MEMORANDUM

Date: 04/22/2014

To: Permit File for Draft Small Massachusetts MS4 General Permit

From: Mark Voorhees, Office of Ecosystem Protection

cc: Thelma Murphy, David Webster, Newton Tedder, David Gray, Suzanne Warner and Andrea Traviglia

Subject: Overview of Methodology to Calculate Baseline Stormwater Phosphorus Loads and Phosphorus Load Reduction Requirements for Charles River Watershed – Draft MA MS4 Permit

The following is an overview of the steps taken to calculate baseline stormwater (SW) phosphorus loads (P loads) and P load reduction requirements for Charles River Watershed Communities, Mass DOT properties, and DCR properties within the Charles River watershed for use in the Draft MA MS4 Permit.

1. GIS data layers were compiled for the Charles River watershed (CRW) to quantify the areal extent of several watershed attributes such as land use, hydrologic soil group, impervious area, urban area, and ownership by Mass DOT or DCR for each municipality within: 1) the entire Charles River Watershed; 2) the Upper Charles watershed upstream of Watertown Dam; and 3) the Lower Charles Watershed downstream of the Watertown Dam. Watershed attributes were determined for Mass DOT and DCR properties within each CRW community so that baseline P loads and reductions could be appropriately apportioned to each municipality, Mass DOT and DCR. Measured areas for the following watershed attributes were determined for each community within the CRW:
    a. Land Use Groups – (40 Mass GIS land use category IDs (2005) were first aggregated into the following 10 land use groups (see Attachment A for details)):
        i. Commercial;
        ii. Industrial;
        iii. High Density Residential;
        iv. Medium Density Residential;
        v. Low Density Residential;
        vi. Highway;
        vii. Open Land;
        viii. Forest;
        ix. Agriculture; and
        x. Water
    b. Total Impervious Area (TIA) by Land Use Group;
    c. Hydrological Soil Groups (HSGs) by Land Use Group:
        i. HSG A;
        ii. HSG B;
        iii. HSG C;
        iv. HSG C/D;
        v. HSG D; and

        vi. Undefined
    d. Urban Area as defined for MS4 permitting; and
    e. Combined Sewer Area
2. Compiled critical information from the two Charles River watershed phosphorus TMDLs, *Final Total Maximum Daily Load for Nutrients in the Lower Charles River Basin, Massachusetts*. (MassDEP and EPA. 2007) http://www.mass.gov/eea/docs/dep/water/resources/a-thru-m/charlesp.pdf and *Total Maximum Daily Load for Nutrients in the Upper/Middle Charles River, Massachusetts*(CRWA and NES for MassDEP, 2011) http://www.mass.gov/eea/docs/dep/water/resources/n-thru-y/ucharles.pdf
   Information taken directly from the TMDL reports includes:
    a. Waste Load Allocations (percent reductions);
    b. Quantification of water quality processes; and
    c. Quantification of phosphorus loads.
3. Calculated Directly Connected Impervious Area (DCIA) percentages using total impervious area (TIA) and applicable Sutherland equations for each aggregate land use group in each community. DCIA percentages were calculated individually for municipal-only (defined as the community area within the CRW less the area of Mass DOT and DCR properties); and Mass DOT and DCR properties within the Charles River watershed (see Attachment B). All combined sewer area were excluded from the analysis;
4. Calculated average annual composite phosphorus load export rates (PLERs) for each aggregated land use group in each CRW community based on the distribution of impervious area and pervious area (as defined by HSG). Land use based composite PLERs were calculated for: 1) municipal-only area; 2) Mass DOT property; and 3) DCR property within the CRW.

   Land use based composite PLERs are calculated weighted averages using land use based distinct PLERs for DCIA and pervious areas (PA) by HSG and the distribution of impervious area and PA by HSG for each land use group within each community. The distinct PLERs used to calculate the base line load are provided in Attachment C. The derivation of the distinct PLERs is described in a separate Memorandum dated April 22, 2014 with the subject heading*: Annual Average Phosphorus Load Export Rates (PLERs) for Use in Fulfilling Phosphorus Load Reduction Requirements in EPA Region 1 Stormwater Permits* ("PLER Memo"). The distinct PLERs for DCIA were taken directly from the PLER Memo, while the distinct PLERs for PA by HSG were calculated as part of the process to estimate baseline P loads for the CRW. These distinct PA PLERs used to calculate baseline P loads differ from those presented in the PLER Memo as follows:
   - For baseline P loads, **developed land** PA PLERs (commercial, industrial, all residential, open land and highway) reflect P loading rates associated with phosphorus fertilizer use, while the distinct PA rates provided in the PLER Memo reflect lower P load conditions expected to occur following adoption of MA's upcoming phosphorus free fertilizer regulations;
   - For baseline P loads, **forested** PA PLERs reflects both P loads from runoff and dry weather baseflow from the entire watershed while the single distinct PA PLER for forested land in the PLER Memo represents primarily runoff. Additionally, distinct PA PLERs for forested land were calculated for each HSG to calculate baseline loads, while only one PA PLER is provided in the PLER Memo; and

- For baseline P loads, **agriculture** PA PLERs were calculated for each PA HSG while only one average PA PLER is presented in the PLER Memo.

In all cases for the CRW, PA PLERs for baseline P loads were calculated by multiplying hydrologic model derived average annual runoff yields by representative annual mean TP concentrations. Table 1 summarizes the annual mean TP concentrations used for calculating PA PLERs to estimate baseline P loads for the CRW.

Table 1: Representative Annual Mean Phosphorus Concentrations used to Calculate Distinct Pervious Area Phosphorus Load Export Rates

Pervious Area (PA) PLER Category	Applicable Land Use Groups	Representative Annual Mean TP Concentration	Comments on Methodology
Developed Land	Commercial, Industrial, All Residential, Open Land & Highway	0.3 mg/L for runoff	Runoff yields derived from SWMM and P8 - Curve Number continuous simulation HRU modeling with assumed TP concentration of 0.3 mg/L for pervious runoff from developed lands. TP of 0.3 mg/L is based on TB-9 (CSN, 2011), and other PLER literature and assumes 50% of pervious developed lands receive P fertilization
Forest	Forest	0.1 mg/L for runoff 0.015 mg/L for baseflow	Runoff yields derived from P8 - Curve Number continuous simulation HRU modeling with assumed TP concentration of 0.1 mg/L for pervious runoff from forested lands. Baseflow volume determined from USGS study of Lower Charles River (Breault,et al, 2002). Baseflow annual mean concentration of 0.015 mg/L is representative of uncontaminated groundwater inflow.
Agriculture	Agriculture	0.5 mg/L for runoff	Runoff yields derived from SWMM and P8 - Curve Number continuous simulation HRU modeling with assumed TP concentration of 0.5 mg/L for pervious runoff from developed lands. TP of 0.5 mg/L is based on PLER literature.

