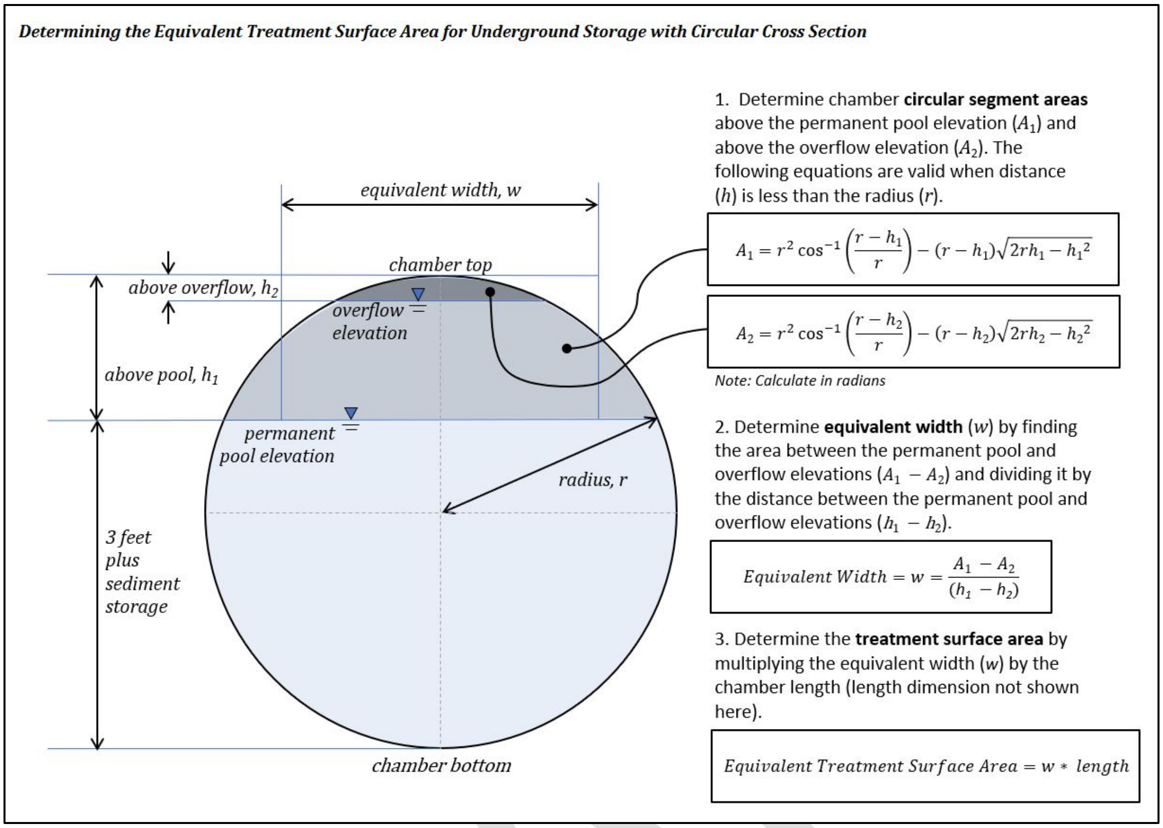

Figure 1 (Determining the Equivalent Treatment Surface Area for Underground Settling with Circular Cross-Section)

Where appropriate, leakage from underground settling tank joints should be minimized to protect groundwater (e.g., locations where a Type A or B wet pond liner would be used (see DNR Wet Pond Technical Standard 1001 – Appendix D).

Note: Underground subsurface detention in most cases is an extension of a storm piping system. The Department of Safety and Professional Services (DSPS) regulates storm systems under its plumbing code in areas outside of the public right of way. Storm systems are to have watertight joints and connections pursuant to ss. SPS 382.21(1)(a)2.b. and 384.40(1)(a), Wis. Adm. Code. DSPS may allow leakage or infiltration from storm plumbing based on its review of a satisfactory soil report pursuant to s. NR 382.365, Wis. Adm. Code.

