Attachment 1:

Impaired Waters Assessments

List of Impaired Waterbodies

Waterbody ID	Waterbody Name
MA41-05	Cady Brook
MA42-03	French River
MA42058	Texas Pond
MA42059	Thayers Pond
MA61-04	Cole River
MA61-02	Lee River
MA62134	Norton Reservoir
MA62-47	Wading River
MA71-01	Aberjona River
MA72055	Kendrick Street Pond
MA72-07	Charles River
MA72-11	Muddy River
MA72-24	South Meadow Brook
MA72-25	Rosemary Brook
MA72-29	Cheese Cake Brook
MA72-31	Unnamed Tributary
MA72-36	Charles River
MA72-38	Charles River
MA93032	Hawkes Pond
MA93060	Lake Quannapowitt
MA93-34	Saugus River
MA93-35	Saugus River
MA95113	Noquochoke Lake
MA95170	Noquochoke Lake
MA95171	Noquochoke Lake

Impaired Waters Assessment for Cady Brook (MA41-05)

Impaired Water Body

Name: Cady Brook

Location: Charlton, MA

Water Body ID: MA41-05

Impairments

Cady Brook (MA41-05) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2008,* final *Massachusetts Year 2010* and proposed *Massachusetts Year 2012 Integrated List of Waters* (MassDEP 2008, 2011 and 2012, respectively). Table 1 below shows the impairments to Cady Brook included on each list. The table includes the 2008 list impairments, even though the final 2010 list is more current, since MassDOT based its Impaired Waters Program commitments (BMP 7U; MassDOT, 2009) on receiving waters listed in the 2008 list.

Table 1. Impairments to Cady Brook (MA41-05) Included on the Massachusetts Integrated List of Waters

Massachusetts Integrated List of Waters		
Final 2008 List	**Final 2010 List**	**Proposed 2012 List**
Flow alteration*	Low flow alterations*	Low flow alterations*
Pathogens	Fecal coliform	Fecal coliform
	Ambient bioassays – Chronic aquatic toxicity	Ambient bioassays – Chronic aquatic toxicity

*Non-pollutants

According to MassDEP's *French & Quinebaug River Watersheds 2001 Water Quality Assessment Report* (MassDEP, 2002), Cady Brook (MA41-05) is impaired for flow alteration due to hydromodification.

As described below, MassDOT recommends the implementation of various Best Management Practices (BMPs) for Cady Brook (MA41-05) to improve water quality based on an assessment using the Impervious Cover (IC) Method. While these recommendations for BMPs address impairments specific to segment MA41-05 of Cady Brook, all receiving water bodies downstream of the BMPs will ultimately benefit from the improvements.

Relevant Water Quality Standards

Water Body Classification: Class B\WWF

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 4 Bacteria*.

- At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml
- for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department

- *314 CMR 4.05 (5) (b) Bottom Pollutants or Alterations*. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.

- *314 CMR 4.05 (5)(e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Site Description

Cady Brook is a small stream located in Charlton, Massachusetts made up of two segments; MA41-05 and MA41-06. This assessment report focuses only on Segment MA41-05 of Cady Brook which begins at the outlet of Glen Echo Lake and continues approximately 1.5 miles until it becomes Segment MA41-06. Refer to Figure 1 for a map identifying Segment MA41-05 and its subwatershed. Note that the total watershed and subwatershed are the same for this water body.

Segment MA41-05 of Cady Brook has a directly contributing subwatershed of approximately 3,127 acres. This subwatershed consists of mainly undeveloped, forested areas. However, there are a significant number of residential and commercial properties and roadways that contribute to a total impervious cover (IC) area within the subwatershed of 318 acres (approximately 10.2%).

The Massachusetts Department of Transportation (MassDOT) currently owns and maintains Interstate 90 (I-90) and Route 20 (Rte 20) within the Cady Brook (MA41-05) subwatershed. Approximately 5.6 acres of I-90 contribute stormwater directly to Cady Brook via MassDOT's stormwater collection systems. Refer to Figure 2 for the location of MassDOT's directly contributing IC watershed.

This water body was originally included to be assessed under the Impaired Waters Program because the GIS analysis identified Route 20 as possibly discharging to Cady Brook. At that time I-90 was part of a separate agency and was not covered under MassHighway's stormwater program. During the field visit performed for this assessment, field teams determined that the stretch of Rte 20 within the Cady Brook subwatershed does not directly contribute stormwater, but instead discharges to non-impaired streams which pass under and run adjacent to Rte 20. Even though I-90 was not part of the Impaired Waters Program original commitments, MassDOT decided to proceed with the assessment of Cady Brook and review potential impacts from I-90.

Assessment under BMP 7U

The impairment of "ambient bioassays - chronic aquatic toxicity" for Cady Brook (MA41-05) has not been addressed by a Total Maximum Daily Load (TMDL). Therefore, MassDOT assessed the impairment using the approach described in BMP 7U (*Water Quality Impaired Waters Assessment and Mitigation Plan*), of MassDOT's Storm Water Management Plan, which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT,2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the impairment of Cady Brook via ambient bioassays – Chronic aquatic toxicity.

The impairment for flow alteration and low flow alteration is not considered a pollutant by the Massachusetts Department of Environmental Protection (MassDEP, 2008; MassDEP, 2011; MassDEP, 2012). Furthermore, stormwater runoff does not contribute to the impairment of low flow alterations.

The impairment for fecal coliform is assessed separately in the section titled Assessment under BMP 7U for Pathogens.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover (IC) Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the impervious cover reduction required to ensure that stormwater is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed had less than 9% IC, MassDOT concluded that stormwater was not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local

watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. Impervious cover data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which impervious cover would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective impervious cover reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective impervious cover reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective impervious cover reductions is described in BMP 7U. When the reduction in effective impervious cover achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for the total contributing watershed of the impaired water (Cady Brook, MA41-05):

Table 2. Site Parameters for Cady Brook (MA41-05)

Total Watershed and Subwatershed*		
Watershed Area	3,127	acres
Impervious Cover (IC) Area	318	acres
Percent Impervious	10.2	%
IC Area at 9% Goal	281	acres
Necessary Reduction % in IC	11.6	%
MassDOT Directly Contributing Watershed		
MassDOT Directly Contributing IC	5.6	acres
MassDOT Target Reduction in Effective IC (11.6% of MassDOT Directly Contributing IC)	0.6	acres

*The total watershed and subwatershed are the same in the case of Cady Brook (MA41-05)

The Cady Brook (MA41-05) subwatershed contains more than 9% IC, indicating that stormwater likely contributes to the water body's impairments. In order to reach the 9% threshold, effective IC

within the subwatershed should be reduced by 11.6%. Therefore, MassDOT's target is to reduce its own effective IC within the directly contributing watershed by the same percentage by removing 0.6 acres of effective IC.

Existing BMPs

There are no existing BMPs within MassDOT's directly contributing watershed to Cady Brook (MA41-05) that are mitigating potential stormwater quality impacts. Therefore, no effective IC reduction is currently provided.

Next Steps

Because there are no existing BMPs currently reducing effective IC, MassDOT is considering the implementation of an infiltration swale to achieve the target reduction. While the consideration for a BMP addresses impairments specific to Segment 41-05 of Cady Brook, all receiving water bodies downstream will ultimately benefit from the resulting improvements in water quality and hydrology.

It is recommended that MassDOT design BMPs to be constructed to meet the target effective IC reduction of 0.6 acres. Preliminary investigation indicates that there is the potential to implement check dams to create an infiltration swale in an existing drainage ditch within MassDOT right-of-way area. Figure 3 shows the location and approximate length of the proposed infiltration swale. Note that this location is approximate and may change during the design process as warranted by actual field conditions, which may include high groundwater, presence of utilities, unsuitable soil conditions, etc.

The effective IC reduction provided under the proposed conditions described below is listed in Table 3. Under these conditions, the recommended BMP will achieve an estimated effective IC reduction of 0.9 acres, slightly exceeding the target 0.6 acre reduction.

Pr-BMP-1
There is an existing drainage ditch adjacent to a stretch of I-90 eastbound which is well-vegetated with grass along the shoulder and becomes lined with small rocks as it approaches Cady Brook. Sheet flow from the center and outer lanes flows into the ditch and east to Cady Brook. Stormwater from the inside lane of I-90 westbound along this stretch enters catch basins and is discharged to this ditch. There is a slight sloped curb along a portion of this stretch of I-90 eastbound. However, there is evidence of sheet flow and the curb does not appear to be effective at directing stormwater to catch basins. There is no curb along the rest of this stretch. Local soils are classified as HSG C, indicating a moderate to poor rate of infiltration. The ditch was wet when observed in the field. MassDOT will consider adding check dams and modifying a 250-feet long portion of this drainage ditch to act as an infiltration swale. A swale with a top width of 11 feet, a bottom width of 2 feet, and a height of 1.5 feet will achieve approximately 37% in reduction of effective IC.

Pr-BMP-1 Infiltration swale.

Table 3. I-90 BMP Recommendations

BMP Identifier	BMP Type	Contributing Watershed IC Area (ac.)	Resulting % Removal of Contributing Watershed IC	Effective IC Area Reduction (ac.)
Pr-BMP-1	Infiltration Swale	2.42	37%	0.9

Assessment under BMP 7U for Pathogens

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an iterative adaptive management approach for stormwater to be consistent with relevant TMDL and permit condition requirements..

In addition, while there is a positive relationship between impervious cover and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 colonies/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 mL have been reported (MassDEP, 2009b). These data suggests that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally cross them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment and Mitigation Plan

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, no date).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contains specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Storm Water Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In

- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. Although not included in this permit term, MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters. In addition, MassDOT has requested coverage under an individual stormwater permit for the next permit term. This permit may contain additional programmatic BMPs to address pathogens.

Conclusions

MassDOT used the IC Method to assess Cady Brook (MA41-05) for the impairments identified in MassDEP's Final *Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing watershed to Cady Brook (MA41-05) by 0.6 acres to achieve the targeted reduction in effective IC.

While technically not required under the BMP 7U commitments since the only stormwater discharge is from I-90 (which were operating under a separate discharge permit at the time of the commitments), MassDOT has proposed the implementation of a stormwater BMP when funding for I-90 becomes available. This conceptual BMP would provide an estimated reduction in effective IC within MassDOT's directly contributing watershed to Cady Brook (MA41-05) of approximately 0.9 acres which will exceed the target removal. Table 4 summarizes IC reductions within MassDOT's directly contributing watershed under existing and proposed conditions.

Table 4. Effective IC Reductions under Existing & Proposed Conditions

Effective IC Reductions	
MassDOT Target Reduction in Effective IC	0.6 acres
Effective IC Reduction under Existing Conditions	0.0 acres
Effective IC Reduction under Proposed Conditions	0.9 acres
Remaining Target	**0 acres***

*Target will be exceeded under proposed conditions

MassDOT will now work with its design consultants to develop design plans for the proposed BMP as part of MassDOT's Impaired Waters Retrofit Initiative. Note that the estimated effective IC reduction that will be achieved may change depending on the final designs for the conceptual BMPs included in this assessment. The final BMP designs will provide treatment to the maximum extent practicable given site constraints that are identified as the design process moves forward.

MassDOT has concluded, based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs

for Massachusetts waters, that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's Programmed Projects Initiative. Work on Programmed Projects often includes broader scale road layout changes that may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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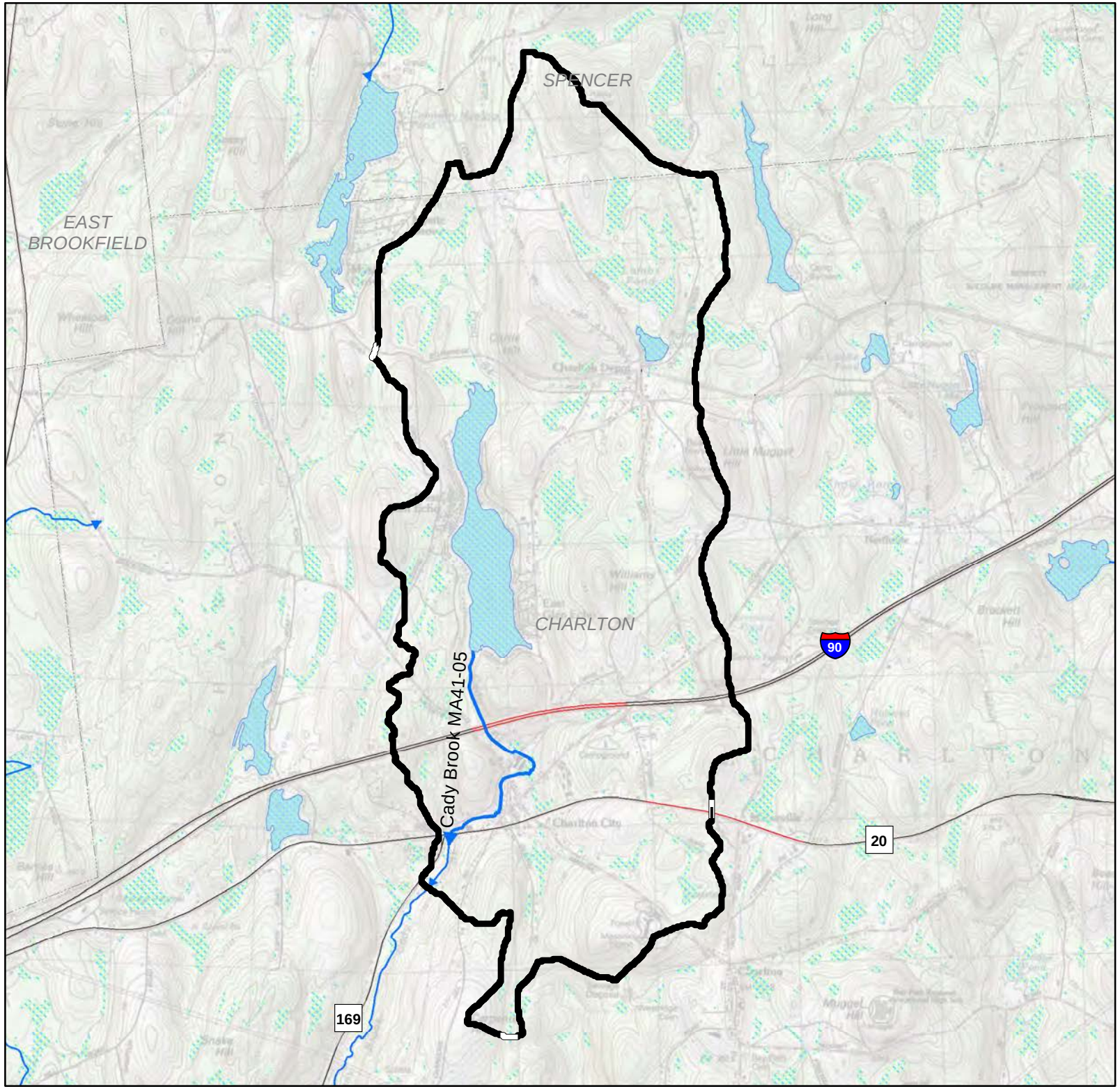

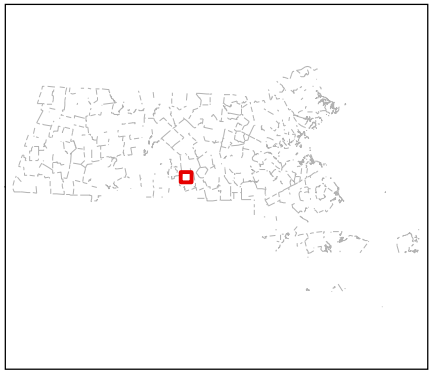

Cady Brook Total Watershed
Cady Brook Subwatershed
MA41-05
Impaired Stream Segments
Impaired Water Bodies
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 0.25 0.5 0.75 1 Miles

1 in = 1 miles

Figure 1

Cady Brook (MA41-05) Subwatershed

June 2012

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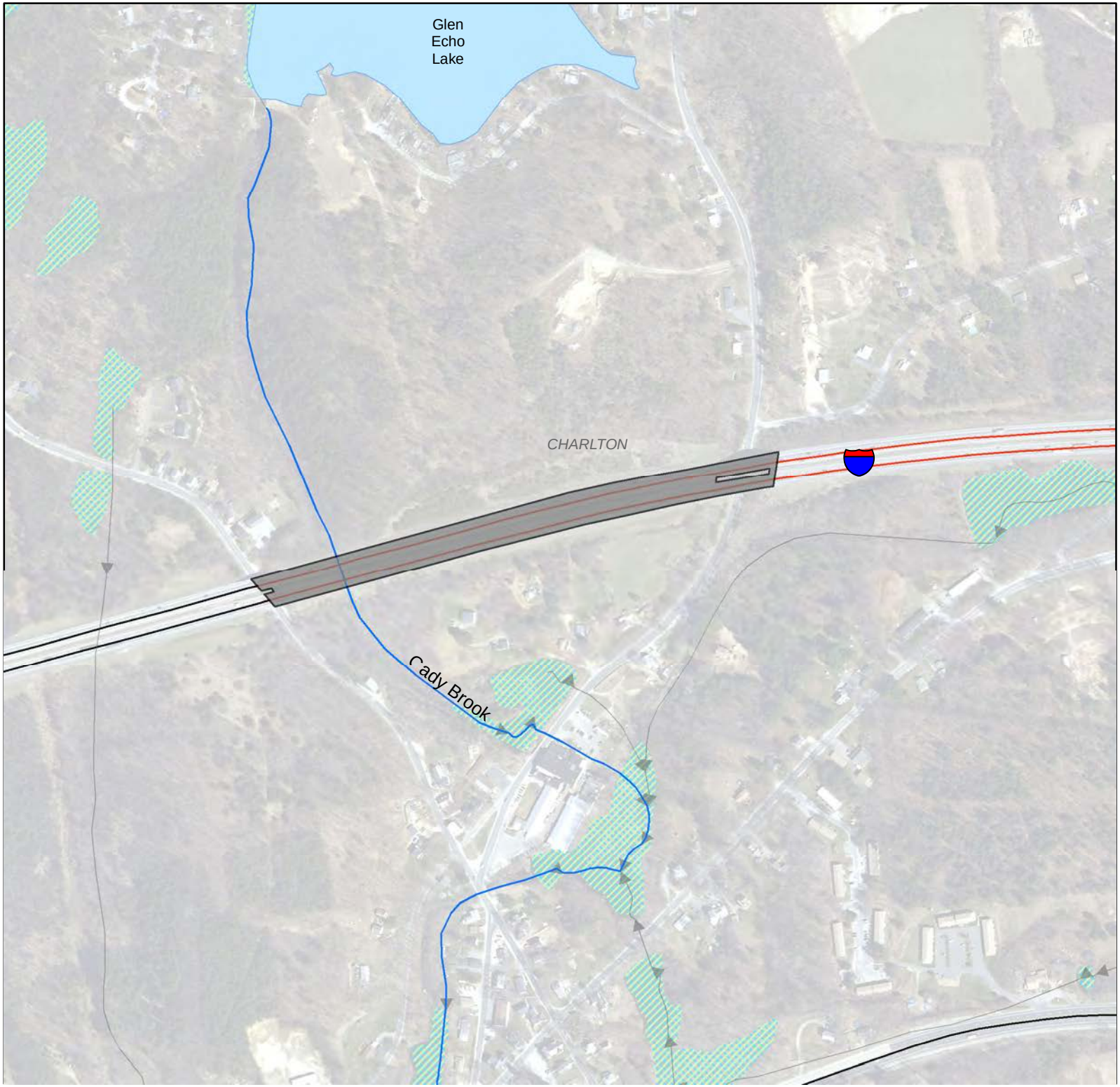

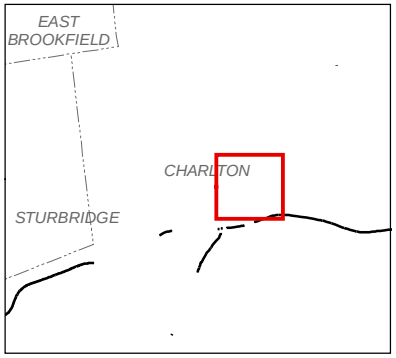

- Stormwater Outfalls
- MassDOT Directly Contributing Watershed
- Impaired Stream Segment
- Impaired Water Bodies
- Non-Impaired Stream Segment
- NWI Wetland Areas
- MassDOT Roads in Urban Areas
- MassDOT Roads
- Town Boundaries

N

0 125 250 500 750 1,000 Feet

1 inch = 500 feet

Figure 2

Cady Brook (MA41-05)
Directly Contributing
MassDOT Watershed

June 2012

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BMP Urban Watershed Area
Proposed BMP - Swale
Impaired Stream Segment
Impaired Water Bodies
Non-Impaired Stream Segment
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 100 200 400 600 800 Feet

1 in = 400 feet

Figure 3

Cady Brook (MA41-05)
Proposed BMP

June 2012

Moving Massachusetts Forward. massDOT

Impaired Waters Assessment for French River (MA42-03) Including Texas Pond (MA42058) and Thayers Pond (MA42059)

Impaired Waterbody

Name: French River (including Texas Pond and Thayers Pond)

Location: Leicester and Oxford, MA

Water Body ID: MA42-03 (including MA42058 and MA42059)

Impairments

Segment MA42-03 of the French River flows through three ponds: Rochdale Pond (MA42048), Texas Pond (MA42058), and Thayers Pond (MA42059). On the Massachusetts Department of Environmental Protection (MassDEP) final *Massachusetts Year 2008 Integrated List of Waters* (2008 List), the four waterbodies are listed separately. Table 1 shows the classification of each waterbody according to the 2008 List. Table 2 shows the impairments for each according to the 2008 List. The tables include the 2008 listings, instead of more recent 2010 final listings, since MassDOT based its Impaired Waters Program Commitments (BMP 7U, MassDOT, 2009) on the receiving waters included in the 2008 list.

Table 1. Waterbody Classifications as Shown on MassDEP's final *Massachusetts Year 2008 Integrated List of Waters*

Waterbody	Category
French River (MA42-03)	Category 5, Waters Requiring a Total Maximum Daily Load (TMDL)
Rochdale Pond (MA42048)	Category 4a, TMDL is Completed
Texas Pond (MA42058)	Category 5, Waters Requiring a TMDL
Thayers Pond (MA42059)	Category 5, Waters Requiring a TMDL

Table 2: Impairments for the French River (MA42-03), Rochdale Pond (MA42048), Texas Pond (MA42058), and Thayers Pond (MA42059) Listed on MassDEP's Final *Massachusetts Year 2008 Integrated List of Waters*

French River (MA42-03)	Rochdale Pond (MA42048)	Texas Pond (MA42058)	Thayers Pond (MA42059)
Metals	Nutrients	Metals	Metals
	Organic Enrichment/Low DO	Noxious Aquatic Plants	Nutrients
	Noxious Aquatic Plants		Turbidity

On MassDEP's final *Massachusetts Year 2010* and proposed *Massachusetts Year 2012 Integrated List of Waters* (2010 and 2012 Lists), both Texas Pond (MA42058) and Thayers Pond (MA42059) are considered run-of-river impoundments due to relatively short retention times and are included as part of French River - Segment MA42-03 (MassDEP, 2008). Rochdale Pond (MA42048) remains listed as a separate waterbody. This assessment focuses only on Segment MA42-03 as defined in the 2010 and 2012 Lists and therefore includes Texas Pond (MA42058) and Thayers Pond (MA42059) but Rochdale Pond (MA42048) will be assessed separately. The 2010 and 2012 Lists classify Segment MA42-03 of the French River under Category 5, Waters Requiring a Total Maximum Daily Load (TMDL). Table 3 below shows the impairments included for this segment on both lists.

Table 3. Impairments to Segment MA42-03 of the French River Included on the Final *Massachusetts Year 2010* and Proposed *Massachusetts Year 2012 Integrated List of Waters*

Massachusetts Integrated List of Waters	
Final 2010 List	**Proposed 2012 List**
Aquatic Plants (Macrophytes)	Aquatic Plants (Macrophytes)
Mercury in Fish Tissue	Mercury in Fish Tissue
Phosphorus (Total)	Phosphorus (Total)
Turbidity	Turbidity

Texas Pond (MA42058) also falls under the jurisdiction of MassDEP's *TMDL of Phosphorus for Selected French Basin Lakes* (2002). This TMDL addresses a variety of waterbody impairments related to the presence of excess phosphorus. In addition to phosphorus, these impairments include noxious aquatic plants (macrophytes) and turbidity, for which Texas Pond (MA42058) is listed on the 2008 List and for which Segment MA42-03 of the French River (including Texas Pond and Thayers Pond) is listed on the 2010 and 2012 Lists.

According to MassDEP's *French & Quinebaug River Watersheds 2004-2008 Water Quality Assessment Report* (2009), the reason for the impairment for metals in Texas Pond (MA42058) and Segment MA42-03 of the French River is the presence of mercury in samples of fish tissue from largemouth bass collected during a sampling survey performed in 1998. It should be noted that although the 2008 List shows Thayers Pond (MA42059) as being impaired for metals, MassDEP's water quality assessment report states that no sampling of fish tissue has been performed for this waterbody (2009).

As described below, the Massachusetts Department of Transportation (MassDOT) recommends the implementation of various Best Management Practices (BMPs) for Segment MA42-03 of the French River to improve water quality. These recommendations are based on assessments using Impervious Cover (IC) Method for Segment MA42-03 in its entirety (including Texas Pond and Thayers Pond) and the TMDL Method for Texas Pond. While these recommendations for BMPs address impairments specific to Segment MA42-03 (including Texas Pond and Thayers Pond), all downstream segments and receiving water bodies downstream of the BMPs will ultimately benefit from the improvements.

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3) (b) 5 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 (3) (b) 6 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 (5) (a) 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 (5) (c) 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 pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.
- *314 CMR 4.05 (5) (e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total

recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations. The Department may establish site specific criteria for toxic pollutants based on site specific considerations. Site specific criteria, human health risk levels and permit limits will be established in accordance with the following:

1. Site Specific Criteria: Where EPA recommended criteria for a specific pollutant are not available or where the Department determines that they are invalid due to site specific physical, chemical or biological considerations, the Department shall use a site specific criterion as the allowable receiving water concentration for the affected waters. In all cases, at a minimum, site specific criteria shall not exceed safe exposure levels determined by toxicity testing using methods approved by the Department. The Department will adopt any such site specific criteria as revisions to 314 CMR 4.00 in accordance with M.G.L. c. 30A.
2. Human Health Risk Levels. Where EPA has not set human health risk levels for a toxic pollutant, the human health based regulation of the toxic pollutant shall be in accordance with guidance issued by the Department of Environmental Protection's Office of Research and Standards. The Department's goal is to prevent all adverse health effects which may result from the ingestion, inhalation or dermal absorption of toxins attributable to waters during their reasonable use as designated in 314 CMR 4.00. When this goal is not attainable, the Department will use a goal of 10-6 as the acceptable excess lifetime cancer risk level for individual carcinogens.
3. Accumulation of Pollutants. Where appropriate the Department shall use an additional margin of safety when establishing water quality based effluent limits to assure that pollutants do not persist in the environment or accumulate in organisms to levels that:
    a. are toxic to humans, wildlife or aquatic life; or
    b. result in unacceptable concentrations in edible portions of marketable fish or shellfish or for the recreational use of fish, shellfish, other aquatic life or wildlife for human consumption.
4. Public Notice. Where EPA recommended criteria are used to establish water quality based effluent limitations, the effluent limitations shall be documented and subject to full intergovernmental coordination and public participation as set forth in 314 CMR 2.00 "Permit Procedures".

Site Description

The French River begins in Leicester, Massachusetts and flows south for approximately 25.3 miles through the Towns of Auburn, Oxford, and Dudley before crossing into Connecticut and discharging to the Quinebaug River. Segment MA42-03 includes only a small 4.7-mile long stretch of the river from the outlet of Greenville Pond in Leicester to the outlet of Thayer Pond in Oxford. This segment, as mentioned above, flows through three ponds: Rochdale Pond (MA42048), Texas Pond (MA42058), and Thayers Pond (MA42059). Segment MA42-03 has a directly contributing subwatershed of approximately 4,178 acres consisting chiefly of undeveloped, forested areas. A small mix of agricultural, commercial, industrial, and residential land uses within the subwatershed combine for a total IC area of 450 acres (approximately 16%). Refer to Figure 1 for the location of Segment MA42-03 and its contributing subwatershed. MassDEP's *French & Quinebaug River Watersheds 2004-2008 Water Quality Assessment Report* (2009) identifies the following NPDES-permitted point source discharges to Segment MA42-03:

- Oxford-Rochdale Sewer District (Treated Wastewater, MA0100170)

- Town of Leicester (MS4, MAR041202)
- Town of Oxford (MS4, MAR041147)

Texas Pond (MA42058) is a small reservoir approximately 28 acres in size. It is located approximately 3.25 miles downstream of the start of Segment MA42-03. According to MassDEP's *Total Maximum Daily Loads of Phosphorus for Selected French Basin Lakes*, the subwatershed to Texas Pond is made up of the land uses listed in
Table 4.

Table 4. Land Uses within the Texas Pond (MA42058) Subwatershed

Land Use	Percentage of Subwatershed
Agricultural	10%
Commercial/Industrial	2%
Forested	70%
High-Density Residential	3%
Rural	9%
Water/Wetlands	6%

MassDOT currently owns and operates Interstate 90 (I-90), Route 20 (Rt. 20), Route 12 (Rt. 12), and a bridge along Route 56 (Rt. 56) within the subwatershed to Segment MA42-03. I-90 crosses the segment about half way between the outlet of Rochdale Pond and the inlet of Texas Pond. Rt. 20 crosses the segment approximately 125 feet downstream of the outlet from Texas Pond. Rt. 12 does not cross Segment MA42-03, but runs parallel to it for approximately 0.5 miles. MassDOT's bridge along Rt. 56 crosses the segment approximately 0.5 miles upstream of the inlet to Thayers Pond. Refer to Figure 2 for these exact locations. Approximately 17.2 acres of IC from the urban portion of these roadways discharge stormwater directly to Segment MA42-03. Refer to Table 5 for a breakdown of the directly discharging IC areas.

Table 5. MassDOT Directly Discharging IC Areas

Urban Roadway	IC Area (ac)
I-90	12.6
Rt. 20	1.5
Rt. 12	3.0
Rt. 56 Bridge	0.1
Total	**17.2**

Segment MA42-03 of the French River was initially assessed under MassDOT's Programmed Projects Initiative due to a resurfacing project being undertaken along I-90 from West Street in Auburn to Interstate 84 (I-84) in Sturbridge. As a result of the original assessment, MassDOT developed conceptual designs of stormwater BMPs to address direct stormwater discharges from I-90 to various waterbodies along the length of the resurfacing project. This assessment includes the BMP recommendations from the original assessment for direct stormwater discharges from I-90 to Segment MA42-03 of the French River.

The segment was originally intended to be assessed under the Impaired Waters Program due to a preliminary desktop analysis that identified possible discharges to the segment from stormwater outfalls along Rt. 12, Rt. 20, and Rt. 56. At that time, I-90 was owned and operated by a separate state agency and therefore MassDOT's original commitment under the Impaired Waters Program did not include a review of stormwater discharges from I-90. Ownership of I-90 has now transferred to MassDOT, however, and as such the stormwater discharges from I-90 are included in this assessment.

Stormwater Assessment under BMP 7U

Of the five impairments to Segment MA42-03 of the French River included on MassDEP's final *Massachusetts Year 2008*, final *Massachusetts Year 2010*, and proposed *Massachusetts Year 2012 Integrated List of Waters*, none have been addressed by a TMDL. Four of the impairments are potentially related to highway runoff and were therefore assessed using the approach described in BMP 7U (*Water Quality Impaired Waters Assessment and Mitigation Plan*) of MassDOT's Stormwater Management Plan (SWMP, 2009), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), IC provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the impairments of aquatic plants (Macrophytes), metals, phosphorus (total), and turbidity.

The impairment for mercury in fish tissue is related to the presence of mercury in the waterbody. Outlined in MassDEP's Final Northeast Regional Mercury TMDL (2007), the main source of mercury in waterbodies in New England is atmospheric deposition. Stormwater contributions to impairments for mercury are *de minimis*. Therefore the impairment for mercury in fish tissue has been excluded from the IC Method assessment and no further action is necessary for this pollutant.

Table 6 below shows the five impairments to Segment MA42-03 of the French River and the assessment methodology/basis for exclusion applicable to each under this assessment.

Table 6: Assessment Methodology Used for Impairments to Segment MA42-03 of the French River (Including Texas Pond and Thayers Pond)

Massachusetts Integrated List of Waters			Assessment Methodology
Final 2008 List	**Final 2010 List**	**Proposed 2012 List**	
	Aquatic Plants (Macrophytes)	Aquatic Plants (Macrophytes)	IC Method
	Phosphorus (Total)	Phosphorus (Total)	
	Turbidity	Turbidity	
Metals	Mercury in Fish Tissue	Mercury in Fish Tissue	N/A (Impairment not linked to stormwater)

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover (IC) Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the impervious cover reduction required to ensure that stormwater is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed had less than 9% IC, MassDOT concluded that stormwater was not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. Impervious cover data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which impervious cover would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective impervious cover reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective impervious cover reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective impervious cover reductions is described in BMP 7U. When the reduction in effective impervious cover achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the site parameters shown in Table 7 below for Segment MA42-03 of the French River.

Table 7. IC Method Site Parameters for Segment MA42-03 of the French River

Total Watershed		
Watershed Area	15,506	acres
IC Area	1,049	acres
Percent Impervious	6.8	%
IC Area at 9% Goal	1,396	acres
Subwatershed		
Subwatershed Area	4,178	acres
IC (IC) Area	450	acres
Percent Impervious	10.8	%
IC Area at 9% Goal	376	acres
Target Reduction % in IC	16.4	%
Reductions Applied to DOT Direct Watershed		
MassDOT Directly Contributing IC	17.2	acres
MassDOT's Target Reduction in Effective IC (16.4% of DOT Directly Contributing IC)	2.8	acres

To be conservative, MassDOT has decided not to rule out water bodies based on the IC value of the total watershed and instead base the IC target decisions on the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis). The subwatershed to Segment MA42-03 contains more than 9% effective IC, indicating that stormwater likely contributes to the impairments assessed under this methodology. In order to reach the 9% target, effective IC within the subwatershed should be reduced by 16.4%. Therefore, MassDOT's target is to reduce effective IC within its own directly contributing watershed by the same percentage, or 2.8 acres.

Existing BMPs

There are no existing BMPs within MassDOT's directly contributing watershed to Segment MA42-03 of the French River that are mitigating potential stormwater quality impacts. Therefore, no effective IC reduction is currently provided.

Next Steps

Because there are no existing BMPs currently reducing effective IC, MassDOT is considering the implementation of additional BMPs to achieve the target reduction. While the consideration for additional BMPs addresses impairments specific to Segment MA42-03 of the French River, all receiving water bodies downstream will ultimately benefit from the resulting improvements in water quality and hydrology.

It is recommended that MassDOT design BMPs to be constructed to meet the target effective IC reduction of 2.8 acres. Conceptual stormwater BMP designs developed include a BMP to address direct discharges from I-90 to Segment MA42-03 of the French River. Table 8 below summarizes

the IC reductions. Refer to Figure 3 for exact location and approximate dimensions of the BMP. It is important to note that this is a conceptual design that is subject to change during further design process as warranted by actual field conditions, which may include high groundwater, presence of utilities, unsuitable soil conditions, etc.

Table 8. Effective Impervious Cover Reductions Provided by Conceptual BMPs to Address Stormwater Discharges from I-90 to Segment MA42-03 of the French River

BMP Identifier	BMP Type	Contributing Watershed IC Area (ac)	Depth of Runoff Treated (in)	% Removal of Contributing Watershed IC	Effective IC Reduction (ac)
Pr-BMP-22	Infiltration Swale	7.6	0.3	50%	3.08
Total		7.6			3.08

Proposed BMP

There is an existing drainage ditch along the westbound shoulder of I-90 west of Leicester Street that collects runoff from several stormwater outfalls. Flow from the ditch enters a small stream and then travels approximately 330 feet before discharging to Segment MA42-03 of the French River. In total, approximately 7.6 acres of IC drain to this ditch. Local soils are classified as HSG B, indicating a moderate rate of infiltration. The photographs below show the existing drainage ditch.

MassDOT will consider retrofitting the existing ditch with an infiltration swale (PR-BMP-22 on Figure 3) to increase retention time, reduce runoff velocities, reduce erosion, and promote infiltration. A swale with a top width of 14 feet, a bottom width of 2 feet, and a depth of 2 feet will achieve approximately 70% in reduction in phosphorus loading from MassDOT's directly contributing IC area and a total reduction in effective IC area of 3.08 acres.

Assessment under BMP 7R

Texas Pond (MA42058) falls under the jurisdiction of MassDEP's *TMDL of Phosphorus for Selected French Basin Lakes* (2002). This TMDL addresses a variety of waterbody impairments related to the presence of excess phosphorus, including noxious aquatic plants, aquatic plants (macrophytes), phosphorus (total), and turbidity, for which Texas Pond (MA42058) is listed on the 2008 List and for which Segment MA42-03 of the French River (which includes Texas Pond) is listed on the 2010 and

2012 Lists. Therefore, MassDOT assessed its contribution to these impairments using the approach described in BMP 7R (TMDL Watershed Review).

In review of the watershed to Texas Pond (Figure 2), MassDOT determined that no MassDOT roadway is directly connected to the pond. Impervious areas along I-90 discharge to Segment MA42-03 of the French River approximately 0.6 miles upstream of Texas Pond and are not considered direct discharges to Segment MA42058. Rt. 20 discharges to Segment MA42-03 approximately 125 feet downstream of Texas Pond and is therefore not considered direct. While further review under BMP 7R is not necessary for the assessment of Texas Pond since there is no direct discharge, MassDOT reviewed the positive impacts the BMPs proposed under the IC Method will have on the downstream water body of Texas Pond.

TMDL Information

MassDEP's TMDL report titled *Total Maximum Daily Loads of Phosphorus for Selected French Basin Lakes* (2002) can be summarized as follows:

- Pollutant of Concern: Phosphorus
- Impairments to Texas Pond and Segment MA42-03 Addressed in TMDL: noxious aquatic plants, aquatic plants (macrophytes), phosphorus (total) turbidity
- Applicable Waste Load Allocation (WLA): See p. 14 and Tables 1 (p. 13), and 2 (p. 16) of TMDL Report.
  - Description of Associated Land Use: Commercial/Industrial
  - Commercial/Industrial Land Use Current Load (TP): 65 kg/yr (143 lbs/yr)
  - Commercial/ Industrial Land Use Target WLA (TP): 39 kg/yr (86 lbs/yr)
  - Commercial/Industrial Area in Watershed: 99.5 ha (246 acres)
  - Commercial/Industrial Land Use Target Areal WLA (TP): 0.39 kg/ha/yr (0.35 lb/acre/yr)

Estimated Loading from MassDOT

MassDOT has no roadway directly connected to Texas Pond and therefore its estimated loading to Texas Pond specifically is 0 lb/yr.

Existing BMPs

MassDOT has no existing BMPs in place to address its direct stormwater discharges to Segment MA42-03 of the French River upstream of Texas Pond (MA42058). Therefore, no pollutant load reduction is currently provided.

Next Steps

Because MassDOT has no IC area discharging directly to Texas Pond, the installation of additional BMPs is not necessary to address the TMDL. However, conceptual stormwater BMP designs developed to address the IC target include one BMP to address direct discharges from I-90 to Segment MA42-03 of the French River. Because this BMP will address direct discharges upstream of Texas Pond, the treatment they ultimately provide will indirectly reduce phosphorus loading to Texas Pond. Pollutant load reductions provided the BMP is summarized in Table 9.

Table 9. Phosphorus Load Reductions Provided by Conceptual BMPs to Address Stormwater Discharges from I-90 to Segment MA42-03 of the French River

BMP Identifier	BMP Type	Contributing Watershed IC Area (ac)	Pre-BMP Pollutant Load (lbs/yr)	% Load Reduction	Post-BMP Load (lbs/yr)
Pr-BMP-22	Infiltration Swale	7.6	12.28	70%	5.45
Total		7.6	12.28		5.45

Conclusions

MassDOT used the IC Method to assess Segment MA42-03 of the French River for the impairments identified in MassDEP's final *Massachusetts Year 2008*, final *Massachusetts Year 2010*, and proposed *Massachusetts Year 2012 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing subwatershed to Segment MA42-03 by 2.8 acres to achieve the targeted reduction in effective IC. MassDOT proposed the implementation of one stormwater BMPs to address direct stormwater discharges from I-90 to Segment MA42-03.

This BMP will provide an estimated reduction in effective IC within MassDOT's directly contributing watershed to Segment MA42-03 of approximately 3.1 acres, which will exceed the target reduction of 2.8 acres. Table 10 summarizes the IC reductions within MassDOT's directly contributing watershed under existing and proposed conditions.

Table 10. Effective IC Reductions under Existing & Proposed Conditions

Effective IC Reductions	
MassDOT Target Reduction in Effective IC	2.8 acres
Effective IC Reduction under Existing Conditions	0.0 acres
Effective IC Reduction under Proposed Conditions	3.1 acres
Remaining Target	**0.0 acres**

MassDOT also used the TMDL method to assess Texas Pond (MA42058) for the impairments related to excess phosphorus as outlined in MassDEP's *TMDL of Phosphorus for Selected French Basin Lakes* (2008). Results indicate that MassDOT has no IC area discharging directly to Texas Pond, and therefore has no required reduction in pollutant load. Since the BMP designed to address the MA42-03 segment is upstream of Texas Pond, MassDOT used the TMDL method to determine the pollutant loading reduction that will be provided to Texas Pond from the proposed BMP.

This conceptual BMP will provide an estimated reduction in phosphorus loading from MassDOT's directly contributing IC area along I-90 to Segment MA42-03 of approximately 5.45 pounds per year. Table 11 summarizes the phosphorus load reductions within MassDOT's directly contributing watershed under existing and proposed conditions.

Table 11. Phosphorus Load Reductions under Existing & Proposed Conditions

Phosphorus Load Reductions		
MassDOT Target Reduction in Effective IC	0.0	acres
Phosphorus Load Reduction under Existing Conditions	0.0	acres
Phosphorus Load Reduction under Proposed Conditions	5.45	acres
Remaining Target	**0.0**	**acres**

MassDOT will now work with its design consultants to develop design plans for the proposed BMP as part of MassDOT's Impaired Waters Retrofit Initiative. Note that the estimated effective IC reduction that will be achieved may change depending on the final designs for the conceptual BMPs included in this assessment. The final BMP designs will provide treatment to the maximum extent practicable given site constraints that are identified as the design process moves forward.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's Programmed Projects Initiative. Work on Programmed Projects often includes broader scale road layout changes that may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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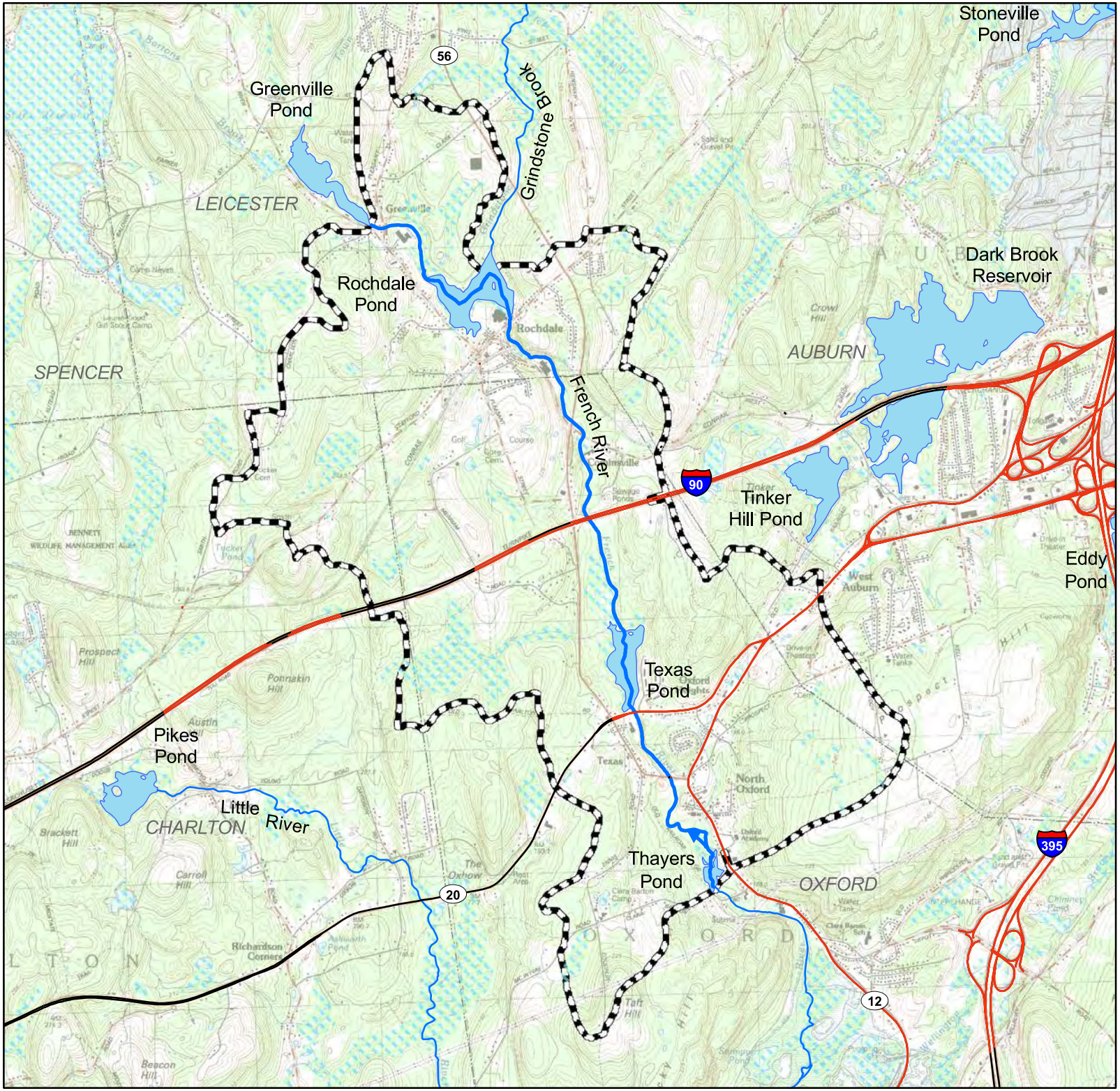

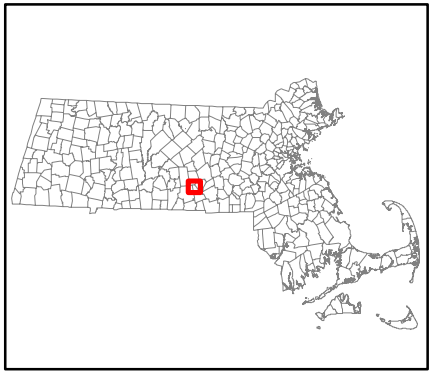

MA42-03 Subwatershed
Impaired Stream Segments
Segment MA42-03
Impaired Waterbodies
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 1,750 3,500 5,250 7,000
Feet

1 inch = 3,500 feet

Figure 1

French River (MA42-03) Subwatershed

June 2012

Moving Massachusetts Forward. massDOT

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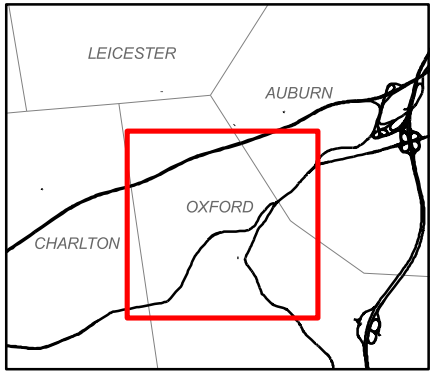

MassDOT Direct Watershed
NHD Stream Segments
Impaired Stream Segments
Segment MA42-03
Impaired Waterbodies
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 750 1,500 2,250 3,000
Feet

1 inch = 1,500 feet

Figure 2

**French River (MA42-03)
Directly Contributing
MassDOT Watershed**

June 2012

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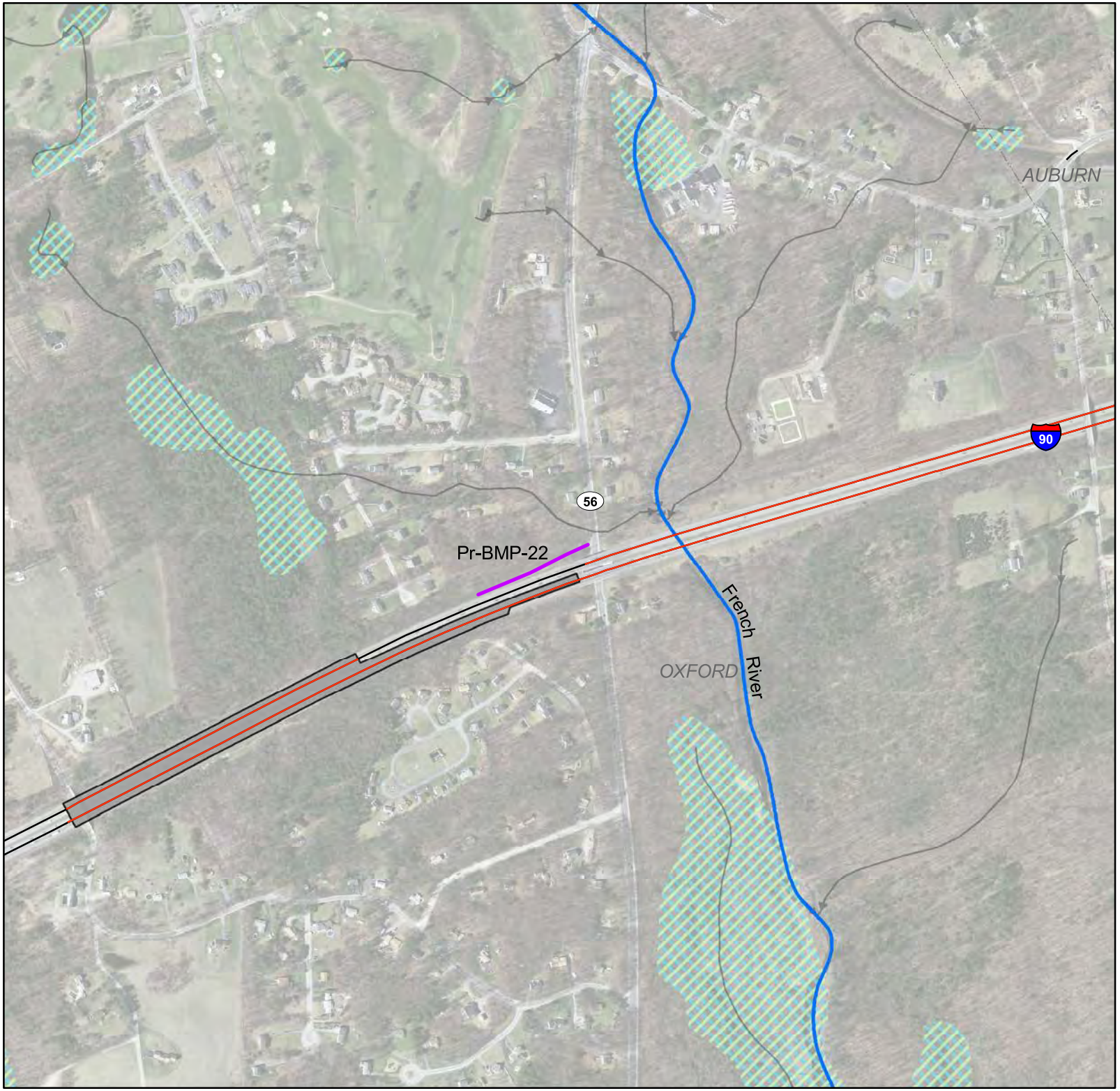

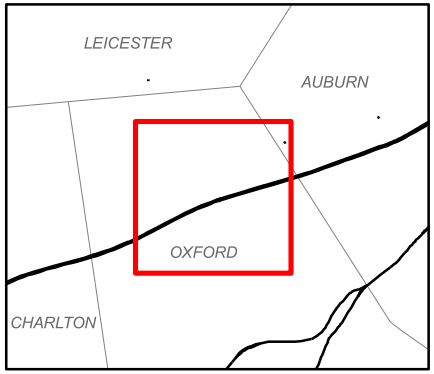

BMP Urban Watershed Area
Proposed BMP - Infiltration Swale
NHD Stream Segments
Impaired Stream Segments
Segment MA42-03
Impaired Waterbodies
NWI Wetland Areas
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 325 650 975 1,300
Feet

1 inch = 650 feet

Figure 3

French River (MA42-03)
Proposed BMPs

June 2012

Moving Massachusetts Forward
massDOT

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Impaired Waters Assessment for Lee River (MA61-02) – Final Report

Introduction

Segment MA61-02 of the Lee River was previously assessed in a progress report titled, *Impaired Waters Assessment for Lee River (MA61-02) – Progress Report*, submitted on 12/8/2011. The progress report stated that MassDOT would work with designers to implement BMPs in order to meet its target reduction of impervious cover (IC). MassDOT has since initiated the design of BMPs to address its contribution of storm water to Lee River. This report presents a summary of the findings of the progress report as well as a final assessment which includes the reduction provided by existing BMPs and the final target IC reduction determined during the Designer's comprehensive investigation and the BMPs in design and their estimated resulting IC removals.

Summary of Progress Report

Impaired Waterbody

Name: Lee River

Location: Swansea and Somerset, MA

Water Body ID: MA61-02

Impairments

Table 1. Impairments of Lee River (MA61-02) Included on the Massachusetts Integrated List of Waters

Massachusetts Integrated List of Waters	
Final 2008 List (MassDEP, 2008)	**Final 2010 List (MassDEP, 2011)**
Pathogens	Fecal coliform
Taste, odor and color	Taste and odor
	Chlorophyll-a
	Nitrogen (Total)
	Oxygen, dissolved
	(Debris/floatables/trash)*

Lee River 02 (MA61-02) is listed under Category 5, "Waters Requiring a TMDL", on both MassDEP's final *Massachusetts Year 2008* and the final *Massachusetts Year 2010 Integrated List of Waters*. According to MassDEP's *Narragansett and Mount Hope Bay Watersheds 2004-2008 Water Quality Assessment Report* (MassDEP, 2009), this segment is impaired due to low dissolved oxygen, elevated total nitrogen, elevated chlorophyll *a*, and elevated total coliform bacteria.

Site Description

MassDOT's property that directly contributed stormwater runoff to the Saugus River is comprised of portions of Route 6, Route 103, Interstate 195 (I-195), Lees River Avenue and the ramps connecting it to I-195, and the ramp from Route 103 East to I-195 East.

Assessment under BMP 7U

For this water body, MassDOT used the IC method to assess the following impairments:

- taste, odor, and color
- chlorophyll *a*
- total nitrogen
- dissolved oxygen.

The impairment for pathogens was assessed separately. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations for the impairment of pathogens.

The Final 2010 Integrated List of Waters added debris/floatables/trash to the list of impairments for this segment. The list indicated that this impairment is considered a non-pollutant and unrelated to stormwater, as denoted by the asterisk. Therefore, MassDOT has determined that further assessment of this impairment to the water body is not required.

Existing BMPs

The progress report stated that there are currently no existing BMPs in the Lee River Segment MA61-02 subwatershed which mitigate potential stormwater quality impacts prior to discharge to the river.

Target Reduction

In the progress report, MassDOT derived the following site parameters and target reduction for DOT's directly contributing watershed draining to the Lee River (MA61-02) using the IC Method:

Table 2. Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	37.8	acres
Target Percent Reduction in Effective IC	51.0	%
Target Reduction in Effective IC to meet 9% IC target	19.2	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	19.2	acres

Final Assessment

Designer Investigation of Existing BMPs

After the submittal of the progress report, further investigation of the Lee River (MA61-02) subwatershed did not identify any existing BMPs associated with the direct discharges from MassDOT property into the river.

Updated Target Reduction

After the submittal of the progress report, further investigation of MassDOT's directly contributing IC area was performed by the Designers. Based on this investigation, the MassDOT Directly Contributing IC Watershed was updated from 37.8 acres to 31.6 acres. Thus, the target reduction of impervious cover, 51.0% of this IC watershed, was also updated by the designers from 19.2 acres to 16.1 acres based on these more in-depth field evaluations. After taking into account the reduction provided by the existing BMPs determined by the designers, the remaining target reduction of effective IC is 8.4 acres. See Table 3 below.

Table 3. Designer Investigation Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	31.6	acres
Target Percent Reduction in Effective IC	51.0	%
Target Reduction in Effective IC to meet 9% IC target	16.1	acres
IC Effectively Reduced by Existing BMPs	0.0	acres
IC Remaining to Mitigate with Proposed BMPs	16.1	acres

BMPs in Design

MassDOT has initiated the design of additional BMPs to address the target IC reduction of 16.1 acres as part of MassDOT's Impaired Waters Retrofit Initiative. There are currently six infiltration swales and 2 infiltration basins in design, described below. Table 4 below lists the impervious stormwater catchment area for each BMP as well as the estimated post-construction IC reduction that will be provided by each BMP.

The vegetated medians east and west of the I-195 bridges over Lee River will be modified to accommodate two infiltration swales. The vegetated shoulder north of the I-195 westbound on-ramp from Lees River Avenue will also be modified to accommodate an infiltration swale. The vegetated shoulder south of the I-195 eastbound on-ramp from Route 103 will be modified to accommodate an infiltration swale. The grassed median east of the Route 103 overpass will be modified to accommodate two infiltration swales. In addition, the grassed infield area between I-195 and the eastbound off ramp to Lees River Avenue and the vegetated infield area between I-195 and the westbound on-ramp from Route 103 will be modified to accommodate two infiltration basins.

The Designers were not able to identify locations for additional BMPs within the Lee River (MA61-02) subwatershed to meet the target reduction due to varying site constraints. Treatment of the directly contributing IC from Route 6 and Route 103 was excluded due to limited available right of way. Directly contributing IC from Route 6 and Route 103 covers approximately 10.0 acres and accounts for roughly one third of the directly contributing IC within the Lee River subwatershed. The inability to treat this area, due to the limited available right of way, is the greatest contributor to falling shy of the 9% impervious cover target. Treatment of additional directly contributing IC from I-195 was restricted due to the proximity of MassDOT stormwater outfalls to resource areas (i.e. streams, wetlands, water bodies), stormwater infrastructure (i.e. structure tie-in elevations) and grading limitations.

Table 6. BMPs in Design

BMP Name	BMP Type	IC Area Treated (ac)	Percent Reduction of Effective IC*	Reduction of Effective IC (ac)
BMP-1	Infiltration Swale	2.53	82%	2.07
BMP-2	Infiltration Swale	0.26	82%	0.21
BMP-3	Infiltration Swale	7.11	82%	5.83
BMP-4	Infiltration Swale	0.37	81%	0.30
BMP-5	Infiltration Swale	0.22	82%	0.18
BMP-6	Infiltration Swale	4.41	82%	3.62
BMP-7	Infiltration Basin	0.22	82%	0.18
BMP-8	Infiltration Basin	1.18	82%	0.97
Total		**16.3**		**13.36**

Conclusions

Table 7 summarizes IC reductions within MassDOT's directly contributing watershed under the design BMP conditions.

Table 7. Design BMP Effective IC Reductions

MassDOT Target Reduction in Effective IC to Meet with Design BMPs	16.1	acres
Effective IC Reduction under Design BMPs	13.4	acres
Remaining Target	**2.7**	**acres**

The five BMPs have been designed to the maximum extent practicable and will achieve 13.4 acres of effective IC reduction. Note that the estimated effective IC reduction that will be achieved may change depending on the final design and construction of the BMPs included in this assessment. . Additional BMPs could not be constructed due to site constraints discussed in Section BMPs in Design and thus the remaining target cannot be met under the Retrofit Initiative.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's Programmed Projects Initiative. Work on Programmed Projects often includes broader scale road layout changes that may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs, and finalized assessments including

reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of storm water.

References

Massachusetts Department of Environmental Protection (MassDEP). (2008). Massachusetts Year 2008 Integrated List of Waters - Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 303(d) and 305(b) of the Clean Water Act. Retrieved from: http://www.mass.gov/dep/water/resources/08list2.pdf

Massachusetts Department of Environmental Protection (MassDEP). (2009). Narragansett and Mount Hope Bay Watersheds 2004-2008 Water Quality Assessment Report. Retrieved from: http://www.mass.gov/dep/water/resources/6153wq08.pdf.

Massachusetts Department of Environmental Protection (MassDEP). (2011). Massachusetts Year 2010 Integrated List of Waters - Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act. Retrieved from: http://www.mass.gov/dep/water/resources/10list6.pdf

Impaired Waters Assessment for Cole River (MA61-04) – Final Report

Introduction

Segment MA61-04 of the Cole River was previously assessed in a progress report titled, *Impaired Waters Assessment for Cole River (MA61-04) – Progress Report*, submitted on 12/8/2011. The progress report stated that MassDOT would work with designers to implement BMPs in order to meet its target reduction of impervious cover (IC). MassDOT has since initiated the design of BMPs to address its contribution of stormwater to Cole River. This report presents a summary of the findings of the progress report as well as a final assessment which includes the reduction provided by existing BMPs and the final target IC reduction determined during the Designer's comprehensive investigation and the BMPs in design and their estimated resulting IC removals.

Summary of Progress Report

Impaired Waterbody

Name: Cole River

Location: Swansea and Somerset, MA

Water Body ID: MA61-04

Impairments

Table 1. Impairments of Cole River (MA61-04) Included on the Massachusetts Integrated List of Waters

Massachusetts Integrated List of Waters	
Final 2008 List (MassDEP, 2008)	**Final 2010 List (MassDEP, 2011)**
Nutrients	Nitrogen (Total)
Organic enrichment/low DO	Oxygen, dissolved
Pathogens	Fecal coliform
	Chlorophyll-*a*

Cole River (MA61-04) is listed under Category 5, "Waters Requiring a TMDL", on both MassDEP's final *Massachusetts Year 2008* and the final *Massachusetts Year 2010 Integrated List of Waters*. According to MassDEP's *Narragansett and Mount Hope Bay Watersheds 2004-2008 Water Quality Assessment Report* (MassDEP, 2009), this segment is impaired for low dissolved oxygen, elevated total nitrogen, elevated chlorophyll a, and elevated total fecal coliform bacteria due to general urban stormwater, discharges from municipal separate storm sewer systems, failing septic systems, and illicit connections to storm sewers.

Site Description

MassDOT's property that directly contributed stormwater runoff to the Saugus River is comprised of portions of Route 6, Route 103, and Interstate 195.

Assessment under BMP 7U

For this water body, MassDOT used the IC method to assess the following impairments:

- Nutrients (including Nitrogen (Total))
- organic enrichment/low DO (including Oxygen, dissolved)
- chlorophyll *a.*

The impairment for pathogens was assessed separately in the progress report and no further assessment is necessary. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations for the impairment of pathogens.

Existing BMPs

The progress report listed two existing BMPs which were identified in the Cole River subwatershed as mitigating potential stormwater quality impacts prior to discharge to the river. A summary of the existing BMP information reported is shown in Table 2.

Table 2. Summary of Existing BMPs

BMP Name	BMP Type	Soil Type	Depth of Runoff Treated (in)	IC Area Treated (ac)	Percent Reduction of Effective IC*	Reduction of Effective IC (ac)
Ex-BMP-1	Vegetated Filter Strip	D	0.2	0.4	21%	0.1
Ex-BMP-2	Vegetated Filter Strip	D	0.2	0.4	22%	0.1
Total				0.8		0.2

*Description of MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT 2011)

Target Reduction

In the progress report, MassDOT derived the following site parameters and target reduction for DOT's directly contributing watershed draining to the Cole River (MA61-04) using the IC Method:

Table 3. Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	20.8	acres
Target Percent Reduction in Effective IC	51.2	%
Target Reduction in Effective IC to meet 9% IC target	10.6	acres
IC Effectively Reduced by Existing BMPs	0.2	acres
IC Remaining to Mitigate with Proposed BMPs	10.4	acres

Final Assessment

Designer Investigation of Existing BMPs

After the submittal of the progress report, further investigation of the existing BMPs found more detailed values of IC area treated and thus more revised values of reduction of effective IC. However, the total reduction of 0.16 ac rounds to the same total reduction provided by existing BMPs, 0.2 ac, reported in the Progress Report. Table 4 below summarizes the updated existing BMP information.

Table 4. Summary of Designer Investigation of Existing BMPs

BMP Name	BMP Type	IC Area Treated (ac)	Reduction of Effective IC (ac)
Ex-BMP-1	Vegetated Filter Strip	0.22	0.08
Ex-BMP-2	Vegetated Filter Strip	0.22	0.08
Total			0.16

Updated Target Reduction

After the submittal of the progress report, further investigation of MassDOT's directly contributing IC area was performed by the Designers. Based on this investigation, the MassDOT Directly Contributing IC Watershed was updated from 20.8 acres to 16.9 acres. Thus, the target reduction of impervious cover, 51.2% of this IC watershed, was also updated by the designers from 10.6 acres to 8.6 acres based on these more in-depth field evaluations. After taking into account the reduction provided by the existing BMPs determined by the designers, the remaining target reduction of effective IC is 8.4 acres. See Table 5 below.

Table 5. Designer Investigation Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	16.9	acres
Target Percent Reduction in Effective IC	51.2	%
Target Reduction in Effective IC to meet 9% IC target	8.6	acres
IC Effectively Reduced by Existing BMPs	0.2	acres
IC Remaining to Mitigate with Proposed BMPs	8.4	acres

BMPs in Design

MassDOT has initiated the design of additional BMPs to address the target IC reduction of 8.4 acres as part of MassDOT's Impaired Waters Retrofit Initiative. There are currently four infiltration swales in design, described below. Table 6 below lists the impervious stormwater catchment area for each BMP as well as the estimated post-construction IC reduction that will be provided by each BMP.

The grassed medians east and west of the I-195 bridges over Cole River will be modified to accommodate two infiltration swales. An existing manmade drainage ditch west of Gardners Neck Road and north of I-195 will be modified to accommodate an infiltration swale. In addition, the

existing manmade drainage ditch west of the I-195 bridges over Cole River and north of I-195 will be modified to accommodate and infiltration swale.

The Designers were not able to identify locations to install additional BMPs within the Cole River (MA61-04) subwatershed to meet the target reduction due to varying site constraints. Treatment of the directly contributing IC from Route 6 and Route 103 was excluded due to a limitation in available right of way. Directly contributing IC from Route 6 and Route 103 covers approximately 8.6 acres and accounts for roughly half of the directly contributing IC within the Cole River subwatershed. The inability to treat this area due to limitated available right of way was the greatest contributor to not meeting the 9% impervious cover target. Treatment of additional directly contributing IC from I-195 was restricted due to the proximity of MassDOT stormwater outfalls to resource areas (i.e. streams, wetlands, water bodies).

Table 6. BMPs in Design

BMP Name	BMP Type	IC Area Treated (ac)	Percent Reduction of Effective IC*	Reduction of Effective IC (ac)
BMP-1	Infiltration Swale	2.17	87%	1.89
BMP-2	Infiltration Swale	2.89	82%	2.37
BMP-3	Infiltration Swale	0.74	82%	0.61
BMP-4	Infiltration Swale	0.90	87%	0.78
Total		**6.7**		**5.65**

Conclusions

Table 7 summarizes IC reductions within MassDOT's directly contributing watershed under the design BMP conditions.

Table 7. Design BMP Effective IC Reductions

MassDOT Target Reduction in Effective IC to Meet with Design BMPs	8.4	acres
Effective IC Reduction under Design BMPs	5.7	acres
Remaining Target	**2.7**	**acres**

The five BMPs have been designed to the maximum extent practicable and will achieve 5.7 acres of effective IC reduction. Note that the estimated effective IC reduction that will be achieved may change depending on the final design and construction of the BMPs included in this assessment. . Additional BMPs could not be constructed due to site constraints discussed in Section BMPs in Design and thus the remaining target cannot be met under the Retrofit Initiative.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's Programmed Projects Initiative. Work on Programmed Projects often includes broader scale road layout changes that may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC

reductions, plans for construction of proposed BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

References

Massachusetts Department of Environmental Protection (MassDEP). (2009). Narragansett and Mount Hope Bay Watersheds 2004-2008 Water Quality Assessment Report. Retrieved from: http://www.mass.gov/dep/water/resources/6153wq08.pdf.

Massachusetts Department of Environmental Protection (MassDEP). (2008). Massachusetts Year 2008 Integrated List of Waters - Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 303(d) and 305(b) of the Clean Water Act. Retrieved from: http://www.mass.gov/dep/water/resources/08list2.pdf

Massachusetts Department of Environmental Protection (MassDEP). (2011). Massachusetts Year 2010 Integrated List of Waters - Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act. Retrieved from: http://www.mass.gov/dep/water/resources/10list6.pdf

Impaired Waters Assessment for Norton Reservoir (MA62134)

Impaired Water Body

Name: Norton Reservoir

Location: Norton, MA and Mansfield, MA

Water body ID: MA62134

Impairments

Final *Massachusetts Year 2008 Integrated List of Waters* (MassDEP, 2008):

- pesticides
- nutrients
- noxious aquatic plants
- turbidity

Final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP, 2011):

- pentachlorophenol (PCP)
- excess algal growth
- phosphorus (total)
- non-native aquatic plants
- dioxins (including 2, 3, 7, 8-TCDD)
- turbidity

Norton Reservoir (MA62134) is listed under Category 5, Waters Requiring a TMDL per MassDEP's final *Massachusetts Year 2008* and final *Massachusetts Year 2010 Integrated List of Waters* (MassDEP 2008 and 2011, respectively). In addition, Massachusetts Department of Public Health has issued a fish consumption advisory for the water body due to elevated levels of dioxins and pesticides (MassDEP, 2005a).

As described below, MassDOT recommends the implementation of various Best Management Practices (BMPs) for Norton Reservoir based on the Impervious Cover (IC) Method. While these recommendations for BMPs address impairments specific to Norton Reservoir, all receiving water bodies downstream of the BMPs will benefit from the improvements.

Relevant Water Quality Standards

Water body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3) (b) 6 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 (5) (a) 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 (5) (c) 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 pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.
- *314 CMR 4.05 (5) (e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Site Description

Norton Reservoir is a 556-acre water body that lies primarily in Norton, MA (see Figure 1). Rumford River (MA62-39) is the major inlet and outlet to the reservoir. Norton Reservoir is bordered to the north by Interstate 495 (I-495) and to the west by South Main St. Both are MassDOT properties that contribute stormwater runoff directly to the impaired water body. In total, 8.0 acres of IC from I-495 drain directly into Norton Reservoir.

MassDOT is in the process of completing construction of a new ramp from South Main St. onto I-495 southbound (SB). The runoff from this ramp is directed to a newly constructed infiltration basin. Additional outfalls along the southern shoulder of I-495 SB feed directly into the small wetland area adjacent to Norton Reservoir.

South Main St. begins draining to Norton Reservoir south of the driveway entrance to the Comcast Center. From this high point in the topography, drainage from the first 0.8 miles collects in small systems that outlet to well-channelized drainage ditches. The channels flow only a few hundred feet before reaching Norton Reservoir. The direct discharge area resumes as South Main St. curves east and passes over the reservoir. Drainage from this area flows into the reservoir through numerous curb cuts. In total, 8.6 acres of IC from South Main St. drain directly into Norton Reservoir. See Figure 2 for the complete watershed of MassDOT IC that drains to Norton Reservoir.

Assessment under BMP 7U

None of the impairments for Norton Reservoir have been addressed by a Total Maximum Daily Load (TMDL). Therefore, MassDOT assessed these impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT Application of IC Method; MassDOT, 2011), IC provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- excess algal growth
- phosphorus (total)
- turbidity

According to the final *Year 2010 Integrated List of Waters*, pentachlorophenol (PCP) and non-native aquatic plants are considered a non-pollutant and unrelated to stormwater. Therefore, MassDOT has determined that further assessment of these impairments to the water body is not required.

According to the *Taunton River Watershed 2001 Water Quality Assessment Report* (MassDEP, 2005a), the impairment for dioxins (including 2, 3, 7, 8-TCDD) is associated with the Hatheway and Patterson Company (HPC) Superfund site. HPC was a former wood preserving facility and ceased operation in 1993. Based on this information, MassDOT concluded that this impairment snot related to highway runoff.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover (IC) Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water body and evaluates the impervious cover reduction required to ensure that stormwater is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% impervious cover, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. Impervious cover data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where

it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which impervious cover would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective impervious cover reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective impervious cover reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective impervious cover reductions is described in BMP 7U. When the reduction in effective impervious cover achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for the total contributing watershed of the impaired water (Norton Reservoir (MA62134).

Watershed		
Watershed Area	12,562	acres
Impervious Cover (IC) Area	2,012	acres
Percent Impervious	16%	
IC Area at 9% Goal	1,131	acres
Necessary Reduction % in IC	44%	

Subwatershed		
Subwatershed Area	3,807	acres
Impervious Cover (IC) Area	415	acres
Percent Impervious	11%	
IC Area at 9% Goal	343	acres
Necessary Reduction % in IC	17.5%	

Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	16.6	acres
MassDOT's Target Reduction in Effective IC (17.5% of DOT Directly Contributing IC)	2.9	acres

The subwatershed is greater than 9% impervious, which indicates that the stormwater is likely contributing to the impairment. The subwatershed needs to reduce its effective IC by 17.5% to

reach the 9% goal. Therefore, MassDOT should aim to reduce its effective IC in the directly contributing watershed by the same percentage by removing 2.9 acres of effective IC.

Existing BMPs

MassDOT has one existing BMP in the watershed contributing directly to Norton Reservoir that is mitigating potential stormwater quality impacts. In our analysis, existing BMPs receive credit for removing the effect of IC depending on their type, size relative to the IC that they process, and the local soil conditions. The soil in the area associated with the existing BMP is characterized as hydrologic group A (loamy sand). The total effective IC reduction provided by the existing MassDOT BMP described below is approximately 1.9 acres (see Table 1, attached).

Ex-BMP-1

MassDOT is in the process of completing construction of a new on ramp from South Main St. to I-495 SB. As part of this project, a new BMP has been constructed in the watershed contributing directly to Norton Reservoir. Ex-BMP-1 is an infiltration basin with dimensions of approximately 360 feet by 100 feet. The basin treats the runoff from the new ramp, which corresponds to 1.9 acres, and it can store a total of 15,500 cu. ft. of water in the sediment forebay and beneath the lowest outlet invert. This infiltration basin achieves 100% effective IC removal for its treatment area.

Ex-BMP-1. Infiltration Basin.

Next Steps

Because the total mitigation of impervious surface achieved by MassDOT's existing BMP is less than the target of 2.9 acres (see Table 1, attached), MassDOT is considering the implementation of additional BMPs. While these considerations for BMPs address impairments specific to Norton Reservoir, all receiving water bodies downstream will benefit from the improvements.

MassDOT has initiated the design of two stormwater BMPs to address its direct stormwater discharges to Norton Reservoir. Conceptual designs for the BMPs are documented in a memorandum prepared for Programmed Project # 605591, the resurfacing of Interstate 495 in the towns of Mansfield, Norton, and Taunton, titled "I-495 Mansfield, Norton, and Taunton – Stormwater Improvement Recommendations" and dated 01/06/2012.

