UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

RESIDUAL DESIGNATION PURSUANT TO CLEAN WATER ACT

REGION I

I. INTRODUCTION

Under Clean Water Act section 402(p), 33 U.S.C. § 1342(p), Congress required EPA to establish permitting requirements for certain storm water discharges. EPA established such requirements in two phases, Phase I, 55 Fed. Reg. 47,990 (Nov. 16, 1990); and Phase II, 64 Fed. Reg. 68,781 (Dec. 8, 1999). In addition, section 402(p)(2)(E) and (6) and 40 C.F.R. § 122.26 (a)(9)(i) (C) and (D) provide that in states where there is no approved state program, the EPA Regional Administrator may designate additional storm water discharges as requiring National Pollutant Discharge Elimination System (NPDES) permits where he determines that: (C) storm water controls are needed for the discharge based on wasteload allocations that are part of "total maximum daily loads" (TMDLs) that address the pollutants of concern, or (D) the discharge, or category of discharges within a geographic area, contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

This Record of Decision documents a preliminary determination pursuant to the Clean Water Act (CWA), 33 U.S.C. §§ 1251 et seq., and 40 C.F.R. §122.26 (9) (i) (C) and (D) by the Regional Administrator of EPA Region I that storm water controls and NPDES permits are needed for discharges to waters of the United States from the following category of storm water discharges ("designated discharges"):

> Storm water discharges from two or more acres of impervious surfaces that are located on a single lot or two or more contiguous lots aggregated in accordance with 314 CMR 21.05 in the Charles River watershed that are located, in whole or in part, within the municipalities of Milford, Bellingham or Franklin, Massachusetts. In determining whether the impervious surfaces located on a single lot or two or more contiguous lots aggregated in accordance with 314 CMR 21.05 constitute impervious surfaces covered by this preliminary residual designation, impervious surfaces shall not include any impervious surfaces owned or operated by a local government unit, the Commonwealth of Massachusetts or the federal government and any impervious surfaces associated solely with any of the following land uses: sporting and recreational camps; recreational vehicle parks and campsites; manufactured housing communities; detached single-family homes located on individual lots; or multi-family housing developments containing four or fewer units including condominiums, cooperatives, apartment buildings, townhouses and rooming and boarding houses. As used in this designation, the terms contiguous lots, sporting and recreational camps, recreational vehicle parks and campsites, and manufactured housing communities, shall have the definitions provided in Attachment A.

The categories of facilities excluded from this designation in the paragraph above match those excluded from a proposed storm water regulation being considered by the Massachusetts Department of Environmental Protection (DEP). EPA is seeking public comment on this designation, including on the categories of facilities to be excluded.

This preliminary residual designation shall not apply to any discharge already subject to the NPDES permitting program.

For purposes of this preliminary residual designation, the Charles River watershed includes all areas that discharge directly to the Charles River or its tributaries or indirectly to the Charles River or its tributaries through Municipal Separate Storm Sewer Systems (MS4s) or other private or public conveyance systems. The watershed boundary in these towns is approximately delineated in Figure 1. This boundary was established using surface elevation data from a USGS topographic map.

For purposes of this preliminary residual designation, impervious surface or impervious area means: any roof other than a green roof constructed in accordance with the Massachusetts Stormwater Handbook; a paved parking area; a paved area used for the storage and/or maintenance of vehicles and/or equipment; a paved area used for the storage of materials, products and/or waste; or a paved access road or driveway leading to a paved parking area. This residual designation does not apply to any storm water discharge otherwise subject to the NPDES permit program.

This is a determination that owners and operators of designated discharges are required to obtain a NPDES permit for two independent reasons because:

1) This category of discharges contributes to violations of water quality standards; and

2) Storm water controls are needed for this category of discharges based on wasteload allocations (WLAs) that are part of a Total Maximum Daily Load (TMDL) for the discharge of phosphorus to the Lower Charles River and its tributaries.

Where a property containing a designated discharge is owned by one person but is operated by another person, the operator of the property is required to obtain the NPDES permit.

This determination is made consistent with § 402(p) of the CWA, 33 U.S.C. § 1342(p), and related regulations found at 40 C.F.R. § 122.26. This preliminary residual designation does not become effective until EPA issues a general permit that will authorize discharges subject to this residual designation. The question of whether this preliminary residual designation was proper will remain open for consideration during the public comment period on any such permit or appeal of any such permit.

This document is structured generally as follows. Section II provides general factual and legal background on the Charles River watershed, and the connections between land use, storm water and phosphorous discharges. Section III discusses the CWA storm water residual designation authorities. Section IV.A then documents how storm water discharges and the phosphorus they contain are currently contributing to violations of Massachusetts water quality standards. Section IV.B describes the derivation of the Lower Charles River phosphorus Total Maximum Daily Load (TMDL) and explains the basis for the TMDL's conclusion that storm water loads to the Lower Charles must be reduced in order to attain water quality standards. Section V provides the basis for EPA's selection of the designated discharges as those needing control in this preliminary residual designation. Finally, Section VI presents EPA's determinations under 40 C.F.R. § 122.26(9) (i) (C) and (D).

Figure 1: Charles River watershed with Milford, Bellingham and Franklin Outlined

The entire Charles River drains a watershed area of 310 square miles (MAEOEA, 2008). Two hundred and sixty-eight square miles of that watershed area drain over the Watertown Dam into the Lower Charles River (Breault et al., 2002). The remaining 42 square miles drain directly into the Lower Charles River. There is also a combined sewer drainage area near the downstream end of the Lower Charles River.

The headwaters of the Charles River are in Hopkinton, Massachusetts. From there, the river flows through the municipalities of Milford, Bellingham, Franklin, Medway, Millis, Medfield, Sherborn, Dover, Natick, Wellesley, Needham, Dedham, Newton, Waltham, Watertown, Cambridge and Boston, MA and from there into Boston Harbor.

Additionally, the Charles River watershed, which drains into the Charles River and its tributaries, includes, in whole or in part, Arlington, Ashland, Belmont, Brookline, Foxborough, Holliston, Hopedale, Lexington, Lincoln, Mendon, Norfolk, Sherborn, Somerville, Walpole, Wayland, Weston, Westwood and Wrentham, Massachusetts.

Milford, Franklin and Bellingham, Massachusetts drain, in whole or in part, into the Charles River upstream of the Watertown Dam. As indicated in Figure 1, these communities are located in the upper Charles River watershed. These upper watershed communities are the first places where the Charles River shows significant signs of cultural eutrophication (MAEOEA, 2008; CRWA, 2004 and 2006; Beskinis, 2005). The portion of the Charles River that is downstream of the Watertown Dam is referred to as the Lower Charles River. The Lower Charles River is one of the most historically and culturally significant rivers in the United States. The river and its adjacent parkland are used by the public for recreation, including windsurfing, sailing, rowing, running, and other water and non-water related recreation by an estimated 20,000 people on an average day (Breault et al., 2002).

Figure 2: Sailboat Racing on the Lower Charles River (Walsh-Rogalski)

Figure 3: Windsurfing on the Lower Charles River

In 1995 EPA Region I launched the Clean Charles initiative aimed at making the Lower Charles River fishable and swimmable—the goals of the CWA. At that time, the Lower Charles River was meeting swimming standards for bacteria 19% of the time and boating standards for bacteria 39% of the time based on Charles River Watershed Association (CRWA) data. (EPA, 2008) In 2007, the Lower Charles River was meeting the bacteria standard for swimming 63% of the time and the bacteria standard for boating 100% of the time based on the same sampling program. These dramatic improvements in reducing bacterial contamination resulted from the investment of hundreds of millions of dollars by the Massachusetts Water Resources Authority (MWRA), EPA, the Massachusetts Department of Environmental Protection (DEP), municipalities in the Lower Charles River watershed and numerous other private and public entities.

While vast strides have been made in reducing bacterial contamination in the river, scientific study indicates that the river's water quality continues to be impaired as a result of cultural eutrophication (DEP et al., 2007). Cultural eutrophication is the process by which phosphorus and other nutrient discharges from human activities cause the growth of excessive plant life, including algae, that impairs water quality. As with bacterial contamination, cultural eutrophication causes violations of water quality standards, including the impairment of the designated uses of the Charles. This residual designation is based in part on those violations and impairments.

The urban and suburban landscape contains a variety of phosphorus sources. These include dust and dirt, atmospheric deposition, decaying organic matter--such as leaf litter and grass clippings--fertilizers, exhaust from internal combustion engines, detergents, and pet waste (Center for Watershed Protection (CWP)), 2007 and Shaver et al. 2007). Intensive uses, including high traffic volume (particularly by trucks and busses), increase pollutant loading to the impervious surfaces, including surfaces adjacent to roadways, loading areas and parking lots.