15. **TSS Calculation**

The Total Suspended Solids (TSS) standard for new development and redevelopment requires control of TSS originating from the post-construction site (new development) or certain source areas of the post-construction site (redevelopment). Control of TSS from runoff that originates off-site generally does not count toward meeting the standard. For a redevelopment site, TSS control credit is to be taken for runoff from parking lot and roadway areas being redeveloped but DNR allows credit for treatment of runoff from other parking and roadway areas that are owned by the permittee and on the same parcel. As identified in s. NR 151.122 (4), Wis. Adm. Code, runoff draining to a treatment device from off-site shall be considered in determining the treatment efficiency of the practice. Any impact on the efficiency shall be compensated for by increasing the size of the treatment practice accordingly. The pollutant load from off-site can be "turned off" but the runoff volume at full build-out needs to be accounted for in calculating the treatment efficiency of the device. To minimize the size of a treatment device, it is beneficial to keep runoff that requires treatment segregated from other runoff until after it has been treated.

WinSLAMM v 10.4.0 and subsequent versions, allow the 'Other Control Device' to be used to either give treatment credit or to remove pollutant loading via a toggle under 'Tools - Program Options'.

The multiple WinSLAMM run method discussed below generally is not necessary where this issue is properly accounted for in WinSLAMM v 10.4.0 and subsequent versions.

To account for additional runoff from an area where the off-site pollutant load is to be removed from the model, multiple WinSLAMM model runs may be used. It is also possible to use one WinSLAMM model run along with some hand calculations to show that adequate mass from on-site areas have been controlled. The following method requires three model runs to account for this:

a) First, model run (A) is used to establish the TSS load generated from on-site areas without modeling any treatment practices (do not include any swales/drainage control).
b) Then, run a second model (B), which includes both off-site and on-site areas and no treatment practices (do not include swales/drainage control). Model run (B) will have an outfall "other control practice" applied to it and the modeler needs to adjust the "other control practice" 'pollutant concentration reduction' so that the TSS load generated from model run (B) is equal to that in model run (A) and the 'water volume (flow) reduction' is not reduced.
c) Finally, a third model run (C) is the same as the second model run (B) except that post-construction treatment practices are now included. Model run (C) will generate the appropriate TSS load discharged from the post-construction site which accounts for the additional runoff from off-site area but does not include the off-site pollutant load.
d) Because WinSLAMM includes the pollutant load reduction from the "other control practice" in the overall percent particulates solid reduction and credit cannot be taken for control of off-site pollutant load, the percent reduction needs to be adjusted. The calculation should be made as follows:

$$\text{Adjusted \% Particulate Solids Reduction} = \left(1 - \frac{\text{Particulate Solids Yield After Controls from Model Run (C)}}{\text{Particulate Solids Yield Before Drainage System from Model Run (A)}}\right) \text{X } 100$$

16. The NURP particle distribution file is to be used for post-construction modeling. Other WinSLAMM and P8 parameter input files including rainfall and winter season dates are identified and available via: http://dnr.wi.gov/topic/stormwater/standards/slamm.html

17. As discussed in items 5 and 10 above, ponds with an outlet on the bottom are prone to scour and resuspension and may not be eligible or allowed substantially less pollutant removal credit based on settling. However, credit may be taken for treatment due to infiltration or

filtration. (See the Flow Chart attached at the end of this document).

18. An aggressive and efficient street cleaning program might achieve a TSS removal efficiency of around 10 to 20%. Since the new development TSS performance standard is 80% control, street cleaning is not a viable option to provide TSS control for new development. Generally, credit for street cleaning should not be used to meet the redevelopment or highway reconstruction post-construction standard of 40% TSS control either. A developer will generally not have authority to ensure that street cleaning will be maintained, and it is not expected to provide enough TSS control to meet the 40% TSS performance standard for redevelopment or highway reconstruction.

19. Runoff that infiltrates is assumed to have 100% TSS and TP removal efficiency provided the facility is designed to prevent scour and resuspension of sediment. Vegetated Swale Standard 1005 has design criteria intended to prevent scour and resuspension, which includes a peak flow velocity not to exceed 1.5 fps and maximum flow depth of 12 inches for the 2-yr/ 24-hr rainfall event.