During site visits on October 26th and 28th as well as November 1st, 3rd, 7th, and 18th, 2011, two proposed BMP locations were identified. Both proposed BMPs are located on the outer shoulder of I-495 northbound (NB) where drainage ditches convey runoff to culverted inlets underneath the highway. These locations were chosen because they can easily be adapted to form vegetated filter

strips. The soil in the area associated with the proposed BMPs is characterized as hydrologic group A (loamy sand).

As shown in Figures 3 and 4, the proposed BMPs will treat water that currently flows from the crown in the road down into the ditch on the shoulder. The direction of stormwater flow through the BMPs is also shown in these figures. The individual BMP watersheds are shown in Figures 5 and 6.

The IC reductions provided by the proposed BMPs within the directly contributing watershed to Norton Reservoir are listed in Table 2, attached. The two vegetated filter strips provide 1.5 acres of effective IC reduction. The recommended BMPs working along with the existing BMPs will achieve a total effective IC reduction of 3.4 acres.

The following paragraphs briefly describe each of the conceptual designs for BMPs included in the memorandum for the I-495 Resurfacing Project (Programmed Project # 605591).

Pr-BMP-1

In the Norton Reservoir subwatershed, most of I-495 NB is drained by allowing runoff to flow laterally from the road crown and into ditches along the shoulder or drop inlets in the median. MassDOT will consider converting a 750-foot stretch of ditch into a vegetated filter strip. The existing grassy area along the I-495 NB shoulder will need to be widened to 40 feet to match the width of its corresponding IC area, and the paved ditch will need to be removed. A vegetated filter strip to these specifications will receive runoff from 0.7 acres of IC and achieve 99% effective IC removal.

Pr-BMP-2

MassDOT will consider converting a 980-foot stretch of ditch into a vegetated filter strip. The existing grassy area along the I-495 NB shoulder will need to be widened to 40 feet to match the width of its corresponding IC area, and the paved ditch will need to be removed. A vegetated filter strip to these specifications will receive runoff from 0.9 acres of IC and achieve 99% effective IC removal.

Location for Pr-BMP-2. Taken from bottom of ditch.

Conclusions

MassDOT used the IC Method to assess Norton Reservoir for the impairments identified in MassDEP's final *Year 2010 Integrated List of Waters*. Results indicate that MassDOT should reduce its effective IC within its directly contributing watershed to Norton Reservoir by 2.9 acres to achieve the targeted reduction in effective IC.

MassDOT has initiated the design of stormwater BMPs under the I-495 Resurfacing Project. These proposed BMPs provide a combined reduction in effective IC within MassDOT's directly contributing watershed to Norton Reservoir of approximately 1.5 acres. In addition to the existing BMP that provides 1.9 acres, the effective IC reduction under proposed conditions is 3.4 acres.
The proposed conditions are presented in the sections above and are summarized as follows:

Summary of Proposed Conditions

BMP Name	BMP Type	Effective IC Percent Reduction	Effective IC Reduction (acres)	Notes for Consideration during design**
Ex-BMP-1	Infiltration Basin	100%	1.9	Confirm construction has been completed according to specifications
Pr-BMP-1	Vegetated Filter Strip	99%	0.6	Widen grassy area and remove paved ditch
Pr-BMP-2	Vegetated Filter Strip	99%	0.9	Widen grassy area and remove paved ditch
Total			**3.4**	

** See sections titled Existing BMPs and Proposed BMPs for more details on notes.

This assessment of Norton Reservoir (MA62134) has shown that, under the proposed conditions, the existing and proposed BMPs collectively provide over 100% of the target reduction in IC. The following table summarizes the effective IC removal of the existing and proposed BMPs. Attached Figures 2 and 3 show the locations of the existing and proposed BMPs.

Effective IC Reductions under Existing and Proposed Conditions

MassDOT Target Reduction in Effective IC	2.9 acres
Effective IC Reduction under Existing Conditions	1.9 acres
Effective IC Reduction under Proposed Conditions for I-495 Resurfacing Project	1.5 acres
Remaining Target	**0 acres***

*Target will be exceeded under proposed conditions

As described above, the BMPs proposed in this assessment were determined to be conceptually feasible within the current right-of-way and road drainage constraints. The proposed BMPs under the I-495 Resurfacing Project will enable MassDOT to meet or exceed the targeted IC reduction. No additional BMPs are necessary under the Impaired Waters Retrofit Program. MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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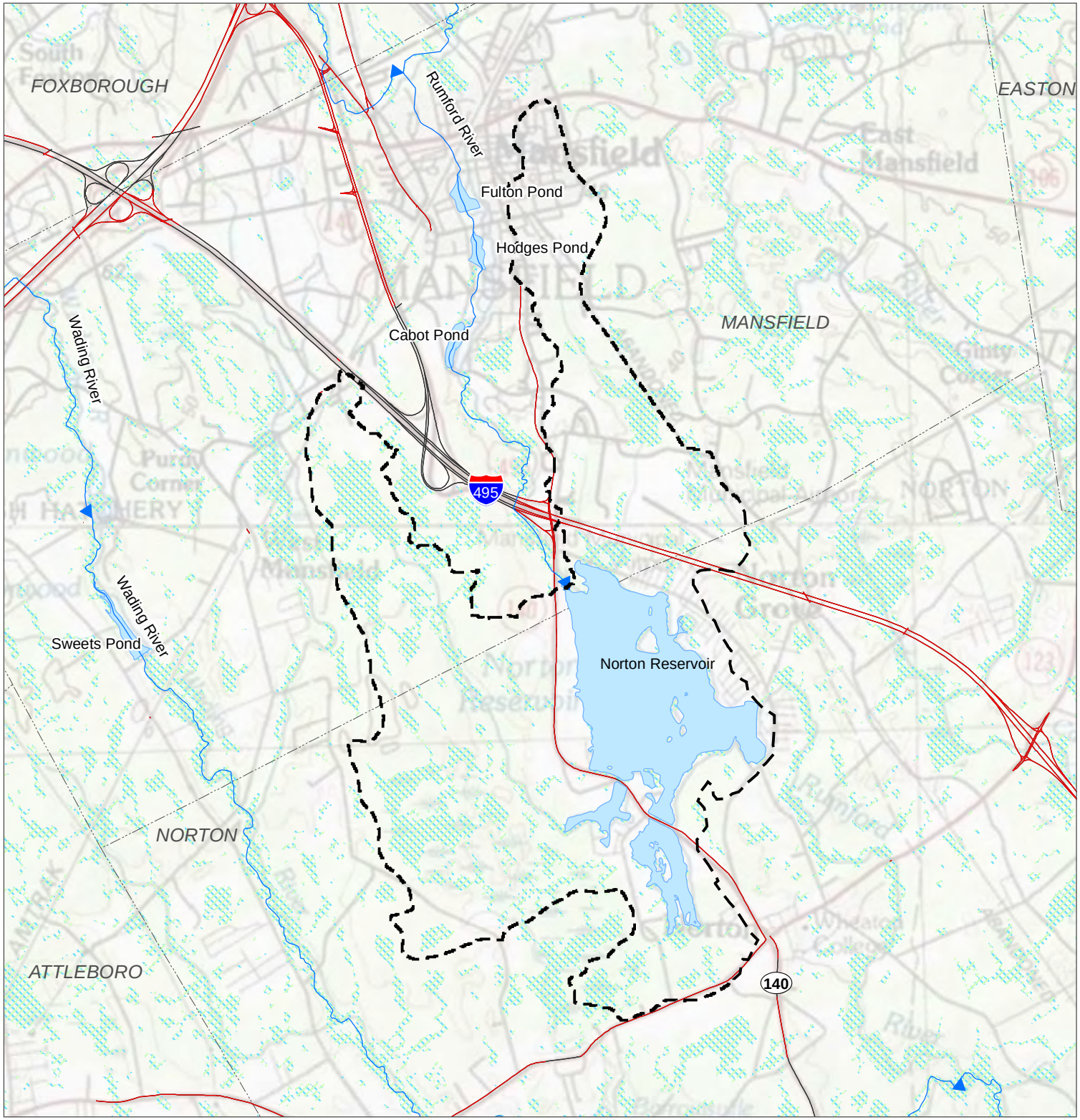
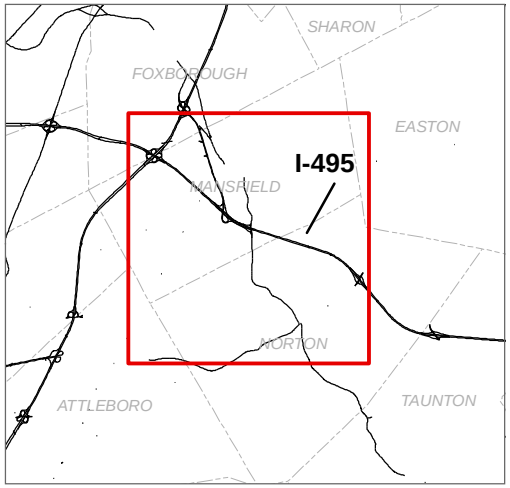
TABLE 1: Reduction Provided by MassDOT BMPs under Existing Conditions

BMP Identifier	BMP Type	Soil Classification	Contributing Watershed IC Area (acres)	BMP Storage Volume (cu. ft.)	BMP Surface Area (sq. ft.)	Depth of Runoff Treated by BMP (in)	Resulting % Removal of Contributing Watershed IC	Effective IC Area Reduction (acres)
Ex-BMP-1	Infiltration Basin	A - Loamy Sand 2.41 in/hr	1.87	15,556	7,778	2.1	100%	1.9
Total			1.87				0%	1.9

TABLE 2: Reduction Provided by MassDOT BMPs under Proposed Conditions for I-495 Resurfacing Project

BMP Identifier	BMP Type	Soil Classification	Contributing Watershed IC Area (acres)	BMP Storage Volume (cu. ft.)	BMP Surface Area (sq. ft.)	Depth of Runoff Treated by BMP (in)	Resulting % Removal of Contributing Watershed IC	Effective IC Area Reduction (acres)
Pr-BMP-1	Vegetated Filter Strip	A - Loamy Sand 2.41 in/hr	0.65	--	31,805	1.7	99%	0.6
Pr-BMP-2	Vegetated Filter Strip	A - Loamy Sand 2.41 in/hr	0.86	--	41,839	1.7	99%	0.9
Total			1.51				0%	1.5





- Norton Reservoir (MA62134) Subwatershed
- Impaired Water Bodies
- NWI Wetland Areas
- Impaired Stream Segments
- MassDOT Roads in Urban Areas
- MassDOT Roads
- Town Boundaries

N

0 0.4 0.8 1.6 Miles

1 in = 0.8 miles

Figure 1

Norton Reservoir (MA62134) Subwatershed

January 2012

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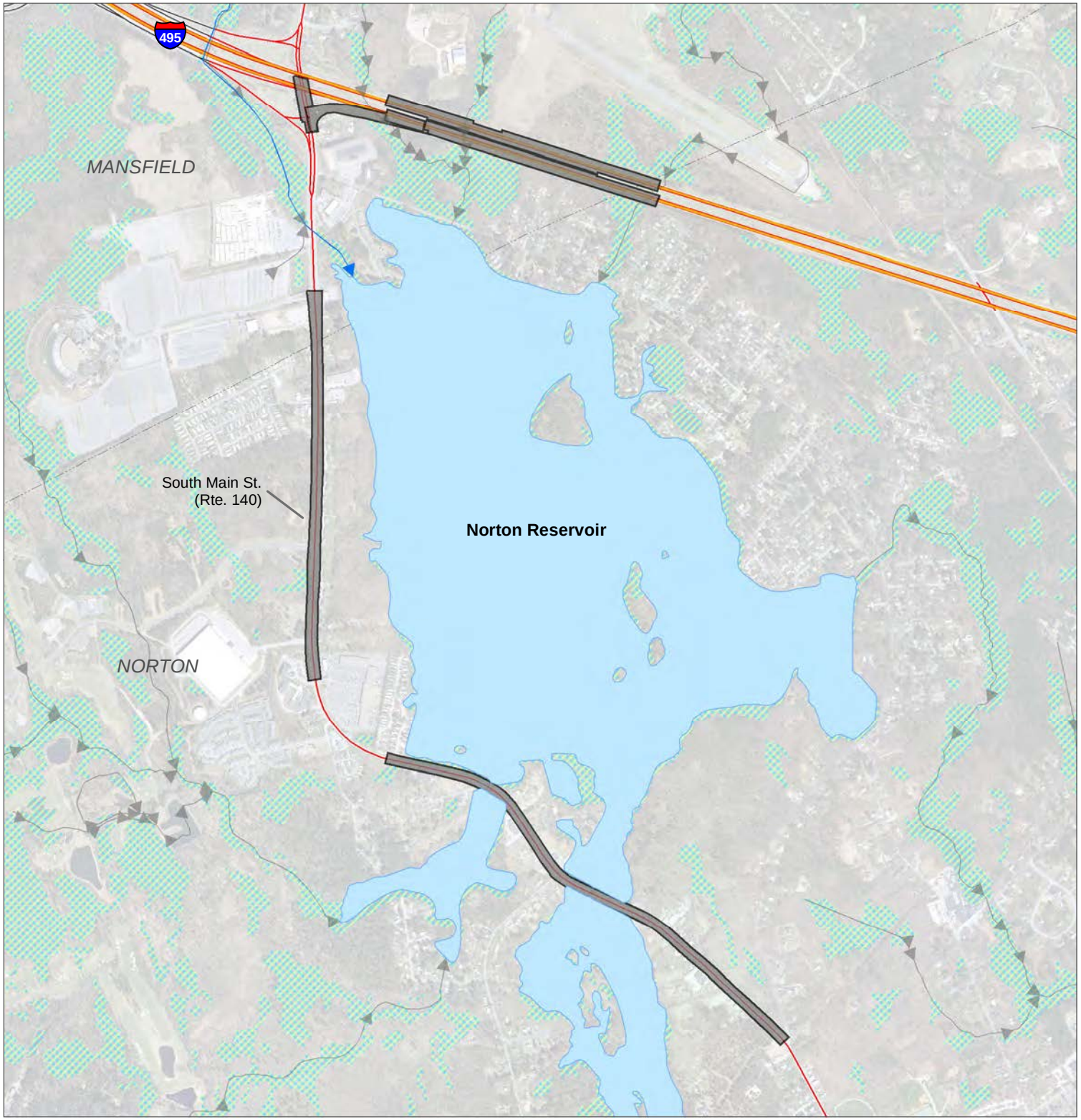

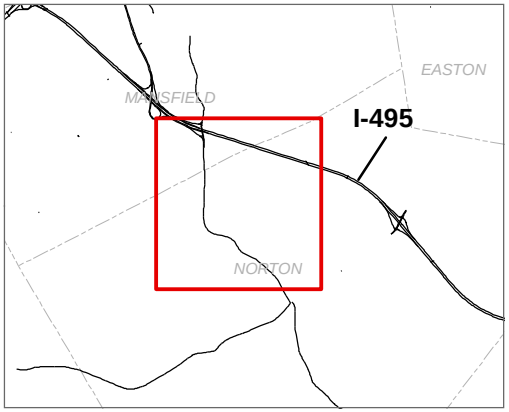

MassDOT Watershed
Impaired Water Bodies
NWI Wetland Areas
Impaired Stream Segments
Non-Impaired Stream Segments
Project Roads
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

0 750 1,500 3,000
Feet

1 in = 1,500 ft

Figure 2

Norton Reservoir (MA62134)
Directly Contributing
MassDOT Watershed

January 2012

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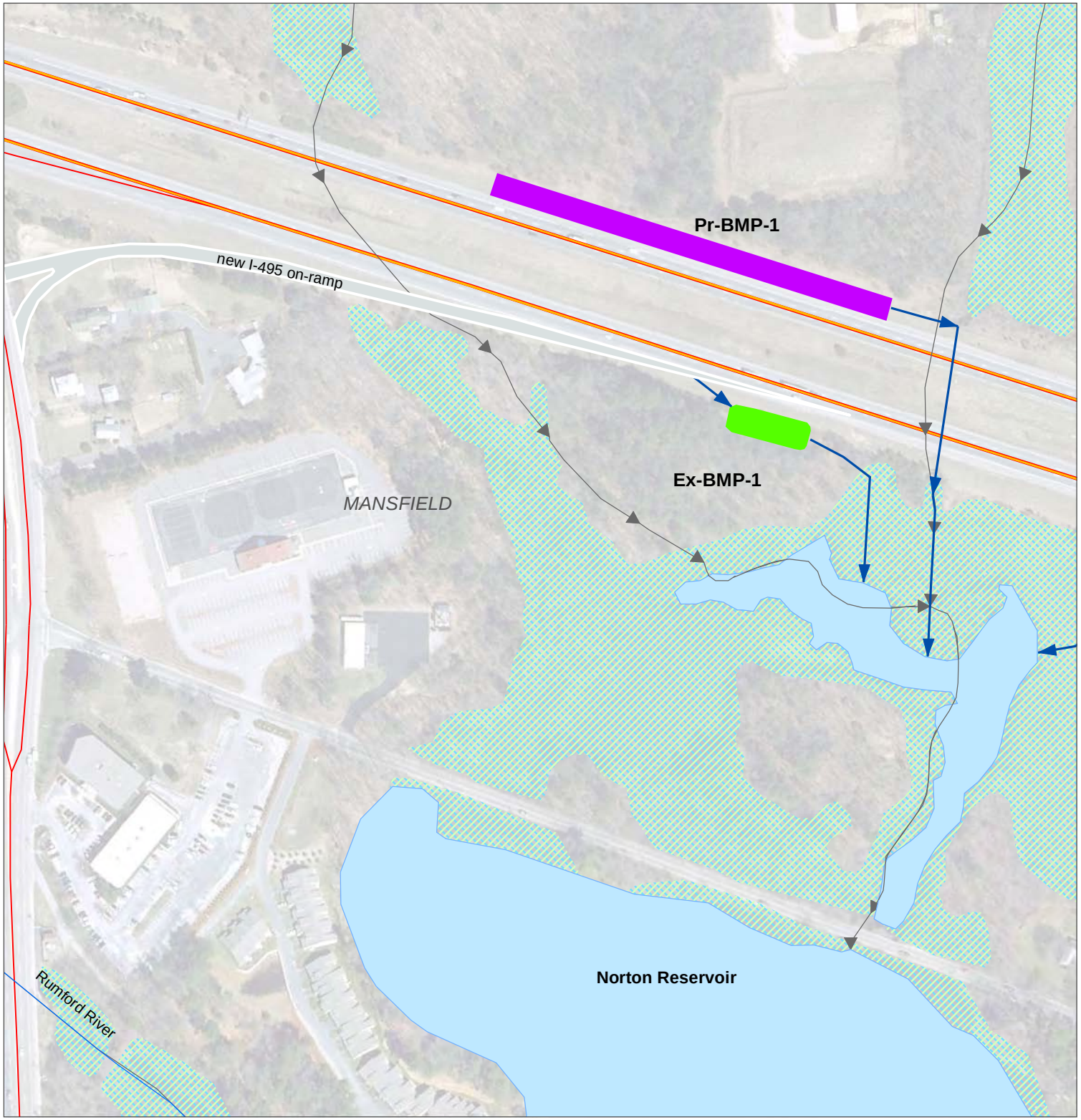

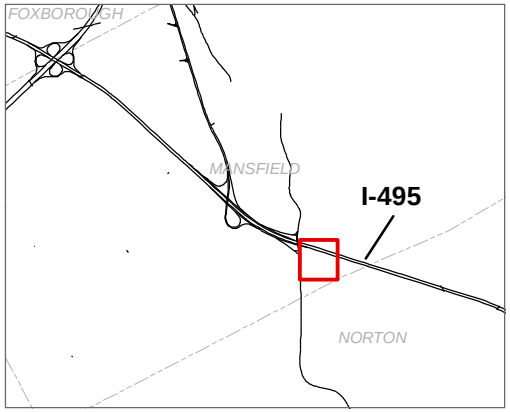

- Direction of Drainage
- Existing BMPs
- Proposed BMPs
- Impaired Water Bodies
- NWI Wetland Areas
- Impaired Stream Segments
- Non-Impaired Stream Segments
- Project Roads
- MassDOT Roads in Urban Areas
- Town Boundaries

N

0 125 250 500 Feet

1 in = 250 ft

Figure 3

Norton Reservoir (MA62134)
Existing and Proposed BMPs
Sheet 1 of 2

January 2012

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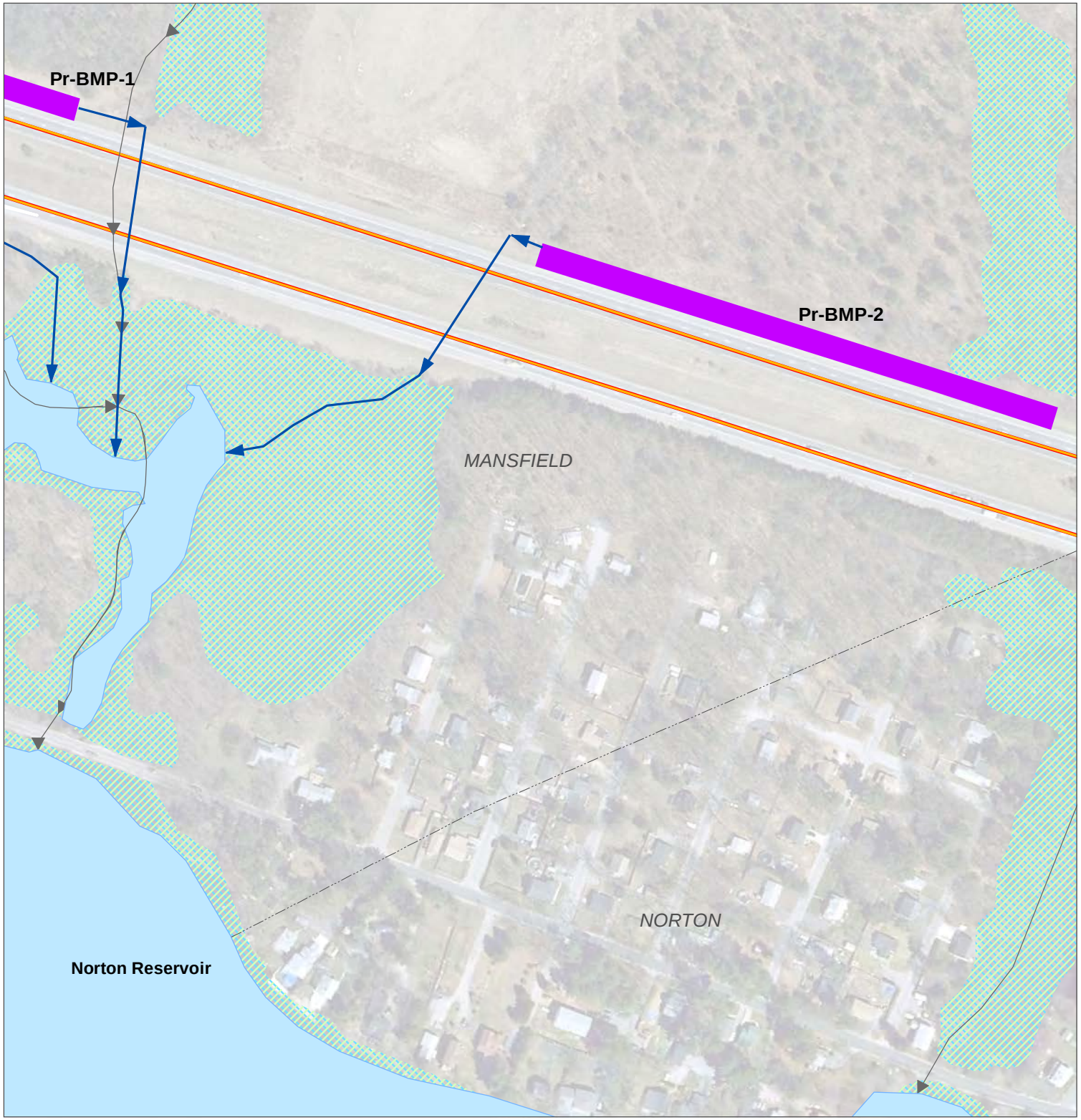

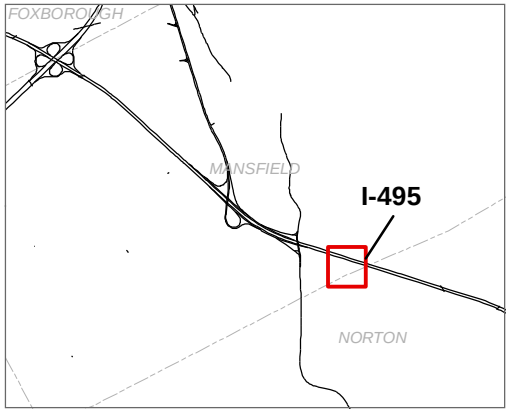

- Direction of Drainage
- Existing BMPs
- Proposed BMPs
- Impaired Water Bodies
- NWI Wetland Areas
- Impaired Stream Segments
- Non-Impaired Stream Segments
- Project Roads
- MassDOT Roads in Urban Areas
- Town Boundaries

N

0 125 250 500 Feet

1 in = 250 ft

Figure 4

Norton Reservoir (MA62134)
Existing and Proposed BMPs
Sheet 2 of 2

January 2012

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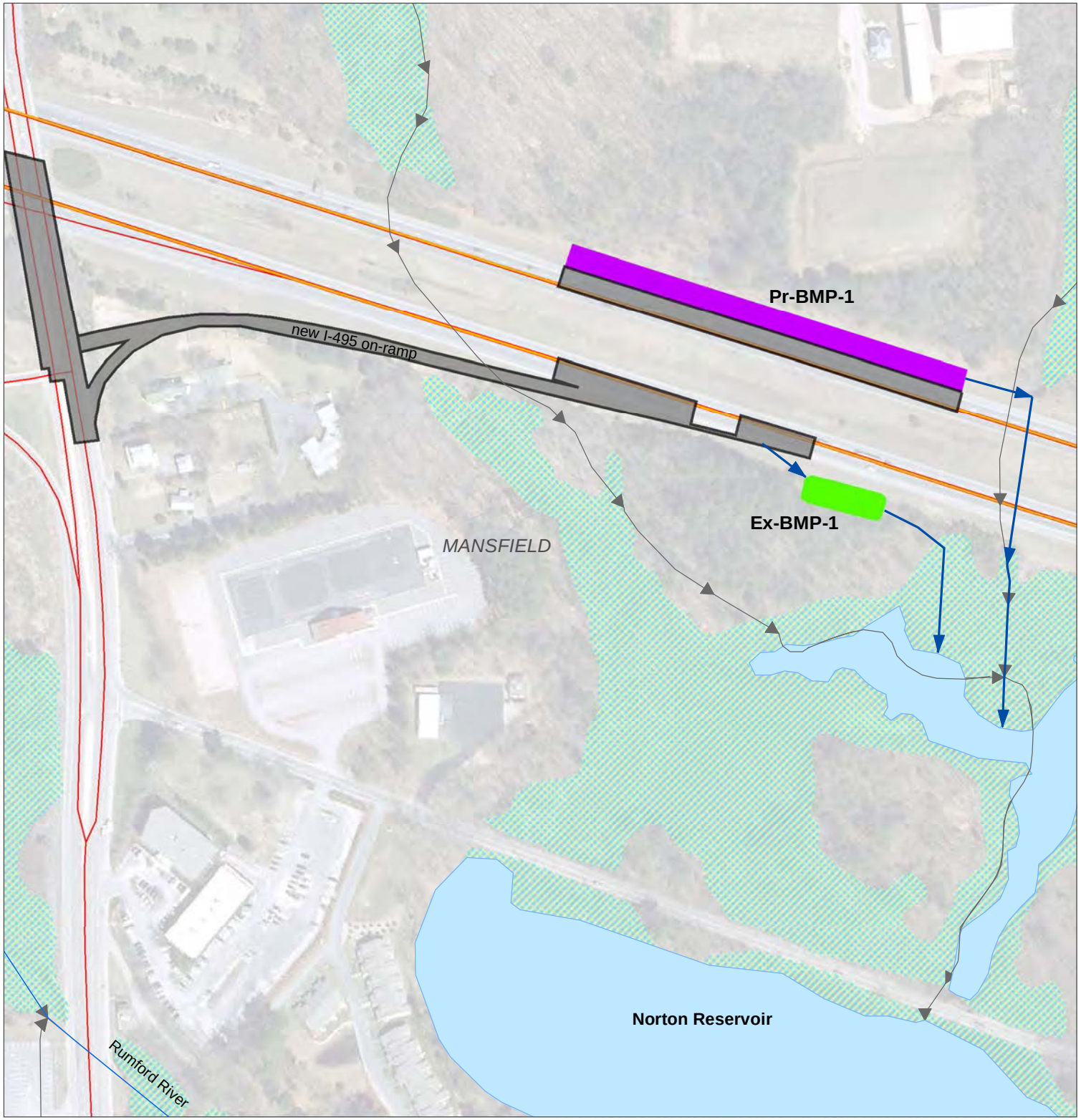

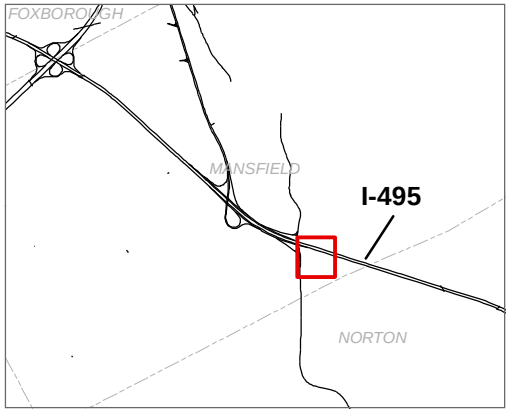

- Direction of Drainage
- Existing BMPs
- Proposed BMPs
- BMP Watershed
- Impaired Water Bodies
- NWI Wetland Areas
- Impaired Stream Segments
- Non-Impaired Stream Segments
- Project Roads
- MassDOT Roads in Urban Areas
- Town Boundaries

N

0 125 250 500 Feet

1 in = 250 ft

Figure 5

Norton Reservoir (MA62134)
Existing and Proposed BMPs
Sheet 1 of 2

January 2012

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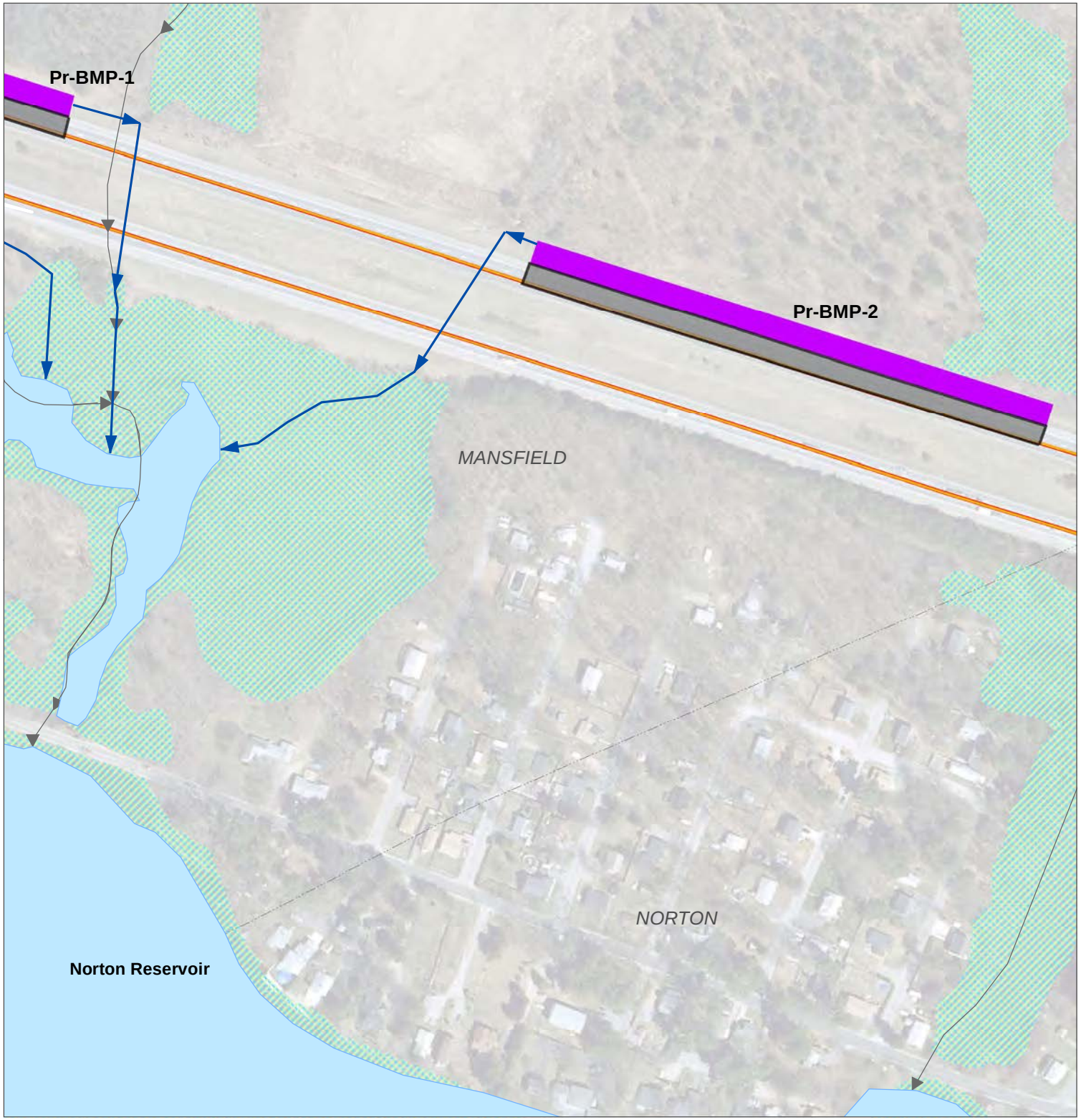

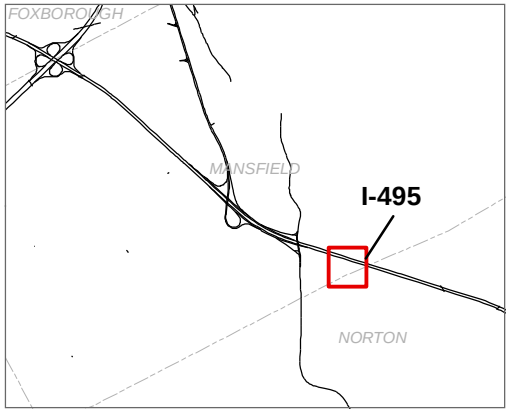

- Direction of Drainage
- Existing BMPs
- Proposed BMPs
- BMP Watershed
- Impaired Water Bodies
- NWI Wetland Areas
- Impaired Stream Segments
- Non-Impaired Stream Segments
- Project Roads
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- Town Boundaries

N

0 125 250 500 Feet

1 in = 250 ft

Figure 6

Norton Reservoir (MA62134)
BMP Watersheds
Sheet 2 of 2

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Impaired Waters Assessment for Wading River (MA62-47)

Impaired Water Body

Name: Wading River

Location: Foxborough and Mansfield, MA

Water Body ID: MA62-47

Impairments

Wading River (MA62-47) is listed under Category 5, "Waters Requiring a TMDL", on MassDEP's final *Massachusetts Year 2008,* final *Massachusetts Year 2010 Integrated List of Waters* and proposed *Massachusetts Year 2012 Integrated List of Waters* (MassDEP 2008, 2011 and 2012, respectively).Table 1 below identifies the impairments.

Table 1. Impairments to Wading River (MA62-47) Included on the Massachusetts Integrated List of Waters

Massachusetts Integrated List of Waters		
Final 2008 List	**Final 2010 List**	**Proposed 2012 List**
Organic enrichment/low DO	Dissolved oxygen	Dissolved oxygen
Pathogens	Fecal coliform	Fecal coliform

This segment of the Wading River serves as the source for the City of Attleboro's water supply and is classified as a Class A public drinking water supply under 314 CMR 4.06. Class A waters are designated as sources of public drinking water supply, as excellent fish and wildlife habitat and for primary and secondary contact recreational activities. The standards for primary contact recreation must be met for Class A waters even if these activities are not permitted (e.g., in a reservoir). Class A waters are also considered to have excellent aesthetic value. This is the most stringent inland water classification and includes strict standards for bacteria, dissolved oxygen, and other characteristics to protect the designated uses of the water and human health.

Relevant Water Quality Standards

Water Body Classification: Proposed Class A

Applicable State Regulations:

- *314 CMR 4.05 (3)(a) 1 Dissolved Oxygen.* Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

- 314 CMR 4.05 (3)(a) 4 *Bacteria*.
    - a. At water supply intakes in unfiltered public water supplies: either fecal coliform shall not exceed 20 fecal coliform organisms per 100 ml in all samples taken in any six month period, or total coliform shall not exceed 100 organisms per 100 ml in 90% of the samples taken in any six month period, If both fecal coliform and total coliform are measured, then only the fecal coliform criterion must be met. More stringent regulations may apply under the Massachusetts Drinking Water regulations, 310 CMR 22.00 (see 314 CMR 4.06(1)(d)1.)
    - b. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml
    - c. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples, and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department

Site Description

Segment MA62-47 of the Wading River, identified as an impaired water body in the area of Interstate-95 (I-95) in the towns of Foxborough and Mansfield (the Project Area), extends from its source in the wetland north of West Street, Foxborough to Balcom Street, Mansfield, in the upper portion of the Wading River Watershed (see Figures 1 and 2). As shown in Figure 1, there are approximately 13 acres of MassDOT owned roadway within the approximately 1,044 acre subwatershed to this segment of the Wading River (USGS Data Series 451, MassGIS). Interstate-95 crosses the Wading River on Bridge M-3-25, which consists of two spans; one for northbound traffic and one for southbound traffic. This reach of the river was modified and straightened when the roadway was constructed and the centerline of the river in the vicinity of the bridges corresponds to Station 60+66 of the roadway. The surrounding land use is predominately forest and single-family residential.

As shown in Figures 3 through 6, the existing stormwater system for the highway in this area consists of traditional open, off-the-shoulder, grassed swale drainage with occasional stormwater conveyance structures. Throughout the project area, runoff from the paved roadway typically sheet flows off onto the grass shoulder which is considered to function as a vegetated filter strip. The shoulders each have a 3 foot level vegetated area which transitions to an approximately 6:1 vegetated slope away from the edge of the roadway. The sloped areas are 21 feet wide on the outside shoulders and 24 feet wide on the median shoulder. At the toe of slope the runoff enters vegetated conveyance swales. These swales do not contain check dams but are well vegetated with a relatively flat slope and show minimal evidence of any scour. The combination of the relatively flat grassy embankments and associated vegetated swales are conducive in infiltrating some portion of the runoff along the flow path.

Approximately 1.2 miles of the I-95 roadway drains to the Wading River with approximately 4,000 feet of both the northbound and southbound lanes contributing stormwater from either side of the bridge crossing. The actual roadway low point appears to be located on the south side of the Wading River. Almost the entire roadway segment has open drainage with runoff flowing as sheet flow to the grassy shoulder except for a small section at the low point in the roadway profile. At this location, there are three sets of catch basins on each side of both the northbound and southbound lanes immediately adjacent to the bridges. These catch basins receive runoff from a small section of roadway and discharge to flared-end sections near the toe of the shoulder. A perforated sub-drain runs parallel to the edge of the roadway preventing water from entering and damaging the roadway sub-base. This sub-drain is connected to the drainage infrastructure. There are no stormwater BMPs present within the project area. There are no scuppers or other such drainage structures which discharge directly to the river from the bridges or the adjacent roadway.

In the roadway area north of the river crossing, stormwater drains into vegetated swales at the toe of the shoulder which contains drop inlets and piped conveyances. Drop inlets within these swales are spaced approximately 250 to 300 feet apart to collect stormwater and convey it toward the river in a closed drainage network. The vegetated swales have developed cells of wetland vegetation between the drop inlets. The outlet from the closed drainage network that serves the southbound travel lanes is within the highway median, approximately 500 feet north of the river at Station 66+00. Drainage in the median flows south through an area of forested wetland, crosses an open grassed area and then drains through a stone-lined channel to the east bank of the river. The outlet from the closed drainage network that serves the northbound travel lanes is located on the shoulder of the northbound roadway, approximately 200 feet north of the river at Station 63+00. Flows from this area enter an area of scrub-shrub and forested wetland before draining to the east bank of the river.

In the project area south of the river, runoff flows over the grass shoulder into the vegetated median or to vegetated swales along the toe of the shoulder. In the median, stormwater flows through a forested wetland system between Station 53+00 and Station 59+00, approximately, and outlets into a 30-inch reinforced concrete pipe (RCP). This pipe connects beneath the roadway to the vegetated swale and forested wetland that runs along the shoulder of the northbound travel lane. The swale along the northbound shoulder outlets to the river between northbound I-95 and the West Street bridges. Drainage on the southbound shoulder flows into the wetland system that is associated with the Wading River upstream from the I-95 bridges.

According to the NRCS soils map, the soils within the roadway corridor are classified as Udorthents (disturbed). Undisturbed soils adjacent to the roadway includes areas with Hinkley Sandy Loam (HSG “A”), several fine sandy loam series (HSG “C”), and two limited pockets of muck series (HSG “D”).

Assessment under BMP 7U

The impairment of dissolved oxygen for Wading River has not been addressed by a TMDL. Therefore, MassDOT assessed these impairments using the approach described in BMP 7U of MassDOT’s Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT’s Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the impairment of dissolved oxygen.

The impairment for pathogens is assessed separately in the section titled Assessment under BMP 7U for Pathogens.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover (IC) Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the impervious cover reduction required to ensure that stormwater is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% impervious cover, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. Impervious cover data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which impervious cover would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet the target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective impervious cover reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective impervious cover reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective impervious cover reductions is described in BMP 7U. When the reduction in effective impervious cover achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for the total contributing watershed of the impaired water (Wading River (MA62-47)):

Table 2: Site Parameters for Wading River (MA62-47)

Total Watershed		
Watershed Area	12,472	acres
Impervious Cover (IC) Area	1,442	acres
Percent Impervious	12	%
IC Area at 9% Goal	1,122	acres
Target Reduction % in IC	22	%
Subwatershed		
Subwatershed Area	1,044	acres
Impervious Cover (IC) Area	136	acres
Percent Impervious	13	%
IC Area at 9% Goal	94	acres
Target Reduction % in IC	31	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	12	acres
MassDOT's Target Reduction in Effective IC (31% of DOT Directly Contributing IC)	3.8	acres

The subwatershed is greater than 9% impervious, which indicates that stormwater may be contributing to the impairment. The subwatershed should target a reduction of its effective IC by 31% to reach the 9% goal. Therefore, MassDOT will aim to reduce its effective IC in the directly contributing watershed by the same percentage by removing 3.8 acres of effective IC.

Existing BMPs

There are currently no existing BMPs in the Wading River (MA62-47) subwatershed which treat direct discharges from MassDOT property.

Next Steps

Because there are no existing BMPs providing effective IC reduction, MassDOT has initiated the design of four infiltration swales to address the target reduction of 3.8 acres. These BMPs would treat a total of 2.8 acres of impervious cover and are estimated to achieve an effective IC reduction of approximately 2.5 acres. Table 3 summarizes the estimated percent reductions in effective IC provided by the BMPs in design. The locations of the design BMPs are shown in Figure 6.

Table 3: Summary of BMPs in Preliminary Design

BMP Identifier	BMP Type	Soil Type	IC Area Treated (acres)	Reduction of Effective IC* (%)	Reduction of Effective IC (acres)
Pr-BMP-1	Infiltration Swale	B – Sandy Loam 1.02 in/hr C – Silt Loam – 0.27 in/hr	0.9	93	0.8
Pr-BMP-2	Infiltration Swale	B – Loam 0.52 in/hr C – Silt Loam – 0.27 in/hr	0.6	74	0.4
Pr-BMP-3	Infiltration Swale	C – Silt Loam – 0.27 in/hr	0.4	92	0.4
Pr-BMP-4	Infiltration Swale	B – Sandy Loam 1.02 in/hr C – Silt Loam – 0.27 in/hr	0.9	90	0.8
Total			**2.8**		**2.5****

*Description of MassDOT's *Application of Impervious Cover Method in BMP 7U (MassDOT Application of IC Method, MassDOT 2011)*.
** Rounding accounts for differences in summation

Assessment under BMP 7U for Pathogens

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between impervious cover and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, DOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliform organisms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliform organisms/100 ml have been reported (MassDEP, 2009b). This data suggests that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally cross them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment and Mitigation Plan

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that

> BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, no date).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contains specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. Although not included in this permit term, MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters. In addition, MassDOT has requested coverage under an individual stormwater permit for the next permit term. This permit may contain additional programmatic BMPs to address pathogens.

Conclusions

MassDOT evaluated its property within the directly contributing watershed to Wading River and identified that there are no existing BMPs. MassDOT has initiated the design of four infiltration swales to address the target effective IC reduction of 3.8 acres.

Table 4 summarizes the effective IC removal provided by the existing and designed BMPs.

Table 4: Effective IC Reductions under Existing & Design Conditions

IC in Directly Contributing Watershed	12	acres
Target Reduction in Effective IC	3.8	acres
Effective IC Reduction under Existing Conditions	0.0	acres
Effective IC Reduction under Proposed Conditions	2.5	acres
Remaining Target Reduction	**1.3**	**acres**

BMPs currently in design are estimated to achieve an effective IC reduction of 2.5 acres. Wetlands in the median and the areas surrounding the river do not allow for construction of additional BMPs. The remaining target reduction in effective IC is 1.3 acres. Note that this remaining target may change depending on the final design and construction of the four infiltration swales included in this assessment. The final BMP designs will provide treatment to the maximum extent practicable given site constraints. Changes during final design and construction will be included in annual reports.

Based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, MassDOT has concluded that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's programmed projects initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding the design progress made towards meeting the IC reduction, plans for construction of the BMPs and finalized assessments. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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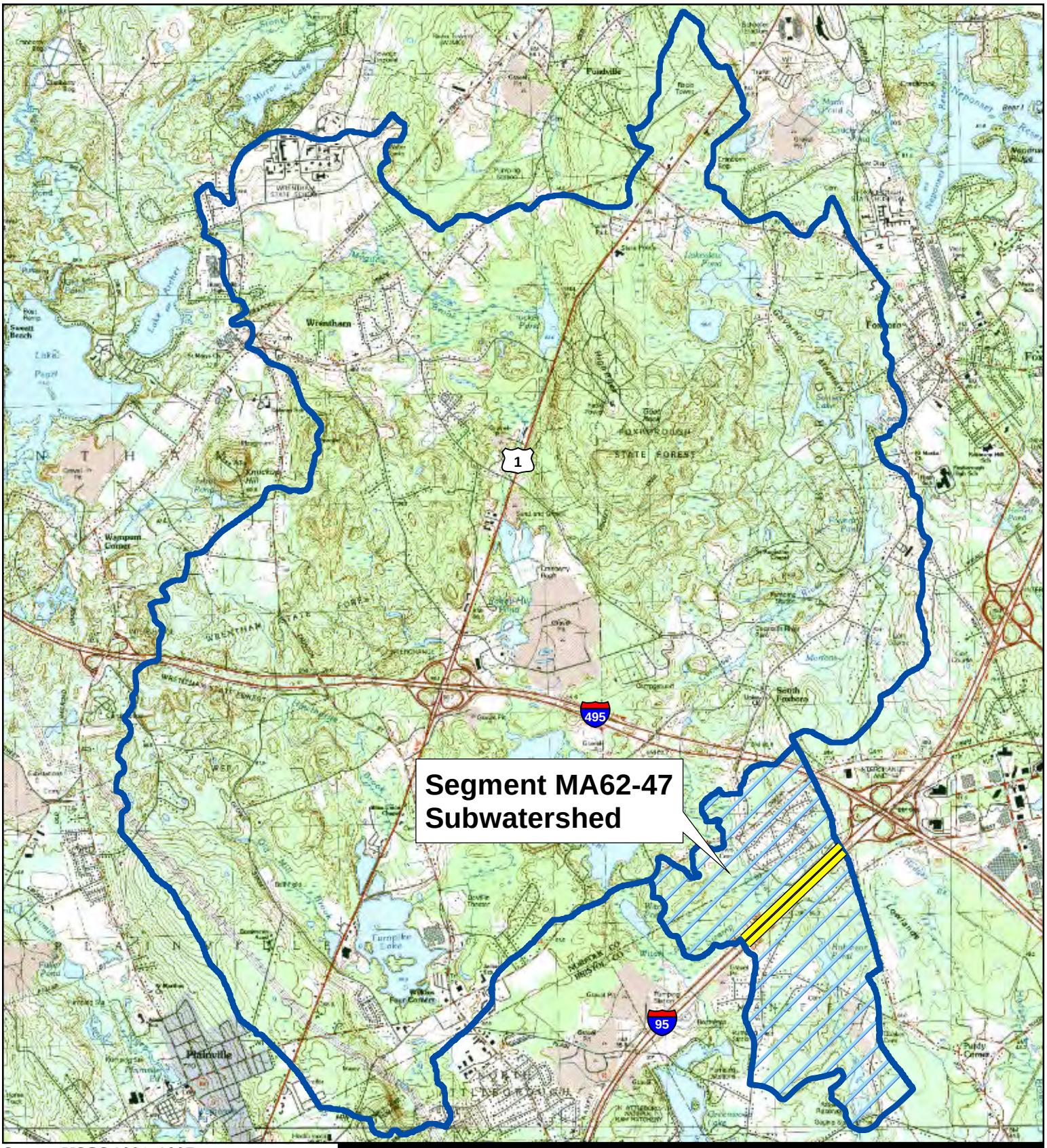

Source: USGS 2001, 2007

Vanasse Hangen Brustlin, Inc.

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Note: Subwatershed polygon based on the USGS Series 451 datalayer modified to match the segment description.

0 2,000 4,000 8,000 Feet

Locus Map

MassDOT Impaired Waters Program
Wading River Watershed
Segment MA62-47
Foxborough / Mansfield, Massachusetts

Figure 1

June 2011

MassDOT Assessed Roadway Segment
Wading River Watershed
MA62-47 Subwatershed

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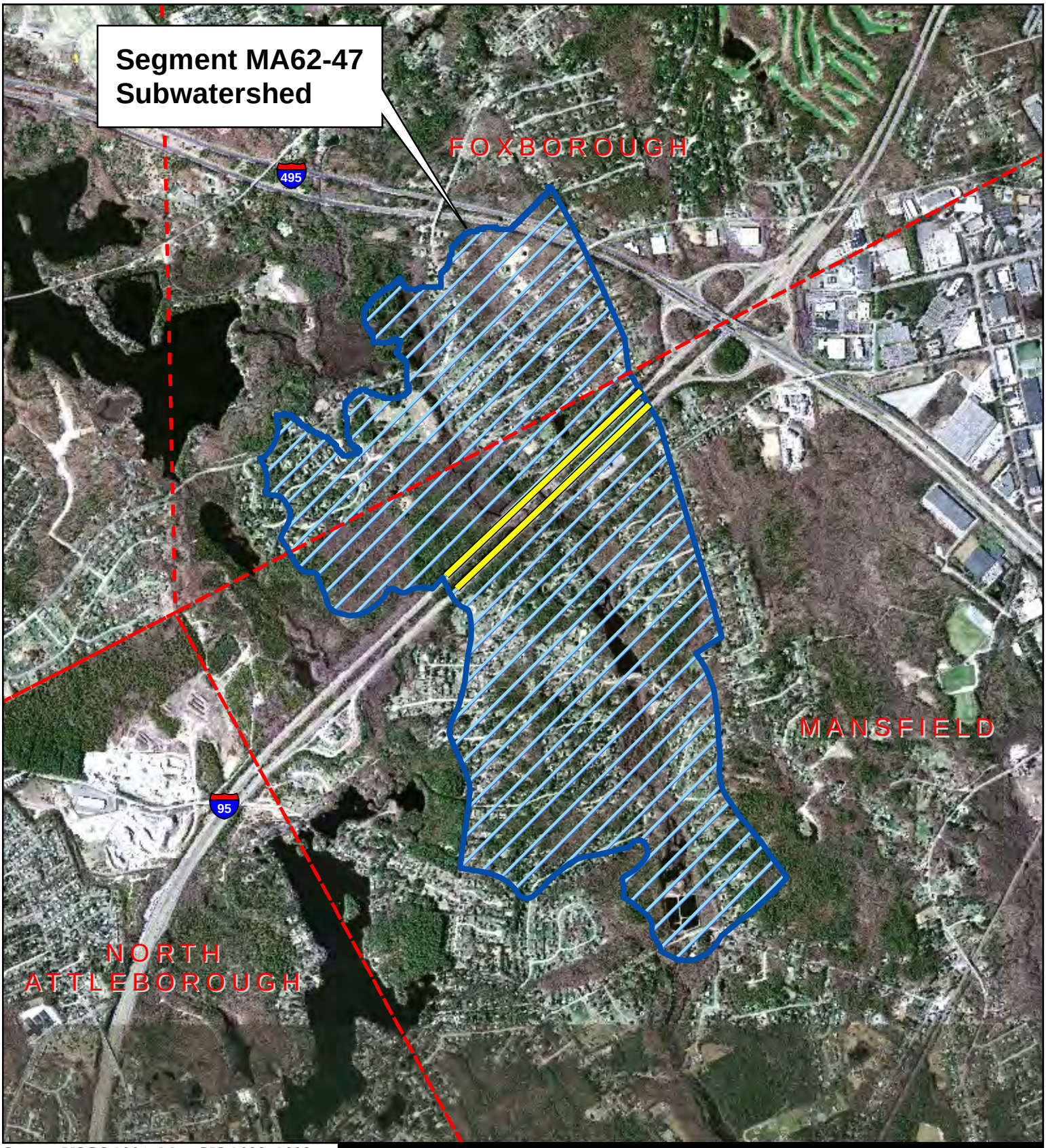

Source: USGS 2001; MassGIS 2008, 2009

Vanasse Hangen Brustlin, Inc.

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Note: Subwatershed polygon based on the USGS Series 451 datalayer modified to match the segment description.

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Aerial Map
MassDOT Impaired Waters Program
Wading River Watershed
Segment MA62-47
Foxborough / Mansfield, Massachusetts

Figure 2

June 2011

MassDOT Assessed Roadway Segment

MA62-47 Subwatershed

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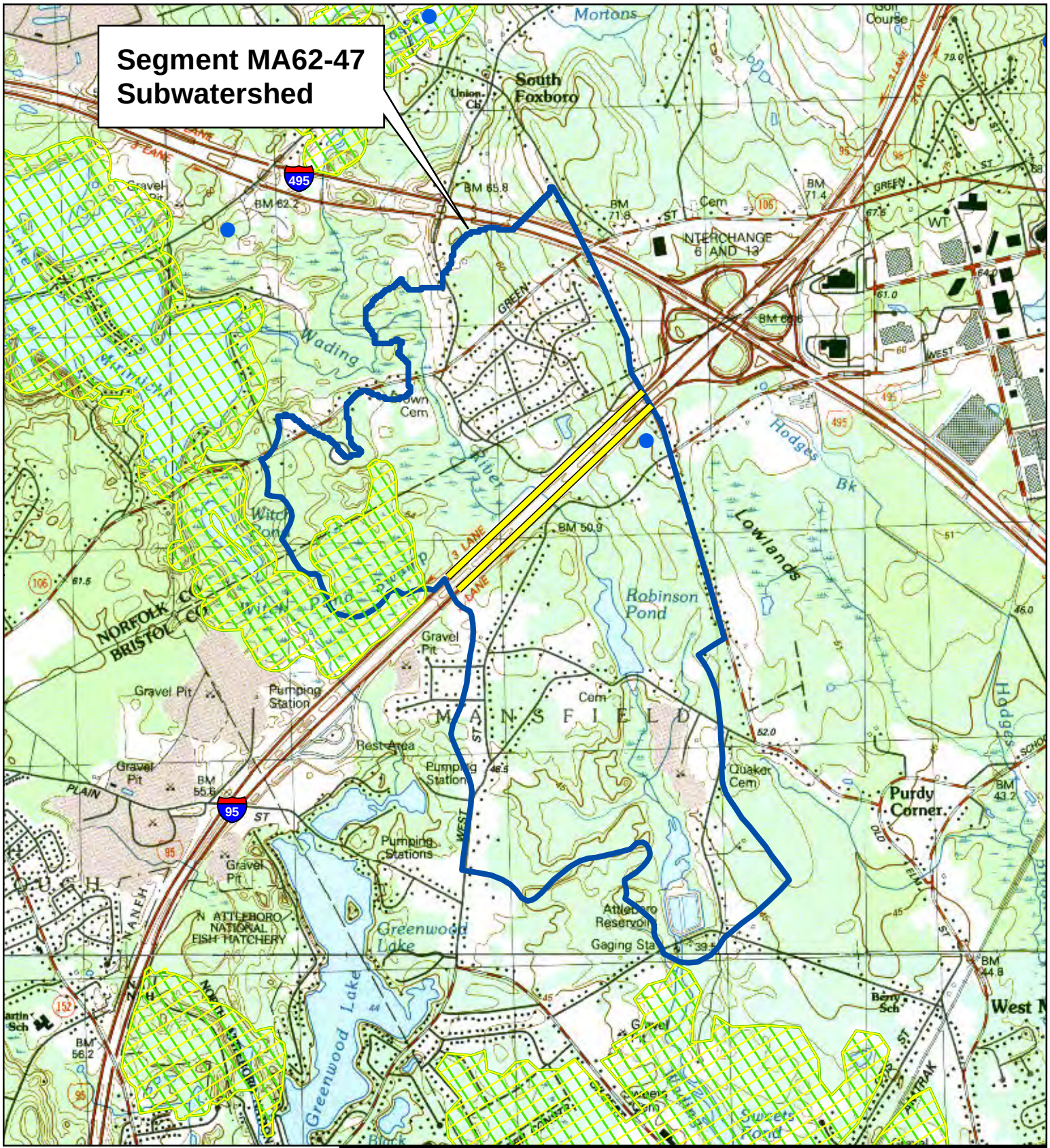

Source: USGS 2001; MassGIS 2008

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Note: Subwatershed polygon based on the USGS Series 451 datalayer modified to match the segment description.

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NHESP Map
MassDOT Impaired Waters Program
Wading River Watershed
Segment MA62-47
Foxborough / Mansfield, Massachusetts

MassDOT Assessed Roadway Segment
MA62-47 Subwatershed

Figure 3

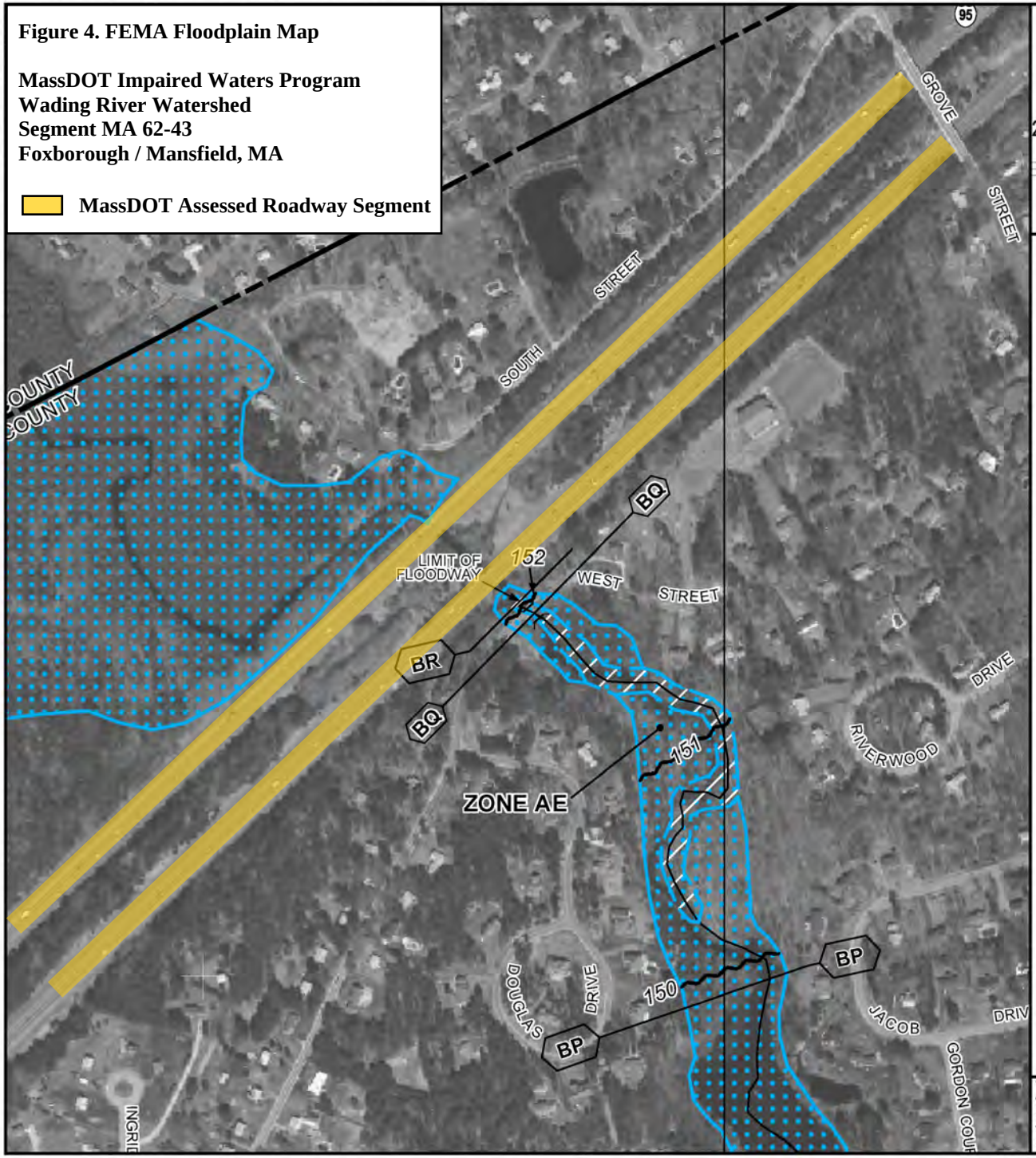
June 2011

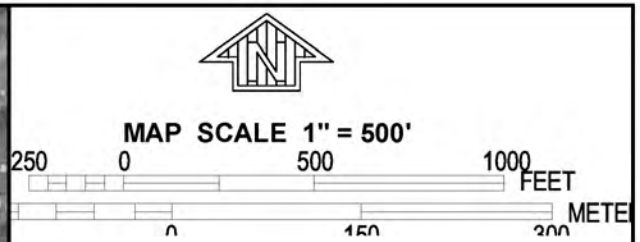
Certified Vernal Pools
Priority Habitats of Rare Species
Estimated Habitats of Rare Wildlife

Figure 4. FEMA Floodplain Map

MassDOT Impaired Waters Program
Wading River Watershed
Segment MA 62-43
Foxborough / Mansfield, MA

MassDOT Assessed Roadway Segment





NFIP

PANEL 0019F

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

BRISTOL COUNTY, MASSACHUSETTS

(ALL JURISDICTIONS)

PANEL 19 OF 550

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MANSFIELD, TOWN OF	250057	0019	F
NORTH ATTLEBOROUGH, TOWN OF	250059	0019	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
25005C0019F

EFFECTIVE DATE
JULY 7, 2009

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

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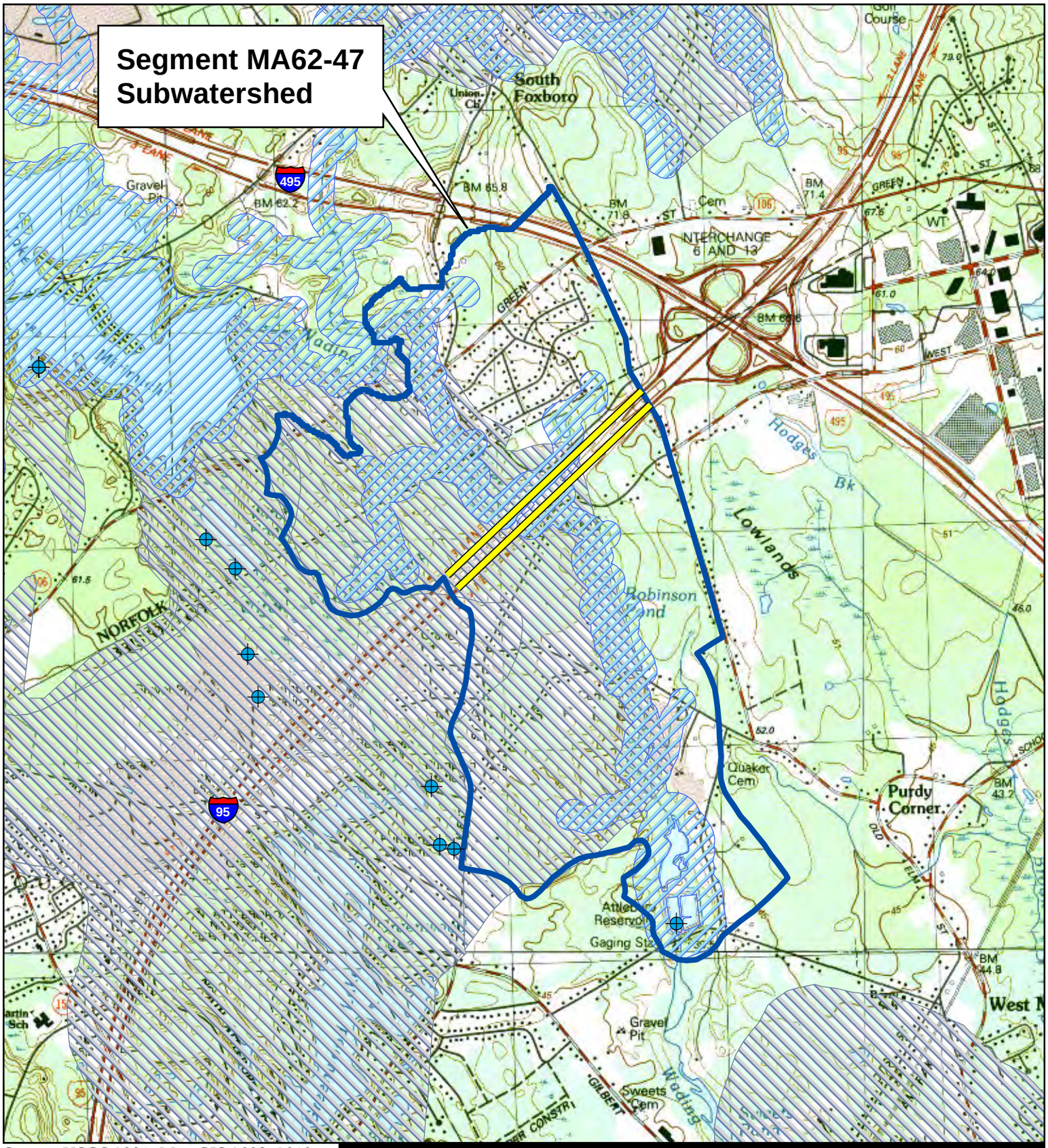

Source: USGS 2001; MassGIS 2008, 2010

Vanasse Hangen Brustlin, Inc.

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Note: Subwatershed polygon based on the USGS Series 451 datalayer modified to match the segment description.

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Stormwater Critical Areas
MassDOT Impaired Waters Program
Wading River Watershed
Segment MA62-47
Foxborough / Mansfield, Massachusetts

MassDOT Assessed Roadway Segment

MA62-47 Subwatershed

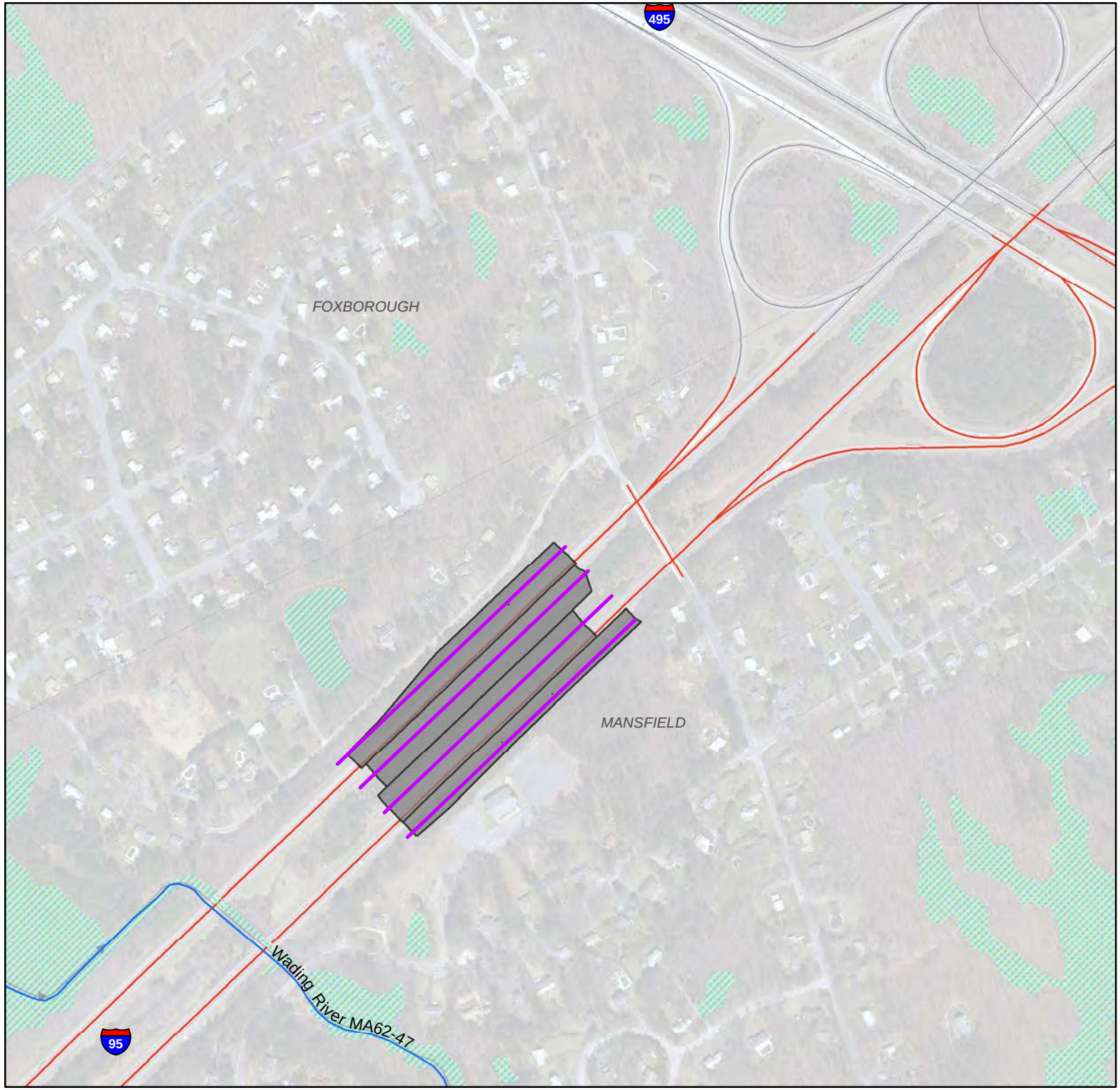
Figure 5

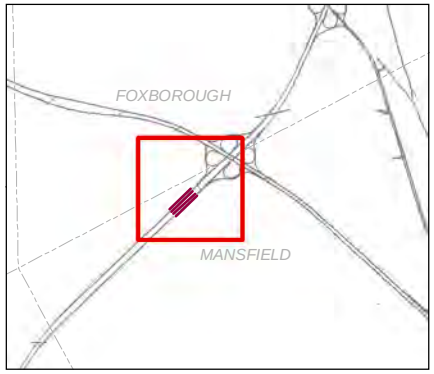
June 2011

Water Supply Wells/Intakes

Zone A Surface Water

Zone II Wellhead Protection





- Proposed BMP - Swale
- BMP Watershed
- Impaired Stream Segment
- Impaired Water Bodies
- Non-Impaired Stream Segment
- NWI Wetland Areas
- MassDOT Roads in Urban Areas
- MassDOT Roads
- Town Boundaries

N

0 125 250 500 750 1,000 Feet

1 in = 500 feet

Figure 6

Wading River (MA62-47)
Design BMPs

June 2012

Moving Massachusetts Forward. massDOT

Impaired Waters Assessment for Aberjona River (MA71-01) – Final Report

Introduction

Aberjona River (MA71-01) was previously assessed in a progress report titled, *Impaired Waters Assessment for Aberjona River (MA71-01) – Progress Report*, submitted on 12/8/2011. The progress report stated that MassDOT would work with designers to implement BMPs in order to meet its target reduction of impervious cover (IC). MassDOT has since initiated the design of BMPs to address its contribution of stormwater to Aberjona River. This report presents a summary of the findings of the progress report as well as a final assessment which includes the reduction provided by existing BMPs and the final target IC reduction determined during the Designer's comprehensive investigation and the BMPs in design and their estimated resulting IC removals.

Summary of Progress Report

Impaired Water Body

Name: Aberjona River

Location: Reading/Winchester/Woburn, MA

Water Body ID: MA71-01

Impairments

Aberjona River (MA71-01) is listed under Category 5, "Waters Requiring a TMDL", on both MassDEP's final *Massachusetts Year 2008* and the final *Massachusetts Year 2010 Integrated List of Waters*, (MassDEP 2008 and 2011, respectively). Table 1 below identifies the impairments. According to MassDEP's *Mystic River Watershed and Coastal Drainage Area 2004-2008 Water Quality Assessment Report* (MassDEP, 2010), unspecified urban stormwater is listed as an impairment source for the following designated uses: aquatic life use, primary contact, secondary contact and aesthetics. The aesthetics use is impaired due to moderate turbidity consistently noted by DWM biologists in Judkins Pond and Mill Pond sections of the Aberjona River during surveys conducted in 2004.

Table 1. Impairments of Aberjona River (MA71-01) Included on the Massachusetts Integrated List of Waters

Massachusetts Integrated List of Waters	
Final 2008 List (MassDEP, 2008)	**Final 2010 List (MassDEP, 2011)**
Cause unknown	Aquatic Macroinvertebrate Bioassessment
Metals	(Physical substrate habitat alterations*)
Unionized ammonia	Ammonia (Un-ionized)
Nutrients	Arsenic
Organic enrichment/low DO	Oxygen, Dissolved
Other habitat alterations	Phosphorus (Total)
Pathogens	Fecal Coliform

Site Description

MassDOT's property that directly contributes stormwater runoff to the Aberjona River is comprised of portions of I-93 and its ramps, I-95 and its ramps, Washington Street, Cedar/ Salem Street, Montvale Avenue, portions of Mishawum Road and the Olympia Ave bridge over the MBTA rail tracks.

Assessment under BMP 7U

For this water body, MassDOT used the IC method to assess the following impairments:

- cause unknown
- metals
- unionized ammonia
- nutrients
- organic enrichment/low DO.

According to the final *Year 2010 Integrated List of Waters*, other habitat alterations is considered a non-pollutant and unrelated to stormwater. Therefore, MassDOT has determined that further assessment of this impairment to the water body is not required.

The impairment for pathogens was assessed separately in the progress report. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations for the impairment of pathogens. See *Impaired Waters Assessment for Aberjona River (MA71-01) – Progress Report* for more information (MassDOT, 2011).

Existing BMPs

The progress report listed one existing BMP which was identified in the Aberjona River subwatershed as mitigating potential stormwater quality impacts prior to discharge to the river. A summary of the existing BMP information reported is shown in Table 2.

