ATTACHMENT 2 TO APPENDIX F

Phosphorus Reduction Credits for Selected Enhanced Non-Structural BMPs in the Watershed

The permittee shall use the following methods to calculate phosphorus load reduction credits for the following enhanced non-structural control practices implemented in the Watershed:

1) Enhanced Sweeping Program;
2) Catch Basin Cleaning;
3) No Application of Fertilizers Containing Phosphorus; and
4) Organic Waste and Leaf Litter Collection program

The methods include the use of default phosphorus reduction factors that EPA has determined are acceptable for calculating phosphorus load reduction credits for these practices.

The methods and annual phosphorus load export rates presented in this attachment are for the purpose of counting load reductions for various BMPs treating storm water runoff from varying site conditions (i.e., impervious or pervious surfaces) and different land uses (e.g. industrial and commercial) within the impaired watershed. Table 2-1 below provides annual phosphorus load export rates by land use category for impervious and pervious areas. The estimates of annual phosphorus load and load reductions resulting from BMP implementation are intended for use by the permittee to measure compliance with its Phosphorus Reduction Requirement under the permit.

Examples are provided to illustrate use of the methods. In calculating phosphorus export rates, the permittee shall select the land use category that most closely represents the actual use for the area in question. For watersheds with institutional type uses, such as government properties, hospitals, and schools, the permittee shall use the commercial land use category for the purpose of calculating phosphorus loads. Table 2-2 provides a crosswalk table of land use codes between land use groups in Table 2-1 and the codes used by Mass GIS. For pervious areas, permittees should use the appropriate value for the hydrologic soil group (HSG) if known, otherwise, assume HSG C/D conditions.

Alternative Methods and/or Phosphorus Reduction Factors: A permittee may propose alternative methods and/or phosphorus reduction factors for calculating phosphorus load reduction credits for these non-structural practices. EPA will consider alternative methods and/or phosphorus reduction factors, provided that the permittee submits adequate supporting documentation to EPA. At a minimum, supporting documentation shall consist of a description of the proposed method, the technical basis of the method, identification of alternative phosphorus reduction factors, supporting calculations, and identification of references and sources of information that support the use of the alternative method and/or factors in the Watershed. If EPA determines that the alternative methods and/or factors are not adequately supported, EPA will notify the permittee and the permittee may receive no phosphorus reduction credit other than a

reduction credit calculated by the permittee following the methods in this attachment for the identified practices.

Table 2-1: Proposed average annual distinct P Load export rates for use in estimating P Load reduction credits in the MA MS4 Permit

Phosphorus Source Category by Land Use	Land Surface Cover	P Load Export Rate, lbs/acre/year	P Load Export Rate, kg/ha/yr
Commercial (Com) and Industrial (Ind)	Directly connected impervious	1.78	2.0
	Pervious	See* DevPERV	See* DevPERV
Multi-Family (MFR) and High-Density Residential (HDR)	Directly connected impervious	2.32	2.6
	Pervious	See* DevPERV	See* DevPERV
Medium -Density Residential (MDR)	Directly connected impervious	1.96	2.2
	Pervious	See* DevPERV	See* DevPERV
Low Density Residential (LDR) - "Rural"	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Highway (HWY)	Directly connected impervious	1.34	1.5
	Pervious	See* DevPERV	See* DevPERV
Forest (For)	Directly connected impervious	1.52	1.7
	Pervious	0.13	0.13
Open Land (Open)	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Agriculture (Ag)	Directly connected impervious	1.52	1.7
	Pervious	0.5	0.5
*Developed Land Pervious (DevPERV) – HSG A	Pervious	0.03	0.03
*Developed Land Pervious (DevPERV) – HSG B	Pervious	0.12	0.13
*Developed Land Pervious (DevPERV) – HSG C	Pervious	0.21	0.24
*Developed Land Pervious (DevPERV) – HSG C/D	Pervious	0.29	0.33
*Developed Land Pervious (DevPERV) – HSG D	Pervious	0.37	0.41

Notes:

- For pervious areas, if the hydrologic soil group (HSG) is known, use the appropriate value from this table. If the HSG is not known, assume HSG D conditions for the phosphorus load export rate.
- Agriculture includes row crops. Actively managed hay fields and pasture lands. Institutional land uses such as government properties, hospitals and schools are to be included in the commercial and industrial land use grouping for the purpose of calculating phosphorus loading.
- Impervious surfaces within the forest land use category are typically roadways adjacent to forested pervious areas.

