BUREAU OF WATERSHED MANAGEMENT
PROGRAM GUIDANCE

WATERSHED MANAGEMENT TEAM
Storm Water Runoff Management Program

Wisconsin Department of Natural Resources
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Municipal Phosphorus Reduction Credit for Leaf Management Programs

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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:

Jill Schoen 2/22/2022

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Jill Schoen, Acting Director Date
Bureau of Watershed Management

A. Introduction/Statement of Problem Being Addressed

Permitted Municipal Separate Storm Sewer Systems (MS4s) are subject to an annual average reduction for the discharge of a pollutant of concern to a surface water that has an approved Total Maximum Daily Load (TMDL). In many TMDLs one of the pollutants of concern is phosphorus. Research indicates that phosphorus loads in stormwater in the fall season may be reduced by leaf collection followed by street cleaning. Municipalities developing implementation plans to meet TMDL wasteload allocations to quantify potential benefits of fall leaf management efforts in their plans.

The purpose of this guidance is to clarify the specific conditions and methods for which numeric credit may be taken by Wisconsin MS4s in demonstrating progress toward TMDL wasteload allocation expressed as a % reduction in annual average discharge of phosphorus in urban storm water. This credit is limited to the specific conditions and methods for which data is available. No numeric credit has been quantified for other land use types, tree canopies, or management programs, but the Department encourages municipalities to apply similar leaf management approaches to other land uses and tree canopy conditions as a source control activity for phosphorus. It is the Department's intent to expand the applicability of the guidance to more conditions and programs as additional studies are completed. This expansion is dependent on availability of funding for further data collection and evaluation.

B. Objectives

This guidance identifies a percent phosphorus reduction credit which may be taken by municipalities as part of TMDL modeling and planning and the conditions required to take that credit.

C. Background and Definitions

Urban trees provide a host of benefits to the residents and workers within a community, such as energy savings, aesthetics, airborne pollutant reduction, noise reduction, and providing bird habitat. Trees are also an important part of the hydrologic cycle in both rural and urban settings. However, urban areas generally have a combination of impervious surfaces and drainage systems that are directly connected to surface waters. This creates a delivery system that is very effective at delivering nutrients from leaf litter to discharge points. Keeping leaf litter out of the delivery system can provide significant reductions in the discharge of nutrients in urban storm water. Each tree species contributes a different amount of phosphorus to the stormwater, but since a diverse set of tree species is beneficial to long-term maintenance of a healthy canopy, this effect is not being addressed at this time.

While there are many sources of phosphorus in urban stormwater, a primary contributor is organic detritus, especially in areas with dense overhead tree canopy (Duan et al, 2014;

Hobbie et al, 2014; and Kalinosky et al, 2014). Measurement of end-of-pipe phosphorus concentrations has demonstrated that phosphorus loads in urban stormwater vary seasonally in certain medium density residential areas, with higher concentrations coinciding with leaf accumulation on streets (Selbig, 2016). As phosphorus discharges in stormwater can vary from year to year depending on timing of rainfall events, seasonal phosphorus loads were modeled over a twenty-year period with WinSLAMM to determine the average proportion that is discharged in the fall. From this information, it is estimated that on average 43% of the annual phosphorus load is discharged in the fall.

A variety of public works programs are already in place to collect leaves from the streets and properties in the fall, but until recently, little was known about the phosphorus reduction potential of different leaf collection programs. Over the last seven years, the United States Geological Survey (USGS) conducted a study to characterize reductions of total and dissolved forms of phosphorus in stormwater through municipal leaf collection and street cleaning programs in Madison, Wisconsin, USA. Numeric credit for phosphorus reduction is warranted based on the information.

To estimate the efficiency of leaf management, leaves were collected three to four times at the test site and collected only once at the end of the fall at the control site. A small vehicle was used to push the leaves from the terrace into the street and then the leaves were pushed into garbage trucks. In this guidance, the term 'terrace' is used to refer to the vegetated area between the sidewalk and the curb, or immediately adjacent to the curb where no sidewalk is present. Within 24 hours of leaf collection, remaining leaf litter in the street was collected using mechanical street cleaners. The frequency of both push leaf collection and street cleaning was approximately once every two weeks. Eight end-of-pipe phosphorus concentration measurements were compared at the test and control sites during the fall of 2016. Water quality data collected indicate that the push collection and transfer method coupled with street cleaning within 24 hours resulted in a 40% reduction of total phosphorus discharge in the fall at the test site versus the control site.

A second year of water quality data with push collection of leaves at the same frequency (roughly once every other week) coupled with weekly street cleaning using a regenerative air street cleaner resulted in a 60% reduction of total phosphorus discharge in the fall at the test site versus the control site. The reduction in total phosphorus may vary with the type of street cleaner so for this credit, therefore only regenerative air street cleaners may be used at this time.