5. Calculated average annual watershed (i.e., land based) P loads for municipal-only, Mass DOT and DCR properties for each community within the entire CRW. P Loads were calculated by multiplying the areas of land use groups by the corresponding land use based composite PLERs calculated for each community. Community specific P loads were estimated each for: 1) municipal-only (i.e., all CRW area less area owned by Mass DOT and DCR); 2) Mass DOT; and 3) DCR using composite PLERs specifically calculated for each ownership group. The P loads were summed and then compared to the reported watershed P loads from the two TMDL reports to evaluate the adequacy of using the calculated PLERs (described above) to estimate baseline watershed P Loads and associated reductions. A comparison of the results provided in Table 2 shows that the estimated SW P load derived by using the calculated composite PLERs agrees well with the TMDL results (percent difference of only 2.3 %).

Table 2: Comparison of Stormwater Phosphorus Loads Estimated using Calculated Composite PLERs with TMDL Reported Results

Watershed	Annual SW/watershed P Load using calculated PLERs, kg/yr	Annual SW/watershed P Load derived from TMDL Reports, kg/yr	Percent Difference
Entire Charles River Watershed	**41,555**	**40,611**	**2.3%**

6. Calculated P load reduction requirements for municipal-only, Mass DOT, and DCR within each community for the entire CRW area. P load reductions were calculated for municipal-only, Mass

DOT and DCR by multiplying the land use based P loads calculated in step 5 by the reduction rates specified in the WLA portions of the TMDL Reports. Different reduction rates apply to the Upper CRW and Lower CRW based on the two TMDL analyses. Table 3 identifies the reduction rates taken from the TMDL reports and used to calculate the total P load reductions for the permit process for the Upper CRW (above Watertown Dam) and the Lower CRW (downstream of Watertown Dam).

As indicated above in step number 4 above, the natural watershed dry-weather baseflow P load was added to the forested land group P load so that the P load estimates and reductions for other land use groups would not include natural dry weather baseflow P load but only SW and illicit P loads. This was done because the reduction rates from the TMDL analyses are intended to apply to the watershed P load excluding the natural baseflow load. For this analysis the natural baseflow P load is added to the forest load since no reductions are being specified for forested lands (i.e., 0% reduction of forest P load).

For those communities that have land area in both the Upper CRW and Lower CRW, P load reductions are equal the sum of the P load reductions calculated for the community's area in each the Upper and Lower CRW. Table 4 provides the baseline watershed P loads, the calculated P load reductions for municipal-only, Mass DOT and DCR for each community in the CRW.

Table 3: TMDL Waste Load Allocation (WLA) P load Reduction Rates applied to Land Use Groups in Upper and Lower Charles River Watersheds

Land Use Group	Upper TMDL WLA % Reduction Rate	Lower TMDL WLA % Reduction Rate
Commercial	65%	62%
Industrial	65%	62%
High Density Residential	65%	62%
Medium Density Residential	65%	62%
Low Density Residential	45%	62%
Highway	65%	62%
Open Space	35%	62%
Agriculture	35%	62%
Forest	0%	0%

7. The WLA percent reduction rates (Table 3) taken from the TMDL reports are intended to apply the total land based watershed P load, which includes the presence of illicit discharges (but excludes WWTFs and CSOs). Therefore, an additional step was taken to estimate the portion of the P load reduction that would be achieved through elimination of illicit discharges (required under the permit). Subtraction of the illicit P load from the total watershed P load reduction is needed to determine the stormwater only P load reduction requirement for the CRW.

   The portion of the land based watershed P load due to the presence of illicit sanitary discharges discharging to the Charles River is estimated to be 10% of the calculated P load from the commercial, industrial, and all residential land use groups. The resulting estimated illicit P load is 3,009 kg/yr, or approximately 7% of the total estimated land based watershed P load to the Charles River (41,555 kg/yr). In other terms, the illicit P load estimate is 0.7% of the estimated total sanitary sewage P load (434,000 kg/yr) generated by the resident population (801,301) in the CRW. The illicit P load estimate is based partially on the magnitude of illicit loads that have

been already identified and eliminated from communities within the CRW. For this permit and for the associated stormwater P load reduction calculations, the illicit P load value should be considered a default value that will be re-evaluated and refined, if needed, in future permit re-issuances. Communities will be required to track and report illicit P load reductions over the course of each permit term so that EPA can make needed adjustments to the baseline P loads subject to reduction requirements in future permit issuances.

Table 4: Watershed Phosphorus Load Reductions by Community for Municipal Only, MassDOT and DCR in the Entire CRW

