

The “Modeling Post-Construction Storm Water Management Treatment” guidance was originally developed in December 2010 to provide clarification to post-construction storm water management plan developers and modelers. This guidance was last updated in April 2011 and has been available on the Department’s web site at:

http://dnr.wi.gov/topic/stormwater/documents/Modeling_Post-Construction_Guidance_2011.pdf.

The guidance document that follows is the proposed update to the April 2011 version.

The Department is soliciting comments from the public on this draft guidance. Once the 21 day notice period is complete, all comments will be considered. After considering all public comments, revisions may be made to the guidance document and final guidance will be made available to internal and external stakeholders. Comments related to this draft guidance document should be sent to: DNRGUIDANCEDOCUMENTS@wisconsin.gov.

DRAFT



BUREAU OF WATERSHED MANAGEMENT PROGRAM GUIDANCE

Storm Water Management Program

Modeling Post-Construction Storm Water Management Treatment

Effective (Insert Date), 2015
Guidance #: 3800-2015-XX

Notice: 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. This guidance does not establish or affect legal rights or obligations, and is not finally determinative of any of the issues addressed. This guidance does not create any rights enforceable by any party in litigation with the State of Wisconsin or the Department of Natural Resources. 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:

Pam Biersach, Director
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Date

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 methods set forth in this document are ways that the DNR's Runoff Management Program staff recognize as appropriate for meeting modeling requirements in the 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.

Additionally, there are references to Technical Standards, DNR Tech. Std. 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. 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>
2. 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 make adjustments 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.com/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.

3. In WinSLAMM, when modeling a wet basin, if the “Initial Stage Elevation” is not changed from “0” to the outlet elevation, the model starts running with an empty basin. This must be changed as an empty basin does not represent a wet basin condition. Therefore, the “Initial Stage Elevation” of a wet basin must be set equal to the invert elevation of the lowest outlet.
4. P8 does not account for scour and sediment resuspension for any of its modeled treatment devices and this is identified within the P8 help menu, model limitation section. Basins need to be designed to prevent resuspension in order 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. A basin with zero permanent pool depth should be considered to get zero credit for pollutant removal due to settling. The DNR recommends using a straight-line depreciation such that a basin 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.
5. 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 are larger than 50 microns. If there were no infiltration, the maximum TSS trapping efficiency for a grass swale would be about 16%.

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 removal credit would be calculated as follows:

$$\begin{aligned} \text{Fraction infiltrated} + 0.16 \times \text{fraction not infiltrated} &= \text{TSS removal} \\ 0.40 + [0.16 \times (1 - 0.40)] &= 0.496 \text{ or } 49.6\% \end{aligned}$$

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 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%. Subtract the settlement credit calculated from the TSS load remaining to get the revised TSS 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.

6. 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. Starting P8 a month early may be adequate for modeling most storm water facilities but may not be adequate for large facility or a series of facilities. In order to be safe, DNR recommends that P8 be started an extra year before the “keep dates”.
7. 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 basin upstream of a wet detention basin). Turn off the treatment efficiency of such practices in P8.

TSS Calculation

8. The Total Suspended Solids (TSS) standard for new development and redevelopment requires control of TSS originating from the post-construction site or certain source areas of the post-construction site. 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 but DNR allows credit for treatment of runoff from other parking and roadways areas that are owned by the permittee. As identified in s. NR 151.122 (4), Wis. Adm. Code, runoff draining to a treatment device from off-site shall be taken into account 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. In order 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.

In WinSLAMM, the “other control practice” can be used to adjust the pollutant load and volume that are generated. WinSLAMM gives treatment reduction credit for this “other control practice;” therefore, simply turning off the pollutant load from an off-site source area will not by itself result in the appropriate treatment efficiency for the site using only one WinSLAMM model run. This is true for WinSLAMM 10 and earlier 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:

- 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).
- 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.
- 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.
- 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:

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

9. The NURP particle distribution file is to be used for post-construction modeling. Other WinSLAMM and P8 parameter input files are identified and available at: <http://dnr.wi.gov/topic/stormwater/standards/slamm.html>
10. As discussed in item 4 above, basins with an outlet on the bottom are prone to scour and resuspension and should not be given pollutant removal credit based on settling. However, credit may be taken for treatment due to infiltration or filtration. Features to prevent scour, when appropriate, should be included. (See the Flow Chart attached at the end of this document).
11. 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.
12. Runoff that infiltrates is assumed to have 100% TSS removal efficiency provided the facility is designed to prevent scour and resuspension of sediment. Vegetated Infiltration 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.
13. 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

14. 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 for any drainage area leaving the site to help limit the potential for off-site erosion.
15. The peak flow requirement does not apply to runoff from off-site which may enter the post-construction site. As identified in #8 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.
16. 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.
17. 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 depth and rainfall distribution. The Natural Resources Conservation Service (NRCS) –Wisconsin has calculated county specific rainfall depths to be used with the specified Atlas 14 rainfall distribution, which are to be made available at:

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/wi/technical/engineering/?cid=nrcs142p2_025417

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.