To determine the average annual benefit of these leaf management efforts, the reduction efficiency is multiplied by the percentage of phosphorus load occurring in fall. The overall phosphorus reduction credit for each study is as follows

- Study 1: 40% x 43% = 17%
- Study 2: 60% x 43% = 25 %

Based on studies to date, the timing of leaf collection and street cleaning appears to be a critical element. Not all species drop their leaves at the same time, and the timing of rainfalls is unknown, so the general principle is to keep the streets as clear of leaf litter as

feasible. As leaves accumulate on the road and are blown onto the road from the terrace and adjacent areas, the volume of leaf litter increases to the point that it reduces the efficiency of street cleaning efforts and bulk collection efforts are needed to supplement cleaning.

In general, leaf accumulation appears to start in late September (northern Wisconsin) or early-October (southern Wisconsin). As the timing of leaf fall varies from year to year and from north to south, local conditions may need to dictate when leaf collection and associated street cleaning begin. There is an existing effort to predict deciduous tree behavior for the purposes of tourism, called the Fall Leaf Color Report (https://www.travelwisconsin.com/fall-color-report). This resource becomes available in September and may be helpful when planning the start of leaf collection. It is important to note that collection may need to begin at least 2 weeks before peak fall color is achieved as different tree species lose their leaves at different times.

D. Guidance Content

A municipality may assume the specified reduction from no controls phosphorus loads provided all conditions are met. Further evaluation is required to determine how leaf management may reduce loading to structural best management practices (BMPs) such as ponds. Therefore, this credit may not be taken in addition to phosphorus reductions from other BMPs in the drainage area at this time. Municipalities may apply the leaf management credit to a subset of their residential area if other BMPs are providing more phosphorus reduction for the remaining area.

Numeric credit may apply to an area if all of the following conditions are met:

1. Land use: Residential land use without alleys. Residential land use with alleys may be included if the alleys receive the same level of leaf collection and street cleaning as the streets.
2. Street Section: Curb and gutter streets with storm sewer drainage systems and light parking densities during street cleaning activities.
3. Tree Canopy: High level of tree canopy determined by one of the following approaches:
    a. An average of one or more medium to large canopy trees located between the sidewalk and the curb for every 80 linear feet of curb. Where sidewalk is not present, trees within 15 feet of the curb may be counted toward tree cover.
    b. An average of 40% or greater leaf canopy over the pavement or 45% tree canopy or greater over the right-of-way determined using leaf-on aerial photography.

In addition, the following legal authorities and policies must also be in place:

1. The municipality has an ordinance prohibiting residents from placement of leaves in the street.
2. The municipality has a policy stating that residents may place leaves on the terrace in bags or piles for collection and that they will be removed at the specified frequency and timing. Leaves may be pushed, vacuumed, or manually loaded into a fully enclosed vehicle, such as a garbage truck or covered dump truck. No leaf piles are left in the street overnight. Regular collection limits the volume of leaves that may blow into the street from adjacent areas.
3. If on-street parking densities are typically greater than light (defined as significant spacing between parked cars so that street cleaners can easily get to the curb for most of the curb length), then an ordinance or enforceable policy to restrict parking during leaf collection and street cleaning activities is needed.

If all the preceding conditions are met, then numeric credit is available for the activities in Table 1 at the specified frequencies.

Table 1: Leaf Management Options for Numeric Credit

Option	Start By (See also discussion below)	Leaf Collection frequency and timing	Street cleaning timing	Applicable annual TP % Reduction[1]
1	See Table 2 for last start date based on county.	3-4 times spaced throughout Late September, October and November	Within 24 hours of leaf collection- Mechanical broom or high efficiency street cleaner[2]	17%
2	See Table 2 for last start date based on county.	3-4 times spaced throughout Late September, October and November	Weekly with regenerative air street cleaner or vacuum-assisted street cleaner	25%

[1]Reduction from a 'no controls' condition as modeled in accordance with DNR guidance

[2]A brush attachment on a skid steer is not an acceptable equivalent

Table 2: Latest Acceptable Start Date

County*	Start No Later Than
Ashland, Bayfield, Burnett, Douglas, Florence, Forest, Iron, Langlade, Lincoln, Marinette, Oneida, Price, Rusk, Sawyer, Taylor, Vilas, Washburn	September 23
Adams, Barron, Brown, Buffalo, Calumet, Chippewa, Clark, Columbia, Dodge, Door, Dunn, Eau Claire, Fond du Lac, Green Lake, Jackson, Juneau, Kewaunee, LaCrosse, Manitowoc, Marathon, Marquette, Menomonie, Monroe, Oconto, Outagamie, Ozaukee, Pepin, Pierce, Polk, Portage, Richland, Sauk, Shawano, Sheboygan, St. Croix, Trempealeau, Vernon, Washington, Waupaca, Waushara, Winnebago, Wood	October 1
Crawford, Dane, Grant, Green, Iowa, Jefferson, Lafayette, Kenosha, Milwaukee, Racine, Rock, Walworth, Waukesha	October 7

*County lists based on USDA planting zones

As the exact timing of leaf fall varies from year-to-year, start of leaf management may be adjusted based on the following: Street cleaning activities for leaf management efforts should start when the amount of leaves in the streets with the earliest leaf drop reaches that depicted with **Figure 1** below. It is recommended that bulk leaf collection activities supplement street cleaning once the amount of leaves in the streets is closer to that depicted in **Figure 2** below and/or residents begin piling leaves on the terrace.