Municipal Only Annual Phosphorus Load Reduction by Community, Entire Charles Watershed (excludes reductions to be achieved by DOT and DCR)				MADOT Annual Stormwater Phosphorus Load Reduction by Community, Entire Charles Watershed				DCR Annual Stormwater Phosphorus Load Reduction by Community, Entire Charles Watershed			
Community	Baseline Watershed Phosphorus Load, kg/yr	Required Watershed P load reduction, kg/yr	Required Percent Reduction in Stormwater only Phosphorus Load (%)	Community	Baseline Stormwater Phosphorus Load, kg/yr	Required Stormwater P load reduction , kg/yr	Required Percent Reduction in Phosphorus Load (%)	Community	Baseline Stormwater Phosphorus Load, kg/yr	Required Stormwater P load reduction, kg/yr	Required Percent Reduction in Phosphorus Load (%)
Arlington	110.8	71.0	64.1%	Arlington	0.8	0.5	64.6%	Arlington	9.7	6.2	64.2%
Ashland	67.4	28.2	41.8%	Ashland	0.3	0.0	9.4%	Ashland	0.0	0.0	0.0%
Bellingham	957.9	404.5	42.2%	Bellingham	48.3	27.9	57.7%	Bellingham	0.0	0.0	0.0%
Belmont	208.1	109.2	52.5%	Belmont	3.2	2.1	64.9%	Belmont	5.5	1.5	27.7%
Boston	7053.2	4247.1	60.2%	Boston	0.7	0.4	60.2%	Boston	0.3	0.2	53.7%
Brookline	1695.0	1004.6	59.3%	Brookline	29.4	17.1	57.9%	Brookline	19.9	8.5	42.7%
Cambridge	522.9	324.2	62.0%	Cambridge	18.1	11.2	62.0%	Cambridge	15.5	9.2	59.2%
Dedham	835.6	422.4	50.5%	Dedham	67.2	37.0	55.1%	Dedham	73.3	15.0	20.4%
Dover	832.8	180.1	21.6%	Dover	0.1	0.0	52.8%	Dover	34.7	6.8	19.6%
Foxborough	1.6	0.4	23.2%	Foxborough	0.2	0.1	44.5%	Foxborough	0.0	0.0	0.0%
Franklin	2366.9	1024.3	43.3%	Franklin	89.1	51.1	57.3%	Franklin	57.8	1.2	2.1%
Holliston	1554.6	502.5	32.3%	Holliston	18.0	7.4	41.4%	Holliston	0.0	0.0	0.0%
Hopedale	107.4	46.9	43.6%	Hopedale	6.2	3.6	58.1%	Hopedale	0.0	0.0	0.0%
Hopkinton	292.7	89.4	30.6%	Hopkinton	8.7	4.7	53.8%	Hopkinton	0.0	0.0	0.0%
Lexington	549.7	253.4	46.1%	Lexington	106.4	62.8	59.0%	Lexington	5.5	1.4	24.9%
Lincoln	594.7	127.9	21.5%	Lincoln	0.2	0.1	33.7%	Lincoln	0.0	0.0	0.0%
Medfield	966.5	351.4	36.4%	Medfield	0.3	0.1	37.8%	Medfield	19.4	1.3	6.5%
Medway	1065.9	402.2	37.7%	Medway	1.8	1.0	55.7%	Medway	0.0	0.0	0.0%
Mendon	28.8	11.5	39.9%	Mendon	3.5	1.6	47.0%	Mendon	0.0	0.0	0.0%
Milford	1653.9	836.3	50.6%	Milford	75.6	43.2	57.1%	Milford	0.6	0.2	32.9%
Millis	972.5	302.9	31.2%	Millis	0.2	0.0	12.6%	Millis	0.0	0.0	0.0%
Natick	1147.8	508.6	44.3%	Natick	25.3	15.1	59.6%	Natick	0.2	0.1	51.1%
Needham	1828.9	1009.5	55.2%	Needham	70.9	41.9	59.1%	Needham	41.9	1.6	3.9%
Newton	4067.1	2478.2	60.9%	Newton	130.0	81.4	62.6%	Newton	37.2	9.4	25.4%
Norfolk	1005.7	286.6	28.5%	Norfolk	3.8	0.9	23.7%	Norfolk	10.9	0.3	2.6%
Somerville	652.9	404.8	62.0%	Somerville	17.7	11.0	62.0%	Somerville	0.3	0.2	62.0%
Sherborn	847.7	156.6	18.5%	Sherborn	0.0	0.0	13.5%	Sherborn	0.0	0.0	0.0%
Walpole	159.0	37.5	23.6%	Walpole	2.9	0.9	31.9%	Walpole	0.0	0.0	0.0%
Waltham	2985.0	1806.5	60.5%	Waltham	74.5	45.4	60.9%	Waltham	43.3	16.2	37.4%
Watertown	1163.9	725.8	62.4%	Watertown	7.3	4.5	61.2%	Watertown	21.5	11.6	53.8%
Wayland	47.7	20.2	42.4%	Wayland	10.1	6.1	60.8%	Wayland	0.0	0.0	33.3%
Wellesley	1506.5	868.5	57.6%	Wellesley	64.7	36.8	56.9%	Wellesley	8.7	1.9	22.3%
Weston	1192.6	383.4	32.1%	Weston	114.2	65.7	57.6%	Weston	14.0	3.5	24.8%
Westwood	394.6	160.4	40.7%	Westwood	18.9	10.7	56.6%	Westwood	0.3	0.2	59.2%
Wrentham	619.7	211.1	34.1%	Wrentham	46.0	23.2	50.4%	Wrentham	12.0	0.2	1.6%
Totals	40058.1	19798.1	49.4%	Totals	1064.8	615.6	57.8%	Totals	432.5	96.6	22.3%

8. Calculated stormwater P load reduction requirements for municipal-only, Mass DOT and DCR for each community by taking into account the expected reductions from illicit discharge elimination work. First, the total stormwater P load reduction for the CRW is determined by subtracting the illicit P load from the total watershed P load reduction determined in step 6 (see Table 4):

$$20{,}510 \text{ kg/yr} - 3{,}009 \text{ kg/yr} = 17{,}501 \text{ kg/yr}$$

(Total watershed P Load Reduction − Illicit P Load = Stormwater P Load Reduction)

Next, watershed load reductions calculated in step 6 for municipal-only in each community were reduced by the illicit load calculated for that community. The illicit load calculated for each community equals 10% of the P load generated by commercial, industrial and residential land

area within the CRW portion of the community. No adjustments were made to the P load reduction requirements for MassDOT and DCR (step 6) because it is assumed that the municipality's IDDE program will be the means for achieving the illicit load reductions.

While community specific illicit P loads were calculated to determine initial permit stormwater P load reduction requirements for each community, the communities should not view the calculated illicit load reductions as their own credits but as watershed-wide credits. If implementation of IDDE programs should result in illicit P load reduction greater than 3,009 kg/yr, then the resulting reduced stormwater P load reduction requirement (to be calculated by EPA in future permits) would be shared by all communities. Similarly, if the IDDE programs ultimately achieve less than the 3,009 kg/yr illicit load reduction, then the resulting increased stormwater P load reduction be needed would also be shared by all communities. This approach prevents any community that may have a disproportionally large amount of illicit P load from not doing its fair share of SW P load reduction work.

Table 5 provides the proposed SW P load reduction requirements for municipal-only, Mass DOT and DCR for each community assuming that all CRW area is managed.

Table 5: Stormwater Only Phosphorus Load Reduction Requirements by Community for Municipal Only, MassDOT and DCR, Entire CRW