Impervious surfaces collect phosphorus deposited on them from these sources. Wind, runoff from rain and snowmelt, landscaping and other human activities and natural mechanisms mobilize and then convey phosphorus from impervious surfaces to waters such as the Charles River.

Numerous scientific studies document that impervious cover both increases the volume of rainfall that becomes runoff and amplifies the loads of pollutants flowing to surface waters (Schuleler, 1987; CWP, 2007; Shaver et al., 2007; Pitt et al., 2004; Horner et al., 1994). There are several reasons for this: 1) rain falling on impervious cover runs off without infiltrating into the ground, thus creating a higher volume of runoff per unit area; 2) unlike pervious areas that trap and filter pollutants through soils and surface retention, impervious areas allow greater amounts of pollutants to be carried away by runoff; and 3) pollutants such as phosphorus on impervious surfaces are particularly susceptible to transport by runoff because of their tendency to adhere to very small (i.e., fine) particles, which are easily washed off hard surfaces by rainfall. These small particles (< 100 microns) account for much of the phosphorus storm water load that discharges to receiving waters. These three factors operating simultaneously dramatically increase phosphorus loadings from impervious surfaces.

Generally, and in the Charles River watershed specifically, the extent of imperviousness differs by land use. As land has been developed from its natural state, impervious surfaces, such as roadways, parking lots and roof tops, have proliferated. The relationship between land use, imperviousness and consequent phosphorus loading is illustrated by Table 1. The first column in Table 1 identifies land use categories typically studied in storm water research; the second column indicates the export loading rates--a measure of phosphorus in storm water discharges expressed in terms of pounds per acre per year--from land use-based research collating numerous storm water studies; the third column provides the phosphorus export loading rates from the various land uses based on a simple model widely used in the field of storm water research; the fourth column identifies the range of imperviousness in various land uses based on general storm water research; and the fifth column identifies the percent of imperviousness in various land uses based on an analysis specific to the Charles River and indicates that the percent of imperviousness in the Charles River watershed is, on a land-use basis, in general agreement with that in numerous storm water studies. Taken as a whole, the data presented in Table 1 establishes two key points: the amount of phosphorus in storm water discharges from various land uses (excepting agricultural, forest and open space land uses) is directly and proportionally related to the per cent imperviousness of that land use; and the Charles River watershed is reflective of general trends when considering the relationship between land use and degree of imperviousness.

Land Cover	Literature reported Phosphorus Export Loading Rates (lbs/acre-yr)	Annual Phosphorus export rate developed from the Simple Method (Schueler 1987) (lbs/acre-yr)	Ranges in percent impervious values for various land uses (Schueler 1987)	Charles River watershed percent impervious by land-use (MassGIS 2007)
Commercial	1.496 (1)	1.15 - 2.29	60-90%	79%
Industrial	1.296 (1)	1.15 - 2.29	60-90%	71%
High Density Residential	1.006 (1)	0.71 - 1.57	35-60%	49%
Medium Density Residential	0.499 (1)	0.45 - 0.97	20-35%	25%
Low Density Residential	0.040 (1)	0.19 - .37	5-20%	20%
Agriculture (crop land)	0.446 (2)	0.10 - 0.13	0-5%	not calculated
Forest	0.115 (3)	0.10 - 0.13	0-5%	not calculated
Open Space	0.030 (1)	0.10 - 0.13	0-5%	not calculated

1. Shaver, E., Horner R., Skupien J., May C., and Ridley G. 2007 Fundamentals of urban runoff management: technical and institutional issues. Prepared by the North American Lake Management Society, Madison, WI, in cooperation with the U.S. Environmental Protection Agency.

2. Budd, Lenore F.and Donald W. Meals. February 17, 1994. Draft Final Report. *Lake Champlain Nonpoint Pollution Assessment*.
3. Mattson, Mark D. and Russell A. Isaac. 1999. *Calibration of phosphorus export coefficients for Total Maximum Daily Loads of Massachusetts's lakes.* Lake Reservoir. Management, 15:209-219.

Table 1. Phosphorus Loading Export Factors from Numerous Sources

As established below, land uses and phosphorus loading rates in the Charles River watershed are reflective of the general trends reported in storm water research.

It is noteworthy that just as impervious cover discharges high loads of phosphorus to surface waters, so too does impervious cover contribute to excess loadings of other pollutants such as heat, metals, and pathogens (Shaver et al., 2007, Horner et al., 1994, CWP, 2007). The types of control technologies that will reduce phosphorus loads will provide the added benefit of reducing loads of these other pollutants.

III. GENERAL LEGAL BACKGROUND

A. Clean Water Act

In 1987, Congress amended the CWA to require implementation, in two phases, of a comprehensive national program for addressing storm water discharges. In 1990, EPA promulgated the Phase I Rule that regulates storm water discharges from major storm water pollution sources, including discharges associated with industrial activities, discharges from construction sites greater than five acres and discharges from large and medium municipal MS4s. 55 Fed. Reg. 47,990 (Nov. 16, 1990). In 1999, EPA expanded the universe of storm water discharges subject to control under the NPDES program by adding discharges from smaller MS4s in urbanized areas (small MS4s) and discharges from construction sites disturbing between one and five acres of land. 64 Fed. Reg. 68,781 (Dec. 8, 1999). EPA promulgated these rules based on data collected through extensive, nationwide storm water studies.

Section 402(p) of the CWA, 33 U.S.C. §1342, and related regulations recognize that in order to protect water quality, additional storm water sources may need to be regulated on a case-by-case or category-by-category basis based on additional information or localized conditions. CWA section 402(p)(2)(E) and (6), 33 U.S.C. §402(p)(2)(E) and (6), and 40 C.F.R. § 122.26 (a)(9)(i) (C) and (D). This authority to regulate other sources based on storm water's localized adverse impact on water quality through NPDES permits is commonly referred to as the "Residual Designation" authority.

B. Relevant Regulatory Provisions

EPA's regulations addressing the control of storm water discharges are found, generally, at 40 C.F.R. Part 122. EPA's authority to designate for NPDES permitting purposes storm water discharges is found at 40 C.F.R. 122.26(a). That section provides, in relevant extract, as follows:

> (9)(i) On and after October 1, 1994, for discharges composed entirely of storm water… operators shall be required to obtain a NPDES permit … if:
>
> (C) The Director, or in States with approved NPDES programs, either the Director or the EPA Regional Administrator, determines that storm water controls are needed for the discharge based on wasteload allocations that are part of "total maximum daily loads" (TMDLs) that address the pollutant(s) of concern; or
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> (D) The Director, or in States with approved NPDES programs, either the Director or the EPA Regional Administrator, determines that the discharge, or category of discharges within a geographic area, contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

This residual designation is based on 40 C.F.R. §122.26(a) (9)(i)(C) and (D).

IV. FACTUAL BASES FOR DETERMINATIONS

This section discusses how phosphorous contributes to the Charles River's eutrophication.

In addition, subsection A of this section describes how eutrophication of the Charles River causes violations of numerous Massachusetts water quality standards, including impairment of the designated uses of primary and secondary contact recreation and aquatic habitat. These eutrophied conditions also violate numerous water quality criteria including those for nutrients, solids, color and turbidity, pH, dissolved oxygen (DO) and aesthetics.

Subsection B of this section discusses how a TMDL for phosphorus was established for the Lower Charles River *(Final Total Maximum Daily Load for Nutrients in the Lower Charles River Basin Massachusetts CN 301.0, June 2007*), and why significant reductions from phosphorous sources in the Charles River watershed will be necessary to meet the waste load allocations in the TMDL. The TMDL report and extensive scientific studies and observations establish the connection between the impervious surfaces represented by the designated discharges and impaired water quality in the Charles River. These scientific studies also support the load reductions needed to meet the TMDL wasteload allocations.

Section V below describes the designated discharges and explains that they convey phosphorus to the Charles River in quantities that contribute to violations of Massachusetts water quality standards and why phosphorus load reductions from these sources are necessary based on the TMDL's waste load allocations.

A. Storm water Discharges of Phosphorous are Contributing to Water Quality Standards Violations in the Charles River.

As discussed above, storm water discharges, particularly storm water discharges from impervious surfaces, carry high phosphorus loads, with the load generally proportional to the extent of impervious cover on a per acre basis. In the Charles River watershed, storm water and the phosphorus it contains are conveyed from multiple impervious surfaces directly and indirectly to the Charles River.