20. The settling velocity of particles in runoff is affected by water density, which in turn is temperature dependent. The DNR recommends that a runoff temperature of no greater than 68 degrees Fahrenheit (20 degrees Celsius) be used to model pollutant removal efficiency.

Peak Flow

21. The post-construction peak flow requirement in ss. NR 151.123 and 151.243, Wis. Adm. Code, allows the peak flow standard to be met for the post-construction site as a whole. However, it is recommended that the peak flows not be increased at each outfall that leaves the site to help limit the potential for off-site erosion.

22. The peak flow requirement does not apply to runoff from off-site which may enter the post-construction site. As identified in item 15 above, the off-site runoff needs to be accounted for in determining the treatment performance of treatment devices. On-site drainage systems need to be properly designed to handle runoff from both on- and off-site areas.

23. Under s. NR 151.123 Wis. Adm. Code, the peak flow requirement does not have to be met if the post-construction site drains directly into a lake over 5,000 acres or a stream or river segment draining more than 500 square miles. These water bodies are identified in an attached map.

24. Use of composite CNs for peak flow calculations (i.e. 1-yr/24-hr rainfall events) is acceptable for pervious surfaces and disconnected impervious surfaces. Combining directly connected impervious surfaces with pervious surfaces may result in underestimation of peak flows, particularly during the 1- and 2-year rainfall events. On sites with storm sewers or directly connected imperviousness, the designer should either evaluate the connected impervious areas separately from the pervious areas or provide documentation that the runoff from the connected impervious area does not control the peak flows during the 1- and 2-year rainfall events.

    See additional discussion about composite CNs under item 31 relative to the infiltration standard.

    Note: HydroCad is a model that is commonly used for calculating peak flows. Hydrocad v 7.1 and earlier versions, calculate a single composite curve number for each subcatchment.

Starting with HydroCad v 8.0, the model allows the option of calculating runoff from pervious and impervious areas separately within a subcatchment but it still averages CNs for pervious areas in a subcatchment. HydroCad v 10.0 allows the option of calculating flow independently from each area with a different CN (without averaging CNs) and then combines the flows to produce the total runoff. Access these options in the HydroCAD 'Advanced' tab of the 'Setting/Calculation' screen.

25. For determining compliance with the peak flow requirement under s. NR 151.123 or 151.243, Wis. Adm. Code, DNR recommends use of the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Precipitation Frequency Estimates for rainfall depth. The Natural Resources Conservation Service (NRCS) –Wisconsin has calculated county-specific Atlas 14 precipitation depths and they are to be used in combination with the appropriate NRCS Midwest/Southeast (MSE) 3 or 4 precipitation distribution. The NRCS calculated county-specific Atlas 14 precipitation depths and MSE3 and MSE4 precipitation distributions are available at: Wisconsin | Field Office Technical Guide | NRCS - USDA
This link should go to the USDA, Field Office Guide for Wisconsin under the Engineering Resources, Other Engineering resources, Hydrology and Hydraulics section.

    Note: NOAA Atlas 15 is currently under development, which is being developed to account for climate change.

26. Where the local flood control authority requires use of NRCS Technical Paper 40 (TP-40) or Bulletin 71 rainfall along with the corresponding type II rainfall distribution, they may be used. In the Southeastern Wisconsin Region, a SEWRPC (Southeastern Wisconsin Regional Planning Commission) storm time distribution may be applied with Atlas 14 precipitation depths. For SEWRPC information on this issue, see: https://www.sewrpc.org/SEWRPC/Environment/RainfallFrequency.htm

Gravel and Dirt Road CNs

27. Technical Release 55 (TR-55) authored by the United States Department of Agriculture (USDA) Soil Conservation Service (now Natural Resources Conservation Service or NRCS), presents simplified procedures to calculate urban hydrology (volume, peak flow, etc.) for small watersheds. TR-55 lists Curve Numbers (CNs), which are used to characterize runoff properties for a particular soil and ground cover. TR-55 includes CNs for gravel roads and dirt roads that include right-of-way. HydroCAD documentation suggests that the CN is based on 30% road surface with a CN of 96 and 70% open space in poor condition. So, 96 would be a reasonable CN value for gravel and dirt roads where there is not open space. Similarly, the CN for a gravel parking area should use the same CN as a gravel road (with no open space). Generally, gravel roads and parking areas should be considered an impervious surface as they generate substantially more runoff than the existing soil and ground cover condition.