MUNICIPAL ONLY Annual Phosphorus Load Reduction by Community, Entire Charles Watershed (excludes illicits and reductions to be achieved by DOT and DCR)				MADOT Annual Stormwater Phosphorus Load Reduction by Community, Entire Charles Watershed				DCR Annual Stormwater Phosphorus Load Reduction by Community, Entire Charles Watershed			
Community	Baseline Phosphorus Load, kg/yr	Required Stormwater P load reduction , kg/yr	Required Percent Reduction in Stormwater only Phosphorus Load (%)	Community	Baseline Stormwater Phosphorus Load, kg/yr	Required Stormwater P load reduction , kg/yr	Required Percent Reduction in Phosphorus Load (%)	Community	Baseline Stormwater Phosphorus Load, kg/yr	Required Stormwater P load reduction, kg/yr	Required Percent Reduction in Phosphorus Load (%)
Arlington	110.8	59.9	54.0%	Arlington	0.8	0.5	64.6%	Arlington	9.7	6.2	64.2%
Ashland	67.4	23.9	35.5%	Ashland	0.3	0.0	9.4%	Ashland	0.0	0.0	0.0%
Bellingham	957.9	344.3	35.9%	Bellingham	48.3	27.9	57.7%	Bellingham	0.0	0.0	0.0%
Belmont	208.1	93.9	45.1%	Belmont	3.2	2.1	64.9%	Belmont	5.5	1.5	27.7%
Boston	7053.2	3632.8	51.5%	Boston	0.7	0.4	60.2%	Boston	0.3	0.2	53.7%
Brookline	1695.0	853.0	50.3%	Brookline	29.4	17.1	57.9%	Brookline	19.9	8.5	42.7%
Cambridge	522.9	273.5	52.3%	Cambridge	18.1	11.2	62.0%	Cambridge	15.5	9.2	59.2%
Dedham	835.6	354.9	42.5%	Dedham	67.2	37.0	55.1%	Dedham	73.3	15.0	20.4%
Dover	832.8	150.5	18.1%	Dover	0.1	0.0	52.8%	Dover	34.7	6.8	19.6%
Foxborough	1.6	0.3	16.5%	Foxborough	0.2	0.1	44.5%	Foxborough	0.0	0.0	0.0%
Franklin	2366.9	868.8	36.7%	Franklin	89.1	51.1	57.3%	Franklin	57.8	1.2	2.1%
Holliston	1554.6	423.7	27.3%	Holliston	18.0	7.4	41.4%	Holliston	0.0	0.0	0.0%
Hopedale	107.4	38.8	36.1%	Hopedale	6.2	3.6	58.1%	Hopedale	0.0	0.0	0.0%
Hopkinton	292.7	72.7	24.8%	Hopkinton	8.7	4.7	53.8%	Hopkinton	0.0	0.0	0.0%
Lexington	549.7	213.6	38.9%	Lexington	106.4	62.8	59.0%	Lexington	5.5	1.4	24.9%
Lincoln	594.7	109.2	18.4%	Lincoln	0.2	0.1	33.7%	Lincoln	0.0	0.0	0.0%
Medfield	966.5	297.0	30.7%	Medfield	0.3	0.1	37.8%	Medfield	19.4	1.3	6.5%
Medway	1065.9	337.3	31.6%	Medway	1.8	1.0	55.7%	Medway	0.0	0.0	0.0%
Mendon	28.8	9.5	32.9%	Mendon	3.5	1.6	47.0%	Mendon	0.0	0.0	0.0%
Milford	1653.9	708.3	42.8%	Milford	75.6	43.2	57.1%	Milford	0.6	0.2	32.9%
Millis	972.5	261.2	26.9%	Millis	0.2	0.0	12.6%	Millis	0.0	0.0	0.0%
Natick	1147.8	428.8	37.4%	Natick	25.3	15.1	59.6%	Natick	0.2	0.1	51.1%
Needham	1828.9	852.3	46.6%	Needham	70.9	41.9	59.1%	Needham	41.9	1.6	3.9%
Newton	4067.1	2100.3	51.6%	Newton	130.0	81.4	62.6%	Newton	37.2	9.4	25.4%
Norfolk	1005.7	244.4	24.3%	Norfolk	3.8	0.9	23.7%	Norfolk	10.9	0.3	2.6%
Somerville	652.9	344.9	52.8%	Somerville	17.7	11.0	62.0%	Somerville	0.3	0.2	62.0%
Sherborn	847.7	136.0	16.0%	Sherborn	0.0	0.0	13.5%	Sherborn	0.0	0.0	0.0%
Walpole	159.0	31.0	19.5%	Walpole	2.9	0.9	31.9%	Walpole	0.0	0.0	0.0%
Waltham	2985.0	1531.2	51.3%	Waltham	74.5	45.4	60.9%	Waltham	43.3	16.2	37.4%
Watertown	1163.9	613.3	52.7%	Watertown	7.3	4.5	61.2%	Watertown	21.5	11.6	53.8%
Wayland	47.7	17.0	35.7%	Wayland	10.1	6.1	60.8%	Wayland	0.0	0.0	33.3%
Wellesley	1506.5	734.1	48.7%	Wellesley	64.7	36.8	56.9%	Wellesley	8.7	1.9	22.3%
Weston	1192.6	318.3	26.7%	Weston	114.2	65.7	57.6%	Weston	14.0	3.5	24.8%
Westwood	394.6	134.3	34.0%	Westwood	18.9	10.7	56.6%	Westwood	0.3	0.2	59.2%
Wrentham	619.7	176.7	28.5%	Wrentham	46.0	23.2	50.4%	Wrentham	12.0	0.2	1.6%
Totals	40058.1	16789.4	41.9%	Totals	1064.8	615.6	57.8%	Totals	432.5	96.6	22.3%

9. Calculated SW P load reduction requirements for designated Urban Area (UA) within each CRW community. UA is defined by the 2010 census and is used to define the minimum required jurisdictional area for MS4 permittees. UA was determined through a GIS analyses and represents a subset of areas used in the above discussed analysis. The same approach as described above in step numbers 6, 7 and 8 was used to calculate the stormwater P load reduction requirements for municipal-only, Mass DOT and DCR in each community. Table 6 presents the Urban Area stormwater only P load reduction requirements by community for municipal only, Mass DOT and DCR.

Table 6: Phosphorus Load Reduction Requirements for Urban Area of CRW Communities, Mass DOT and DCR