Table 2-2: Crosswalk of Mass GIS land use categories to land use groups for P load calculations

Mass GIS Land Use LU_CODE	Description	Land Use group for calculating P Load - 2013/14 MA MS4
1	Crop Land	Agriculture
2	Pasture (active)	Agriculture
3	Forest	Forest
4	Wetland	Forest
5	Mining	Industrial
6	Open Land includes inactive pasture	open land
7	Participation Recreation	open land
8	spectator recreation	open land
9	Water Based Recreation	open land
10	Multi-Family Residential	High Density Residential
11	High Density Residential	High Density Residential
12	Medium Density Residential	Medium Density Residential
13	Low Density Residential	Low Density Residential
14	Saltwater Wetland	Water
15	Commercial	Commercial
16	Industrial	Industrial
17	Urban Open	open land
18	Transportation	Highway
19	Waste Disposal	Industrial
20	Water	Water
23	cranberry bog	Agriculture
24	Powerline	open land
25	Saltwater Sandy Beach	open land
26	Golf Course	Agriculture
29	Marina	Commercial
31	Urban Public	Commercial
34	Cemetery	open land
35	Orchard	Forest
36	Nursery	Agriculture
37	Forested Wetland	Forest
38	Very Low Density residential	Low Density Residential
39	Junkyards	Industrial
40	Brush land/Successional	Forest

(1) Enhanced Sweeping Program: The permittee may earn a phosphorus reduction credit for conducting an enhanced sweeping program of impervious surfaces. Table 2-2 below outlines the default phosphorus removal factors for enhanced sweeping programs. The credit shall be calculated by using the following equation:

$$Credit_{sweeping} = IA_{swept} \times PLE_{IC\text{-}land\ use} \times PRF_{sweeping} \times AF \qquad \textbf{(Equation 2-1)}$$

Where:

$Credit_{sweeping}$ = Amount of phosphorus load removed by enhanced sweeping program (lb/year)

IA_{swept} = Area of impervious surface that is swept under the enhanced sweeping program (acres)

$PLE_{IC\text{-}land\ use}$ = Phosphorus Load Export Rate for impervious cover and specified land use (lb/acre/yr) (see Table 2-1)

$PRF_{sweeping}$ = Phosphorus Reduction Factor for sweeping based on sweeper type and frequency (see Table 2-3).

AF = Annual Frequency of sweeping. For example, if sweeping does not occur in Dec/Jan/Feb, the AF would be 9 mo./12 mo. = 0.75. For year-round sweeping, AF=1.0[1]

As an alternative, the permittee may apply a credible sweeping model of the Watershed and perform continuous simulations reflecting build-up and wash-off of phosphorus using long-term local rainfall data.

Table 2-3: Phosphorus reduction efficiency factors ($PRF_{sweeping}$) for sweeping impervious areas

Frequency[1]	Sweeper Technology	$PRF_{sweeping}$
2/year (spring and fall)[2]	Mechanical Broom	0.01
2/year (spring and fall)[2]	Vacuum Assisted	0.02
2/year (spring and fall)[2]	High-Efficiency Regenerative Air-Vacuum	0.02
Monthly	Mechanical Broom	0.03
Monthly	Vacuum Assisted	0.04
Monthly	High Efficiency Regenerative Air-Vacuum	0.08
Weekly	Mechanical Broom	0.05
Weekly	Vacuum Assisted	0.08
Weekly	High Efficiency Regenerative Air-Vacuum	0.10

[1]For full credit for monthly and weekly frequency, sweeping must be conducted year round. Otherwise, the credit should be adjusted proportionally based on the duration of the sweeping season (using AF factor).

[2] In order to earn credit for semi-annual sweeping the sweeping must occur in the spring following snow-melt and road sand applications to impervious surfaces and in the fall after leaf-fall and prior to the onset to the snow season.