Massachusetts Water Quality Standards

The goal of the Clean Water Act is to restore and maintain the chemical, physical and biological integrity of the Nation's waters, including, the protection and propagation of fish, shellfish and wildlife and the provision of recreation in and on the water. CWA section 101(a), 33 U.S.C. §1251. To advance these goals, states are required to promulgate water quality standards that include both (1) beneficial *uses* of their waters; and (2) *criteria* to protect those uses. CWA section 303, 33 U.S.C. §1313. Massachusetts has identified the Lower Charles River as a Class B water designated to support fish habitat, other aquatic life and wildlife, and primary and secondary contact recreation. Class B waters are also expected to have consistently good aesthetic quality. Massachusetts has developed water quality criteria for nutrients, including phosphorus, so that the designated uses can be attained.

A summary of the Massachusetts water quality criteria that are relevant to the Lower Charles River and this residual designation is presented in Table 2. There are no specific, numeric criteria for phosphorus, but there are narrative nutrient criteria. In addition, excessive phosphorus causes violations of other numeric criteria, such as those for pH and dissolved oxygen (DO).

Table 2: Applicable Massachusetts water quality criteria

Pollutant	Criteria	Source
DO	Shall not be less than 5.0 mg/L in warm water fisheries unless background conditions are lower; natural seasonal and daily variations above these levels shall be maintained; and levels shall not be below 60 percent of saturation in warm water fisheries due to a discharge.	314 CMR: 4.05: Classes and Criteria (3)(b) 1
pH	Shall be in the range of 6.5 - 8.3 standard units and not more than 0.5 units outside of the background range. There shall be no change from background conditions that would impair any use assigned to this class.	314 CMR: 4.05: Classes and Criteria (3)(b) 3
Solids	These waters shall be free from floating, suspended, and settleable solids in concentrations and combinations that would impair any use assigned to this Class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.	314 CMR: 4.05: Classes and Criteria (3)(b) 5.
Color and Turbidity	These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this Class.	314 CMR: 4.05: Classes and Criteria (3)(b) 6
Aesthetics	All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.	314 CMR: 4.05: Classes and Criteria (5)(a)
Nutrients	Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department.	314 CMR: 4.05: Classes and Criteria (5)(c)

Source: 314 Code of Massachusetts Regulations (CMR) 4.05 DEP 2006).

On a periodic basis, Massachusetts and other states issue a list under Section 303(d) of the CWA that identifies all surface waters that do not meet applicable state water quality standards. Based on water quality data available for the Charles River and applicable State water quality standards, DEP included the Lower Charles River on the State’s 2002, 2004 and 2006 Section 303(d) lists for the following pollutants and conditions that it determined caused violations of those standards:

- Unknown toxicity
- Priority organics

- Metals
- Nutrients
- Organic enrichment/Low DO
- Pathogens
- Oil and grease
- Taste, odor, and color
- Noxious aquatic plants
- Turbidity

Excess phosphorus loads are contributing to water quality standards violations relating to nutrients, low DO, taste, odor and color, noxious aquatic plants, and turbidity in the Charles River.

Effects of Phosphorous Generally and in the Charles River Specifically

The causal relationship between excessive phosphorus loads and water quality impairments is well understood. Generally speaking, the availability of phosphorus and other nutrients, light, and higher water temperatures fuel algal and aquatic plant growth. In the Charles River, that growth is largely controlled by the availability of nutrients: a scarcity of nutrients will limit growth while their abundance will stimulate growth. Phosphorus is usually the nutrient whose absence or presence controls algal and aquatic plant growth during the middle to later summer period in the Charles River when recreational use of the river peaks. Nitrogen, the other nutrient on which algal growth depends, tends to control growth in salt water, while phosphorus is the critical nutrient in fresh. During mid to late summer, phosphorus abundance in the Lower Charles River coincides with water quality and climatic conditions -- increased water residence times, high light intensity, and warm ambient temperatures -- that are optimal for algal and aquatic plant growth. When high phosphorus levels in the Charles River coincide with these optimal growth periods, plant biomass increases dramatically. [(DEP et al.,2007); EPA data 1998-2007).]

A waterbody's trophic state is a description of its biological condition. There are three general trophic states: (1) oligotrophic, indicating low plant biomass; (2) mesotrophic, indicating intermediate plant biomass; and (3) eutrophic, indicating high plant biomass. The term eutrophication applies when a waterbody is becoming more productive (i.e., producing more plant biomass). Cultural eutrophication, or accelerated eutrophication, indicates that a waterbody is producing more than a natural amount of plant biomass as a result of anthropogenic activities such as the discharge of nutrients to the waterbody.

Recent and ongoing assessments of the trophic condition of the Charles River indicate that (except for the headwaters in Hopkinton) the river is undergoing cultural eutrophication because of excessive phosphorus loading and is manifesting the resultant degraded water quality conditions.

Water quality problems that are common to eutrophic wasters and that are manifest in the Charles River include poor aesthetic quality, low DO and undesirable alterations to species composition and the food web. Excessive algae results in poor aesthetic quality due to reduced water clarity and a green-brown coloration. Additionally, excessive amounts of algae and/or the presence of noxious algae species have impaired primary contact recreational uses in the Charles (e.g., swimming, kayaking and sail boarding) because of bad odors and skin irritations. Excessive algae can also cause very high supersaturated DO levels in the upper water column and low DO in the lower water column. Both harm fish. In addition, excessive algae produce fluctuating pH. As a result of these conditions, the Lower

Charles River often violates water quality standards for the designated recreational and aquatic life uses and the criteria to support those uses.

One of the most serious problems caused by excessive plant biomass in the Charles River and other eutrophic waterbodies is the tendency for undesirable and potentially harmful species of algae to predominate the community assemblage. Although many species of algae are important contributors to the base of the food web, there are species that are inedible, have low value in the food chain, are sometimes toxic to aquatic life, and are potentially hazardous to human health. Several of these species fall into a group known as cyanobacteria or “blue-greens.” These organisms are bacteria with a photosynthetic pigment, chlorophyll. Some of the most troublesome have other characteristics, such as the ability to float, which gives them greater access to sunlight and allows them to predominate over other species. The presence of high phosphorus levels from storm water discharges to the Charles River leads to the proliferation of algae in general and blue-greens in particular (Watson et al., 1997).

Specific Water Quality Standards Violations Caused by Phosphorus Discharges

As noted generally above, elevated phosphorus levels during the summer and early fall cause intense growths of algae and aquatic plants in the Charles River. An explanation of how these growths contribute to the impairment of designated uses and violations of specific water quality criteria (presented in Table 2) is provided below.

Nutrients

The Massachusetts water quality criterion for nutrients applicable to all surface waters requires that, unless naturally occurring, waters shall be free of nutrients in concentrations that would cause or contribute to impairments of existing or designated uses. The Charles River is designated a Class B water under the Massachusetts water quality standards and is thus required to support fish habitat, other aquatic life and wildlife, and primary and secondary contact recreation (DEP, 2007).

Excess phosphorus in the Charles River impairs fish habitat by accelerating the growth of nuisance algae species that crowd out species that provide a source of food for fish. Also, as algae and plants die, the resultant organic matter settles to the bottom of the river in depositional areas (typically in impoundments and slow moving sections of the river). Its decomposition alters water chemistry, the most dramatic effect being the lowering of dissolved oxygen (DO) levels. (The Massachusetts water quality standards include a specific criterion for DO, discussed below.) Low DO harms resident aquatic organisms that rely on DO and can also cause other detrimental changes in water chemistry such as the release of sulfides, which are extremely toxic to organisms. The release of sulfides, in turn, can contribute to the release of trace metals from sediments that can be toxic to benthic organisms, a food source for fish and important links in the aquatic food chain. This metals release occurs in the downstream portion of the lower Charles where DO levels drop close to 0 mg/l (USEPA, 2003; Breault, 2000). Low DO is also a problem in many other impounded segments of the Charles River throughout the watershed. As part of the water quality monitoring conducted by the Charles River Watershed Association (CRWA) for the mid and upper Charles River nutrient TMDL currently under development, low DO (< 2 mg/l) was observed in several impoundments (CRWA, 2006).

Excess phosphorus also contributes to the excessive growth of cyanobacteria whose toxic effects impair existing and designated recreational uses of the Charles River, specifically including the primary and secondary activities of windsurfing, sailboating, rowing and swimming that occur throughout the summer in the Lower Charles River.

Numerous field studies document that blooms of cyanobacteria change the zooplankton community structure. Zooplankton is an important component of the food web that consumes algae and is, in turn, preyed upon by many fish species. Three genera of cyanobacteria -- *Anabaena, Aphanizomenon,* and *Microcystes* -- are commonly associated with the spread of cyanobacteria in fresh water lakes (Mattson et al., 2003; USEPA, 2003; DEP et al., 2007). All three genera have been consistently observed in the Lower Charles River during all summers when algal sampling was conducted (DEP et al., 2007). During the summers of 2006 and 2007, very severe blooms occurred in the Lower Charles River, causing the Massachusetts Department of Public Health and the Massachusetts Department of Conservation and Recreation to post warnings for the public and their pets to avoid contact with the river water. This included recreational uses -- such as windsurfing and kayaking -- that have become commonplace as bacterial contamination has been dramatically reduced.