MUNICIPAL ONLY Annual Phosphorus Load Reduction by Community, Entire Charles Watershed (excludes illicits and reductions to be achieved by DOT and DCR)				MADOT Annual Stormwater Phosphorus Load Reduction by Community, Entire Charles Watershed				DCR Annual Stormwater Phosphorus Load Reduction by Community, Entire Charles Watershed			
Community	Baseline Watershed Phosphorus Load, kg/yr	Required Stormwater P load reduction , kg/yr	Required Percent Reduction in Stormwater only Phosphorus Load (%)	Community	Baseline Stormwater Phosphorus Load, kg/yr	Required Stormwater P load reduction , kg/yr	Required Percent Reduction in Phosphorus Load (%)	Community	Baseline Stormwater Phosphorus Load, kg/yr	Required Stormwater P load reduction, kg/yr	Required Percent Reduction in Phosphorus Load (%)
Arlington	110.8	59.9	54.0%	Arlington	0.8	0.5	64.6%	Arlington	9.7	6.2	64.2%
Ashland	67.4	23.9	35.5%	Ashland	0.3	0.0	9.4%	Ashland	0.0	0.0	0.0%
Bellingham	812.0	303.8	37.4%	Bellingham	48.3	27.9	57.7%	Bellingham	0.0	0.0	0.0%
Belmont	208.1	93.9	45.1%	Belmont	3.2	2.1	64.9%	Belmont	5.5	1.5	27.7%
Boston	7053.2	3632.8	51.5%	Boston	0.7	0.4	60.2%	Boston	0.3	0.2	53.7%
Brookline	1695.0	853.0	50.3%	Brookline	29.4	17.1	57.9%	Brookline	19.9	8.5	42.7%
Cambridge	522.9	273.5	52.3%	Cambridge	18.1	11.2	62.0%	Cambridge	15.5	9.2	59.2%
Dedham	835.6	354.9	42.5%	Dedham	67.2	37.0	55.1%	Dedham	73.3	15.0	20.4%
Dover	282.2	66.5	23.6%	Dover	0.1	0.0	52.8%	Dover	15.5	4.5	28.9%
Foxborough	1.6	0.3	16.5%	Foxborough	0.2	0.1	44.5%	Foxborough	0.0	0.0	0.0%
Franklin	2334.4	864.4	37.0%	Franklin	89.1	51.1	57.3%	Franklin	52.2	1.2	2.3%
Holliston	1369.5	397.6	29.0%	Holliston	18.0	7.4	41.4%	Holliston	0.0	0.0	0.0%
Hopedale	107.3	38.7	36.1%	Hopedale	6.2	3.6	58.1%	Hopedale	0.0	0.0	0.0%
Hopkinton	279.9	71.9	25.7%	Hopkinton	8.7	4.7	53.9%	Hopkinton	0.0	0.0	0.0%
Lexington	544.4	212.3	39.0%	Lexington	106.4	62.8	59.0%	Lexington	5.5	1.4	24.9%
Lincoln	366.9	70.6	19.2%	Lincoln	0.2	0.1	33.7%	Lincoln	0.0	0.0	0.0%
Medfield	838.0	288.8	34.5%	Medfield	0.3	0.1	39.1%	Medfield	19.3	1.3	6.6%
Medway	1040.1	328.2	31.6%	Medway	1.8	1.0	55.7%	Medway	0.0	0.0	0.0%
Mendon	10.4	4.7	44.9%	Mendon	3.1	1.4	45.2%	Mendon	0.0	0.0	0.0%
Milford	1528.4	698.4	45.7%	Milford	68.0	39.9	58.7%	Milford	0.6	0.2	32.9%
Millis	502.9	171.4	34.1%	Millis	0.1	0.0	15.6%	Millis	0.0	0.0	0.0%
Natick	1032.4	401.6	38.9%	Natick	25.3	15.1	59.6%	Natick	0.2	0.1	51.1%
Needham	1828.1	852.2	46.6%	Needham	70.8	41.9	59.1%	Needham	41.9	1.6	3.9%
Newton	4067.1	2100.3	51.6%	Newton	130.0	81.4	62.6%	Newton	37.2	9.4	25.4%
Norfolk	1002.7	243.8	24.3%	Norfolk	3.8	0.9	23.7%	Norfolk	10.9	0.3	2.6%
Somerville	652.9	344.9	52.8%	Somerville	17.7	11.0	62.0%	Somerville	0.3	0.2	62.0%
Sherborn	203.3	43.0	21.1%	Sherborn	0.0	0.0	#DIV/0!	Sherborn	0.0	0.0	0.0%
Walpole	159.0	31.0	19.5%	Walpole	2.9	0.9	31.9%	Walpole	0.0	0.0	0.0%
Waltham	2985.0	1531.2	51.3%	Waltham	74.5	45.4	60.9%	Waltham	43.3	16.2	37.4%
Watertown	1163.9	613.3	52.7%	Watertown	7.3	4.5	61.2%	Watertown	21.5	11.6	53.8%
Wayland	47.7	17.0	35.7%	Wayland	10.1	6.1	60.8%	Wayland	0.0	0.0	33.3%
Wellesley	1506.5	734.1	48.7%	Wellesley	64.7	36.8	56.9%	Wellesley	8.7	1.9	22.3%
Weston	1192.6	318.3	26.7%	Weston	114.2	65.7	57.6%	Weston	14.0	3.5	24.8%
Westwood	364.1	128.0	35.2%	Westwood	18.9	10.7	56.6%	Westwood	0.3	0.2	59.2%
Wrentham	558.3	164.2	29.4%	Wrentham	44.0	22.4	51.0%	Wrentham	8.2	0.2	2.3%
Totals	37274.8	16332.3	43.8%	Totals	1054.5	611.1	58.0%	Totals	403.9	94.3	23.3%

ATTACHMENT A

Crosswalk MassGIS Land Use to Land Use Groups for Phosphorus load Calculations

Mass GIS Land Use LU_CODE	Description	Land Use group for calculating Phosphorus 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

ATTACHMENT B

Sutherland Equations Used to Estimate Percent Directly Connected Impervious Area (DCIA) by Land Use Group

Land Cover	Sutherland DCIA Equation Description	Sutherland Equation Used To Estimate Directly Connected Impervious Area (DCIA)
Commercial	Highly Connected	**$DCIA=0.4(TIA)^{1.2}$**
Industrial	Highly Connected	**$DCIA=0.4(TIA)^{1.2}$**
High Density Residential	Highly Connected	**$DCIA=0.4(TIA)^{1.2}$**
Medium Density Residential	Average	**$DCIA=0.1(TIA)^{1.5}$**
Low Density Residential	Average	**$DCIA=0.1(TIA)^{1.5}$**
Freeway	Average	**$DCIA=0.1(TIA)^{1.5}$**
Open Space	Average	**$DCIA=0.1(TIA)^{1.5}$**
Agriculture	Mostly Disconnected	**$DCIA=0.01(TIA)^{2.0}$**
Forest	Mostly Disconnected	**$DCIA=0.01(TIA)^{2.0}$**

ATTACHMENT C

Table C- 1. Distinct Average Annual Phosphorus Load Export Rates (PLERs) used to calculate Composite PLERs for calculating baseline Phosphorus Loads for Charles River Watershed -Draft MA MS4 Permit

Phosphorus Source Category by Land Use	Land Surface Cover	Phosphorus Load Export Rate, kg/ha/yr	Comments
Commercial (Com) and Industrial (Ind)	Directly connected impervious	2 0	Derived using a combination of the Lower Charles USGS Loads study and NSWQ dataset This PLER is approximately 75% of the HDR PLER and reflects the difference in the distributions of SW TP EMCs between Commercial/Industrial and Residential
	Pervious	See* DevPERV	
Multi-Family (MFR) and High-Density Residential (HDR)	Directly connected impervious	2 6	Largely based on loading information from Charles USGS loads, SWMM HRU modeling, and NSWQ data set
	Pervious	See* DevPERV	
Medium -Density Residential (MDR)	Directly connected impervious	2 2	Largely based on loading information from Charles USGS loads, SWMM HRU modeling, and NSWQ data set
	Pervious	See* DevPERV	
Low Density Residential (LDR) - "Rural"	Directly connected impervious	1 7	Derived in part from Mattson Issac, HRU modeling, lawn runoff TP quality information from Chesapeake Bay and subsequent modeling to estimate distinct PLER for DCIA to approximate literature reported composite rate 0 3 kg/ha/yr
	Pervious	See* DevPERV	
Highway (HWY)	Directly connected impervious	1 5	Largely based on USGS highway runoff data, HRU modeling, information from Shaver et al and subsequent modeling to estimate distinct PLER for DCIA for literature reported composite rate 0 9 kg/ha/yr
	Pervious	See* DevPERV	
Forest (For)	Directly connected impervious	1 7	Derived from Mattson & Issac and subsequent modeling to estimate PLER for DCIA that corresponds with the literature reported composite rate of 0 13 kg/ha/yr (Table 14)
	Pervious	**See ForPERV	
Open Land (Open)	Directly connected impervious	1 7	Derived in part from Mattson Issac, HRU modeling, lawn runoff TP quality information from Chesapeake Bay and subsequent modeling to estimate PLER for DCIA (Table 14) to approximate literature reported composite rate 0 3 kg/ha/yr
	Pervious	See* DevPERV	
Agriculture (Ag)	Directly connected impervious	1 7	Derived from Budd, L F and D W Meals and subsequent modeling to estimate PLER for DCIA to approximate reported composite PLER of 0 5 kg/ha/yr
	Pervious	***See AgPERV	
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group A	Pervious	0 05	Derived from SWMM and P8 - Curve Number continuous simulation HRU modeling with assumed TP concentration of 0 3 mg/L for pervious runoff from developed lands TP of 0 3 mg/L is based on TB-9 (CSN, 2011), and other PLER literature and assumes 50% of pervious developed lands receive P fertilization
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group B	Pervious	0 20	
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C	Pervious	0 40	
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C/D	Pervious	0 51	
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group D	Pervious	0 61	
**Forested Land Pervious (ForPERV)- Hydrologic Soil Group A (includes baseflow)	Pervious	0 12	Derived from P8 - Curve Number continuous simulation HRU modeling with assumed TP concentration of 0 1 mg/L for pervious runoff from forested lands and baseflow with TP concentration of 0 015mg/l Baseflow yields determined from USGS Lower Charles Loads study
**Forested Land Pervious (ForPERV)- Hydrologic Soil Group B (includes baseflow)	Pervious	0 16	
**Forested Land Pervious (ForPERV)- Hydrologic Soil Group C (includes baseflow)	Pervious	0 21	
**Forested Land Pervious (ForPERV) - Hydrologic Soil Group C/D (includes baseflow)	Pervious	0 23	
*Forested Land Pervious (ForPERV) - Hydrologic Soil Group D (includes baseflow)	Pervious	0 26	
***Agriculture Land Pervious (AgPERV)- Hydrologic Soil Group A	Pervious	0 08	Derived from SWMM and P8 - Curve Number continuous simulation HRU modeling with assumed TP concentration of 0 5 mg/L for pervious runoff from developed lands TP of 0 5 mg/L is based on PLER literature
***Agriculture Land Pervious (AgPERV)-Hydrologic Soil Group B	Pervious	0 33	
***Agriculture Land Pervious (AgPERV)- Hydrologic Soil Group C	Pervious	0 67	
***Agriculture Land Pervious (AgPERV)-Hydrologic Soil Group C/D	Pervious	0 85	
***Agriculture Land Pervious (AgPERV)- Hydrologic Soil Group D	Pervious	1 02	