Example 2-1: Calculation of enhanced sweeping program credit (Credit $_{sweeping}$): A permittee proposes to implement an enhanced sweeping program and perform weekly sweeping from March 1 – December 1 (9 months) in their Watershed, using a vacuum assisted sweeper on 20.3 acres of parking lots and roadways in a high-density residential area of the Watershed. For this site the needed information is:

IA_{swept}	= 20.3 acres
$PLE_{IC\text{-}HDR}$	= 2.3 lb/acre/yr (from Table 2-1)
$PRF_{sweeping}$	= 0.08 (from Table 2-2)
AF	= (9 months / 12 months) = 0.75

Substitution into equation 2-1 yields a $Credit_{sweeping}$ of 3.2 pounds of phosphorus removed per year.

$Credit_{sweeping}$ = IA_{swept} x $PLE_{land\ use}$ x $PRF_{sweeping}$ x AF
= 20.30 acres x 2.3 lbs/acre/yr x 0.08 x 0.75
= 2.8 lbs/yr

(2) Catch Basin Cleaning: The permittee may earn a phosphorus reduction credit, $Credit_{CB}$, by removing accumulated materials from catch basins (i.e., catch basin cleaning) in the Watershed such that a minimum sump storage capacity of 50% is maintained throughout the year. The credit shall be calculated by using the following equation:

$$Credit_{CB} = IA_{CB} \times PLE_{IC\text{-}land\ use} \times PRF_{CB} \quad \textbf{(Equation 2-2)}$$

Where:

$Credit_{CB}$	=	Amount of phosphorus load removed by catch basin cleaning (lb/year)
IA_{CB}	=	Impervious drainage area to catch basins (acres)
$PLE_{IC\text{-}and\ use}$	=	Phosphorus Load Export Rate for impervious cover and specified land use (lb/acre/yr) (see Table 2-1)
PRF_{CB}	=	Phosphorus Reduction Factor for catch basin cleaning (see Table 2-4)

Table 2-4: Phosphorus reduction efficiency factor (PRF_{CB}) for semi-annual catch basin cleaning

Frequency	Practice	PRF_{CB}
Semi-annual	Catch Basin Cleaning	0.02

Example 2-2: Calculation for catch basin cleaning credit (Credit $_{CB}$):
A permittee proposes to clean catch basins in their Watershed (i.e., remove accumulated sediments and contaminants captured in the catch basins) that drain runoff from 15.3 acres of medium-density residential impervious area. For this site the needed information is:

IA_{CB}	= 15.3 acre
$PLE_{IC\text{-}MDR}$	= 2.0 lbs/acre/yr (from Table 2-1)
PRF_{CB}	= 0.02 (from Table 2-4)

Substitution into equation 2-2 yields a Credit $_{CB}$ of 0.6 pounds of phosphorus removed per year:

Credit $_{CB}$	= IA_{CB} x $PLE_{IC\text{-}MDR}$ x PRF_{CB}
	= 15.3 acre x 2.0 lbs/acre/yr x 0.02
	= 0.6 lbs/yr

(3) No Application of Fertilizers Containing Phosphorus: If within the permittees regulated area there has been historical and regular use of fertilizer containing phosphorus, the permittee may earn a phosphorus reduction credit (Credit $_{fertilizer}$) by effectively ending the use of fertilizers that contain phosphorus to managed and landscaped pervious areas (lawn areas) from which runoff discharges to the TMDL waterbody or its tributaries. The application of any fertilizers containing phosphorus at any time during the reporting year within the permittee's regulated area shall preclude the permittee from earning this credit for the reporting year. The permittee must provide written certification to EPA annually that no fertilizers containing phosphorus have been applied to any area in the Watershed in order to earn the credit. The Credit $_{fertilizer}$ (in lb/year) shall be determined using the following equation:

$$\text{Credit}_{fertilizer} = WPLER * 0.5 * \sum^{LU}(Area_{LU} * Lawn\%_{LU} * FF) \qquad \textbf{(Equation 2-3)}$$

Where:

WPLER[3]	= Weighted Phosphorus Load Export Rate (lb/ac/yr) for the municipality, based on the distribution of hydrologic soil groups in the municipality.
0.5	= Phosphorus reduction factor: based on available data, EPA expects that phosphorus concentrations in runoff from landscaped pervious areas will be reduced by 50% when phosphorus is removed from fertilizers.
$Area_{LU}$	= total area (acres) for each of 10 relevant land uses identified by EPA (see example calculation) within the municipality; default values for each town determined by EPA using Mass GIS data.
$Lawn\%_{LU}$	= lawn area percentage (decimal form) for each of the 10 relevant land uses; default values provided by EPA through analysis of Mass GIS data

[3] Lawn phosphorus export rates were calculated using the same modelling approach as the export rates in Table 2-1, but with more specific grassy area land use data.