Gravel and Dirt Road CNs

18. 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

19. 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

20. 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 the purpose of 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”.
21. The use of composite CNs for determining compliance with ch. NR 151, Wis. Adm. Code, infiltration standard is not appropriate. 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.

Use of CNs for peak flow calculations is generally considered acceptable for design storm events (i.e. 1-yr/24-hr rainfall events) for pervious surfaces and disconnected impervious surfaces. Combining directly connected impervious surfaces with pervious surfaces may result in underestimation of peak flows, particularly for 1 and 2 year rainfall events.

22. 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 removal credit of 100% is given for the recharge (infiltrated) volume.

23. Average annual runoff and infiltration volumes may be calculated using WinSLAMM or RECARGA. The following approaches could be used:
 - 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.
 - In RECARGA, the pre-development infiltration volume can be calculated using the "stay on" depth obtained from the "Target Stay-On (Annual Infiltration) Requirement" chart and multiplying the "stay on" depth by the pre-development area. This chart is available for download at:
http://dnr.wi.gov/topic/stormwater/standards/postconst_standards_note.html
However, calculation of the post-development infiltration volume may require a model run for each post-development drainage area including areas not draining to an infiltration practice.
24. Infiltration and bioretention facilities should have their surface outlet raised off the bottom of the basin to ensure runoff 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, and designing the facility so the surface of the facility drains down within 24 hours.
25. 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 located 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.
26. 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.
27. An effective infiltration area should not be given double credit both as an infiltration device and also as an area with a pervious area CN. The effective infiltration area should be given a CN of 100 when modeled as an infiltration facility.

Engineered Soil

28. DNR allows 100% TSS removal credit for the volume of runoff that is infiltrated into the underlying soil; 80% TSS 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”.

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

Green Roof

30. 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 may have a significant effect on runoff volume and peak flow control. However, roof runoff generally contains a relatively low level of TSS and a green roof may lead to an increased discharge of nutrients. Therefore, no TSS reduction credit should be taken for a green roof.

Connected Imperviousness

31. “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.
32. 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.
33. 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.
34. Disconnection for impervious surfaces other than rooftops from one- and two-family residential dwellings may be assumed provided all of the following are met:
 - The source area flow length does not exceed 75 feet,
 - The pervious area is covered with a self-sustaining vegetation in “good” condition and at a slope not exceeding 8%,
 - 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.
 - 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.

Hydrodynamic Proprietary Devices

- 35. 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 as long as the modeling and lab analysis conforms to WDNR Technical Standard 1006 “Proprietary Storm Water Sedimentation Devices”. Otherwise, such devices should be modeled in WinSLAMM utilizing the Hydrodynamic Device source area control practice.

Transportation Facility – Swale Treatment Performance Standard

- 36. Section NR 151.249 (1)(b), Wis. Adm. Code, directs that swales shall comply with DNR Tech. Std. 1005 “Vegetated Infiltration Swale”, except as authorized in writing by the DNR. DNR does not expect a transportation facility swale to be designed for infiltration and therefore, only certain sections of the standard are applicable. A transportation facility swale treatment section is to be designed to follow sections V.F. (Velocity and Depth) and V.G. (Swale Geometry Criteria) with a swale treatment length as long as that specified in section V.C. (Pre-Treatment). Transportation facility swale treatment does not have to comply with the other sections of Tech. Std. 1005.
- 37. Some water quality models require a swale bottom width to be entered and which is not zero. If a “V” swale is proposed then a 0.1’ bottom width should be entered.
- 38. Wide swales are prone to channelization. DNR recommends that flat bottom swales be no more than 6 feet in width to help prevent channelization.