Excluding land use areas in communities that total less than 5 acres

Percent Total Impervious Area (TIA) Cover of aggregate land use categories in the Charles River Watershed

Community	Commercial	Industrial	High Density Residential	Medium Density Residential	Low Density Residential	Highway	open land	Agriculture	Forest	overall %TIA
Arlington	59.9%		43.4%			83.6%	34.1%		4.2%	**45.0%**
Ashland			33.7%	26.1%	26.3%			3.4%	1.8%	**12.2%**
Bellingham	68.8%	72.7%	32.6%	26.0%	23.7%	49.3%	16.3%	4.7%	1.9%	**14.7%**
Belmont	48.5%	31.5%	42.1%	32.0%	37.1%	85.6%	24.9%	7.1%	4.4%	**21.8%**
Boston	72.6%	81.9%	57.5%	32.3%	30.9%	87.8%	27.1%	10.6%	8.1%	**48.3%**
Brookline	70.1%	68.4%	56.1%	33.4%	28.3%	82.9%	24.2%	8.7%	8.6%	**39.0%**
Cambridge	77.6%	93.2%	68.4%	38.1%		92.2%	29.6%		10.1%	**51.2%**
Dedham	66.7%	87.3%	38.9%	29.9%	23.1%	60.9%	27.7%	1.9%	2.5%	**19.8%**
DoverU	47.3%			29.4%	21.7%	7.2%	11.8%	5.2%	1.8%	**6.8%**
Foxborough									2.3%	**12.1%**
Franklin	66.6%	69.0%	38.7%	26.4%	23.1%	56.5%	20.7%	5.6%	2.2%	**15.2%**
Holliston	53.1%	55.6%	32.3%	24.4%	21.2%		14.5%	5.7%	1.7%	**9.7%**
Hopedale	56.2%	80.6%		27.5%	24.2%		13.9%		2.3%	**17.1%**
Hopkinton	61.3%	71.9%	30.3%	22.0%	22.7%	32.5%	42.6%	16.6%	1.9%	**10.8%**
Lexington	55.0%	57.9%	37.5%	28.4%	25.7%	60.7%	9.4%	8.2%	2.8%	**19.2%**
Lincoln	51.4%		33.3%		23.3%	73.3%	9.6%	2.7%	3.4%	**7.4%**
Medfield	59.8%	52.6%	34.8%	28.5%	25.5%	45.4%	14.2%	5.3%	1.8%	**11.4%**
Medway	65.0%	58.8%	33.4%	26.2%	22.4%	34.2%	14.6%	7.7%	2.1%	**13.1%**
Mendon	76.3%	69.9%			26.7%		5 2%	2.8%	1.6%	**14.3%**
Milford	76.0%	75.7%	40.3%	27.6%	24.9%	40.1%	25.0%	7.5%	3.1%	**21.1%**
Millis	66.6%	76.8%	37.6%	23.1%	19.3%	52.2%	17.3%	5.7%	1.5%	**9.0%**
Natick	63.5%	68.9%	37.8%	29.2%	23.9%	65.1%	19.1%	7.9%	2.4%	**15.7%**
Needham	67.5%	80.5%	34.7%	32.6%	23.2%	62.0%	17.0%	6.4%	2.3%	**23.0%**
Newton	67.8%	77.3%	44.1%	33.8%	23.6%	75.5%	20.2%	7.0%	4.5%	**35.3%**
Norfolk	52.7%	59.8%	45.2%	23.6%	21.8%	26.4%	20.2%	11.2%	2.3%	**9.5%**
Somerville	84.9%	95.1%	74.0%			95.7%	43.3%			**82.4%**
Sherborn	43.1%	61.4%	30.8%		18.9%	60.3%	9 2%	3.8%	2.2%	**5.2%**
Walpole	56.4%			34.7%	24.3%		14.6%	3.5%	2.2%	**8.5%**
Waltham	64.0%	75.8%	47.6%	32.9%	28.6%	67.9%	30.0%	10.1%	4.3%	**36.1%**
Watertown	74.6%	82.7%	48.9%			53.2%	21.4%	4.7%	10.7%	**49.3%**
Wayland			44.2%	29.2%	27.5%	63.9%	7 9%		4.7%	**17.1%**
Wellesley	51.5%		41.8%	30.1%	30.5%	69.8%	19.5%	6.2%	4.6%	**24.6%**
Weston	52.6%	40.6%	35.2%	24.6%	25.3%	69.7%	18.3%	6.9%	3.9%	**13.3%**
Westwood	51.6%	70.6%	41.9%	23.8%	20.3%	63.7%	16.3%	6.0%	2.7%	**13.6%**
Wrentham	60.9%	84.4%	33.3%	26.7%	24.6%	53.6%	22.7%	12.2%	2.3%	**11.5%**
indicates <5 acres										
Charles River Watershed (exc. CSA)	**66.1%**	**73.3%**	**48.6%**	**28.9%**	**23.1%**	**65.8%**	**21.3%**	**6.4%**	**2.6%**	**20.1%**
Distribution of percent total impervious area (TIA) by Land Use for communities in the Charles River watershed										
average	**62.2%**	**70.4%**	**41.7%**	**28.7%**	**24.7%**	**61.1%**	**20.1%**	**6.7%**	**3.5%**	**21.8%**
median	**62.4%**	**71.9%**	**38.8%**	**28.4%**	**24.0%**	**62.0%**	**19.1%**	**6.2%**	**2.4%**	**15.2%**
low	43.1%	31.5%	30.3%	22.0%	18.9%	7.2%	5 2%	1.9%	1.5%	5.2%
high	84.9%	95.1%	74.0%	38.1%	37.1%	95.7%	43.3%	16.6%	10.7%	82.4%
1st quartile	**52.8%**	**59.8%**	**33.7%**	**26.0%**	**22.6%**	**50.8%**	**14.3%**	**4.7%**	**2.0%**	**11.4%**
3rd quartile	**68.6%**	**80.6%**	**44.4%**	**32.2%**	**26.4%**	**74.4%**	**24.9%**	**8.1%**	**4.4%**	**24.6%**
	Commercial	**Industrial**	**High Density Residential**	**Medium Density Residential**	**Low Density Residential**	**Highway**	**open land**	**Agriculture**	**Forest**	**All**