FF = Fertilization factor = 0.5 for EPA default values; the percentage of lawn area currently receiving P fertilizer applications (decimal form).

Example 2-3: Calculation for P-free fertilizer credit (Credit $_{fertilizer}$):

A permittee is planning to adopt the upcoming Massachusetts phosphorus fertilizer ban within their regulated area under the MS4. EPA has provided the town with a WPLER of 0.181 lb/acre/yr based on soil types in the area. Through a survey, the town determines that approximately 60% of lawns are fertilized in town. The town determines the total areas for each of the 10 land uses[4] in the regulated area through a spatial analysis and uses default EPA lawn percentages for each land use.

So: WPLER = 0.181 lb/ac/yr FF = 60% = 0.6

These values are shown in the table on the next page. For each land use, the total area and the lawn percentage are multiplied to get the lawn area for each land use; the fertilization factor is multiplied in; these values are added up for each land use in the last column to get the total fertilized lawn area in the permittee's regulate area.

Land use (LU)	$Area_{LU}$ (acre)	Lawn % (as decimal)	FF	$Area_{LU}$ x Lawn % x FF
Low Density Residential	180	0.25	0.6	27.0
Medium Density Residential	259	0.20	0.6	31.1
Participation Recreation	23	0.42	0.6	5.8
Golf Courses	25	0.62	0.6	9.3
Public/Institutional Lands	51	0.19	0.6	5.9
Very Low Density Residential	27	0.16	0.6	2.6
Multi-Family Residential	40	0.19	0.6	4.5
High Density Residential	13	0.05	0.6	0.4
Commercial	34	0.01	0.6	0.2
Industrial	123	0.01	0.6	0.7
				87.5

= total fertilized lawn area (acres)

Then, the credits are determined by Equation 2-3:

$$Credit_{fertilizer} = WPLER * 0.5 * \sum^{LU}(Area_{LU} * Lawn\%_{LU} * FF)$$

Where WPLER has been calculated for the municipality by EPA (0.181 lb/ac/yr) and the sum expression (Σ) is equal to the total fertilized lawn area (calculated above as 87.5 ac). Substitution of these values into Equation 2-3 yields the total fertilizer credits:

Credit $_{fertilizer}$ = 0.181 lb/ac/yr * 0.5 * 87.5 acres
= **7.9 lb/yr**

[4] Not all 10 land uses may be present within the regulated area within each community. Land uses not represented within the regulated area should have 0 acre for the $Area_{LU}$ in the calculation table (next page).

NOTE: For permittees within the Charles River Watershed, EPA has calculated default fertilizer reduction credits using spatial data for the regulated areas within these municipalities and the default lawn percentages shown above. Permittees may choose to use the default EPA credits or may use the EPA-calculated WPLERs, along with site-specific information about land uses and fertilizer use, to calculate $Credit_{fertilizer}$ using the method described above. The calculated WPLERs for the permittees, as well as the calculated default fertilizer credits, are provided in Table 2-5 on the next page.

Table 2-5: Calculated weighted export rates and fertilizer credits for Charles River Watershed small MS4 permittees

Town	WPLER (lb/acre/yr)	$Credit_{fertilizer}$ (lb/yr)	Town	WPLER (lb/acre/yr)	$Credit_{fertilizer}$ (lb/yr)
Arlington	0.261	1.2	**Mendon**	0.119	0.3
Ashland	0.207	1.7	**Milford**	0.205	34.0
Bellingham	0.152	10.8	**Millis**	0.130	16.0
Belmont	0.227	8.0	**Natick**	0.240	37.6
Brookline	0.273	53.9	**Needham**	0.221	44.8
Cambridge	0.261	9.0	**Newton**	0.252	113.1
Dedham	0.290	23.7	**Norfolk**	0.096	15.8
Dover	0.216	16.7	**Sherborn**	0.162	13.3
Foxborough	0.139	0.1	**Somerville**	0.291	8.2
Franklin	0.236	58.8	**Walpole**	0.156	3.7
Holliston	0.164	33.2	**Waltham**	0.255	45.4
Hopedale	0.162	2.0	**Watertown**	0.283	21.1
Hopkinton	0.136	9.5	**Wayland**	0.209	1.4
Lexington	0.206	16.3	**Wellesley**	0.220	56.7
Lincoln	0.238	9.9	**Weston**	0.159	40.9
Medfield	0.148	21.6	**Westwood**	0.248	18.8
Medway	0.159	28.8	**Wrentham**	0.076	6.0