Figure 4: MA DPH posting along the Banks of the Lower Charles River in August 2006 (by CRWA)

The 2006 algal bloom consisted of extremely high cell counts of over one million cells/milliliter of cyano-bacteria and included the organism *microcystes* that is toxic at elevated levels. By way of perspective, the World Health Organization (WHO) has provided the following benchmarks for blue-green cell counts that indicate potential levels of concern (WHO, 2003):

- 5,000 cells/ml – Scum can form, which concentrates toxins. Adverse health effects have been noted in studies in which exposure at this level continued for over an hour.
- 20,000 cells/ml – Skin and eye irritation is likely from contact with the blue-green algae. WHO recommends that when cells are observed at this concentration, individuals should be notified of the possible health risks associated with water contact.

The Massachusetts Department of Public Health has developed a protocol that dictates the immediate posting of warning signs at 70,000 cells/ml (MDPH, 2007).

Blooms also cause aesthetic impairments in the Charles. Figures 8 and 10 illustrate instances where algal blooms caused the water of the Lower Charles River to turn a bright green.

Solids

The Massachusetts criteria relating to solids provide that Class B waters shall be free from floating, suspended, and settleable solids in concentrations and combinations that would impair any use assigned to this Class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

Increased algal and plant growth fueled by high phosphorus levels in the Charles River creates suspended matter and floating scum that is aesthetically objectionable and that impairs the designated uses of primary and secondary contact recreation. Figure 5 depicts floating scum of blue-green algae created by excess phosphorus in the Charles River.

Figure 5: Floating Scum at Charles River in Medway (by CRWA)

Figure 6: Charles River at Milford Pond (by CRWA)

Figure 6 depicts floating solids in the form of plant life that impair primary and secondary uses of the Charles River at one of its impoundments, Milford Pond. Algae and scum also cause aesthetically objectionable conditions, as outlined in the aesthetic standards violations section below.

Overabundant algae and aquatic plants caused by excess phosphorus produce suspended and settleable solids in concentrations and combinations that impair assigned uses, harm benthic biota and degrade the chemical composition of the bottom. Harm to benthic biota occurs through the degradation of habitat and changes in water quality in a number of ways. First, proliferation of attached algae (i.e., periphyton) along the bottom of the river causes a loss of desirable fish habitat and a loss of diversity in the benthic invertebrate community. Figure 7 shows dense growths of attached algae in the mainstem of the Charles River in Franklin. The bottom substrate is almost entirely covered by thick mats of algae that eliminate nooks and crannies among the rocks and cobbles providing important habitat to benthic organisms and small fish. As noted in the discussion on nutrients immediately above, phosphorus and the algal growth to which it contributes degrades the chemical composition of the water by lowering DO levels, as well.

Figure 7: Attached Algae on Charles at Franklin (by CRWA)

Color and Turbidity

The Massachusetts criterion for color and turbidity in Class B waters provides that they shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this Class. The color and turbidity impairments in the Charles are due to the discoloration of the water from the algae blooms described above (see figures 8 and 10) and the loss in water clarity from the algal cells that increase water turbidity.

Color and turbity problems attributable to excess algae impair recreational uses. Secchi disc depths measured in the Lower Charles River during the years 1998-2008 frequently did not attain the clarity levels that Mass DEP uses in assessing if waters are safe for swimming. Secchi depth measurement is an indication of water clarity and represents the depth at which a small black and white disc lowered into the water column can be seen from the water surface.

Massachusetts uses a Secchi depth of four feet (1.2 meters) to assess attainment of primary contact recreation use (MAEOEA, 2003). Based on a review of the EPA Secchi depth data collected at sampling stations CRBL06 (downstream of the BU Bridge), CRBL07 (downstream of the Harvard Bridge), and CRBL11 (between the Longfellow Bridge and the Museum of Science), only 17, 61, and 80 percent of the observations, respectively, attained the four-foot clarity level. Suspended algae in the water column, which result in part from the presence of elevated phosphorus levels, are partially responsible for the poor water clarity because of light absorption and light scattering in the water column (Wetzel, 1983).

pH

The Massachusetts water quality criterion for Class B waters provides that pH levels shall be in the range of 6.5 - 8.3 standard units and not more than 0.5 units outside of the background range. It further provides that there shall be no change from background conditions that would impair any use assigned to this class.

EPA continuously monitored for pH levels during the summer months of 1998-2008 as part of its Core Monitoring Program. That monitoring data showed numerous levels above the Massachusetts's pH criterion in the Lower Charles River. The observed pH often exceeded the 8.3 criterion value during times when chlorophyll *a* levels were high. Monitoring of pH and DO showed that the violations of the pH criterion coincide with supersaturated DO conditions. This phenomenon is directly related to the presence of excess algae. Algal photosynthesis consumes carbon dioxide in the ambient water. As carbon dioxide levels plunge and supersaturated oxygen levels rise, pH levels increase. In addition to exceeding the range of 6.5 to 8.3 units, pH levels exceeded the water quality criterion as the excursions were more than .5 units outside the background range on numerous occasions during EPA's monitoring of the Charles River in the years from 1998-2006. In summary, an increase in algal biomass caused by excessive phosphorus levels contributes to a pH level above the applicable water quality criterion.

Dissolved Oxygen (DO)

The water quality criterion for Class B waters for DO requires that levels not be less than 5 mg/l in warm water fisheries unless naturally occurring background levels are lower. The Charles River is a warm water fishery. Very low DO levels, typically between 0 and 3 mg/l, have been regularly measured during the summers in the bottom waters of the Charles River Basin (that section of the Lower Charles River between Boston University Bridge and Boston Harbor). Such low DO levels are not naturally occurring and are not meeting the Massachusetts water quality criterion of 5 mg/l. These low DO levels will not sustain a healthy and balanced aquatic community. Algae blooms contribute to the low DO levels in the Lower Charles River through algal respiration and the depletion of oxygen caused by the decomposition of dead algae that settle to the bottom. Low DO levels < 5 mg/l have also been measured in Milford Pond and several tributaries located in the upper watershed (CRWA, 2006).

Aesthetic Impairments

The Massachusetts water quality criterion for Class B waters relating to aesthetics requires that all surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

As noted above, the presence of cyanobacteria has caused recreational use impairments in the Lower Charles River. Its presence has also caused aesthetic impairments in upstream segments of the river. During September of 2004, a severe cyanobacteria bloom occurred in Populatic Pond, as shown in Figure 9. Populatic Pond is an impoundment in the Charles River located in the Upper Charles watershed, above Watertown Dam. During the 2004 bloom, DEP collected and analyzed samples from a bloom that began in Populatic Pond and that had cell counts of over 200,000 cells/ml (Beskenis 2005), a level that is ten times greater than the concentration at which aesthetic conditions become impaired, as discussed below.

Figure 8: Blue-Green Bloom in the Lower Charles River, August 2006

Figure 9: Blue-green Bloom in Populatic Pond (DEP September 2004)

Figure 10: Blue-Green Bloom in the Lower Charles River, August 2006

The discussion immediately above on nutrients, solids, color and turbidity addresses how excess phosphorus contributes to conditions that violate the objective components of the aesthetics criteria, such as the existence of scum and color. The discussion also indicates the presence of undesirable and nuisance species of aquatic life, another example of a violation of the objective component of the aesthetics criterion related to nutrients. In addition to these objective conditions, the aesthetics criterion also contains a subjective component in that it refers to conditions that are "objectionable."

There is a limited number of references in the literature concerning the relationship between specific chlorophyll *a* levels (which indicate the presence of algae) and subjective aesthetic impacts. Some of the more informative studies involve the analysis of simultaneously collected water quality and user-perception data. The results of two "user-perception" based studies are summarized below to provide general information concerning the relationship between the presence of algae as measured by the magnitude of chlorophyll *a* values and perceived aesthetic impairments.

Smeltzer presents the results of a study conducted by the Vermont Water Resources Board to develop nutrient criteria for Lake Champlain from user survey data. Results from this study indicate that over 50 percent of the respondents found that enjoyment of the lake was impaired when chlorophyll *a* levels were 8 – 11.9 µg/l. The frequency of this response increased to approximately 90 percent when chlorophyll *a* concentrations were greater than 20 µg/l. Vermont ultimately used the results of this user perception study as the basis for incorporating numeric phosphorus criteria for Lake Champlain into the Vermont water quality standards.