Ballasted Railroad Tracks

28. Ballasted railroad tracks are designed to allow rainfall to efficiently drain laterally from its tracks and the underlying native soils are compacted, which generally allows for little to no infiltration. However, ballast rock does have a level of water retention. A Colorado Department of Transportation Report (No. CDOT-2012-8 Final Report) concluded that in general 0.3 to 0.4 inches of rainfall is detained in ballasted railroad tracks and with a 0.5-inch rainfall it produces only a small fraction of runoff. This correlates with a CN of about 84, which DNR feels is a reasonable CN for the area of the railroad ballasted tracks. With respect to TSS control, ballasted railroad tracks should be modeled as an unpaved parking source area.

Infiltration

29. The ch. NR 151, Wis. Adm. Code, infiltration standard is based on the pre-development infiltration volume that occurs on a post-construction site. For compliance with the ch. NR 151, Wis. Adm. Code, infiltration standard, the “stay-on” volume may be used to show compliance with the required infiltration volume. “Stay-on” includes infiltration, evapotranspiration, and runoff reuse for other uses. Runoff that does not leave the site via surface discharge is considered “stay-on”.

30. Water from off-site or outside of the proposed development area should not be included in the analysis to show compliance with the infiltration standard. Whereas a pollutant treatment analysis includes all hydrology entering a treatment device as identified in item 15.

31. The use of composite CNs for determining compliance with ch. NR 151, Wis. Adm. Code, infiltration standard is not appropriate and may not be appropriate for peak flow calculation as well. Composite CNs for different land cover condition may result in significantly different runoff volume for small rainfall events (i.e. smaller than 1-yr/24-hr rainfall events) including an annual average rainfall series.

    See additional discussion about composite CNs under item 24 relative to the peak flow standard.

32. RECARGA is a bioretention/rain garden sizing program developed by the UW-Madison Civil and Environmental Engineering Water Resources Group. It is publicly available and can be downloaded via the DNR Runoff Management Models web page:
    http://dnr.wi.gov/topic/stormwater/standards/recarga.html
    RECARGA may also be used to determine TSS removal credit for non-vegetated infiltration practices. To eliminate evapotranspiration, the root layer depth can be set at a very small value (such as 0.1”) but it cannot be set at zero. TSS and TP removal credit of 100% is given for the recharge (infiltrated) volume.

33. Average annual runoff and infiltration volumes may be calculated using WinSLAMM or RECARGA. The following approaches could be used:
    a) In WinSLAMM, the pre-development runoff volume is calculated by entering the pre-developed acreage and curve number in the "Pre-Development Runoff Volume" located under the “Tools” tab. The results are produced in the model output summary under the “Outfall” and "Runoff Volume" tabs. This can be accomplished in a single model run.
    b) In RECARGA, the pre-development infiltration volume can be calculated by inputting the existing condition tributary area, percent impervious and pervious CN, with a very small facility area such as 0.01 sf.

34. Infiltration and bioretention facilities should have their surface outlet raised off the bottom to ensure infiltration occurs across the entire bottom of the facility. An elevated outlet also helps keep accumulated sediment within the facility. DNR generally recommends placing the outlet 6 to 12 inches above the top of the engineered soil.

35. An infiltration basin should be designed to draw down within 24 hours from the end of a single rainfall event such as a 1-yr/24-hr event. An infiltration basin should be designed to draw down within 72 hours from the end of a 100-yr/24-hr rainfall event. These calculations do not have to account for back-to-back rainfall events. The surface ponding depth divided by the design infiltration rate should not exceed the surface draw down time of 24 hours. Also,

the design of the infiltration facility should take into consideration an extended period of release from an upgradient detention facility.