Table 2. Summary of Existing BMPs

BMP Name	BMP Type	Soil Type	Depth of Runoff Treated (inches)	IC Area Treated (acres)	Reduction of Effective IC* (%)	Reduction of Effective IC (acres)
Ex-BMP-1	Infiltration Basin	C – Silt Loam – 0.27 in/hr	4.1	2.9	95	2.8

*Description of MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT 2011)

Target Reduction

In the progress report, MassDOT derived the following site parameters and target reduction for DOT's directly contributing watershed draining to the Aberjona River (MA71-01) using the IC Method:

Table 3. Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	56	acres
Target Percent Reduction in Effective IC	76	%
Target Reduction in Effective IC to meet 9% IC target	43	acres
IC Effectively Reduced by Existing BMPs	2.8	acres
IC Remaining to Mitigate with Proposed BMPs	40	acres

Final Assessment

Designer Investigation of Existing BMPs

After the submittal of the progress report, further investigation of the existing BMP found more precise values of storage volume, IC area treated, and percent reduction of effective IC, although in the end the effective IC value did not change. Table 4 below summarizes the updated existing BMP information.

Table 4. Summary of Designer Investigation of Existing BMPs

BMP Name	BMP Type	NRCS Hydrologic Soil Group	Storage Volume (in)	IC Area Treated (ac)	Percent Reduction of Effective IC*	Reduction of Effective IC (ac)
Ex-BMP-1	Infiltration Basin	D – Urban Lane	3.1	3.0	93%	2.8

*Description of MassDOT's *Application of Impervious Cover Method in BMP 7*U (*MassDOT Application of IC Method, MassDOT 2011*).

Updated Target Reduction

After the submittal of the progress report, further investigation of MassDOT's directly contributing IC area was performed by the designers. Based on this investigation, the MassDOT Directly Contributing IC Watershed was updated from 56 acres to 52 acres. Thus, the target reduction of impervious cover, 76% of this IC watershed, was also updated by the designers from 43 acres to 40 acres based on these more in-depth field evaluations. After taking into account the reduction provided by the existing BMPs determined by the designers, the remaining target reduction of effective IC is 37 acres. See Table 5 below.

Table 5. Designer Investigation Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	52	acres
Target Percent Reduction in Effective IC	76	%
Target Reduction in Effective IC to meet 9% IC target	40	acres
IC Effectively Reduced by Existing BMPs	2.8	acres
IC Remaining to Mitigate with Proposed BMPs	37	acres

BMPs in Design

MassDOT has initiated the design of additional BMPs to address the target IC reduction of 37 acres as part of MassDOT's Impaired Waters Retrofit Initiative. There are currently four infiltration swales and five infiltration basins in design, for a total of nine BMPs, as described below. Table 6 below lists the impervious stormwater catchment area for each BMP as well as the estimated post-construction IC reduction that will be provided by each BMP.

The vegetated shoulder of the I-95 southbound travel lane west of the Washington Street Interchange (Exit 36) will be modified to accommodate an infiltration swale. The existing manmade drainage ditch in the I-95 northbound travel lane shoulder and west of the Washington Street Interchange (Exit 36) will be modified to also accommodate an infiltration swale. There is an existing manmade drainage ditch east of the I-95 northbound on ramp at the Washington Street Interchange (Exit 36) which will be modified to accommodate an infiltration swale. The grassed infield area of the I-95 northbound on and off ramps will be modified to accommodate an infiltration basin. The grassed shoulder of I-93 northbound north of the Commerce Way/Atlantic Avenue on ramp (Exit 37C) will be modified to accommodate an infiltration swale. There is a forested infield area of the I-93 southbound on ramp at the Montvale Avenue Interchange (Exit 36) which will be modified to accommodate four infiltration basins.

Table 6. Summary of BMPs in Design

BMP Name	BMP Type	IC Area Treated (ac)	Reduction of Effective IC (ac)
BMP-1	Infiltration Swale	0.31	0.28
BMP-2*	Infiltration Swale	--	--
BMP-3	Infiltration Swale	6.6	6.4
BMP-4	Infiltration Swale	1.9	1.8
BMP-5	Infiltration Swale	2.7	2.6
BMP-6*	Infiltration Swale	--	--
BMP-7	Infiltration Basin	1.6	1.4
BMP-8	Infiltration Basin	0.1	0.12
BMP-9	Infiltration Basin	0.28	0.25
BMP-10	Infiltration Basin	1.31	1.2
BMP-11	Infiltration Basin	0.11	0.3
Total		**15**	**14**

*Plans for BMP-2 were eliminated due to State Highway Layout restrictions associated with grading for an infiltration swale, and BMP-6 was eliminated due to high groundwater restrictions based upon test pits data

The installation of additional BMPs within the Aberjona River subwatershed to provide treatment to meet the target reduction was not able to be accomplished due to varying site constraints. Treatment of the directly contributing IC from Mishawum Road, Washington Street, Cedar Street, and Salem Street was excluded due to a limitation in available right of way. Additionally, treatment of a large portion of the directly contributing IC from I-93 was excluded due to a limitation in available right of way. Directly contributing IC from these roadways covers approximately 26 acres and accounts for roughly half of the directly contributing IC within the Aberjona River subwatershed. The inability to treat this area due to limited right of way is the greatest contributor to reaching the 37-acre IC target. Treatment of additional directly contributing IC from I-93 and I-95 was restricted due to the proximity of MassDOT stormwater outfalls to resource areas (i.e. streams, wetlands, water bodies), constructability conflicts due to the urbanized area, stormwater infrastructure (i.e. structure tie-in elevations) and grading limitations, high groundwater restrictions, and right of way limitations.

Conclusions

Table 7 summarizes IC reductions within MassDOT's directly contributing watershed under the design BMP conditions.

Table 7. Design BMP Effective IC Reductions

MassDOT Target Reduction in Effective IC to Meet with Design BMPs	37 acres
Effective IC Reduction under Design BMPs	14 acres
Remaining Target	**23 acres**

The nine BMPs have been designed to the maximum extent practicable and will achieve 14 acres of effective IC reduction. . Note that the estimated effective IC reduction that will be achieved may change depending on the final designs for the BMPs included in this assessment. The final BMP designs will provide treatment to the maximum extent practicable. Additional BMPs could not be constructed due to site constraints discussed in Section BMPs in Design and thus the remaining target cannot be met under the Retrofit Initiative.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's Programmed Projects Initiative. Work on Programmed Projects often includes broader scale road layout changes that may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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Impaired Waters Assessment for Kendrick Street Pond (MA72055)

Impaired Waterbody

Name: Kendrick Street Pond (also known as Cutler Pond)

Location: Needham, MA

Water Body ID: MA72055

Impairments

According to the MassDEP Final Year 2010 Integrated List of Waters, Kendrick Street Pond is listed under Category 5, indicating that a Total Maximum Daily Load (TMDL) is required for one impairment: turbidity. No other impairments have been identified for Kendrick Street Pond.

The Charles River Watershed 2002-2006 Water Quality Assessment Report (MassDEP, 2008) did not identify a known or potential source of the turbidity causing the impairment.

Relevant Water Quality Standards

- Water Body Classification: B
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
- 314 CMR § 4.05 (3)(b)(6) – *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.*

Summary

MassDOT has assessed stormwater discharges from MassDOT properties to Kendrick Street Pond using BMP 7U in order to address impairments not covered by a TMDL. The following sections describe the methodology for this assessment. Based on this assessment, MassDOT determined that a 1.9-acre reduction in effective impervious cover (IC) would be needed to meet the targets of the watershed.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)
MassDOT's Area Directly Contributing to Impaired Segment	3.7
Target Reduction	1.9
Reduction Provided in Proposed Conditions	1.6

Presently, MassDOT's properties draining to the Kendrick Street Pond do not include stormwater BMPs. The area of Interstate 95 (I-95) that makes up the entire MassDOT directly contributing drainage area is currently being reconstructed with the inclusion of stormwater BMPs. As part of that project, stormwater BMPs (which nearly meet the IC target) have been included to the maximum extent practical given the project and site constraints of the interstate highway location, and therefore, MassDOT has not proposed additional BMPs under this retrofit initiative. See the **Proposed Mitigation Plan** section of this assessment for more information.

Site Description

Kendrick Street Pond (also known as Cutler Pond) is within the Town of Needham, Massachusetts. The Pond covers approximately 39 acres (see Figure 1). Based on the 2008 MassGIS aerial, adjacent land uses include residential housing, commercial/light industrial facilities, and a major transportation corridor (Route 128 / I-95). Route 128/ I-95 in this area is a divided interstate highway with a 3-foot grassed median separating two 55-foot barrels, each carrying three lanes of travel and two shoulders. A 2,000-foot section of MassDOT's Route 128 / I-95 discharges directly to Kendrick Street Pond (see Figure 2).

An existing MassDOT project, the I-95/I-93 Transportation Improvement Project, also known as the Add-A-Lane project, is currently under design along I-95. The project includes the addition of a travel lane and shoulder in each travel direction along 14.3 miles of I-95 between north of Route 9 in Wellesley to Route 24 in Randolph. The 2,000-foot section of Route 128/ I-95 which discharges to Kendrick Street Pond is within the Add-A-Lane project corridor.

Assessment for Turbidity under BMP 7U

The Charles River pathogen and phosphorus TMDLs do not address Kendrick Street Pond's turbidity impairment. Therefore, MassDOT assessed the stormwater-related impairment using the approach described in BMP 7U of MassDOT's *Stormwater Management Plan* (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have not been addressed by a TMDL.

For the water body's stormwater-related impairment not covered by a TMDL, MassDOT used an application of EPA Region I's Impervious Cover (IC) Method described in the EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006). MassDOT used this method to assess potential stormwater impacts on the impaired water and develop the target IC to ensure that stormwater is not the cause of the impairments. The IC Method relates an aquatic system's health (i.e., state of impairment) to the percentage of IC in its contributing watershed. This method is largely based on the work of the Center for Watershed Protection, which has compiled and evaluated extensive data relating watershed IC to the hydrologic, physical, water quality, and biological conditions of aquatic systems (Schueler, 2003). Water quality in tributary streams, rivers, lakes and ponds is a direct reflection of loading from the watershed (Wetzel, 2001); therefore, the IC method can be used as a surrogate for pollutant loading when evaluating water quality impairments

and their causes. Consistent with the findings of EPA and others, MassDOT concluded that when a watershed had less than 9% IC, stormwater was not the likely cause of the impairment.

MassDOT developed the target IC reduction using the approach outlined in *Description of MassDOT's Application of Impervious Cover Method in BMP 7U* (MassDOT, 2011). The watersheds of the subject water body were delineated using a combination of USGS Data Series 451 basin delineations and USGS topographical maps. The IC within the watersheds was calculated using both USGS Data Series 451 and MassGIS's Impervious Surface data layer.

The MassDOT IC method for the impaired waters of the Charles River basin includes the following steps:

1. Calculate the percent IC of the water body's entire contributing watershed (total watershed to downstream end of impaired segment) and that of the local watershed contributing directly to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body.
2. For subwatersheds with greater than 9% IC, calculate the amount of IC reduction needed to achieve 9%. For watersheds with less and 9% IC, perform no further analysis under BMP 7U.
3. Calculate percentage of IC in the MassDOT directly contributing drainage area.
4. Apply reduction of IC necessary for the subwatershed to achieve 9% to the MassDOT contributing drainage area as a target to address the stormwater impairments. Calculate resulting target IC for the MassDOT drainage area.
5. In the case where BMPs are in place or where BMPs are proposed, derive IC reduction rates for the BMPs using MassDOT's assessment model based on size, function, and contributing watersheds of the BMPs. See the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

BMP 7U Assessment

Using the approach described above, MassDOT calculated the following values for the contributing watershed of Kendrick Street Pond to determine the IC target (see Figure 1). For Kendrick Street Pond, MassDOT determined that the total watershed (total watershed upstream of the downstream end of the impaired segment) and the subwatershed (local watershed contributing directly to the impaired segment) were the same.

Watershed Impervious Cover

	Total Watershed
Watershed Area	248 acres
Impervious Cover (IC) Area	57 acres
Percent Impervious	23%
IC Area at 9% Goal	22 acres
Target Reduction % in IC	61%

Since the total watershed is greater than 9% impervious, the analysis indicates that stormwater is a likely contributor to the impairment. To meet the 9% effective IC target, the effective IC within the watershed needs to be reduced by 61%. Therefore, the effective IC of MassDOT's directly

contributing area should to be reduced by the same percentage to meet the target. The following table shows the resulting targets for MassDOT's contributing property.

Reductions Applied to MassDOT Direct Watershed

MassDOT's Area Directly Contributing to Impaired Segment	3.7 acres
MassDOT's IC Area Directly Contributing to Impaired Segment	3.1 acres
MassDOT's Percent Impervious	84 %
MassDOT's Target Reduction in Effective IC (61% of DOT Directly Contributing IC)	1.9 acres
Target Effective IC	33 %

MassDOT's directly contributing area includes 3.1 acres of IC (or 84% of total contributing area). To meet the effective IC target reduction, MassDOT needs to mitigate 1.9 acres of effective IC. Equivalently, MassDOT's contributing drainage area should act as a watershed with 33% IC.

There are no existing BMPs to mitigate the effects of IC.

BMP 7U Mitigation Plan

Under existing conditions, MassDOT's estimated effective IC exceeds the target as described above. To mitigate the effects of IC, MassDOT will implement stormwater BMPs to the maximum extent practical given site and cost constraints.

As part of an existing project, stormwater BMPs to treat MassDOT property draining to Kendrick Street Pond are being proposed. The Proposed Mitigation Plan section discusses the site constraints and mitigation plan.

Proposed Mitigation Plan to Address Impervious Cover

As described in the Site Description section, MassDOT is undertaking the I-95/I-93 Transportation Improvement Project along I-95 also known as the Add-A-Lane project (MassDOT Project #603711). The project includes the addition of a travel lane and shoulder in each travel direction along 14.3 miles of I-95 between north of Route 9 in Wellesley to Route 24 in Randolph. A portion of this project area discharges directly to Kendrick Street Pond. The Add-A-Lane project will increase IC within the project area; as such stormwater improvements have been included in the proposed design.

The table below shows the BMPs proposed as part of the Add-A-Lane project. Figure 3 shows these BMPs. These BMPs will treat MassDOT direct stormwater discharges to Kendrick Street Pond. This table includes proposed BMPs in addition to their respective MassDOT drainage areas and estimated IC reductions. This data is available in the stormwater report completed for the Add-A-Lane Project.

Proposed Effective IC Mitigation

Watershed/ BMP ID	BMP Type	Estimated IC Watershed (Acres)	Estimated Percent Reduction Effective IC	Estimated Load Reduction Effective IC Acres
Infiltration Basin #2	Infiltration Basin	1.6	100	1.6
Total Watershed	**--**	**1.6**	**100**	**1.6**

Source: MassDOT, 18 November, 2011. *Stormwater Report for Route 128 Add-a-Lane Project (Bridge V Contract).* Prepared by Green International Affiliates, Inc.

Note: As per the project's stormwater report, removal rates were obtained from either the MassDEP *Stormwater Handbook Volume 2* or the *Stormwater Best Management Practices (BMP) Performance Analysis* by EPA Region 1 (December 2008).

In addition to the infiltration basin shown in the table above, one leaching catch basin (LCB #7 located at 609+41 RT) is proposed along I-95 to treat stormwater discharging to Kendrick Street Pond. The project's stormwater report (MassDOT, 2011) indicates that this leaching catch basin does not provide treatment for impervious surfaces. However, a review of the project plans indicates that this leaching catch basin does receive flow from impervious surfaces and therefore will provide some additional reduction in effective IC. Reduction in effective IC provided by this leaching catch basin was not calculated.

MassDOT is reviewing the Charles River basin as an entire watershed and has committed to constructing stormwater BMP retrofit projects to address impaired waters. During this assessment phase of the Impaired Waters Program, MassDOT has focused on directly contributing areas and identified BMPs that can be constructed entirely on MassDOT property without resulting in substantial wetland impacts or result in an adverse impact on historical or archeological resources. Projects that meet these requirements can utilize the Federal Highway Administration's Alternative Contracting mechanism (SEP-14) created for this program. MassDOT will advance designs for BMPs where practical in the watershed above and beyond the target mitigation to compensate for areas where site constraints prohibit BMPs.

In addition, BMP implementation through MassDOT's programmed projects, such as the Add-A-Lane project are carefully evaluated and implemented where practicable, and documented through the Water Quality Data Form.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to Kendrick Street Pond using BMP 7U in order to address impairments not covered by a TMDL. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. As part of an upcoming roadway improvement project, the I-95/I-93 Transportation Improvement Project, stormwater BMPs are proposed to treat MassDOT property draining to Kendrick Street Pond. As part of this project, stormwater BMPs which nearly meet the IC target have been included to the maximum extent practical given the project and site constraints of the interstate highway location. Therefore, MassDOT has not proposed additional BMPs under this retrofit initiative.

The following table summarizes the total effective IC reductions proposed in the Kendrick Street Pond watershed:

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)
MassDOT's Area Directly Contributing to Impaired Segment	3.7
Target Reduction	1.9
Reduction Provided in Proposed Conditions	1.6

This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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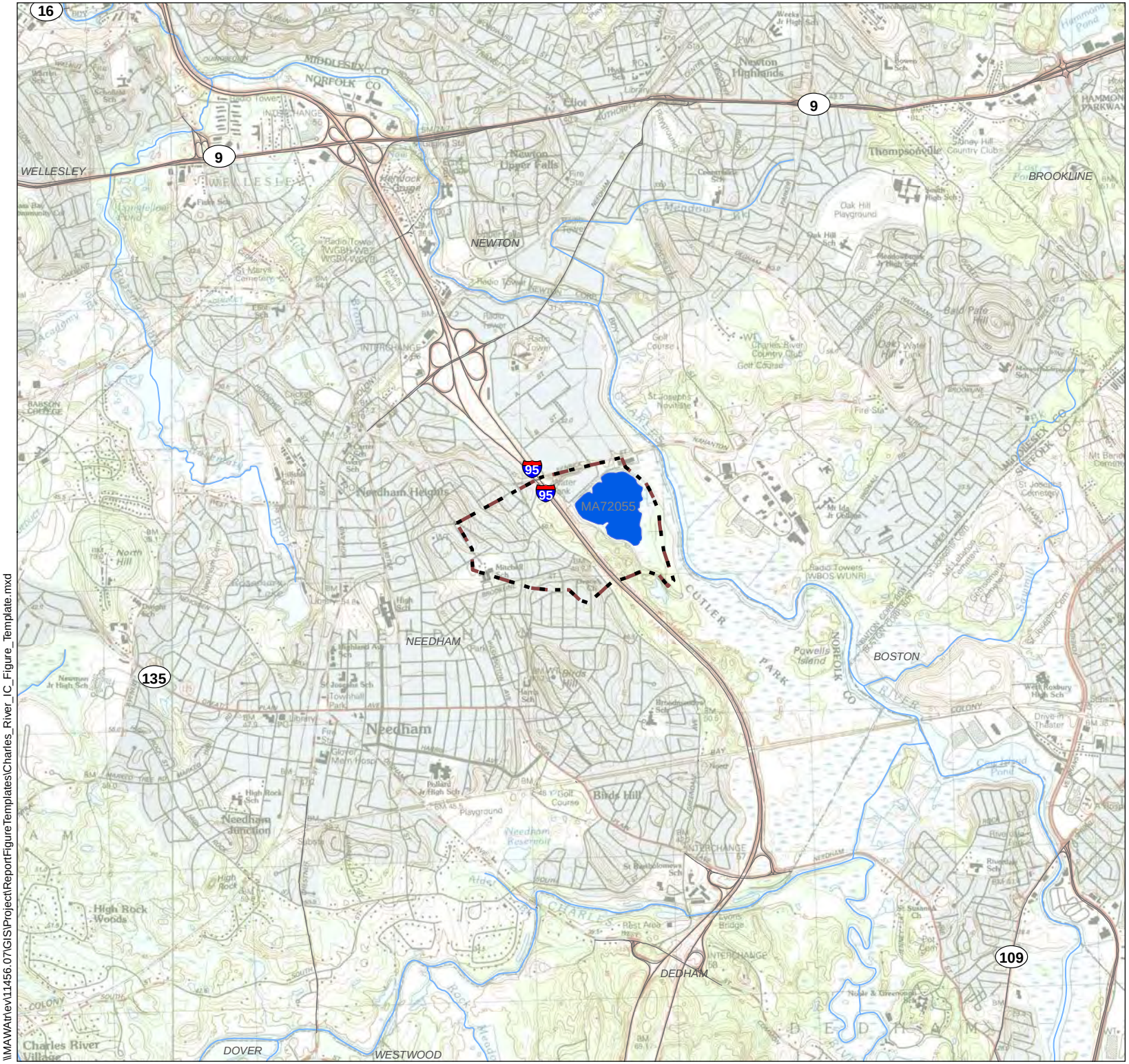

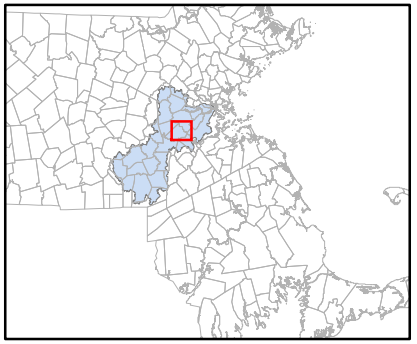

Assessed Stream Segment

Assessed Lake Segment

Total Watershed

Subwatershed

Impaired Lakes

Impaired Streams

MassDOT Roadways

N

0 0.5 1 Miles

Figure 1

Kendrick Street Pond MA72055 Watersheds

June 2012

massDOT Massachusetts Department of Transportation Highway Division

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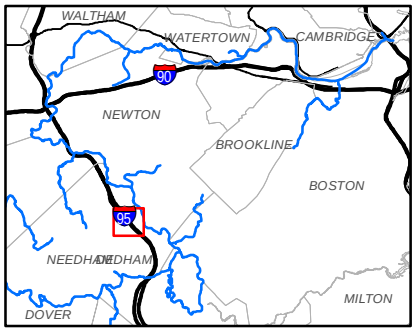

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 250 500 1,000 Feet

Figure 2

Kendrick Street Pond
MA72055
Directly Contributing
MassDOT Watershed

June 2012

massDOT
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Highway Division

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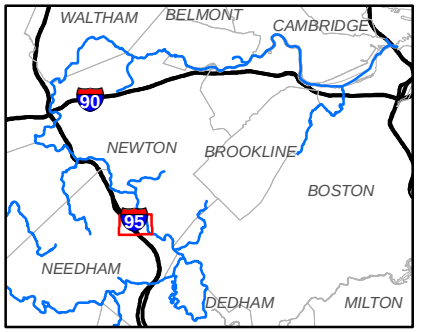

Impaired Streams

Impaired Waters

Proposed BMPs

Proposed BMP Watersheds

MassDOT Roadways

N

0 250 500 1,000 Feet

Figure 3

Kendrick Street Pond
MA72055
Add-A-Lane (Bridge V)
Proposed BMPs

June 2012

massDOT
Massachusetts Department of Transportation
Highway Division

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Impaired Waters Assessment for Charles River [MA72-07]

Impaired Waterbody

Name: Charles River

Location: Dover, Needham, Westwood, Dedham, Boston, Newton, Wellesley, Weston, Waltham and Watertown, MA

Water Body ID: MA72-07

Impairments

According to the MassDEP Final Year 2010 Integrated List of Waters, this segment of the Charles River is listed under Category 5 as impaired for DDT, fishes bioassessments, PCB in fish tissue, non-native aquatic plants, fish-passage barrier, other flow regime alterations, nutrient/eutrophication biological indicators, total phosphorus, and Escherichia coli.

Two TMDL reports have been finalized that address the Upper/Middle Charles River, which includes this segment:

- *Final Nutrient TMDL Report for the Upper/Middle Charles River (CN 272.0),* addressing the nutrient/eutrophication biological indicators and total phosphorus impairments.
- *Final Pathogen TMDL Report for the Charles River Watershed (CN 01560),* addressing the impairment.

The Charles River Watershed 2002-2006 Water Quality Assessment Report (MassDEP, 2008) lists discharges from municipal NPDES discharges (waste water treatment plants), discharges from municipal separate storm sewer systems, unspecified urban stormwater and urban runoff/storm sewers among the main sources of impairments to this segment. Other sources of impairments in the subwatershed include the introduction of non-native plants and habitat alterations associated with dams/impoundments.

Relevant Water Quality Standards

- Water Body Classification: B, Warm Water Fishery
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
- 314 CMR § 4.05 (3)(b)(1) – *Dissolved Oxygen. a. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.*

- 314 CMR § 4.05 (3)(b)(4) – *Bacteria.*
  a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
  b.for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;
- 314 CMR § 4.05 (5)(a) – *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 (5)(b) – *Bottom Pollutants or Alterations. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.*
- 314 CMR § 4.05 (5)(c) – *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 pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.*
- 314 CMR § 4.05 (5)(e) - *Toxic Pollutants. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total*

recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Summary

MassDOT has assessed stormwater impacts from MassDOT properties discharging to the Charles River using BMP 7R to address the Phosphorus and Pathogen TMDLs. MassDOT determined that some water body impairments for the Charles River segment MA72-07 are not related to stormwater runoff. Specific impairments unrelated to stormwater for this segment of the Charles River include fish passage barrier, fishes bioassessments, non-native aquatic plants, other flow regime alterations, and PCB in fish tissue. MassDOT has not included these impairments in this assessment as they are not caused by stormwater runoff.

The following sections describe the methodology for this assessment. Based on this assessment, MassDOT determined that a 307 pound reduction in annual phosphorus loading would be needed to meet the targets of the watershed.

MassDOT has concluded that no existing stormwater best management practices (BMPs) are in place. To reduce MassDOT's contribution to impairments within the Charles River, MassDOT proposes 40 BMPs. These BMPs will provide 128 pounds of phosphorus annual load reduction.

Reductions Applied to DOT Direct Watershed

	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	503
Target Reduction	307
Reduction Provided in Proposed Conditions	128

Under an ongoing MassDOT project, a portion Interstate 95 (I-95) within this segment's directly contributing drainage area is currently being reconstructed with the inclusion of stormwater BMPs. The BMPs proposed under this assessment and as part of that ongoing project are described in the Proposed Mitigation Plan section of this assessment.

Site Description

The segment of the Charles River designated as MA72-07 is a 24.8 mile long segment of the Charles River that flow south to north from Chestnut Street in Needham to the Watertown Dam in Watertown. According to the *2002-2006 Water Quality Assessment Report,* the estimated percent IC for this 271.2 square mile subwatershed is 13.7% and the primary land uses are forest (39%), residential (36%), and open land (8%).

MassDOT has reviewed its direct discharges to this segment in six separate sections as shown on Figure 1:

- Chestnut Street Area
- VFW Parkway Area
- Highland Avenue Area

- Interstate 95 Add-a-Lane Area
- Interstate 95 North Area
- Toll Area

Each of these sections is described below.

Chestnut Street Area

This Charles River section includes the most upstream portion of MA72-07 which flows under Chestnut Street at the Needham/Dover town line (see Figure 2). MassDOT owns Chestnut Street in Needham which directly contributes stormwater runoff to this portion of MA72-07. Approximately 1,000 feet of Chestnut Street, including unpaved shoulders, discharge to this section of the Charles River via a closed drainage system and one outfall. There are no existing BMPs treating MassDOT directly discharging properties within this section.

Chestnut Street in Needham is a two lane undivided road with narrow paved shoulder on both sides. It is surrounded by sparse residential development on both sides. There is no curb, but the adjoining unpaved areas are higher than the road, which keeps stormwater runoff within the right-of-way. Approximately ten feet of adjoining unpaved areas contribute stormwater runoff to the roadway on both sides. It appears that a portion of the runoff from Southfield Court flows onto Chestnut Street as well. Runoff from the roadway flows into a closed drainage system via a series of catch basins and discharge to an unpaved area northwest of the Charles River bridge. The discharge location is within a MassDOT easement on private property.

Stormwater runoff from the Needham side of the bridge flows into the main drainage system on Chestnut Street in Needham. Stormwater runoff from the Dover side of the bridge flows into catch basins on the Dover side of the Charles River and outfalls to a small tributary just upstream of its confluence with the Charles River. MassDOT does not own the roadways on the Dover side of the bridge contributing stormwater runoff to the Charles River.

VFW Parkway Area

This Charles River section includes the portion of MA72-07 which flows in an oxbow through Dedham and along the Boston-Dedham town line (see Figure 3). MassDOT owns one bridge and three road segments that directly contribute stormwater runoff to this section of MA72-07 via a closed drainage system and 6 outfalls. There are no existing BMPs treating MassDOT directly discharging properties within this section.

The southern of the two Charles River bridges on Bridge Street (Route 109) does not appear to directly contribute runoff to the segment. The bridge is a two lane road with curbs on both sides. Runoff from the bridge is directed along the curb line to a ditch and to a catch basin north of the Charles, which do not discharge directly to the Charles River.

Runoff from the northern of the two Charles River bridges on Bridge Street does drain directly to the Charles River. This bridge crosses the Charles River at the intersection of VFW Parkway, Spring Street and Bridge Street. The bridge consists of four lanes bounded by vertical curbs and a sidewalk on either side. Runoff from the bridge is directed via catch basins to a closed pipe network which discharges to the Charles River.

Runoff from approximately 2,200 feet of Ames Street north of the Charles River bridge drains directly to the segment. Ames Street is a two lane road with no median and sidewalks along a portion of its length. It is surrounded by residences and wetlands. Stormwater runoff from Ames Street is collected via a series of catch basin and is believed to discharge to the Charles River.

Runoff from approximately 1 mile of Bridge Street north of the intersection with Ames Street drains directly to the segment. Bridge Street is a four lane road with no median and with curbs and sidewalks along both sides of its length. The area surrounding Bridge Street is primarily residential with some small businesses and one office park adjacent to a wetland buffering the Charles River. Bridge Street drains to a closed drainage system via a series of catch basins. Runoff from the west side of Bridge Street discharges at several locations to wetlands located within residential neighborhoods. The east side of Bridge Street drains to a pipe network that discharges to a wetland buffering the Charles River via two outfalls. The discharge location is within a United States Army Corps of Engineers easement.

Runoff from approximately 4,700 feet of VFW Parkway, as shown on Figure 3, drains directly to this section of the Charles River. VFW Parkway is a four lane divided highway with a paved median, curbs and sidewalks on both sides, and one ramp system within the directly discharging section. The intersection with Spring Street contains divided dedicated turn lanes with paved dividers. The area surrounding VFW Parkway is highly developed and consists predominantly of large commercial areas with some restaurants and residences. VFW parkway drains via a catch basin and pipe network that discharges to a 10.5-foot by 10.5-foot box culvert leading to a manmade ditch which flows directly to the Charles River. The ditch also takes flows from Boston Water and Sewer Commission (BWSC) Outfall 006.

Runoff from the southern portion of VFW Parkway in this area discharges to Mother Brook, which has been diverted away from the Charles River by a manmade dam at its mouth.

Highland Ave Area

MassDOT owns Highland Avenue in Needham which becomes Needham Street as it crosses the Charles River into Newton (see Figure 4). The entire roadway is curbed, with frequent breaks in curbing for intersections and driveways. Approximately 2,600 feet of Highland Avenue drains to this segment of the Charles via a closed drainage system and 3 outfalls. There are no existing BMPs treating MassDOT directly discharging properties within this section.

On Highland Avenue stormwater runoff flows to catch basins along both sides of the roadway and collects in a central drainage system. Approximately 2,000 feet of this roadway drains directly into the Charles River. This drainage system discharges from a flared end section into a small drainage channel approximately 45 feet from the river bank on the south eastern quadrant of the bridge, within the Department of Conservation and Recreation (DCR) owned Charles River Reservation.

One catch basin along the southwestern quadrant of the bridge collects stormwater from a small portion of the roadway. Stormwater collected in this catch basin is discharged at the toe of the slope, flows over a private driveway, and discharges directly into the Charles River.

On the Newton side of the Charles River, approximately 700 feet of Needham Street drains to catch basins along the roadway which discharge directly to the Charles through a headwall (Newton Outfall #10) in the north western quadrant Charles River bridge abutment.

The I-95 ramp in this area is part of the Add-a-Lane project described in the following section.

Add-A-Lane Area

MassDOT is undertaking the I-95/I-93 Transportation Improvement Project along I-95 (also known as the Add-A-Lane project). The project includes the addition of a travel lane in each travel direction along 14.3 miles of I-95 between north of Route 9 in Wellesley to Route 24 in Randolph. A portion of this project area discharges directly to the Charles River segment MA72-07 and its wetlands, beginning north of West Street (Route 135) crossing in Dedham to the northern limits of the project area, just north of Route 9 (see Figures 1 and 5-7). Approximately 199 acres of MassDOT area, including unpaved medians, discharge to this section of the Charles.

Improvements to Interstate 95 (I-95) from the Kendrick Street in Needham, MA to just north of Route 9 (Worcester Street) in Wellesley, MA are currently in the design phase of a reconstruction project as part of the Bridge V I-95/I-93 Transportation Improvement Project. Improvements to I-95 from the Westwood-Dedham town line north to the Needham Commuter Rail line crossing are in the final stages of reconstruction as part of the Bridge IV I-95/I-93 Transportation Improvement Project.

The Add-A-Lane project involves increasing impervious cover (IC) within the project area therefore stormwater improvements are being incorporated as part of the project. See the Proposed Mitigation Plan section of this assessment for more information on the proposed stormwater improvements.

In the vicinity of the Add-A-Lane project, MassDOT owns the Dedham Avenue Bridge and Lyons Street Bridge over the Charles River (Figure 5). Road way curbs direct stormwater from the Dedham Avenue Bridge off the bridge and then overland to the river. Stormwater from the Lyons Street Bridge flows overland to a collection system not owned by MassDOT but that discharges to the Charles River.

Interstate 95 North Area

This Charles River section includes the portion of MA72-07 which flows adjacent to I-95 between the confluence with Rosemary Brook to the south and the I-95 crossing to the north (see Figure 8). The MassDOT roads that directly contribute stormwater runoff to this portion of MA72-07 include I-95 including unpaved medians and the Route 16 Charles River crossing drain to this segment of the Charles via a closed drainage system and 17 outfalls. There are no existing BMPs treating MassDOT directly discharging properties within this section.

I-95 parallels the Charles River in this area and crosses over it once. Where the river does not directly abut the highway, the land surrounding the river is generally undeveloped. The segment of I-95 that discharges directly to this section of the Charles River consists of a divided eight lane highway. A portion of the median is paved with curbs and shoulders along both sides of the highway and ramp system. This section of highway includes one Charles River bridge, the Route 16 ramp system, and a portion of Quenobequin Road which is within the Route 16 ramp system.

This segment of Charles River marks the town boundary between Wellesley and Newton. Route 16 (Washington Street) at the Charles River crossing is a four lane road with no median divider. It is bounded by curbs and sidewalks on both sides. The bridge has a high point in the center and runoff from the Wellesley side flows into the Town of Wellesley municipal drainage system, which discharges to an outfall in the bank of the Charles River just upstream of the bridge on the Wellesley side. Runoff from the Newton side of the bridge flows into the City of Newton municipal drainage system, which discharges to an outfall in the bank of the Charles just downstream of the bridge on the Newton side.

Toll Area

This Charles River section includes the portion of MA72-07 which flows directly adjacent to the I-95 where it intersects with Route 30 and Interstate 90 (I-90) in Weston (see Figure 9). The I-90/I-95 interchange is located in Weston immediately west of the Charles River, which is the town boundary between Newton and Weston. There is suburban development in Newton on both sides of I-90 and sparse residential development in Weston. Approximately 165 acres of MassDOT area, including the tolls and unpaved medians, discharge to this section of the Charles. There are no existing BMPs treating MassDOT directly discharging properties within this section.

Tolls at the interchange are located in both the northbound and southbound lanes of I-90. Most of the area in between the highways is unpaved vegetated land, with the exception of a few small paved areas used by MassDOT as storage for materials and equipment. Almost the entire paved surface is lined with granite edging and there is a series of closed drainage networks and open paved ditches that convey runoff to the Charles River.

Approximately half of the directly contributing area from I-90 is piped through the closed network to Seavern's Brook. Seavern's Brook flows east between Route 30 and I-90 until it discharges directly into the Charles River. Although Seavern's Brook is not listed as impaired, it is in close proximity to the Charles River and receives a considerable amount of runoff from the developed interchange area. Therefore, MassDOT has considered BMP recommendations for areas that discharge to the brook under this assessment.

The remaining stormwater drains by means of closed networks, paved waterways, and ditches into a large manmade channel and then via a separate outfalls directly into the Charles River. The majority of the runoff from the I-95 portion of this area is captured and piped separately to the Charles River by means of individual outfalls.

Assessment under BMP 7R for Impairments Addressed by Phosphorus TMDL [CN 301.0]

The Total Maximum Daily Load (TMDL) for Nutrients in the Upper/Middle Charles River, Massachusetts (CN 272.0) addresses the nutrient/eutrophication biological indicators and total phosphorus impairments for this water body. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT properties to this water body using the approach described in BMP 7R of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have been addressed by a TMDL.

Pollutant of Concern: Phosphorus

1) Impairment Addressed: nutrient/eutrophication biological indicators and total phosphorus
2) Applicable Waste Load Allocation (WLA): See Table ES-3 Phase III Final Report.
    - Description of Associated Land Use: Transportation
    - Transportation Land Use Current Load (TP): 2,167 kilograms per year (kg/yr)
    - Transportation Land Use WLA (TP): 759 kg/yr
    - Commercial/Industrial/Transportation Area in Watershed: 15.9 sq miles or 5.9% (reported in Phase III Calibration Report Table 5. Transportation not separated from Commercial/Industrial during TMDL analysis)
    - Commercial/Industrial/Transportation Land Use Areal WLA: 0.72 kilograms per hectare per year (kg/ha/yr) (0.64 pounds per acre per year (lbs/ac/yr)) (calculated)

3) Applicable Recommendations: Section 7.2 Phase III Final Report

- Management of Stormwater systems - Page 83 Phase III Final Report
  - "Comprehensive programs will be necessary to achieve the phosphorus reduction and water quality goals of this TMDL. Programs should build upon existing stormwater management to accomplish the following tasks:
    - characterize the drainage areas that contribute to discharges requiring permit coverage under the Permittee's jurisdiction
    - implement a comprehensive Illicit Discharge Detection and Elimination (IDDE) program
    - prioritize source areas for stormwater management and control
    - identify site-specific and regional opportunities for implementation of BMPs
    - include the necessary structural and non-structural BMPs that, upon implementation, will achieve reductions in phosphorus loadings from the NPDES covered drainage areas that are consistent with the phosphorus load reductions identified in this TMDL)
  - Management of illicit discharges to stormwater drainage systems"

For BMP 7R Phosphorus Assessment, MassDOT used a site-specific, continuous, long-term hydrologic and pollutant simulation model (the assessment model) to estimate annual median pollutant loads from its property and treatment through both existing and proposed BMPs, if present. The assessment model was run for a 10-year period using hourly Boston rainfall data to capture a range of meteorological conditions and estimate annual median pollutant loads. The pollutant loading portion of the assessment model was calibrated to match pollutant runoff data from the USGS Highway-Runoff Database (Version 1.0, September 2009). The assessment model directly evaluates BMP effects on hydrology (detention, infiltration) and pollutant loads (losses through infiltration, settling, filtration, and biological treatment). For a more detailed description of this approach, see Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

The following table summarizes the assessment model results for the MassDOT directly contributing watershed to the Charles River for existing conditions.

Annual Watershed Phosphorus Loading under Existing Conditions

Watershed/ BMP ID	Watershed Size (Acres)	Pre- BMP Annual Load (pounds/year)	Post-BMP Annual Load (pounds/year)	Estimated Annual Removal Efficiency
Total Directly Contributing MassDOT Watershed	306	503	503	0%

*Existing phosphorus loading under existing conditions includes increased impervious cover proposed from the Add-A-Lane project. Treatment from Add-A-Lane BMPs is included in proposed conditions analysis.

The assessment model predicts that the annual median phosphorus load from the MassDOT directly contributing watershed is approximately 503 pounds. Based on the TMDL, MassDOT's WLA is 0.72 kg/ha/yr (0.64 lbs/ac/yr). For the 306 acres of directly contributing MassDOT watershed, this equates to 197 pounds of phosphorus per year for MassDOT's directly contributing watershed.

BMP 7R Phosphorus Mitigation Plan

Under existing conditions, MassDOT's estimated directly contributing annual phosphorus load exceeds the TMDL WLA. To mitigate this load, MassDOT will implement stormwater BMPs to the maximum extent given site constraints.

This assessment has identified locations for potential stormwater BMPs and estimated their potential phosphorus removal performance. The Proposed Mitigation Plan section of this assessment describes the BMPs and their estimated annual load reduction performance.

Assessment under BMP 7R for Pathogens

The Pathogen Total Maximum Daily Load (TMDL) for the Charles River Watershed (CN 0156.0) covers the Charles River. The TMDL states that sources of indicator bacteria in the Charles River Watershed were found to be many and varied. The TMDL lists sources as including failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals and direct overland stormwater runoff.

In addition, as page 12 of the TMDL states, *Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, stormwater drainage systems and associated stormwater culverts and outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.*

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by orders of magnitude within a given storm event (Mass DEP, 2009). Therefore, it is difficult to predict stormwater pathogen concentrations with accuracy. Due to this difficulty, MassDOT is not conducting site specific assessments of loading at each location impaired for pathogens as part of this Retrofit Program. However, MassDOT recognizes that its roadways, especially in urbanized areas, contribute to the pathogen impairment of the Charles River Watershed and has performed a general assessment and developed a mitigation plan as described below.

BMP 7R Pathogens Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT has reviewed its existing programs and their consistency with the Pathogen TMDL for the Charles River Watershed recommendations as well as the draft EPA National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements for the North Coastal Watershed.

The Pathogen TMDL for the Charles River Watershed recognizes that mitigation for pathogen impairments is difficult to address and emphasizes the need for an iterative adaptive management approach. The Executive Summary of the TMDL, page xi, states:

> *TMDL implementation to achieve [the pathogen reduction goals] should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected*

> *sanitary sewer flows and best management practices to mitigate stormwater runoff volume.*

The existing NPDES MS4 permit that covers MassDOT stormwater discharges does not provide guidance on what measures are necessary to comply with the Pathogen TMDL for the Charles River Watershed. The fact sheet for the draft permit for MS4 stormwater discharges for the North Coastal Watershed contains some guidance on what measures EPA has determined necessary to be consistent with the Pathogen TMDL for the Charles River Watershed. Page 36 of the fact sheet states:

> *Instead of a numeric limitation for bacteria, the draft permit includes requirements for MS4s to provide education to pet owners and owners of septic systems, to implement a comprehensive illicit discharge detection and elimination program that addresses not only sources of pathogens but also sources of phosphorus, and to implement programs to address water fowl. In addition, although entitled "Phosphorus Control Plan" most of the actions needed to develop and implement a successful PCP are also effective in supporting the achievement of the WLA for the Charles River pathogen TMDL.*

As discussed above, both the Pathogen TMDL for the Charles River Watershed and the draft North Coastal Watershed MS4 permit state that identification of illicit discharges and addressing stormwater volumes and pollutants, such as phosphorus, are the best approaches to mitigate the pathogen impairments. MassDOT has developed a mitigation plan, described below, to address the pathogen impairments using guidance from these two documents.

BMP 7R Pathogens Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific non-structural BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

Although not included in this permit term, MassDOT will be implementing a pet waste management program at its rest stops, including those that have discharges to pathogen impaired waters. In addition, MassDOT has requested to be covered under an Individual MS4 permit for the next permit term. A future individual permit may contain additional programmatic BMPs to address pathogens.

The structural BMPs that will be considered to reduce phosphorus loading and the effects of IC would also reduce pathogen loads. See the Proposed Mitigation Plan section of this assessment for more information on specific BMPs proposed as part of this assessment.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations.

Proposed Mitigation Plan to Address Phosphorus

MassDOT is reviewing the Charles River Basin as an entire watershed and has committed to constructing stormwater BMP retrofit projects to address impaired waters. During this assessment phase of the Impaired Waters Program, MassDOT has focused on directly contributing areas and identified BMPs that can be constructed entirely on MassDOT property without resulting in substantial wetland impacts or result in an adverse impact on historical or archeological resources. Projects that meet these requirements can utilize the Federal Highway Administration's Alternative Contracting mechanism (SEP-14) created for this program. MassDOT will advance designs for BMPs where practicable in the watershed above and beyond the target mitigation to compensate for areas where site constraints prohibit the construction of stormwater BMPs.

As an overall program, MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted for programmed projects in the area. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. During this assessment analysis, potential BMPs beyond the scope of the impaired waters program were identified and can be reviewed during future projects.

In this assessment, MassDOT has identified 40 stormwater BMPs (25 infiltration basins and 15 water quality swales) that may be implemented on MassDOT property to reduce phosphorus loads. These locations were chosen based on a cursory review of the drainage systems, topography, property lines, and other site constraints. Detailed survey, complete utility location information, official property ownership, and soils evaluation information will influence the final selection and design of BMPs. In addition, MassDOT is constructing 20 BMPs to treat stormwater runoff discharging directly to the Charles River as part of the Add-A-Lane project. Below is a description of the potential proposed BMPs or the site constraints limiting the potential for BMPs. Figures 10-14 show the proposed BMPs with their estimated contributing drainage areas.

Chestnut Street Area

Based on the review of MassDOT's directly contributing drainage area, no retrofit BMPs have been identified in the Chestnut Street Area that can be implemented on MassDOT property to address the impairments of the Charles River given the site constraints. Site limitations within the Chestnut Street Area include limited MassDOT right-of-way. Stormwater runoff is directed to a closed drainage system and the outfall is located outside of MassDOT property. As such, BMPs cannot be implemented within MassDOT's directly contributing drainage area without impacting property outside of MassDOT property.

VFW Parkway Area

Based on the review of MassDOT's directly contributing drainage area, no retrofit BMPs have been identified that can be implemented on MassDOT property to address the impairments of the Charles River in the VFW Parkway Area given the site constraints. Site limitations within the VFW Parkway Area include limited MassDOT right-of-way which is currently used entirely for travel lanes and sidewalks, leaving no open space for stormwater retrofits. Along Bridge Street, a number of stormwater outfalls are located in private property, city-owned public open space, or within property owned by the Army Corps of Engineers. The stormwater discharging from VFW Parkway enters a man-made ditch owned by the City of Boston. This ditch receives flow from other unknown sources before crossing under VFW Parkway. As such, BMPs cannot be implemented within MassDOT's directly contributing drainage area without impacting property outside of MassDOT property.

Highland Avenue Area

Based on the review of MassDOT's directly contributing drainage area, no BMPs have been identified that can be implemented on Highland Avenue to address the impairments of the Charles River given the site constraints. Site limitations within the VFW Parkway Area include limited MassDOT right-of-way which is currently used entirely for travel lanes and sidewalks, leaving no open space for stormwater retrofits. As such, BMPs cannot be implemented within MassDOT's directly contributing drainage area without impacting property outside of MassDOT property.

An existing MassDOT roadway reconstruction project (MassDOT Project #606635) is currently under design along Highland Avenue in Needham and Needham Street in Newton. Construction of stormwater BMPs under this programmed project will be carefully evaluated and implemented where practical, and will be documented through the MassDOT Water Quality Data Form. The potential for BMPs outside of MassDOT property will be reviewed during the design phase of this project and through ongoing discussions with the affected municipalities. Following the completion of this project, the roadway will be turned over to the Towns of Needham and Newton, respectively, and will no longer be under the jurisdiction of MassDOT.

Add-A-Lane Area

MassDOT's I-95/I-93 Transportation Improvement Project ((MassDOT Project #s 603206 and 603711) along I-95 (also known as the Add-A-Lane project) includes numerous stormwater BMPs as part of its design. The projects include stormwater improvements to address the Massachusetts Department of Environmental Protection's (MassDEP's) Stormwater Policy and Charles River TMDLs. The BMPs proposed for the areas directly contributing to this segment of the Charles River include leaching catch basins, infiltration basins and extended dry detention basins. Figures 10-12 show the BMPs.

The table below lists the BMPs and their estimated annual phosphorus load and reductions. MassDOT estimated the phosphorus loads using the long-term assessment model. Phosphorus reduction percentages are from the stormwater reports prepared by the project design consultants. Some leaching catch basins were listed with 0% phosphorus reduction, although they will likely provide some treatment through the capture and infiltration of highway runoff.

Proposed Phosphorus Mitigation
Add-a-Lane Area

Watershed/ BMP ID	BMP Type	Estimated Contributing Watershed Phosphorous Load Pre-BMP (lbs/yr)	Estimated Percent Reduction of Phosphorous*	Estimated Reduction of Phosphorous (lbs/yr)
Infiltration Basin #1	Infiltration Basin	9.1	65%	5.9
Infiltration Basin #4	Infiltration Basin	5.7	82%	4.7
Detention Basin #3	Extended Dry Detention Basin	21	20%	4.2
Infiltration Basin #4	Infiltration Basin	3.0	65%	1.9
Detention Basin #5	Extended Dry Detention Basin	6.6	20%	1.3
Detention Basin #2	Extended Dry Detention Basin	5.8	20%	1.2
Detention Basin #4	Extended Dry Detention Basin	2.7	20%	0.5
Detention Basin #6	Extended Dry Detention Basin	1.3	9%	0.1
LCB 154+35 RT	Leaching CB	626	0%	0
LCB 173+11 LT	Leaching CB	521	0%	0
LCB 173+46 RT and LCB 173+90 LT	Leaching CB	1,241	0%	0
LCB 583+20 LT	Leaching CB	1.7	0%	0
LCB 583+15 LT	Leaching CB	0.5	0%	0
LCB 592+46 RT	Leaching CB	0.6	0%	0
LCB 594+08 RT	Leaching CB	0.5	0%	0
LCB 596+87 LT	Leaching CB	0.6	0%	0
LCB 603+62 RT	Leaching CB	0.1	0%	0
LCB 22+25 RT	Leaching CB	1.3	0%	0
LCB 24+08 LT	Leaching CB	1.2	0%	0

Sources: MassDOT, 18 November, 2011. *Stormwater Report for Route 128 Add-a-Lane Project (Bridge V Contract).* Prepared by Green International Affiliates, Inc.

MassHighway, May 2009. *Route 128 Transportation Improvement Project in the Towns of Westwood, Dedham and Needham Stormwater Checklist Report.* Prepared by the Louis Berger Group, Inc.

* As stated in the project's stormwater report, removal rates were obtained from either the MassDEP *Stormwater Handbook Volume 2* or the *Stormwater Best Management Practices (BMP) Performance Analysis* by EPA Region 1 (December 2008)Source: MassDOT

In addition, according to the drainage reports prepared by the design consultant, the project will include deep sump catchbasins with hoods (replacing all existing inlets and catch basins) and sediment forebays for pretreatment upstream of all basins and swales.

Interstate 95 North Area

In this assessment, MassDOT has identified 7 stormwater BMPs in the I-95 North area that may be implemented on MassDOT property to reduce phosphorus loads and mitigate the effects of IC to address the Charles River impairments. These BMPs include 4 infiltration basins and 3 water quality swales, shown with their estimated contributing drainage areas in Figure 13. Based on Natural Resources Conservation Service (NRCS) soil classifications, the BMPs are located in areas classified as hydrologic soil group (HSG) C soils. Detailed survey, complete utility location information, official property ownership, and soils evaluation information will influence the final selection and design of BMPs. Below is a description of these potential proposed BMPs.

Infiltration Basins

MassDOT has identified 4 areas along I-95 north of the Add-A-Lane project area and south of the I-90/I-95 interchange to collect stormwater runoff in basins for infiltration (Pr BMPs 36, 39, 41, and 42). As shown on Figure 13, the basins have been located in infield areas between the highway and ramp systems and in areas where roadway runoff discharges directly into the Charles River. In some cases, stormwater runoff is currently conveyed through these open areas via closed drainage systems or ditches. Stormwater would either continue to drain to these areas via the current stormwater infrastructure or be directed to these areas via overland flow or minor modifications to the existing infrastructure.

The proposed basins would be excavated and fitted with outlet control to store and infiltrate a prescribed amount of runoff. For this assessment, MassDOT has preliminarily sized the basins by balancing currently known site constraints and storage volume to provide maximum water quality treatment. Although HSG C soils provide low infiltration rates, infiltration can still occur and there is generally sufficient available space for creating BMPs with larger storage volumes. The soils in these areas will be further reviewed for BMP potential during the design phase. In general, the basins as shown with a two foot depth are estimated to provide 39% to 94% phosphorus mitigation assuming typical infiltration rates for HSG C soils. Model results indicate that, in general, these BMPs would completely infiltrate runoff from the majority of storm events analyzed (1983-1994 Boston rainfall data).

Water Quality Swales

MassDOT has identified 3 areas for potential water quality swales (Pr BMPs 37, 38, and 40). Swales have been primarily proposed in areas with limited space or for smaller contributing drainage areas not requiring large basins for treatment. In each case, stormwater runoff is currently piped underground in closed drainage systems through these open areas. These closed drainage systems could be modified to create surface storage in pervious, vegetated areas and include outlet control to promote infiltration and detention. Check dams are proposed for longer swales and those requiring additional storage to provide enhanced water quality treatment. For this assessment, MassDOT has assumed swales with outlet control creating 2-foot storage depths which results in estimated 26% to 95% phosphorus mitigation. The analysis indicates that the swales can completely infiltrate runoff from the majority of storm events analyzed (1983-1994 Boston rainfall data).

The existing conditions assessment model was modified to develop a proposed conditions simulation including proposed BMPs, estimated potential contributing drainage areas and rough sizing of the proposed BMPs. The table below shows the proposed BMPs, including their respective MassDOT drainage areas, and estimated phosphorus reductions. The assessment model identifies each BMP by a unique ID, which is included in the table below.

Proposed Phosphorus Mitigation
I-95 North Area

BMP ID (Unique ID)	BMP Type	Estimated Contributing Watershed Phosphorous Load Pre-BMP (lbs/yr)	Estimated Percent Reduction of Phosphorous	Estimated Reduction of Phosphorous (lbs/yr)
PR BMP 36 (32.7)	Infiltration Basin	5.4	39%	2.1
PR BMP 37 (37.6)	Water Quality Swale	12.3	26%	3.2
PR BMP 38 (20.6)	Water Quality Swale	10.7	94%	10.1
PR BMP 39 (33.7)	Infiltration Basin	3.8	77%	2.9
PR BMP 40 (19.6)	Water Quality Swale	4.5	95%	4.2
PR BMP 41 (37.7)	Infiltration Basin	11.9	94%	11.2
PR BMP 42 (39.7)	Infiltration Basin	1.9	52%	1.0

Toll Area

In this assessment, MassDOT has identified 33 stormwater BMPs in the I-90 / I-95 area that may be implemented on MassDOT property to reduce phosphorus loads and mitigate the effective of IC to address the Charles River impairments. These BMPs include 21 infiltration basins and 12 water quality swales, shown along with their estimated contributing drainage areas in Figure 14. Over 60% of this area drains to a proposed BMPs. These locations were chosen based on a preliminary review of the drainage systems, topography, property lines, and other site constraints including a MWRA easement, Newton drinking water wells, and a large-diameter gas main. Based on NRCS soil classifications, the BMPs are all located in areas classified as HSG C soils. A review of the site indicates that the soils are primarily fill. Based on NRCS soil classifications, areas immediately outside of the interchange have HSG B soils and therefore some BMPs were assumed to have infiltration rates more indicative of HSG B soils based on their proximity to areas classified as HSG B soils. Detailed survey, complete utility location information, official property ownership, and soils evaluation information will influence the final selection and design of BMPs. Below is a description of these potential proposed BMPs.

Infiltration Basins

MassDOT has identified 21 areas within the I-90/I-95 interchange area to collect stormwater runoff in basins for infiltration (Pr BMPs 1, 2, 3, 4, 6, 7, 8, 11, 15, 18, 19, 20, 23, 26, 28, 29, 32, 33, 34, and 35). As shown on Figure 14, the basins are proposed in infield areas between the highway and ramp systems. In some cases, stormwater runoff is currently conveyed through these open areas via concrete lined ditches. Stormwater runoff would either continue to discharge to these areas via the current stormwater infrastructure or be directed to these areas via overland flow or minor modifications to the existing infrastructure.

The proposed basins would be constructed by excavating pervious storage areas and including outlet control to store and infiltrate a prescribed amount of runoff. For this preliminary assessment, MassDOT has sized the basins by balancing currently known site constraints and storage volume to provide maximum water quality treatment. Although HSG C soils have low infiltration rates, infiltration can still occur and there is generally sufficient available space for creating BMPs with larger storage volumes. The soils in these areas will be further reviewed for BMP potential during the design phase. All but one basin are estimated to provide over 90% median annual phosphorus mitigation based on preliminary sizing and assuming typical infiltration rates for HSG C soils and many basins could completely infiltrate runoff from the majority of storm events analyzed (1983-1994 Boston rainfall data).

Water Quality Swales

MassDOT has identified 12 areas for potential water quality swales (Pr BMPs 5, 9, 10, 13, 14, 16, 17, 24, 25, 27, 30, and 31). Swales have been primarily proposed in areas with limited space or for smaller contributing drainage areas not requiring large basins for treatment. In some cases, stormwater runoff is currently conveyed through these open areas via concrete lined ditches that could be readily modified to include pervious, vegetated lining and outlet control to promote infiltration and detention. Check dams are proposed for longer basins and those requiring additional storage to provide enhanced water quality treatment. For this assessment, MassDOT has assumed swales with outlet control creating 2-foot storage depths which results in estimated 47% to 98% median annual phosphorus mitigation.

The existing conditions assessment model was modified to develop a proposed conditions simulation including proposed BMPs, estimated potential contributing drainage areas and rough sizing of the proposed BMPs. The table below shows the proposed BMPs, including their respective MassDOT drainage areas, and estimated phosphorus reductions. The assessment model identifies each BMP by a unique ID, which is included in the table below.

Proposed Phosphorus Mitigation
Toll Area

BMP ID (Unique ID)	BMP Type	Estimated Contributing Watershed Phosphorous Load Pre-BMP (lbs/yr)	Estimated Percent Reduction of Phosphorous	Estimated Reduction of Phosphorous (lbs/yr)
Pr-01 (31.7)	Infiltration Basin	0.8	100%	0.8
Pr-02 (12.7)	Infiltration Basin	6.0	99%	6.0
Pr-03 (10.6)	Infiltration Basin	1.9	100%	1.9
Pr-04 (15.7)	Infiltration Basin	0.3	98%	0.3
Pr-05 (7.6)	Water Quality Swale	0.7	98%	0.6
Pr-06 (16.7)	Infiltration Basin	0.4	100%	0.4
Pr-07 (13.7)	Infiltration Basin	9.7	100%	9.7
Pr-08 (14.7)	Infiltration Basin	1.9	99%	1.9
Pr-09 (12.6)	Water Quality Swale	0.2	93%	0.2
Pr-10 (15.6)	Water Quality Swale	23.9	65%	15.6
Pr-11 (25.7)	Infiltration Basin	43.2	97%	41.9
Pr-12 (8.6)	Infiltration Basin	1.1	67%	0.7
Pr-13 (16.6)	Water Quality Swale	0.8	79%	0.6
Pr-14 (14.6)	Water Quality Swale	3.7	47%	1.7
Pr-15 (61.7)	Infiltration Basin	1.1	100%	1.1
Pr-16 (9.6)	Water Quality Swale	1.7	90%	1.6
Pr-17 (13.6)	Water Quality Swale	2.2	88%	2.0
Pr-18 (10.7)	Infiltration Basin	5.1	91%	4.7
Pr-19 (23.7)	Infiltration Basin	0.7	99%	0.7
Pr-20 (17.7)	Infiltration Basin	0.8	98%	0.7
Pr-23 (26.7)	Infiltration Basin	2.9	97%	2.8
Pr-24 (28.6)	Water Quality Swale	3.3	72%	2.4
Pr-25 (27.6)	Water Quality Swale	8.0	76%	6.0
Pr-26 (24.7)	Infiltration Basin	3.0	98%	2.9
Pr-27 (18.6)	Water Quality Swale	0.5	94%	0.5
Pr-28 (29.7)	Infiltration Basin	4.1	99%	4.1
Pr-29 (27.7)	Infiltration Basin	4.0	93%	3.7
Pr-30 (29.6)	Water Quality Swale	4.0	86%	3.5
Pr-31 (26.6)	Water Quality Swale	0.3	71%	0.2
Pr-32 (11.7)	Infiltration Basin	0.3	100%	0.3
Pr-33 (60.7)	Infiltration Basin	0.7	100%	0.7
Pr-34 (30.7)	Infiltration Basin	1.9	93%	1.7
Pr-35 (21.7)	Infiltration Basin	1.5	90%	1.3

Note: BMPs 21 and 22 have been removed and are no longer being considered potential BMPs.

The proposed BMPs from each segment would result in an estimated 128 pounds of phosphorus per year, compared to the target reduction of 307 pounds.

MassDOT will continue to ensure proper non-structural BMPs are being implemented within the watershed of the Charles River, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to the Charles River using BMP 7R to address the Phosphorus and Pathogen TMDLs. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. MassDOT proposes to install 40 BMPs to reduce MassDOT's contribution to impairments within the Charles River watershed. In addition, 20 BMPs are included as part of the ongoing Add-A-Lane project to treat stormwater discharging directly from I-95 to the Charles River.

The following table summarizes the total phosphorus reductions proposed in the Charles River watershed:

Reductions Applied to DOT Direct Watershed

	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	503
Target Reduction	307
Reduction Provided in Proposed Conditions*	128

* Total phosphorus load reduction based on the assessment model results for the total MassDOT directly discharging drainage area to the receiving water (not sum of individual BMP reductions).

The proposed BMPs will result in a reduction in an annual phosphorus loading of 128 pounds, compared to the target reduction of 307 pounds per year. This includes the phosphorus reductions associated with the BMPs included in the Add-A-Lane project.

MassDOT will proceed to the design phase to develop design and construction plans for the proposed BMPs as part of the MassDOT Impaired Waters Program. The designers will gather additional information in this phase, such as soil data and site survey to further refine the proposed BMPs. Once the design of the proposed BMPs is finalized, MassDOT will provide an update of the additional information and summarize the final phosphorus and effective IC reduction based on the as-built condition. MassDOT will continue to implement non-structural BMPs that reduce potential nutrient and sediment loading.

As an overall program, MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted as programmed projects for the area. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs.

This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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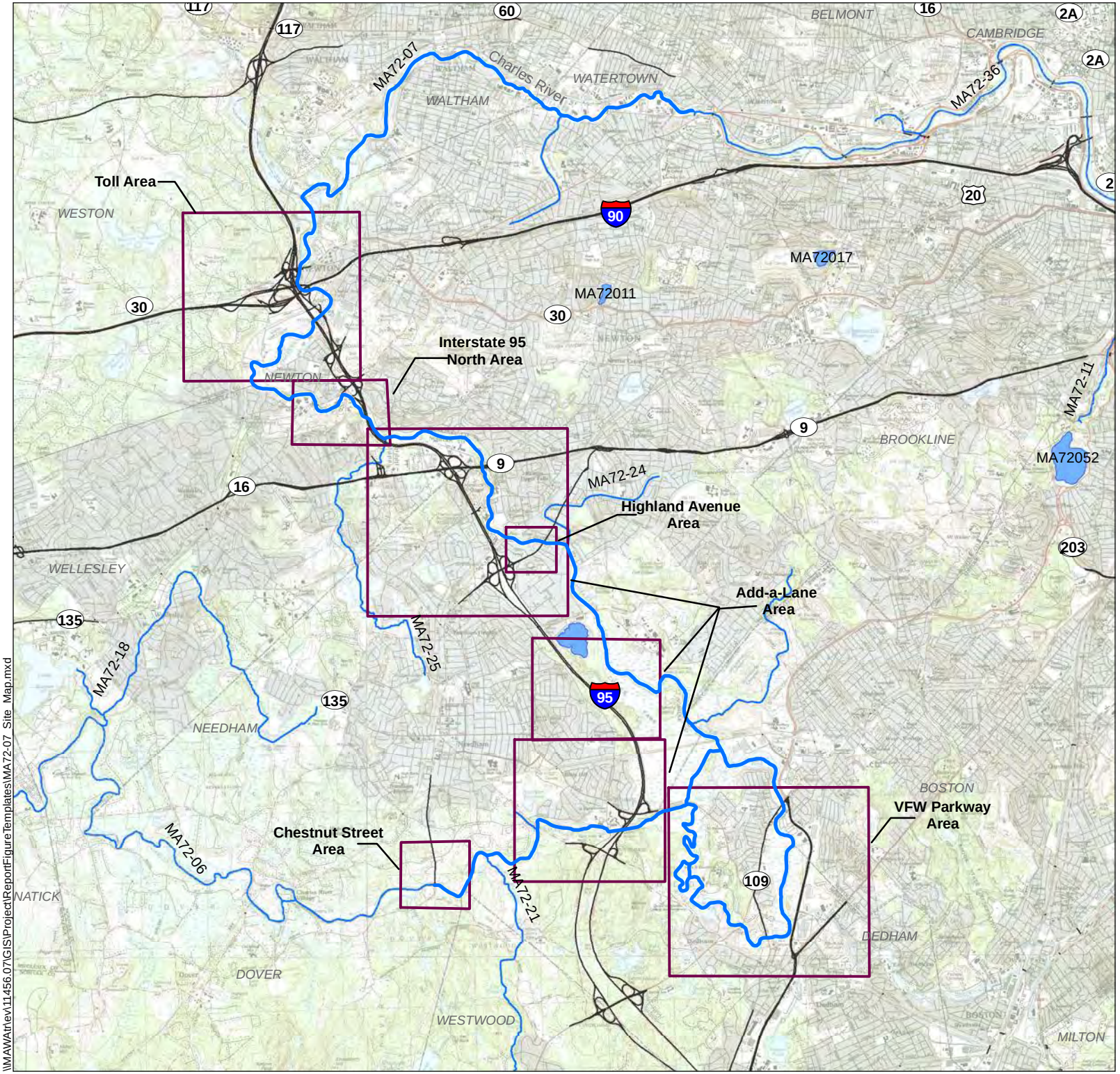

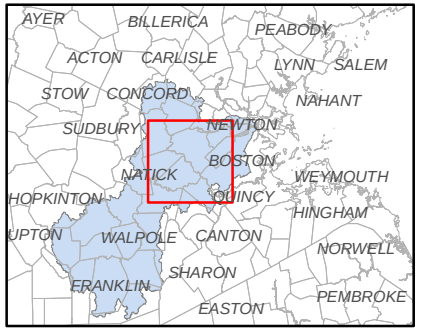

MassDOT Roadways

Impaired Waters

Impaired Streams

N

0 0.5 1 2 Miles

Figure 1
Locus Map

Charles River
MA72-07

June 2012

massDOT
Massachusetts Department of Transportation
Highway Division

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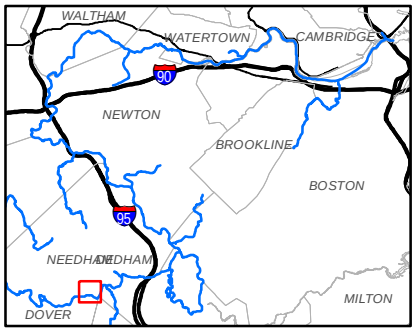

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 250 500 1,000 Feet

Figure 2

Charles River MA72-07 Directly Contributing MassDOT Watershed

June 2012

massDOT Massachusetts Department of Transportation Highway Division

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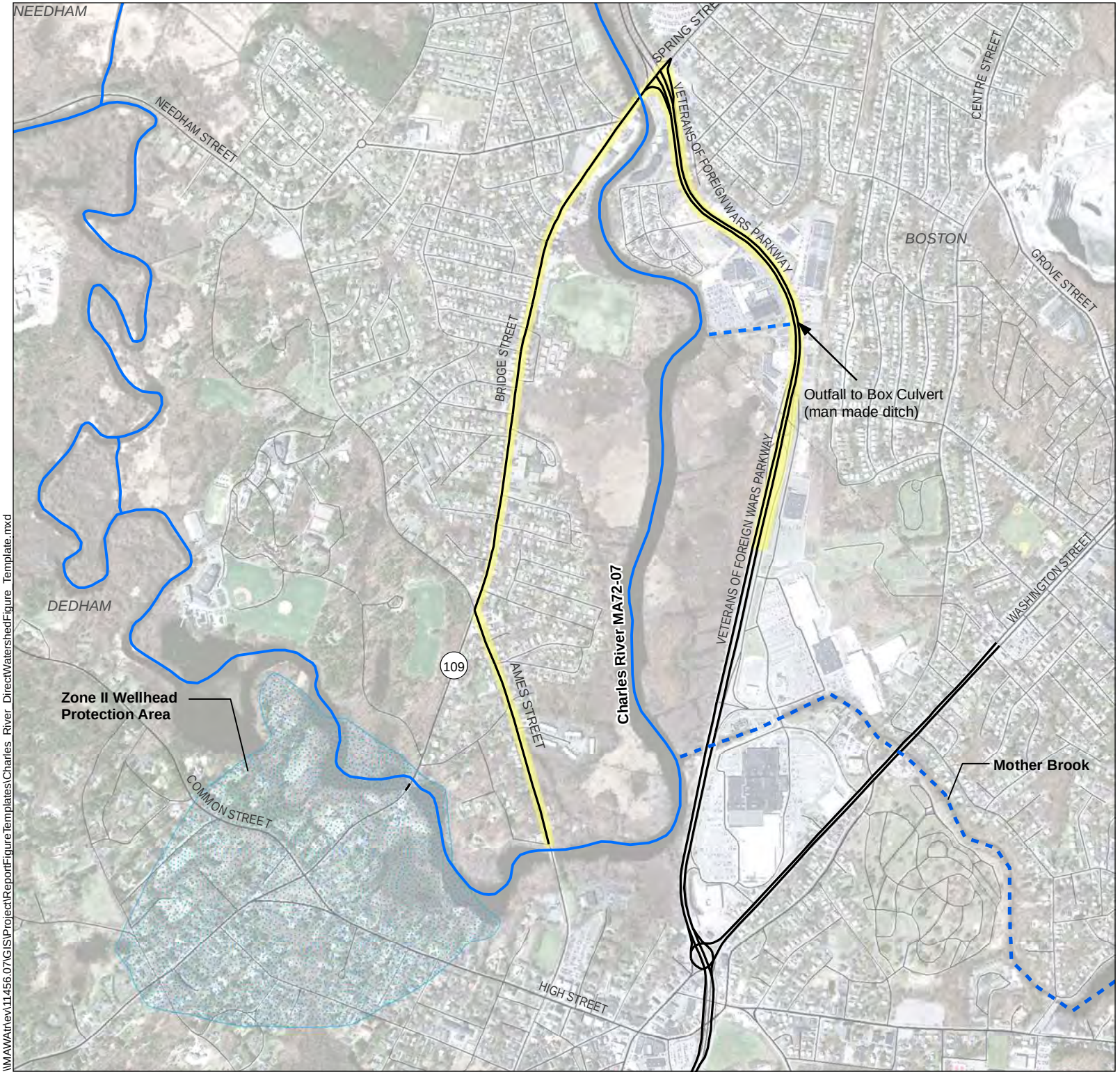

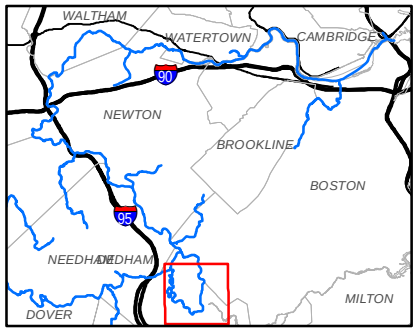

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 500 1,000 2,000 Feet

Figure 3

Charles River
MA72-07
Directly Contributing
MassDOT Watershed

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massDOT
Massachusetts Department of Transportation
Highway Division

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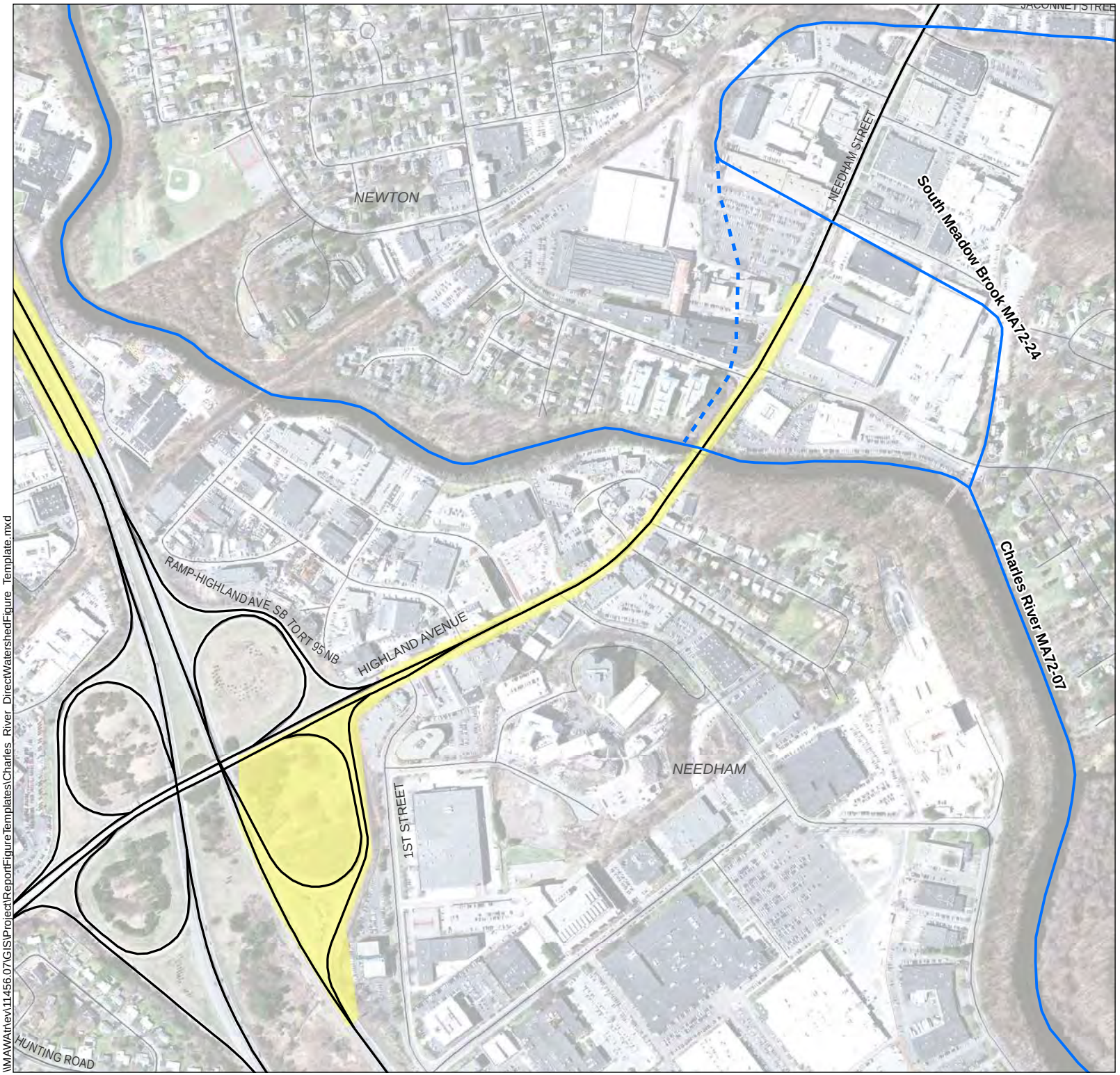