The Vermont Department of Environmental Conservation conducted a similar analysis applying user-perception based studies from 60 inland lakes. The results indicate that between 40 percent and 60 percent of the respondents found water quality to be aesthetically impaired when chlorophyll *a* was at a 10 – 20 µg/ml level.

A comparison of the high chlorophyll *a* levels regularly observed in the Lower Charles River Basin to those in user perception-based studies strongly supports the case that the water quality of the Lower Charles River is aesthetically impaired. Analysis of chlorophyll *a* data collected by EPA during the summer season (July 1 – October 31) evaluated the frequency at which certain levels of chlorophyll *a* were exceeded. The data show that 100, 40, and 21 percent of 42 sampling events conducted by EPA found chlorophyll *a* concentrations at one or more stations in the Basin at levels above 20 µg/l, 30 µg/l, and 40 µg/l, respectively (EPA Data, 1998-2004). An analysis of the MWRA summer season data collected for the same years at station 166 located at the downstream end of the Basin (just upstream of the Museum of Science) revealed that 55, 25, and 13 percent of 121 sampling events found chlorophyll *a* concentrations that were greater than 20 µg/l, 30 µg/l, and 40 µg/l, respectively. The lower frequencies of observed elevated chlorophyll *a* concentrations at station 166 compared to data from the entire Lower Charles River are believed to reflect the improved water quality conditions that typically occur in the downstream-most segment of the river. Thus, excess algae caused by phosphorus violate the subjective component of the water quality criterion because measured levels of chlorophyll *a* frequently exceed levels found to be objectionable in user-perception studies.

In summary, storm water discharges, particularly storm water discharges from impervious surfaces, carry high phosphorus loads to the Charles River where they contribute to eutrophication. This eutrophication of the Charles River causes or contributes to violations of numerous Massachusetts water quality standards, including impairment of the designated uses of primary and secondary contact recreation and aquatic habitat and violations of water quality criteria, including those for nutrients, solids, color and turbidity, pH, dissolved oxygen and aesthetics.

B. Derivation of the Total Maximum Daily Load (TMDL) for Phosphorous in the Lower Charles River and the Need to Control Phosphorous Discharges to Meet the Waste Load Allocations of the TMDL

Section 303(d) of the CWA and EPA's implementing regulations (40 C.F.R. Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for impaired waterbodies, i.e., waters not meeting the state's applicable water quality standards. A TMDL establishes the amount of a pollutant that a water can assimilate without exceeding its water quality standard for the pollutant. TMDLs provide a scientific basis for a state to establish water quality-based controls to reduce pollutant discharges from both point sources and nonpoint sources (if state law provides for regulation of nonpoint sources) to attain the state's applicable water quality standards. On October 17, 2007, EPA approved a TMDL submitted by the Commonwealth of Massachusetts because of water quality standards violations in the Lower Charles River caused by the discharge of phosphorus in the Charles River watershed (the TMDL). The pollutant of concern for the TMDL was phosphorus.

The TMDL uses chlorophyll *a* concentrations as a means to measure acceptable amounts of algae in the Lower Charles River and to determine acceptable phosphorus loads. Chlorophyll *a* is the photosynthetic pigment found in algae and is, therefore, a direct indicator of algal biomass. Since the eutrophication-related impairments in the Lower Charles River are the result of excessive amounts of algae, a chlorophyll *a* target is a reasonable surrogate to define acceptable amounts of algae that will support designated uses.

The TMDL set a chlorophyll *a* target of 10 µg/l on a seasonal average basis. The seasonal average is defined as the mean chlorophyll *a* concentration in the Lower Charles River between June 1 and October 31 of each year. This period represents critical conditions when algal blooms are typically most severe in the Lower Charles River and have the greatest impact on designated uses.

The target was derived using a weight of evidence approach and is based on literature values of chlorophyll *a* relating to trophic classifications, user-perception studies that relate chlorophyll *a* to aesthetic impairments, and site-specific information concerning the physical, chemical, and biological characteristics of the Lower Charles River. The chlorophyll *a* target is set at a level that will satisfy all applicable Class B narrative (nutrients, aesthetics, and clarity) and numeric (DO and pH) criteria as specified in the Massachusetts water quality standards presented in Table 2. A detailed, calibrated water quality model in combination with extensive water quality data from the Charles River provided a method for determining the allowable phosphorus loads.

A TMDL for a given pollutant and waterbody is composed of the sum of individual wasteload allocations (WLAs) for NPDES-regulated point sources--such as wastewater treatment facilities, combined sewer overflows, and storm water discharges through point sources--and load allocations (LAs) for nonpoint sources, non-regulated point sources and natural background levels. 40 C.F.R. § 130.3(i). In addition, a TMDL includes a margin of safety (MOS) to account for uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. CWA section 303(d)(1)(C),33U.S.C.§ 1313(d)(1)(C) and 40 C.F.R. § 130.7(c).

In the Lower Charles Phosphorus TMDL**,** the non-regulated point source and nonpoint source discharges, which are typically addressed by a LA, are included within the WLA, because of the difficulty in separating these sources from regulated point source discharges required to be addressed by a WLA. Hence, the LA has been set at zero.

A TMDL explains the basis for allocating loads and wasteloads to various sources to meet applicable water quality standards under the CWA. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the loading capacity of the receiving water must be established and thereafter become the basis for establishing water quality-based controls from dischargers to a waterbody.

The Lower Charles Phosphorus TMDL sets two sets of individual allocations and seven aggregate allocations. With respect to the former, the TMDL sets individual allocations for each of the wastewater treatment facilities (WWTFs) in the upstream watershed and for each of the combined sewer overflows (CSOs) in the Lower Charles watershed. With respect to the seven aggregate allocations, the TMDL sets allocations for: 1) the upstream watershed at Watertown Dam (including the wastewater treatment facilities combined); 2) the Lower Charles CSO discharges combined; 3) the Stony Brook watershed; 4) the Muddy River watershed, 5) the Laundry Brook watershed; 6) the Faneuil Brook watershed; and, 7) other drainage areas that eventually discharge into the Lower Charles River.

Table 3 presents the total phosphorus loads to the Lower Charles River during the 1998-2000 period and the reductions needed to meet the TMDL's 10 µg/l seasonal average chlorophyll *a* water quality target. Based on 1998-2000 data, the TMDL estimates that the Lower Charles River receives an annual phosphorus load of 40,050 kg/year. In order for the Lower Charles River to meet water quality standards, this load must be reduced to 19,544 kilograms per year (kg/yr).

The summary of the total phosphorus TMDL for the Lower Charles River is presented in Table 3 and indicates that needed phosphorus loading reductions to the Lower Charles River range from 48% (upper watershed) to 96% (CSOs).

Table 3 Summary of phosphorus TMDL for the Lower Charles River

Source	Existing Load (1998-2002) (kg/year)	WLA (kg/year)	LA (kg/year)	TMDL (kg/year)	% Reduction
Upstream Watershed at Watertown Dam[a]	28,925	15,109	0	15,109	48
CSOs[b]	2,263	90	0	90[c]	96
Stony Brook Watershed	5,123	1,950	0	1,950	62
Muddy River Watershed	1,549	590	0	590	62
Laundry Brook Watershed	409	155	0	155	62
Faneuil Brook Watershed	326	125	0	125	62
Other Drainage Areas	1,455	550	0	550	62
Explicit Margin of Safety	-	-	-	979	
TOTAL	40,050	18,565	0	19,544[d]	54

[a] The aggregate allocation for sources in the upstream watershed includes all point and nonpoint sources in the upstream watershed, including WWTFs. For the TMDL period (1998-2002), 23% of the total phosphorus load at Watertown Dam was attributable to the WWTFs in the upper watershed. Therefore 77% of the total phosphorus load at Watertown Dam was due to other sources such as storm water. Many of those storm water discharges are currently controlled by the small MS4 NPDES general storm water permit and a few additional sources are covered by the Multi-Sector General Permit (MSGP) for storm water. Those permits will be made consistent with the TMDL on their next reissuance.
[b] The 96% reduction is based on required CSO volume reductions in the Long Term CSO Control Plan.

[c] This value represents an estimate that would be needed under 1998-2002 conditions. The TMDL however is based on a typical year and compliance with the approved long-term control plan.

[d]. This number includes 979 kg/yr that represents the margin of safety.