Area of aggregate land use categories in the entire Charles River Watershed, hectares (ha) (excludes combined sewer area)										
Community	Commercial	Industrial	High Density Residential	Medium Density Residential	Low Density Residential	Highway	open land	Agriculture	Forest	Total
Arlington_MA	5.8	0.0	84.8	0.0	0.0	5.3	4.1	0.0	2.6	102.6
Ashland_MA	1.4	0.7	16.1	31.6	12.6	0.0	1.1	7.9	92.8	164.2
Bellingham_M	97.6	132.3	152.7	138.3	164.6	66.3	129.8	47.4	1547.8	2476.8
Belmont_MA	30.1	6.8	72.0	25.9	14.3	3.6	2.5	62.3	118.9	336.5
Boston_MA	1230.7	147.7	2540.5	44.6	10.4	235.7	690.6	102.6	913.2	5915.9
Brookline_MA	198.4	8.0	609.2	184.5	215.9	23.0	117.1	128.4	264.5	1749.1
Cambridge_MA	117.1	25.8	150.5	15.4	1.3	18.2	62.2	0.0	4.4	394.9
Dedham_MA	195.5	22.8	80.2	325.4	125.5	44.9	75.0	39.6	937.0	1845.8
Dover_MA	46.5	0.0	0.0	13.9	640.0	6.8	65.7	220.6	2298.2	3291.7
Foxborough_M	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	3.8	5.3
Franklin_MA	175.9	270.5	143.2	871.0	801.6	105.8	253.5	183.4	3527.3	6332.1
Holliston_MA	87.3	155.1	53.0	458.0	612.3	0.7	134.4	160.2	3165.9	4826.9
Hopedale_MA	10.1	16.3	0.0	45.5	46.4	1.7	6.0	0.9	154.6	281.5
Hopkinton_MA	4.1	21.9	10.1	5.4	240.6	12.7	12.2	3.1	555.2	865.1
Lexington_MA	111.7	18.6	47.4	197.0	103.9	85.5	48.6	41.6	608.6	1262.9
Lincoln_MA	29.6	1.2	14.8	0.1	351.6	8.9	46.6	160.2	1603.4	2216.4
Medfield_MA	84.5	37.2	62.3	357.0	331.4	14.1	75.2	104.4	1837.6	2903.6
Medway_MA	77.1	52.1	107.7	160.3	733.6	3.1	170.3	150.6	1525.0	2979.9
Mendon_MA	5.2	4.6	0.7	0.0	12.1	0.0	2.7	4.7	51.2	81.1
Milford_MA	151.2	175.1	283.6	578.7	181.4	96.7	187.8	6.7	1616.4	3277.6
Millis_MA	47.3	68.1	35.1	240.3	342.8	8.4	75.5	304.6	1994.7	3116.8
Natick_MA	101.4	19.8	176.0	306.4	428.4	13.4	67.0	146.1	1211.7	2470.3
Needham_MA	156.5	124.7	655.2	451.4	357.7	69.7	107.8	67.3	1201.1	3191.4
Newton_MA	468.3	58.4	1770.8	971.6	93.7	113.0	203.3	197.3	740.2	4616.7
Norfolk_MA	87.9	35.1	11.1	254.0	557.3	49.2	169.6	135.9	2569.2	3869.2
Somerville_MA	81.5	75.2	159.1	0.0	0.0	44.8	10.6	0.0	0.0	371.3
Sherborn_MA	21.9	3.5	6.3	0.7	452.0	6.4	57.0	276.1	2406.8	3230.8
Walpole_MA	11.6	0.0	0.1	5.1	109.4	1.8	18.3	17.2	405.9	569.5
Waltham_MA	621.6	234.4	1038.0	220.4	22.2	71.0	143.2	31.2	907.7	3289.7
Watertown_MA	215.4	66.7	491.1	0.0	0.0	4.7	117.5	25.1	29.6	950.3
Wayland_MA	0.0	0.3	9.5	22.6	10.7	9.3	2.1	0.5	83.5	138.5
Wellesley_MA	371.4	0.7	145.7	1040.9	66.9	34.2	79.8	77.2	774.3	2591.1
Weston_MA	117.9	29.1	25.7	89.2	973.7	91.0	125.6	215.5	2298.9	3966.5
Westwood_MA	49.4	3.2	5.3	121.7	216.7	16.0	25.5	56.3	464.6	958.5
Wrentham_MA	68.4	77.0	18.9	73.9	286.5	34.8	82.5	35.1	1585.5	2262.6
										76903.4