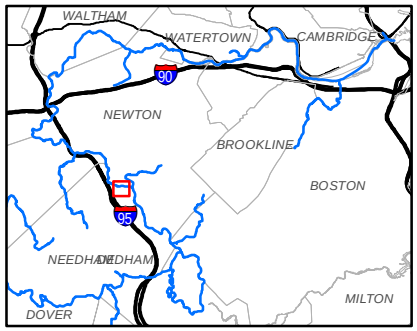

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 250 500 1,000 Feet

Figure 4

Charles River MA72-07 Directly Contributing MassDOT Watershed

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massDOT Massachusetts Department of Transportation Highway Division

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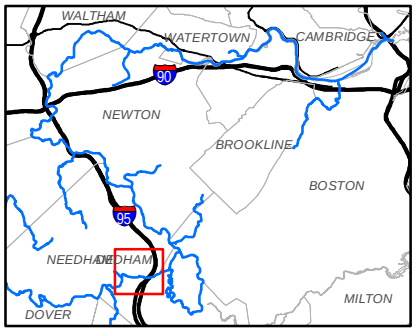

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 375 750 1,500 Feet

Figure 5

Charles River MA72-07 Directly Contributing MassDOT Watershed

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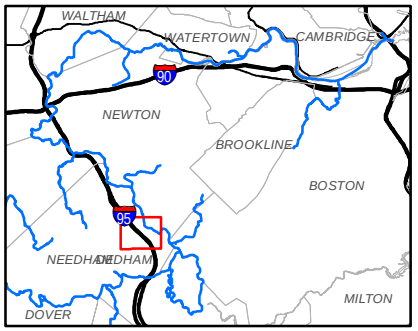

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 375 750 1,500 Feet

Figure 6

Charles River MA72-07 Directly Contributing MassDOT Watershed

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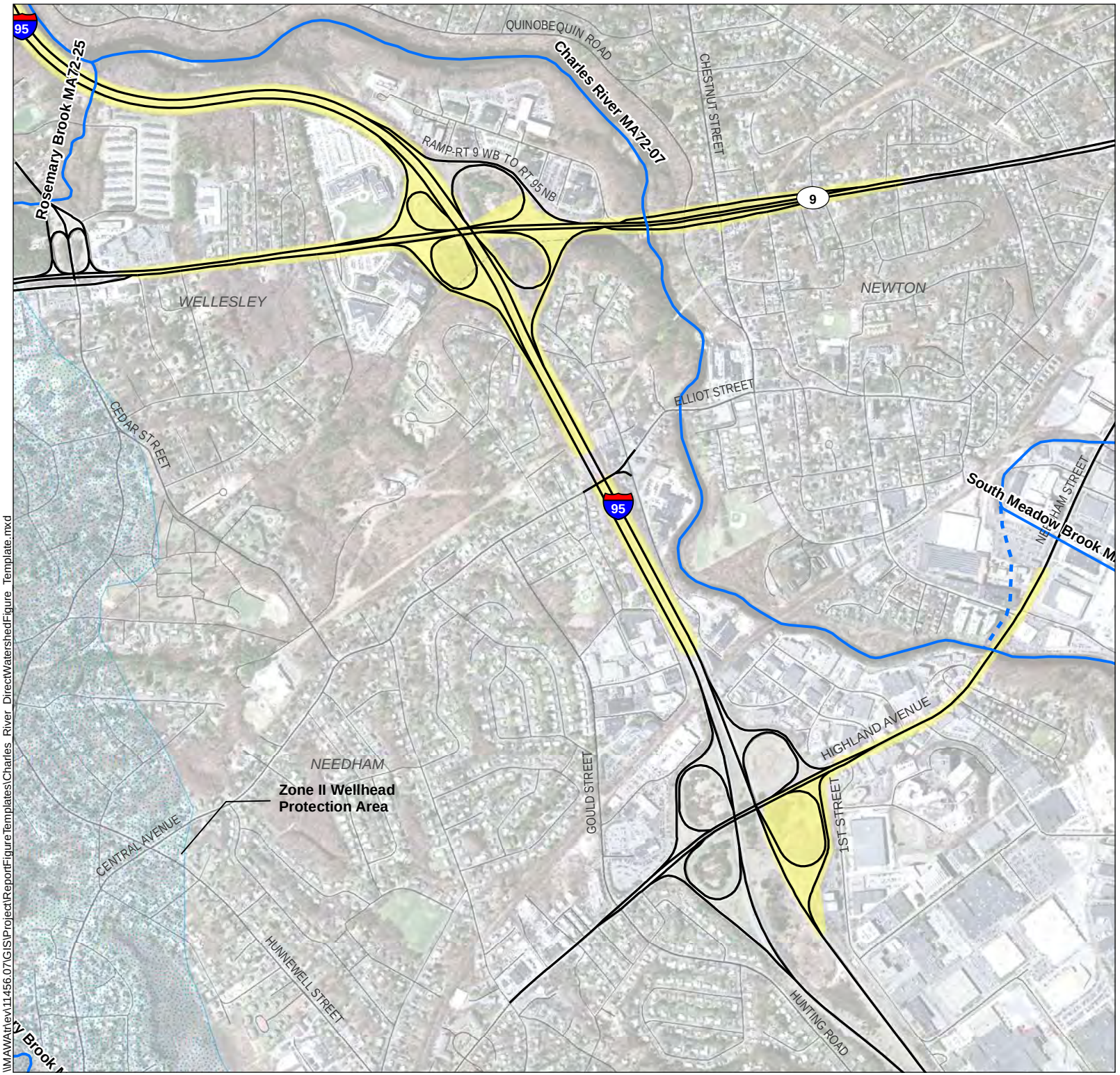

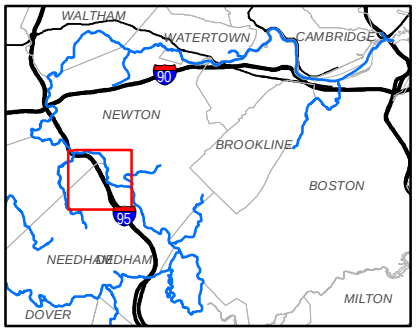

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 500 1,000 2,000 Feet

Figure 7

Charles River MA72-07 Directly Contributing MassDOT Watershed

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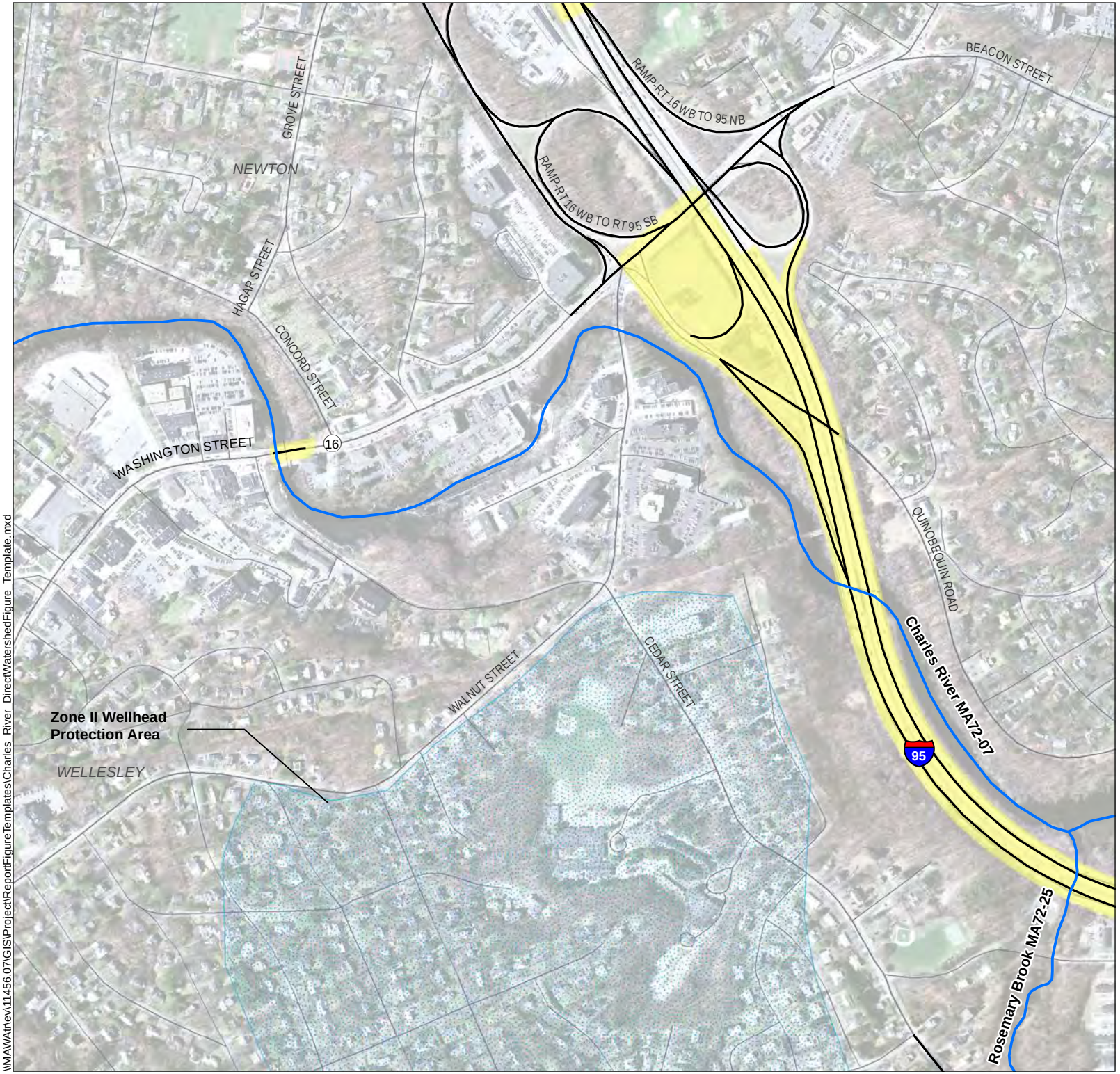

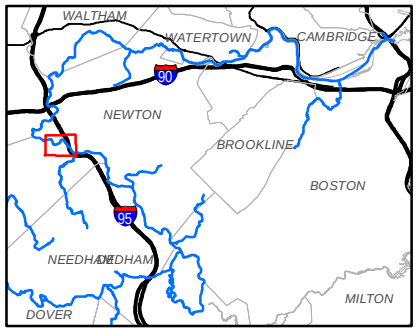

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 250 500 1,000 Feet

Figure 8

Charles River
MA72-07
Directly Contributing
MassDOT Watershed

June 2012

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Massachusetts Department of Transportation
Highway Division

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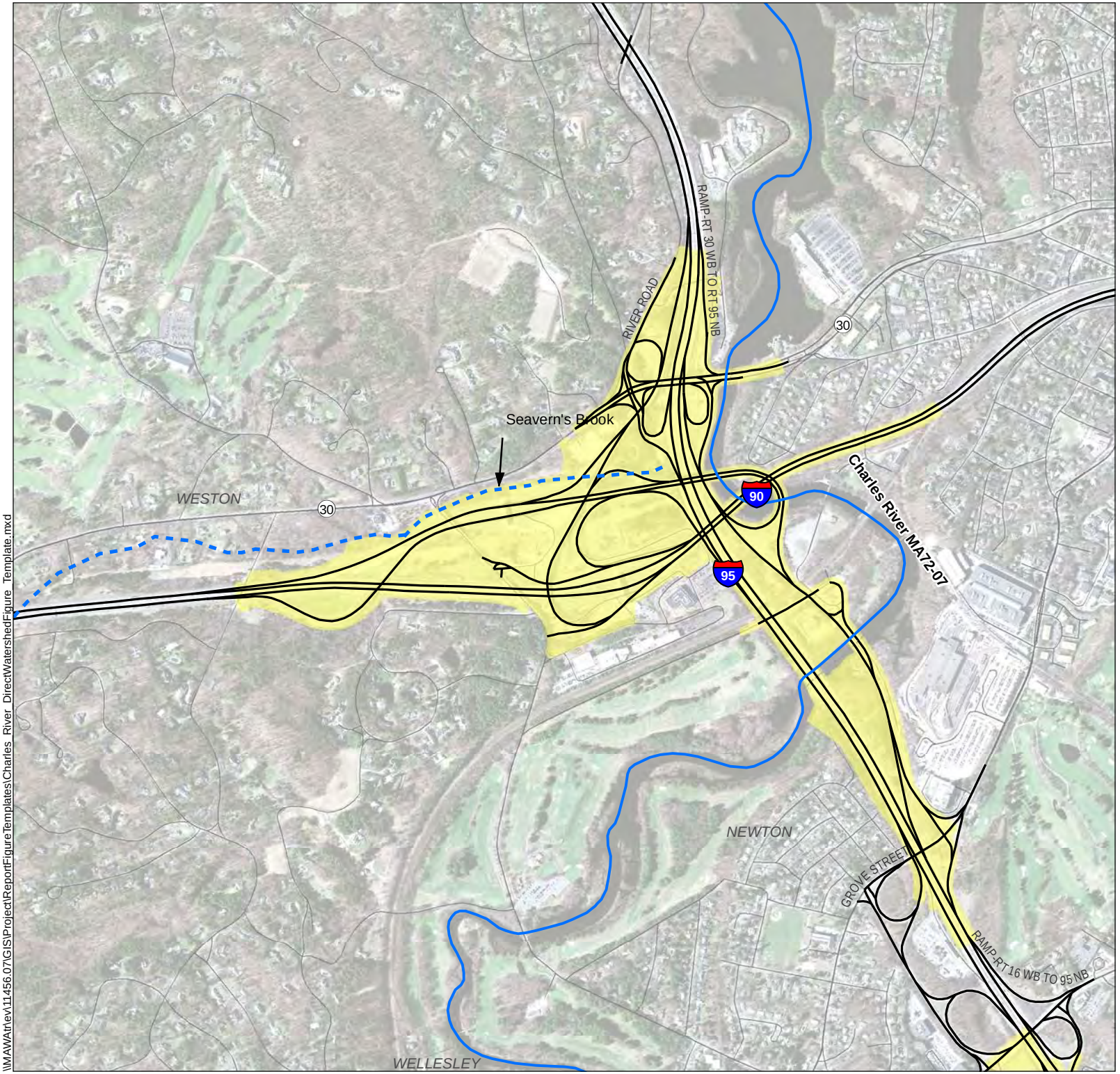

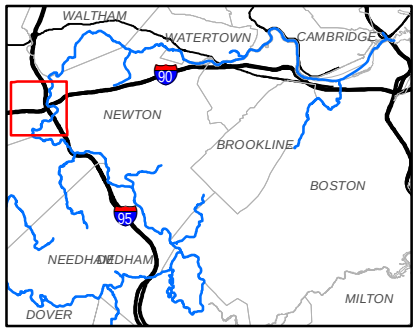

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 500 1,000 2,000 Feet

Figure 9

Charles River MA72-07 Directly Contributing MassDOT Watershed

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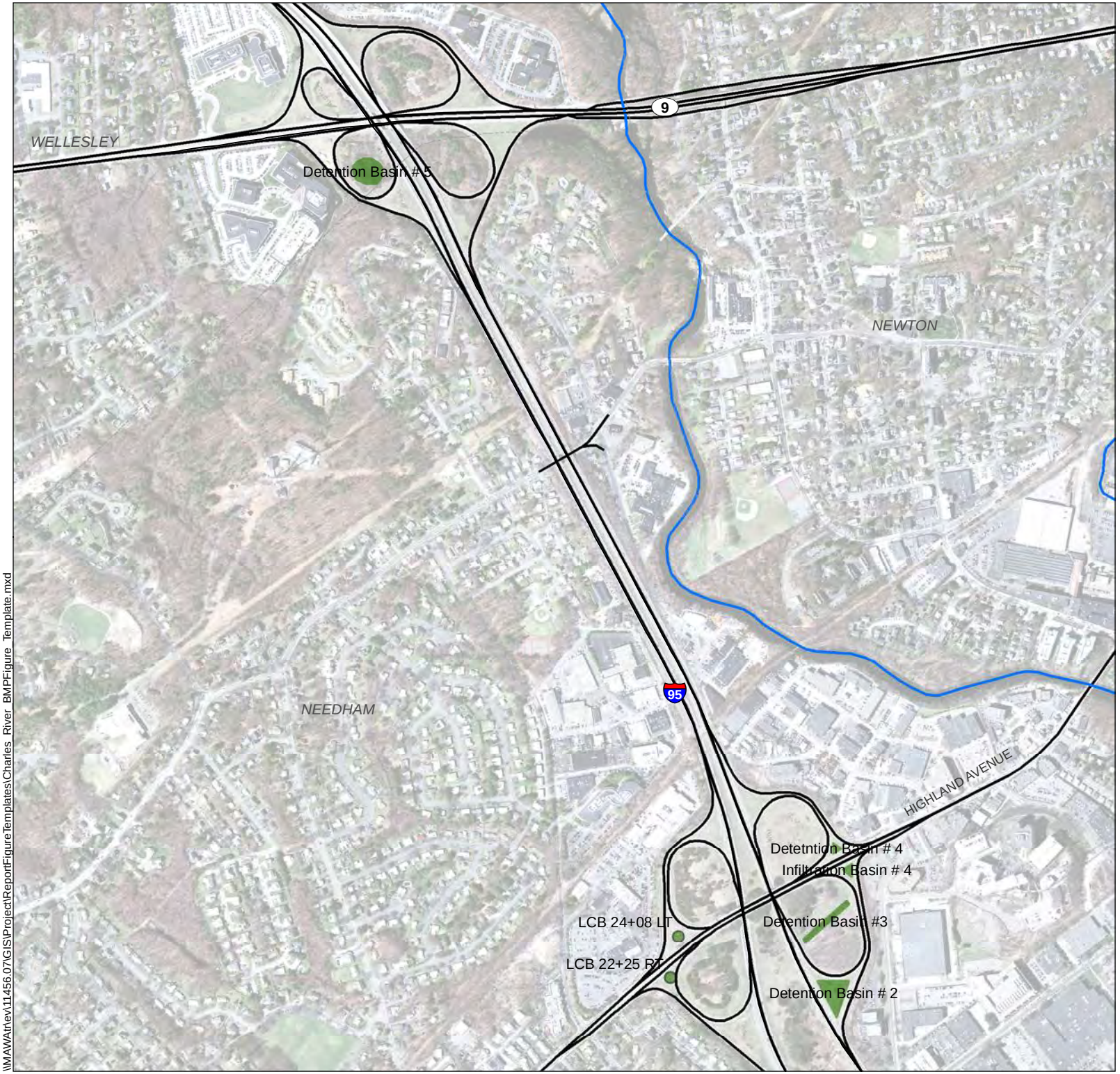

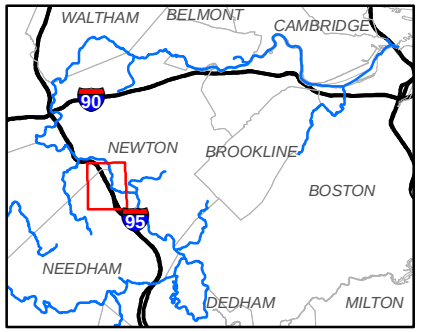

Impaired Streams

Impaired Waters

Proposed BMPs

Proposed BMP Watersheds

MassDOT Roadways

N

0 375 750 1,500 Feet

Figure 10

Charles RIver
MA72-07
Add-A-Lane (Bridge V)
Proposed BMPs

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Highway Division

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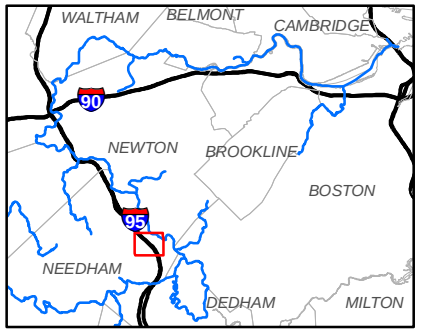

Impaired Streams

Impaired Waters

Proposed BMPs

Proposed BMP Watersheds

MassDOT Roadways

N

0 250 500 1,000 Feet

Figure 11

Charles River
MA72-07
Add-A-Lane (Bridge IV and V)
Proposed BMPs

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Highway Division

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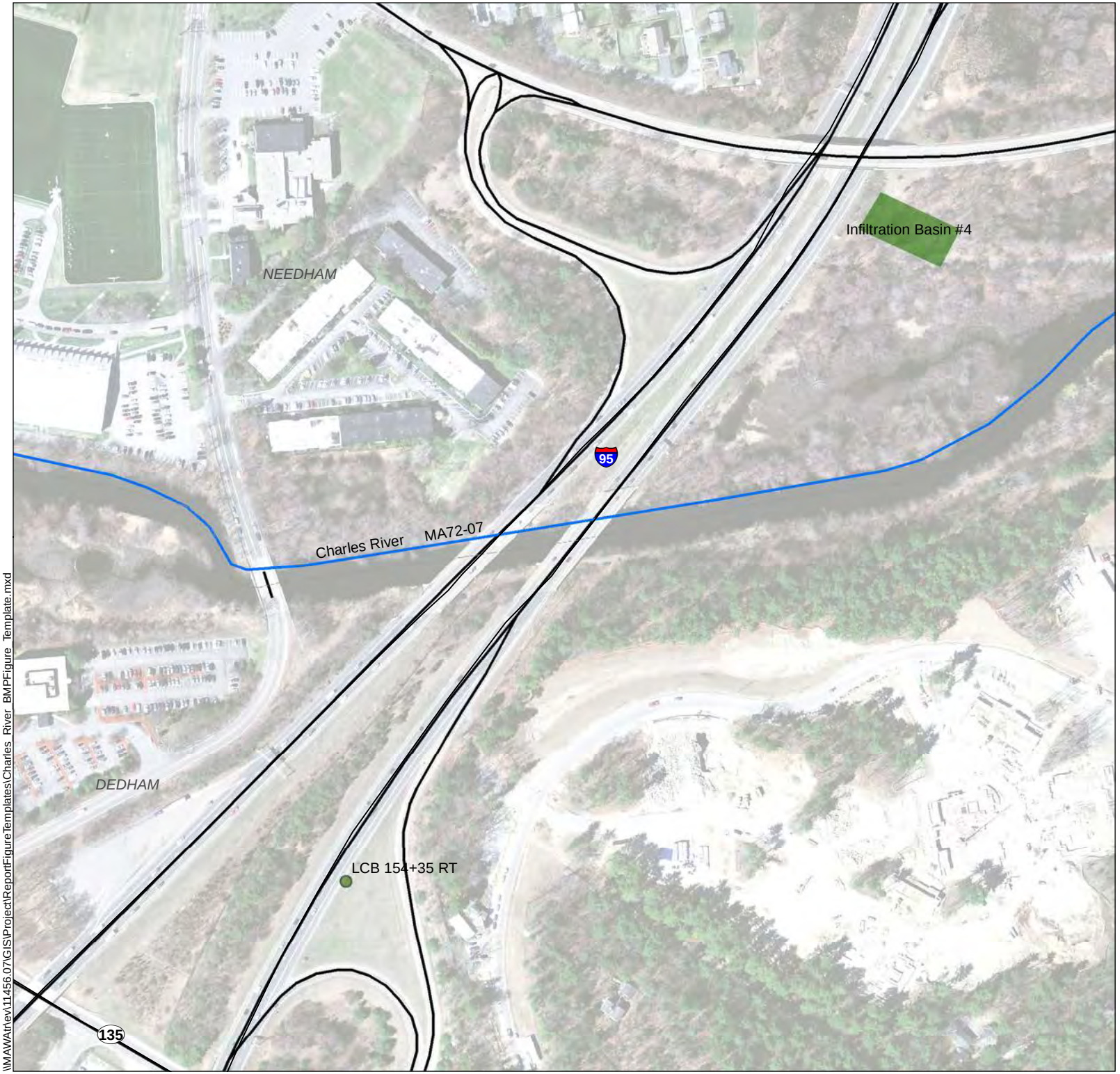

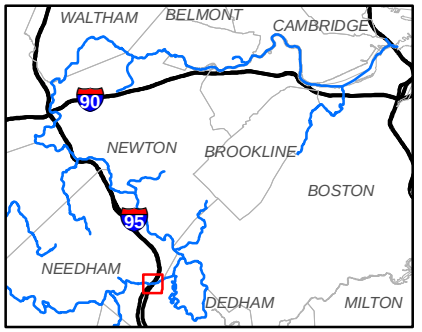

Impaired Streams

Impaired Waters

Proposed BMPs

Proposed BMP Watersheds

MassDOT Roadways

N

0 125 250 500 Feet

Figure 12

Charles River
MA72-07
Add-A-Lane (Bridge IV)
Proposed BMPs

June 2012

massDOT
Massachusetts Department of Transportation
Highway Division

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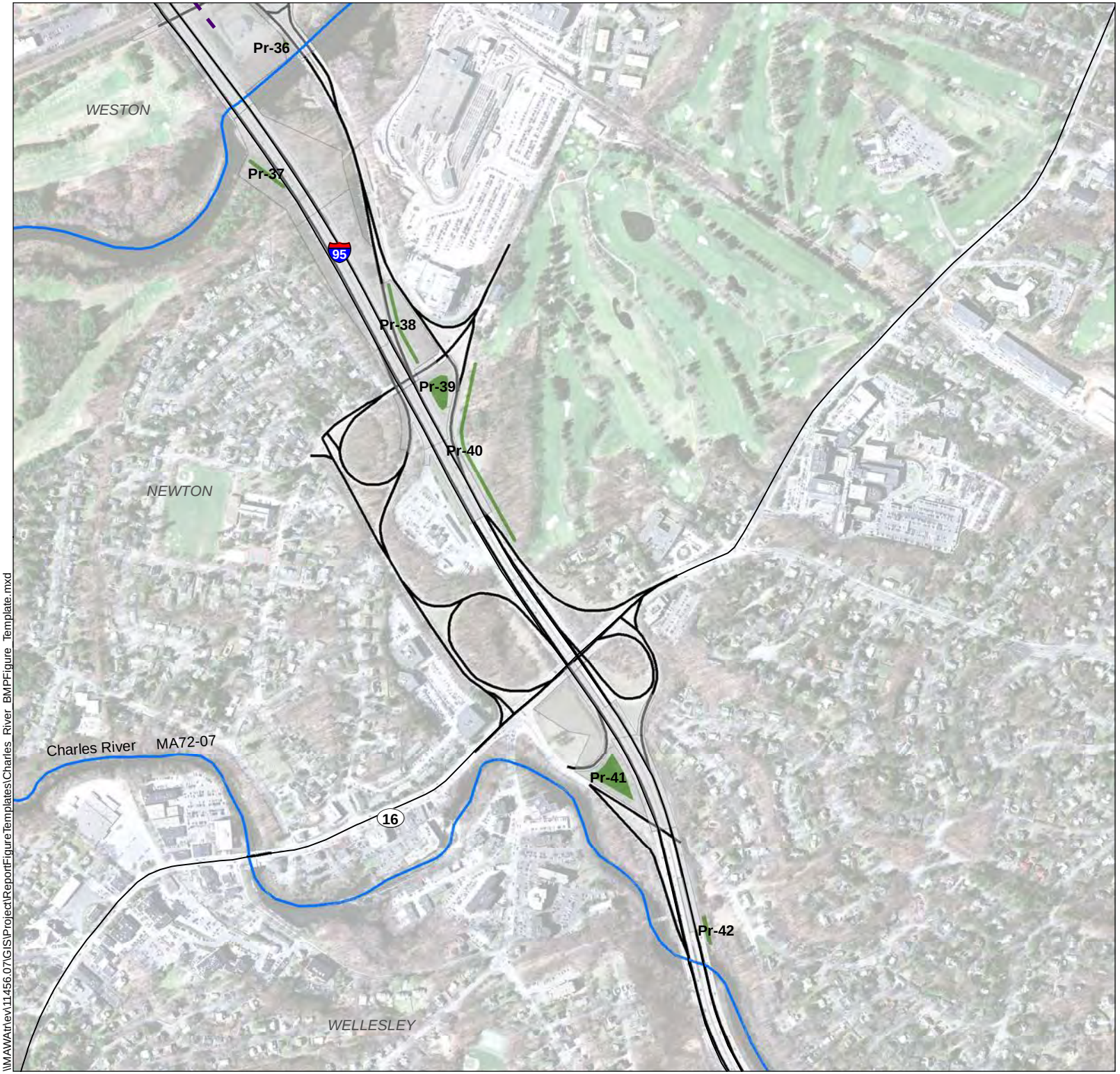

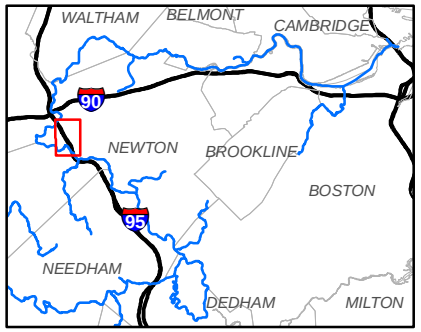

Impaired Streams

Impaired Waters

Proposed BMPs

Proposed BMP Watersheds

MassDOT Roadways

N

0 325 650 1,300 Feet

Figure 13

Charles River
MA72-07

Proposed BMPs

June 2012

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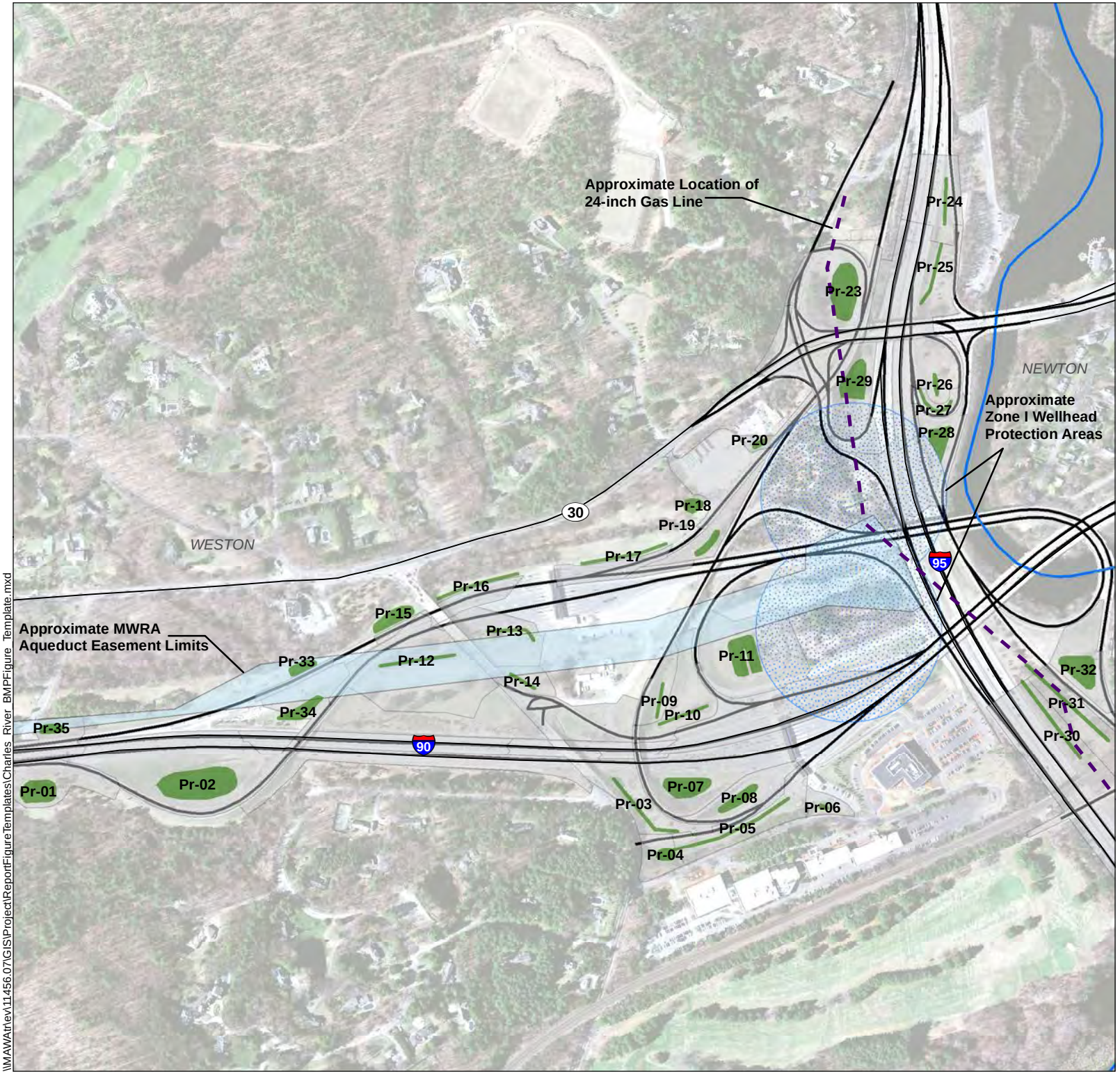

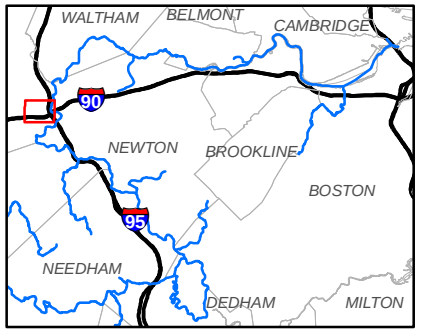

Impaired Streams

Impaired Waters

Proposed BMPs

Proposed BMP Watersheds

MassDOT Roadways

N

0 250 500 1,000 Feet

Figure 14

Charles River
MA72-07

Proposed BMPs

June 2012

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Impaired Waters Assessment for Muddy River (MA72-11)

Impaired Waterbody

Name: Muddy River

Location: Boston and Brookline, MA

Water Body ID: MA72-11

Impairments

According to the MassDEP Final Year 2010 Integrated List of Waters, the Muddy River is listed under Category 5 as impaired for oil and grease; PCB in fish tissue; non-native aquatic plants, physical substrate habitat alterations, dissolved oxygen, turbidity, taste odor and color, bottom deposits, Escherichia coli, and other (unspecified metals in sediments).

In addition, two TMDL reports have been finalized that address the Lower Charles River, which includes the Muddy River:

- *Final Phosphorus TMDL Report for the Lower Charles River Basin* (*Control Number (CN) 301.0,)* addressing the following impairments: dissolved oxygen, turbidity, taste, odor and color, and bottom deposits.
- *Final Pathogen TMDL Reports for the Charles River Watershed (CN 0156.0),* addressing the following additional impairment: Escherichia coil.

The Charles River Watershed 2002-2006 Water Quality Assessment Report (Mass DEP, 2008) lists wet weather discharges (point source and combination of stormwater, sanitary sewer overflows (SSO) or combined sewer overflow (CSO)) among the main sources of impairments to this segment. The report also identifies other sources of impairments in the water body, including legacy pollutants, channelization, and loss of riparian habitat.

Relevant Water Quality Standards

- Water Body Classification: B, Warm Water Fishery, Combined Sewer Overflow
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
- 314 CMR § 4.05 (3)(b)(1) – *Dissolved Oxygen. a. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.*

- 314 CMR § 4.05 (3)(b)(4) – *Bacteria.*
  a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
  b. for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;
- *314 CMR § 4.05 (5)(b) – Bottom Pollutants or Alterations. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.*
- 314 CMR § 4.05 (3)(b)(6) – *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 (3)(b)(7) –*Oil and Grease. These waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.*
- 314 CMR § 4.05 (5)(a) – *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 (5)(c) – *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 pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.*
- 314 CMR § 4.05 (5)(e) - *Toxic Pollutants. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background*

concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Summary

MassDOT has assessed stormwater impacts from MassDOT properties discharging to the Muddy River using BMP 7R to address the Phosphorus and Pathogen TMDLs and BMP 7U to address impairments not covered by a TMDL. The following sections describe the methodology for these assessments. Based on this assessment, MassDOT determined that a 34 pound reduction in annual phosphorus loading and 12 acre reduction in effective impervious cover (IC) would be needed to meet the targets of the watershed.

Presently, Mass DOT's properties draining to the Muddy River do not include stormwater best management practices (BMPs). MassDOT has also concluded that site constraints and other factors limit the potential for MassDOT to install stormwater BMPs for runoff draining to the Muddy River. See the **Proposed Mitigation Plan** section of this assessment for more information.

Reductions Applied to DOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	15	42
Target Reduction	12	34
Reduction Provided in Proposed Conditions	0	0

Site Description

The Muddy River (MA72-11) is a tributary to the Charles River in Boston and Brookline, MA which flows from the outlet of Ward Pond for approximately 3.6 miles to the Charles River (see Figure 1). The Muddy River generally flows in a northerly direction along the Boston/Brookline boundary until it reaches Park Drive, where the Muddy River enters a culvert under Brookline Avenue and flows southeast. The Muddy River then flows in a northerly direction through the Back Bay Fens to the Charles River.

The Muddy River flows through Boston's Emerald Necklace linear park, including Olmstead Park, the Riverway, and the Back Bay Fens. The Emerald Necklace provides a maintained vegetated buffer on each side of the Muddy River. The Muddy River watershed extends south to include Jamaica Pond and west into Newton to include the Chestnut Hill Reservoir (see Figure 1). The Muddy River watershed is in an urbanized area, and in addition to open space provided by the Emerald Necklace, land uses include transportation, high density residential, and commercial. According to the *2002-2006 Water Quality Assessment Report*, the estimated percent IC for this subwatershed is 29.5% and the top three land uses of the 6.5 square mile subwatershed are residential (55%), open land (22%), and commercial (9%).

MassDOT roadways that directly discharge stormwater to the Muddy River include Route 9, Interstate 90 (I-90), and various bridges (see Figures 2 and 3). Approximately 0.3 miles of Route 9 at Brookline Village discharges to an underground brook which flows into Leverett Pond, a run of the Muddy River. Route 9 is a principal arterial four-lane roadway, with two lanes in each direction, and a total width of approximately 75 feet. MassDOT owns the Riverway bridge over Route 9, which directly contributes runoff via sheet flow to the adjacent Muddy River.

Additionally, approximately 0.5 miles of I-90, which crosses over the Muddy River at the Charlesgate Overpass, directly contributes runoff to the Muddy River. A series of drop inlets convey I-90 runoff to the main drainage trunk lines which discharge directly into the Muddy River via outfalls in each abutment of the I-90 bridge over the Muddy River. I-90 is an interstate highway approximately 120 feet wide with four lanes of traffic in each direction, separated by a raised concrete median.

MassDOT owns seven bridges over the Muddy River at various locations in Boston. Those bridges, which contribute runoff from the bridges themselves to the Muddy River, include:

- Longwood Avenue;
- Commonwealth Avenue (eastbound and westbound);
- Beacon Street;
- Charlesgate overpass and its associated on and off ramps;
- Agassiz Road;
- Brookline Avenue; and
- The Riverway on and off ramps at Park Drive.

At each of these bridge locations, the surrounding properties are owned by either the City of Boston or the Massachusetts Department of Conservation and Recreation (DCR). No existing BMPs treating MassDOT stormwater discharges exist in the Muddy River subwatershed.

Assessment under BMP 7R for Impairments Addressed by Phosphorus TMDL (CN 301.0)

The Total Maximum Daily Load (TMDL) for Nutrients in the Lower Charles River, Massachusetts (CN 301.0) addresses the dissolved oxygen, phosphorous, turbidity, taste, odor and color, and bottom deposits impairments for this water body. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT properties to this water body using the approach described in BMP 7R of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have been addressed by a TMDL.

Pollutant of Concern: Phosphorus

1) Impairment Addressed: dissolved oxygen, phosphorus, turbidity, taste, odor and color, and bottom deposits.
2) Applicable Waste Load Allocation (WLA): See Table ES-3 Final TMDL Report. As Transportation is not specifically identified as a land use in the Final TMDL, MassDOT will use the Commercial land use for this analysis under the conservative assumption that Transportation is most similar to Commercial land uses.
    a) Description of Associated Land Use: Commercial
    b) Commercial Land Use Current Load (TP): 3,676 kilograms per year (kg/yr)
    c) Commercial Land Use WLA (TP): 1,286 kg/yr
    d) Percent Load Reduction (TP): 65%
    e) Commercial Area in Watershed: 8.36 square miles or 2.7% (based on total watershed area of 308 square miles. Transportation not separated from Commercial/Industrial during TMDL analysis)
    f) Commercial Land Use Area WLA: 0.59 kilograms per hectare per year (kg/ha/yr) (0.53 pounds per acre per year (lbs/ac/yr)) (calculated)
3) Implementation Strategy Components: Section 6.2 Final Report
    a) Management of Stormwater from Drainage Systems – Pages 113-115 of the Final TMDL:
        i) "The development and implementation of comprehensive storm water management programs throughout the Charles River watershed will be necessary to achieve the phosphorus reduction and water quality goals of this TMDL. The management program should accomplish the following tasks:
            (1) characterize the drainage areas that contribute to discharges requiring permit coverage under the Permittee's jurisdiction
            (2) implement a comprehensive Illicit Discharge Detection and Elimination (IDDE) program
            (3) prioritize source areas for control
            (4) include the necessary structural and non-structural best management practices (BMPs) that, upon implementation, will achieve reductions in phosphorus loadings from the NPDES covered drainage areas that are consistent with the phosphorus load reductions identified in this TMDL."

For BMP 7R Phosphorus Assessment, MassDOT used a site-specific, continuous, long-term hydrologic and pollutant simulation model (the assessment model) to estimate annual pollutant loads from its property and treatment through both existing and proposed BMPs, if present. The assessment model was run for a 10-year period using hourly Boston rainfall data to capture a range of meteorological conditions and estimate annual average pollutant loads. The pollutant loading portion of the assessment model was calibrated to match pollutant runoff data from the USGS Highway-Runoff Database (Version 1.0, September 2009). The assessment model directly evaluates BMP effects on hydrology (detention, infiltration) and pollutant loads (losses through infiltration, settling, filtration, and biological treatment). For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

The following table summarizes the assessment model results for the MassDOT directly contributing watershed contributing to the Muddy River for existing conditions.

Annual Watershed Phosphorus Loading under Existing Conditions

Watershed/ BMP ID	Watershed Size (Acres)	Pre-BMP Annual Load (pounds/year)	Post-BMP Annual Load (pounds/yaer)	Estimated Annual Removal Efficiency
Total Directly Contributing MassDOT Watershed	16	42	42	0%

The assessment model predicts that the load from the MassDOT directly contributing watershed is approximately 42 pounds of phosphorus per year. There are no existing BMPs in place to treat this runoff.

Based on the TMDL, MassDOT's WLA is 0.59 kg/ha/yr (0.53 lbs/ac/yr) or 8 pounds of phosphorus per year for MassDOT's directly contributing watershed.

BMP 7R Phosphorus Mitigation Plan

Under existing conditions, MassDOT's estimated directly contributing annual phosphorus load exceeds the TMDL WLA. To mitigate this load, MassDOT will implement stormwater BMPs to the maximum extent given site constraints.

This assessment does not identify practical locations for stormwater management improvements within the current MassDOT right-of-way. The Proposed Mitigation Plan section discusses the site constraints and mitigation plan.

Assessment under BMP 7R for Pathogens

The Pathogen Total Maximum Daily Load (TMDL) for the Charles River Watershed (CN 0156.0) covers the Muddy River. The TMDL states that sources of indicator bacteria in the Charles River Watershed were found to be many and varied. The TMDL lists sources as including failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals and direct overland stormwater runoff.

In addition, as page 12 of the TMDL states, *Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, stormwater drainage systems and associated stormwater culverts and outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.*

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by orders of magnitude within a given storm event (Mass DEP, 2009). Therefore, it is difficult to predict stormwater pathogen concentrations with accuracy. Due to this difficulty, MassDOT is not conducting site specific assessments of loading at each location impaired for pathogens as part of this Retrofit Program. However, MassDOT recognizes that its roadways, especially in urbanized areas, contribute to the pathogen impairment of the Charles River Watershed and has performed a general assessment and developed a mitigation plan as described below.

BMP 7R Pathogens Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT has reviewed its existing programs and their consistency with the Pathogen TMDL for the Charles River Watershed recommendations as well as the draft EPA National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements for the North Coastal Watershed.

The Pathogen TMDL for the Charles River Watershed recognizes that mitigation for pathogen impairments is difficult to address and emphasizes the need for an iterative adaptive management approach. The Executive Summary of the TMDL, page xi, states:

> *TMDL implementation to achieve [the pathogen reduction goals] should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate stormwater runoff volume.*

The existing NPDES MS4 permit that covers MassDOT stormwater discharges does not provide guidance on what measures are necessary to comply with the Pathogen TMDL for the Charles River Watershed. The fact sheet for the draft permit for MS4 stormwater discharges for the North Coastal Watershed contains some guidance on what measures EPA has determined necessary to be consistent with the Pathogen TMDL for the Charles River Watershed. Page 36 of the fact sheet states:

> *Instead of a numeric limitation for bacteria, the draft permit includes requirements for MS4s to provide education to pet owners and owners of septic systems, to implement a comprehensive illicit discharge detection and elimination program that addresses not only sources of pathogens but also sources of phosphorus, and to implement programs to address water fowl. In addition, although entitled "Phosphorus Control Plan" most of the actions needed to develop and implement a successful PCP are also effective in supporting the achievement of the WLA for the Charles River pathogen TMDL.*

As discussed above, both the Pathogen TMDL for the Charles River Watershed and the draft North Coastal Watershed MS4 permit state that identification of illicit discharges and addressing stormwater volumes and pollutants, such as phosphorus, are the best approaches to mitigate the pathogen impairments. MassDOT has developed a mitigation plan, described below, to address the pathogen impairments using guidance from these two documents.

BMP 7R Pathogens Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Storm Water Management Plan (SWMP) including educational programs, illicit connection review, and source control. The specific non-structural BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In

- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

Although not included in this permit term, MassDOT will be implementing a pet waste management program at its rest stops, including those that have discharges to pathogen impaired waters. In addition, MassDOT has requested to be covered under an Individual MS4 permit for the next permit term. A future individual permit may contain additional programmatic BMPs to address pathogens.

The structural BMPs that will be considered to reduce phosphorus loading and the effects of IC would also reduce pathogen loads. See the Proposed Mitigation Plan section of this assessment for more information on specific BMPs proposed as part of this assessment. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations.

Assessment for Oil and Grease and Other (Unspecified Metals) Under BMP 7U

The Charles River pathogen and phosphorus TMDLs do not address all of the Muddy River's impairments, which include oil and grease and other (unspecified metals). Therefore, MassDOT assessed the stormwater-related impairments not addressed by a TMDL using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have not been addressed by a TMDL.

MassDOT has identified a subset of water body impairments in the Charles River Watershed which are not related to stormwater runoff. Specific impairments unrelated to stormwater for the Muddy River include non-native aquatic plants, other flow regime alterations, physical substrate habitat alterations, and PCB in fish tissue. MassDOT is not including these impairments in this assessment as they are not caused by stormwater runoff.

For the stormwater-related impairments for this water body not covered by a TMDL, MassDOT used an application of EPA Region I's Impervious Cover (IC) Method described in EPA's Stormwater TMDL Implementation Support Manual (ENSR, 2006). MassDOT used this method to assess potential stormwater impacts on the impaired water and develop the target IC to ensure that stormwater is not the cause of the impairments. The IC Method relates an aquatic system's health (i.e., state of impairment) to the percentage of IC in its contributing watershed. This method is largely based on the work of the Center for Watershed Protection, which has compiled and evaluated extensive data relating watershed IC to the hydrologic, physical, water quality, and biological conditions of aquatic systems (Schueler, 2003). Water quality in tributary streams, rivers, lakes and ponds is a direct reflection of loading from the watershed (Wetzel, 2001); therefore, the IC method can be used as a surrogate for pollutant loading when evaluating water quality impairments and their causes. Consistent with the findings of EPA and others, MassDOT concluded that when a watershed had less than 9% IC, stormwater was not the likely cause of the impairment.

MassDOT developed the target IC reduction using the approach outlined in *Description of MassDOT's Application of Impervious Cover Method in BMP 7U* (MassDOT, 2011). The watersheds of the subject water body were delineated using a combination of USGS Data Series

451 basin delineations and USGS topographical maps. The IC within the watersheds were calculated using both USGS Data Series 451 and MassGIS's Impervious Surface data layer.

The MassDOT IC method for the impaired waters of the Charles River basin includes the following steps:

1. Calculate the percent IC of the water body's entire contributing watershed (total watershed to downstream end of impaired segment) and that of the local watershed contributing directly to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body.
2. For subwatersheds with greater than 9% IC, calculate the amount of IC reduction needed to achieve 9%. For subwatersheds with less and 9% IC, perform no further analysis under BMP 7U.
3. Calculate percentage of IC in MassDOT directly contributing drainage area.
4. Apply reduction of IC necessary for the subwatershed to achieve 9% to MassDOT contributing drainage area as a target to address the stormwater impairments. Calculate resulting target IC for MassDOT drainage area.
5. In the case where BMPs are in place or BMPs are proposed, derive IC reduction rates for the BMPs using EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis Report (*EPA, 2010b) based on size, function, and contributing watersheds of the BMPs.

BMP 7U Assessment

Using the approach described above, MassDOT calculated the following values for the total contributing watershed of the impaired water (Muddy River) to determine the IC target (see Figure 1). For the Muddy River, MassDOT determined that the total watershed (total watershed upstream of the downstream end of the impaired segment) and the subwatershed (local watershed contributing directly to the impaired segment) were the same.

Watershed Impervious Cover

	Total Watershed
Watershed Area	4,064 acres
Impervious Cover (IC) Area	1,956 acres
Percent Impervious	48%
IC Area at 9% Goal	366 acres
Target Reduction % in IC	81%

The total and sub watersheds are greater than 9% impervious which indicates that stormwater is a likely contributor to the impairment. To meet the 9% effective IC target, the effective IC within the subwatershed will need to be reduced by 81%. Therefore, the effective IC of MassDOT's directly contributing area should also be reduced by the same percentage to meet the target. The following table shows the resulting targets for MassDOT's contributing property.

Reductions Applied to DOT Direct Watershed	
MassDOT's Area Directly Contributing to Impaired Segment	16 acres
MassDOT's IC Area Directly Contributing to Impaired Segment	15 acres
MassDOT's Percent Impervious	97%
MassDOT's Target Reduction in Effective IC (81% of DOT Directly Contributing IC)	12 acres
Target Effective IC	18%

MassDOT's directly contributing area includes15 acres of IC. To meet the target reduction of effective IC, MassDOT should mitigate the effect of 12 acres of IC. Equivalently, MassDOT's contributing drainage area should act as a watershed of 18% IC.

BMP 7U Mitigation Plan

Under existing conditions, MassDOT's estimated effective IC exceeds the target as described above. To mitigate the effects of IC, MassDOT will implement stormwater BMPs to the maximum extent practicable.

MassDOT was not able to identify practical locations for stormwater management improvements within the current MassDOT right-of-way. The Proposed Mitigation Plan section discusses the site constraints and mitigation plan.

Proposed Mitigation Plan to Address Phosphorus and Impervious Cover

MassDOT is reviewing the Charles River basin as an entire watershed and has committed to constructing stormwater BMP retrofit projects to address impaired waters. During this assessment phase of the Impaired Waters Program, MassDOT has focused on directly contributing areas and identified BMPs that can be constructed entirely on MassDOT property without resulting in substantial wetland impacts or result in an adverse impact on historical or archeological resources. Projects that meet these requirements can utilize the Federal Highway Administration's Alternative Contracting mechanism (SEP-14) created for this program. MassDOT will advance designs for BMPs where practicable in the watershed above and beyond the target mitigation to compensate for areas like the Muddy River, where site constraints prohibit BMPs.

Based on the review of MassDOT's directly contributing drainage area, no BMPs have been identified that can be implemented on MassDOT property to address the impairments of the Muddy River given the site constraints described below.

Site limitations in the Muddy River watershed include limited right-of-way owned by MassDOT. The City of Boston owns and manages the Riverway Park and the Back Bay Fens, which surrounds the Muddy River for almost its entire run. These parks are part of the larger Emerald Necklace Park system in Boston. The parkways (roadways) which extend through the Emerald Necklace Park are under the ownership of DCR with the exception of several bridges which were transferred to MassDOT in 2010. The parks surrounding the Muddy River are heavily used for recreational purposes and may not be appropriate for stormwater BMPs.

In addition, BMP implementation through MassDOT's programmed projects are carefully evaluated and implemented where practicable, and documented through the MassDOT Water Quality Data Form. The potential for BMPs outside of MassDOT property will be reviewed during the design phase of these projects and through ongoing partnerships with other state and local entities. During

this assessment analysis, potential BMPs beyond the scope of the impaired waters program were identified and can be reviewed during future projects.

The DCR has an existing project planned near the intersection of the Riverway with Park Drive. The Muddy River is culverted under the roadways at this location, for a distance of approximately 830 feet. This project would involve day lighting portions of the Muddy River in this location. MassDOT will work with DCR to determine if stormwater improvements from adjacent MassDOT bridges can be incorporated into this project.

An existing MassDOT project in the Muddy River subwatershed exists in Brookline Village (MassDOT Project #605110). This project involves intersection and signal improvements. Stormwater improvements will be considered in this project's development.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to the Muddy River using BMP 7R to address the Phosphorus and Pathogen TMDLs and BMP 7U to address impairments linked to IC. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. No locations on MassDOT property were identified for stormwater improvements related to discharges to the Muddy River.

Reductions Applied to DOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	15	42
Target Reduction	12	34
Reduction Provided in Proposed Conditions	0	0

The above table summarizes the target reductions in effective IC and phosphorus loading. To meet the targets for the Muddy River, MassDOT needs to treat stormwater discharges from MassDOT-owned property to reduce effective IC by 12 acres and annual phosphorus loads by 34 pounds. No treatment BMPs are being proposed as part of this assessment due to site constraints and no treatment is provided under proposed conditions.

As an overall program, MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted as programmed projects for the area. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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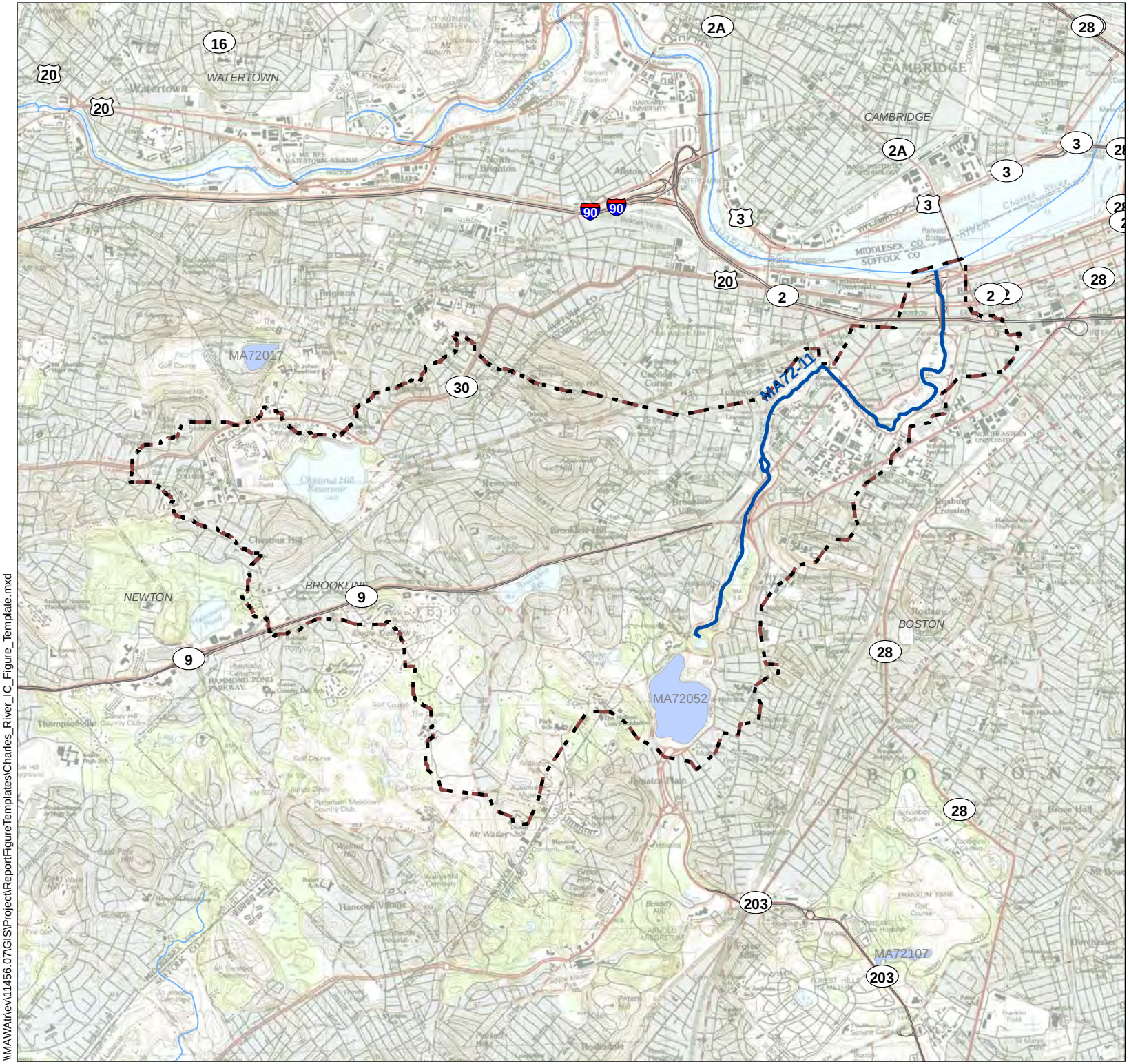

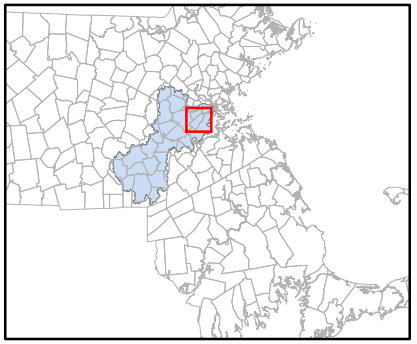

Assessed Stream Segment

Assessed Lake Segment

Total Watershed

Subwatershed

Impaired Lakes

Impaired Streams

MassDOT Roadways

N

0 0.5 1 Miles

Figure 1

Muddy River MA72-11 Watersheds

June 2012

massDOT Massachusetts Department of Transportation Highway Division

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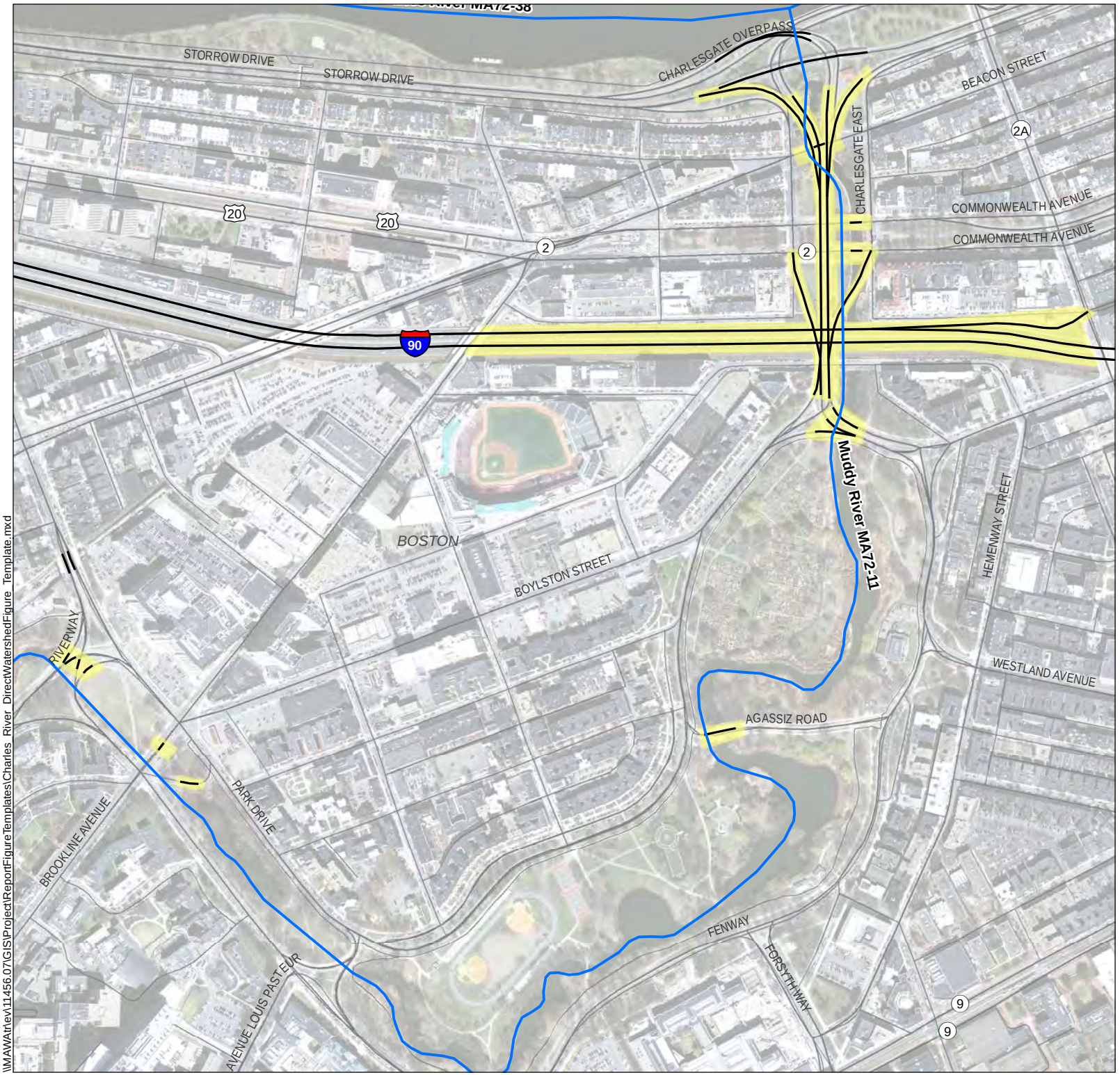

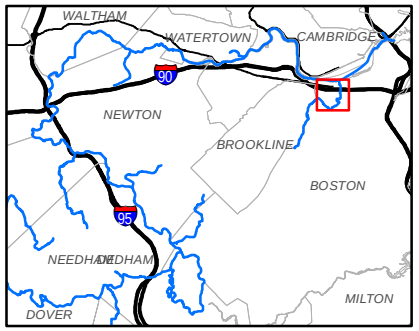

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 250 500 1,000 Feet

Figure 2

Muddy River
MA72-11
Directly Contributing
MassDOT Watershed

June 2012

massDOT
Massachusetts Department of Transportation
Highway Division

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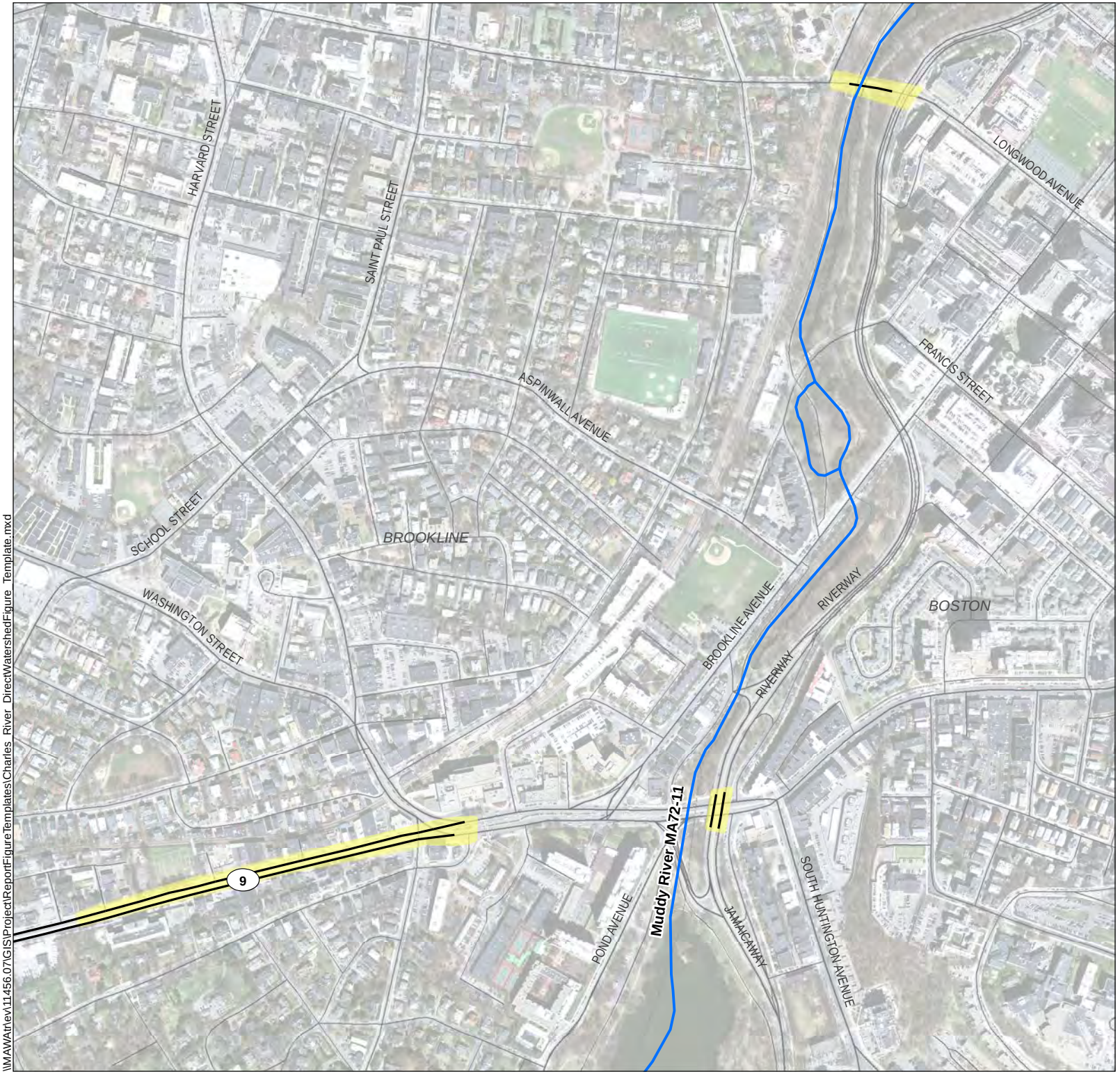

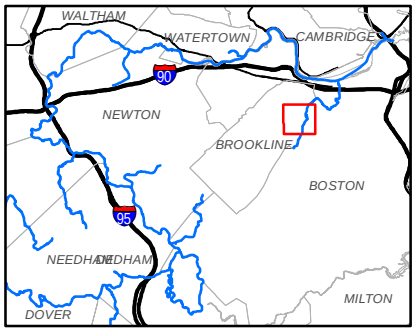

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 250 500 1,000 Feet

Figure 3

Muddy River MA72-11 Directly Contributing MassDOT Watershed

June 2012

massDOT Massachusetts Department of Transportation Highway Division

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Impaired Waters Assessment for South Meadow Brook (MA72-24)

Impaired Waterbody

Name: South Meadow Brook

Location: Newton, MA

Water Body ID: MA72-24

Impairments

According to the MassDEP Final Year 2010 Integrated List of Waters, South Meadow Brook is listed under Category 5 as impaired for debris/floatables/trash, Escherichia coli, dissolved oxygen, physical substrate habitat alterations, turbidity, total phosphorus, and bottom deposits.

Two TMDL reports have been finalized that address the Upper/Middle Charles River, which includes this subwatershed. Those reports are:

- *Final Nutrient TMDL Report for the Upper/Middle Charles River (Control Number (CN) 272.0),* addressing the following impairments: phosphorus, dissolved oxygen, and turbidity.
- *Final Pathogen TMDL Reports for the Charles River Watershed (CN 0156.0),* addressing the *Escherichia coli* impairment.

The *Charles River Watershed 2002-2006 Water Quality Assessment Report* (MassDEP, 2008) lists discharges from municipal separate storm sewer systems and unspecified urban stormwater as the main sources of impairments to this subwatershed. Other sources of impairment in the subwatershed include illicit connections/hook-ups to storm sewers.

Relevant Water Quality Standards

- Water Body Classification: B
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
- 314 CMR § 4.05 (3)(b)(1) – *Dissolved Oxygen. a. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.*
- 314 CMR § 4.05 (3)(b)(4) – *Bacteria.*
  a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105

CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
b. for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;

- 314 CMR § 4.05 (3)(b)(5) – *Solids. These waters shall be free from floating, suspended and settleable solids in concentrations or 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 (3)(b)(6) – *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 (5)(b) – *Bottom Pollutants or Alterations. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.*
- 314 CMR § 4.05 (5)(c) – *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 pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.*

Summary

MassDOT has assessed stormwater discharges from MassDOT properties to South Meadow Brook using BMP 7R in order to address the Phosphorus and Pathogen TMDLs and BMP 7U in order to address impairments not covered by a TMDL. The following sections describe the methodology for these assessments. Based on this assessment, MassDOT determined that a 5.3 pound reduction in annual phosphorus loading and a 2.0 acre reduction in effective impervious cover (IC) would be needed to meet the targets of the watershed.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	2.6	7.0
Target Reduction	2.0	5.3
Reduction Provided in Proposed Conditions	0	0

Presently, MassDOT's properties draining to South Meadow Brook do not include stormwater best management practices (BMPs). MassDOT has concluded that site constraints and other factors limit the potential for MassDOT to install stormwater BMPs for runoff draining to South Meadow Brook. See the **Proposed Mitigation Plan** section of this assessment for more information.

Site Description

From its emergence west of Parker Street in Newton to confluence with the Charles River in Newton, South Meadow Brook is concrete lined with culverted sections at roadway crossings. South Meadow Brook crosses under Needham Street in Newton just south of Jaconnet Street through a double box culvert (see Figure 1). The brook daylights downstream of the crossing of Needham Street for approximately 600 feet and then flows into a culvert under an industrial area. The stream daylights again south of Oak Street (west of Needham Street) and flows above ground for approximately 300 feet before flowing into the Charles River. The stream flow path was observed in the field and is different from what is shown on the MassDEP 303d GIS layer (see Figure 2).

According to the *2002-2006 Water Quality Assessment Report*, the estimated percent IC for this subwatershed is 30.1% and the primary land uses of the 2.9 square mile subwatershed are residential (68%), forest (13%), and open land (8%).

MassDOT property directly contributing to South Meadow Brook includes Needham Street in Newton. Needham Street is classified as an Urban Minor Arterial with one lane in each direction and a center lane which acts as a turning lane. The roadway also includes sidewalks on each side of the road for a total roadway width of approximately 60 feet. MassDOT's property does not include right-of-way beyond the sidewalk limits.

Approximately 2,500 feet of Needham Street discharges directly to South Meadow Brook (see Figure 2). Runoff on Needham Street flows to catch basins along each side of the roadway to two outfalls along the steep banks of South Meadow Brook on the western side of the Needham Street crossing. It is also possible that additional runoff enters the brook within the box culverts.

Portions of Route 9 discharge roadway runoff to a swale running parallel to the roadway from which runoff flows to a closed Municipal Separate Storm Sewer System (MS4) and may flow to the

headwaters of South Meadow Brook. At this time, MassDOT is not considering this a direct discharge.

No existing stormwater best management practices (BMPs) exist in the MassDOT directly contributing area.

Assessment under BMP 7R for Impairments Addressed by Nutrients TMDL (CN 272.0)

The *Total Maximum Daily Load for Nutrients in the Upper/Middle Charles River, Massachusetts (CN 272.0)* addresses the dissolved oxygen, phosphorus, and turbidity impairments for this water body. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT properties to this water body using the approach described in BMP 7R of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have been addressed by a TMDL.

Pollutant of Concern: Phosphorus

1) Impairment Addressed: dissolved oxygen, phosphorus, and turbidity
2) Applicable Waste Load Allocation (WLA): See Table ES-3 Phase III Final Report.
    a) Description of Associated Land Use: Transportation
    b) Transportation Land Use Current Load (TP): 2,167 kilograms per year (kg/yr)
    c) Transportation Land Use WLA (TP): 759 kg/yr
    d) Commercial/Industrial/Transportation Area in Watershed: 15.9 sq miles or 5.9% (reported in Phase III Calibration Report Table 5. Transportation not separated from Commercial/Industrial during TMDL analysis)
    e) Commercial/Industrial/Transportation Land Use Areal WLA: 0.72 kilograms per hectare per year (kg/ha/yr) (0.64 pounds per acre per year (lbs/ac/yr)) (calculated)
3) Applicable Recommendations: Section 7.2 Phase III Final Report
    a) Management of Stormwater systems - Page 83 Phase III Final Report
        i) "Comprehensive programs will be necessary to achieve the phosphorus reduction and water quality goals of this TMDL. Programs should build upon existing stormwater management to accomplish the following tasks:
            (1) characterize the drainage areas that contribute to discharges requiring permit coverage under the Permittee's jurisdiction
            (2) implement a comprehensive Illicit Discharge Detection and Elimination (IDDE) program
            (3) prioritize source areas for stormwater management and control
            (4) identify site-specific and regional opportunities for implementation of BMPs
            (5) include the necessary structural and non-structural best management practices (BMPs) that, upon implementation, will achieve reductions in phosphorus load from the NPDES covered drainage areas that are consistent with the phosphorus load reductions identified in this TMDL)
        ii) Management of illicit discharges to stormwater drainage systems"

For BMP 7R Phosphorus Assessment, MassDOT used a site-specific, continuous, long-term hydrologic and pollutant simulation model (the assessment model) to estimate median annual pollutant loads from its property and treatment through both existing and proposed BMPs, if present. The assessment model was run for a 10-year period using hourly Boston rainfall data to capture a range of meteorological conditions and estimate annual median pollutant loads. The pollutant loading portion of the assessment model was calibrated to match pollutant runoff data from the USGS Highway-Runoff Database (Version 1.0, September 2009). The assessment model directly evaluates BMP effects on hydrology (detention, infiltration) and pollutant loads (losses through infiltration, settling, filtration, and biological treatment). For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

The following table summarizes the assessment model results for the MassDOT directly contributing watershed discharging to South Meadow Brook for existing conditions.

Annual Watershed Phosphorus Loading under Existing Conditions

Watershed/ BMP ID	Watershed Size (Acres)	Pre- BMP Annual Load (pounds/year)	Post-BMP Annual Load (pounds/year)	Estimated Annual Removal Efficiency
Total Directly Contributing MassDOT Watershed	2.7	7.0	7.0	0%

The assessment model predicts a median annual load from the MassDOT directly contributing watershed of approximately 7.0 pounds.

Based on the TMDL, MassDOT's WLA is 0.72 kg/ha/yr (0.64 lbs/ac/yr) or 1.7 pounds of phosphorus per year for MassDOT's directly contributing watershed.

BMP 7R Phosphorus Mitigation Plan

Under existing conditions, MassDOT's estimated directly contributing annual phosphorus load exceeds the TMDL WLA. To mitigate this load, MassDOT will implement stormwater BMPs to the maximum extent given site constraints.

This assessment does not identify practical locations for stormwater management improvements within the current MassDOT right-of-way. The Proposed Mitigation Plan section discusses the site constraints and mitigation plan.