Waste Load Allocation and Reductions from Storm Water

The TMDL indicates that the existing loads (as of 1998-2000) of 40,050 kg/yr must be reduced by 21,485 kg/yr to achieve the TMDL of 18,565 kg/year. The required reduction from CSOs, all located below the Watertown Dam, is 2263 kg /yr, reflecting the court ordered reduction based on the Long Term Control Plan. The required reduction from WWTFs, all located above the Watertown Dam, totals 2162 kg /yr (see Table 4). Once these reductions are accounted for, the vast bulk of the remaining phosphorus load reductions both above and below the Watertown Dam must be achieved through controls on storm water discharges.

Table 4 presents the reductions needed from storm water system discharges based on various land uses in the watershed including commercial, industrial, high density residential, medium density residential, low density residential, agricultural, forest and open space uses, as discussed in detail below.

Table 4 Summary of land cover phosphorus loading and TMDL loading for the Charles River Watershed from TMDL Report

Land Cover / Source Category	Area (square miles)	1998-2002 phosphorus Loading (kg / yr)	TMDL phosphorus Loading (kg / yr)	Percent Load Reduction
Commercial	8.36	3676	1286	65%
Industrial	15.01	5718	1972	65%
High Density Residential	35.62	10437	3600	65%
Medium Density Residential	36.00	5278	1820	65%
Low Density Residential	42.73	503	276	45%
Agriculture	7.96	1042	672	35%
Forest	119.09	4018	4018	0%
Open Land	32.52	289	187	35%
WWTF		6825	4663	32%
CSO		2263	90[1]	96%
Total	**297.20**	**40,050**	**18,565**	**53.6%**

The TMDL Report on which the TMDL is based, ***[Final Total Maximum Daily Load for Nutrients in the Lower Charles River Basin Massachusetts CN 1301.0, June 2007],*** calculated in a multi-step process the recommended load reductions from storm water discharges in each land use. The first step involved performing a land cover analysis that evaluated the percentage of the watershed devoted to each of the eight land use categories mentioned above.

The phosphorus load from each of the different land use categories was then calculated by taking the amount of area in the watershed devoted to each of the land uses and multiplying that area by export phosphorus loading factors representative of that land use. These factors were derived from research of extensive scientific literature. Applying phosphorus loading export factors to estimate watershed phosphorus loading is a common practice used in developing TMDLs for eutrophic waters.

In addition to calculating phosphorus loads through a land use analysis, the TMDL Report estimated phosphorus loads based on extensive water flow and water quality data refined through a model calibration process. The phosphorus load analysis that was based on the land use analysis produced results that were very similar to measured watershed loads for the five-year study period. This high correlation between the loadings based on a land use analysis and the loadings based on data and modeling validates the land use-based loading analysis.

Once calculated, the reductions from the land use categories were evaluated for feasibility while keeping the total reduction in mind. Based on this evaluation, the TMDL Report concluded that the substantial areas of forested lands within the watershed (38% of watershed area) are, for the most part, in a natural condition with relatively low phosphorus export rates. Consequently, it was determined that assigning load reductions for forested areas would not be reasonable or appropriate.

Because the agricultural areas in the Charles River watershed are generally not regulated and because agricultural storm water discharges are beyond the scope of NPDES regulation, CWA section 502(14), 33 U.S.C.§1362(14), it was determined that a relatively high percentage reduction was not likely to be achieved from agricultural discharges. However, since agricultural areas are known to contribute nutrients, and because the control of some agricultural areas using low-cost practices such as pollution prevention is feasible and desirable, a percent reduction of 35 percent was recommended.

Feasibility was also considered in developing a reduction level for low density residential and open space land uses. Because export loading rates for these land uses are already low compared to the rates for the uses with higher imperviousness, achieving high load reductions was determined to raise implementability challenges. As with the agricultural land use, these sources were identified in the TMDL Report so that communities could take them into account in zoning restriction and development planning and requirements. Addressed prospectively, phosphorus loads created by development may be reduced at relatively low cost.

Finally, in order to achieve the remaining needed reduction of 16,431 kg/yr, a reduction of 65 percent was assigned to the major sources (commercial, industrial, high density residential and medium density residential land uses). These sources together represent about 62 percent of the total phosphorus load to the Lower Charles River.

As part of the TMDL implementation plan, an analysis of land use in each of the communities upstream of Watertown was performed and a rough calculation of the reductions needed from each community estimated. The results of those calculations for Milford, Bellingham and Franklin are provided in Table 5.

Charles River Watershed Community	Comm.	Industrial	High Density Residential	Medium Density Residential	Low Density Residential	Agricul.	Forest	Open land	Total	Percent Reduction Required
Bellingham										
Drainage Area (ha)	58.8	212.0	134.2	240	212.2	57.1	1315.9	245.0	2475.3	
1998-2002 Loading (kg/yr)	99.8	311.7	151.9	135.9	9.7	28.8	171.6	8.4	917.8	
TMDL Loading (kg/yr)	34.4	107.5	52.4	46.9	503	18.6	171.6	5.4	442.1	51.8%
Franklin										
Drainage Area (ha)	87.5	351.2	110.5	1455.0	597.6	119.8	2966.7	600.3	6288.6	
1998-2002 Loading (kg/yr)	148.6	516.4	125.0	823.5	27.2	60.6	386.8	20.6	2108.7	
TMDL Loading (kg/yr)	51.2	178.1	43.1	284	14.9	39.1	386.8	13.3	1010.6	52.1%
Milford										
Drainage Area (ha)	80.3	328.9	270.7	647.7	243.4	3.1	149.1	265.2	3278.4	
1998-2002 Loading (kg/yr)	136.4	483.7	306.3	366.6	11.1	1.6	187.6	9.1	1502.3	
TMDL Loading (kg/yr)	47	166.8	105.6	126.4	6.1	1.0	187.6	5.9	646.5	57.0%

Table 5: Phosphorus Loading by Community By Land Use

Table 5 indicates that very large reductions in phosphorus loads are needed in the communities of Milford, Bellingham and Franklin in order to meet the TMDL. To achieve those reductions will require reducing phosphorus loads from all land uses having significant impervious areas.

In summary, significant reductions from numerous phosphorus sources in the Charles River watershed will be necessary to meet the waste load allocations of the TMDL. Some of those reductions can be achieved through the implementation of an existing consent decree (CSOs) or through the enforcement of current permits and the reissuance of permits that are consistent with the WLAs (MS4 and WWTF permits). Even after those reductions are made, significant additional reductions from land generating high phosphorus loads in storm water must be made to assure water quality is consistent with Massachusetts water quality standards and to meet the WLAs of the TMDL. This residual designation helps to assure that those additional phosphorus reductions are secured through the reliable, enforceable process provided by the NPDES permitting program.

V: SELECTION OF DESIGNATED DISCHARGES

As noted above, regulations promulgated under the CWA provide EPA with the authority to designate a wide range of storm water discharges or categories of discharges once specific standards in 40 C.F.R. §122.26 are met. The regulations also provide EPA with broad discretion in designating discharges based on localized considerations.

In enacting CWA Section 402(p), Congress allowed for the immediate regulation of specified sources known to present the most significant threats to surface water quality. Likewise, in promulgating the Phase II storm water rule (64 Fed. Reg. 68722, Dec. 8, 1999), EPA sought to control sources presenting the greatest potential harm to water quality on a nationwide basis. This preliminary residual designation follows a similar principle in controlling localized discharges that are known to be contributing to water quality standards violations in the lower Charles River and that are currently unregulated.

This preliminary Residual Designation covers storm water discharges from real property containing impervious surfaces equal to or greater than two acres in Milford, Bellingham or Franklin, Massachusetts. Below is a discussion of the rationale used by EPA to identify this category of discharges for this preliminary residual designation.

A. Selection of Milford, Bellingham and Franklin

This residual designation identifies for NPDES permitting storm water discharges in the municipalities of Milford, Bellingham and Franklin. The Agency is focusing this preliminary residual designation on these three municipalities for several reasons.

1. The available information indicates that these municipalities are the first places where the Charles River experiences significant eutrophication. The Charles River begins in Hopkinton, Massachusetts and flows from there into the municipalities of Milford, Bellingham and Franklin. At its headwaters in Hopkinton, the Charles enjoys extremely high water quality and is in fact used as a drinking water supply. The first indications that phosphorus is degrading water quality appear as the river runs through Milford, Bellingham and Franklin.

DEP has performed water quality assessments of the entire Charles River in order to determine water quality conditions and the extent to which the Charles River and its tributaries are supporting designated uses. The results of the most recent assessments are reported in the *Charles River Watershed 2002-2006 Water Quality Assessment Report* released in April 2008. The report identifies the many segments of the Charles River and its tributaries and presents the results of various water quality monitoring efforts conducted during the last several years. Additionally, in those instances where segments are determined not to be attaining standards, the report identifies, when known, the probable sources and causes of the water quality impairments.