Figure 1: Level of leaf accumulation triggering start of street cleaning for leaf collection with weekly sweeping.

Figure 2: Level of leaf accumulation triggering start of collection in addition to street cleaning

At this time, numeric credit for leaf management is not available for other land use types, lower-density tree canopies, or non-curbed streets. The Department encourages communities to extend their leaf management efforts into all areas where leaf litter accumulates in gutters and drainageways and report this as a non-quantifiable source control effort. Leaf management studies to date have demonstrated that the frequency of removing the leaves from the street is more important than the method of removing the leaves. It is difficult to predict the timing of rainfall, so it is important to keep the streets clear of leaves to limit discharge of phosphorus.
Please see Attachment 1 for an example of how this guidance could be applied in the context of a TMDL tabular summary.

It is anticipated that additional scenarios will be added as research is completed.

E. References

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Selbig, W.R., Buer, N.H., Bannerman, R.T., and Gaebler, P., 2020, Reducing leaf litter contributions of phosphorus and nitrogen to urban stormwater through municipal leaf collection and street cleaning practices: U.S. Geological Survey Scientific Investigations Report 5109, 17 p., https://doi.org/10.3133/sir20205109

CREATED:

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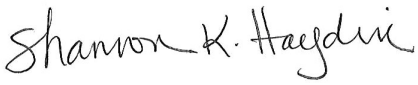
Amy Minser, Stormwater Engineer — Date
On behalf of the Storm Water Liaison Team

APPROVED:



February 22, 2022

Shannon Haydin, Chief — Date
Storm Water Runoff Management Section

Watershed Management Team approved on February 17, 2022.

ATTACHMENT 1: Example of How to Apply the Credit for Leaf Management

The fictional Village of Hartsookville currently has an ordinance that prohibits raking leaves into the street, light on-street parking, collects leaves 3-4 times per season, and sweeps streets bi-weekly during the fall. It has 3 drainage areas in a TMDL reachshed for which it is considering taking credit for fall leaf collection. The Village has modeled its pollution control using WinSLAMM with its existing best management practices, resulting in the numbers in Table A-1 for Total Phosphorus (TP).

Table A-1 Total Phosphorus reduction without Leaf Management Credit

Basin	TP Yield No Controls (lbs/yr)	TP Load With Controls (lbs/yr)	TP Percent Yield Reduction
DA1	87.1	80.1	8.1
DA2	87.1	60.3	30.7
DA3	82.0	82.0	0.0
Total	**256.2**	**222.4**	**13.2**

Drainage Area 1 (DA1) contains 80 acres medium density residential land use without alleys and 20 acres strip commercial. This entire area has curb and gutter drainage which is swept with a Vacuum sweeper once every 4 weeks. The phosphorus reduction from street cleaning is lower than that offered by leaf management (17%). The village has confirmed that the residential area meets the tree canopy threshold. From the modeling, the village has determined that the residential area contributes 65.6 lbs of TP per year for the drainage area without controls. If the village takes leaf collection credit for the residential area and the street cleaning credit for the commercial area, the with-controls TP discharge would be as shown in Table A-2.

Table A-2: Leaf Management Credit Application to Drainage Area 1

Land use	TP Yield No Controls (lbs/yr)	TP Load With Controls (lbs/yr)	Percent Yield Reduction
MDRNA	65.6	54.5	17% From Leaf Management
Strip Commercial	21.5	19.5	9.4% from Street Cleaning per detailed WinSLAMM output
Total DA1	**87.1**	**74.0**	**15.1%**

Drainage Area 2 (DA2) is served by a regional pond that provides more phosphorus reduction that the leaf management credit, so it does not make sense to take credit for leaf management for DA2.

Drainage Area 3 (DA3) is not served by a best management practice and is 100% residential land use meeting the tree canopy requirements. The no-controls annual TP discharge is 82.0 lbs/yr. With the leaf management credit, the with controls annual TP discharge would be 82.0 x (1-0.17) = 68.1 lbs per year.

Table 3 summarizes the results of the Village's application of the leaf management credit.

Table A-3 Total Phosphorus reduction with Leaf Credit

Basin	TP Yield No Controls (lbs/yr)	TP Load With Controls (lbs/yr)	TP Percent Yield Reduction
DA1	87.1	74.0	15.1
DA2	87.1	60.3	30.7
DA3	82.0	68.1	17.0
Total	**256.2**	**202.3**	**21.0**