Assessment under BMP 7R for Pathogens

The *Pathogen Total Maximum Daily Load (TMDL) for the Charles River Watershed (CN 0156.0)* covers South Meadow Brook. The TMDL states that sources of indicator bacteria in the Charles River Watershed were found to be many and varied. The TMDL lists sources such as failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals, and direct overland stormwater runoff.

In addition, as stated on page 12 of the TMDL, *Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, stormwater drainage systems and associated stormwater culverts and*

outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by orders of magnitude within a given storm event (MassDEP, 2009). Therefore, it is difficult to predict stormwater pathogen concentrations with accuracy. Due to this difficulty, MassDOT is not conducting site specific assessments of loading at each location impaired for pathogens as part of this Retrofit Program. However, MassDOT recognizes that its roadways, especially in urbanized areas, contribute to the pathogen impairment of the Charles River Watershed and has performed a general assessment and developed a mitigation plan as described below.

BMP 7R Pathogens Assessment

Pathogen loads are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT has reviewed its existing programs and their consistency with the Pathogen TMDL for the Charles River Watershed recommendations as well as the draft EPA National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements for the North Coastal Watershed.

The Pathogen TMDL for the Charles River Watershed recognizes that mitigation for pathogen impairments is difficult to address and emphasizes the need for an iterative adaptive management approach. The Executive Summary of the TMDL, page xi, states:

> *TMDL implementation to achieve [the pathogen reduction goals] should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate stormwater runoff volume.*

The existing NPDES MS4 permit that covers MassDOT stormwater discharges does not provide guidance on what measures are necessary to comply with the Pathogen TMDL for the Charles River Watershed. The fact sheet for the draft permit for MS4 stormwater discharges for the North Coastal Watershed contains some guidance on what measures EPA has determined necessary to be consistent with the Pathogen TMDL for the Charles River Watershed. Page 36 of the fact sheet states:

> *Instead of a numeric limitation for bacteria, the draft permit includes requirements for MS4s to provide education to pet owners and owners of septic systems, to implement a comprehensive illicit discharge detection and elimination program that addresses not only sources of pathogens but also sources of phosphorus, and to implement programs to address water fowl. In addition, although entitled "Phosphorus Control Plan" most of the actions needed to develop and implement a successful PCP are also effective in supporting the achievement of the WLA for the Charles River pathogen TMDL.*

As discussed above, both the Pathogen TMDL for the Charles River Watershed and the draft North Coastal Watershed MS4 permit state that identification of illicit discharges and addressing stormwater volumes and pollutants, such as phosphorus, are the best approaches to mitigate the pathogen impairments. MassDOT has developed a mitigation plan, described below, to address the pathogen impairments using guidance from these two documents.

BMP 7R Pathogens Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review, and source control. The specific non-structural BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

Although not included in this permit term, MassDOT will be implementing a pet waste management program at its rest stops, including those that have discharges to pathogen impaired waters. In addition, MassDOT has requested to be covered under an Individual MS4 permit for the next permit term. A future individual permit may contain additional programmatic BMPs to address pathogens.

The structural BMPs that will be considered to reduce phosphorus loading and the effects of IC would also reduce pathogen loads. See the Proposed Mitigation Plan section of this assessment for more information on the specific BMPs proposed as part of this assessment. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations.

Assessment for Floatables and Bottom Deposits under BMP 7U

The Charles River pathogen and phosphorus TMDLs do not address all of South Meadow Brook's impairments including debris/floatables/trash and bottom deposits. Therefore, MassDOT assessed the stormwater-related impairments not addressed by a TMDL using the approach described in BMP 7U of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan). BMP 7U applies to impairments that have not been addressed by a TMDL.

MassDOT identified a subset of water body impairments in the Charles River Watershed which are not related to stormwater runoff. Specific impairments unrelated to stormwater for South Meadow Brook include physical substrate habitat alterations. MassDOT has not included this impairment in this assessment as it is not caused by stormwater runoff.

For the stormwater-related impairments for this water body not covered by a TMDL, MassDOT used an application of EPA Region I's Impervious Cover (IC) Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006). MassDOT used this method to assess potential stormwater impacts on the impaired water and develop the target IC to ensure that stormwater is not the cause of the impairments. The IC Method relates an aquatic system's health (i.e., state of impairment) to the percentage of IC in its contributing watershed. This method is largely based on the work of the Center for Watershed Protection, which has compiled and

evaluated extensive data relating watershed IC to the hydrologic, physical, water quality, and biological conditions of aquatic systems (Schueler, 2003). Water quality in tributary streams, rivers, lakes and ponds is a direct reflection of loading from the watershed (Wetzel, 2001); therefore, the IC method can be used as a surrogate for pollutant loading when evaluating water quality impairments and their causes. Consistent with the findings of EPA and others, MassDOT concluded that when a watershed had less than 9% IC, stormwater was not the likely cause of the impairment.

MassDOT developed the target IC reduction using the approach outlined in *Description of MassDOT's Application of Impervious Cover Method in BMP 7U* (MassDOT, 2011). The watersheds of the subject water body were delineated using a combination of USGS Data Series 451 basin delineations and USGS topographical maps. The IC within the watersheds was calculated using both USGS Data Series 451 and MassGIS's Impervious Surface data layer.

The MassDOT IC method for the impaired waters of the Charles River basin includes the following steps:

1. Calculate the percent IC of the water body's entire contributing watershed (total watershed to downstream end of impaired segment) and that of the local watershed contributing directly to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body.
2. For subwatersheds with greater than 9% IC, calculate the amount of IC reduction needed to achieve 9%. For subwatersheds with less and 9% IC, perform no further analysis under BMP 7U.
3. Calculate percentage of IC in the MassDOT directly contributing drainage area.
4. Apply reduction of IC necessary for the subwatershed to achieve 9% to MassDOT contributing drainage area as a target to address the stormwater impairments. Calculate resulting target IC for MassDOT drainage area.
5. In the case where BMPs are in place or where BMPs are proposed, derive IC reduction rates for the BMPs using MassDOT's assessment model based on size, function, and contributing watersheds of the BMPs. See the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

BMP 7U Assessment

Using the approach described above, MassDOT calculated the following values for the total contributing watershed of the impaired water (South Meadow Brook) to determine the IC target (see Figure 1). For South Meadow Brook, MassDOT determined that the total watershed (total watershed upstream of the downstream end of the impaired segment) and the subwatershed (local watershed contributing directly to the impaired segment) were the same.

Watershed Impervious Cover	
	Total Watershed
Watershed Area	1,921 acres
Impervious Cover (IC) Area	701 acres
Percent Impervious	36%
IC Area at 9% Goal	173 acres
Target Reduction % in IC	75%

Since the total and subwatersheds are greater than 9% impervious, the analysis indicates that stormwater is a likely contributor to the impairment. To meet the 9% effective IC target, the effective IC within the subwatershed needs to be reduced by 75%. Therefore, the effective IC of MassDOT's directly contributing area also should be reduced by the same percentage to meet the target. The following table shows the resulting targets for MassDOT's contributing property.

Reductions Applied to MassDOT Direct Watershed	
MassDOT's Area Directly Contributing to Impaired Segment	2.7 acres
MassDOT's IC Area Directly Contributing to Impaired Segment	2.6 acres
MassDOT's Percent Impervious	97 %
MassDOT's Target Reduction in Effective IC (75% of DOT Directly Contributing IC)	2.0 acres
Target Effective IC	24 %

MassDOT's directly contributing area includes 2.6 acres of IC (or 97% of total contributing area). To meet the effective IC target reduction, MassDOT should mitigate 2.0 acres of effective IC. Equivalently, MassDOT's contributing drainage area should act as a watershed of 24% IC.

There are no existing BMPs to mitigate the effects of IC.

BMP 7U Mitigation Plan

Under existing conditions, MassDOT's estimated effective IC exceeds the target as described above. To mitigate the effects of IC, MassDOT will implement stormwater BMPs to the maximum extent practical give site constraints.

MassDOT was not able to identify practical locations for stormwater management improvements within the current MassDOT right-of-way. The Proposed Mitigation Plan section discusses the site constraints and mitigation plan.

Proposed Mitigation Plan to Address Phosphorus, Floatables and Bottom Deposits

MassDOT is reviewing the Charles River basin as an entire watershed and has committed to constructing stormwater BMP retrofit projects to address impaired waters. During this assessment phase of the Impaired Waters Program, MassDOT has focused on directly contributing areas and identified BMPs that can be constructed entirely on MassDOT property without resulting in substantial wetland impacts or result in an adverse impact on historical or archeological resources.

Projects that meet these requirements can utilize the Federal Highway Administration's Alternative Contracting mechanism (SEP-14) created for this program. MassDOT will advance designs for BMPs where practicable in the watershed above and beyond the target mitigation to compensate for areas like these, where site constraints prohibit BMPs.

Based on the review of MassDOT's directly contributing drainage area, no BMPs have been identified that can be implemented on MassDOT property to address the impairments of South Meadow Brook given the site constraints. Site limitations within the South Meadow Brook subwatershed include limited MassDOT right-of-way within the MassDOT's direct watershed and where roadway runoff discharges into the brook. The outfalls are located along the steep slopes of South Meadow Brook and the surrounding area is heavily developed. As such, BMPs cannot be implemented within MassDOT's directly contributing drainage area without impacting property outside of MassDOT property.

An existing MassDOT roadway reconstruction project (MassDOT Project #606635) is currently under design along Needham Street in Newton. BMP implementation under this programmed project will be carefully evaluated and implemented where practical, and will be documented through the Water Quality Data Form. The potential for BMPs outside of MassDOT property will be reviewed during the design phase of these projects and through ongoing partnerships with other state and local entities. Following the completion of this project, the roadway will be turned over to the Town of Newton and no longer under the jurisdiction of MassDOT.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties which directly discharges to South Meadow Brook using BMP 7R to address the Phosphorus and Pathogen TMDLs and BMP 7U to address impairments not covered by a TMDL. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. Additionally, no locations on MassDOT-owned property were identified for stormwater improvements related to discharges of South Meadow Brook.

The following table summarizes the total phosphorus and effective IC reductions proposed in South Meadow Brook's watershed:

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	2.6	7.0
Target Reduction	2.0	5.3
Reduction Provided in Proposed Conditions	0	0

As previously noted, an existing MassDOT project (MassDOT Project #606635) is currently under design along Needham Street in Newton. Opportunities for implementing BMPs to treat stormwater discharges from MassDOT roadways to South Meadow Brook will be evaluated through this programmed project. Following the completion of this project, the roadway will be turned over to the Town of Newton and no longer under the jurisdiction of MassDOT.

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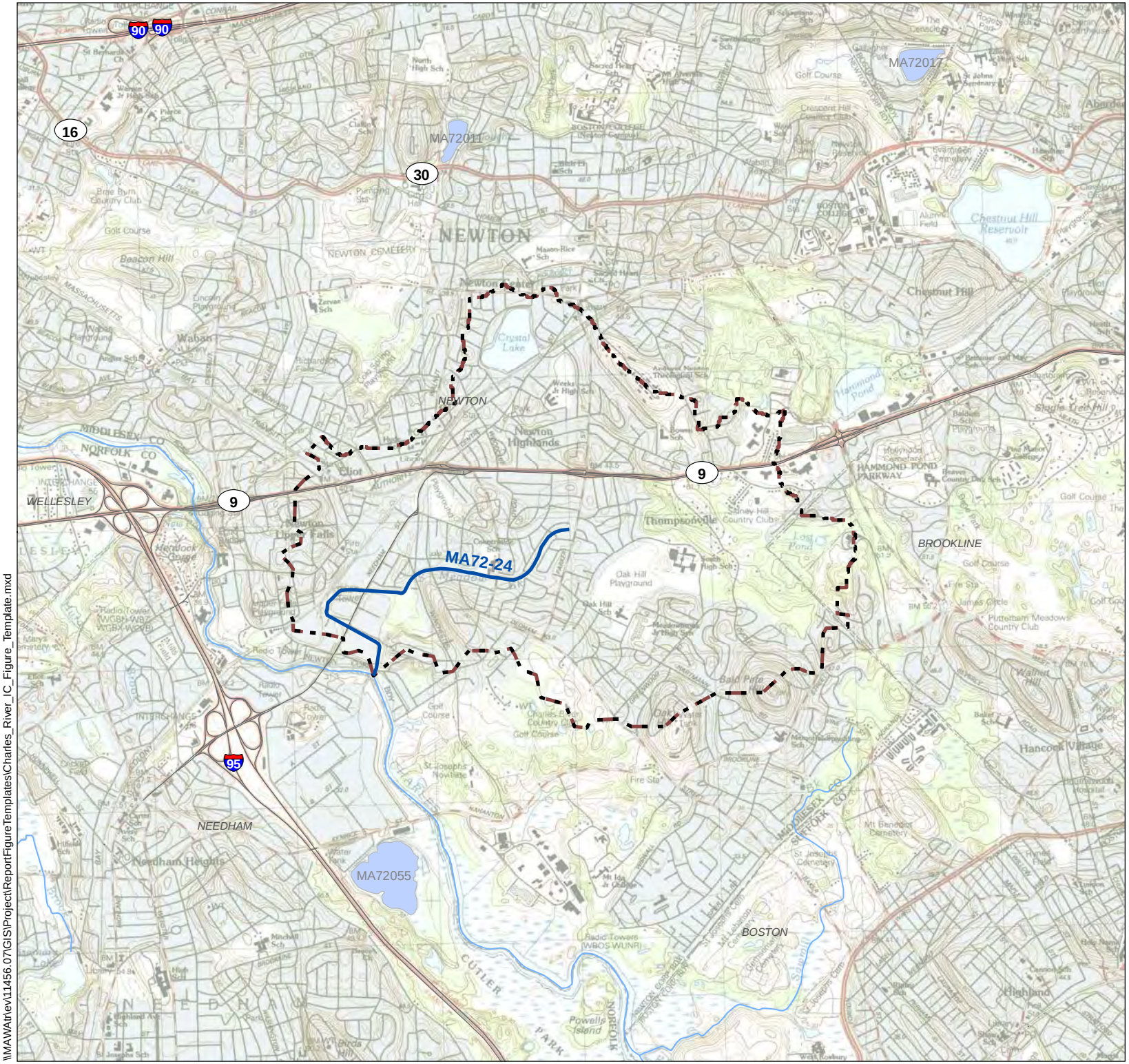

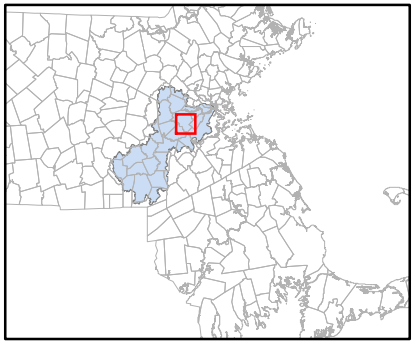

- Assessed Stream Segment
- Assessed Lake Segment
- Total Watershed
- Subwatershed
- Impaired Lakes
- Impaired Streams
- MassDOT Roadways

N

0 0.5 1 Miles

Figure 1

South Meadow Brook MA72-24 Watersheds

June 2012

massDOT Massachusetts Department of Transportation Highway Division

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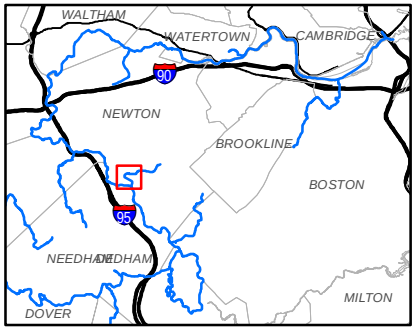

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 250 500 1,000 Feet

Figure 2

South Meadow Brook MA72-24 Directly Contributing MassDOT Watershed

June 2012

massDOT Massachusetts Department of Transportation Highway Division

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Impaired Waters Assessment for Rosemary Brook (MA72-25)

Impaired Waterbody

Name: Rosemary Brook

Location: Needham and Wellesley, MA

Water Body ID: MA72-25

Impairments

According to the MassDEP Final Year 2010 Integrated List of Waters, Rosemary Brook is listed under Category 5 as impaired for phosphorus (total) and dissolved oxygen.

Two TMDL reports have been finalized that address the Upper/Middle Charles River, which includes this subwatershed:

- *Final Nutrient TMDL Report for the Upper/Middle Charles River (Control Number (CN) 272.0,)* addressing the following impairments: phosphorus (total) and dissolved oxygen.
- *Final Pathogen TMDL Report for the Charles River Watershed (CN 0156.0)* (Although not impaired for pathogens, the segment is included in the pathogen TMDL as a low priority.)

The *Charles River Watershed 2002-2006 Water Quality Assessment Report* (MassDEP, 2008) lists the operation and maintenance of nearby golf courses, habitat modification associated with dams, baseflow depletion from groundwater withdrawals, and nonpoint sources from urban/residential areas as the main sources of impairments to this segment.

Relevant Water Quality Standards

- Water Body Classification: B
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
- 314 CMR 4.05 (3)(b) 1: *Dissolved Oxygen. a. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.*
- 314 CMR 4.05 (5)(c): *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 pursuant to 314 CMR 4.00. Any existing point*

source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

Summary

MassDOT has assessed stormwater impacts from MassDOT properties discharging to Rosemary Brook using BMP 7R to address the Phosphorus and Pathogen TMDLs. The following sections describe the methodology for these assessments. Based on this assessment, MassDOT determined that a 26 pound reduction in annual phosphorus loading would be needed to meet the targets of the watershed. See the Proposed Mitigation Plan section of this assessment for more information.

Reductions Applied to MassDOT Direct Watershed

	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	37
Target Reduction	26
Reduction Provided in Proposed Conditions	8.1

Site Description

Rosemary Brook is a tributary to the Charles River originating in Rosemary Pond, Needham. It generally flows to the north for 3.3 miles to its confluence with the Charles River in Wellesley (see Figure 1). From the outlet of Rosemary Pond, the Brook flows through a large wetland system, crosses into Wellesley, and then flows through an impoundment known as Longfellow Pond. From the outlet of Longfellow Pond, the Brook continues to flow northward and crosses beneath Worcester Street (Route 9) west of Cedar Street in Wellesley. Once north of Route 9, the Brook runs east (approximately parallel to Route 9) and then again turns north and crosses beneath Interstate 95 (Route 128). The Brook discharges to the Charles River shortly after crossing beneath Interstate 95. Although the headwaters of the Brook are within a relatively developed area of Needham, the Brook runs largely through conservation land within the Town of Wellesley. According to the *2002-2006 Water Quality Assessment Report*, the estimated percent impervious cover (IC) for this subwatershed is 19.0% and the primary land uses of the 3.8 square mile subwatershed are residential (54%), open land (19%), and forest (15%).

Route 9 in the vicinity of Rosemary Brook is a four-lane divided highway with a paved median and a paved sidewalk on each side of the road. The roadway is curbed and stormwater runoff is managed via a closed drainage system consisting of catch basins and reinforced concrete pipes that discharge to wetlands adjacent to the roadway or directly to the Brook itself. The right-of-way associated with Route 9 includes the sidewalks and a narrow grass strip on either side of the roadway, but does not include significant shoulders or other easements.

The Rosemary Brook watershed includes an approximately 1.0 mile segment of Route 9, extending from Cedar Street in the east to Bancroft Road in the west. The roadway profile drops from each

end toward the Brook crossing, approximately 0.4 miles west of Cedar Street. An area of commercial development is present near the Cedar Street interchange, and single-family residential neighborhoods are adjacent to the roadway west of the Brook. The remainder of the roadway is bordered by undeveloped conservation land including forested uplands, forested wetlands, and marshes. Two Town of Wellesley drinking water supply wells are present near the Brook and approximately 1,300 feet of Route 9 is located within the estimated Zone I wellhead protection areas associated with these wells. In addition, approximately 2,500 feet of Route 9 crosses the Zone II Wellhead Protection Area associated with these wells.

On December 13, 2011 and January 11, 2012, MassDOT's stormwater collection systems within the Rosemary Brook watershed were reviewed in the field. Based on data collected during the field visits, MassDOT determined that approximately 17.5 acres including 14.7 acres of IC along Route 9 and the Cedar Street interchange drain directly to Rosemary Brook. Figure 2 shows the MassDOT's directly contributing area.

The Route 9 drainage network that discharges to Rosemary Brook can be grouped into three major drainage areas. Runoff from the roadway near Cedar Street discharges to a swale near the Rosemary Well pump house. This swale flows north to connect with Rosemary Brook approximately 75 feet north of the roadway. The other two Route 9 drainage areas discharge via outfalls that penetrate the embankments of the Rosemary Brook culvert.

In addition to Route 9, MassDOT's direct drainage area includes the Cedar Street bridge and ramp system (Bridge W-13-015). Stormwater from this system of ramps and frontage roads is collected via catch basins and discharged to Rosemary Brook at the box culvert where the Brook crosses beneath the Cedar Street embankment, approximately 650 feet north of Route 9.

No best management practices (BMPs) are currently in place to manage runoff from the Cedar Street ramp system or the segment of Route 9 that drains to Rosemary Brook.

Assessment under BMP 7R for Impairments Addressed by Nutrients TMDL (CN 272.0)

The *Total Maximum Daily Load for Nutrients in the Upper/Middle Charles River, Massachusetts (CN 272.0)* addresses the impairments for this water body. MassDOT assessed the contribution of phosphorus from MassDOT properties to this water body using the approach described in BMP 7R of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have been addressed by a TMDL.

Pollutant of Concern: Phosphorus

1) Impairments Addressed: dissolved oxygen, phosphorus
2) Applicable Waste Load Allocation (WLA): See Table ES-3 Phase III Final Report.
    a) Description of Associated Land Use: Transportation
    b) Transportation Land Use Current Load (TP): 2,167 kilograms per year (kg/yr)
    c) Transportation Land Use WLA (TP): 759 kg/yr
    d) Commercial/Industrial/Transportation Area in Watershed: 15.9 sq miles or 5.9% (reported in Phase III Calibration Report Table 5. Transportation not separated from Commercial/Industrial during TMDL analysis)
    e) Commercial/Industrial/Transportation Land Use Areal WLA: 0.72 kilograms per hectare per year (kg/ha/yr) (0.64 pounds per acre per year (lbs/ac/yr)) (calculated)

3) Applicable Recommendations: Section 7.2 Phase III Final Report

   a) Management of Stormwater systems - Page 83 Phase III Final Report

      i) "Comprehensive programs will be necessary to achieve the phosphorus reduction and water quality goals of this TMDL. Programs should build upon existing stormwater management to accomplish the following tasks:

         (1) characterize the drainage areas that contribute to discharges requiring permit coverage under the Permittee's jurisdiction

         (2) implement a comprehensive Illicit Discharge Detection and Elimination (IDDE) program

         (3) prioritize source areas for stormwater management and control

         (4) identify site-specific and regional opportunities for implementation of BMPs

         (5) include the necessary structural and non-structural BMPs that, upon implementation, will achieve reductions in phosphorus loadings from the NPDES covered drainage areas that are consistent with the phosphorus load reductions identified in this TMDL)

      ii) Management of illicit discharges to stormwater drainage systems"

For BMP 7R Phosphorus Assessment, MassDOT used a site-specific, continuous, long-term hydrologic and pollutant simulation model (the assessment model) to estimate annual median pollutant loads from its property and treatment through both existing and proposed BMPs, if present. The assessment model was run for a 10-year period using hourly Boston rainfall data to capture a range of meteorological conditions and estimate annual median pollutant loads. The pollutant loading portion of the assessment model was calibrated to match pollutant runoff data from the USGS Highway-Runoff Database (Version 1.0, September 2009). The assessment model directly evaluates BMP effects on hydrology (detention, infiltration) and pollutant loads (losses through infiltration, settling, filtration, and biological treatment). For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

The following table summarizes the assessment model results for the MassDOT directly contributing watershed discharging to Rosemary Brook for existing conditions.

Annual Watershed Phosphorus Loading under Existing Conditions

Watershed/ BMP ID	Watershed Size (Acres)	Pre- BMP Annual Load (pounds/year)	Post-BMP Annual Load (pounds/year)	Estimated Annual Removal Efficiency
Total Directly Contributing MassDOT Watershed	17.7	37	37	0%

The assessment model predicts that the median load from the MassDOT directly contributing watershed is approximately 37 pounds of phosphorus per year. Based on the TMDL, MassDOT's WLA is 0.72 kg/ha/yr (0.64 lbs/ac/yr) or 11 pounds of phosphorus for MassDOT's 17.7 acres of directly contributing watershed, requiring a reduction of 26 pounds of phosphorus per year.

BMP 7R Phosphorus Mitigation Plan

Under existing conditions, MassDOT's estimated directly contributing annual phosphorus load exceeds the TMDL WLA. To mitigate this load, MassDOT will implement stormwater BMPs to the maximum extent given site constraints.

This assessment has identified locations for potential stormwater BMPs and estimated their potential annual phosphorus removal performance. The Proposed Mitigation Plan section of this assessment describes the BMPs and their estimated load reduction performance.

Assessment under BMP 7R for Pathogens

The *Pathogen Total Maximum Daily Load (TMDL) for the Charles River Watershed (CN 0156.0)* covers Rosemary Brook. The TMDL states that sources of indicator bacteria in the Charles River Watershed were found to be many and varied. The TMDL lists sources as including failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals and direct overland stormwater runoff.

In addition, as stated on page 12 of the TMDL, *Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, stormwater drainage systems and associated stormwater culverts and outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.*

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by orders of magnitude within a given storm event (MassDEP, 2009). Therefore, it is difficult to predict stormwater pathogen concentrations with accuracy. Due to this difficulty, MassDOT is not conducting site specific assessments of loading at each location impaired for pathogens as part of this Retrofit Program. However, MassDOT recognizes that its roadways, especially in urbanized areas, contribute to the pathogen impairment of the Charles River Watershed and has performed a general assessment and developed a mitigation plan as described below.

BMP 7R Pathogens Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT has reviewed its existing programs and their consistency with the Pathogen TMDL for the Charles River Watershed recommendations as well as the draft EPA National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements for the North Coastal Watershed.

The Pathogen TMDL for the Charles River Watershed recognizes that mitigation for pathogen impairments is difficult to address and emphasizes the need for an iterative adaptive management approach. The Executive Summary of the TMDL, page xi, states:

> *TMDL implementation to achieve [the pathogen reduction goals] should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate stormwater runoff volume.*

The existing NPDES MS4 permit that covers MassDOT stormwater discharges does not provide guidance on what measures are necessary to comply with the Pathogen TMDL for the Charles River Watershed. The fact sheet for the draft permit for MS4 stormwater discharges for the North Coastal Watershed contains some guidance on what measures EPA has determined necessary to be consistent with the Pathogen TMDL for the Charles River Watershed. Page 36 of the fact sheet states:

> *Instead of a numeric limitation for bacteria, the draft permit includes requirements for MS4s to provide education to pet owners and owners of septic systems, to implement a comprehensive illicit discharge detection and elimination program that addresses not only sources of pathogens but also sources of phosphorus, and to implement programs to address water fowl. In addition, although entitled "Phosphorus Control Plan" most of the actions needed to develop and implement a successful PCP are also effective in supporting the achievement of the WLA for the Charles River pathogen TMDL.*

As discussed above, both the Pathogen TMDL for the Charles River Watershed and the draft North Coastal Watershed MS4 permit state that identification of illicit discharges and addressing stormwater volumes and pollutants, such as phosphorus, are the best approaches to mitigate the pathogen impairments. MassDOT has developed a mitigation plan, described below, to address the pathogen impairments using guidance from these two documents.

BMP 7R Pathogens Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review, and source control. The specific non-structural BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

Although not included in this permit term, MassDOT will be implementing a pet waste management program at its rest stops, including those that have discharges to pathogen impaired waters. In addition, MassDOT has requested to be covered under an Individual MS4 permit for the next permit term. A future individual permit may contain additional programmatic BMPs to address pathogens.

The structural BMPs that will be considered to reduce phosphorus loading and the effects of IC would also reduce pathogen loads. See the Proposed Mitigation Plan section of this assessment for more information on the specific BMPs proposed as part of this assessment. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations.

Proposed Mitigation Plan to Address Phosphorus and Dissolved Oxygen

In this preliminary assessment, MassDOT has identified six stormwater BMPs that may be implemented on MassDOT property to reduce annual phosphorus loads and mitigate the effect IC to address the Rosemary Brook impairments. These BMPs include three infiltration basins, two water quality swales, and one set of leaching catch basins. Figure 3 shows the BMPs and their estimated contributing drainage areas. These locations were chosen based on a cursory review of the drainage systems, topography, property lines, Zone II Wellhead Protection Zone, and other site constraints. According to the Massachusetts Stormwater Policy (2008), no stormwater BMPs may be located in Zone I areas and BMPs located in Zone II must include 44% total suspended solids (TSS) removal prior to discharging to an infiltration BMP. Retrofit BMPs are not recommended within the Route 9 right-of-way in the western portion of MassDOT's direct drainage area to Rosemary Brook due to the limited right-of-way width.

The Topographic Base Plan for the Cedar Street interchange performed for MassDOT in June of 2004 includes one-foot contours of the Cedar Street Ramp area provides useful information for determining potential BMPs locations. Detailed survey, complete utility location information, official property ownership, and soils evaluation information will influence the final selection and design of BMPs. Below is a description of these potential proposed BMPs followed by a table of their estimated phosphorus treatment performance.

PR-BMP 1, 2 and 3
BMPs 1, 2 and 3 are infiltration basins proposed in the infields of the Cedar Street/ Route 9 ramp system. They would be placed in flatter areas down-gradient of stormwater runoff from the impervious surfaces of the ramp system. From a preliminary review, it appears that stormwater runoff could be directed to these areas by either overland flow through openings in the curbing or by redirecting existing drainage pipes to the areas. For this assessment, proposed BMPs 1 and 2 are divided to avoid the Rosemary Brook culvert under Cedar Street and have been simulated with separate contributing watersheds with the larger drainage area directed to the smaller basin. However, during subsequent project design, another alternative may allow for collecting and treating additional runoff. Figure 3 shows the rough size of the BMPs to achieve 68-100% reduction of phosphorus loads on an annual median basis.

PR-BMP 4 and 5
BMPs 4 and 5 are proposed water quality swales within the infield areas of the Cedar Street/Route 9 ramp system where the topography is gently sloping and would not be able to accommodate a large stormwater treatment area. From a preliminary review, it appears that stormwater runoff from additional areas of the interchange could be directed to these water quality swales by overland flow through openings in the curbing. To provide infiltration, the water quality swales would require impervious checkdams and/or outlet controls. Based on the assessment calculations, a 2-foot depth and 6-foot width would provide storage for significant infiltration and water quality treatment on annual median conditions.

PR-BMP 6
BMP 6 includes a series of proposed leaching catch basins. NRCS soils data shows that the MassDOT property consists of Hydrologic Soil Group C soils (poor to moderately draining soils) but also shows that the area just outside of the MassDOT right-of-way north of Route 9 and west of the Cedar Street interchange have Hydrologic Soil Group A soils, indicating higher infiltration rates. Therefore, leaching catch basins are recommended in this area to treat stormwater runoff from the roads in the area that cannot be directed to one of the other proposed BMPs. Leaching basins could be installed as additions to the existing drainage system at the existing catch basins or manholes. Alternatively, leaching basins could be placed off line of the existing drainage pipes collecting water from Cedar Street immediately south of the interchange, a portion of Route 9, and the Worcester Street Branch, and convey it west to the ultimate outfall to Rosemary Brook.

Alternatively, one large leaching basin could be constructed underneath the small median where several existing drain lines converge. The basins would provide a prescribed amount of infiltration and excess flow would be drained by the existing system and outfall.

The existing conditions assessment model was modified to develop a proposed conditions simulation including the existing and proposed BMPs, estimated potential contributing drainage areas, and rough sizing of the proposed BMPs. The table below shows the proposed BMPs, including their respective MassDOT drainage areas and estimated phosphorus load reductions. The assessment model identifies each BMP by unique ID, which is included in the table below.

Proposed Mitigation

Watershed/ BMP ID (Unique ID)	BMP Type	Estimated Contributing Watershed Phosphorus Load Pre-BMP (pounds/year)	Estimated Percent Reduction	Estimated Phosphorus Load Reduction (pounds/year)
PR BMP-1 (54.7)	Infiltration Basin	0.9	68%	1.4
PR BMP-2 (9.7)	Infiltration Basin	0.7	100%	0.7
PR BMP-3 (34.6)	Infiltration Basin	1.8	98%	2.1
PR BMP-4 (35.6)	Water Quality Swale	0.6	89%	0.1
PR BMP-5 (49.7)	Water Quality Swale	0.4	96%	0.5
PR BMP-6 (56.7)	Leaching Catch Basins	2.8	68%	3.2
Total				**8.1***

* Total phosphorus load reduction based on the assessment model results for the total MassDOT directly discharging drainage area to the receiving water (not sum of individual BMP reductions).

The proposed BMPs would result in an estimated 8.1 pounds of phosphorus reduction on an annual median basis resulting in a total annual load of 29 pounds, compared to the WLA of 11 pounds.

In addition, MassDOT will continue to ensure proper non-structural BMPs are being implemented within the watershed of Rosemary Brook, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to Rosemary Brook using BMP 7R to address the Phosphorus and Pathogen TMDLs. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. MassDOT proposes to install six BMPs to reduce MassDOT's contribution to the Rosemary Brook impairments.

The following table summarizes the total annual phosphorus reductions proposed in Rosemary Brook's watershed:

Reductions Applied to MassDOT Direct Watershed

	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	37
Target Reduction	26
Reduction Provided in Proposed Conditions	8.1

The proposed BMPs would reduce median annual phosphorus loads by 8.1 lbs, which is less than the target reduction to meet the TMDL's WLA. During the design phase of the proposed BMPs, MassDOT will evaluate soil conditions along Route 9 to determine if other areas within the direct drainage area would be supportive of infiltration and therefore also leaching catch basins.

MassDOT will proceed to the design phase to develop design and construction plans for the proposed BMPs as part of the MassDOT Impaired Waters Program. The designers will gather additional information in this phase, such as soil data and site survey to further refine the proposed BMPs. Once the design of the proposed BMPs is finalized, MassDOT will provide an update with additional information and summarize the final phosphorus redetection based on the as-built condition. MassDOT will continue to implement non-structural BMPs that reduce potential nutrient and sediment loading.

MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted as programmed projects for the area. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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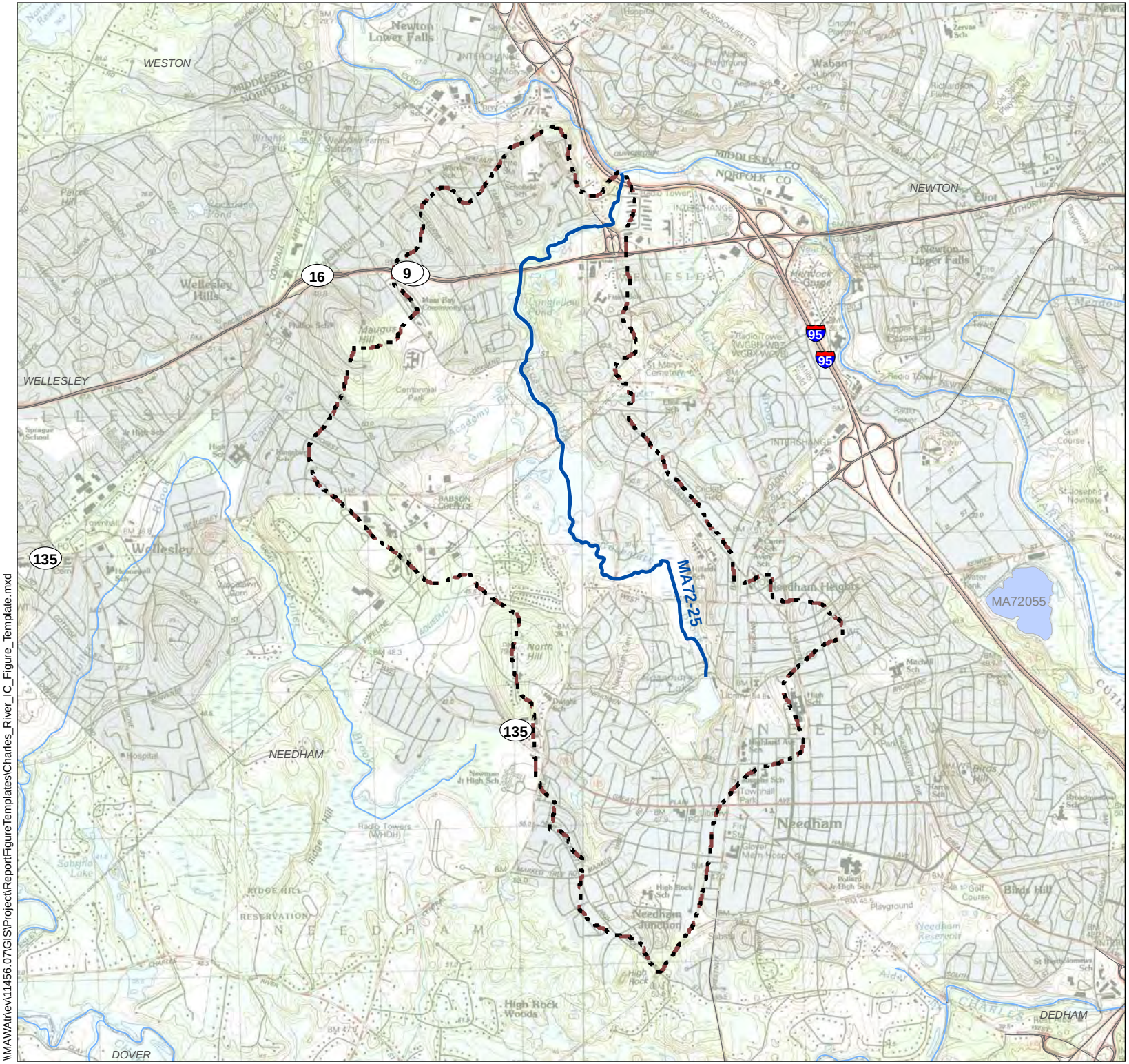

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Figure 1

Rosemary Brook MA72-25 Watersheds

June 2012

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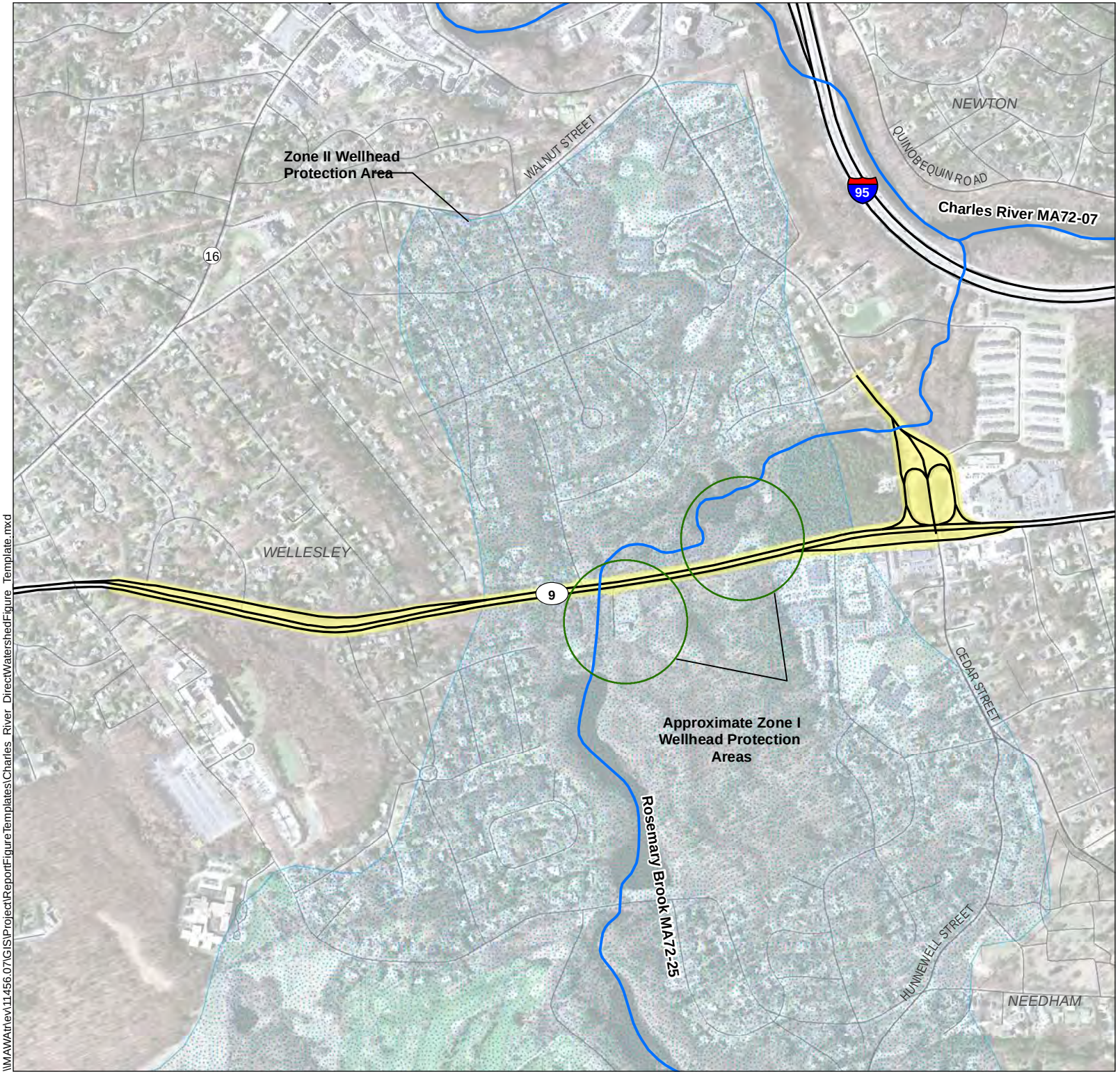
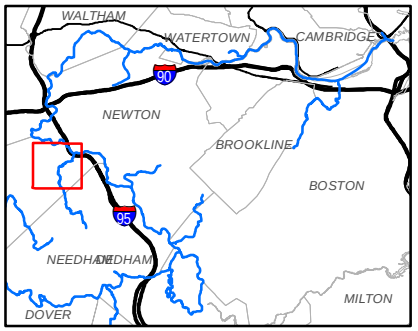
Massachusetts Department of Transportation
Highway Division





Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 375 750 1,500 Feet

Figure 2

Rosemary Brook
MA72-25
Directly Contributing
MassDOT Watershed

June 2012

massDOT
Massachusetts Department of Transportation
Highway Division

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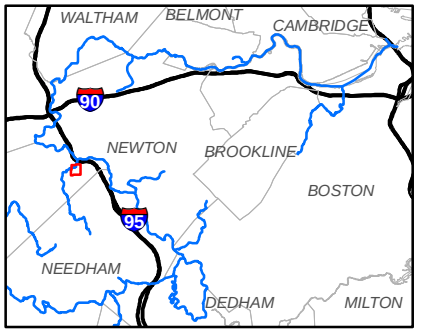

Impaired Streams

Impaired Waters

Proposed BMPs

Proposed BMP Watersheds

MassDOT Roadways

N

0 75 150 300 Feet

Figure 3

Rosemary Brook
MA72-25

Proposed BMPs

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Impaired Waters Assessment for Cheese Cake Brook (MA72-29)

Impaired Waterbody

Name: Cheese Cake Brook

Location: Newton, MA

Water Body ID: MA72-29

Impairments

According to the MassDEP Final Year 2010 Integrated List of Waters, Cheese Cake Brook is listed under Category 5 as impaired for alteration in stream-side or littoral vegetative covers, dissolved oxygen saturation, other anthropogenic substrate alterations, Escherichia coli, excessive algal growth, and total phosphorus.

Two TMDL reports have been finalized that address the Upper/Middle Charles River, which includes this subwatershed.

- *Final Nutrient TMDL Report for the Upper/Middle Charles River (Control Number (CN) 272.0)* addressing the dissolved oxygen saturation, excess algal growth, and total phosphorus impairments.
- *Final Pathogen TMDL Report for the Charles River Watershed (CN0156.0)* addressing Escherichia coli impairment.

The *Charles River Watershed 2002-2006 Water Quality Assessment Report* (MassDEP, 2008) lists unspecified urban stormwater, channelization, and loss of riparian habitat as the main sources of impairments to this segment. Other sources of impairments in the subwatershed include unknown sources (possible illicit connections) and waterfowl.

Relevant Water Quality Standards

- Water Body Classification: B
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
- 314 CMR § 4.05 (3)(b)(1) – *Dissolved Oxygen. a. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.*

- 314 CMR § 4.05 (3)(b)(4) – *Bacteria.*
  a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
  b. for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;
- 314 CMR § 4.05 (5)(a) – *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 (5)(c) – *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 pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.*

Summary

MassDOT has assessed stormwater impacts from MassDOT properties discharging to Cheese Cake Brook using BMP 7R to address the Phosphorus and Pathogen TMDLs. MassDOT determined that some water body impairments for the Charles River segment MA72-29 are not related to stormwater runoff. Specific impairments unrelated to stormwater for this segment of the Charles River include alteration in stream-side or littoral covers and other anthropogenic substrate alterations. MassDOT has not included these impairments in this assessment as they are not caused by stormwater runoff.

The following sections describe the methodology for the assessments using BMP 7R. Based on this assessment, MassDOT determined that a 62 pound reduction in annual phosphorus loading would be needed to meet the targets of the watershed.

No existing stormwater best management practices (BMPs) are present to reduce annual phosphorus loads for MassDOT directly discharging properties. To reduce MassDOT's contribution to Cheese Cake Brook impairments, MassDOT proposes seven BMPs. These BMPs would provide 8.6 pound annual median phosphorus load reduction.

Reductions Applied to MassDOT Direct Watershed

	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	95
Target Reduction	62
Reduction Provided in Proposed Conditions	8.6

Site Description

Cheese Cake Brook is a tributary to the Charles River that originates south of Route 16 in Newton and generally flows first east then north for a total of 1.4 miles to its confluence with the Charles River (see Figure 1). The brook has been straightened and channelized for its entire length between the headwaters and the Charles River. According to the *2002-2006 Water Quality Assessment Report*, the estimated percent impervious cover (IC) for this subwatershed is 32.2% and the primary land uses of the 2.7 square mile subwatershed are residential (71%), open land (16%), and transportation (4%).

MassDOT's directly contributing drainage area to Cheese Cake Brook consists of approximately 2.2 miles of Interstate 90 (I-90) from the railroad crossing just east of the former Weston toll plaza to the east and between Chestnut Street and Lowell Avenue to the west as well as a portion of the Interchange 16 ramp system (see Figures 2 and 3). I-90 in the vicinity of Cheese Cake Brook is a 6-lane divided highway with a paved median and a paved shoulder along a portion of each side of the highway. The entire westbound side of the highway is bordered by a railroad easement. A portion of the eastbound side of the highway is bounded by wooden sound barrier walls. The highway is curbed and stormwater runoff is managed by a closed drainage system consisting of catch basins and pipes that discharge directly to Cheese Cake Brook via one 4-foot by 5-foot box outfall. Drainage patterns along I-90 and the ramp system generally match the topography.

The MassDOT-owned portion of the Interchange 16 ramp system includes two small public parking lots. Stormwater runoff from the ramps and parking lots is directed via catch basins to closed drainage systems that also discharge directly to Cheese Cake Brook.

The total MassDOT tributary area to Cheesecake Brook is approximately 51 acres. The tributary area is predominantly impervious, with small disturbed pervious areas bordering the roadway; therefore, soil conditions do not have a significant impact on runoff patterns.

No BMPs are currently in place to manage runoff from the portion of I-90 or the Interchange 16 ramp system which drain to Cheese Cake Brook.

Assessment under BMP 7R for Impairments Addressed by Nutrients TMDL (CN 272.0)

The *Total Maximum Daily Load for Nutrients in the Upper/Middle Charles River, Massachusetts (CN 272.0)* addresses the dissolved oxygen saturation, excess algal growth, and phosphorus impairments for this water body. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT properties to this water body using the approach described in BMP 7R of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have been addressed by a TMDL.

Pollutant of Concern: Phosphorus

1) Impairment Addressed: dissolved oxygen saturation, excess algal growth, and phosphorus
2) Applicable Waste Load Allocation (WLA): See Table ES-3 Phase III Final Report.
    a) Description of Associated Land Use: Transportation
    b) Transportation Land Use Current Load (TP): 2,167 kilograms per year (kg/yr)
    c) Transportation Land Use WLA (TP): 759 kg/yr
    d) Commercial/Industrial/Transportation Area in Watershed: 15.9 sq miles or 5.9% (reported in Phase III Calibration Report Table 5. Transportation not separated from Commercial/Industrial during TMDL analysis)
    e) Commercial/Industrial/Transportation Land Use Areal WLA: 0.72 kilograms per hectare per year (kg/ha/yr) (0.64 pounds per acre per year (lbs/ac/yr)) (calculated)
3) Applicable Recommendations: Section 7.2 Phase III Final Report
    a) Management of Stormwater systems - Page 83 Phase III Final Report
        i) "Comprehensive programs will be necessary to achieve the phosphorus reduction and water quality goals of this TMDL. Programs should build upon existing stormwater management to accomplish the following tasks:
            (1) characterize the drainage areas that contribute to discharges requiring permit coverage under the Permittee's jurisdiction
            (2) implement a comprehensive Illicit Discharge Detection and Elimination (IDDE) program
            (3) prioritize source areas for stormwater management and control
            (4) identify site-specific and regional opportunities for implementation of BMPs
            (5) include the necessary structural and non-structural best management practices (BMPs) that, upon implementation, will achieve reductions in phosphorus loadings from the NPDES covered drainage areas that are consistent with the phosphorus load reductions identified in this TMDL)
        ii) Management of illicit discharges to stormwater drainage systems"

For BMP 7R Phosphorus Assessment, MassDOT used a site-specific, continuous, long-term hydrologic and pollutant simulation model (the assessment model) to estimate annual pollutant loads from its property and treatment through both existing and proposed BMPs, if present. The assessment model was run for a 10-year period using hourly Boston rainfall data to capture a range of meteorological conditions and estimate annual median pollutant loads. The pollutant loading portion of the assessment model was calibrated to match pollutant runoff data from the USGS Highway-Runoff Database (Version 1.0, September 2009). The assessment model directly evaluates BMP effects on hydrology (detention, infiltration) and pollutant loads (losses through infiltration, settling, filtration, and biological treatment). For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

The following table summarizes the assessment model results for the MassDOT directly contributing watershed discharging to Cheese Cake Brook for existing conditions.

Annual Watershed Phosphorus Loading under Existing Conditions

Watershed/ BMP ID	Watershed Size (Acres)	Pre- BMP Annual Load (pounds/year)	Post-BMP Annual Load (pounds/year)	Estimated Annual Removal Efficiency
Total Directly Contributing MassDOT Watershed	51	95	95	0%

The assessment model predicts that the annual median load from the MassDOT directly contributing watershed is approximately 95 pounds of phosphorus.

Based on the TMDL, MassDOT's WLA is 0.72 kg/ha/yr (0.64 lbs/ac/yr) or 33 pounds per year of phosphorus for MassDOT's directly contributing watershed.

BMP 7R Phosphorus Mitigation Plan

Under the existing conditions, MassDOT's estimated directly contributing annual phosphorus load exceeds the TMDL WLA. To mitigate this load, MassDOT will implement stormwater BMPs to the maximum extent practical give site constraints.

This assessment has identified locations for potential stormwater BMPs and estimated their potential phosphorus removal performance. The Proposed Mitigation Plan section of this assessment describes the BMPs and their estimated annual load reduction performance.

Assessment under BMP 7R for Pathogens

The *Pathogen Total Maximum Daily Load (TMDL) for the Charles River Watershed (CN 0156.0)* covers Cheese Cake Brook. The TMDL states that sources of indicator bacteria in the Charles River Watershed were found to be many and varied. The TMDL lists sources as including failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals and direct overland stormwater runoff.

In addition, as stated on page 12 of the TMDL, *Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, stormwater drainage systems and associated stormwater culverts and outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.*

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by orders of magnitude within a given storm event (MassDEP, 2009). Therefore, it is difficult to predict stormwater pathogen concentrations with accuracy. Due to this difficulty, MassDOT is not conducting site specific assessments of loading at each location impaired for pathogens as part of this Retrofit Program. However, MassDOT recognizes that its roadways, especially in urbanized areas, contribute to the pathogen impairment of the Charles River Watershed and has performed a general assessment and developed a mitigation plan as described below.

BMP 7R Pathogens Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT has reviewed its existing programs and their consistency

with the Pathogen TMDL for the Charles River Watershed recommendations as well as the draft EPA National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements for the North Coastal Watershed.

The Pathogen TMDL for the Charles River Watershed recognizes that mitigation for pathogen impairments is difficult to address and emphasizes the need for an iterative adaptive management approach. The Executive Summary of the TMDL, page xi, states:

> *TMDL implementation to achieve [the pathogen reduction goals] should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate stormwater runoff volume.*

The existing NPDES MS4 permit that covers MassDOT stormwater discharges does not provide guidance on what measures are necessary to comply with the Pathogen TMDL for the Charles River Watershed. The fact sheet for the draft permit for MS4 stormwater discharges for the North Coastal Watershed contains some guidance on what measures EPA has determined necessary to be consistent with the Pathogen TMDL for the Charles River Watershed. Page 36 of the fact sheet states:

> *Instead of a numeric limitation for bacteria, the draft permit includes requirements for MS4s to provide education to pet owners and owners of septic systems, to implement a comprehensive illicit discharge detection and elimination program that addresses not only sources of pathogens but also sources of phosphorus, and to implement programs to address water fowl. In addition, although entitled "Phosphorus Control Plan" most of the actions needed to develop and implement a successful PCP are also effective in supporting the achievement of the WLA for the Charles River pathogen TMDL.*

As discussed above, both the Pathogen TMDL for the Charles River Watershed and the draft North Coastal Watershed MS4 permit state that identification of illicit discharges and addressing stormwater volumes and pollutants, such as phosphorus, are the best approaches to mitigate the pathogen impairments. MassDOT has developed a mitigation plan, described below, to address the pathogen impairments using guidance from these two documents.

BMP 7R Pathogens Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review, and source control. The specific non-structural BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program

- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

Although not included in this permit term, MassDOT will be implementing a pet waste management program at its rest stops, including those that have discharges to pathogen impaired waters. In addition, MassDOT has requested to be covered under an Individual MS4 permit for the next permit term. A future individual permit may contain additional programmatic BMPs to address pathogens.

The structural BMPs that will be considered to reduce annual phosphorus loading would also reduce pathogen loads. See the Proposed Mitigation Plan section of this assessment for more information on specific BMPs proposed as part of this assessment. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations.

Proposed Mitigation Plan to Address Phosphorus

In this preliminary assessment, MassDOT has identified seven stormwater BMPs that may be implemented on MassDOT property to reduce annual phosphorus loads in order to address the Cheese Cake Brook impairments. These BMPs include six infiltration basins and one permeable pavement parking lot, shown with their estimated contributing drainage areas in Figure 4. These locations were chosen based on a cursory review of the drainage systems, topography, property lines, and other site constraints. Detailed survey, complete utility location information, official property ownership, and soils evaluation information will influence the final selection and design of BMPs. Below is a description of the proposed BMPs.

PR-01, 02, and 03
BMPs 01, 02, and 03 are infiltration basins proposed in the eastbound right-of-way of I-90. The three BMPs are proposed in open, flat, grassed areas between I-90 and the sound barrier walls. Based on this assessment, the infiltration basins could be 1 to 2 feet deep based on the available space and grading limitations of the right-of-way. Small storm event stormwater runoff from catch basins along I-90 could be directed to these basins with overflows continuing to be collected and discharged via the existing stormwater system.

PR-04, 05, and 06
BMPs 04, 05, and 06 are infiltration basins proposed in the eastern public parking lot within the Route 16/I-90 ramp system. The three BMPs are proposed in existing grassed areas surrounding the parking area. Based on this assessment, the infiltration basins could be 1 to 2 feet deep based on the space limitations of the ramp system. The infiltration basins would collect runoff from the ramp system that would otherwise have been directed to the Cheese Cake Brook culvert within the parking lot.

PR-07
BMP 07 is a permeable pavement parking lot proposed within the Route 16/I-90 ramp system. The existing public parking lot is flat and in need of repair making it a good candidate for restoration using permeable pavement. Runoff from the parking lot and surrounding grass slopes could infiltrate through the permeable pavement with large storm event runoff discharging to the existing drainage system.

The existing conditions assessment model was modified to develop a proposed conditions simulation including the proposed BMPs, estimated potential contributing drainage areas, and rough sizing of the proposed BMPs. The table below shows the proposed BMPs, including their respective MassDOT drainage areas, and estimated phosphorus reductions. The assessment model identifies each BMP by unique ID, which is included in the table below.

Proposed Mitigation

Watershed/ BMP ID (Unique ID)	BMP Type	Estimated Contributing Watershed Phosphorous Load Pre-BMP (Pounds/year)	Estimated Percent Reduction Phosphorus	Estimated Load Reduction Phosphorus (Pounds/year)
PR-01 (2.7)	Infiltration Basin	1.0	74%	0.8
PR-02 (6.7)	Infiltration Basin	1.1	98%	1.0
PR-03 (5.7)	Infiltration Basin	0.5	99%	0.5
PR-04 (8.7)	Infiltration Basin	1.4	88%	1.2
PR-05 (7.7)	Infiltration Basin	2.5	77%	1.9
PR-06 (3.7)	Infiltration Basin	0.6	87%	0.5
Pr-07 (9.7)	Pervious Pavement	4.2	98%	4.1
Total	**--**			**8.6***

* Total Phosphorus reduction based on assessment model results for the total MassDOT directly discharging drainage area to the receiving water (not sum of individual BMP reductions).

The proposed BMPs would result in an estimated 8.6 lbs of phosphorus reduction on an annual median basis resulting in a total annual load of 86 pounds, compared to the WLA of 33 pounds.

MassDOT will continue to ensure proper non-structural BMPs are being implemented within the watershed of Cheese Cake Brook, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to Cheese Cake Brook using BMP 7R to address the Phosphorus and Pathogen TMDLs. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. MassDOT proposes to install seven BMPs to reduce MassDOT's contribution to impairments within the Cheese Cake Brook watershed.

The following table summarizes the total annual phosphorus reductions proposed in Cheese Cake Brook's watershed:

Reductions Applied to MassDOT Direct Watershed

	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	95
Target Reduction	63
Reduction Provided in Proposed Conditions	8.6

The proposed BMPs would reduce phosphorus loads by 8.6 lbs/yr, which is less than the target but reflects the maximum amount practical given the limited undeveloped MassDOT right-of-way within the Cheese Cake tributary area.

MassDOT will proceed to the design phase to develop design and construction plans for the proposed BMPs as part of the MassDOT Impaired Waters Program. The project designers will gather additional information in this phase, such as soil data and site survey to further refine the proposed BMPs. For Cheese Cake Brook, the design effort is being progressed concurrently with this report. Once the design of the proposed BMPs is finalized, MassDOT will provide an update with additional information and summarize the final phosphorus and effective IC reduction based on the as-built condition. MassDOT will continue to implement non-structural BMPs that reduce potential nutrient and sediment loading.

As an overall program, MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted as programmed projects for the area. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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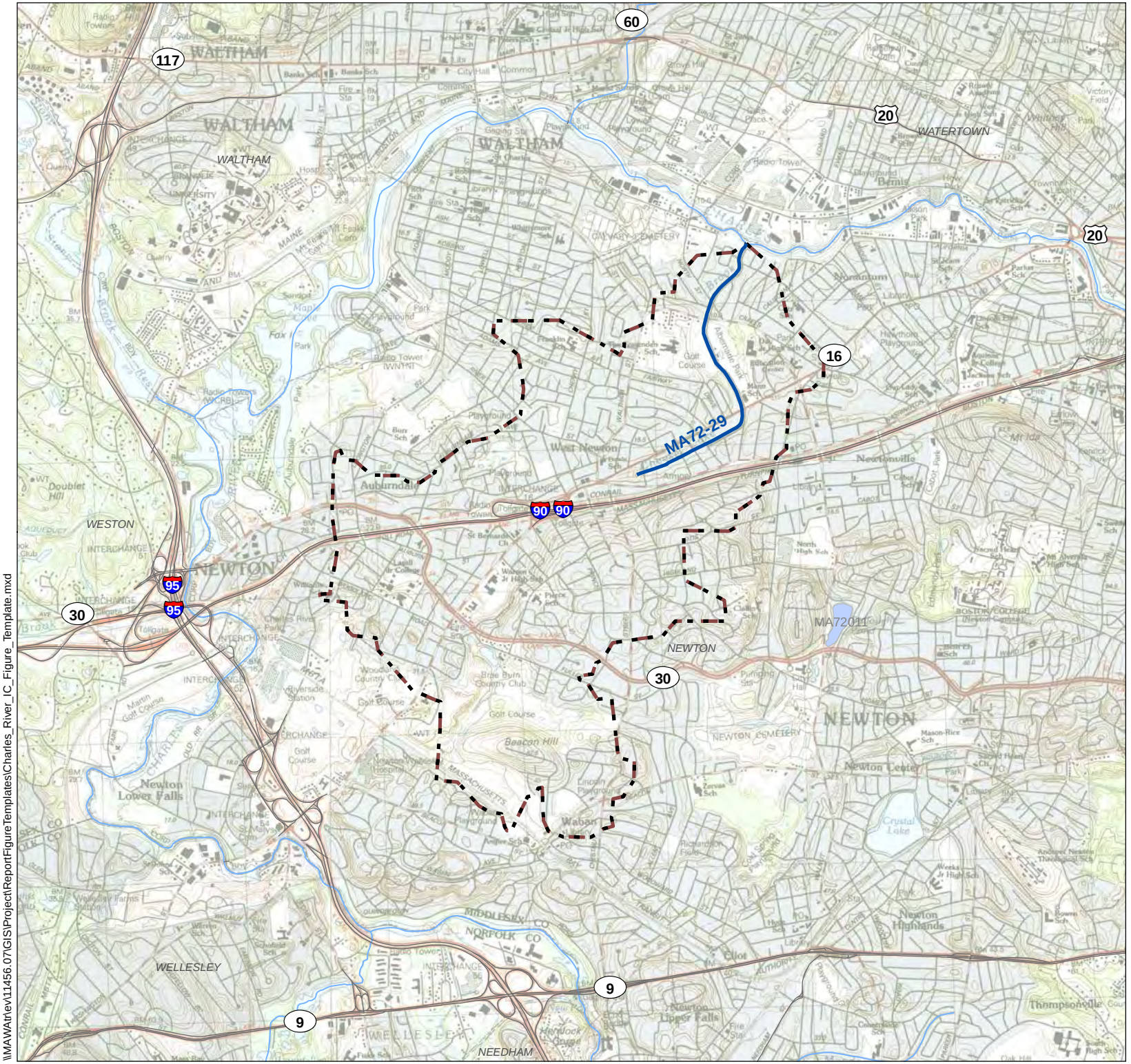

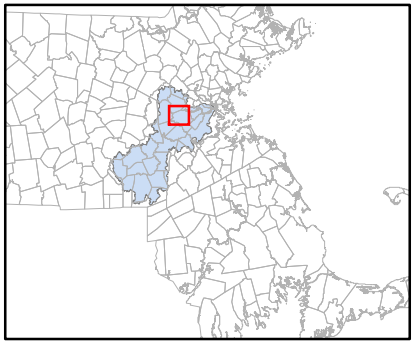

- Assessed Stream Segment
- Assessed Lake Segment
- Total Watershed
- Subwatershed
- Impaired Lakes
- Impaired Streams
- MassDOT Roadways

N

0 0.5 1 Miles

Figure 1

Cheese Cake Brook MA72-29 Watersheds

June 2012

massDOT Massachusetts Department of Transportation Highway Division

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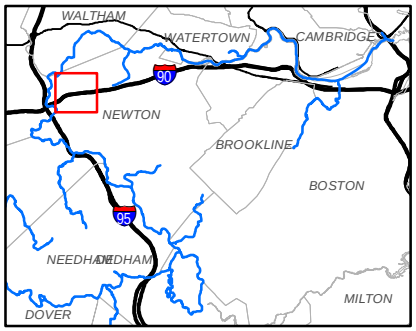

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 375 750 1,500 Feet

Figure 2

Cheese Cake Brook
MA72-29
Directly Contributing
MassDOT Watershed

June 2012

massDOT
Massachusetts Department of Transportation
Highway Division

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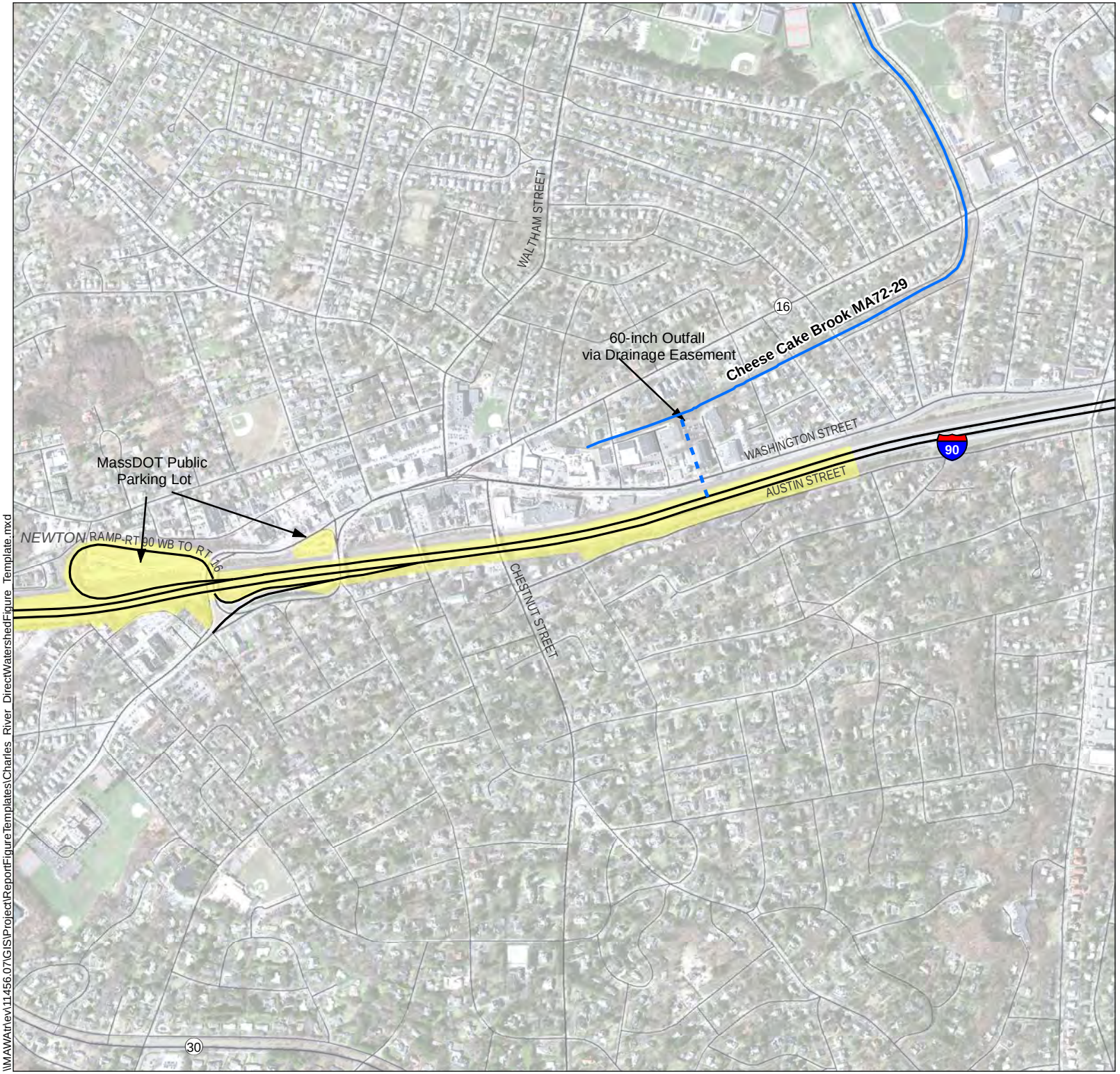

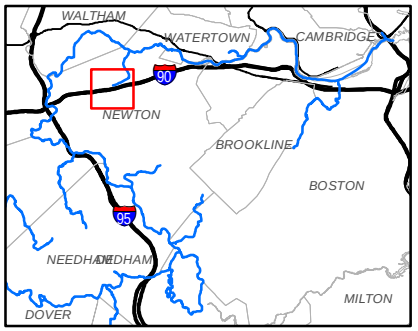

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 375 750 1,500 Feet

Figure 3

Cheese Cake Brook MA72-29 Directly Contributing MassDOT Watershed

June 2012

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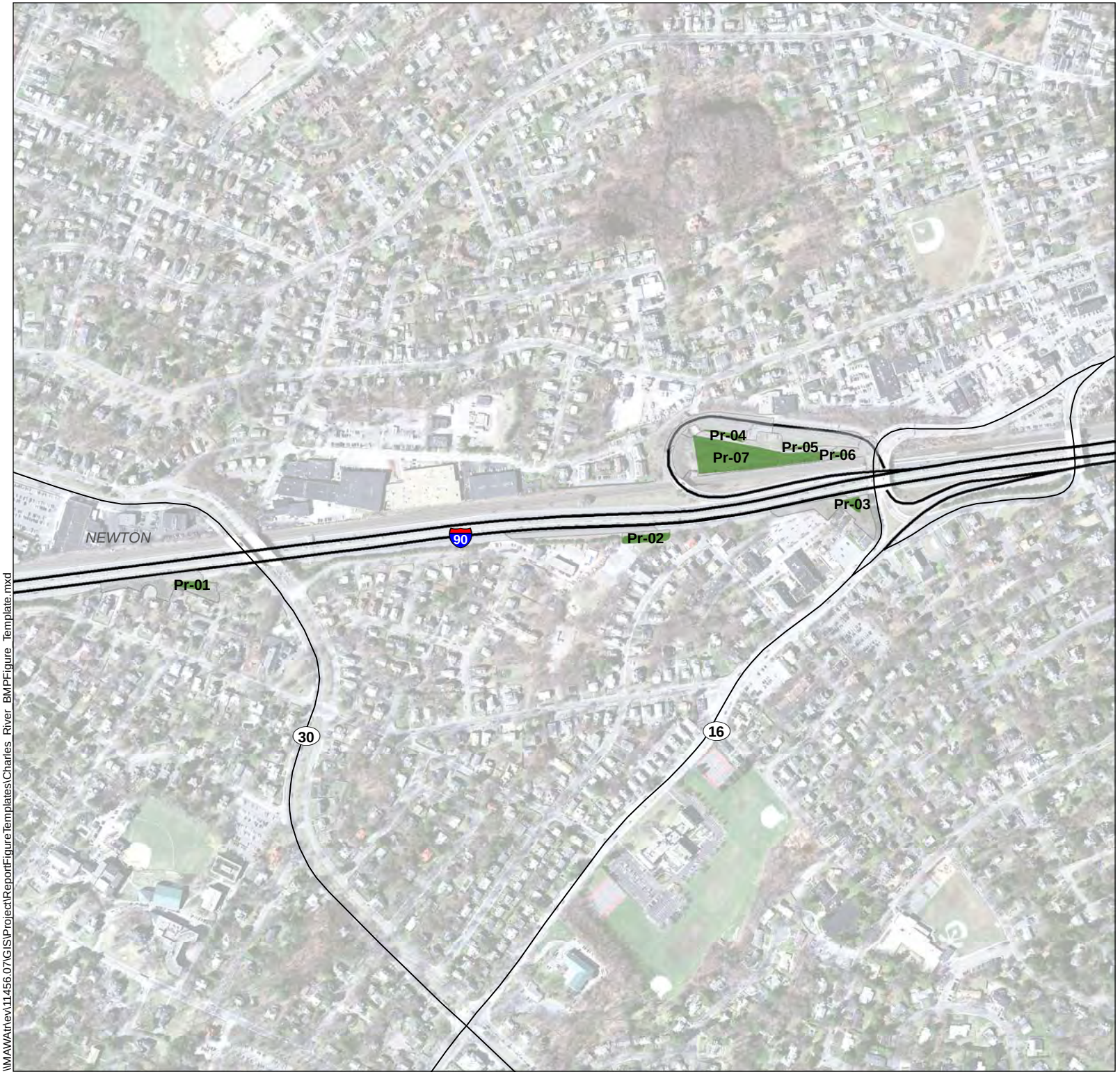

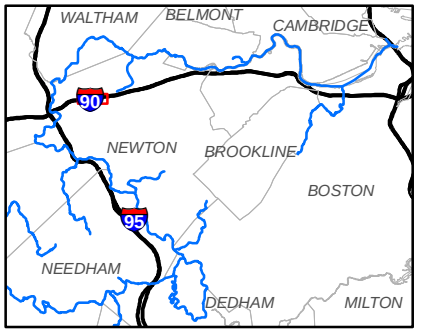

Impaired Streams

Impaired Waters

Proposed BMPs

Proposed BMP Watersheds

MassDOT Roadways

N

0 250 500 1,000 Feet

Figure 4

Cheese Cake Brook
MA72-29

Proposed BMPs

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Impaired Waters Assessment for Unnamed Tributary (Millers River) (MA72-31)

Impaired Waterbody

Name: Unnamed Tributary (Millers River)

Location: Boston and Cambridge, MA

Water Body ID: MA72-31

Impairments

According to the MassDEP Final Year 2010 Integrated List of Waters, the Unnamed Tributary (Millers River) is listed under Category 5 as impaired for foam/flocs/scum/oil slicks, habitat assessment (streams) polychlorinated biphenyls (PCBs), sedimentation/siltation, polycyclic aromatic hydrocarbons (PAHs), taste and odor, bottom deposits, other, and petroleum hydrocarbons.

A TMDL report has been finalized that addresses the Lower Charles River, which includes the Millers River subwatershed. The TMDL that has been finalized is the *Final Phosphorus TMDL Report for the Lower Charles River Basin* (*Control Number (CN) 301.0)*, which addresses the foam/flocs/scum/oil slicks, sedimentation/siltation, taste and odor, and bottom deposits impairments.

The *Charles River Watershed 2002-2006 Water Quality Assessment Report* (MassDEP, 2008) lists urban stormwater runoff, NPDES discharge(s) and discharges from municipal separate storm sewer systems among the main sources of impairments to this segment. Other sources of impairments in the subwatershed include sediment contamination, channelization, and the loss of riparian habitat.

Relevant Water Quality Standards

- Water Body Classification: B
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
- 314 CMR § 4.05 (3)(b)(5) – *Solids. These waters shall be free from floating, suspended and settleable solids in concentrations or 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 (3)(b)(6) – *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 (3)(b)(7) –*Oil and Grease. These waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.*

- 314 CMR § 4.05 (5)(a) – *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 (5)(b) – *Bottom Pollutants or Alterations. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.*
- 314 CMR § 4.05 (5)(e) - *Toxic Pollutants. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.*

Summary

MassDOT has assessed stormwater impacts from MassDOT properties discharging to Millers River using BMP 7R to address the Phosphorus TMDL and BMP 7U to address impairments not addressed by the TMDL. The following sections describe the methodology for these assessments. Based on this assessment, MassDOT determined that a 19.4 pound reduction in annual phosphorus loading and an 8.6 acre reduction in effective impervious cover (IC) would be needed to meet the targets of the watershed.