Plant selection should consider that the infiltration basin could see intermittent periods of inundation and periods of saturated soils. The design allows for drawdown times ranging between 24 to 72 hours for single rainfall events; however, the impact of back-to-back rainfall events should also be considered. The plants listed in the “Rain Gardens, Guide for Homeowners and Landscapers” have been recommended for Wisconsin rain gardens and bioretention facilities: Rain gardens: a beautiful way to reduce runoff pollution! | | Wisconsin DNR

Models analyzing an annual rainfall series might not be designed to measure draw down from the end of a rainfall event or may include the effect of back-to-back rainfalls on its calculated draw down time.

Note: In WinSLAMM, to determine if the 24 hour surface drain down time is being met, in the EventPerformanceSum.cvs detailed output file, subtract the Rain Duration from the Surface Ponding Duration.

36. DNR’s engineered soil filtering layer defined in DNR Bioretention for Infiltration Standard 1004, part V.B.6.d. qualifies as a “filtering layer” as defined in s. NR 151.002(14r), Wis. Adm. Code. DNR’s engineered soil mixture calls for 15 to 30% compost and 70 to 85% sand. The sand gradation required in the engineered soil mixture has a very low percent fines level, however, when mixed with compost, it is considered an acceptable filtering layer. If an infiltration facility is in an area with a level of percent fines that does not meet the filtering layer standard, then 2 to 3 inches of compost may be tilled into the top 6 to 12 inches of native sand for it to qualify as an acceptable filtering layer.

37. The side infiltration rate of a bioretention facility should be set at zero or substantially reduced because the soils along the side of a bioretention facility are commonly less conducive to infiltration and may also be compromised by smearing or compaction.

38. An effective infiltration area should not be given double credit both as an infiltration device and as a pervious area CN. The effective infiltration area should be given a CN of 100 when modeled as an infiltration facility.

39. In order for an effective infiltration area to count toward the effective infiltration area cap under s. NR 151.124(1) (a) to (c), Wis. Adm. Code, the infiltration must be to the maximum extent practicable (MEP) of what the site could achieve with an infiltration device with a static infiltration rate designed to infiltrate to the MEP. A grass swale or filter strip have a dynamic design infiltration rate and their effective infiltration area is not going to provide infiltration to the MEP for most sites.

40. Evaporation from a wet pond may be modeled to count toward the infiltration standard. This 1982 NOAA publication, Table II pan evaporation rates, corrected by 0.75, may be used: https://semspub.epa.gov/work/01/554363.pdf

41. The infiltration performance standard under ch. NR 151, Wis. Adm, Code, shall be evaluated based on the same area from existing to proposed conditions.

Bioretention

42. DNR allows 100% TSS and TP removal credit for the volume of runoff that is infiltrated into the underlying soil; 80% TSS and 0% TP removal credit for the volume of runoff that is filtered through an engineered soil filtering layer that meets the requirements of Technical Standard 1004 (Bioretention for Infiltration), and that is discharged via an underdrain; and 0% removal credit for the volume of runoff that overflows or bypasses the filter. Biofiltration practices using engineered soil will continue to get TSS filtering credit based on the DNR allowable level that was in place at the time the DNR received a ch. NR 216, Wis. Adm. Code, Notice of Intent (NOI) for the construction project or when the practice was installed where no NOI was required (projects/installations prior to Dec. 20, 2011).

    Note: In WinSLAMM, for "engineered soil type" input "manually entered;" then 80% can be manually entered for the "percent solids reduction due to engineered soil".

43. The DNR allows an engineered soil infiltration rate of up to 3.6 inches per hour and an engineered soil porosity of 0.27. The DNR recommends a rock or sand storage area porosity of 0.33.

44. The current engineered soil mixture specified in Technical Standard 1004 with 15 to 30% compost has not shown a reduction in TP that is filtered. DNR allows 100% TP removal credit for the volume of runoff that is infiltrated into the underlying soil and 0% removal credit for the remaining runoff volume.