(4) Enhanced Organic Waste and Leaf Litter Collection program: The permittee may earn a phosphorus reduction credit by performing regular gathering, removal and disposal of landscaping wastes, organic debris, and leaf litter from impervious surfaces from which runoff discharges to the TMDL waterbody or its tributaries. In order to earn this credit ($Credit_{leaf\ litter}$), the permittee must gather and remove all landscaping wastes, organic debris, and leaf litter from all impervious roadways and parking lots at least once per week during the period of September 1 to December 1 of each year. The gathering and removal shall occur immediately following any landscaping activities in the Watershed and at additional times when necessary to achieve a weekly cleaning frequency. The permittee must ensure that the disposal of these materials will not contribute pollutants to any surface water discharges. The permittee may use an enhanced sweeping program (e.g., weekly frequency) as part of earning this credit provided that the sweeping is effective at removing leaf litter and organic materials. The $Credit_{leaf\ litter}$ shall be determined by the following equation:

Credit $_{\text{leaf litter}}$ = (Watershed Area) x (PLE $_{\text{IC-land use}}$) x (0.05) **(Equation 2-4)**

Where:

Credit $_{\text{leaf litter}}$ = Amount of phosphorus load reduction credit for organic waste and leaf litter collection program (lb/year)

Watershed Area = All impervious area (acre) from which runoff discharges to the TMDL waterbody or its tributaries in the Watershed

PLE $_{\text{IC-land use}}$ = Phosphorus Load Export Rate for impervious cover and specified land use (lbs/acre/yr) (see Table 2-1)

0.05 = 5% phosphorus reduction factor for organic waste and leaf litter collection program in the Watershed

Example 2-4: Calculation for organic waste and leaf litter collection program credit (Credit $_{\text{leaf litter}}$): A permittee proposes to implement an organic waste and leaf litter collection program by sweeping the parking lots and access drives at a minimum of once per week using a mechanical broom sweeper for the period of September 1 to December 1 over 12.5 acres of impervious roadways and parking lots in an industrial/commercial area of the Watershed. Also, the permittee will ensure that organic materials are removed from impervious areas immediately following all landscaping activities at the site. For this site the needed information to calculate the Credit $_{\text{leaf litter}}$ is:

Watershed Area = 12.5; and

PLE $_{\text{IC-commercial}}$ = 1.8 lbs/acre/yr (from Table 2-1)

Substitution into equation 2-4 yields a Credit $_{\text{leaf litter}}$ of 1.1 pounds of phosphorus removed per year:

Credit $_{\text{leaf litter}}$ = (12.5 acre) x (1.8 lbs/acre/yr) x (0.05)
= 1.1 lbs/yr

The permittee also may earn a phosphorus reduction credit for enhanced sweeping of roads and parking lot areas (i.e., Credit $_{\text{sweeping}}$) for the three months of use. Using equation 2-1, Credit $_{\text{sweeping}}$ is:

Credit $_{\text{sweeping}}$ = IA $_{\text{swept}}$ x PLE $_{\text{IC-land use}}$ x PRF $_{\text{sweeping}}$ x AF **(Equation 2-1)**

IA $_{\text{swept}}$ = 12.5 acre

PLE $_{\text{IC-commercial}}$ = 1.8 lbs/acre/yr (from Table 2-1)

PRF $_{\text{sweeping}}$ = 0.05 (from Table 2-2)

AF = 3 mo./12 mo. = 0.25

Substitution into equation 2-1 yields a Credit $_{\text{sweeping}}$ of 0.28 pounds of phosphorus removed per year.

Credit $_{\text{sweeping}}$ = IA $_{\text{swept}}$ x PLE $_{\text{IC-commercial}}$ x PRF $_{\text{sweeping}}$ x AF
= 12.5 acre x 1.8 lbs/acre/yr x 0.05 x 0.25
= 0.28 lbs/yr