Presently, MassDOT's properties draining to Millers River do not include stormwater best management practices (BMPs). Although MassDOT has also concluded that site constraints and other factors limit the potential for MassDOT to install stormwater BMPs for runoff draining to Millers River, one small proposed BMP is included in this assessment. See the Proposed Mitigation Plan section of this assessment for more information.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	9.4	24.3
Target Reduction	8.6	19.4
Reduction Provided in Proposed Conditions	0.4	0.8

Site Description

Millers River is a tributary to the Charles River that originates in an underground culvert in the City of Somerville and generally flows to the south approximately 1,000 feet to its confluence with the Charles River in Charlestown (see Figure 1). From the culvert mouth, the river flows through a riprap lined channel with armored or sheet pile banks to its confluence with the Charles just upstream of the New Charles River Dam. The west bank is bordered by Boston Sand and Gravel Company and the east bank is bordered by MBTA tracks, the highway ramp from Rutherford Avenue to Route 1 Northbound, and the Leonard P. Zakim Bridge Underbridge Plaza. Several concrete bridge piers are located within its main channel. The river appears to be dominated by backwater from the Charles River, though the Water Quality Assessment Report states that there is some baseflow.

There are several stormwater outfalls to the Millers River. Interstate 93 (I-93) and Route 1 as well as the I-93/Route 1 interchange ramps appear to contribute to the outfalls, though the exact tributary area is unknown. This area is predominantly owned by MassDOT, MBTA, Boston Sand and Gravel Company, and the Department of Conservation and Recreation (DCR). Based on the development condition of the surrounding area, Millers River is assumed to have a nearly 100% impervious tributary area.

The estimated watershed, including MassDOT's property, is highly developed and intricate (see Figure 2). Stormwater plans for MassDOT's property in the area are not readily available and site inspections of the major highways and interchanges are not feasible without significant disruption to traffic. Based on a desktop review of available information, the potential for retrofit BMPs in the area is minimal due to the very limited right-of-way beyond existing travel lanes and available undeveloped space.

During a site visit several BMPs were noted, including:

- Dual chamber sheet pile settling basin located near the headwater along the Boston Sand and Gravel driveway.
- Stormceptor unit approximately 300 feet downstream of the headwater on the east bank which discharges to a 30-inch outfall.
- Several tiers of floating booms transversing the entire width of the river. The booms appear to be providing treatment as there is a noticeable improvement in water clarity between the upstream and downstream sides of the booms.

MassDOT identified one area for a potential new BMP. An approximately 2,000 square foot area between the Rutherford Ave/Route 1 ramp and the pedestrian walkway is currently a small gravel-lined depression with a catch basin in the center which could be retrofitted to provide treatment. See the **Proposed Mitigation Plan**.

Assessment under BMP 7R for Impairments Addressed by Phosphorus TMDL (CN 301.0)

The *Total Maximum Daily Load (TMDL) for Nutrients in the Lower Charles River, Massachusetts (CN 301.0)* addresses the foam/flocs/scum/oil slicks, sedimentation/siltation, taste and odor, and bottom deposits for this water body. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT properties to this water body using the approach described in BMP 7R of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have been addressed by a TMDL.

Pollutant of Concern: Phosphorus

1) Impairment Addressed: foam/flocs/scum/oil slicks, sedimentation/siltation, taste and odor, and bottom deposits
2) Applicable Waste Load Allocation (WLA): See Table ES-3 of the Final TMDL. As the Final TMDL does not specifically identify Transportation as a land use, MassDOT used the Commercial land use for this WLA analysis based on the conservative assumption that Transportation is most similar to Commercial land uses.
    a) Description of Associated Land Use: Commercial
    b) Commercial Land Use Current Load (TP): 3,676 kilograms per year (kg/yr)
    c) Commercial Land Use WLA (TP): 1,286 kg/yr
    d) Percent Load Reduction (TP): 65%
    e) Commercial Area in Watershed: 8.36 square miles or 2.7% (based on total watershed area of 308 square miles. Transportation not separated from Commercial/Industrial during TMDL analysis)
    f) Commercial Land Use Area WLA: 0.59 kilograms per hectare per year (kg/ha/yr) (0.53 pounds per acre per year (lbs/ac/yr)) (calculated)
3) Implementation Strategy Components: Section 6.2 Final Report
    a) Management of Stormwater from Drainage Systems – Pages 113-115 of the Final TMDL:
        i) "The development and implementation of comprehensive stormwater management programs throughout the Charles River watershed will be necessary to achieve the phosphorus reduction and water quality goals of this TMDL. The management program should accomplish the following tasks:
            (1) characterize the drainage areas that contribute to discharges requiring permit coverage under the Permittee's jurisdiction
            (2) implement a comprehensive Illicit Discharge Detection and Elimination (IDDE) program
            (3) prioritize source areas for control
            (4) include the necessary structural and non-structural best management practices (BMPs) that, upon implementation, will achieve reductions in phosphorus loadings from the NPDES covered drainage areas that are consistent with the phosphorus load reductions identified in this TMDL."

For BMP 7R Phosphorus Assessment, MassDOT used a site-specific, continuous, long-term hydrologic and pollutant simulation model (the assessment model) to estimate median annual pollutant loads from its property and treatment through both existing and proposed best

management practices (BMPs), if present. The assessment model was run for a 10-year period using hourly Boston rainfall data to capture a range of meteorological conditions and estimate annual median pollutant loads. The pollutant loading portion of the assessment model was calibrated to match pollutant runoff data from the USGS Highway-Runoff Database (Version 1.0, September 2009). The assessment model directly evaluates BMP effects on hydrology (detention, infiltration) and pollutant loads (losses through infiltration, settling, filtration, and biological treatment). For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

The following table summarizes the assessment model results for the MassDOT directly contributing watershed discharging to the Millers River for existing conditions.

Annual Watershed Phosphorus Loading under Existing Conditions

Watershed/ BMP ID	Watershed Size (Acres)	Pre- BMP Annual Load (pounds/year)	Post-BMP Annual Load (pounds/year)	Estimated Annual Removal Efficiency
Total Directly Contributing MassDOT Watershed	9.4	24.3	24.3	0%

The assessment model predicts that the annual median load of the MassDOT directly contributing watershed is approximately 24.3 pounds of phosphorus. No BMPs currently exist to treat MassDOT's property directly discharging to Millers River.

Based on the TMDL, MassDOT's WLA is 0.59 kg/ha/yr (0.53 lbs/ac/yr). The 9.4 acres of directly contributing MassDOT watershed equates to 4.9 pounds of phosphorus per year discharging from MassDOT's directly contributing watershed.

BMP 7R Phosphorus Mitigation Plan

Under existing conditions, MassDOT's estimated directly contributing annual phosphorus load exceeds the TMDL WLA. To mitigate this load, MassDOT will implement stormwater BMPs to the maximum extent given the site constraints.

This assessment has identified locations for potential stormwater BMPs and estimated their potential annual phosphorus removal performance. The Proposed Mitigation Plan section of this assessment describes the BMPs and their estimated annual load reduction performance.

Assessment for PAHs and Petroleum Hydrocarbons under BMP 7U

The Charles River phosphorus TMDL does not address all of Millers River's impairments, including PAHs and petroleum hydrocarbons. Therefore, MassDOT assessed the stormwater-related impairments not addressed by a TMDL using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have not been addressed by a TMDL.

MassDOT has identified a subset of water body impairments in the Charles River Watershed which are not related to stormwater runoff. The specific impairments unrelated to stormwater for Millers River are habitat assessment and polychlorinated biphenyls (PCBs). MassDOT has not included these impairments in this assessment as they are not caused by stormwater runoff.

For the stormwater-related impairments for this water body not covered by a TMDL, MassDOT used an application of EPA Region I's Impervious Cover (IC) Method described in EPA's Stormwater TMDL Implementation Support Manual (ENSR, 2006). MassDOT used this method to assess potential stormwater impacts on the impaired water and develop the target IC to ensure that stormwater is not the cause of the impairments. The IC Method relates an aquatic system's health (i.e., state of impairment) to the percentage of IC in its contributing watershed. This method is largely based on the work of the Center for Watershed Protection, which has compiled and evaluated extensive data relating watershed IC to the hydrologic, physical, water quality, and biological conditions of aquatic systems (Schueler, 2003). Water quality in tributary streams, rivers, lakes and ponds is a direct reflection of loading from the watershed (Wetzel, 2001); therefore the IC method can be used as a surrogate for pollutant loading when evaluating water quality impairments and their causes. Consistent with the findings of EPA and others, MassDOT concluded that when a watershed had less than 9% IC, stormwater was not the likely cause of the impairment.

MassDOT developed the target IC reduction using the approach outlined in *Description of MassDOT's Application of Impervious Cover Method in BMP 7U* (MassDOT, 2011). Since the development of the MassDOT Application of IC Method, MassDOT has further refined its approach to evaluate MassDOT's effective IC and BMP performance. For the Charles River basin, MassDOT used the long-term continuous simulation model (the assessment model) to estimate phosphorus loading and to estimate effective IC.

MassDOT estimated the effective IC of its contributing drainage area with existing and proposed stormwater BMPs by comparing the runoff and pollutant response of its drainage area to the response of simulated watersheds with equivalent area, but varying IC from 0 to 100% (simulated IC watersheds). The IC percentage of the watershed that produces a similar response to MassDOT's watershed was determined to be the effective IC of MassDOT's watershed. For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

The MassDOT IC method for the impaired waters of the Charles River basin includes the following steps:

1. Calculate the percent IC of the water body's entire contributing watershed (total watershed to downstream end of impaired segment) and that of the local watershed contributing directly to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body.
2. For subwatersheds with greater than 9% IC, calculate the amount of IC reduction needed to achieve 9%. For subwatersheds with less and 9% IC, perform no further analysis under BMP 7U.
3. Calculate percentage of IC in the MassDOT directly contributing drainage area.
4. Apply reduction of IC necessary for the subwatershed to achieve 9% to the MassDOT contributing drainage area as a target to address the stormwater impairments. Calculate resulting target IC for the MassDOT drainage area.
5. Run the assessment model with specific MassDOT drainage areas and BMPs to estimate:
    a. Flow and pollutant statistics for MassDOT's current drainage area including treatment though existing BMPs.
    b. Flow and pollutant statistics for target watershed (watershed with target percent IC) and simulated IC watersheds.

6. Compare MassDOT runoff and pollutant annual loading and flow statistics with target and simulated IC watersheds.
7. Locate additional stormwater BMPs to the maximum extent practicable and run the long-term simulation to quantify their performance.

BMP 7U Assessment

Using the approach described above, MassDOT calculated the following values for the total contributing watershed and the subwatershed of the impaired water (Millers River) to determine the IC target. The watershed to Millers River was approximated and assumed to be 100% impervious.

Watershed Impervious Cover

Watershed Area	23 acres (approximate)
Impervious Cover (IC) Area	23 acres (assumed)
Percent Impervious	100% (assumed)
IC Area at 9% Goal	2.1 acres
Target Reduction % in IC	91%

Since the watershed is greater than 9% impervious, the analysis indicates that stormwater is a likely contributor to the impairment. To meet the 9% effective IC target, the effective IC within the watershed needs to be reduced by 91%. Therefore, the effective IC of MassDOT's directly contributing area also should be reduced by the same percentage to meet the target. The following table shows the resulting targets for MassDOT's contributing property.

Reductions Applied to MassDOT Direct Watershed

MassDOT's Area Directly Contributing to Impaired Segment	9.4 acres
MassDOT's IC Area Directly Contributing to Impaired Segment	9.4 acres
MassDOT's Percent Impervious	100%
MassDOT's Target Reduction in Effective IC (91% of DOT Directly Contributing IC)	8.6 acres
Target Effective IC	9 %

MassDOT's directly contributing area includes 9.4 acres of IC, which is 100% of total contributing area. To meet the target reduction of effective IC, MassDOT should mitigate 8.6 acres of effective IC. Equivalently, MassDOT's contributing drainage area should act as a watershed of 9% IC.

There are no existing BMPs to mitigate the effects of IC.

BMP 7U Mitigation Plan

Under existing conditions, MassDOT's estimated effective IC exceeds the target as described above. To mitigate this load, MassDOT will implement stormwater BMPs to the maximum extent given site and cost constraints.

This assessment has identified locations for potential stormwater BMPs and estimated their potential effective IC reduction performance. The Proposed Mitigation Plan section of this assessment describes the BMPs and their estimated effective IC reduction performance.

Proposed Mitigation Plan to Address Phosphorus, PAHs and Petroleum Hydrocarbons

In this preliminary assessment, MassDOT has identified one potential stormwater BMP that may be implemented on MassDOT property to reduce phosphorus loads and mitigate the effective IC to address the Millers River impairments. The proposed BMP includes an extended detention basin shown with its estimated contributing drainage areas in Figure 3. This location was chosen based on a preliminary review of the drainage systems, topography, property lines, and other site constraints. Detailed survey, complete utility location information, official property ownership, and soils evaluation information will influence the final selection and design of BMPs. Below is a description of the potential proposed BMP.

PR-BMP 1
Proposed BMP 1 is an extended detention basin located in an existing gravel area surrounded by concrete barriers beneath the Leonard P. Zakim Bridge adjacent to the Bridge's Underbridge Plaza between the I-93 south onramp from Route 99 and the Adamski Memorial Highway (Route 1) ramp. Based on the preliminary review of the site, the BMP could collect a diverted portion of the runoff from the Adamski Memorial Highway (Route 1) stormwater collection pipe.

The existing conditions assessment model was modified to develop a proposed conditions simulation including the proposed BMP, estimated potential contributing drainage areas, and rough sizing of the proposed BMP. The table below shows the proposed BMP, its MassDOT drainage areas, and estimated phosphorus and effective IC reductions. The output from the assessment model showing effective IC analysis for the BMP is attached. The assessment model identifies each BMP by a unique ID, which is included in the table below.

Proposed Mitigation

Watershed/ BMP ID	BMP Type	Estimated Watershed Load Pre-BMP		Estimated Percent Reduction		Estimated Load Reduction	
		Effective IC Acres	Phosphorus Pounds/year	Effective IC	Phosphorus	Effective IC Acres	Phosphorus Pounds/year
PR BMP-1 (58.7)	Extended Detention Basin	0.33	0.91	85%	95%	0.3	0.8
Total *						**0.4**	**0.8**

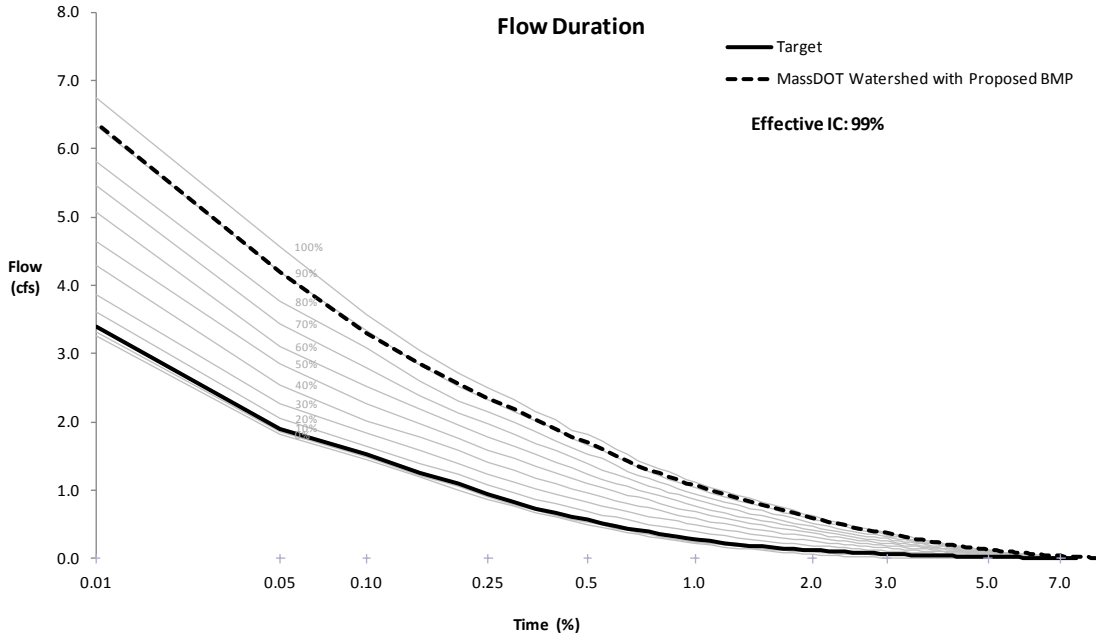
* Total Effective IC and phosphorus load reduction based on the assessment model results for the total MassDOT directly discharging drainage area to the receiving water (not sum of individual BMP reductions).

The proposed BMP would result in an estimated 0.8 pounds of phosphorus reduction on an annual median basis resulting in a total annual load of 23.5 pounds, compared to the WLA of 4.9 pounds.

MassDOT used the assessment model to simulate the MassDOT directly contributing watershed and proposed BMP for this segment of the Charles River. The assessment model also simulated watersheds with the same area as the MassDOT watershed but with varying percentages of IC from 0 to 100% (simulated IC watersheds). The results of the simulated IC watersheds are used as "benchmarks" to determine effective IC of the MassDOT directly contributing watershed. The annual median runoff volume, phosphorus and total suspended solids (TSS) loads, and flow duration for the MassDOT watershed were compared to those results for the simulated IC watersheds to determine, (based on similar runoff and load responses) the equivalent or effective impervious cover of the MassDOT watershed with BMPs treating a portion of the runoff. The graph and table below summarize assessment model results for the MassDOT directly contributing drainage area including the impacts of the proposed BMPs, along with the simulated IC watersheds.

Proposed Median Annual Load Comparisons

Simulated IC Watersheds	Runoff (ac-ft)	P (lb.)	TSS (lb.)
0% IC	6.8	0.5	33
5% IC	8.0	0.8	163
Target 9%	**9.0**	**1.1**	**309**
10% IC	9.2	1.2	345
20% IC	11.5	2.4	954
30% IC	13.9	4.2	1,946
40% IC	16.2	6.6	3,285
50% IC	18.5	9.5	4,921
60% IC	20.7	12.6	6,711
70% IC	23.0	15.8	8,518
80% IC	25.3	19.0	10,319
90% IC	27.6	22.1	12,076
100% IC	29.9	25.3	13,862
Existing Conditions	29.5	24.3	13,336
Proposed Conditions	28.8	23.5	12,874
Reduction %	2%	3%	3%
Effective IC	96%	95%	94%



Effective IC Results

Existing Estimated Effective IC	9.4 ac
Proposed Estimated Effective IC	9.0 ac
IC Reduction % with Proposed BMPs	4%
Estimated Effective IC*	96%

*Average of estimated Effective IC for annual median runoff volume, phosphorus and TSS loads, and flow duration

MassDOT estimated the effective IC under proposed conditions as 96% by comparing the annual median runoff volumes, phosphorus and TSS loads, and flow distribution statistics (flow duration) from MassDOT drainage area to the receiving water to those results for simulated IC watersheds. The proposed BMPs mitigate an estimated 0.4 acres of IC, resulting in 9.0 acres of IC for the MassDOT direct watershed.

MassDOT will continue to ensure proper non-structural BMPs are being implemented within the watershed of Millers River, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education.

In addition, BMP implementation through MassDOT's programmed projects are carefully evaluated and implemented where practicable, and documented through the MassDOT Water Quality Data Form. The potential for BMPs outside of MassDOT property will be reviewed during the design phase of these projects and through ongoing partnerships with other state and local entities. During this assessment analysis, potential BMPs beyond the scope of the impaired waters program were identified and can be reviewed during future projects.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to Millers River using BMP 7R to address the Phosphorus TMDL and BMP 7U to address impairments not covered by a TMDL. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. MassDOT proposes to install one BMP to reduce MassDOT's contribution to the Millers River impairments.

The following table summarizes the total phosphorus and effective IC reductions proposed in the Millers River's watershed:

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	9.4	24.3
Target Reduction	8.6	19.4
Reduction Provided in Proposed Conditions	0.4	0.8

The proposed BMP will result in a reduction in annual phosphorus loading by 0.8 lbs, which is less than the target reduction to meet the TMDL's WLA. The proposed BMP will also result in a reduction of effective IC of 0.4 acres.

MassDOT will proceed to the design phase to develop design and construction plans for the proposed BMP as part of the MassDOT Impaired Waters Program. The designers will gather additional information in this phase, such as soil data and site survey to further refine the proposed BMP. Once the design of the proposed BMP is finalized, MassDOT will provide an update with additional information and summarize the final phosphorus redetection based on the as-built condition. MassDOT will continue to implement non-structural BMPs that reduce potential nutrient and sediment loading.

MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted as programmed projects for the area. Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide

additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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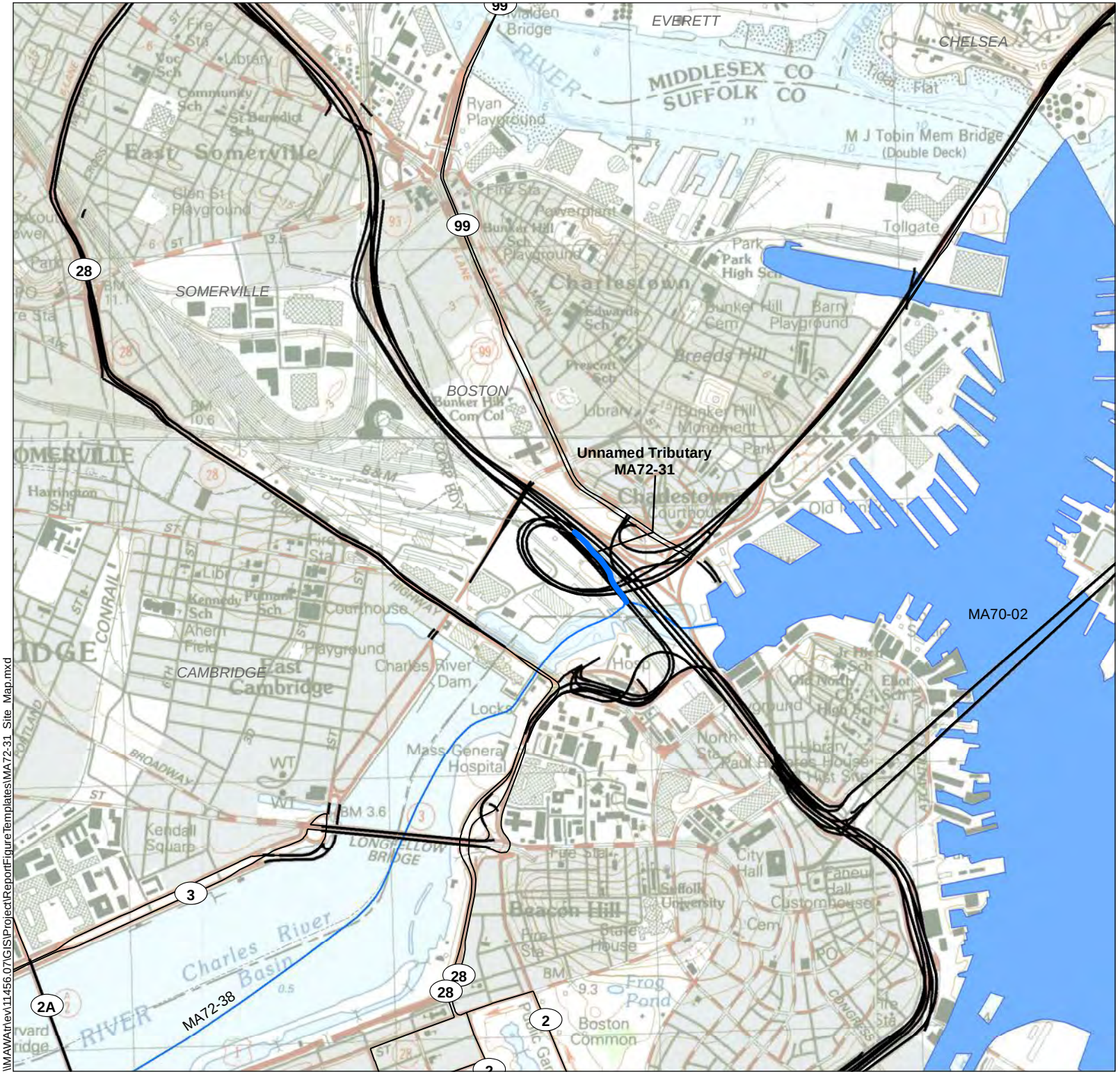

MassDOT Roadways

Impaired Waters

Impaired Streams

N

0 0.125 0.25 0.5 Miles

Figure 1
Locus Map

Charles River
MA72-31

June 2012

massDOT
Massachusetts Department of Transportation
Highway Division

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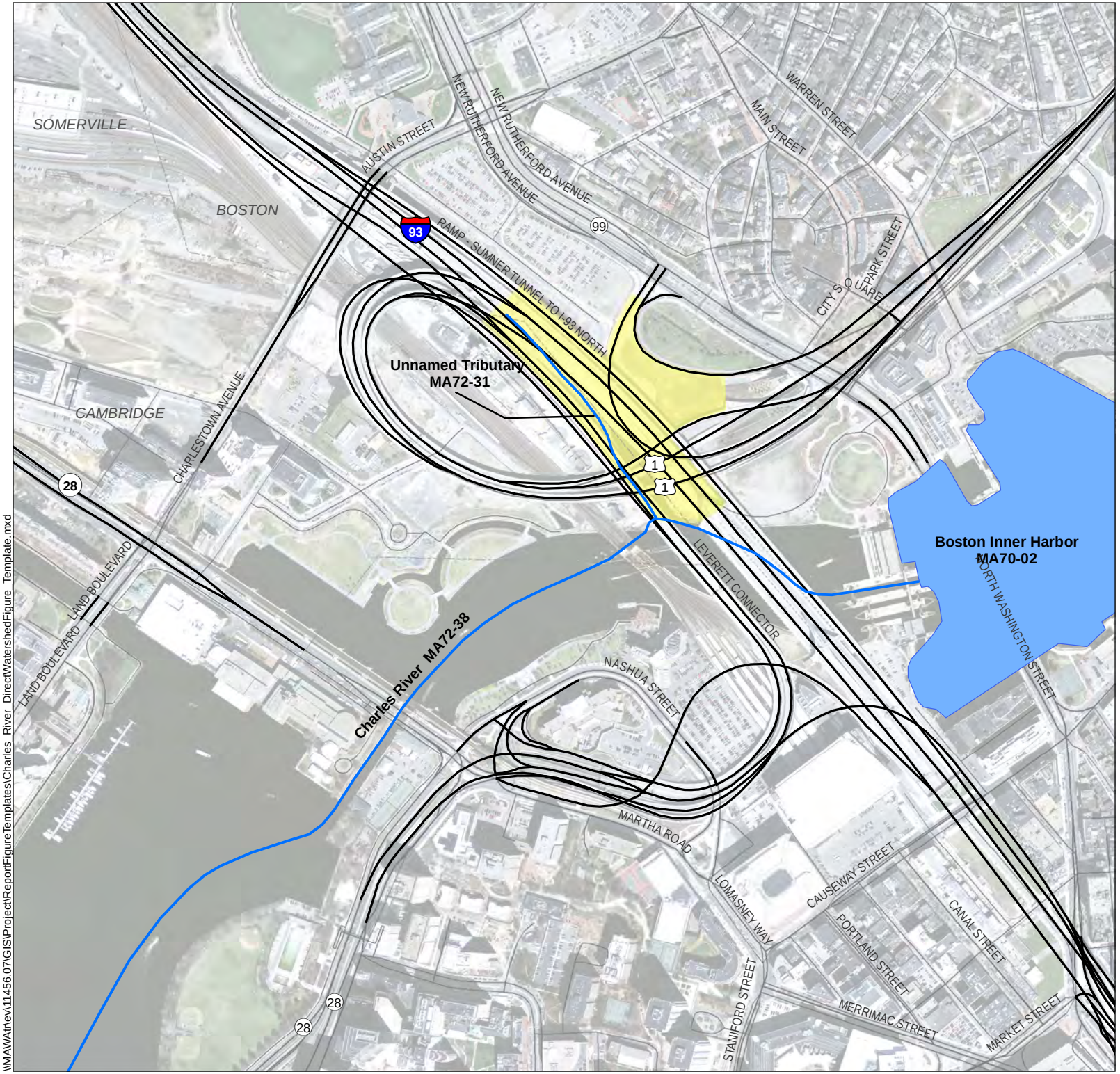

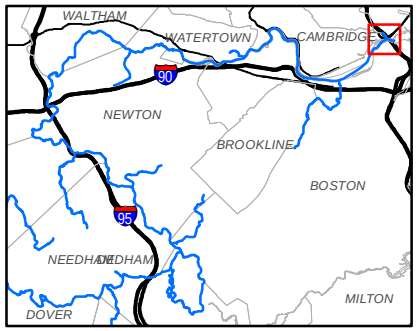

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 250 500 1,000 Feet

Figure 2

Unnamed Tributary MA72-31 Directly Contributing MassDOT Watershed

June 2012

massDOT Massachusetts Department of Transportation Highway Division

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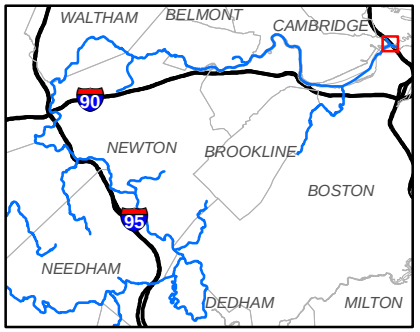

Impaired Streams

Impaired Waters

Proposed BMPs

Proposed BMP Watersheds

MassDOT Roadways

N

0 125 250 500 Feet

Figure 3

Unnamed Tributary MA72-31

Proposed BMPs

June 2012

massDOT Massachusetts Department of Transportation Highway Division

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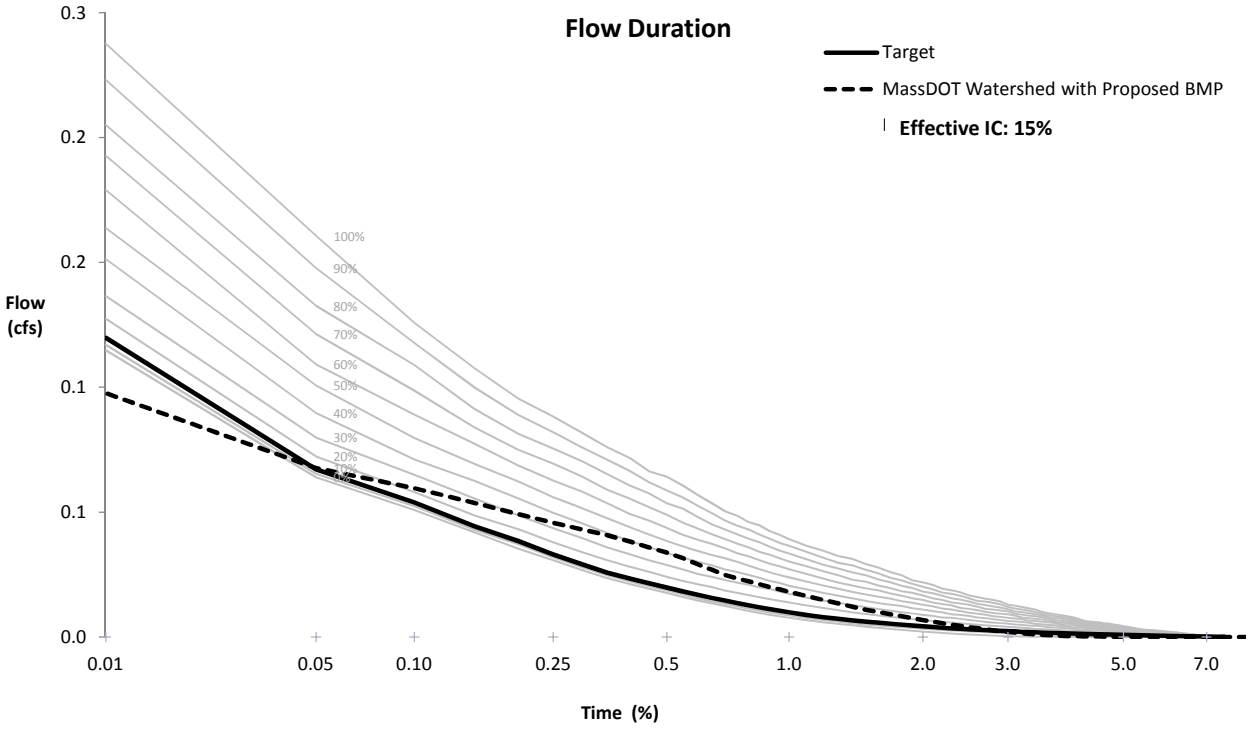
MA 72-31 Assessment Mode Result Summary for Impervious Cover
BMP 58.7



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.2	0.0	1
5%IC	0.3	0.0	6
10% IC	0.3	0.0	12
20% IC	0.4	0.1	34
30% IC	0.5	0.1	69
40% IC	0.6	0.2	116
50% IC	0.7	0.3	174
60% IC	0.7	0.4	237
70% IC	0.8	0.6	300
80% IC	0.9	0.7	364
90% IC	1.0	0.8	426
100% IC	1.1	0.9	489
Watershed Load	1.04	0.86	470
BMP Output	0.40	0.05	10
Target	0.3	0.04	11
Reduction %	**62%**	**95%**	**98%**
Effective IC	**19%**	**11%**	**8%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		0.33
Watershed IC (no BMP)	100%	0.33
Target IC	9%	0.03
Effective IC w/BMP	15%	0.05
Difference fromTarget		0.02
IC Reduction	85%	0.28

* Effective IC calculated as follows:

1. Interpolate effective IC separately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effective percentage% by using linear interpolation of percentage to closest load/volume values
   b. For flow duration, calculate average of individually interpolated values taken at equal probability intervals (based on normal distribution)
2. Determine the maximum IC indictor for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

Impaired Waters Assessment for Charles River (MA72-36)

Impaired Waterbody

Name: Charles River

Location: Watertown, Newton, Boston and Cambridge, Massachusetts

Water Body ID: MA72-36 (Formerly part of segment MA72-08)

Impairments

According to the MassDEP Final Year 2010 Integrated List of Waters, this segment of the Charles River is listed under Category 5 as impaired for chlorophyll-a, DDT, Escherichia coli, fish-passage barrier, fishes biassessments, non-native aquatic plants, oil and grease, other flow regime alterations, dissolved oxygen, secchi disk transparency, nutrient/eutrophication biological indicators, total phosphorus, PCB in fish tissue, sediment biassays, acute toxicity freshwater, other, and high pH.

Two TMDL reports have been finalized that address the Lower Charles River, which includes this segment.

- *Final Phosphorus TMDL Report for the Lower Charles River Basin (CN 301.0)* addressing chlorophyll-a, dissolved oxygen, secchi disk transparency, nutrient/eutrophication biological indicators, total phosphorus, and high pH impairments.
- *Final Pathogen TMDL Report for the Charles River Watershed (CN 0156.0)* addressing Escherichia coli impairment.

The *Charles River Watershed 2002-2006 Water Quality Assessment Report* (MassDEP, 2008) lists non-point sources, unspecified urban stormwater, and urban runoff/storm sewers among the main sources of impairments to this segment. Other sources of impairments in the subwatershed include legacy pollutants, combined sewer outfall (CSO) discharges, and discharges from upstream municipal treatment plants.

Relevant Water Quality Standards

- Water Body Classification: B
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*
- 314 CMR § 4.05 (3)(b)(1) – *Dissolved Oxygen. a. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions.*

Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

- 314 CMR § 4.05 (3)(b)(3) – *pH. Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.*
- 314 CMR § 4.05 (3)(b)(4) – *Bacteria.*
  a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;
  b. for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department;
- 314 CMR § 4.05 (3)(b)(5) – *Solids. These waters shall be free from floating, suspended and settleable solids in concentrations or 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 (3)(b)(6) – *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 (3)(b)(7) –*Oil and Grease. These waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.*
- 314 CMR § 4.05 (5)(a) – *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 (5)(b) – *Bottom Pollutants or Alterations. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.*
- 314 CMR § 4.05 (5)(c) – *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 pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint*

source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

- 314 CMR § 4.05 (5)(e) - *Toxic Pollutants. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.*

Summary

MassDOT has assessed stormwater impacts from MassDOT properties discharging to the Charles River using BMP 7R to address the Phosphorus and Pathogen TMDLs and BMP 7U to address impairments not covered by a TMDL. The following sections describe the methodology for these assessments. Based on this assessment, MassDOT determined that a 254-pound reduction in annual phosphorus loading and a 99-acre reduction in effective impervious cover (IC) would be needed to meet the targets for this watershed.

Presently, MassDOT's properties draining to the Charles River do not include stormwater best management practices (BMPs). To reduce MassDOT's contribution to Charles River impairments, MassDOT proposes five BMPs, which will provide 18.6 lbs/yr phosphorus load reduction and 7.4 acres effective IC reduction. See the **Proposed Mitigation Plan** section of this assessment for more information.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (Pounds/year)
MassDOT's Area Directly Contributing to Impaired Segment	138	327
Target Reduction	99	254
Reduction Provided in Proposed Conditions	7.4	18.6

Site Description

This segment of the Charles River extends 6.1 miles from the Watertown Dam in Watertown to the Boston University (BU) Bridge in Boston/Cambridge (see Figure 1). Segment MA72-36 was previously a part of segment MA72-08, which extended from the Watertown Dam in Watertown to the New Charles River Dam in Boston. Segment MA72-08 was split into two segments, MA72-36 (described herein) and MA72-38, which covers the remainder of the reach from the BU Bridge to the New Charles River Dam. The watershed is within an urbanized area that is densely developed with significant single- and multi-family residences, commercial, industrial, and institutional

properties. According to the *2002-2006 Water Quality Assessment Report*, the estimated percent IC for this subwatershed is 14.6% and the primary land uses of the 281.3 square mile subwatershed include forest (38%), residential (37%), and open land (9%).

Major transportation corridors within the watershed, include the Massachusetts Turnpike (I-90), U.S. Route 20, Storrow Drive, and Memorial Drive.

The 138-acre MassDOT direct drainage watershed to this segment of the Charles River includes Interstate 90 (I-90) from Centre Street, Newton, to Massachusetts Avenue, Boston, and seven bridges. See Figures 2 through 5. The seven MassDOT-owned bridges which cross over and contribute stormwater runoff to this segment of the Charles River include:

- River Street between Cambridge and Boston;
- Western Avenue between Cambridge and Boston;
- Anderson Bridge (John F. Kennedy Street/North Harvard Street) between Cambridge and Boston;
- Soldiers Field Road Extension between Cambridge and Boston;
- Arsenal Street/Western Avenue between Watertown and Boston;
- North Beacon Street (Route 20) between Watertown and Boston; and
- Galen Street in Watertown.

With the exception of the Galen Street bridge over the Charles River, each of these bridges was recently transferred to MassDOT from the Massachusetts Department of Conservation and Recreation (DCR). The Galen Street bridge is surrounded by municipally-owned roadways and properties. The remaining bridges are surrounded by DCR-owned property and municipally-owned roadways.

In addition to the bridges crossing the Charles River, MassDOT also recently acquired two bridges along Memorial Drive at the intersection of Brookline Street in Cambridge. The two bridges carry Memorial Drive over the rotary at Brookline Street and over the CSX Railroad. Due to the close proximity of these bridge to the Charles River, MassDOT assumes the roadway runoff discharges directly to the Charles River.

Stormwater runoff from an approximate 6.3-mile portion of I-90 and the Allston-Brighton Toll Plaza in the Towns of Newton, Boston, and Brookline directly drain to this segment of the Charles River. Stormwater runoff drains for this portion of I-90 via both open channel and closed pipe systems. I-90 generally consists of eight lanes of roadway with paved shoulders and curbs. In addition to the paved roadways, the Boston & Albany Main Line rail road track (also known as the MBTA Framingham/Worcester Line) follows the same alignment as the I-90 roadway between Centre Street, Newton, and Beacon Park Yard, Boston. The railroad track in this area was reconstructed when I-90 was built. Although the rail bed does not generate significant amounts of runoff due to its limited footprint and open gravel cover, it shares the drainage system and outfalls with the MassDOT roadway runoff.

Between the Brookline Avenue Bridge and the viaduct at the Allston-Brighton toll plaza, gutter flow conveys stormwater to catch basins and a closed drainage system beneath the median of the roadway. The trunk line for this drainage area terminates at Pump Station #2, located beneath the viaduct near the BU Bridge. This pump station discharges stormwater to a 60-inch outfall to the Charles River upstream of the BU Bridge. The pump station receives flow from a 54-inch drain, a 30-inch drain, and an 18-inch drain which passes through a set of bar screens and into a wet well before being pumped to the discharge manhole. Between Cambridge Street and the BU Bridge, stormwater from the Allston-Brighton Toll Plaza is conveyed via closed drainage systems to outfalls to the Charles River.

West of Cambridge Street, gutter flow and paved waterways convey stormwater flows to catch basins or drop inlets that discharge to paved swales adjacent to the roadway embankment. These swales, in turn, discharge to closed drainage systems that convey flows to the Charles River.

Portions of I-90 drain to culverted brooks that are tributary to the Charles River. Because these brooks do not contain open or natural sections, they have been included as part of the direct MassDOT drainage area.

Grit chambers and other sub-surface BMPs are present within the Allston-Brighton Toll Plaza and associated tractor-trailer parking areas. No other BMPs were identified within the existing drainage systems associated with this segment of roadway.

Assessment under BMP 7R for Impairments Addressed by Phosphorus TMDL (CN 301.0)

The *Total Maximum Daily Load (TMDL) for Nutrients in the Lower Charles River, Massachusetts (CN 301.0)* addresses the total phosphorus dissolved oxygen, nutrient/eutrophication biological indicators, chlorophyll-a, secchi disk transparency, and pH impairments for this water body. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT properties to this water body using the approach described in BMP 7R of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have been addressed by a TMDL.

Pollutant of Concern: Phosphorus

1) Impairment Addressed: total phosphorus dissolved oxygen, nutrient/eutrophication biological indicators, chlorophyll-a, secchi disk transparency, and pH
2) Applicable Waste Load Allocation (WLA): See Table ES-3 of the Final TMDL. As the Final TMDL does not specifically identify Transportation as a land use, MassDOT used the Commercial land use for this WLA analysis based on the conservative assumption that Transportation is most similar to Commercial land uses.
    a) Description of Associated Land Use: Commercial
    b) Commercial Land Use Current Load (TP): 3,676 kilograms per year (kg/yr)
    c) Commercial Land Use WLA (TP): 1,286 kg/yr
    d) Percent Load Reduction (TP): 65%
    e) Commercial Area in Watershed: 8.36 square miles or 2.7% (based on total watershed area of 308 square miles. Transportation not separated from Commercial/Industrial during TMDL analysis)
    f) Commercial Land Use Area WLA: 0.59 kilograms per hectare per year (kg/ha/yr) (0.53 pounds per acre per year (lbs/ac/yr)) (calculated)
3) Implementation Strategy Components: Section 6.2 Final Report
    a) Management of Stormwater from Drainage Systems – Pages 113-115 of the Final TMDL:
        i) "The development and implementation of comprehensive stormwater management programs throughout the Charles River watershed will be necessary to achieve the phosphorus reduction and water quality goals of this TMDL. The management program should accomplish the following tasks:

(1) characterize the drainage areas that contribute to discharges requiring permit coverage under the Permittee's jurisdiction

(2) implement a comprehensive Illicit Discharge Detection and Elimination (IDDE) program

(3) prioritize source areas for control

(4) include the necessary structural and non-structural best management practices (BMPs) that, upon implementation, will achieve reductions in phosphorus loadings from the NPDES covered drainage areas that are consistent with the phosphorus load reductions identified in this TMDL."

For the BMP 7R Phosphorus Assessment, MassDOT used a site-specific, continuous, long-term hydrologic and pollutant simulation model (the assessment model) to estimate annual pollutant loads from its property and treatment through both existing and proposed BMPs, if present. The assessment model was run for a 10-year period using hourly Boston rainfall data to capture a range of meteorological conditions and estimate annual median pollutant loads. The pollutant loading portion of the assessment model was calibrated to match pollutant runoff data from the USGS Highway-Runoff Database (Version 1.0, September 2009). The assessment model directly evaluates BMP effects on hydrology (detention, infiltration) and pollutant loads (losses through infiltration, settling, filtration, and biological treatment). For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

The following table summarizes the assessment model results for the MassDOT directly contributing watershed contributing to the Charles River for existing conditions.

Annual Watershed Phosphorus Loading under Existing Conditions

Watershed/ BMP ID	Watershed Size (Acres)	Pre- BMP Annual Load (pounds/year)	Post-BMP Annual Load (pounds/year)	Estimated Annual Removal Efficiency
Total Directly Contributing MassDOT Watershed	138	327	327	0%

The assessment model predicts that the MassDOT directly contributing watershed contributes approximately 327 pounds of phosphorus per year. No BMPs currently exist to treat stormwater from MassDOT's property directly discharging to this segment of the Charles River.

Based on the TMDL, MassDOT's WLA is 0.59 kg/ha/yr (0.53 lbs/ac/yr). The 138 acres of directly contributing MassDOT watershed equates to 73 pounds per year of phosphorus for MassDOT's directly contributing watershed.

BMP 7R Phosphorus Mitigation Plan

Under existing conditions, MassDOT's estimated directly contributing annual phosphorus load exceeds the TMDL WLA. To mitigate this load, MassDOT will implement stormwater BMPs to the maximum extent given the site constraints.

This assessment has identified locations for potential stormwater BMPs and estimated their potential phosphorus removal performance. The Proposed Mitigation Plan section of this assessment describes the BMPs and their estimated annual load reduction performance.

Assessment under BMP 7R for Pathogens

The *Pathogen Total Maximum Daily Load (TMDL) for the Charles River Watershed (CN 0156.0)* covers the Charles River. The TMDL states that sources of indicator bacteria in the Charles River Watershed were found to be many and varied. The TMDL lists sources as including failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals, and direct overland stormwater runoff.

In addition, as stated on page 12 of the TMDL, *Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, stormwater drainage systems and associated stormwater culverts and outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.*

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by orders of magnitude within a given storm event (MassDEP, 2009). Therefore, it is difficult to predict stormwater pathogen concentrations with accuracy. Due to this difficulty, MassDOT is not conducting site specific assessments of loading at each location impaired for pathogens as part of this Retrofit Program. However, MassDOT recognizes that its roadways, especially in urbanized areas, contribute to the pathogen impairment of the Charles River Watershed and has performed a general assessment and developed a mitigation plan as described below.

BMP 7R Pathogens Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT has reviewed its existing programs and their consistency with the Pathogen TMDL for the Charles River Watershed recommendations as well as the draft EPA National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements for the North Coastal Watershed.

The Pathogen TMDL for the Charles River Watershed recognizes that mitigation for pathogen impairments is difficult to address and emphasizes the need for an iterative adaptive management approach. The Executive Summary of the TMDL, page xi, states:

> *TMDL implementation to achieve [the pathogen reduction goals] should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate stormwater runoff volume.*

The existing NPDES MS4 permit that covers MassDOT stormwater discharges does not provide guidance on what measures are necessary to comply with the Pathogen TMDL for the Charles River Watershed. The fact sheet for the draft permit for MS4 stormwater discharges for the North Coastal Watershed contains some guidance on what measures EPA has determined necessary to be consistent with the Pathogen TMDL for the Charles River Watershed. Page 36 of the fact sheet states:

> *Instead of a numeric limitation for bacteria, the draft permit includes requirements for MS4s to provide education to pet owners and owners of septic systems, to implement a comprehensive illicit discharge detection and elimination program that addresses not only sources of pathogens but also sources of phosphorus,*

and to implement programs to address water fowl. In addition, although entitled "Phosphorus Control Plan" most of the actions needed to develop and implement a successful PCP are also effective in supporting the achievement of the WLA for the Charles River pathogen TMDL.

As discussed above, both the Pathogen TMDL for the Charles River Watershed and the draft North Coastal Watershed MS4 permit state that identification of illicit discharges and addressing stormwater volumes and pollutants, such as phosphorus, are the best approaches to mitigate the pathogen impairments. MassDOT has developed a mitigation plan, described below, to address the pathogen impairments using guidance from these two documents.

BMP 7R Pathogens Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing StormWater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific non-structural BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

Although not included in this permit term, MassDOT will be implementing a pet waste management program at its rest stops, including those that have discharges to pathogen impaired waters. In addition, MassDOT has requested to be covered under an Individual MS4 permit for the next permit term. A future individual permit may contain additional programmatic BMPs to address pathogens.

The structural BMPs that will be considered to reduce phosphorus loading and the effects of IC would also reduce pathogen loads. See the Proposed Mitigation Plan section of this assessment for more information on specific BMPs proposed as part of this assessment. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations.

Assessment for Oil and Grease under BMP 7U

The Charles River pathogen and phosphorus TMDLs do not address all of the Charles River's impairments including oil and grease. Therefore, MassDOT assessed the stormwater-related impairments not addressed by a TMDL using the approach described in BMP 7U of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have not been addressed by a TMDL.

MassDOT has identified a subset of water body impairments in the Charles River Watershed which are not related to stormwater runoff. Specific impairments unrelated to stormwater for the Charles River include fish passage barrier, flow regime alterations, fishes bioassessments, sediment

bioassays, acute toxicity freshwater, DDT, non-native aquatic plants, and PCB in fish tissue. MassDOT has not included these impairments in this assessment as they are not caused by stormwater runoff.

For the stormwater-related impairments for this water body not covered by a TMDL, MassDOT used an application of EPA Region I's Impervious Cover (IC) Method described in EPA's Stormwater TMDL Implementation Support Manual (ENSR, 2006). MassDOT used this method to assess potential stormwater impacts on the impaired water and develop the target IC to ensure that stormwater is not the cause of the impairments. The IC Method relates an aquatic system's health (i.e., state of impairment) to the percentage of IC in its contributing watershed. This method is largely based on the work of the Center for Watershed Protection, which has compiled and evaluated extensive data relating watershed IC to the hydrologic, physical, water quality, and biological conditions of aquatic systems (Schueler, 2003). Water quality in tributary streams, rivers, lakes and ponds is a direct reflection of loading from the watershed (Wetzel, 2001); therefore, the IC method can be used as a surrogate for pollutant loading when evaluating water quality impairments and their causes. Consistent with the findings of EPA and others, MassDOT concluded that when a watershed had less than 9% IC, stormwater was not the likely cause of the impairment.

MassDOT developed the target IC reduction using the approach outlined in *Description of MassDOT's Application of Impervious Cover Method in BMP 7U* (MassDOT, 2011). Since the development of the MassDOT Application of IC Method, MassDOT has further refined its approach to evaluate MassDOT's effective IC and BMP performance. For the Charles River basin, MassDOT used the long-term continuous simulation model (the assessment model) to estimate phosphorus loading and to estimate effective IC.

MassDOT estimated the effective IC of its contributing drainage area with existing and proposed stormwater BMPs by comparing the runoff and pollutant response of its drainage area to the response of simulated watersheds with equivalent area, but varying IC from 0 to 100% (simulated IC watersheds). The IC percentage of the watershed that produces a similar response to MassDOT's watershed was determined to be the effective IC of MassDOT's watershed. For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

The MassDOT IC method for the impaired waters of the Charles River basin includes the following steps:

1. Calculate the percent IC of the water body's entire contributing watershed (total watershed to downstream end of impaired segment) and that of the local watershed contributing directly to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body.
2. For subwatersheds with greater than 9% IC, calculate the amount of IC reduction needed to achieve 9%. For subwatersheds with less and 9% IC, perform no further analysis under BMP 7U.
3. Calculate percentage of IC in the MassDOT directly contributing drainage area.
4. Apply reduction of IC necessary for the subwatershed to achieve 9% to the MassDOT contributing drainage area as a target to address the stormwater impairments. Calculate resulting target IC for the MassDOT drainage area.
5. Run the assessment model with specific MassDOT drainage areas and BMPs to estimate:
    a. Flow and pollutant statistics for MassDOT's current drainage area including treatment though existing BMPs.

b. Flow and pollutant statistics for target watershed (watershed with target percent IC) and simulated IC watersheds.

6. Compare MassDOT runoff and pollutant annual loading and flow statistics with target and simulated IC watersheds.
7. Locate additional stormwater BMPs to maximum extent practicable and run long-term simulation to quantify their performance.

BMP 7U Assessment

Using the approach described above, MassDOT calculated the following values for the total contributing watershed and the subwatershed of the impaired water (Charles River) to determine the IC target (see Figure 1).

Watershed Impervious Cover

	Total Watershed	Subwatershed
Watershed Area	180,762 acres	12,583 acres
Impervious Cover (IC) Area	31,962 acres	5,732 acres
Percent Impervious	18%	46%
IC Area at 9% Goal	16,269 acres	1,132 acres
Target Reduction % in IC	49 %	80%

The total and subwatersheds are greater than 9% impervious indicating that stormwater is a likely contributor to the impairment. To meet the 9% effective IC target, the effective IC within the subwatershed need to be reduced by 80%. Therefore, the effective IC of MassDOT's directly contributing area also should be reduced by the same percentage to meet the target. The following table shows the resulting targets for MassDOT's contributing property.

Reductions Applied to MassDOT Direct Watershed

MassDOT's Area Directly Contributing to Impaired Segment	138 acres
MassDOT's IC Area Directly Contributing to Impaired Segment	123 acres
MassDOT's Percent Impervious	89%
MassDOT's Target Reduction in Effective IC (80% of DOT Directly Contributing IC)	99 acres
Target Effective IC	18 %

MassDOT's directly contributing area includes 123 acres of IC (89% of total contributing area). To meet the target reduction of effective IC, MassDOT should mitigate 99 acres of effective IC. Equivalently, MassDOT's contributing drainage area should act as a watershed of 18% IC.

There are no existing BMPs to mitigate the effects of IC.

BMP 7U Mitigation Plan

Under existing conditions, MassDOT's estimated effective IC exceeds the target as described above. To mitigate the effects of IC, MassDOT will implement stormwater BMPs to the maximum extent practicable.

This assessment has identified locations for potential stormwater BMPs and estimated their potential effective IC reduction performance. The Proposed Mitigation Plan section of this assessment describes the BMPs and their estimated effective IC reduction performance.

Proposed Mitigation Plan to Address Phosphorus and Impervious Cover

In this assessment, MassDOT has identified 5 stormwater BMPs that may be implemented on MassDOT property to reduce annual phosphorus loads and mitigate the effective IC to address the Charles River impairments. These BMPs include three infiltration basins and four water quality swales, shown with their estimated contributing drainage areas in Figures 6 and 7. These locations were chosen based on a cursory review of the drainage systems, topography, property lines, and other site constraints. Detailed survey, complete utility location information, official property ownership, and soils evaluation information will influence the final selection and design of BMPs. Below is a description of these potential proposed BMPs.

PR- 01, 02, and 03
Proposed BMPs 01, 02, and 03 are infiltration basin located in the westbound right-of-way of I-90. Figure 6 shows the estimated drainage area of these basins based on preliminary review of topography and property boundaries. The three infiltration basins would collect a prescribed volume of runoff diverted from a main collection pipe that runs along this westbound right-of-way. The infiltration basins have been preliminarily sized at 2 feet deep.

PR-04 and 04
Proposed BMPs 04 and 05 are water quality swales proposed within existing drainage ditches located adjacent to the existing railroad easement, as shown on Figure 7. Runoff from I-90 currently either flows overland or via catch basins and drainage pipe to the ditches which are paved and have no outlet control. The ditches could be converted to water quality swales by removing the paved lining, replacing with a top layer of infiltrating soils and vegetation. Including outlet control and check dams could further enable infiltration.

The existing conditions assessment was modified to develop a proposed conditions simulation including proposed BMPs, estimated potential contributing drainage areas and rough sizing of the proposed BMPs. The table below shows the proposed BMPs, their MassDOT drainage areas, and estimated annual phosphorus load as well as effective IC reductions. The outputs from the assessment model showing effective IC analysis for each BMP are attached. The assessment model identifies each BMP by unique ID, which is included in the table below.

Proposed Mitigation

Watershed / BMP ID	BMP Type	Estimated Watershed Load Pre-BMP		Estimated Percent Reduction		Estimated Load Reduction	
		Effective IC Acres	Phosphorus Pounds/year	Effective IC	Phosphorus	Effective IC Acres	Phosphorus Pounds/year
PR 01 (44.7)	Infiltration Basin	1.0	3.0	85%	93%	0.9	2.8
PR 02 (45.7)	Infiltration Basin	1.7	5.0	73%	89%	1.2	4.4
PR 03 (46.7)	Infiltration Basin	3.5	9.4	94%	96%	3.3	9.0
PR 04 (3.6)	Water Quality Swale	8.6	22.3	4%	6%	0.3	1.4
PR 05 (5.6)	Water Quality Swale	1.8	4.6	10%	19%	0.2	0.9
Total*						**7.4**	**18.6**

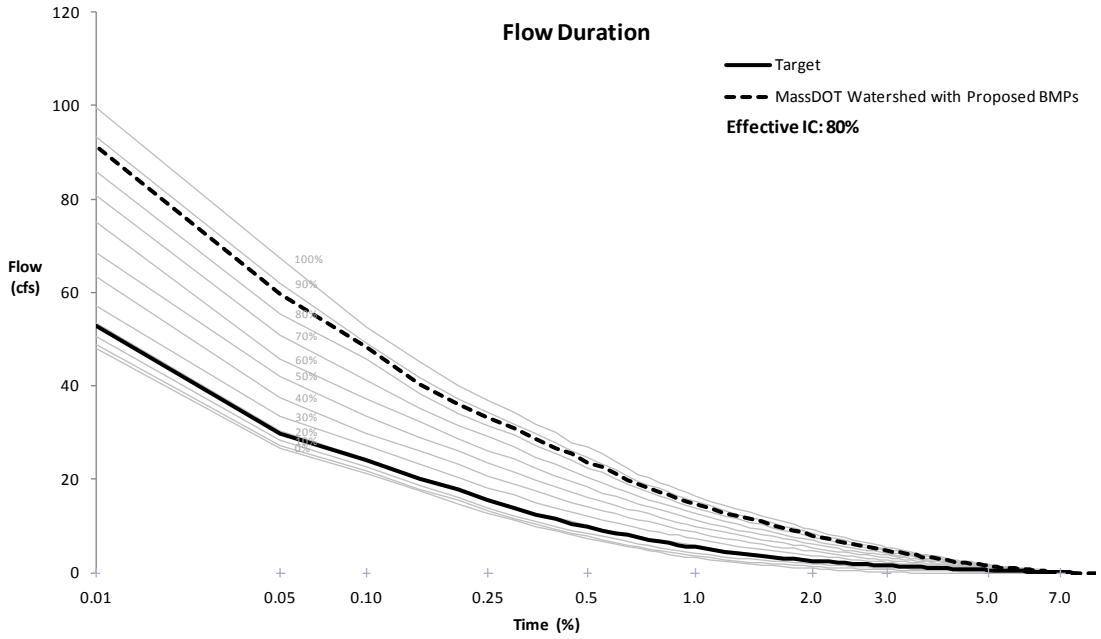
* Total Effective IC and phosphorus load reduction based on the assessment model results for the total MassDOT directly discharging drainage area to the receiving water (not sum of individual BMP reductions).

The proposed BMPs would result in an estimated 18.6 pounds phosphorus reduction on an annual median basis resulting in a total load of 309 pounds per year, compared to the WLA of 73 pounds per year.

MassDOT used the assessment model to simulate the MassDOT directly contributing watershed and proposed BMPs for this segment of the Charles River. The assessment model also simulated watersheds with the same area as the MassDOT watershed but with varying percentages of IC from 0 to 100% (simulated IC watersheds). The results of the simulated IC watersheds are used as “benchmarks” to determine effective IC of the MassDOT directly contributing watershed. The annual median runoff volume, phosphorus and total suspended solids (TSS) loads, and flow duration for the MassDOT watershed were compared to those results for the simulated IC watersheds to determine (based on similar runoff and load responses) the equivalent or effective impervious cover of the MassDOT watershed with BMPs treating a portion of the runoff. The graph and table below summarize assessment model results for the MassDOT directly contributing drainage area including the impacts of the proposed BMPs, along with the simulated IC watersheds.

Proposed Median Annual Load Comparisons

Simulated IC Watersheds	Runoff (ac-ft)	P (lb.)	TSS (lb.)
0% IC	100	7	488
5% IC	118	12	2,403
10% IC	136	17	5,096
Target 18% IC	**164**	**31**	**12,283**
20% IC	170	35	14,079
30% IC	205	62	28,730
40% IC	240	98	48,498
50% IC	273	140	72,655
60% IC	306	186	99,072
70% IC	340	233	125,751
80% IC	373	280	152,346
90% IC	407	326	178,278
100% IC	441	373	204,655
Existing Conditions	406	327	179,326
Proposed Conditions	390	308	167,585
Reduction %	**4%**	**6%**	**7%**
Effective IC	**85%**	**86%**	**86%**



Effective IC Results

Existing Estimated Effective IC	123 ac
Proposed Estimated Effective IC	115 ac
IC Reduction % with Proposed BMPs	6%
Estimated Effective IC*	84%

*Average of estimated Effective IC for annual median runoff volume, phosphorus and TSS loads, and flow duration

MassDOT estimated the effective IC under proposed conditions as 84% by comparing the annual median runoff volume, phosphorus and TSS loads, and flow distribution statistics (flow duration) from MassDOT drainage area to the receiving water to those results for simulated IC watersheds. The proposed BMPs mitigate an estimated 7.4 acres of IC, resulting in 115 acres of IC for the MassDOT direct watershed.

MassDOT owns a limited amount of right-of-way outside of the actual roadways within the Charles River Segment MA72-36 watershed. This significantly constrains MassDOT in proposing additional stormwater BMPs in this area. The Department of Conservation and Recreation (DCR) owns and manages the Charles River Reservation, a linear park along the Charles River extending from the Boston Harbor upstream 20 miles. This Park is heavily used for recreational purposes and may not be appropriate for stormwater BMPs. Bridges owned by MassDOT and tributary to this segment are bounded by municipal roads and do not have MassDOT-owned property available for stormwater treatment.

MassDOT will continue to ensure proper non-structural BMPs are being implemented within the watershed of the Charles River, including regular roadway and drainage system maintenance, erosion and sedimentation control, and outreach and education.

In addition, BMP implementation through MassDOT's programmed projects are carefully evaluated and implemented where practicable, and documented through the MassDOT Water Quality Data Form. The potential for BMPs outside of MassDOT property will be reviewed during the design phase of these projects and through ongoing partnerships with other state and local entities. During this assessment analysis, potential BMPs beyond the scope of the impaired waters program were identified and can be reviewed during future projects.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to the Charles River using BMP 7R to address the Phosphorus and Pathogen TMDLs and BMP 7U to address impairments not covered by a TMDL. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. MassDOT proposes to install five BMPs to reduce MassDOT's contribution to impairments within the Charles River watershed.

The following table summarizes the total phosphorus and effective IC reductions proposed in the Charles River's watershed of.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	138	327
Target Reduction	99	254
Reduction Provided in Proposed Conditions	7.4	18.6

The proposed BMPs will result in a reduction in annual phosphorus loading by 18.6 lbs, which is less than the target reduction of 254 lbs/yr. The proposed BMPs will also reduce the effective IC of the watershed by 7.4 acres, which is less than the target reduction of 99 acres.

MassDOT will proceed to the design phase to develop construction plans for the proposed BMPs as part of the MassDOT Impaired Waters Program. The project designer will gather additional information in this phase, such as soil data and site survey, to further refine the proposed BMPs. For the proposed infiltration basins identified in this assessment, the design effort is being

progressed concurrently with this report. Once the design of the proposed BMPs is finalized, MassDOT will provide an update with additional information and summarize the final phosphorus and effective IC reduction based on the as-built condition. MassDOT will continue to implement non-structural BMPs that reduce potential nutrient and sediment loading.

As an overall program, MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted as programmed projects for the area. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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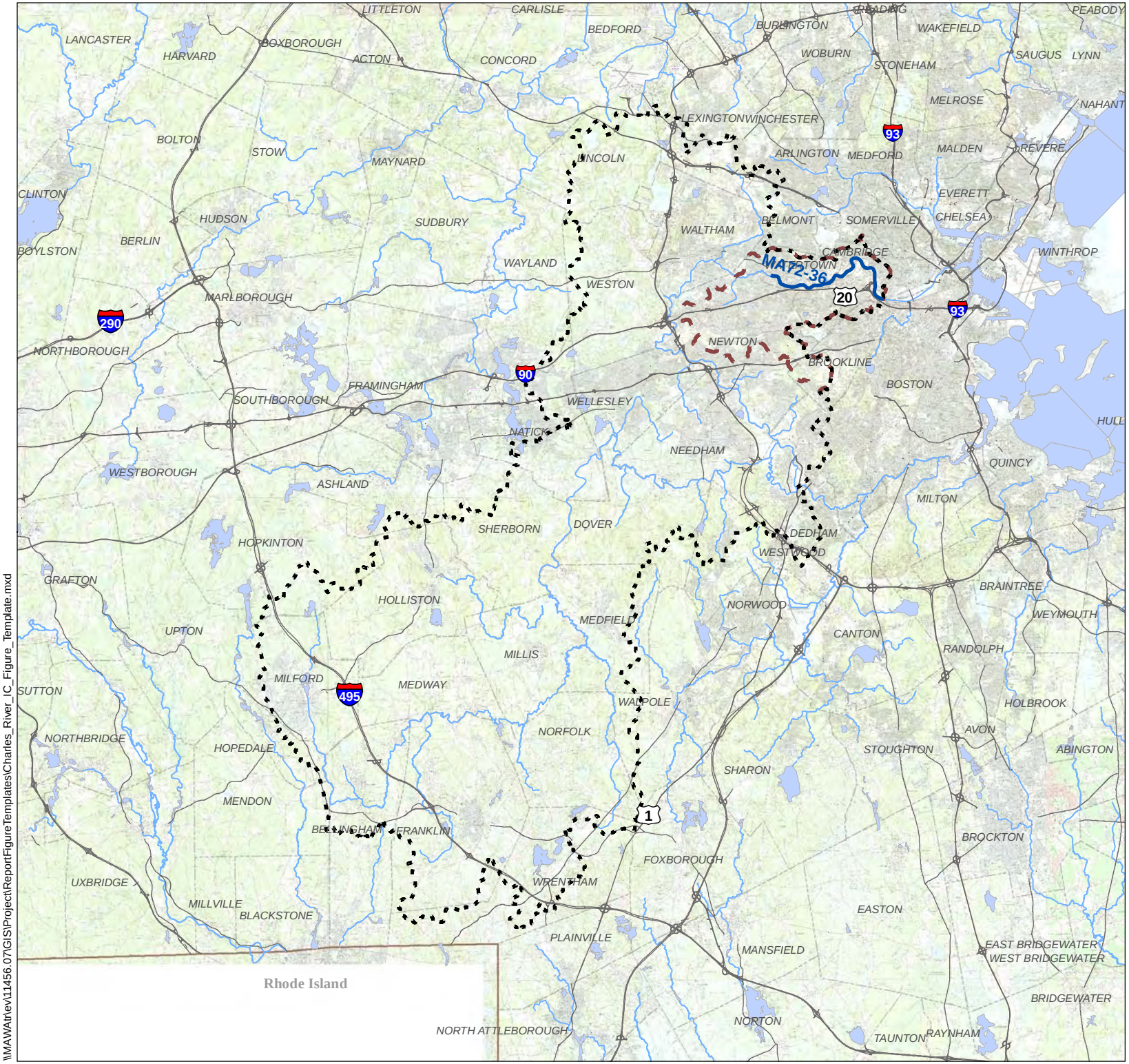

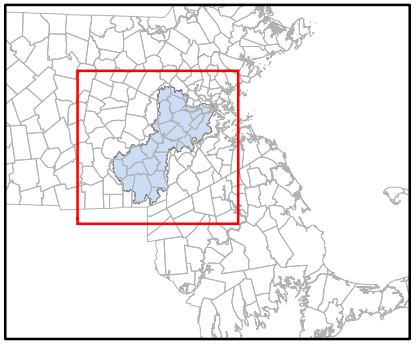

Assessed Stream Segment

Assessed Lake Segment

Total Watershed

Subwatershed

Impaired Lakes

Impaired Streams

MassDOT Roadways

N

0 4 8 Miles

Figure 1

Charles River MA72-36 Watersheds

June 2012

MassDOT Massachusetts Department of Transportation Highway Division

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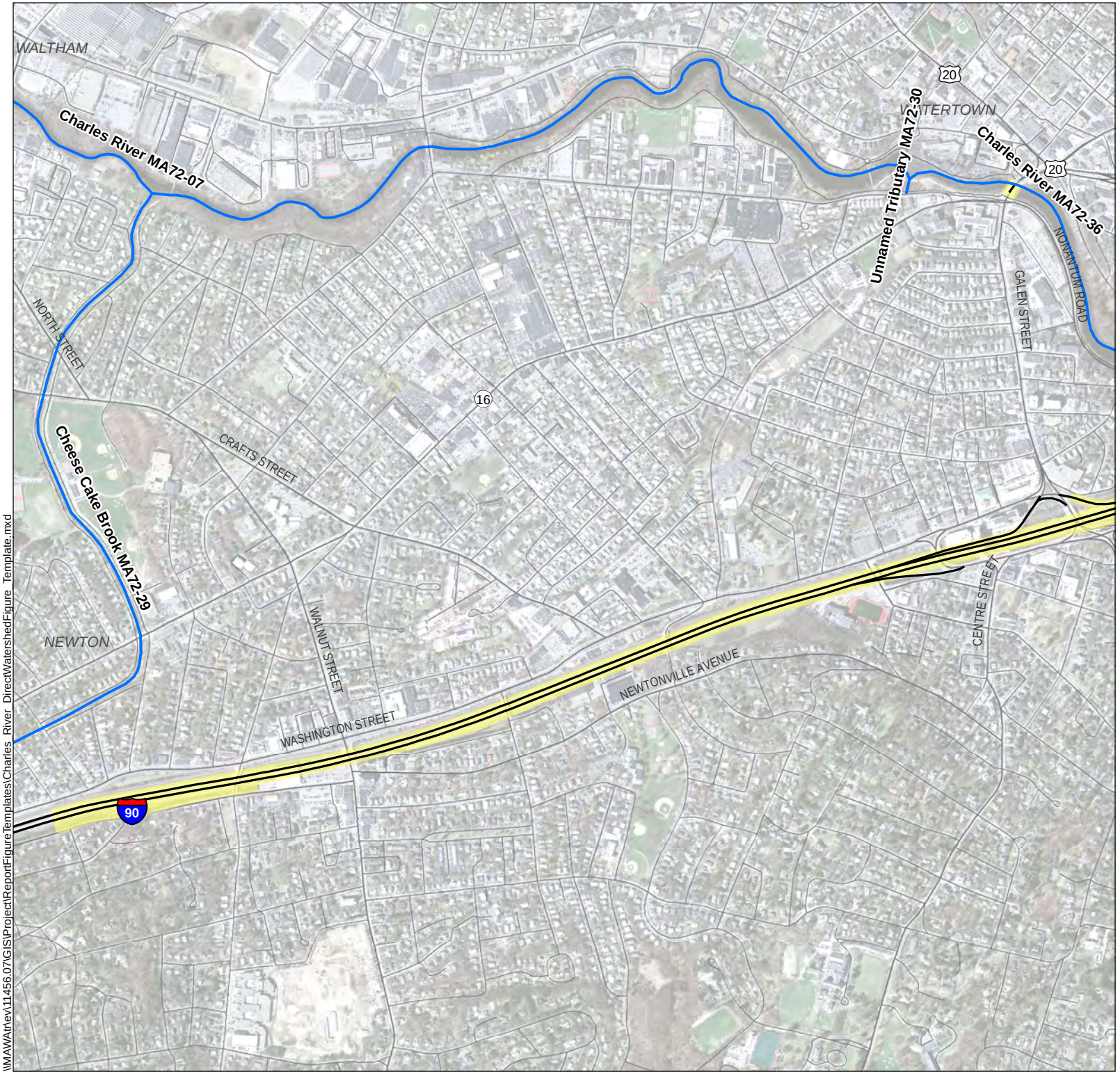

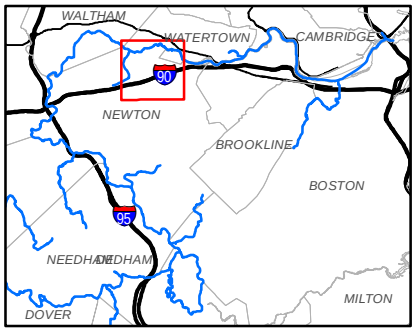

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 500 1,000 2,000 Feet

Figure 2

Charles River MA72-36 Directly Contributing MassDOT Watershed

June 2012

massDOT Massachusetts Department of Transportation Highway Division

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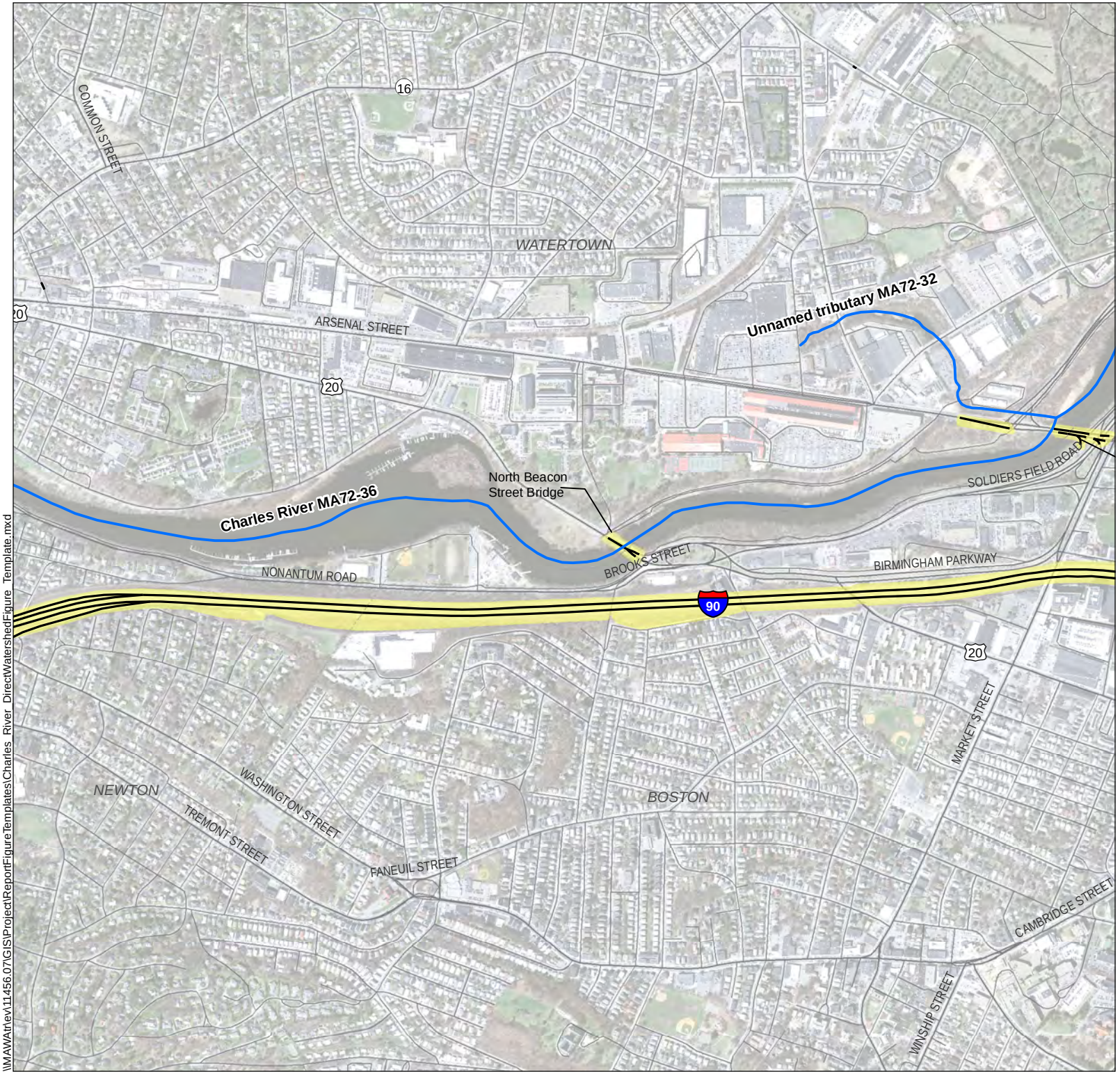