Unclassified Hydrologic Soil Group (HSG) Soil

- 39. There are areas in Wisconsin 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:
<ftp://ftp.wcc.nrcs.usda.gov/wntsc/H&H/NEHhydrology/ch7.pdf>

DRAFTED BY:

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On behalf of the Storm Water Liaison Team

Date

APPROVED:

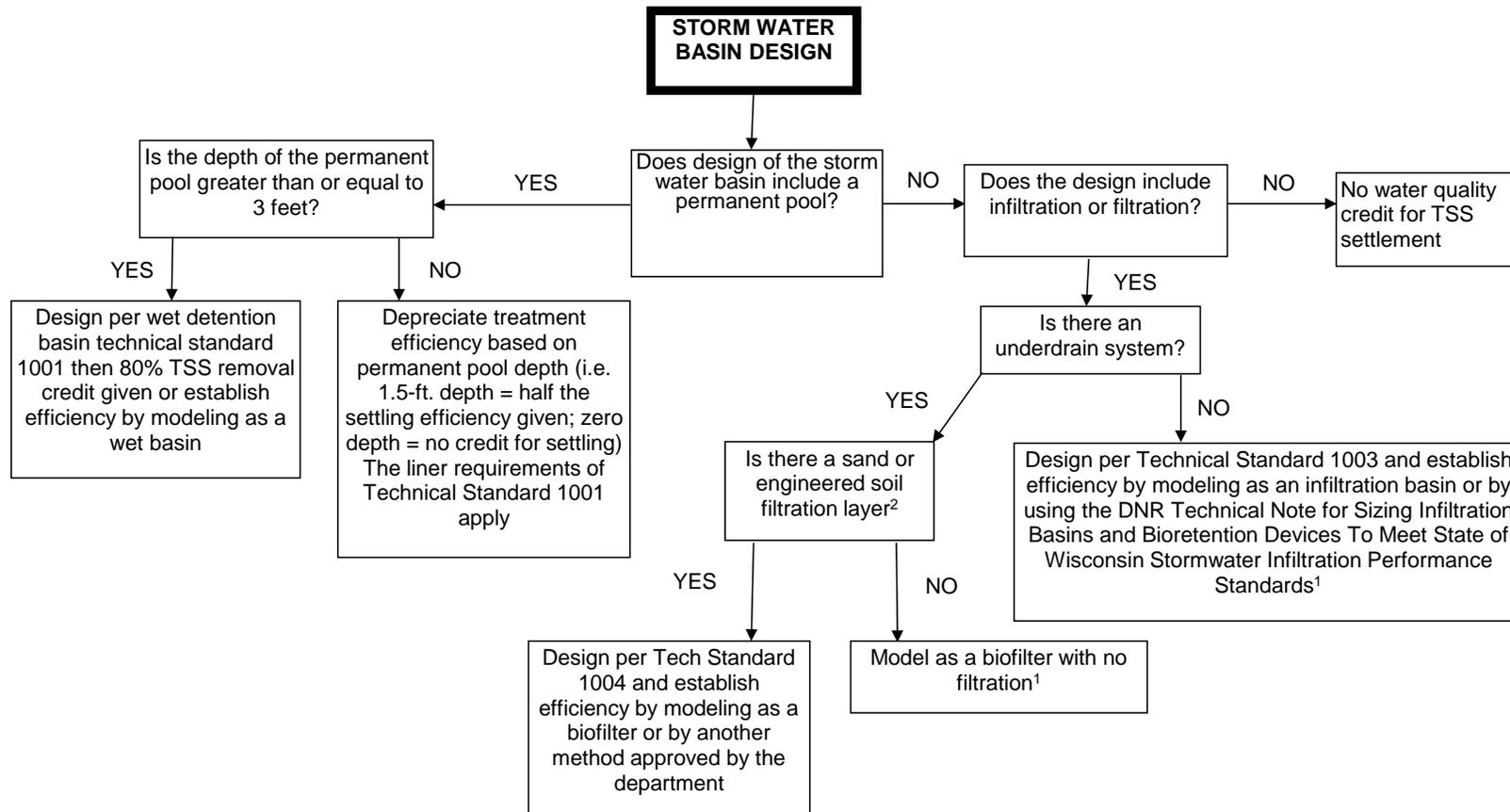
Mary Anne Lowndes, Chief
Runoff Management Section

Date

Runoff Management Policy Management Team approved on _____ (date).

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

DETERMINING WATER QUALITY CREDIT FOR STORM WATER DETENTION BASINS FOR COMPLIANCE WITH CONSTRUCTION AND MUNICIPAL PERFORMANCE STANDARDS



Notes:

1. This chart does not address pretreatment of runoff prior to infiltration. Pretreatment is required before infiltrating runoff from parking lots and new road construction in commercial, industrial and institutional areas under s. NR 151.12(5)(c)4, Wis. Adm. Code.
2. Technical standard 1004 requires a two foot depth of engineered soil.