The results of the assessments for most of the upstream portion of the Charles River indicate that storm water runoff, with the elevated levels of phosphorus it contains, is a contributing source to water quality impairments. Excerpts of DEP's assessment report for the upstream segments are presented in Table 6 and indicate that, with the single exception of the uppermost, headwater segment, the Charles River is impaired, at least in part, because of elevated phosphorus and excessive aquatic plant growth. The headwater segment, MA72-01, drains a relatively undeveloped watershed and does not show evidence of nutrient enrichment and excessive plant growth. However, starting with Milford Pond (Figure 6) and moving downstream through Populatic Pond (Figure 9), there is documented evidence of impairments resulting from excessive phosphorus. In all cases, the report identifies discharges from municipal separate storm sewers and urban runoff/storm water as suspected sources.

Table 6. Summary of DEP water quality assessments for the river segments in the upper Charles River Watershed related to phosphorus and eutrophication (source: Charles River Watershed 2002-2006 Water Quality Assessment Report, DEP, April, 2008)

Waterbody Name and Segment No.	Segment Description	Use impairment related to phosphorus and eutrophication	Suspected source contributing to impairment caused or contributed to by elevated phosphorus and eutrophication
Charles River (MA72-01)	Outlet of Echo Lake to just upstream of Milford pond, 2.5 miles, Hopkinton/Milford	None identified	None identified
Charles River (MA72-02)	Outlet of Milford Pond to the Milford WWTF discharge, 2.0 miles, Milford/Hopedale	Aquatic life	Discharges from municipal separate storm sewer systems, urban runoff/storm water
Charles River (MA72-03)	Milford WWTF discharge to Outlet of Box Pond, 3.4 miles, Hopedale/Bellingham	Aquatic life, primary contact, secondary contact, and aesthetics	Discharges from municipal separate storm sewer systems, urban runoff/storm water
Charles River (MA72-04)	Outlet Box Pond to inlet to Populatic Pond, 11.5 miles, Bellingham, Norfolk/Medway	Aquatic life	Discharges from municipal separate storm sewer systems, urban runoff/storm water

In addition to these river segment assessments, DEP has assessed Milford Pond (Figure 6) as impaired due to excessive aquatic plant growth and Populatic Pond (Figure 9) as impaired due to excessive algal growth. These ponds are impoundments in the mainstream of the Charles River.

2. Controlling phosphorous discharges in these municipalities is a logical place to start for this preliminary residual designation. This approach fits well with DEP's implementation plan for the Lower Charles phosphorus TMDL, which recommends an adaptive management approach--a control strategy that relies on an iterative process that sets realistic goals and schedules, which are then adjusted as monitoring and assessment of control activities dictate. By designating and then controlling phosphorus discharges from large impervious areas in the upstream municipalities of Milford, Franklin and Bellingham through NPDES permits, EPA will be able to assess how quickly and effectively the river responds to those controls. If municipalities further down in the watershed were addressed before these upstream municipalities, sorting out the effectiveness of controls in the downstream municipalities may be confounded by phosphorus from upstream sources. By examining the effects of implemented storm water controls at the top of the watershed, EPA will be able to observe their utility and effectiveness for application lower in the watershed.

3. Controlling phosphorus sources in the upper watershed has the potential to benefit water quality throughout the entire length of the Charles River. Control of phosphorus discharges in the upper watershed will result in immediate, local improvements as the supply of nutrients and the eutrophication it causes decline. The reduction of upstream phosphorus sources will reduce the amount of the phosphorus making its way to the Lower Charles and will provide water quality benefits there as well.

4. Controlling phosphorus discharges in the upper watershed will have longer term benefits than achieving reductions elsewhere, as once phosphorus is introduced into the Charles River system, it becomes available as a nutrient source that causes eutrophication over and over again. This dynamic exists because phosphorus persists as river water flows slowly downstream and has the potential to repeatedly become available.

One of the most important features affecting phosphorus transport in the Charles is the existence of numerous impoundments above dams. In these impoundments, water velocities slow, increasing sedimentation rates and the opportunity for algal blooms. The process of sedimentation results in the removal of some of the phosphorus as it sinks and becomes part of the bottom sediment. However, some of this settled phosphorus can later be reincorporated into the overlying river water through a variety of mechanisms including re-suspension when river flow rates increase or through chemical release when conditions are favorable for phosphorus to become dissolved (e.g., low DO). Also, in shallow areas of the impoundments where plants get much of their nutrients from sediment, phosphorus-laden sediments help to fuel plant growth.

Thus, because of phosphorous's repeated availability as a nutrient, and because of the numerous dams at and above Watertown Dam, phosphorus entering the system from the upper watershed, such as from discharges in Milford, Franklin and Bellingham, can become part of the algae or plant mass growth cycle many times over a period of years before it is finally discharged to Boston Harbor.

B. Selection of Impervious Cover

As a general matter and as discussed above in section II, across all land uses, imperviousness, more than any other single factor, determines the magnitude of phosphorus loads in storm water discharges. This amplified phosphorus load results from the adhesion of phosphorus to fine particles highly susceptible to wash off from impervious surfaces. Increased runoff volumes and decreased infiltration opportunities typical of impervious surfaces also contribute to high loads.

Table 1 illustrates the direct relationship between the amount of phosphorus discharged from various land uses and the degree of imperviousness associated with each. The data all substantiate the conclusion that the amount of imperviousness generally dictates the amount of phosphorus discharged from land on an acre-for-acre basis.

This correlation between imperviousness and phosphorus loading is evident in the Charles River watershed as shown in Figure 11, below. This chart shows that imperviousness and export loading rates vary directly. For instance, the land use with the highest percent imperviousness in the watershed—commercial land use—also has the highest export loading rate. [Note: each bar represents a land use with the percent of imperviousness associated with the land use for the Charles River watershed in parentheses. The vertical axis displays the export loading rate]. Likewise, the land use with the second highest percent imperviousness—industrial—has the second highest phosphorus export loading rate.

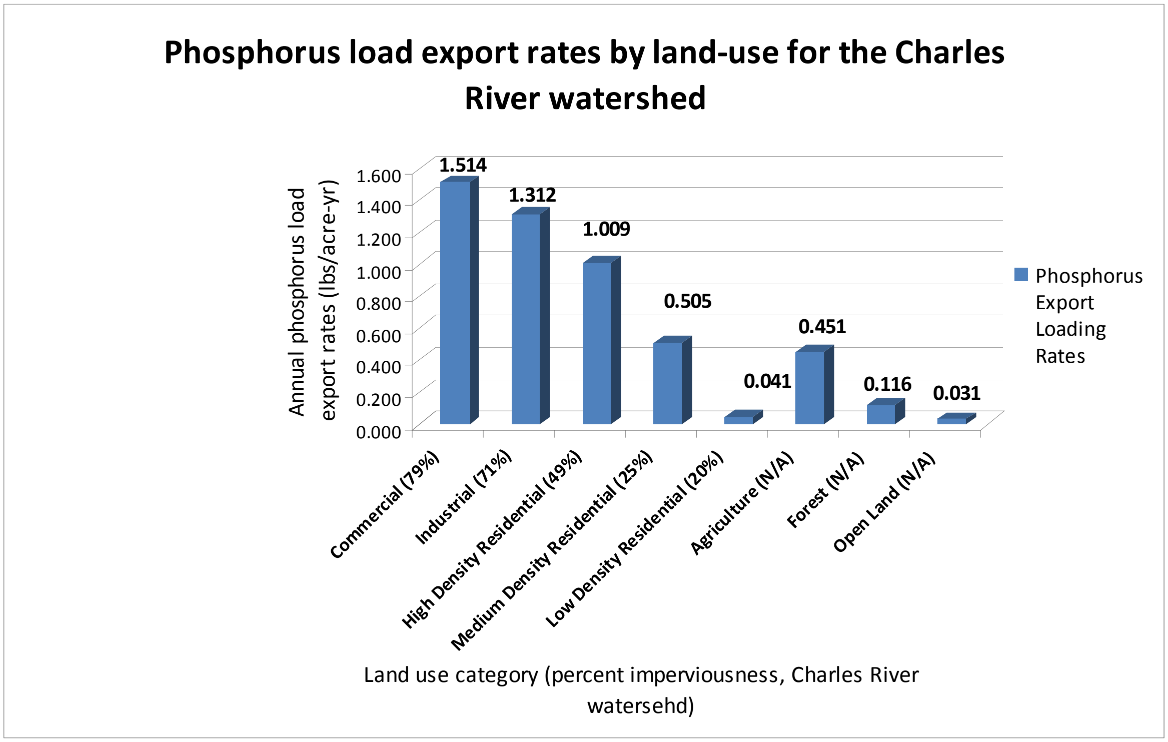

Figure 11. Export loading rates by land use in Charles River Watershed

Given that the goal of this residual designation is to control phosphorus in storm water discharges, imperviousness is a logical criterion to use in identifying sources of pollutant discharges.