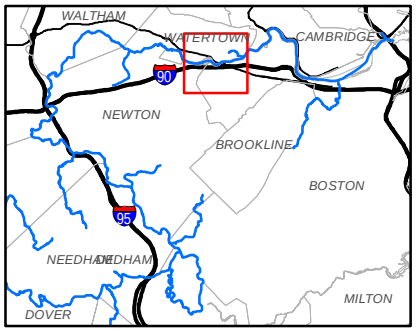

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 500 1,000 2,000 Feet

Figure 3

Charles River MA72-36 Directly Contributing MassDOT Watershed

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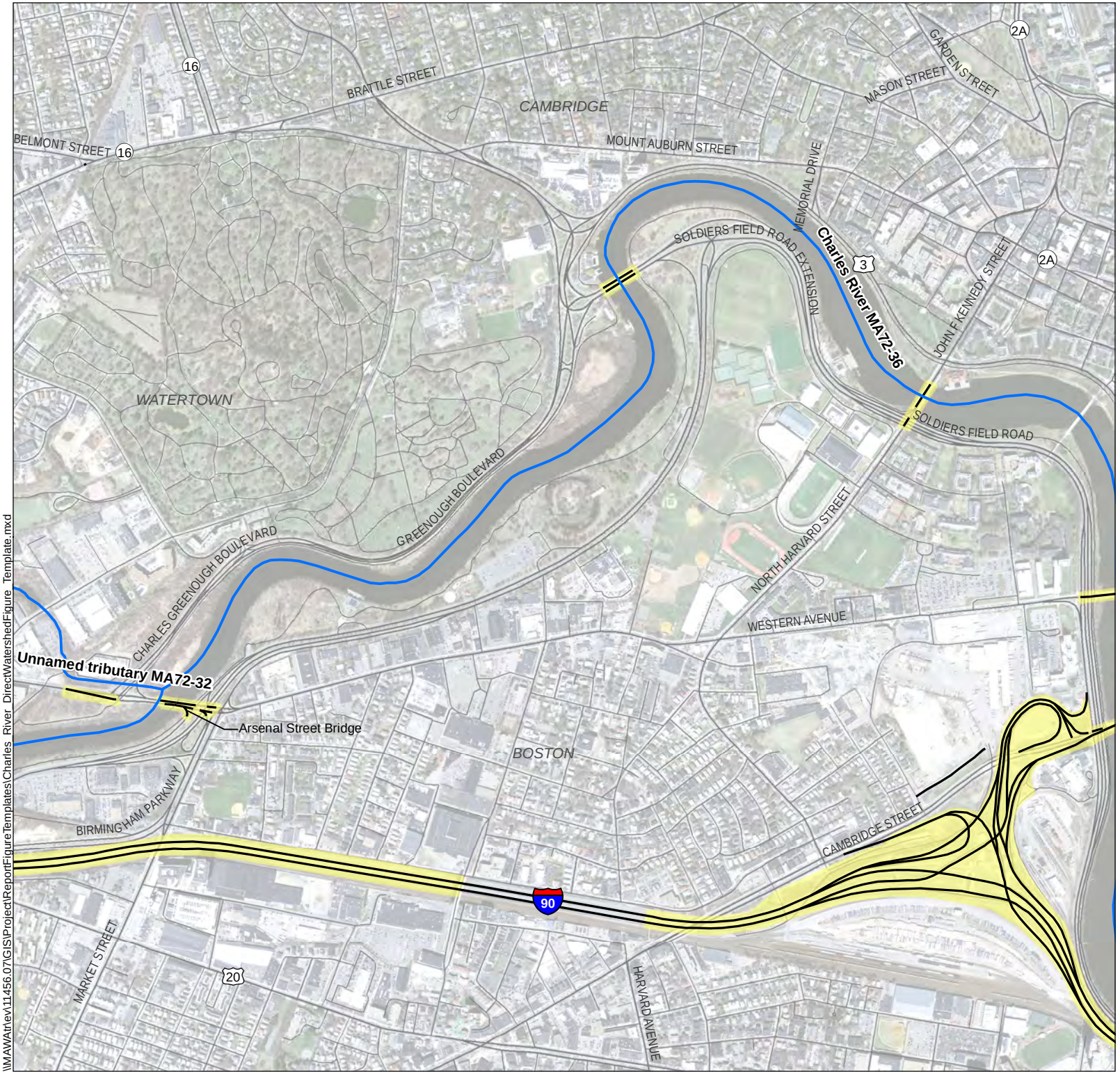

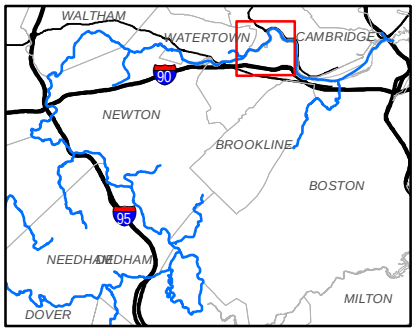

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 500 1,000 2,000 Feet

Figure 4

Charles River MA72-36 Directly Contributing MassDOT Watershed

June 2012

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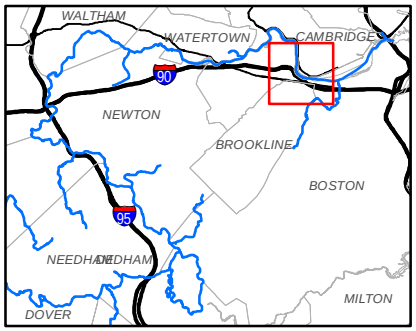

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 500 1,000 2,000 Feet

Figure 5

Charles River MA72-36 Directly Contributing MassDOT Watershed

June 2012

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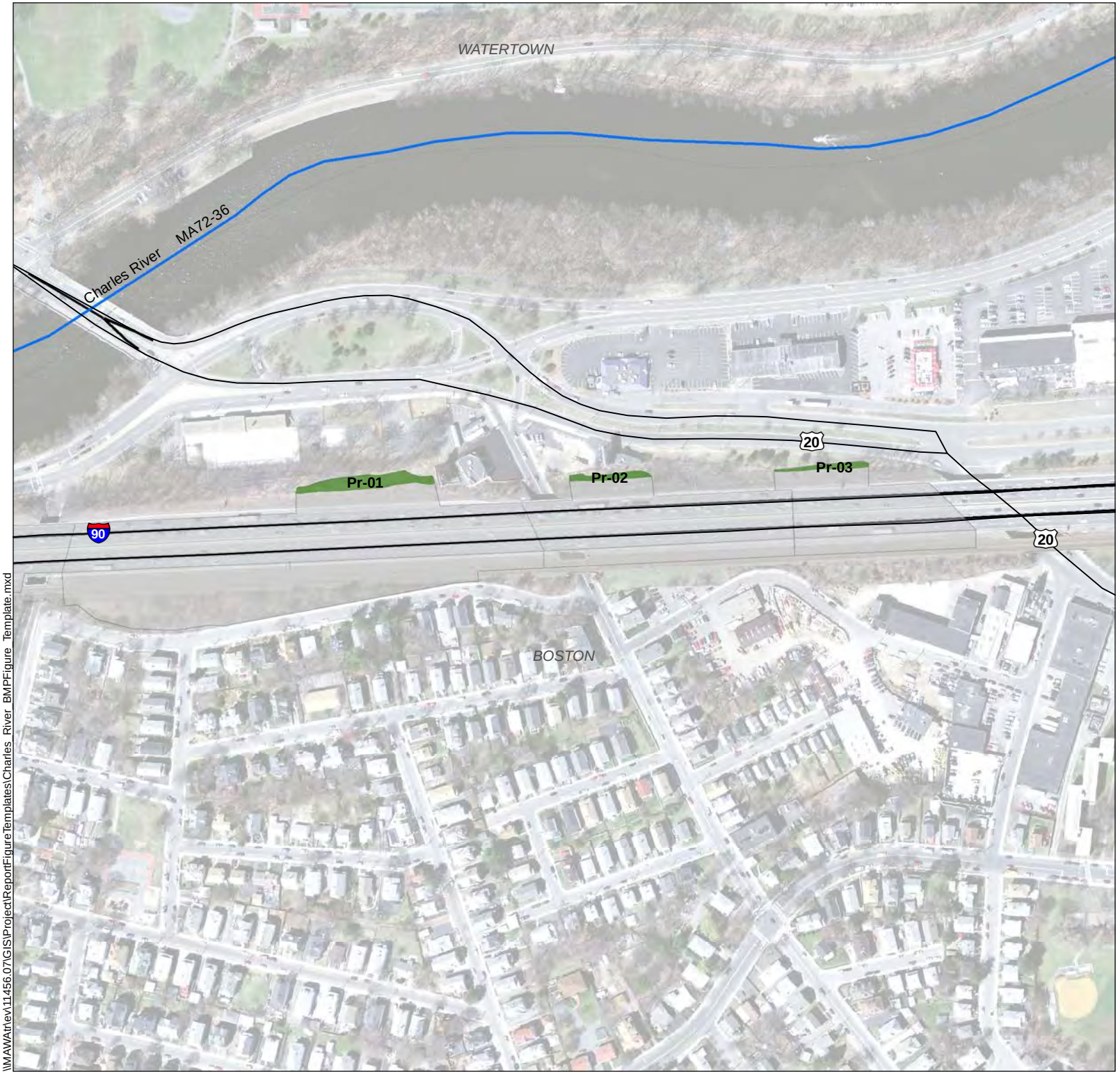

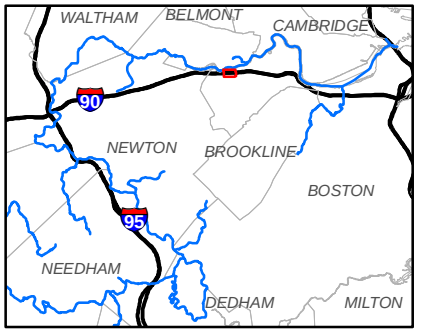

Impaired Streams

Impaired Waters

Proposed BMPs

Proposed BMP Watersheds

MassDOT Roadways

N

0 125 250 500 Feet

Figure 6

Charles River
MA72-36

Proposed BMPs

June 2012

massDOT
Massachusetts Department of Transportation
Highway Division

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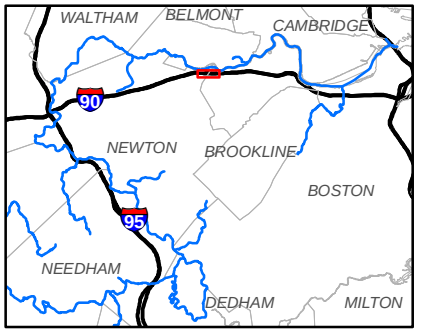

Impaired Streams

Impaired Waters

Proposed BMPs

Proposed BMP Watersheds

MassDOT Roadways

N

0 250 500 1,000 Feet

Figure 7

Charles River
MA72-36

Proposed BMPs

June 2012

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Highway Division

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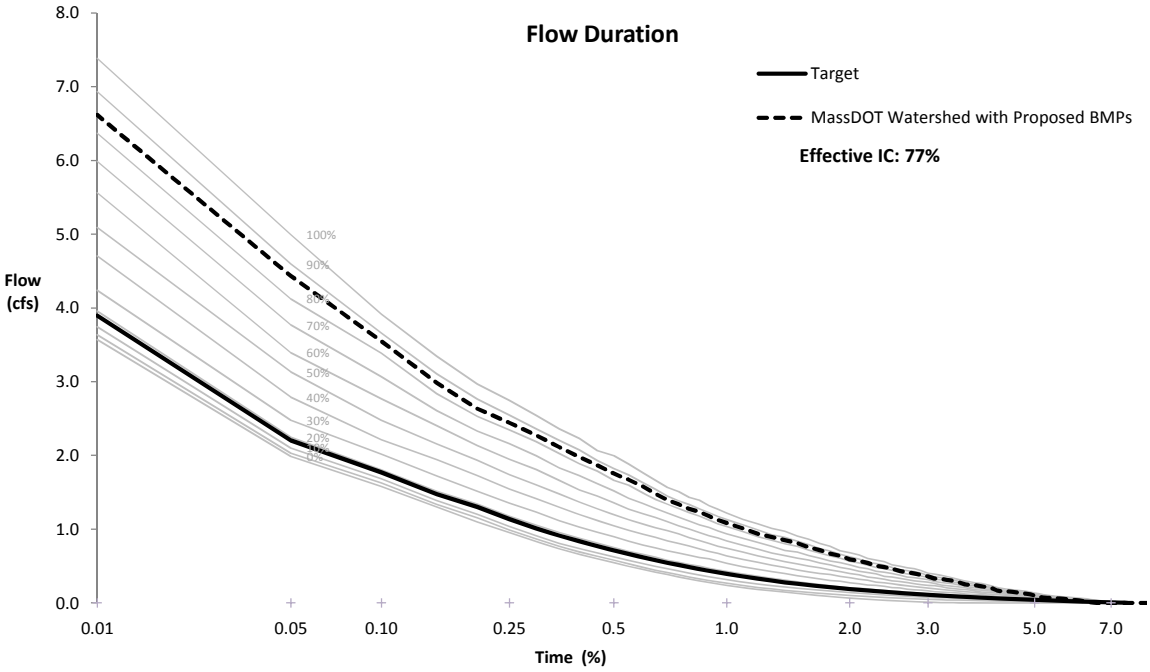
MA 72-36 Assessment Mode Result Summary for Impervious Cover 3.6



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	7.4	0.5	36
5%IC	8.8	0.9	178
10% IC	10.1	1.3	378
20% IC	12.7	2.6	1,045
30% IC	15.2	4.6	2,133
40% IC	17.8	7.2	3,601
50% IC	20.3	10.4	5,394
60% IC	22.7	13.8	7,356
70% IC	25.2	17.3	9,337
80% IC	27.7	20.8	11,311
90% IC	30.2	24.2	13,237
100% IC	32.7	27.7	15,195
Watershed Load	28.8	22.3	12,191
BMP Output	28.5	21.0	10,559
Target	11.9	2.2	845
Reduction %	**1%**	**6%**	**13%**
Effective IC	**83%**	**80%**	**76%**

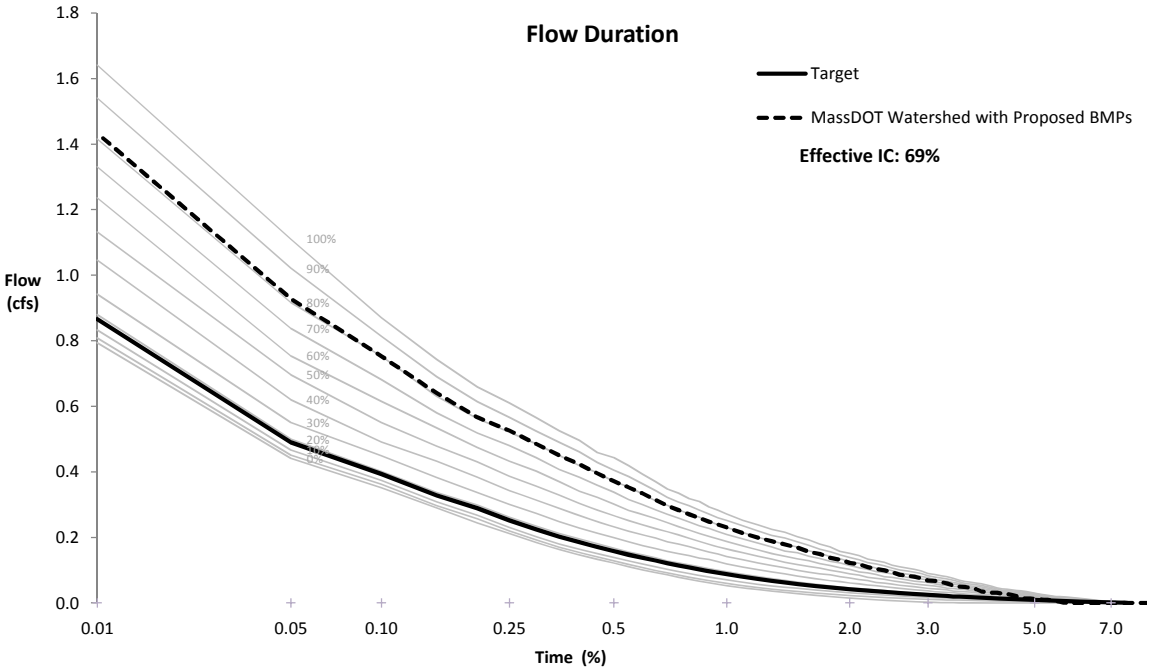
Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		10.3
Watershed IC (no BMP)	100%	10.3
Target IC	17%	1.7
Effective IC w/BMP*	80%	8.2
Difference fromTarget		6.5
IC Reduction	20%	2.0

* Effective IC calculated as follows:

1. Interpolate effective IC separately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effective percentage% by using linear interpolation of percentage to closest load/volume values
   b. For flow duration, calculate average of individually interpolated values taken at equal probability intervals (based on normal distribution)
2. Determine the maximum IC indictor for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA 72-36 Assessment Mode Result Summary for Impervious Cover 5.6



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.7	0.1	8
5%IC	2.0	0.2	40
10% IC	2.2	0.3	84
20% IC	2.8	0.6	232
30% IC	3.4	1.0	474
40% IC	4.0	1.6	800
50% IC	4.5	2.3	1,199
60% IC	5.1	3.1	1,635
70% IC	5.6	3.8	2,075
80% IC	6.2	4.6	2,514
90% IC	6.7	5.4	2,942
100% IC	7.3	6.2	3,377
Watershed Load	6.2	4.6	2,515
BMP Output	5.8	3.8	1,678
Target	2.6	0.5	188
Reduction %	**6%**	**19%**	**33%**
Effective IC	**74%**	**69%**	**61%**

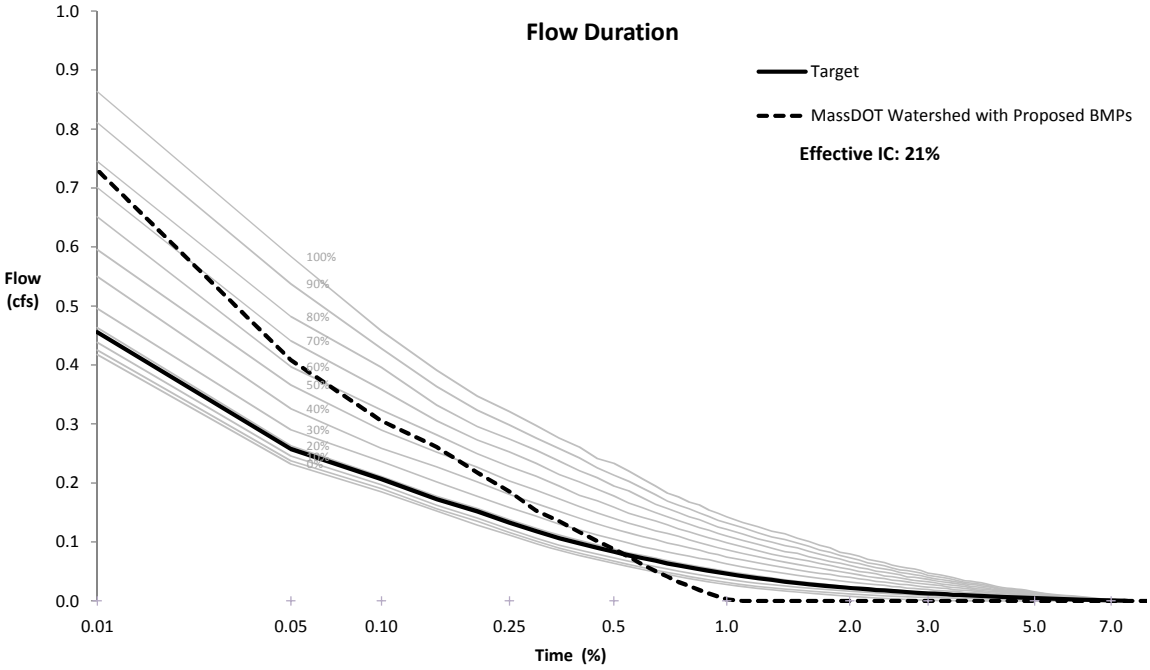
Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		2.3
Watershed IC (no BMP)	100%	2.3
Target IC	17%	0.4
Effective IC w/BMP*	71%	1.6
Difference fromTarget		1.2
IC Reduction	29%	0.7

* Effective IC calculated as follows:

1. Interpolate effective IC separately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effective percentage% by using linear interpolation of percentage to closest load/volume values
   b. For flow duration, calculate average of individually interpolated values taken at equal probability intervals (based on normal distribution)
2. Determine the maximum IC indictor for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA 72-36 Assessment Mode Result Summary for Impervious Cover 44.7



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	0.9	0.1	4
5%IC	1.0	0.1	21
10% IC	1.2	0.1	44
20% IC	1.5	0.3	122
30% IC	1.8	0.5	249
40% IC	2.1	0.8	421
50% IC	2.4	1.2	631
60% IC	2.7	1.6	860
70% IC	2.9	2.0	1,092
80% IC	3.2	2.4	1,323
90% IC	3.5	2.8	1,548
100% IC	3.8	3.2	1,777
Watershed Load	3.4	3.0	1,663
BMP Output	1.0	0.2	61
Target	1.4	0.3	99
Reduction %	**70%**	**93%**	**96%**
Effective IC	**5%**	**14%**	**12%**

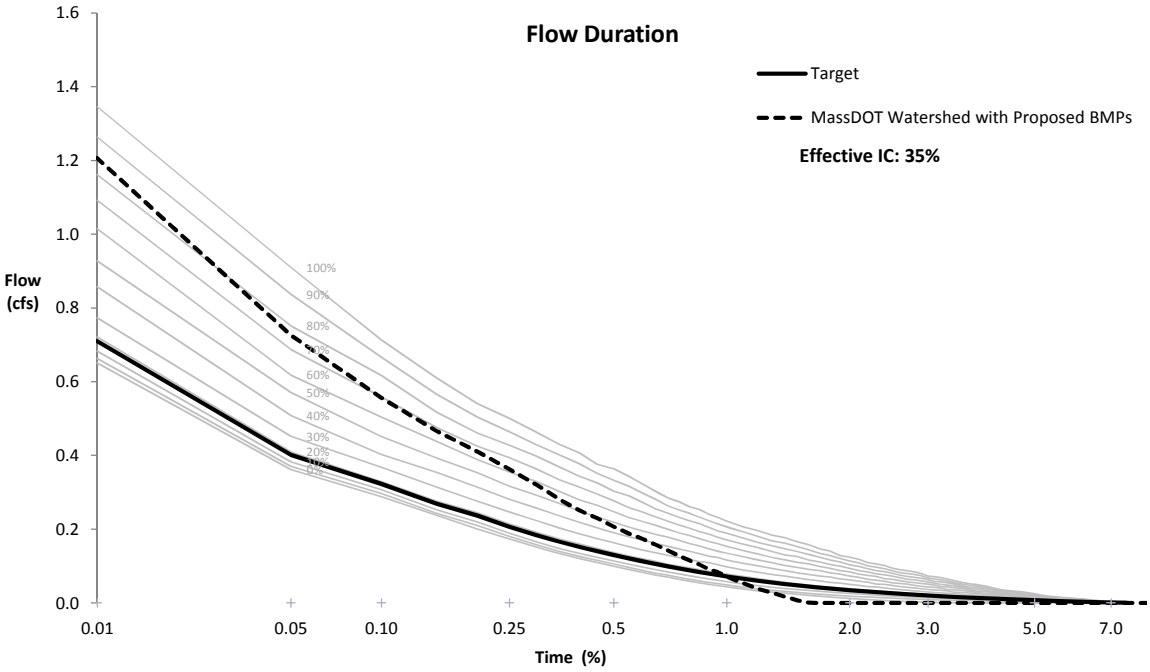
Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.2
Watershed IC (no BMP)	100%	1.2
Target IC	17%	0.2
Effective IC w/BMP*	13%	0.2
Difference fromTarget		(0.0)
IC Reduction	87%	1.0

* Effective IC calculated as follows:

1. Interpolate effective IC separately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effective percentage% by using linear interpolation of percentage to closest load/volume values
   b. For flow duration, calculate average of individually interpolated values taken at equal probability intervals (based on normal distribution)
2. Determine the maximum IC indictor for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA 72-36 Assessment Mode Result Summary for Impervious Cover 45.7



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	1.4	0.1	7
5%IC	1.6	0.2	33
10% IC	1.8	0.2	69
20% IC	2.3	0.5	191
30% IC	2.8	0.8	389
40% IC	3.2	1.3	656
50% IC	3.7	1.9	983
60% IC	4.1	2.5	1,341
70% IC	4.6	3.2	1,702
80% IC	5.0	3.8	2,062
90% IC	5.5	4.4	2,413
100% IC	6.0	5.0	2,769
Watershed Load	5.6	5.0	2,754
BMP Output	2.2	0.6	178
Target	2.2	0.4	154
Reduction %	**61%**	**89%**	**94%**
Effective IC	**18%**	**22%**	**19%**

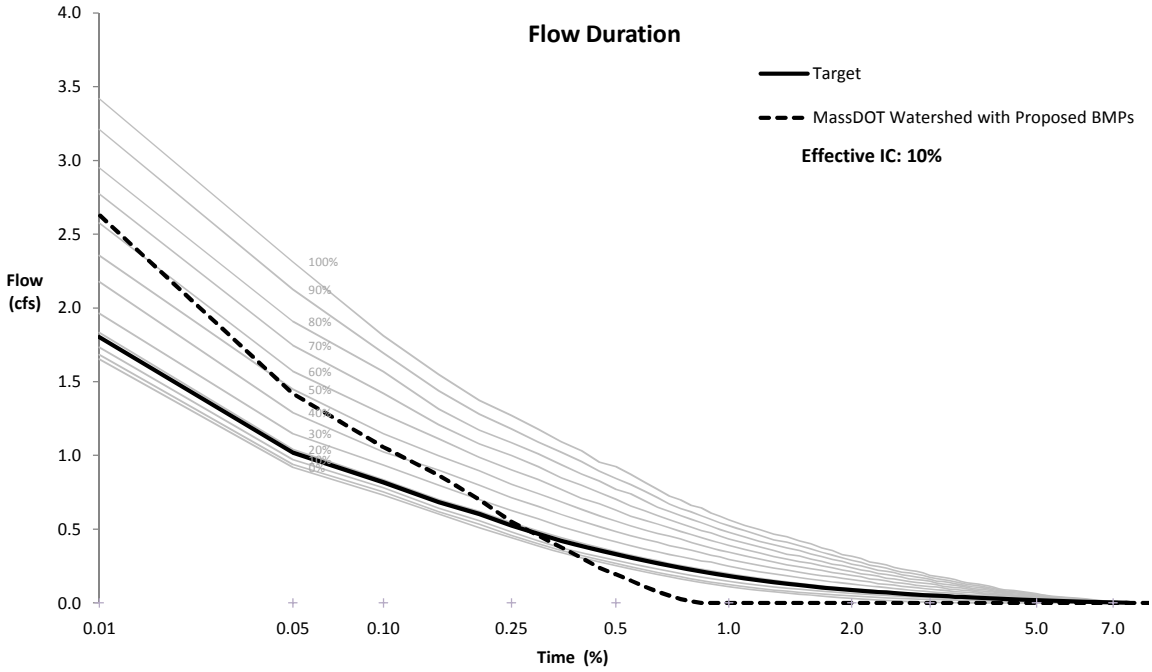
Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		1.9
Watershed IC (no BMP)	100%	1.9
Target IC	17%	0.3
Effective IC w/BMP*	25%	0.5
Difference fromTarget		0.2
IC Reduction	75%	1.4

* Effective IC calculated as follows:

1. Interpolate effective IC separately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effective percentage% by using linear interpolation of percentage to closest load/volume values
   b. For flow duration, calculate average of individually interpolated values taken at equal probability intervals (based on normal distribution)
2. Determine the maximum IC indictor for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

MA 72-36 Assessment Mode Result Summary for Impervious Cover 46.7



Median Annual Load Comparison Table

Condition	Runoff (ac-ft)	Phos. (lb.)	TSS (lb.)
0%IC	3.4	0.3	17
5%IC	4.1	0.4	83
10% IC	4.7	0.6	175
20% IC	5.9	1.2	484
30% IC	7.0	2.1	988
40% IC	8.2	3.4	1,667
50% IC	9.4	4.8	2,497
60% IC	10.5	6.4	3,406
70% IC	11.7	8.0	4,323
80% IC	12.8	9.6	5,237
90% IC	14.0	11.2	6,128
100% IC	15.1	12.8	7,035
Watershed Load	12.1	9.4	5,136
BMP Output	3.0	0.4	108
Target	5.5	1.0	391
Reduction %	**75%**	**96%**	**98%**
Effective IC	**-3%**	**6%**	**6%**

Result Summary

Metric	Area (%)	Area (acres)
Watershed Area		4.8
Watershed IC (no BMP)	100%	4.8
Target IC	17%	0.8
Effective IC w/BMP*	4%	0.2
Difference fromTarget		(0.6)
IC Reduction	96%	4.5

* Effective IC calculated as follows:

1. Interpolate effective IC separately for each metric via interpolation of reference tables/curves
   a. For TSS, P and Flow volume, calculate effective percentage% by using linear interpolation of percentage to closest load/volume values
   b. For flow duration, calculate average of individually interpolated values taken at equal probability intervals (based on normal distribution)
2. Determine the maximum IC indictor for the flow metrics (TSS load and TP load)
3. Take the average of the three IC indicators (runoff volume, maximum of TSS and TP load, flow duration) as the representative effective IC for the watershed

Impaired Waters Assessment for Charles River (MA72-38)

Impaired Waterbody

Name: Charles River

Location: Boston and Cambridge, Massachusetts

Water Body ID: MA72-38 (Formerly part of segment MA72-08)

Impairments

According to the MassDEP Final Year 2010 Integrated List of Waters, this segment of the Charles River is listed under Category 5 as impaired for chlorophyll, combined biota/habitat bioassessments, DDT, dissolved oxygen saturation, excess algal growth, oil and grease, other flow regime alterations, salinity, secchi disk transparency, temperature, nutrient/eutrophication biological indicators, taste and odor, phosphorus (total), sediment screening value (exceedence), and PCB in fish tissue.

Two TMDL reports have been finalized that address the Lower Charles River, which includes this segment:

- *Final Phosphorus TMDL Report for the Lower Charles River Basin (CN 301.0)* which addresses the following impairments: chlorophyll, dissolved oxygen saturation, excess algal growth, secchi disk transparency, nutrient/eutrophication biological indicators, taste and odor, and phosphorus impairments.
- *Final Pathogen TMDL Report for the Charles River Watershed (CN 0156.0).* (Although not impaired for pathogens, the segment is included in the pathogen TMDL.)

The *Charles River Watershed 2002-2006 Water Quality Assessment Report* (MassDEP, 2008) lists discharges from municipal separate storm sewer systems, unspecified urban stormwater, and urban runoff/storm sewers among the main sources of impairments to this segment. Other sources of impairments in the subwatershed include legacy pollutants, thermal discharges, habitat alteration associated with dams/impoundments, contaminated sediments, and upstream sources. Additionally, for this segment of the Charles River, the salinity impairment is related to tidal influences from Boston Inner Harbor and not roadway salt.

Relevant Water Quality Standards

- Water Body Classification: B
- 301 CMR § 4.05 (3)(b) – *Class B. These waters are designed as habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth, and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*

- 314 CMR § 4.05 (3)(b)(1) – *Dissolved Oxygen. a. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.*
- 314 CMR § 4.05 (3)(b)(5) – *Solids. These waters shall be free from floating, suspended and settleable solids in concentrations or 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 (3)(b)(6) – *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 (3)(b)(7) – *Oil and Grease. These waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.*
- 314 CMR § 4.05 (3)(b)(8) – *Taste and Odor. None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to this Class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.*
- 314 CMR § 4.05 (5)(a) – *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 (5)(b) – *Bottom Pollutants or Alterations. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.*
- 314 CMR § 4.05 (5)(c) – *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 pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.*
- 314 CMR § 4.05 (5)(e) - *Toxic Pollutants. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using*

EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants based on site specific considerations.

Summary

MassDOT has assessed stormwater discharges from MassDOT properties to the Charles River using BMP 7R in order to address the Phosphorus and Pathogen TMDLs and BMP 7U in order to address impairments not covered by a TMDL. The following sections describe the methodology for these assessments. Based on this assessment, MassDOT determined that a 27 pound per year reduction in annual phosphorus loading and a 10.2 acre reduction in effective impervious cover (IC) would be needed to meet the targets of the watershed.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	12.2	33
Target Reduction	10.2	27
Reduction Provided in Proposed Conditions	0	0

Presently, Mass DOT's properties draining to the Charles River do not include stormwater best management practices (BMPs). MassDOT has concluded that site constraints and other factors limit the potential for MassDOT to install retrofit stormwater BMPs to treat direct runoff to the Charles River. See the **Proposed Mitigation Plan** section of this assessment for more information.

Site Description

The subject segment is a 3.1 mile segment of the Charles River extending from the Boston University Bridge in Boston/Cambridge to the New Charles River Dam in Boston (see Figure 1). It was formerly part of segment MA72-08. According to the *2002-2006 Water Quality Assessment Report*, the estimated percent IC for this subwatershed is 16.4% and the primary land uses of the 310.6 square mile subwatershed include residential (38%), forest (35%), and open land (10%).

MassDOT roadways that directly discharge stormwater to this segment of the Charles River include the Massachusetts Avenue Bridge and the Longfellow Bridge (Route 3), which both cross over the Charles River, and various ramps and bridges along Storrow Drive and Memorial Drive in the vicinity of these bridges (see Figures 2 and 3). These roadways, ramps, and bridges were recently transferred to MassDOT from the Massachusetts Department of Conservation and Recreation (DCR).

Additional roadways, including the Monsignor O'Brien Highway (Route 28), were also recently transferred to MassDOT from DCR and may contribute runoff to this segment of the Charles River. At this time, the drainage infrastructure and fate of runoff from these areas is unknown, but MassDOT is working with DCR to better understand the drainage system.

Assessment under BMP 7R for Impairments Addressed by Phosphorus TMDL (CN 301.0)

The *Total Maximum Daily Load (TMDL) for Nutrients in the Lower Charles River, Massachusetts (CN 301.0)* addresses the dissolved oxygen, dissolved oxygen saturation, excess algal growth, nutrient/eutrophication biological indicators, phosphorus, taste and odor, chlorophyll-a, and secchi disk transparency impairments for this water body. Therefore, MassDOT assessed the contribution of phosphorus from MassDOT properties to this water body using the approach described in BMP 7R of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have been addressed by a TMDL.

Pollutant of Concern: Phosphorus

1) Impairment Addressed: dissolved oxygen, dissolved oxygen saturation, excess algal growth, nutrient/eutrophication biological indicators, phosphorus, taste and odor, chlorophyll-a, and secchi disk transparency
2) Applicable Waste Load Allocation (WLA): See Table ES-3 of the Final TMDL. As the Final TMDL does not specifically identify Transportation as a land use, MassDOT used the Commercial land use for this WLA analysis based on the conservative assumption that Transportation is most similar to Commercial land uses.
    a) Description of Associated Land Use: Commercial
    b) Commercial Land Use Current Load (TP): 3,676 kilograms per year (kg/yr)
    c) Commercial Land Use WLA (TP): 1,286 kg/yr
    d) Percent Load Reduction (TP): 65%
    e) Commercial Area in Watershed: 8.36 square miles or 2.7% (based on total watershed area of 308 square miles. Transportation not separated from Commercial/Industrial during TMDL analysis)
    f) Commercial Land Use Area WLA: 0.59 kilograms per hectare per year (kg/ha/yr) (0.53 pounds per acre per year (lbs/ac/yr)) (calculated)
3) Implementation Strategy Components: Section 6.2 Final Report
    a) Management of Stormwater from Drainage Systems – Pages 113-115 of the Final TMDL:
        i) "The development and implementation of comprehensive stormwater management programs throughout the Charles River watershed will be necessary to achieve the phosphorus reduction and water quality goals of this TMDL. The management program should accomplish the following tasks:
            (1) characterize the drainage areas that contribute to discharges requiring permit coverage under the Permittee's jurisdiction
            (2) implement a comprehensive Illicit Discharge Detection and Elimination (IDDE) program
            (3) prioritize source areas for control
            (4) include the necessary structural and non-structural best management practices (BMPs) that, upon implementation, will achieve reductions in phosphorus loadings from the NPDES covered drainage areas that are consistent with the phosphorus load reductions identified in this TMDL."

For the BMP 7R Phosphorus Assessment, MassDOT used a site-specific, continuous, long-term hydrologic and pollutant simulation model (the assessment model) to estimate median annual pollutant loads from its property and treatment through both existing and proposed BMPs, if present. The assessment model was run for a 10-year period using hourly Boston rainfall data to capture a range of meteorological conditions and estimate median annual pollutant loads. The pollutant loading portion of the assessment model was calibrated to match pollutant runoff data from the USGS Highway-Runoff Database (Version 1.0, September 2009). The assessment model directly evaluates BMP effects on hydrology (detention, infiltration) and pollutant loads (losses through infiltration, settling, filtration, and biological treatment). For a more detailed description of this approach, see the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

The following table summarizes the assessment model results for the MassDOT directly contributing watershed discharging to the Charles River for existing conditions.

Annual Watershed Phosphorus Loading under Existing Conditions

Watershed/ BMP ID	Watershed Size (Acres)	Pre- BMP Annual Load (pounds/year)	Post-BMP Annual Load (pounds/year)	Estimated Annual Removal Efficiency
Total Directly Contributing MassDOT Watershed	12.4	33	33	0%

The assessment model predicts an annual median load from the MassDOT directly contributing watershed of approximately 33 pounds.

Based on the TMDL, MassDOT's WLA is 0.59 kg/ha/yr (0.53 lbs/ac/yr). For the 12.4 acres of directly contributing MassDOT watershed, this equates to 6.5 pounds per year of phosphorus for MassDOT's directly contributing watershed.

BMP 7R Phosphorus Mitigation Plan

Under existing conditions, MassDOT's estimated directly contributing annual phosphorus load exceeds the TMDL WLA. To mitigate this load, MassDOT will implement stormwater BMPs to the maximum extent given the site constraints.

This assessment does not identify practical locations for stormwater management improvements within the current MassDOT right-of-way. The Proposed Mitigation Plan section discusses the site constraints and mitigation plan.

Assessment under BMP 7R for Pathogens

The *Pathogen Total Maximum Daily Load (TMDL) for the Charles River Watershed (CN 0156.0)* covers the Charles River. The TMDL states that sources of indicator bacteria in the Charles River Watershed were found to be many and varied. The TMDL lists sources as including failing septic systems, combined sewer overflows (CSO), sanitary sewer overflows (SSO), sewer pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals, and direct overland stormwater runoff.

In addition, as stated on page 12 of the TMDL, *Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, stormwater drainage systems and associated stormwater culverts and*

outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by orders of magnitude within a given storm event (MassDEP, 2009). Therefore, it is difficult to predict stormwater pathogen concentrations with accuracy. Due to this difficulty, MassDOT is not conducting site specific assessments of loading at each location impaired for pathogens as part of this Retrofit Program. However, MassDOT recognizes that its roadways, especially in urbanized areas, contribute to the pathogen impairment of the Charles River Watershed and has performed a general assessment and developed a mitigation plan as described below.

BMP 7R Pathogens Assessment

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT has reviewed its existing programs and their consistency with the Pathogen TMDL for the Charles River Watershed recommendations as well as the draft EPA National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements for the North Coastal Watershed.

The Pathogen TMDL for the Charles River Watershed recognizes that mitigation for pathogen impairments is difficult to address and emphasizes the need for an iterative adaptive management approach. The Executive Summary of the TMDL, page xi, states:

> *TMDL implementation to achieve [the pathogen reduction goals] should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate stormwater runoff volume.*

The existing NPDES MS4 permit that covers MassDOT stormwater discharges does not provide guidance on what measures are necessary to comply with the Pathogen TMDL for the Charles River Watershed. The fact sheet for the draft permit for MS4 stormwater discharges for the North Coastal Watershed contains some guidance on what measures EPA has determined necessary to be consistent with the Pathogen TMDL for the Charles River Watershed. Page 36 of the fact sheet states:

> *Instead of a numeric limitation for bacteria, the draft permit includes requirements for MS4s to provide education to pet owners and owners of septic systems, to implement a comprehensive illicit discharge detection and elimination program that addresses not only sources of pathogens but also sources of phosphorus, and to implement programs to address water fowl. In addition, although entitled "Phosphorus Control Plan" most of the actions needed to develop and implement a successful PCP are also effective in supporting the achievement of the WLA for the Charles River pathogen TMDL.*

As discussed above, both the Pathogen TMDL for the Charles River Watershed and the draft North Coastal Watershed MS4 permit state that identification of illicit discharges and addressing stormwater volumes and pollutants, such as phosphorus, are the best approaches to mitigate the pathogen impairments. MassDOT has developed a mitigation plan, described below, to address the pathogen impairments using guidance from these two documents.

BMP 7R Pathogens Mitigation Plan

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review, and source control. The specific non-structural BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

Although not included in this permit term, MassDOT will be implementing a pet waste management program at its rest stops, including those that have discharges to pathogen impaired waters. In addition, MassDOT has requested to be covered under an Individual MS4 permit for the next permit term. A future individual permit may contain additional programmatic BMPs to address pathogens.

The structural BMPs that will be considered to reduce phosphorus loading and the effects of IC would also reduce pathogen loads. See the Proposed Mitigation Plan section of this assessment for more information on the specific BMPs proposed as part of this assessment. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations.

Assessment for Oil & Grease and Temperature under BMP 7U

The Charles River pathogen and phosphorus TMDLs do not address all of the Charles River's impairments, including oil and grease and temperature. Therefore, MassDOT assessed the stormwater-related impairments not addressed by a TMDL using the approach described in BMP 7U of MassDOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan). BMP 7U applies to impairments that have not been addressed by a TMDL.

MassDOT identified a subset of water body impairments in the Charles River Watershed which are not related to stormwater runoff. Specific impairments unrelated to stormwater for the Charles River include biota/habitat bioassessments, flow regime alterations, sediment screening value exceedance, salinity, DDT, and PCB in fish tissue. MassDOT has not included these impairments in this assessment as they are not caused by stormwater runoff. For this segment of the Charles River, the salinity impairment is related to tidal influences from Boston Inner Harbor and not roadway salt.

For the stormwater-related impairments for this water body not covered by a TMDL, MassDOT used an application of EPA Region I's Impervious Cover (IC) Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006). MassDOT used this method to assess potential stormwater impacts on the impaired water and develop the target IC to ensure that stormwater is not the cause of the impairments. The IC Method relates an aquatic system's health

(i.e., state of impairment) to the percentage of IC in its contributing watershed. This method is largely based on the work of the Center for Watershed Protection, which has compiled and evaluated extensive data relating watershed IC to the hydrologic, physical, water quality, and biological conditions of aquatic systems (Schueler, 2003). Water quality in tributary streams, rivers, lakes and ponds is a direct reflection of loading from the watershed (Wetzel, 2001); therefore, the IC method can be used as a surrogate for pollutant loading when evaluating water quality impairments and their causes. Consistent with findings of EPA and others, MassDOT concluded that when a watershed had less than 9% IC, stormwater was not the likely cause of the impairment.

MassDOT developed the target IC reduction using the approach outlined in *Description of MassDOT's Application of Impervious Cover Method in BMP 7U* (MassDOT, 2011). The watersheds of the subject water body were delineated using a combination of USGS Data Series 451 basin delineations and USGS topographical maps. The IC within the watersheds was calculated using both USGS Data Series 451 and MassGIS's Impervious Surface data layer.

The MassDOT IC method for the impaired waters of the Charles River basin includes the following steps:

1. Calculate the percent IC of the water body's entire contributing watershed (total watershed to downstream end of impaired segment) and that of the local watershed contributing directly to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body.
2. For subwatersheds with greater than 9% IC, calculate the amount of IC reduction needed to achieve 9%. For subwatersheds with less and 9% IC, perform no further analysis under BMP 7U.
3. Calculate percentage of IC in the MassDOT directly contributing drainage area.
4. Apply reduction of IC necessary for the subwatershed to achieve 9% to MassDOT contributing drainage area as a target to address the stormwater impairments. Calculate resulting target IC for MassDOT drainage area.
5. In the case where BMPs are in place or where BMPs are proposed, derive IC reduction rates for the BMPs using MassDOT's assessment model based on size, function, and contributing watersheds of the BMPs. See the Long-Term Continuous Simulation for Pollutant Loading and Treatment for MassDOT Impaired Waters Program included in this submittal.

BMP 7U Assessment

Using the approach described above, MassDOT calculated the following values for the total contributing watershed and the subwatershed of the impaired water (Charles River) to determine the IC target (see Figure 1).

Watershed Impervious Cover

	Total Watershed	Subwatershed
Watershed Area	200,373 acres	32,193 acres
Impervious Cover (IC) Area	42,918 acres	16,689 acres
Percent Impervious	21%	52%
IC Area at 9% Goal	18,034 acres	16,268 acres
Target Reduction % in IC	58%	84%

Since the total and subwatersheds are greater than 9% impervious, the analysis indicates that stormwater is a likely contributor to the impairment. To meet the 9% effective IC target, the effective IC within the subwatershed needs to be reduced by 84%. Therefore, the effective IC of MassDOT's directly contributing area also should be reduced by the same percentage to meet the target. The following table shows the resulting targets for MassDOT's contributing property.

Reductions Applied to MassDOT Direct Watershed

MassDOT's Area Directly Contributing to Impaired Segment	12.4 acres
MassDOT's IC Area Directly Contributing to Impaired Segment	12.2 acres
MassDOT's Percent Impervious	99%
MassDOT's Target Reduction in Effective IC (84% of DOT Directly Contributing IC)	10.2 acres
Target Effective IC	16 %

MassDOT's directly contributing area includes 12.2 acres of IC (or 99% of total contributing area). To meet the effective IC target reduction, MassDOT should mitigate 10.2 acres of effective IC. Equivalently, MassDOT's contributing drainage area should act as a watershed of 16% IC.

There are no existing BMPs to mitigate the effects of IC.

BMP 7U Mitigation Plan

Under existing conditions, MassDOT's estimated effective IC exceeds the target as described above. To mitigate the effects of IC, MassDOT will implement stormwater BMPs to the maximum extent practicable.

MassDOT was not able to identify practical locations for stormwater management improvements within the current MassDOT right-of-way. The Proposed Mitigation Plan section discusses the site constraints and mitigation plan.

Proposed Mitigation Plan to Address Phosphorus, Oil & Grease and Temperature

MassDOT is reviewing the Charles River basin as an entire watershed and has committed to constructing stormwater BMP retrofit projects to address impaired waters. During this assessment phase of the Impaired Waters Program, MassDOT has focused on directly contributing areas and identified BMPs that can be constructed entirely on MassDOT property without resulting in substantial wetland impacts or result in an adverse impact on historical or archeological resources. Projects that meet these requirements can utilize the Federal Highway Administration's Alternative Contracting mechanism (SEP-14) created for this program. MassDOT will advance designs for BMPs where practicable in the watershed above and beyond the target mitigation to compensate for areas like these, where site constraints prohibit BMPs.

Based on the review of MassDOT's directly contributing drainage area, no locations for additional BMPs have been identified that can be implemented on MassDOT property to address the impairments of the Charles River given the site constraints described below.

As noted in earlier sections of this assessment, a number of roadways, ramps, and bridges were transferred from the DCR to MassDOT recently. MassDOT will continue to work with the DCR to better understand the drainage in this area. Currently, MassDOT performs inspections with assistance from DCR personnel as one way to better understand the drainage systems.

MassDOT is proposing to rehabilitate the Longfellow Bridge over the Charles River (MassDOT Project #604361). As part of this project, MassDOT has included BMPs to treat stormwater runoff discharging to the Charles River from the Longfellow Bridge. The BMPs may include a gravel wetland located on DCR property in an existing paved area on the Boston side of the bridge. Additional BMPs on the Cambridge side of the bridge may also be constructed. MassDOT continues coordination with DCR and other regulatory agencies to determine the most appropriate stormwater treatment plan for this area. Although not quantified in this assessment, this BMP would reduce the effective IC and annual phosphorus loads to the Charles River. This project serves as an example of MassDOT taking opportunities to include stormwater improvements in programmed projects beyond the limitations of the retrofit program.

In addition, BMP implementation through MassDOT's programmed projects are carefully evaluated and implemented where practicable, and documented through the MassDOT Water Quality Data Form. The potential for BMPs outside of MassDOT property will be reviewed during the design phase of these projects and through ongoing partnerships with other state and local entities. During this assessment analysis, potential BMPs beyond the scope of the impaired waters program were identified and can be reviewed during future projects. In addition to the Longfellow Bridge project, MassDOT will be reviewing upcoming planned improvements on other Charles River bridges for stormwater improvement potential.

Conclusions

MassDOT has assessed stormwater impacts from MassDOT properties directly discharging to the Charles River using BMP 7R to address the Phosphorus and Pathogen TMDLs and BMP 7U to address impairments not covered by a TMDL. This assessment found that no existing BMPs treat stormwater discharges from MassDOT properties. Stormwater BMPs are being implemented in the subwatershed as part of the Longfellow Bridge Rehabilitation Project. No additional locations on MassDOT property were identified for retrofit stormwater improvements.

The following table summarizes the total annual phosphorus and effective IC reductions proposed in the Charles River's watershed.

Reductions Applied to MassDOT Direct Watershed

	Effective IC (Acres)	Phosphorus Load (lbs/yr)
MassDOT's Area Directly Contributing to Impaired Segment	12.2	33
Target Reduction	10.2	27
Reduction Provided in Proposed Conditions*	0	0

* Stormwater improvements included in the Longfellow Bridge project are not included

As an overall program, MassDOT will re-evaluate the potential need for structural BMPs to address pollutant loading when roadwork is conducted as programmed projects for the area.

Further work by MassDOT on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs.

This is consistent with an iterative adaptive management approach to address impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs and finalized assessments including reduction achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater

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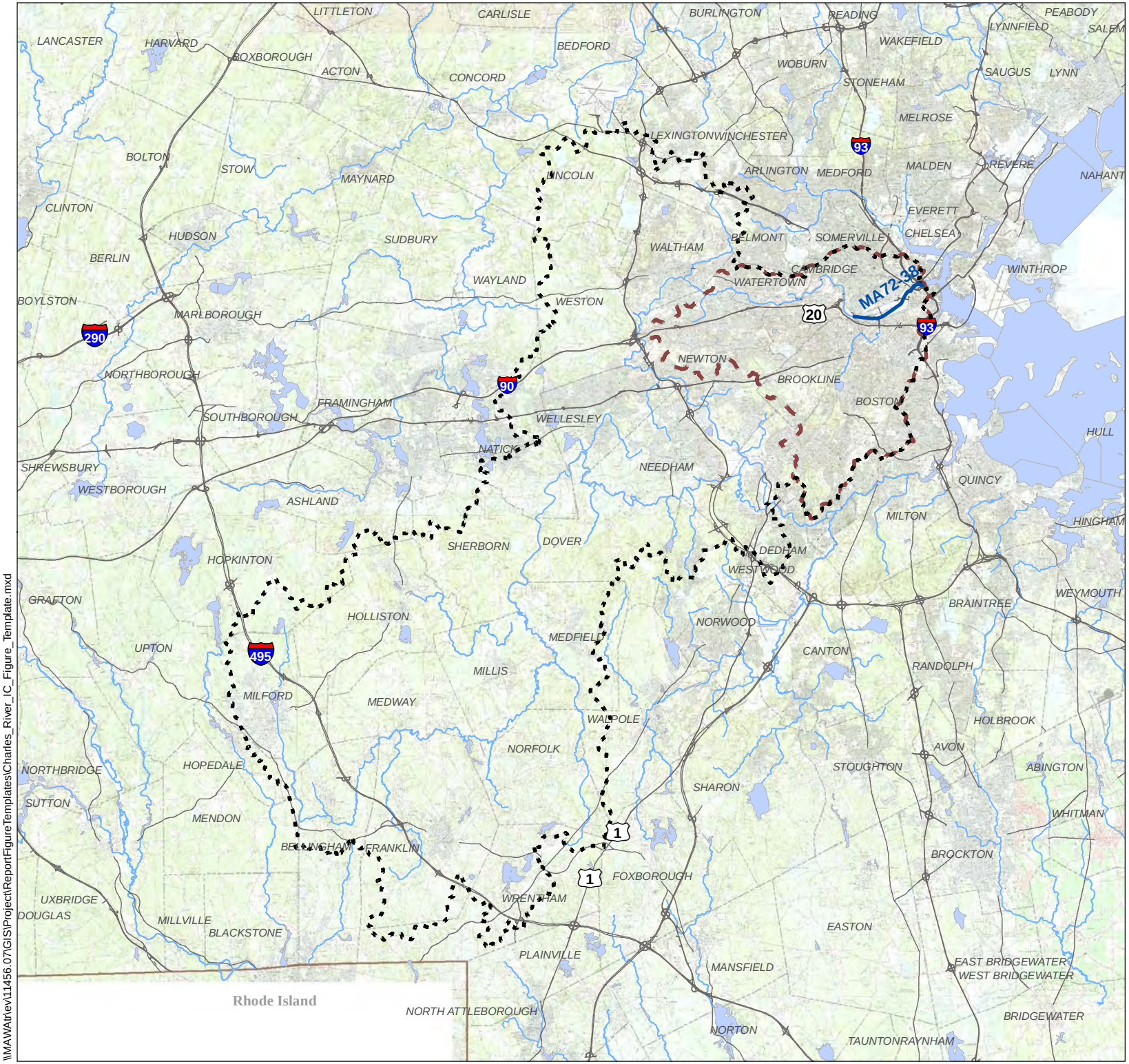

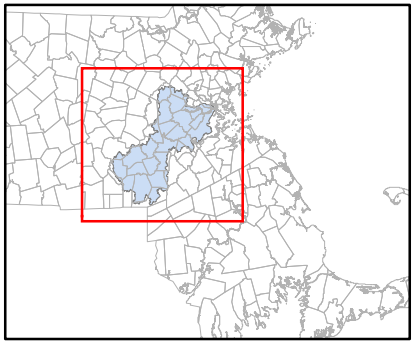

Assessed Stream Segment

Assessed Lake Segment

Total Watershed

Subwatershed

Impaired Lakes

Impaired Streams

MassDOT Roadways

N

0 4 8 Miles

Figure 1

Charles River MA72-38 Watersheds

June 2012

massDOT
Massachusetts Department of Transportation
Highway Division

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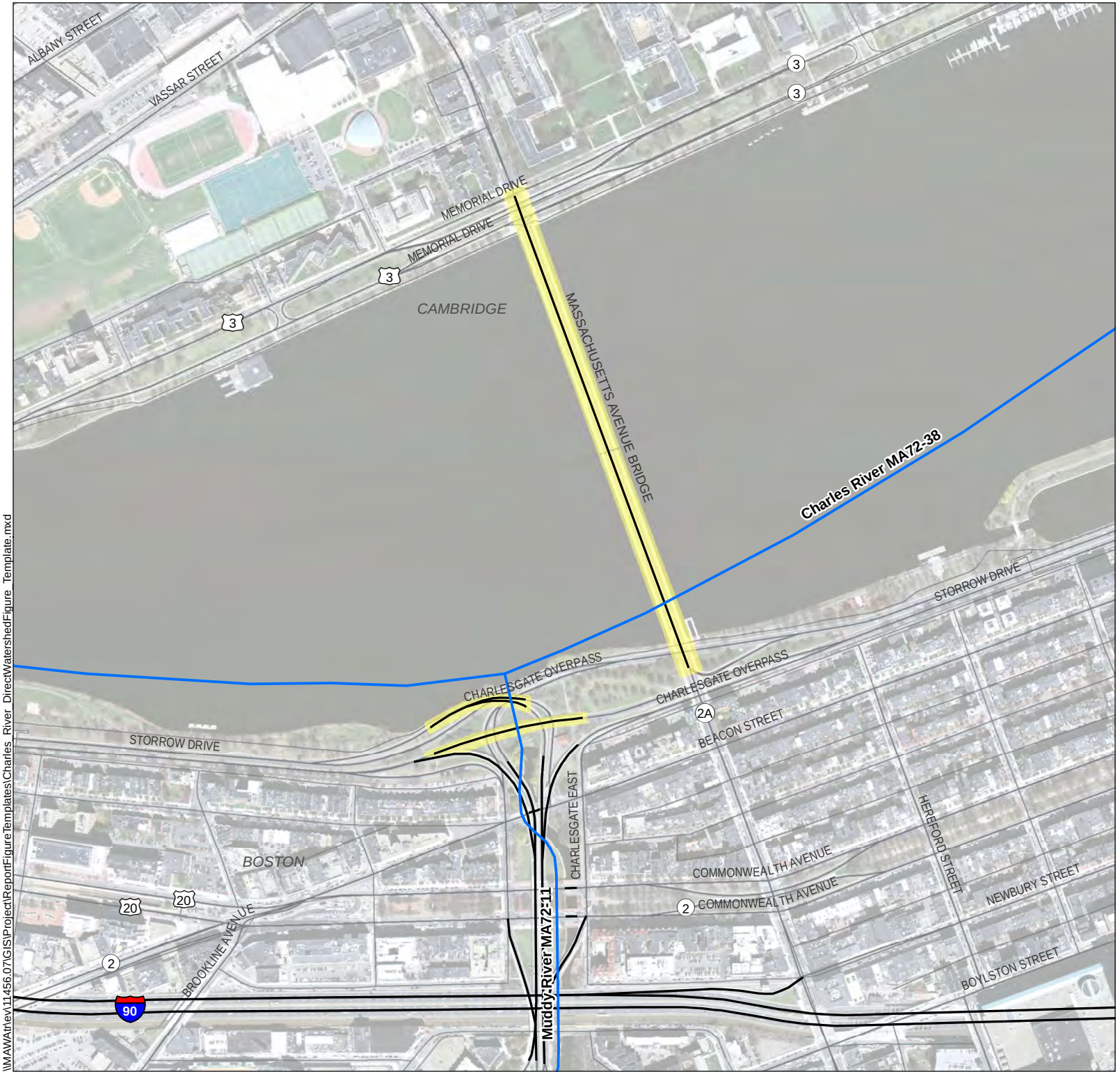

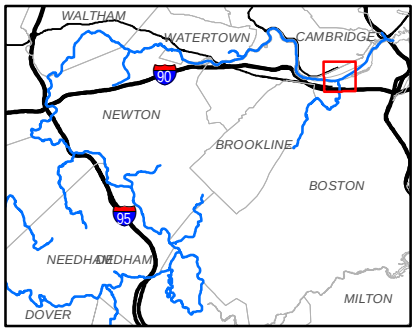

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 250 500 1,000 Feet

Figure 2

Charles River MA72-38 Directly Contributing MassDOT Watershed

June 2012

massDOT Massachusetts Department of Transportation Highway Division

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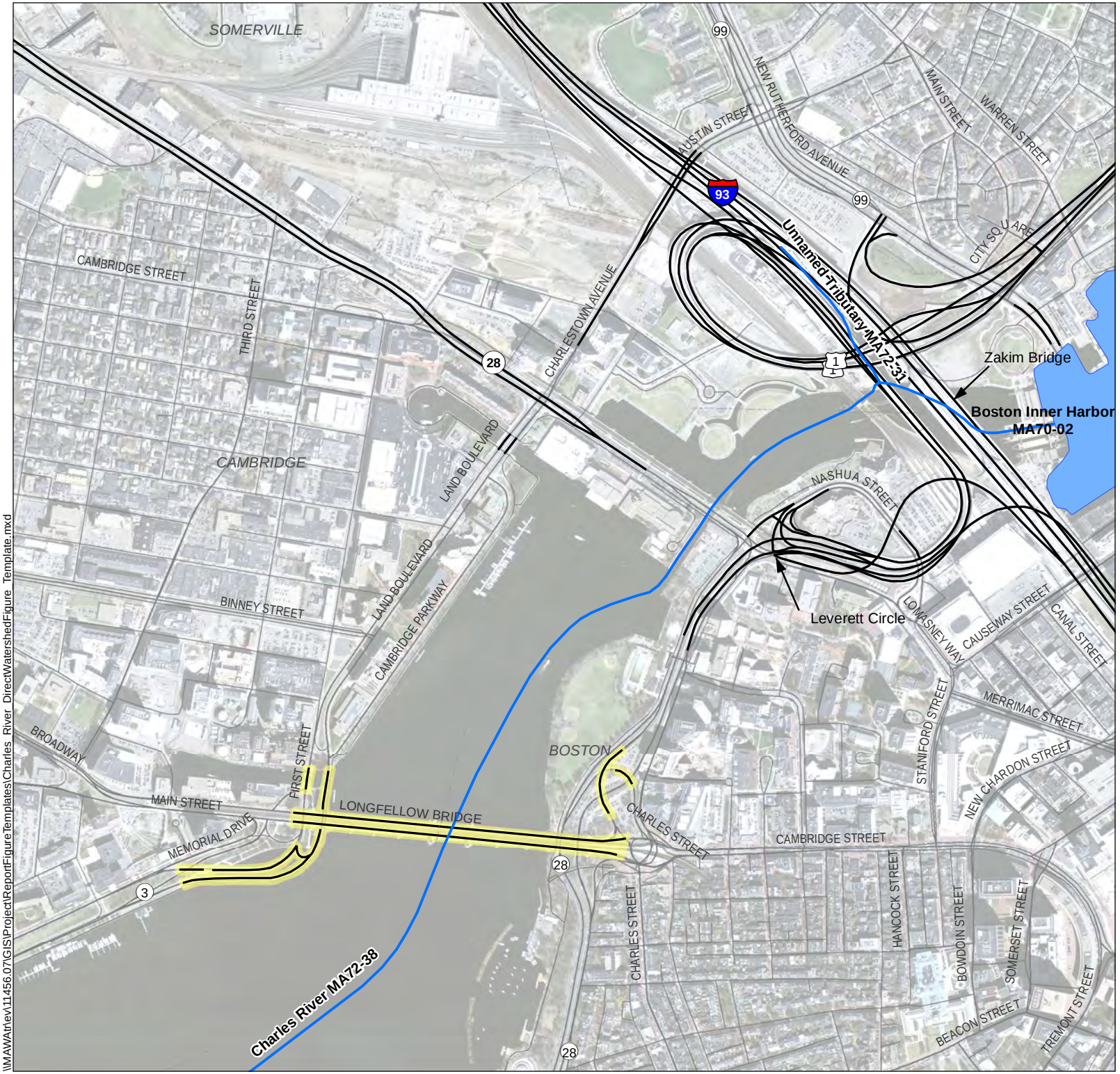

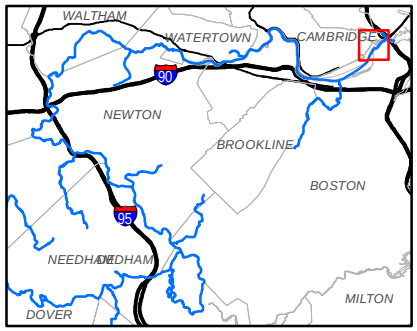

Impaired Streams

Impaired Waters

MassDOT Roadways

MassDOT Directly Discharging Watershed

N

0 375 750 1,500 Feet

Figure 3

Charles River
MA72-38
Directly Contributing
MassDOT Watershed

June 2012

massDOT
Massachusetts Department of Transportation
Highway Division

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Impaired Waters Assessment for Hawkes Pond (MA93032) – Final Report

Introduction

Hawkes Pond (MA93032) was previously assessed in a progress report titled, *Impaired Waters Assessment for Hawkes Pond (MA93032) – Progress Report*, submitted on 12/8/2011. The progress report stated that MassDOT would work with designers to implement BMPs in order to meet its target reduction of impervious cover (IC). MassDOT has since initiated the design of BMPs to address its contribution of storm water to Hawkes Pond. This report presents a summary of the findings of the progress report as well as a final assessment which includes the reduction provided by existing BMPs and the final target IC reduction determined during the Designer's comprehensive investigation and the BMPs in design and their estimated resulting IC removals.

Summary of Progress Report

Impaired Water Body

Name: Hawkes Pond

Location: Lynnfield and Saugus, MA

Water Body ID: MA93032

Impairments

Hawkes Pond (MA93032) is listed under Category 5, "Waters Requiring a TMDL", on both MassDEP's final *Massachusetts Year 2008* and the proposed *Massachusetts Year 2010 Integrated List of Waters*. Table 1 below shows the impairments to Segment MA93032 included on each list.

Table 1. Impairments of Hawkes Pond (MA93032) Included on the Massachusetts Integrated List of Waters

Massachusetts Integrated List of Waters	
Final 2008 List (MassDEP, 2008)	**Proposed 2010 List (MassDEP, 2010a)**
Turbidity	Turbidity

Site Description

Stream inlets discharging to Hawkes Pond are located in the northern side of the pond near Interstate 95 (I-95). The outlet, which is located on the southern side of the pond abutting Route 1 in Saugus, discharges to the lower portion of Hawkes Brook. Drainage from Route 1 in the Hawkes Pond watershed does not discharge directly to Hawkes Pond. Drainage from I-95 on the eastern side Interchange 43 is conveyed to two tributary streams that flow into Hawkes Pond (Figure 3a and

3b). The stormwater outfalls from I-95 in this area are considered direct discharges. Approximately 22acres of MassDOT impervious surface near Interchange 43 drain directly to Hawkes Pond.

Assessment under BMP 7U

The impairment listed for Hawkes Pond, turbidity, has not been addressed by a TMDL. Therefore, MassDOT assessed this impairment using the approach described in BMP 7U (MassDOT, 2011).

Existing BMPs

The progress report listed one existing BMP which was identified in the Hawkes Pond subwatershed as mitigating potential stormwater quality impacts prior to discharge to the pond. A summary of the existing BMP information reported is shown in Table 2.

Table 2. Summary of Existing BMPs

BMP Name	BMP Type	Soil Type	Depth of Runoff Treated (inches)	IC Area Treated (acres)	Reduction of Effective IC* (%)	Reduction of Effective IC (acres)
Ex-BMP-1	Infiltration Basin	C - Silt Loam - 0.27 in/hr	0.9	4.1	80	3.3

*Description of MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT 2011)

Target Reduction

In the progress report, MassDOT derived the following site parameters and target reduction for DOT's directly contributing watershed draining to Hawkes Pond (MA93032) using the IC Method:

Table 3. Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	22	acres
Target Percent Reduction in Effective IC	41	%
Target Reduction in Effective IC to meet 9% IC target	8.9	acres
IC Effectively Reduced by Existing BMPs	3.3	acres
IC Remaining to Mitigate with Proposed BMPs	5.6	acres

Final Assessment

Designer Investigation of Existing BMPs

After the submittal of the progress report, further investigation of the Hawkes Pond subwatershed identified two additional existing BMPs mitigating potential stormwater quality impacts prior to discharge to the pond. The comprehensive investigation also found more precise values of IC area treated and reduction of effective IC for Ex-BMP-1, revising the reduction achieved by this BMP from 3.3 acres to 0.3 acres. Table 4 below summarizes the updated existing BMP information.

Table 4. Summary of Designer Investigation of Existing BMPs

BMP Name	BMP Type	NRCS Hydrologic Soil Group	Storage Volume (in)	IC Area Treated (ac)	Percent Reduction of Effective IC*	Reduction of Effective IC (ac)
Ex-BMP-1	Infiltration Basin	C – Silt Loam 0.27 in/hr	0.9	0.4	80%	0.3
Ex-BMP-2	Infiltration Swale	C – Silt Loam 0.27 in/hr	0.7	1.6	71%	1.2
Ex-BMP-3	Infiltration Basin	C – Silt Loam 0.27 in/hr	1.6	0.6	92%	0.6
Total				**2.6**		**2.0**

*Description of MassDOT's *Application of Impervious Cover Method in BMP 7*U (*MassDOT Application of IC Method, MassDOT 2011*).

Updated Target Reduction

After the submittal of the progress report, further investigation of MassDOT's directly contributing IC area was performed by the Designers. Based on this investigation, the MassDOT Directly Contributing IC Watershed was updated from 21.7 acres to 19.5 acres. Thus, the target reduction of impervious cover, 41% of this IC watershed, was also updated by the designers from 8.9 acres to 7.9 acres based on these more in-depth field evaluations. After taking into account the reduction provided by the existing BMPs determined by the designers, the remaining target reduction of effective IC is 5.9 acres. See Table 5 below.

After the submittal of the progress report, the target reduction of impervious cover was updated from 5.6 acres to 5.9 acres based on more in-depth field evaluations and MassDOT BMP designs.

Table 5. Designer Investigation Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	20	acres
Target Percent Reduction in Effective IC	41	%
Target Reduction in Effective IC to meet 9% IC target	7.9	acres
IC Effectively Reduced by Existing BMPs	2.0	acres
IC Remaining to Mitigate with Proposed BMPs	**5.9**	**acres**

BMPs in Design

MassDOT has initiated the design of additional BMPs to address the target IC reduction of 5.9 acres as part of MassDOT's Impaired Waters Retrofit Initiative. There are currently six infiltration basins and one infiltration swale in design, described below. Table 6 below lists the impervious stormwater catchment area for each BMP as well as the estimated post-construction IC reduction that will be provided by each BMP.

BMP-1

The forested infield area of the I-95 southbound on-ramp at the Walnut Street interchange (Exit 43) could be modified to accommodate an infiltration basin. Modifications would include the restoration

of an existing drainage ditch, adjustments to the existing drainage infrastructure outside of the pavement limits, and installation of a sediment forebay and infiltration basin. NRCS soil data indicates soils in this area are Woodbridge fine sandy loam with an assigned HSG of C. Installing a BMP at this location would reduce the overall effective impervious cover by 0.25 acres.

BMP-2
The forested shoulder area of the I-95 southbound off-ramp at the Walnut Street interchange (Exit 43) could be modified to accommodate an infiltration swale. Modifications would include minor regrading of the shoulder area, adjustments to the existing drainage infrastructure outside of the pavement limits, and installation of an infiltration swale and check dams. NRCS soil data indicates soils in this area are Woodbridge fine sandy loam with an assigned HSG of C. Installing a BMP at this location would reduce the overall effective impervious cover by 0.09 acres.

BMP-3
The vegetated infield area between I-95 and the northbound on-ramp at the Walnut Street interchange (Exit 43) could be modified to accommodate an infiltration basin. Modifications would include the removal of an existing paved waterway, restoration of an existing drainage ditch, the installation of guardrail, adjustments to the existing drainage infrastructure as well as installation of new drainage infrastructure outside of the pavement limits, and installation of sediment forebays and an infiltration basin. NRCS soil data indicates soils in this area are Woodbridge fine sandy loam with an assigned HSG of C. Installing a BMP at this location would reduce the overall effective impervious cover by 1.75 acres.

BMP-4
The grassed shoulder area of the I-95 northbound on-ramp at the Walnut Street interchange (Exit 43) could be modified to accommodate an infiltration basin. Modifications would include minor regrading of an existing drainage ditch, adjustments to the existing drainage infrastructure as well as installation of new drainage infrastructure outside of the pavement limits, extension of the existing guardrail, and installation of a sediment forebay and infiltration basin. NRCS soil data indicates soils in this area are Woodbridge fine sandy loam with an assigned HSG of C. Installing a BMP at this location would reduce the overall effective impervious cover by 0.28 acres.

BMP-5
The forested shoulder area of the I-95 northbound on-ramp at the Walnut Street interchange (Exit 43) could be modified to accommodate an infiltration basin. Modifications would include adjustments to the existing drainage infrastructure outside of the pavement limits, and installation of a sediment forebay and infiltration basin. NRCS soil data indicates soils in this area are Woodbridge fine sandy loam with an assigned HSG of C. Installing a BMP at this location would reduce the overall effective impervious cover by 0.10 acres.

BMP-6
The forested shoulder area of the I-95 northbound barrel could be modified to accommodate an infiltration basin. Modifications would include adjustments to the existing drainage infrastructure as well as installation of new drainage infrastructure outside of the pavement limits, and installation of sediment forebays and an infiltration basin. NRCS soil data indicates soils in this area are Whitman loam with an assigned HSG of D. Installing a BMP at this location would reduce the overall effective impervious cover by 0.25 acres.

BMP-7
The forested shoulder area of the I-95 northbound barrel could be modified to accommodate an infiltration basin. Modifications would include potential adjustments to the existing drainage infrastructure outside of the pavement limits, and installation of a sediment forebay and infiltration basin. NRCS soil data indicates soils in this area are Paxton fine sandy loam with an assigned HSG of C. Installing a BMP at this location would reduce the overall effective impervious cover by 1.00 acres.

Table 6. Summary of BMPs in Design

BMP Name	BMP Type	NRCS Hydrologic Soil Group	Storage Volume (in)	IC Area Treated (ac)	Percent Reduction of Effective IC*	Estimated Post-Construction IC Reduction (ac)
BMP-1	Infiltration Basin	C	1.0	0.3	82%	0.3
BMP-2	Infiltration Swale	C	1.0	0.1	82%	0.1
BMP-3	Infiltration Basin	C	1.0	2.1	82%	1.8
BMP-4	Infiltration Basin	C	1.0	0.3	82%	0.3
BMP-5	Infiltration Basin	C	1.0	0.1	82%	0.1
BMP-6	Infiltration Basin	D	1.0	0.3	74%	0.3
BMP-7	Infiltration Basin	C	1.0	1.2	82%	1.0
Total				**4.5***		**3.8***

* Rounding accounts for difference in summation

Conclusions

Table 7 summarizes IC reductions within MassDOT's directly contributing watershed under the design BMP conditions.

Table 4. Effective IC Reductions Under Design Conditions

Target Reduction in Effective IC	5.9 acres
Effective IC Reduction under Proposed Conditions	3.7 acres
Remaining Target	**2.2 acres**

The seven BMPs have been designed to the maximum extent practicable in order to achieve 3.72 acres of effective IC reduction. The construction of the BMPs is predicted to be complete by the end of August 2012. Note that the estimated effective IC reduction that will be achieved may change depending on the final designs for the conceptual BMPs included in this assessment. The final BMP designs will provide treatment to the maximum extent practicable given site constraints that are identified as the design process moves forward.