45. Proprietary additives or iron fillings may potentially be added to engineered soil to improve capture of TP and Dissolved Reactive Phosphorus (DRP). DNR requires that additive products be reviewed for performance and potential aquatic toxicity. DNR's review of potential aquatic toxicity is conducted following DNR guidance 'Water Quality Review Procedures For Additives', dated November 28, 2022, accessible at: Storm water publications/guidance | | Wisconsin DNR . For stormwater additives, Amy Minser (DNR storm water engineer) can help with providing direction on information needed to conduct this review.

46. Research has shown that salt can cause both phosphorus and metals to leach out of bioretention soil mixes. Also salt can affect the Sodium Absorption Ratio (SAR), which may adversely affect the soil structure and in turn the permeability of the soil. To the extent feasible, winter runoff that may contain road salt should be diverted around a bioretention facility.

Sand Filter

47. The DNR will allow a filtering credit of 80% for TSS for treatment through 100% sand meeting one of the gradation options specified in Technical Standard 1004 and following the other design requirements contained in Technical Standard 1004.

    Note: Although addition of compost in a filter does not help in removing phosphorus, it may still be beneficial as a soil amendment for certain plants and also increase the removal of metals and hydrocarbons from runoff that is filtered.

Permeable Pavement

48. Permeable pavement that is designed, installed and maintained in accordance with DNR Permeable Pavement Technical Standard 1008 is given filtering credit of 65% for TSS and 35% for TP. A 100% reduction credit is given for TSS and TP in the volume of runoff that is

infiltrated. The design infiltration rate of the soil under the rock storage area should be based on DNR's Site Evaluation for Stormwater Infiltration – Standard 1002, default infiltration rates based on soil texture listed in Table 2.

DNR considers permeable pavement to be a treatment device, which may allow for infiltration depending on the site-specific conditions. When modeled, the permeable pavement area should be modeled as an impervious source area as it receives infiltration credit based on its design infiltration rate.

In WinSLAMM, version 10 and subsequent versions should be used to model permeable pavement. In WinSLAMM 9.4 and earlier versions, the porous pavement calculation has an error in the calculation.

Green Roof

49. Green roofs are generally classified as "extensive" with 2 to 6 inches of soil media or "intensive" with 6 to 24 inches or more soil media. The soil media and accompanying vegetation of a green roof can reduce both the overall runoff volume and peak flow when compared to a conventionally designed roof; however, TSS and TP concentrations can be higher from a green roof due to the vegetation and soil media. Therefore, no TSS or TP reduction credit should be taken for runoff filtered through a green roof.

Connected Imperviousness

50. "Connected Imperviousness" is defined under s. NR 151.002 (6), Wis. Adm. Code. The percent of connected imperviousness should be no greater than that in the appropriate WinSLAMM standard land use files unless the percent disconnection is known at the time of plan development. In P8, the help menu provides standard land use values that can be used as the percent directly connected versus indirectly connected impervious surfaces.

51. The actual percent connected imperviousness should be used for any site where the impervious surface drainage patterns are known at the time of stormwater plan development. This is generally the case for most commercial building sites, schools, condos, parking lot expansions, etc. Residential subdivisions and business parks are two development types where detailed building, parking and/or driveway drainage may not be known at the time of plan development.

52. When evaluating the flow length for impervious surface disconnection, flow lengths should not extend into vegetated swales, filter strips, areas of concentrated flow, or other storm water treatment devices,

53. Disconnection of rooftops from one- and two-family residential dwellings may be assumed provided the runoff has a flow length of at least 20 feet over a pervious area in good condition.

54. Disconnection of impervious surfaces other than rooftops from one- and two-family residential dwellings may be assumed provided all of the following are met:
    a) The source area flow length does not exceed 75 feet,
    b) The pervious area is covered with a self-sustaining vegetation in "good" condition and at a slope not exceeding 8%,
    c) The pervious area flow length is at least as long as the contributing impervious area flow length and there can be no additional runoff flowing into the pervious area other than that from the source area.

d) The pervious area must receive runoff in a sheet flow manner across an impervious area with a pervious width at least as wide as the contributing impervious source area.