Impervious Area of aggregate land use categories in the Charles River Watershed, hectares (ha) -excludes combined sewer area										
Community	Commercial	Industrial	High Density Residential	Medium Density Residential	Low Density Residential	Highway	open land	Agriculture	Forest	Total
Arlington_MA	3.5	0.0	36.8	0.0	0.0	4.4	1.4	0.0	0.1	46.2
Ashland_MA	0.6	0.2	5.4	8.3	3.3	0.0	0.4	0.3	1.6	20.1
Bellingham_MA	67.2	96.2	49.8	36.0	39.0	32.7	21.1	2.2	29.0	373.1
Belmont_MA	14.6	2.2	30.3	8.3	5.3	3.1	0.6	4.4	5 3	74.1
Boston_MA	893.3	121.0	1460.1	14.4	3.2	206.9	187.4	10.9	73.8	2970.9
Brookline_MA	139.1	5.5	341.5	61.6	61.1	19.1	28.3	11.2	22.6	690.1
Cambridge_MA	90.8	24.0	102.9	5.9	0.3	16.8	18.4	0.0	0.4	259.6
Dedham_MA	130.5	19.9	31.2	97.4	29.0	27.3	20.8	0.7	23.1	379.9
Dover_MA	22.0	0.0	0.0	4.1	138.7	0.5	7.8	11.4	41.0	225.4
Foxborough_MA	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.1	0.6
Franklin_MA	117.2	186.6	55.4	230.1	184.9	59.8	52.3	10.4	76.3	972.9
Holliston_MA	46.4	86.1	17.1	111.6	129.6	0.4	19.5	9.2	53.9	473.8
Hopedale_MA	5.7	13.2	0.0	12.5	11.2	0.9	0.8	0.1	3.6	48.0
Hopkinton_MA	2.5	15.8	3.0	1.2	54.6	4.1	5.2	0.5	10.8	97.7
Lexington_MA	61.4	10.8	17.8	55.9	26.7	51.9	4.5	3.4	17.1	249.6
Lincoln_MA	15.2	0.8	4.9	0.0	82.0	6.5	4.5	4.4	55.2	173.5
Medfield_MA	50.6	19.6	21.7	101.7	84.5	6.4	10.7	5.5	33.3	333.9
Medway_MA	50.1	30.6	36.0	41.9	164.4	1.1	24.8	11.6	31.4	392.0
Mendon_MA	3.9	3.2	0.4	0.0	3.2	0.0	0.1	0.1	0.8	11.8
Milford_MA	115.0	132.6	114.4	159.6	45.3	38.8	46.9	0.5	50.8	703.8
Millis_MA	31.5	52.3	13.2	55.5	66.3	4.4	13.1	17.3	30.3	283.8
Natick_MA	64.4	13.7	66.6	89.4	102.5	8.7	12.8	11.6	29.0	398.7
Needham_MA	105.6	100.4	227.6	147.3	83.0	43.3	18.3	4.3	27.2	756.8
Newton_MA	317.4	45.1	781.1	328.0	22.1	85.3	41.1	13.7	33 2	1667.1
Norfolk_MA	46.3	21.0	5.0	59.9	121.4	13.0	34.3	15.3	60.0	376.2
Somerville_MA	69.2	71.6	117.7	0.0	0.0	42.9	4.6	0.0	0.0	306.0
Sherborn_MA	9.4	2.2	1.9	0.1	85.5	3.9	5.3	10.5	53.4	172.1
Walpole_MA	6.5	0.0	0.1	1.8	26.5	1.4	2.7	0.6	8.7	48.4
Waltham_MA	397.7	177.6	493.9	72.6	6.3	48.2	42.9	3.1	39.4	1282.0
Watertown_MA	160.7	55.2	240.2	0.0	0.0	2.5	25.1	1.2	3 2	488.1
Wayland_MA	0.0	0.0	4.2	6.6	3.0	5.9	0.2	0.1	4.0	23.9
Wellesley_MA	191.2	0.6	60.9	313.6	20.4	23.9	15.5	4.8	35.3	666.1
Weston_MA	62.0	11.8	9.0	21.9	246.3	63.4	22.9	14.8	89.4	541.6
Westwood_MA	25.5	2.2	2.2	28.9	44.0	10.2	4.2	3.4	12.7	133.3
Wrentham_MA	41.6	65.0	6.3	19.7	70.5	18.7	18.8	4.3	35.9	280.6

Charles River Watershed - Hydrologic Soil Distribution by Community , %

Community	HSG A	HSG B	HSG C	HSG C/D	HSG D	Not Defined	Total
Arlington_MA	0.0%	27.8%	0.1%	0.0%	0.3%	71.8%	100%
Ashland_MA	1.8%	26.3%	54.2%	0.0%	14.0%	3.7%	100%
Bellingham_MA	30.7%	23.6%	17.3%	2.2%	17.6%	8.5%	100%
Belmont_MA	1.3%	32.8%	26.2%	3.0%	10.2%	26.5%	100%
Boston_MA	3.2%	16.6%	7.0%	6.5%	4.1%	62.7%	100%
Brookline_MA	2.0%	20.4%	8.6%	5.4%	4.9%	58.7%	100%
Cambridge_MA	5.1%	12.5%	0.0%	0.0%	0.0%	82.4%	100%
Dedham_MA	15.9%	14.6%	3.0%	21.7%	19.4%	25.4%	100%
Dover_MA	21.0%	26.2%	27.1%	13.3%	11.3%	1.1%	100%
Foxborough_MA	0.8%	7.2%	92.0%	0.0%	0.0%	0.0%	100%
Franklin_MA	20.2%	27.9%	28.5%	3.2%	12.8%	7.5%	100%
Holliston_MA	15.7%	25.1%	28.5%	8.2%	17.7%	4.7%	100%
Hopedale_MA	10.3%	63.0%	11.1%	0.0%	13.6%	2.0%	100%
Hopkinton_MA	0.1%	25.3%	58.0%	7.0%	7.9%	1.8%	100%
Lexington_MA	2.1%	26.2%	12.0%	7.8%	18.7%	33.2%	100%
Lincoln_MA	11.0%	46.9%	12.6%	3.3%	24.8%	1.4%	100%
Medfield_MA	18.5%	31.7%	11.9%	7.6%	24.4%	5.9%	100%
Medway_MA	14.5%	37.3%	31.0%	0.1%	15.2%	1.9%	100%
Mendon_MA	12.3%	71.9%	9.3%	0.0%	6.2%	0.3%	100%
Milford_MA	11.3%	38.3%	17.6%	0.1%	14.3%	18.4%	100%
Millis_MA	25.6%	25.0%	19.3%	0.0%	27.4%	2.5%	100%
Natick_MA	11.9%	17.1%	24.5%	8.5%	13.5%	24.5%	100%
Needham_MA	18.0%	18.1%	11.7%	8.5%	14.0%	29.7%	100%
Newton_MA	7.4%	18.7%	3.1%	2.7%	3.9%	64.0%	100%
Norfolk_MA	34.9%	31.4%	12.8%	2.2%	17.4%	1.3%	100%
Somerville_MA	0.0%	12.9%	0.0%	0.0%	0.0%	87.1%	100%
Sherborn_MA	17.5%	22.0%	33.7%	5.7%	20.4%	0.7%	100%
Walpole_MA	12.4%	28.3%	45.2%	0.2%	13.9%	0.0%	100%
Waltham_MA	2.9%	28.8%	4.5%	5.5%	5.9%	52.5%	100%
Watertown_MA	4.9%	14.7%	3.9%	0.0%	0.0%	76.5%	100%
Wayland_MA	4.8%	54.9%	0.4%	1.0%	9.2%	29.6%	100%
Wellesley_MA	20.3%	18.9%	9.0%	5.1%	4.8%	41.9%	100%
Weston_MA	5.1%	59.9%	10.7%	3.5%	9.9%	10.8%	100%
Westwood_MA	5.5%	25.1%	12.2%	16.8%	15.1%	25.3%	100%
Wrentham_MA	42.4%	26.5%	4.5%	6.0%	10.1%	10.4%	100%
Overall CRW	15.1%	27.3%	16.5%	5.3%	13.1%	22.6%	100%