The installation of additional BMPs within the Hawkes Pond subwatershed to provide treatment to meet the target reduction was not able to be accomplished due to varying site constraints. Treatment of additional directly contributing IC from Interstate 95 was restricted due to the proximity of MassDOT stormwater outfalls to resource areas (i.e. streams, wetlands, water bodies) and the Lynn Water and Sewer Commission Diversion Channel, stormwater infrastructure mainlines that

convey discharges into three existing culvert crossings under Interstate 95, stormwater infrastructure limitations (i.e. structure tie-in elevations), and right of way limitations. Directly contributing IC from Interstate 95 stormwater infrastructure mainlines that convey discharges into three existing culvert crossings under Interstate 95 covers approximately 7.89 acres and accounts for roughly two fifths of the directly contributing IC within the Hawkes Pond subwatershed. The inability to treat this area due to the location of the stormwater infrastructure mainline, as well as right of way limitations, is the greatest contributor to falling shy of the 9% impervious cover goal.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's Programmed Projects Initiative. Work on Programmed Projects often includes broader scale road layout changes that may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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Impaired Waters Assessment for Lake Quannapowitt (MA93060) – Final Report

Introduction

Lake Quannapowitt (MA93060) was previously assessed in a progress report titled, *Impaired Waters Assessment for Lake Quannapowitt (MA93060) – Progress Report*, submitted on 12/8/2011. The progress report stated storm water from MassDOT does not discharge directly to Lake Quannapowitt. After further review by the design consultants, it was determined that approximately 0.4 acres of storm water from MassDOT property discharges directly to Lake Quannapowitt. This report presents a summary of the findings of the progress report as well as a final assessment which includes the reduction provided by existing BMPs and the final target IC reduction determined during the Designer's comprehensive investigation.

Summary of Progress Report

Impaired Water Body

Name: Lake Quannapowitt

Location: Wakefield, MA

Water Body Segment ID: MA93060

Impairments

Lake Quannapowitt (MA93060) is listed under Category 5, "Waters Requiring a TMDL", on both MassDEP's final *Massachusetts Year 2008* and the final *Massachusetts Year 2010 Integrated List of Waters*. Table 1 below shows the impairments to Segment MA93060 included on each list.

Table 1. Impairments of Lake Quannapowitt (MA93060) Included on the Massachusetts Integrated List of Waters

Massachusetts Integrated List of Waters	
Final 2008 List (MassDEP, 2008)	**Final 2010 List (MassDEP, 2011)**
Excess algal growth	Excess algal growth
Non-native aquatic plants	Non-native aquatic plants
Turbidity	Turbidity
	DDT

Site Description

Lake Quannapowitt is located in the Town of Wakefield, Massachusetts. The lake is located south of Interstate 95 (I-95) and west of Route 129 and has a surface area of approximately 246 acres and outlets at the beginning of the upper reach of the Saugus River (MA93-34). The Lake Quannapowitt subwatershed, delineated as the portion of watershed draining directly to the lake is approximately 667 acres, of which approximately 244 acres are impervious surface. MassDOT property in the Lake Quannapowitt subwatershed includes portions of I-95, portions of the Lowell Street interchange (Exit 40), and portions of Route 129 (Refer to AECOM's Impaired Waters

Assessment for Lake Quannapowitt – Figure 1). Based upon initial review it was determined in the progress report for Lake Quannapowitt that storm water from MassDOT property did not drain to the lake. After the submittal of the progress report, further investigation of the site concluded that storm water from MassDOT property directly discharges to the lake.

Storm water from approximately 0.4 acres of the Lowell Street/Route 129 rotary on and off ramps at the I-95 interchange (Exit 40) owned by MassDOT is collected by a series of catch basins and manholes. Storm water from this area discharges from a Town of Wakefield storm water outfall west of the Lowell Street/Main Street intersection directly into Lake Quannapowitt (See Figure 2).

Final Assessment

Assessment under BMP 7U

The following impairments for Lake Quannapowitt (MA93060) have not been addressed by a TMDL: excess algal growth, non-native aquatic plants, turbidity and DDT. Therefore, MassDOT assessed these impairments using the approach described in BMP 7U of MassDOT's Storm Water Management Plan (*Water Quality Impaired Waters Assessment and Mitigation Plan*), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- excess algal growth
- turbidity

According to the final *Year 2010 Integrated List of Waters*, non-native aquatic plants is considered a non-pollutant and unrelated to stormwater. Therefore, MassDOT has determined that further assessment of this impairment to the water body is not required.

Stormwater is not likely to contribute significantly to the impairment due to DDT. The Nationwide Urban Runoff Program (NURP) conducted by the EPA found that DDT was detected in less than 1% of 121 samples collected and that it "should be considered to pose a minimal threat to the quality of surface waters from runoff contamination" (EPA, 1983). Therefore, MassDOT concluded that stormwater runoff from its roadways does not contribute to the impairment of DDT.

MassDOT's Application of the Impervious Cover Method

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether storm water has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. Impervious cover data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that storm water was a potential cause of the impairment, MassDOT calculated the degree to which impervious cover would need to be reduced in the subwatershed to meet the 9% IC target. This reduction is then applied proportionally to the area of MassDOT roadways/ properties directly discharging to the water body segment to identify MassDOT's target IC reduction.

The 9% IC reduction serves only as a recommended target, and is not meant to imply that any reductions below that target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

Because there are no existing BMPs for Lake Quannapowitt (MA93060), there was no effective IC reduction to take into account when performing these calculations.

Applying the Impervious Cover Method, MassDOT derived the following site parameters to the contributing subwatershed of Lake Quannapowitt:

Subwatershed		
Subwatershed Area	667	acres
Impervious Cover (IC) Area	244	acres
Percent Impervious	37	%
IC Area at 9% Goal	60	acres
Target Reduction % in IC	75	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	0.4	acres
MassDOT's Target Reduction in Effective IC (75% of DOT Directly Contributing IC)	0.3	acres

The subwatershed is greater than 9% impervious which indicates that the storm water may be contributing to the impairment. The subwatershed should target a reduction of its effective IC by 75% to reach the 9% goal. Therefore, MassDOT should aim to reduce its effective IC by the same percentage by removing the effect of 0.3 acres of effective IC.

Recommendations

Since there are no MassDOT existing BMPs providing mitigation of impervious surface to achieve the target of 0.3 acres, MassDOT considered locations for additional BMPs. A review of the MassDOT property indicated that the installation of BMPs within the Lake Quannapowitt subwatershed was not possible due to a limitation in available right of way.

Conclusions

The entire subwatershed of MassDOT owned roadways was investigated and approximately 0.4 acres of MassDOT impervious cover contributes stormwater directly to Lake Quannapowitt. There are currently no existing BMPs associated with the direct discharges from MassDOT property into Lake Quannapowitt. MassDOT reviewed their property and determined that, due to the lack of available space appropriate for BMP construction within right of way, the placement of a BMP for the treatment of their directly contributing impervious cover is not feasible under the Retrofit Initiative.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's Programmed Projects Initiative. Work on Programmed Projects often includes broader scale road layout changes that may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

References

Massachusetts Department of Environmental Protection (MassDEP). (2008). Massachusetts Year 2008 Integrated List of Waters - Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 303(d) and 305(b) of the Clean Water Act. Retrieved from: http://www.mass.gov/dep/water/resources/08list2.pdf

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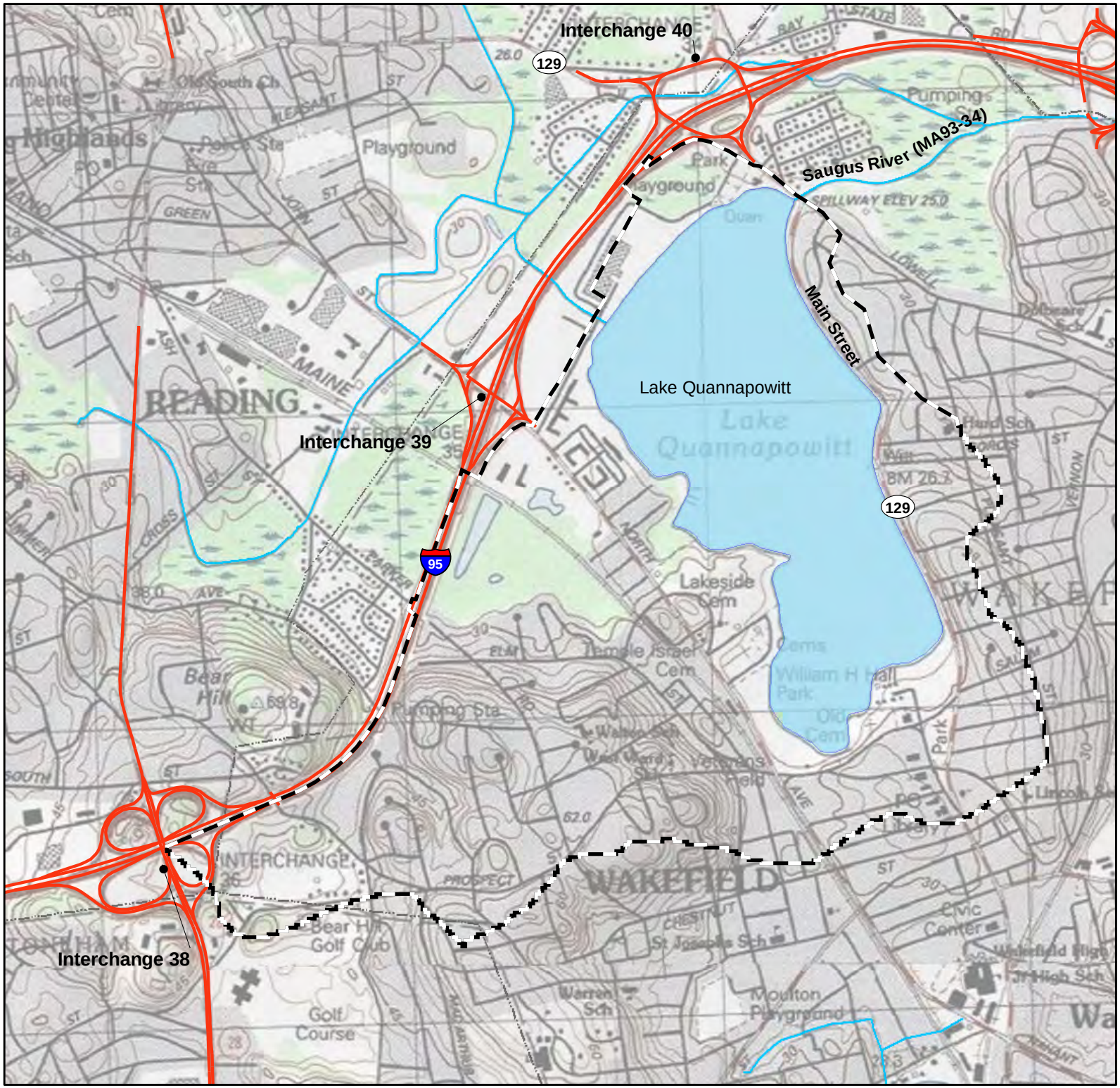
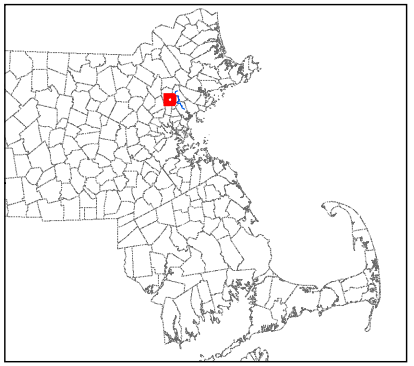




Lake Quannapowitt (MA93060)
Lake Quannapowitt Watershed
MassDOT Roads in Urban Areas
Stream/River
Town Boundary

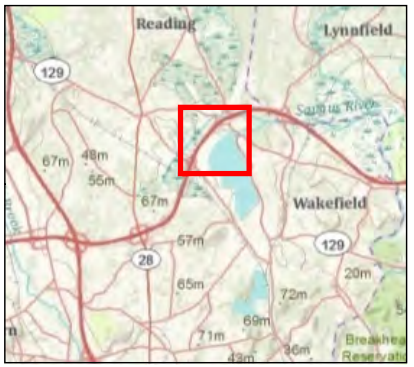
N

0 0.2 0.4 Miles

Figure 1
Lake Quannapowitt Watershed MA93060

September 2011

massDOT



- Stormwater Outfall
- Stream/River
- MassDOT Roads in Urban Areas
- MassDOT Property Drainage Area
- Lake Quannapowitt Watershed Boundary

NWI Wetland Areas

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland

N

0 500 1,000 Feet

Figure 2
MassDOT Drainage Areas
Lake Quannapowitt Watershed
MA93060

September 2011

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Impaired Waters Assessment for Saugus River (MA93-34) – Final Report

Introduction

Segment MA93-34 of the Saugus River was previously assessed in a progress report titled, *Impaired Waters Assessment for Saugus River (MA93-34) – Progress Report*, submitted on 12/8/2011. The progress report stated that MassDOT would work with designers to implement BMPs in order to meet its target reduction of impervious cover (IC). MassDOT has since initiated the design of BMPs to address its contribution of stormwater to Saugus River. This report presents a summary of the findings of the progress report BMPs and the final target IC reduction determined during the Designer's comprehensive investigation and the BMPs in design and their estimated resulting IC removals.

Summary of Progress Report

Impaired Water Body

Name: Saugus River

Location: Lynnfield and Wakefield, MA

Water Body ID: MA93-34

Impairments

Saugus River (MA93-34) is listed under Category 5, "Waters Requiring a TMDL", on both MassDEP's final *Massachusetts Year 2008* and the final *Massachusetts Year 2010 Integrated List of Waters*. Table 1 below shows the impairments to Segment MA93-34 included on each list.

Table 1. Impairments of Saugus River (MA93-34) Included on the Massachusetts Integrated List of Waters

Massachusetts Integrated List of Waters	
Final 2008 List (MassDEP, 2008)	**Final 2010 List (MassDEP, 2011)**
Excess algal growth	Excess algal growth
Fish-passage barrier (Physical substrate habitat alterations)*	Fish-passage barrier (Physical substrate habitat alterations)*
Fecal coliform	Fecal coliform
Turbidity	Turbidity
Total nitrogen	Nitrogen (Total)
Total phosphorus	Phosphorus (Total)
Aquatic plants (Macrophytes)	Aquatic plants (Macrophytes)

Site Description

Drainage from Route 129 (Rte 129) at Interchange 20 with Interstate 90 (I-90) appears to outlet into the Saugus River under Route 129. Stormwater from I-95 and portions of the ramps at Interchange 41 discharges close to or into the river.

Assessment under BMP 7U

None of the impairments for the Saugus River have been addressed by a Total Maximum Daily Load (TMDL). Therefore, MassDOT assessed these impairments using the approach described in BMP 7U of Mass DOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (Mass DOT application of IC Method; MassDOT, 2011), IC provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- excess algal growth
- turbidity
- total nitrogen
- total phosphorus
- aquatic plants (macrophytes)

The impairments for fecal coliform (pathogens) and fish-passage barrier were assessed separately in the progress report. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations for the impairment of pathogens. Also, MassDOT has determined that further assessment of the impairment of fish-passage barrier, caused by a concrete dam, is not required because the impairment is unrelated to stormwater.

According to the Final 2010 Integrated List of Waters, physical substrate habitat alterations are considered a non-pollutant and unrelated to stormwater. Therefore, MassDOT has determined that further assessment of this impairment to the water body is not required.

Existing BMPs

The progress report stated that there are currently no existing BMPs in the Saugus River Segment MA93-34 subwatershed which mitigate potential stormwater quality impacts prior to discharge to the river.

Target Reduction

In the progress report, MassDOT derived the following site parameters and target reduction for DOT's directly contributing watershed draining to the Saugus River (MA93-34) using the IC Method:

Table 2. Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	13	acres
Target Percent Reduction in Effective IC	50	%
Target Reduction in Effective IC to meet 9% IC target	6.5	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	6.5	acres

Final Assessment

Designer Investigation of Existing BMPs

After the submittal of the progress report, further investigation of the Saugus River (MA93-34) subwatershed by the design contractor did not identify any existing BMPs associated with the direct discharges from MassDOT property into the river.

Updated Target Reduction

After the submittal of the progress report, further investigation of MassDOT's directly contributing IC area including closer review of drainage system was performed by the Designers. Based on this investigation, the MassDOT Directly Contributing IC Watershed was updated from 13 acres to 10 acres. Thus, the target reduction of impervious cover, 50% of this IC watershed, was also updated by the designers from 6.5 acres to 5.1 acres based on these more in-depth field evaluations. Because no existing BMPs were identified, the target reduction of effective IC is 5.1 acres. See Table 3 below.

Table 3. Designer Investigation Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	10	acres
Target Percent Reduction in Effective IC	50	%
Target Reduction in Effective IC to meet 9% IC target	5.1	acres
IC Effectively Reduced by Existing BMPs	0	acres
IC Remaining to Mitigate with Proposed BMPs	5.1	acres

BMPs in Design

MassDOT has initiated the design of additional BMPs to address the target IC reduction of 5.1 acres as part of MassDOT's Impaired Waters Retrofit Initiative. There are currently two infiltration swales and three infiltration basins in design, described below. Table 4 below lists the impervious stormwater catchment area for each BMP as well as the estimated post-construction IC reduction that will be provided by each BMP.

BMP-1
The vegetated infield area of the I-95 southbound on-ramp at the Main Street/Vernon Street interchange (Exit 41) could be modified to accommodate an infiltration basin. Modifications would include the restoration of an existing drainage ditch, adjustments to the existing drainage infrastructure outside of the pavement limits, and installation of sediment forebays and an infiltration basin. Natural Resources and Conservation Service (NRCS) soil data indicates soils in this area are Udorthents, smoothed and are adjacent to Hydraulic Soil Group (HSG) A and D. Installing a BMP at this location would reduce the overall effective impervious cover by 0.16 acres.

BMP-2
The grassed infield area of the I-95 southbound on- and off-ramps at the Main Street/Vernon Street interchange (Exit 41) could be modified to accommodate an infiltration swale. Modifications would include adjustments to the existing drainage infrastructure outside of the pavement limits and minor regrading of the infield area for the installation of an infiltration swale and check dams. NRCS soil data indicates soils in this area are Udorthents, smoothed and are adjacent to HSG A and D soils. Installing a BMP at this location would reduce the overall effective impervious cover by 0.13 acres.

BMP-3
The grassed infield area of the I-95 northbound on-ramp at the Main Street/Vernon Street interchange (Exit 41) could be modified to accommodate an infiltration swale. Modifications would include adjustments to the existing drainage infrastructure outside of the pavement limits and minor regrading of the infield area for the installation of an infiltration swale with check dams. NRCS soil data indicates soils in this area are Udorthents, smoothed and Freetown muck with an assigned HSG of D. Installing a BMP at this location would reduce the overall effective impervious cover by 0.12 acres.

BMP-4
The vegetated infield area of the I-95 northbound off-ramp at the Main Street/Vernon Street interchange (Exit 41) could be modified to accommodate an infiltration basin. Modifications would include potential adjustments to the existing drainage infrastructure outside of the pavement limits, the installation of a sediment forebay and infiltration basin. NRCS soil data indicates soils in this area are Freetown muck with an assigned HSG of D. Installing a BMP at this location would reduce the overall effective impervious cover by 0.09 acres.

BMP-5
The grassed infield area of the I-95 northbound off-ramp at the Main Street/Vernon Street interchange (Exit 41) could be modified to accommodate an infiltration basin. Modifications would include adjustments to the existing drainage infrastructure outside of the pavement limits, extension of the existing guardrail, and the installation of a sediment forebay and infiltration basin. NRCS soil data indicates soils in this area are Freetown muck with an assigned HSG of D. Installing a BMP at this location would reduce the overall effective impervious cover by 0.11 acres.

The Designers were not able to identify locations for additional BMPs within the Saugus River (MA93-34) subwatershed to fully meet the target reduction due to varying site constraints. Treatment of additional directly contributing IC from I-95 was restricted due to the proximity of MassDOT stormwater outfalls to resource areas (i.e. streams, wetlands, water bodies), stormwater infrastructure mainlines that convey discharges into two existing culvert crossings, one under Main/Vernon Street and one under I-95, stormwater infrastructure (i.e. structure tie-in elevations) and grading limitations, and right of way limitations. Directly contributing IC from I-95 stormwater infrastructure that conveys discharges into the Reedy Meadow wetland system covers approximately 6.5 acres and accounts for roughly three fifths of the directly contributing IC within the Saugus River (MA93-34) subwatershed. The inability to treat this area due to the proximity of the Reedy Meadow wetland system to the road, as well as right of way limitations, is the greatest contributor to falling shy of the 9% impervious cover goal.

Table 4. BMPs in Design

BMP Name	BMP Type	NRCS Hydrologic Soil Group	Storage Volume (in)	IC Area Treated (ac)	Percent Reduction of Effective IC*	Reduction of Effective IC (ac)
BMP-1	Infiltration Basin	D	1.0	0.21	74%	0.16
BMP-2	Infiltration Swale	D	1.0	0.18	74%	0.13
BMP-3	Infiltration Swale	D	1.0	0.16	74%	0.12
BMP-4	Infiltration Basin	D	1.0	0.12	74%	0.09
BMP-5	Infiltration Basin	D	1.0	0.14	74%	0.11
Total				**0.81**		**0.61**

Conclusions

Table 5 summarizes IC reductions within MassDOT's directly contributing watershed under the design BMP conditions.

Table 5.Effective IC Reductions Under Design Conditions

Target Reduction in Effective IC	5.1	acres
Effective IC Reduction under Proposed Conditions	0.6	acres
Remaining Target	**4.5**	**acres**

The five BMPs have been designed to the maximum extent practicable and will achieve 0.6 acres of effective IC reduction. Note that the estimated effective IC reduction that will be achieved may change depending on the final designs for the BMPs included in this assessment. The final BMP designs will provide treatment to the maximum extent practicable. Additional BMPs could not be constructed due to site constraints discussed in Section BMPs in Design and thus the remaining target cannot be met under the Retrofit Initiative.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's Programmed Projects Initiative. Work on Programmed Projects often includes broader scale road layout changes that may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

References

Massachusetts Department of Environmental Protection (MassDEP). (2008). Massachusetts Year 2008 Integrated List of Waters - Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 303(d) and 305(b) of the Clean Water Act. Retrieved from: http://www.mass.gov/dep/water/resources/08list2.pdf

Massachusetts Department of Environmental Protection (MassDEP). (2011). Massachusetts Year 2010 Integrated List of Waters - Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act. Retrieved from: http://www.mass.gov/dep/water/resources/10list6.pdf

Massachusetts Department of Transportation (MassDOT). (2011). Description of MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT Application of IC Method).

Impaired Waters Assessment for Saugus River (MA93-35) – Final Report

Introduction

Segment MA93-95 of the Saugus River was previously assessed in a progress report titled, *Impaired Waters Assessment for Saugus River (MA93-35) – Progress Report*, submitted on 12/8/2011. The progress report stated that MassDOT would work with designers to implement BMPs in order to meet its target reduction of impervious cover (IC). MassDOT has since initiated the design of BMPs to address its contribution of stormwater to Saugus River. This report presents a summary of the findings of the progress report as well as a final assessment which includes the reduction provided by existing BMPs and the final target IC reduction determined during the Designer's comprehensive investigation as well as the BMPs in design and their estimated resulting IC removals.

Summary of Progress Report

Impaired Water Body

Name: Saugus River

Location: Lynnfield, Wakefield, and Saugus, MA

Water Body ID: MA93-35

Impairments

Saugus River (MA93-35) is listed under Category 5, "Waters Requiring a TMDL", on both MassDEP's final *Massachusetts Year 2008* and the final *Massachusetts Year 2010 Integrated List of Waters*. Table 1 below shows the impairments to Segment MA93-35 included on each list.

Table 1. Impairments of Saugus River (MA93-35) Included on the Massachusetts Integrated List of Waters

Massachusetts Integrated List of Waters	
Final 2008 List (MassDEP, 2008)	**Final 2010 List (MassDEP, 2011)**
Low flow alterations	Low flow alterations
Fecal coliform	Fecal coliform
Alteration in stream-side or littoral vegetative covers	Alteration in stream-side or littoral vegetative covers

Site Description

MassDOT's property that directly contributed stormwater runoff to the Saugus River is comprised of portions of both the southbound and northbound lanes of Interstate 95 at interchange 42 as well as portions of both the southbound and northbound lanes of Route 1.

Assessment under BMP 7U

None of the impairments for the Saugus River have been addressed by a Total Maximum Daily Load (TMDL). MassDOT assessed the impairment of alteration in stream-side and littoral vegetative covers using the approach described in BMP 7U of Mass DOT's Stormwater Management Plan (Water Quality Impaired Waters Assessment and Mitigation Plan), which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (Mass DOT application of IC Method; MassDOT, 2011), IC provides a measure of the potential impact of stormwater on many impairments.

The impairments for fecal coliform and low flow alterations were assessed separately in the progress report for this segment. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations for the impairment of pathogens. Also, MassDOT has determined that further assessment of the impairment of low flow alterations, caused by the diversion from the upstream segment of the Saugus River to Hawkes Pond, is not required because the impairment is unrelated to stormwater.

Existing BMPs

The progress report listed one existing BMP which was identified in the Saugus River subwatershed as mitigating potential stormwater quality impacts prior to discharge to the river. A summary of the existing BMP information reported is shown in Table 2.

Table 2. Summary of Existing BMPs

BMP Name	BMP Type	Soil Type	Depth of Runoff Treated (inches)	IC Area Treated (acres)	Reduction of Effective IC* (%)	Reduction of Effective IC (acres)
Ex-BMP-1	Infiltration Basin	B – Loam 0.52 in/hr	1.8	1.2	96%	1.1

*Description of MassDOT's *Application of Impervious Cover Method in BMP 7U* (*MassDOT Application of IC Method, MassDOT 2011*).

Target Reduction

In the progress report, MassDOT derived the following site parameters and target reduction for DOT's directly contributing watershed draining to the Saugus River (MA93-35) using the IC Method:

Table 3. Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	16	acres
Target Percent Reduction in Effective IC	63	%
Target Reduction in Effective IC to meet 9% IC target	10	acres
IC Effectively Reduced by Existing BMPs	1.1	acres
IC Remaining to Mitigate with Proposed BMPs	9.0	acres

Final Assessment

Designer Investigation of Existing BMPs

After the submittal of the progress report, further investigation of the existing BMP found a more precise value of IC area treated and thus a more precise value of reduction of effective IC. Table 4 below summarizes the updated existing BMP information.

Table 4. Summary of Designer Investigation of Existing BMPs

BMP Name	BMP Type	NRCS Hydrologic Soil Group	Storage Volume (in)	IC Area Treated (ac)	Percent Reduction of Effective IC*	Reduction of Effective IC (ac)
Ex-BMP-1	Infiltration Basin	B – Loam 0.52 in/hr	1.8	1.3	96%	1.3

*Description of MassDOT's *Application of Impervious Cover Method in BMP 7*U (*MassDOT Application of IC Method, MassDOT 2011*).

Updated Target Reduction

After the submittal of the progress report, further investigation of MassDOT's directly contributing IC area was performed by the Designers. Based on this investigation, the MassDOT Directly Contributing IC Watershed was updated from 16 acres to 20 acres. Thus, the target reduction of impervious cover, 63% of this IC watershed, was also updated by the designers from 10 acres to 13acres based on these more in-depth field evaluations. After taking into account the reduction provided by the existing BMPs determined by the designers, the remaining target reduction of effective IC is 12acres. See Table 5 below.

Table 5. Designer Investigation Site Parameters and Target IC Reduction

IC in DOT's Directly Contributing Watershed	20	acres
Target Percent Reduction in Effective IC	63	%
Target Reduction in Effective IC to meet 9% IC target	13	acres
IC Effectively Reduced by Existing BMPs	1.3	acres
IC Remaining to Mitigate with Proposed BMPs	12	acres

BMPs in Design

MassDOT has initiated the design of additional BMPs to address the target IC reduction of 12 acres as part of MassDOT's Impaired Waters Retrofit Initiative. There are currently five infiltration basins in design, described below. Table 6 below lists the impervious stormwater catchment area for each BMP as well as the estimated post-construction IC reduction that will be provided by each BMP.

BMP-1

The vegetated shoulder area north of the I-95 southbound off-ramp at the Audubon Road/Salem Street interchange (Exit 42), west of the culverted section of the Saugus River, could be modified to accommodate an infiltration basin. Modifications would include minor regrading for a conveyance swale, adjustments to the existing drainage infrastructure outside of the pavement limits, and the installation of a sediment forebay and infiltration basin. NRCS soil data indicates soils in this area are Urban Land with a wet substratum and Deerfield loamy fine sand with an

assigned HSG of B. Installing a BMP at this location would reduce the overall effective impervious cover by 0.33 acres.

BMP-2
The vegetated shoulder area north of the I-95 southbound deceleration lane at the Audubon Road/Salem Street interchange (Exit 42), east of the culverted section of the Saugus River, could be modified to accommodate an infiltration basin. Modifications would include adjustments to the existing drainage infrastructure as well as installation of new drainage infrastructure outside of the pavement limits, and the installation of a sediment forebay and infiltration basin. NRCS soil data indicates soils in this area are Deerfield loamy fine sand with an assigned HSG of B. Installing a BMP at this location would reduce the overall effective impervious cover by 0.24 acres.

BMP-3
The forested area south of I-95 at the Audubon Road/Salem Street interchange (Exit 42), east of the I-95 Saugus River culvert, could be modified to accommodate an infiltration basin. Modifications would include adjustments to the existing drainage infrastructure outside of the pavement limits, and the installation of a sediment forebay and infiltration basin. NRCS soil data indicates soils in this area are Deerfield loamy fine sand with an assigned HSG of B. Installing a BMP at this location would reduce the overall effective impervious cover by 0.13 acres.

BMP-4
The grass shoulder area east of where the Lynn Fells Parkway on-ramp meets Route 1 northbound could be modified to accommodate an infiltration basin. Modifications would include adjustments to the existing drainage infrastructure outside of the pavement limits, extension of the existing guardrail, and the installation of a sediment forebay and infiltration basin. NRCS soil data indicates soils in this area are Urban Land and are adjacent to HSG B soils. Installing a BMP at this location would reduce the overall effective impervious cover by 2.1acres.

BMP-5
The vegetated shoulder area east of the Route 1 northbound on-ramp from Lynn Fells Parkway could be modified to accommodate an infiltration basin. Modifications would include adjustments to the existing drainage infrastructure outside of the pavement limits, and the installation of a sediment forebay and infiltration basin. NRCS soil data indicates soils in this area are Urban Land and are adjacent to HSG B soils. Installing a BMP at this location would reduce the overall effective impervious cover by 0.16 acres.

The installation of additional BMPs within the Saugus River (MA93-35) subwatershed to provide treatment to meet the target reduction was not able to be accomplished due to varying site constraints. Treatment of additional directly contributing IC from I-95 was restricted due to the proximity of MassDOT stormwater outfalls to resource areas (i.e. streams, wetlands, water bodies) and right of way limitations. Treatment of additional directly contributing IC from Route 1 was restricted due to the proximity of MassDOT stormwater outfalls to resource areas (i.e. streams, wetlands, water bodies), stormwater infrastructure that conveys discharges into an existing culvert crossing under Route 1, stormwater infrastructure (i.e. structure tie-in elevations) and grading limitations, and right of way limitations. Directly contributing IC from Route 1 stormwater infrastructure that conveys discharges east and west of existing retail lots abutting Route 1 covers approximately 8.2 acres and accounts for roughly two fifths of the directly contributing IC within the Saugus River (MA93-35) subwatershed. The inability to treat this area, due limitations in available right of way, is the greatest contributor to not meeting the 9% impervious cover target.

Table 6. BMPs in Design

BMP Name	BMP Type	NRCS Hydrologic Soil Group	Storage Volume (in)	IC Area Treated (ac)	Percent Reduction of Effective IC*	Reduction of Effective IC (ac)
BMP-1	Infiltration Basin	B	1.0	0.38	87%	0.33
BMP-2	Infiltration Basin	B	1.0	0.28	87%	0.24
BMP-3	Infiltration Basin	B	1.0	0.15	87%	0.13
BMP-4	Infiltration Basin	B	1.0	2.37	87%	2.07
BMP-5	Infiltration Basin	B	1.0	0.18	87%	0.16
Total				**3.4***		**2.9**

Conclusions

Table 7 summarizes IC reductions within MassDOT's directly contributing watershed under the design BMP conditions.

Table 7. Effective IC Reductions Under Design Conditions

Target Reduction in Effective IC	11.5	acres
Effective IC Reduction under Proposed Conditions	2.9	acres
Remaining Target	**8.6**	**acres**

The five BMPs have been designed to the maximum extent practicable and will achieve 2.9 acres of effective IC reduction. Note that the estimated effective IC reduction that will be achieved may change depending on the final design and construction of the BMPs included in this assessment. . Additional BMPs could not be constructed due to site constraints discussed in Section BMPs in Design and thus the remaining target cannot be met under the Retrofit Initiative.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's Programmed Projects Initiative. Work on Programmed Projects often includes broader scale road layout changes that may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding progress made towards meeting target IC reductions, plans for construction of proposed BMPs, and finalized assessments including reductions achieved by finalized BMP designs. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

References

Massachusetts Department of Environmental Protection (MassDEP). (2008). Massachusetts Year 2008 Integrated List of Waters - Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 303(d) and 305(b) of the Clean Water Act. Retrieved from: http://www.mass.gov/dep/water/resources/08list2.pdf

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Impaired Waters Assessment for Noquochoke Lake - Main, South, and North Basins (MA95113, MA95170 and MA95171) – Final Report

Impaired Water Body

Name: Noquochoke Lake (Main Basin, South Basin, and North Basin)

Location: Dartmouth, MA

Water Body ID: MA95113 (Main Basin); MA95170 (South Basin); MA95171 (North Basin)

Impairments

The Noquochoke Lake basins (MA 95113, MA95170 and MA95171) are listed under Category 5, Waters Requiring a TMDL, on MassDEP's final *Year 2008*, final *Year 2010* and proposed *Year 2012 Integrated List of Waters*. Table 1 below shows the impairments to Noquochoke Lake included on each list.

Table 1. Impairments to Noquochoke Lake (MA95113, MA95170 and MA95171) Included on the Massachusetts Integrated Lists of Waters

Massachusetts Integrated List of Waters		
Final 2008 List	**Final 2010 List**	**Proposed 2012 List**
Priority organics	PCB in fish tissue	PCB in fish tissue
Metals	Mercury in fish tissue	Mercury in fish tissue
Pathogens (MA95113 only)	Enterococcus (MA95113 only)	Enterococcus (MA95113 only)
Noxious aquatic plants	Aquatic plants (Macrophytes)	Aquatic plants (macrophytes)
Turbidity	Turbidity	Turbidity
Exotic species (non-pollutant)	(Non-native aquatic plants*)	Non-native aquatic plants*

According to MassDEP's *Buzzards Bay Watershed 2000 Water Quality Assessment Report* (MassDEP 2003), segments MA95113 and MA95170 are impaired due to non-native plants, and segment MA95171 is impaired due to non-native plants and phosphate. The report also states that all three basins are impaired due to mercury and polychlorinated biphenyl (PCBs).

Relevant Water Quality Standards

Water Body Classification: Class B

Applicable State Regulations:

- *314 CMR 4.05 (3)(b) 4. Bacteria.*
    - a. At bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the

bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml

- b. For other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department

- *314 CMR 4.05 (3)(b) 6. 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 (5)(a) 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 (5)(e) Toxic Pollutants*. All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the *National Recommended Water Quality Criteria: 2001, EPA 822-R-02-047, November 200*2 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. Where the Department determines that naturally occurring background concentrations are higher, those concentrations shall be the allowable receiving water concentrations. The department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction. The EPA recommended criteria based on total recoverable metals shall be converted to dissolved metals using EPA's published conversion factors. Permit limits will be written in terms of total recoverable metals. Translation from dissolved metals criteria to total recoverable metals permit limits will be based on EPA's conversion factors or other methods approved by the Department. The Department may establish site specific criteria for toxic pollutants base on site specific considerations.

Site Description

The main, south, and north basins of Noquochoke Lake are located in the Town of Dartmouth, Massachusetts. These basins have surface areas of 88 acres, 13 acres, and 17acres, respectively, with a total contributing watershed area of 3,593 acres. There are two tributaries that discharge into Noquochoke Lake; Shingle Island River, which is tributary to the north basin of Noquochoke Lake, and Upper Pond, which is tributary to the main basin of Noquochoke Lake. The main basin is connected to the north and south basins at the crossing of Reed Road. The main basin of Noquochoke Lake discharges over a spillway into the East Branch Westport River at its southern boundary with Route 6 (See Figure 1).

The Noquochoke Lake subwatershed, delineated as the portion of the watershed draining directly to Noquochoke Lake, is approximately 1,395 acres, of which approximately 138 acres are

impervious surface. MassDOT property in the Noquochoke Lake subwatershed includes portions of Interstate 195 (I-195), the I-195/Reed Road interchange (Exit 11), and portions of US Route 6 (See Figure 2).

Most of the stormwater from I-195 is collected in catch basins and discharges to both the median and shoulders of the highway. Stormwater then flows to Noquochoke Lake through densely vegetated forest, existing wetlands, non-impaired waterways, or stream segments. Stormwater discharges from these portions of the highway are considered indirect and are not included in the BMP 7U assessment. However, there are seven MassDOT stormwater outfalls east of the Shingle Island River culvert that discharge stormwater directly to Noquochoke Lake (See Figure 3).

Directly to the south of the I-195 interchange on Reed Road there are two MassDOT stormwater outfalls. These two MassDOT outfalls are located on the north and south side of the culvert crossing that connects the north basin of Noquochoke Lake to the main basin. Stormwater is collected by a series of catch basins which discharge directly into Noquochoke Lake (See Figure 3).

MassDOT owns three outfalls at the intersection of Route 6 and Route 177. Two of the three outfalls directly discharge to the southern boundary of Noquochoke Lake adjacent to the spillway to the East Branch Westport River (MA 95-40). The third outfall discharges directly to the culvert connecting Noquochoke Lake to East Branch Westport River which is considered a tributary to East Branch Westport River (MA 95-40) and should be included in the Impaired Waters Assessment for that water body segment (See Figure 4).

Assessment under BMP 7U

The following impairments for Noquochoke Lake have not been addressed by a TMDL: priority organics, metals, pathogens, noxious aquatic plants, turbidity, and exotic species. MassDOT assessed these impairments using the approach described in BMP 7U (*Water Quality Impaired Waters Assessment and Mitigation Plan*) of MassDOT's Stormwater Management Plan, which applies to impairments that have been assigned to a water body prior to completion of a TMDL. As described in MassDOT's Application of Impervious Cover Method in BMP 7U (MassDOT, 2011), impervious cover (IC) provides a measure of the potential impact of stormwater on many impairments. For this water body, MassDOT used the IC method to assess the following impairments:

- Priority organics
- Metals
- Noxious aquatic plants
- Turbidity.

The impairment for pathogens was assessed separately in the section titled Assessment under BMP 7U for Pathogens. MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations for the impairment of pathogens.

According to the Final 2010 Integrated List of Waters, non-native aquatic plants are considered a non-pollutant and unrelated to stormwater. Therefore, MassDOT has determined that further assessment of this impairment for the water bodies is not required under BMP 7U.

MassDOT's Application of the Impervious Cover Method

MassDOT's Application of the Impervious Cover Method in BMP 7U applies many aspects of USEPA Region I's Impervious Cover (IC) Method described in EPA's *Stormwater TMDL Implementation Support Manual* (ENSR, 2006) to MassDOT's program. This method assesses potential stormwater impacts on the impaired water and evaluates the impervious cover reduction required to ensure that stormwater is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed has less than 9% impervious cover, MassDOT concludes that stormwater is not the likely cause of the impairment. Additional information regarding this method is provided in MassDOT's Application of IC Method document.

First, MassDOT calculated the percent IC of the water body's entire contributing watershed (total watershed upstream of the downstream end of an impaired segment) and that of the local watershed contributing to the impaired segment (referred to as the subwatershed in this analysis) to determine whether stormwater has a potential to cause the impairments of the receiving water body. The total watershed and subwatershed to the impaired water body were delineated using the USGS Data Series 451. When USGS Data Series watersheds did not delineate the subwatershed of the water body under review, the GIS shapefiles were modified by delineating to the water body based on USGS topography to add specificity. Impervious cover data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces data layer. In cases where it was determined that stormwater was a potential cause of the impairment, MassDOT calculated the degree to which impervious cover would need to be reduced in the subwatershed to meet the 9% IC target. This reduction was then applied proportionally to the area of MassDOT roadways/properties directly discharging to the water body segment to identify MassDOT's target IC reduction. The 9% IC reduction serves only as a recommended target and is not meant to imply that failing to meet that target would cause an exceedance in water quality standards. As explained in BMP 7U, MassDOT will consider a variety of factors apart from numeric guidelines, including site constraints and the magnitude of any potential exceedances in water quality standards, to determine the precise nature and extent of additional BMPs recommended for particular locations. This approach is consistent with the iterative, adaptive management BMP approach set forth in EPA guidelines.

MassDOT calculated the effective impervious cover reduction afforded by the existing structural BMPs currently incorporated into the stormwater infrastructure of MassDOT's properties. This effective IC reduction was calculated by applying effective impervious cover reduction rates to existing BMPs based on their size, function and contributing watershed. BMP performances were derived from EPA Region 1's *Stormwater Best Management Practices (BMP) Performance Analysis* report (EPA, 2010) and engineering judgment. More information on the approach used to calculate the effective impervious cover reductions is described in BMP 7U. When the reduction in effective impervious cover achieved by the existing BMPs was equal to or greater than the target reduction, no further measures were proposed. When this was not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

Using this approach, MassDOT derived the following site parameters for the total contributing watershed of the impaired water (Noquochoke Lake (MA95113, MA95170 and MA95171)):

Table 2. Site Parameters for Noquochoke Lake

Subwatershed		
Subwatershed Area	1,395	acres
Impervious Cover (IC) Area	138	acres
Percent Impervious	9.9	%
IC Area at 9% Goal	126	acres
Target Reduction % in IC	8.7	%
Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	3.9	acres
MassDOT's Target Reduction in Effective IC (8.7% of DOT Directly Contributing IC)	0.3	acres

The subwatershed has impervious cover above the 9% target, which indicates that stormwater likely contributes to the impairments. Impervious cover within the subwatershed should be reduced by 8.7% to reach the 9% target. Therefore, MassDOT should aim to reduce its effective IC by the same percentage by removing the effect of 0.3 acres of effective IC.

Existing BMPs

There are currently no existing BMP's associated with the direct discharges from MassDOT property into Noquochoke Lake. There are three MassDOT directly contributing outfalls where infiltration may occur during low-flow events, however, due to the close proximity of Noquochoke Lake to the outfalls, significant treatment is unlikely to occur during moderate and high flow events.

Next Steps

Since there are no MassDOT existing BMPs providing mitigation of impervious surface to achieve the target of 0.3 acres, MassDOT has initiated the design of an infiltration basin. The moderately forested median area of I-195 east of the culvert connecting Shingle Island River to Noquochoke Lake will be modified to provide treatment as an infiltration basin. The modification is expected to include the construction of forebays at the five directly contributing MassDOT outfall locations within the median, as well as construction of a berm at the base of slope upstream of the existing culvert. Figure 5 shows the location of the infiltration basin in design.

As shown in the table below, the BMP in design is estimated to reduce the overall effective impervious cover by 0.9 acres thus exceeding the target reduction of effective IC within the Noquochoke Lake subwatershed.

Table 3. Summary of BMPs in Design

BMP Name	BMP Type	Soil Type	IC Area Treated (acres)	Reduction of Effective IC* (%)	Reduction of Effective IC (acres)
BMP-1	Infiltration Basin	D	1.2	74%	0.9

*Description of MassDOT's *Application of Impervious Cover Method in BMP 7U (MassDOT Application of IC Method, MassDOT 2011)*.

Assessment under BMP 7U for Pathogens

Pathogen concentrations in stormwater vary widely temporally and spatially; concentrations can vary by an order of magnitude within a given storm event at a single location (MassDEP, 2009b). Therefore, it is difficult to predict pathogen concentrations in stormwater with accuracy. Due to this difficulty, MassDOT generally will not conduct site specific assessments of loading at each location impaired for pathogens. Instead these sites will be assessed collectively based on available information on pathogen loading from highways, MassDOT actions, and information available from EPA and DEP. Based on this information MassDOT developed an approach to be consistent with relevant TMDL and permit condition requirements and an iterative adaptive management approach to stormwater management.

In addition, while there is a positive relationship between impervious cover and pathogen loading, the relationship is not as direct as other impairments. According to the Center for Watershed Protection "…Other studies show that concentrations of bacteria are typically higher in urban areas than rural areas (USGS, 1999), but they are not always directly related to IC (CWP, 2003)." Therefore, MassDOT did not rely solely on the IC method to assess pathogen impairments. Instead, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

Pathogens in MassDOT Discharge

A study conducted on MassDOT's South East Expressway measured bacterial concentrations in stormwater runoff (Smith, 2002). This study found a geometric mean of 186 fecal coliformorganisms/100 ml. Concentrations of pathogens in stormwater runoff from roadways can vary widely and pathogen concentrations in runoff across the state likely deviate significantly from this stretch of roadway's specific estimate. Event mean concentrations of fecal coliform bacteria in urban stormwater from other sources ranging between 14,000 and 17,000 fecal coliformorganisms/100 ml have been reported (MassDEP, 2009b). This data suggests that pathogen loading from highways may be lower than other urban areas.

Consideration of the potential sources of pathogens supports the idea that pathogens are present in lower concentrations in highway runoff since potential pathogen sources are likely to be less prevalent in the highway environment than other urban roadways:

- Illicit discharges: Due to the typical setback of highways from residential and commercial developments and the stand alone nature of the drainage system, the potential for illicit discharges (e.g. sewer connections, laundry tie-ins) is much lower than in other stormwater systems. This has been confirmed by MassDOT's illicit discharge detection on many miles of urban roadways within a broad range of areas across Massachusetts. After assessment of almost 140 miles, and investigation of more than 2,500 stormwater features, MassDOT's consultant performing the broad scope reviews has found no confirmed illicit discharges.
- Limited Sewer Utilities in Road Right of Ways: Since DOT does not provide sewer services, many MassDOT roads do not have sewer utilities within the road's right of way; thereby eliminating the chance of cross-connections or leaking pipes as a source of pathogens into the stormwater system.
- Pet waste: Pets are only present on highways in rare instances. In urban residential areas pets and their associated waste are much more common. MassDOT is aware that pet waste at road side rest stops may represent a potential source of pathogens to stormwater in certain situations.
- Wildlife: Highways are not generally an attractive place for wildlife. Wildlife generally avoids highways and only occasionally cross them.

The dearth of pathogen sources on highways and the relatively low concentrations of pathogens measured in the South East Expressway study together suggest that pathogen loading from stormwater runoff from highways is lower than other urban sources.

Furthermore, in almost all cases the contribution of pathogens from MassDOT to a specific water body is likely to be very small relative to other sources of pathogens in the watershed. Since MassDOT urban roadways are linear and usually cross watersheds, they represent a small fraction of the receiving water body's watershed. The water quality within these water bodies is dependent on discharge from various sources, including discharges from other stormwater systems and a large number of other factors.

Assessment and Mitigation Plan

Pathogen loadings are highly variable and, as a result, quantitative assessments are challenging and of little value. Therefore, MassDOT reviewed its existing programs and their consistency with EPA NPDES MS4 general permit requirements and Pathogen TMDL recommendations.

TMDLs for pathogen impairments in Massachusetts recognize that pathogens are highly variable and difficult to address and emphasize the need for an iterative adaptive management approach to address pathogens. Examples of relevant language from these TMDLs are included below:

- "given the vast potential number of bacteria sources and the difficulty of identifying and removing them from some sources such as stormwater require an iterative process and will take some time to accomplish. While the stated goal in the TMDL is to meet the water quality standard at the point of discharge it also attempts to be clear that MassDEP's expectation is that for stormwater an iterative approach is needed…" (MassDEP, 2009a)
- "The NPDES permit does not, however, establish numeric effluent limitations for stormwater discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals."(MassDEP, 2009b)
- "Although the TMDL presents quantified WLAs for stormwater that are set equivalent to the criteria in the Massachusetts Water Quality Standards, the Phase II NPDES permits will not include numeric effluent limitations. Phase II permits are intended to be BMP based permits that will require communities to develop and implement comprehensive stormwater management programs involving the use of BMPs. Massachusetts and EPA believe that BMP based Phase II permits involving comprehensive stormwater management together with specific emphasis on pollutants contributing to existing water quality problems can be consistent with the intent of the quantitative WLAs for stormwater discharges in TMDLs." (MassDEP, no date).

This language clearly indicates that an iterative adaptive management approach is the appropriate way to address discharges to pathogen impaired waters. The recommendations in pathogen TMDLs for waters in Massachusetts generally require development and implementation of stormwater management programs, illicit discharge detection and elimination efforts, and in some cases installing BMPs to the maximum extent practicable

The draft North Coastal Watershed General MS4 permit and the draft Interstate, Merrimack, and South Coastal (IMS) watershed permits contains specific requirements for compliance with pathogen TMDLs (in Appendix G). While these permits are still in draft form, MassDOT believes they represent the best available guidance on what EPA believes is appropriate for addressing stormwater discharges to pathogen-impaired waters. Section 2.2.1(c) of the permit states "For any discharge from its MS4 to impaired waters with an approved TMDL, the permittee shall comply with the specific terms of Part 2.1 of this permit. In addition, where an approved TMDL establishes a

WLA that applies to its MS4 discharges, the permittee shall implement the specific BMPs and other permit requirements identified in Appendix G to achieve consistency with the WLA." Appendix G references a number of programmatic BMPs that are necessary to address pathogen loading. These cover the following general topics:

- Residential educational program
- Illicit connection identification, tracking and removal
- Pet waste management

MassDOT implements a variety of non-structural BMP programs across their system in accordance with their existing Stormwater Management Plan (SWMP) including educational programs, illicit connection review and source control. The specific BMPs that can help reduce potential pathogen loading in the current SWMP include:

- BMP 3C-1: Drainage Connection Policy
- BMP 3C-2: Drainage Tie-In Standard Operating Procedure
- BMP 3D: Illicit Discharge Detection Review
- BMP 5H-1: Post Construction Runoff Enforcement – Illicit Discharge Prohibition
- BMP 5H-2: Post Construction Runoff Enforcement – Drainage Tie-In
- BMP 5H-3: Post Construction Runoff Enforcement – Offsite Pollution to MassHighway Drainage System
- BMP 6A-1: Source Control – 511 Program
- BMP 6A-2: Source Control – Adopt-A-Highway Program
- BMP 6C-1: Maintenance Program

In addition, the structural BMPs that will be considered to reduce the IC will also have the effect of reducing pathogen loads.

MassDOT believes the existing and proposed efforts are consistent with the current and draft MS4 permit's requirements and TMDL recommendations. MassDOT's existing stormwater management plan outlines BMPs that include education and illicit discharge detection and elimination. Although not included in this permit term, MassDOT will be implementing a pet waste management program at its rest stops that have discharges to pathogen impaired waters. In addition, MassDOT has requested coverage under an individual stormwater permit for the next permit term. This permit may contain additional programmatic BMPs to address pathogens.

Conclusions

MassDOT evaluated its property within the directly contributing watershed to Noquochoke Lake (MA95113, MA95170 and MA95171) and no existing BMPs were identified. Therefore, BMPs should be implemented to achieve the target effective IC reduction of 0.3 acres.

The following table summarizes the effective IC removal of BMPs in Design.

Table 4. Effective IC Reductions under Existing & Design Conditions

IC in Directly Contributing Watershed	3.9	acres
Target Reduction in Effective IC	0.3	acres
Effective IC Reduction under Existing Conditions	0.0	acres
Effective IC Reduction under Proposed Conditions	0.9	acres
Remaining Target Reduction	**0.0**	**acres**

The BMP currently in design is estimated to provide a reduction of approximately 0.9 acres which exceeds the target removal.

Based on review of the draft North Coastal Watershed General MS4 permit, the draft Interstate, Merrimack, and South Coastal watershed permits, and pathogen TMDLs for Massachusetts waters, MassDOT has concluded that the BMPs outlined in the stormwater management plan and those under consideration for reducing effective IC from MassDOT areas are consistent with its existing permit requirements. MassDOT believes that these measures achieve pathogen reductions to the maximum extent practicable and are consistent with the intent of its existing stormwater permit and the applicable Pathogen TMDLs.

MassDOT will continue to identify opportunities to implement additional structural BMPs to address pollutant loading when road work is conducted under MassDOT's Programmed Projects Initiative. Work on programmed projects, which often include broader scale road layout changes, may provide additional opportunities for construction of new treatment BMPs. This is consistent with an iterative adaptive management approach to addressing impairments. MassDOT will include an update in annual reports and biannual submittals to EPA regarding the design progress made towards meeting the IC reduction, plans for construction of the BMPs and finalized assessments. Furthermore, MassDOT will continue to implement non-structural BMPs that reduce the impacts of stormwater.

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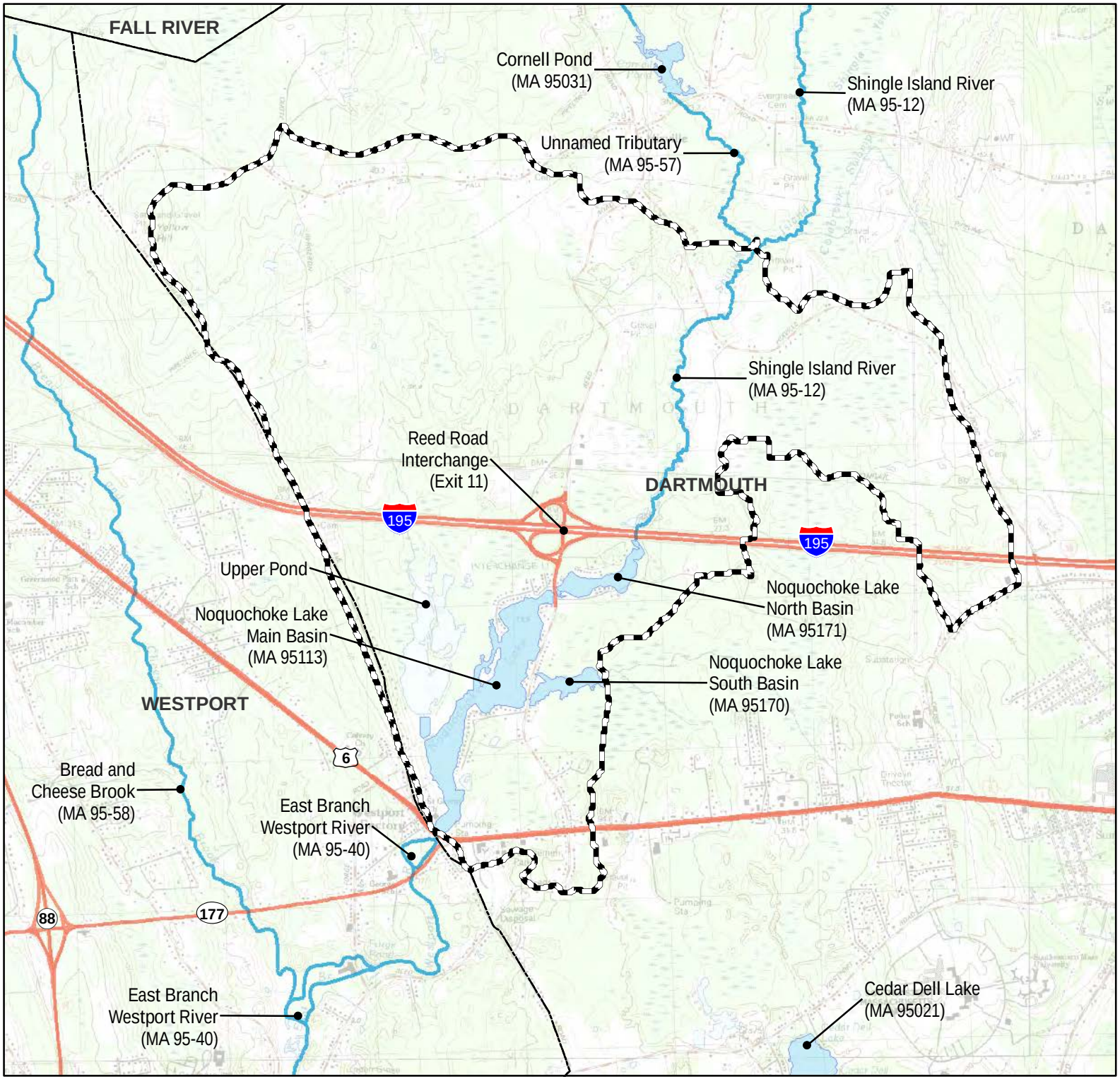
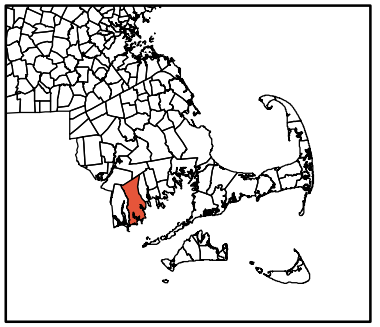




Noquochoke Lake Watershed Boundary
Town Boundary
MassDOT Roads
Impaired Water Bodies
Impaired Stream Segments

N

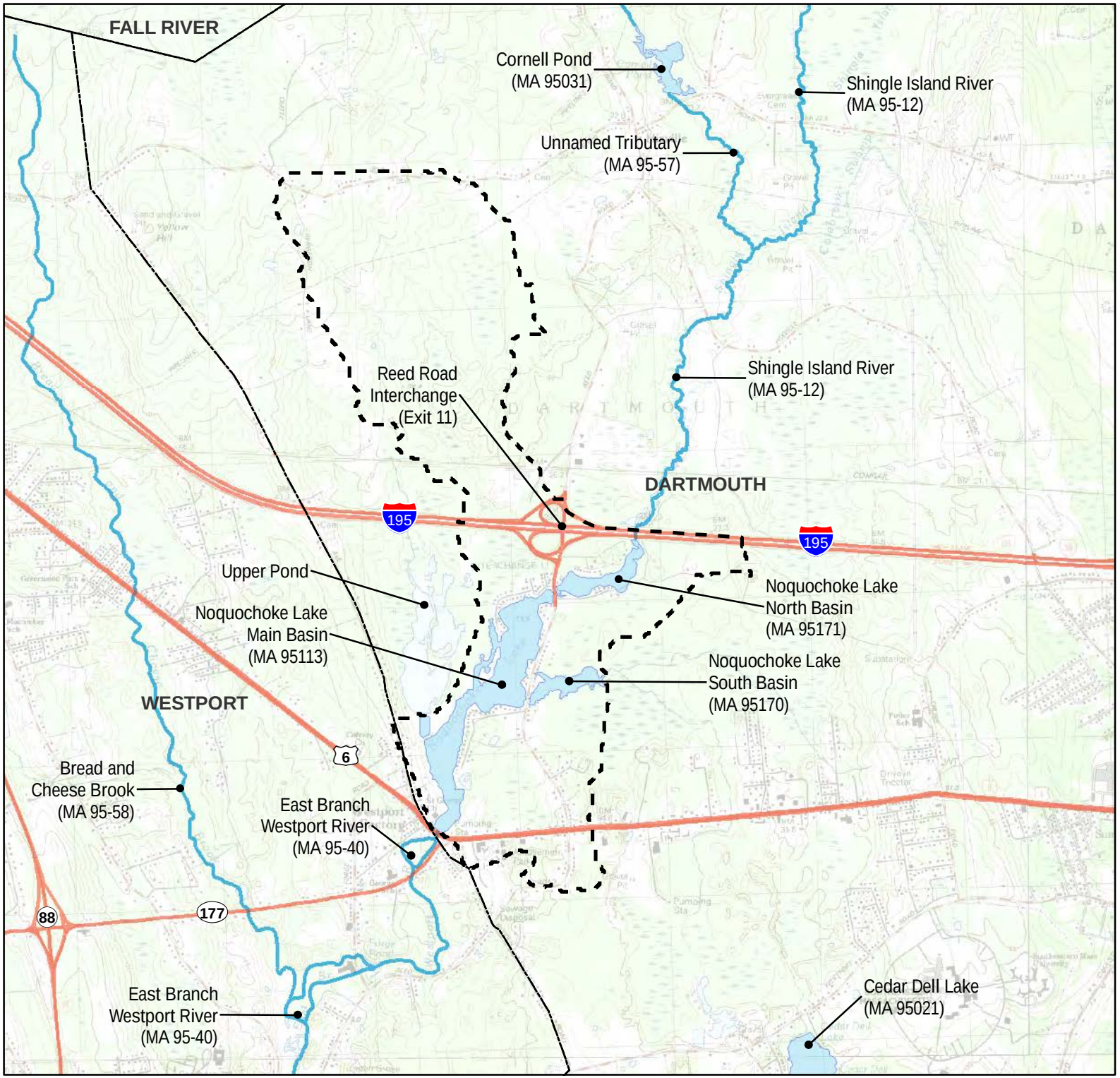
0 1,500 3,000
Feet

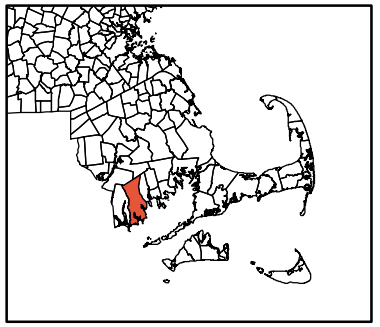
Figure 1

Noquochoke Lake
Total Contributing Watershed
Main, South, and North Basins
(MA 95113; MA 95170; MA 95171)

January 2012

massDOT
Massachusetts Department of Transportation
Highway Division





Noquochoke Lake Subwatershed Boundary

Town Boundary

MassDOT Roads

Impaired Water Bodies

Impaired Stream Segments

N

0 1,500 3,000

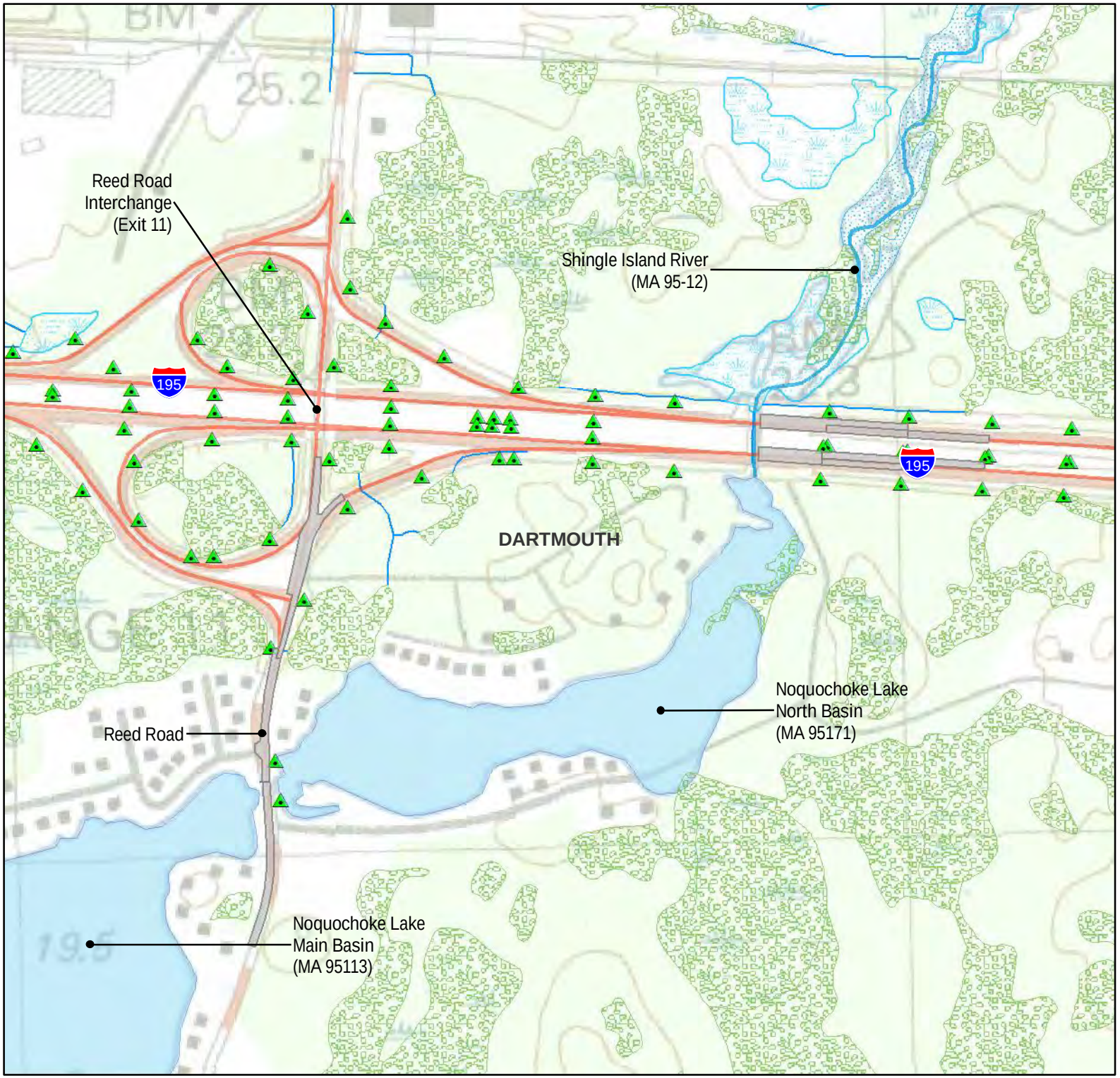
Feet

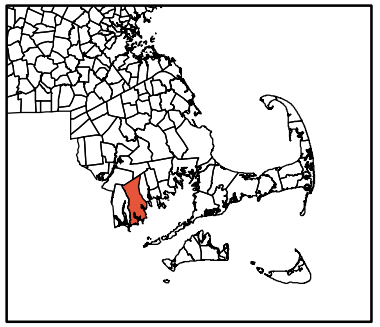
Figure 2

Noquochoke Lake
Directly Contributing Subwatershed

January 2012

MassDOT
Massachusetts Department of Transportation
Highway Division





Town Boundary
MassDOT Stormwater Outfalls
MassDOT Roads
Hydrologic Connection
Marsh/Bog
Wooded Marsh
Open Water
Impaired Stream Segments
Impaired Water Bodies
MassDOT Directly Contributing Impervious Area

N

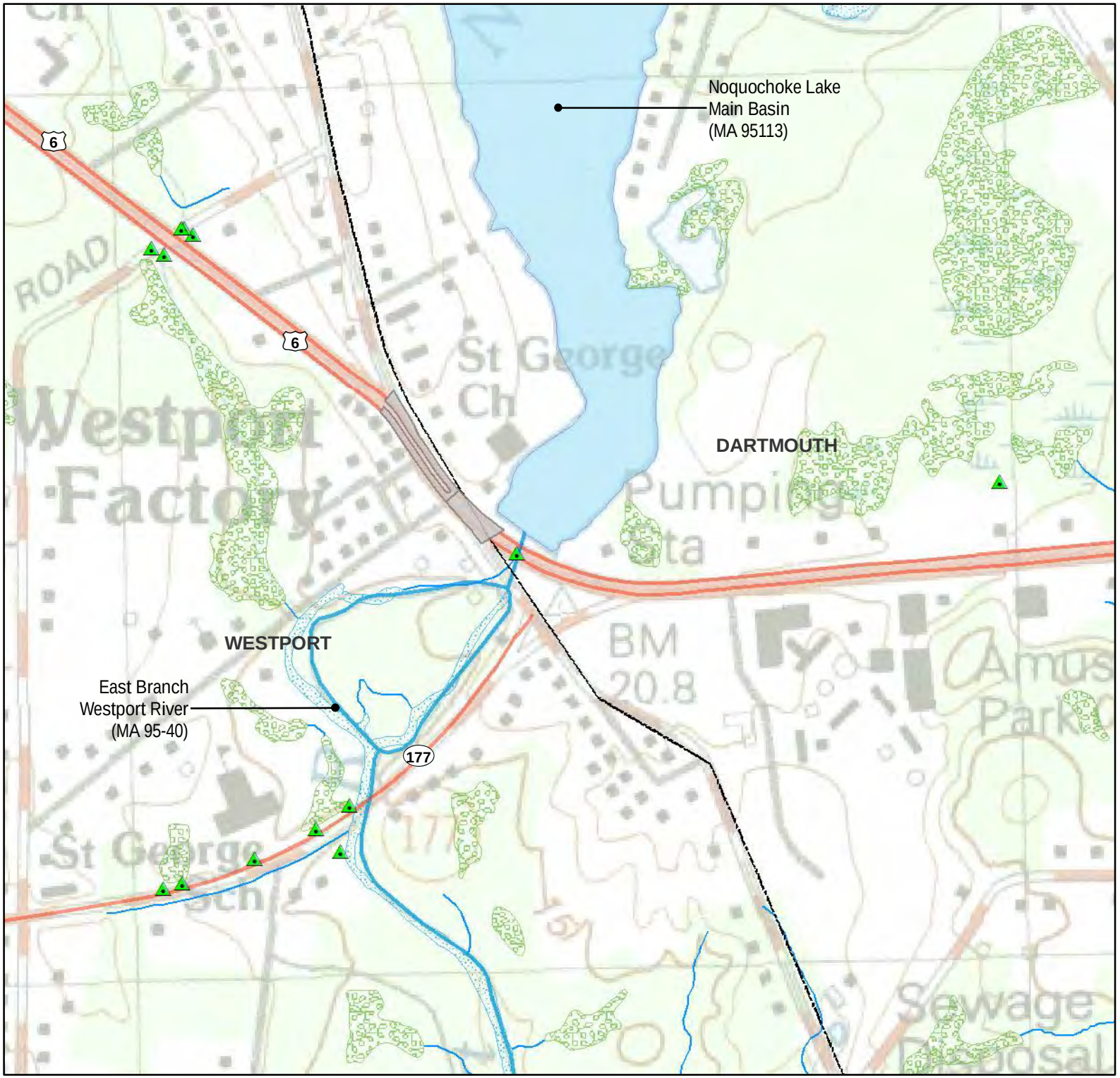
0 250 500
Feet

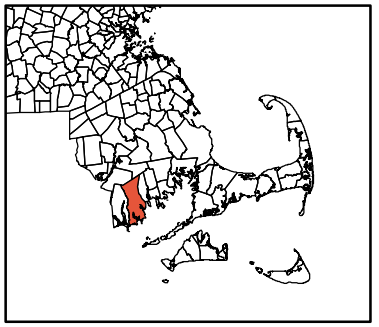
Figure 3

MassDOT Directly Contributing Impervious Area
(Interstate 195 and Reed Road)

January 2012

MassDOT
Massachusetts Department of Transportation
Highway Division





Town Boundary
MassDOT Stormwater Outfalls
MassDOT Roads
Hydrologic Connection
Marsh/Bog
Wooded Marsh
Open Water
Impaired Stream Segments
Impaired Water Bodies
MassDOT Directly Contributing Impervious Area

N

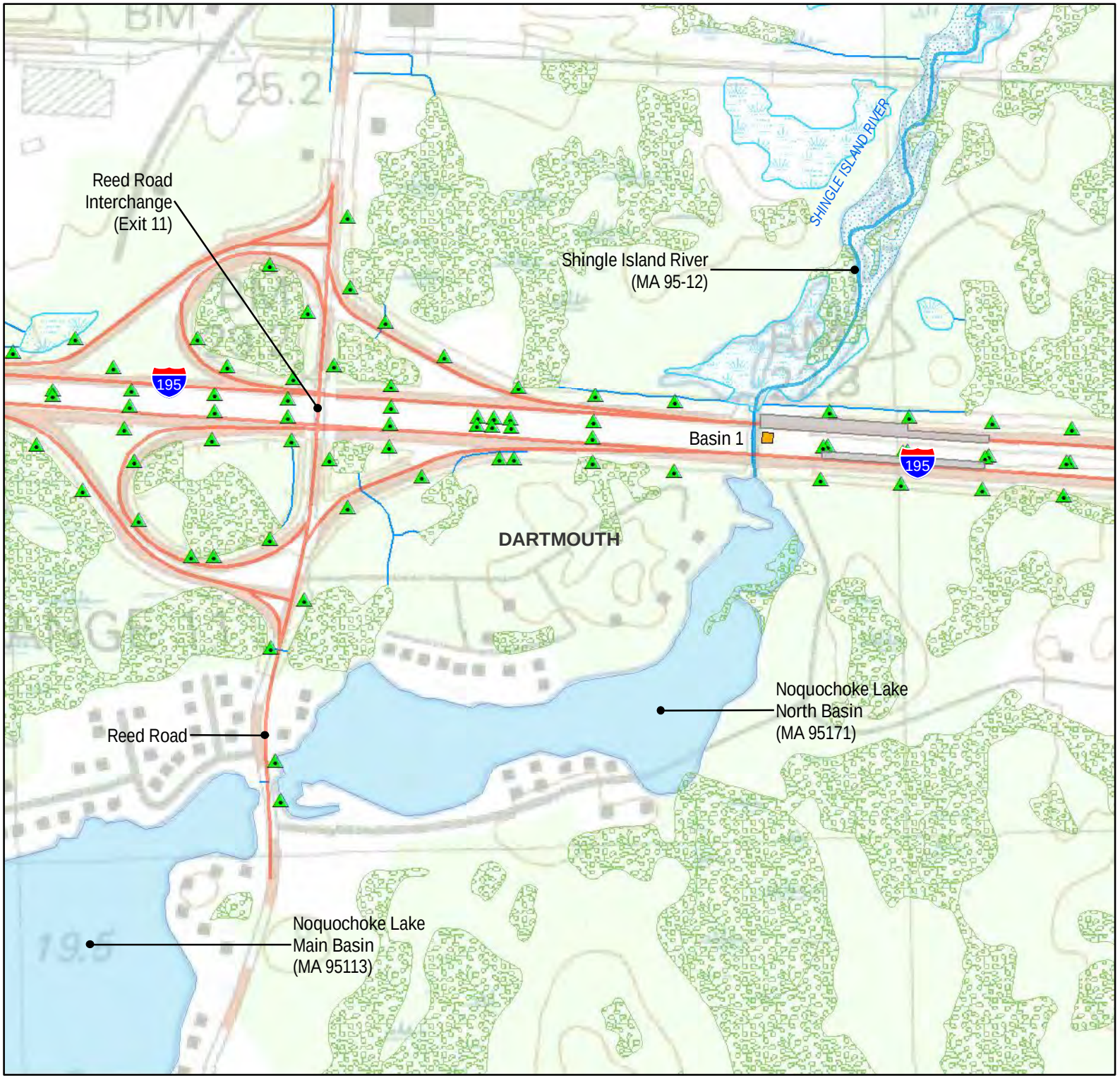
0 250 500
Feet

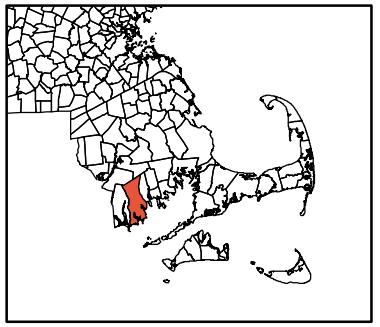
Figure 4

MassDOT Directly Contributing Impervious Area
(Route 6)

January 2012

MassDOT
Massachusetts Department of Transportation
Highway Division





Town Boundary
MassDOT Stormwater Outfalls
MassDOT Roads
Hydrologic Connection
Marsh/Bog
Wooded Marsh
Open Water
Impaired Stream Segments
Impaired Water Bodies
Proposed BMP Contributing Impervious Area Watershed
Proposed BMP Location

N

0 250 500
Feet

Figure 5

Proposed BMP Location

January 2012

MassDOT
Massachusetts Department of Transportation
Highway Division