Filter Strips

55. Runoff from an impervious area to a vegetated buffer can be modeled as either disconnected or as a filter strip but should not be modeled as both. SLAMM model may overestimate pollutant reduction and/or infiltration when modeling both in series.

56. Filter strip treatment may be modeled in WinSLAMM, but only for treating sheet flow runoff traveling less than 100 feet in the direction of flow. Sheet flow length is typically between 50 and 100 feet; however, based on Manning's n and slope, shallow concentrated flow can occur in less than 100 feet. The total length of contributing flow plus the length of the filter strip needs to be considered to ensure that sheet flow conditions will be maintained.

57. SLAMM filter strip device was designed to estimate pollutant control, but version 10.5 does not accurately assess both infiltration and pollutant control correctly in the same model run. Keep in mind that an effective infiltration area should be modeled as source area 70 (Water Body Area) to eliminate double counting of infiltration. However if effective infiltration area of a filter strip is modeled as source area 70 to eliminate double counting of infiltration, then the TSS load from the vegetated area is eliminated and the TSS/pollutant calculation will be incorrect.

    Recommendation: When calculating TSS control in SLAMM, modeling as a filter strip will give appropriate TSS control with the filter strip coded as a pervious source area. However, if modeling to show infiltration reduction (not TSS control), then model as a disconnected source area if the disconnection criteria are met. If desired/necessary to model with filter strip for infiltration, then code its effective infiltration area of filter strip as source area 70 (Water Body Area) to eliminate double counting of infiltration.

Hydrodynamic Proprietary Devices

58. Manufacturers of hydrodynamic proprietary devices commonly estimate TSS reduction efficiencies for their products. However, the modeled efficiency supplied by the manufacturer may only be used if the modeling and lab analysis conforms to Technical Standard 1006 "Proprietary Storm Water Sedimentation Devices". Otherwise, such devices should be modeled in WinSLAMM utilizing the Hydrodynamic Device source area control practice. As of the date this guidance was released, no proprietary hydrodynamic settling devices have been reviewed by the DNR as described in Standard 1006, nor have any such devices been included in WinSLAMM.

Transportation Facility – Swale Treatment Performance Standard

59. Pursuant to s. NR 151.249 (1), Wis. Adm. Code, in some cases transportation facilities that use swales for runoff conveyance and pollutant removal are exempt from TSS, peak discharge, and infiltration performance standards. However, the exemption does not specify or assume an amount of treatment credit. If the amount of treatment credit is needed, design, model, construct, and maintain swales in accordance with DNR guidance, the Vegetated Swale Technical Standard 1005, and the Site Evaluation for Infiltration Technical Standard 1002.

60. For “V” bottom swales, enter a bottom width of 0.1 inches to avoid an error associated with a zero bottom width being entered.

Unclassified Hydrologic Soil Group (HSG) Soil

61. Wisconsin has areas where NRCS has not mapped out HSG classifications. In such areas, the criteria in Table 7-1 of the NRCS National Engineering Handbook Part 630, Chapter 7 (January 2009) may be used to determine a representative HSG classification. This handbook is accessible at: https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=22526.wba

Ground Mounted Solar

62. Vegetation under and around ground mounted solar installations can function as a storm water best management practice under most conditions. Please see the ‘What Is Next?’ tab at: https://dnr.wisconsin.gov/topic/Sectors/SolarInstallations

DRAFTED BY:

__________________________________ _____________

Eric S. Rortvedt, Water Resources Engineer Date
On behalf of the Storm Water Liaison Team

APPROVED:

__________________________________ ____________

Shannon K. Haydin, Chief Date
Storm Water Runoff Section

Runoff Management Policy Management Team approved on [insert date].

Attachments: Flow Chart – Determining Water Quality Credit for Stormwater Detention Basins
Map of Lakes Larger than 500 Acres & Streams Draining more than 500 squ. mi.

Note to reviewers: The two attachments above are not changing from the existing guidance at: ModelingPostConstructionGuidance.pdf (wisconsin.gov)