C. Selection of Two Acre Threshold

1. Discharges of storm water from impervious surfaces in the upper Charles River watershed are contributing to violations of water quality standards. Large reductions in phosphorus loads from these discharges are needed to meet the requirements of the waste load allocations in the TMDL. Because phosphorus loads from impervious surfaces are proportional to their area, it is reasonable for this preliminary residual designation in the Charles River watershed to focus on relatively large impervious surfaces.

As noted above, this residual designation is focused on the three municipalities for a host of reasons. Achieving significant phosphorus reductions in those communities necessarily includes achieving reductions from sizable impervious areas.

Table 5 indicates that steep reductions in storm water phosphorus loads in Milford Bellingham and Franklin that amount to 57, 51.8 and 52%, respectively, are necessary to meet the TMDL implementation plan's goals for these municipalities. An NPDES storm water permitting approach that achieves a 65% reduction in phosphorus loads, a level that is attainable with effective storm water best management practices, will yield a total, combined reduction of 1,670 pounds in these three municipalities. This represents a significant contribution toward the necessary reduction of 2428.9 pounds required in the implementation plan but will not by itself achieve that goal. Controls of additional sources and enhanced controls of sources currently regulated under the NPDES program, such as MS4s, will also be necessary. A preliminary residual designation at the two-acre threshold, however, is a necessary foundation for and component of a larger phosphorus load reduction program in the three municipalities.

The implementation plan for the TMDL recommends an adaptive management approach that relies on an iterative process that sets realistic goals and schedules. Those goals and schedules will then be adjusted as monitoring and assessment of control activities dictate. In accordance with the TMDL's adaptive management approach, additional controls will be determined if adequate progress is not being made or not being made in a reasonable timeframe.

2. By focusing on discharges from impervious surfaces equal to or greater than two acres, this residual designation will provide efficiencies in terms of storm water management costs and storm water management administration. With respect to storm water management costs, there is a clear economy of scale. Both construction costs and operation and maintenance costs decrease on an acre-for-acre basis as the size of managed areas increase. From the perspective of management efficiencies, larger tracts under single ownership or management allow for simplified planning and implementation. As parcel size decreases and the number of owners and managers increases on an acre-for-acre basis, greater administrative costs for coordinating a unified management scheme result. While additional residual designations using acreage thresholds below two acres may be necessary in the future, this action aims to secure the efficiencies offered by designating at the relatively high two-acre threshold. Based on these analyses, this preliminary residual designation will cover storm water discharges from two or more acres of impervious surfaces that are located on a single lot or two or more contiguous lots aggregated in accordance with 314 CMR 21.05 in the Charles River watershed that are located, in whole or in part, within the municipalities of Milford, Bellingham or Franklin, Massachusetts.

This residual designation is intended to help restore the Charles River and is not a determination that smaller impervious surfaces are not contributing to water quality standards violations or that their control is not needed to implement the TMDL. Additional storm water management measures, including control of smaller impervious surfaces, may be necessary in the future if this designation and other anticipated phosphorus control activities do not provide the anticipated water quality improvements.

VI: DETERMINATIONS

Each of the following determinations is a separate and independent basis for this preliminary residual designation.

A. DETERMINATION THAT THE DISCHARGE OR CATEGORY OF DISCHARGES WITHIN A GEOGRAPHIC AREA CONTRIBUTES TO A VIOLATION OF A WATER QUALITY STANDARD PURSUANT TO 40 C.F.R. §122.26(a) (9)(i)(D)

1. The applicable Massachusetts water quality standards identify the Charles River below the uppermost segment, which serves as a drinking water supply, as a Class B water, designated as a habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. Additionally, Class B waters are required to have consistently good aesthetic value. The water quality standards also contain criteria to protect those designated uses. *314 Code of Massachusetts Regulations (CMR) 4.05 DEP* ***2006****).*

2. Based on extensive water quality sampling, the Massachusetts DEP determined in its 2002, 2004 and 2006 Section 303(d) lists that the Charles River was not meeting water quality standards relating to a number of pollutants and conditions. For purposes of this residual designation, the water quality criteria that are being violated include those related to DO; pH; solids; color and turbidity; aesthetics; and nutrients.

3. The discharges identified in this decision document as “designated discharges” are discharges of storm water from two or more acres of impervious surfaces that are located on a single lot or two or more contiguous lots aggregated in accordance with 314 CMR 21.05 in the Charles River watershed that are located, in whole or in part, within the municipalities of Milford, Bellingham or Franklin, Massachusetts, directly or indirectly, to the Charles River, excluding the categories of facilities identified as excluded on page one of this document.

4. Discharges of storm water, including the designated discharges, contain phosphorus that is causing or contributing to excessive plant growth, including algae growth, in the Charles River. This excessive plant growth is directly and indirectly causing violations of the applicable Massachusetts water quality standards. Therefore, the category of designated discharges is contributing to violations of those water quality standards.

B. DETERMINATION THAT STORM WATER CONTROLS ARE NEEDED FOR A DISCHARGE OF STORM WATER BASED ON WASTELOAD ALLOCATIONS THAT ARE PART OF A TOTAL MAXIUMUM DAILY LOAD (TMDL) THAT ADDRESSES THE POLLUTANT OF CONCERN PURSUANT TO 40 C.F.R. §122.26(a)(9)(i)(C)

1. The discharges identified in this decision document as “designated discharges” are discharges of storm water from two or more acres of impervious surfaces that are located on a single lot or two or more contiguous lots aggregated in accordance with 314 CMR 21.05 in the Charles River watershed that are located, in whole or in part, within the municipalities of Milford, Bellingham or Franklin, Massachusetts, directly or indirectly, to the Charles River, excluding the categories of facilities identified as excluded on page one of this document.

2. The Lower Charles phosphorus TMDL establishes a wasteload allocation for phosphorus from the watershed upstream of the Watertown Dam of 15,109 kg/year. The existing load (1998-2002) for phosphorus is 28,925 kg/year. Thus, for the WLAs in the phosphorus TMDL to be achieved, an overall reduction of 48% is needed from phosphorus loads upstream of the Watertown Dam.
3. The TMDL identifies storm water as a significant source of phosphorus loads that are contributing to impairments to water quality in the Lower Charles River.
4. Discharges of phosphorus from wastewater treatment facilities, combined sewer overflows and some storm water sources are currently regulated by NPDES permits. Even after phosphorus reductions from currently regulated sources are achieved, the waste load allocations from the Charles watershed upstream of Watertown Dam will not be met and the relevant water quality standards will not be attained unless phosphorus discharges from additional sources are controlled.
5. Sources of phosphorus that need to be reduced in order for the WLA to be achieved include, but are not limited to, the designated discharges.
6. In order to ensure effective and enforceable reductions of phosphorus loads from the designated discharges, that category of discharges must be controlled through the issuance of permits under the NPDES program.

VII: AUTHORIZING SIGNATURE

U.S. Environmental Protection Agency

By: ________________________ Date: ____________________

Robert W. Varney
Regional Administrator
EPA Region 1

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Appendix A

As used in this document, the following terms shall have the following meanings:

Contiguous Lots - two or more lots that directly abut each other or are separated only by a privately owned access way or driveway. Lots are also considered to be contiguous if, although separated by a public right of way, they are functioning as part of a single facility or campus.

Manufactured Home - a structure, built in conformance to the National Manufactured Home Construction and Safety Standards which is transportable in one or more sections, which in the traveling mode, is eight body feet or more in width or forty body feet or more in length, or, when erected on site, is three hundred twenty or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling unit with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air conditioning, and electrical systems contained therein and is a manufactured home as defined in M.G.L. c. 140, § 32Q.

Manufactured Housing Community - a lot or tract of land upon which three or more manufactured homes occupied for dwelling purposes are located, including any buildings, structures, fixtures and equipment used in connection with manufactured homes, and that constitutes a manufactured housing community as defined in M.G.L. c. 140, § 32F.

Recreational Vehicle Parks and Campsites – establishments primarily engaged in the activities identified in Standard Industrial Classification Code 7033. These establishments include, without limitation, establishments primarily engaged in providing overnight or short-term sites for recreational vehicles, trailers, campers or tents.

Sporting and Recreational Camps - establishments primarily engaged in the activities identified in Standard Industrial Code Classification 7032. These activities include without limitation, boys' camps, dude ranches, fishing camps, girls' camps, hunting camps, and summer camps.