MassDOT Quarter 2 Submittal

(September 8 – December 7, 2010)

NPDES MS4 General Permit Compliance Water Quality Impaired Waters Assessment and Mitigation Plan

December 8, 2010

Deval L. Patrick, Governor
Timothy P. Murray, Lt. Governor
Jeffrey B. Mullan, Secretary & CEO
Luisa Paiewonsky, Administrator

massDOT
Massachusetts Department of Transportation
Highway Division

December 8, 2010

David Gray
U.S. Environmental Protection Agency, Region 1
5 Post Office Square - Suite 100, Mail Code #OEP06-1
Boston, MA 02110

Subject: Quarter 2 Submittal under Impaired Waters Program

Dear Mr. Gray,

As part of MassDOT's June 9, 2010 and July 23, 2010 submittals to EPA, MassDOT committed to assessing, for possible mitigation, 684 impaired water bodies using the processes outlined BMP 7U: Impaired Waters Assessment and Mitigation Plan (the "Impaired Waters Program") and BMP 7R: TMDL Watershed Review. MassDOT committed to provide reports on its progress to EPA with quarterly reports during the first year and semi-annual reports thereafter. The attached report documents MassDOT's review during the second quarter of the Impaired Waters Program.

MassDOT completed assessments under BMP 7U on 32 water bodies from Appendix L-1 (dated July 22, 2010, included in MassDOT's July 23 submittal) during the second quarter. The results of these assessments are included in Attachments 1-2. Each of the reports contained in Attachment 1 includes the relevant assessments for the water body listed under BMP 7U (other impairments not covered by TMDL reports).

MassDOT has further refined its method for addressing impaired waters without a TMDL in light of US EPA's recent memorandum regarding the appropriateness of the Impervious Cover (IC) approach to assessing the impacts of storm water and identifying quantifiable targets for mitigating the impacts of storm water has recently been affirmed by US EPA[1]. For assessments included in this submittal, DOT used EPA Region I's "IC Method" to assess storm water's impacts on the impaired water and evaluate the level of impervious cover reduction required to ensure that storm water is not the cause of the impairments. The IC method uses percent impervious cover in a watershed as an indicator of the potential contribution of storm water to water quality impairments. According to *Pilot TMDL Applications Using the Impervious Cover Method* (ENSR 2005), "Based on extensive data and the best information available, it appears that if the IC target is met (by reducing actual IC, reducing directly connected IC, or other measures) storm water-impaired waters will be brought back into compliance with water

[1] EPA Region 1, "Revisions to the November 22, 2002 Memorandum "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLA) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs", November 12, 2010.

quality standards (WQS)." As described in this document, the IC Method is based on the relationship between the portion of impervious cover in a watershed and the receiving stream quality. The method is largely based on the work of The Center for Watershed Protection, which has compiled and evaluated extensive data relating watershed impervious cover to hydrologic, physical, water quality, and biological conditions (Schueler, 2003). Water quality in tributary streams, rivers, lakes and ponds is a direct reflection of loading from the watershed (Wetzel, 2001); therefore the impervious cover method can be used as a surrogate for pollutant loading when evaluating water quality impairments.

EPA recommends a target of 9% impervious cover in a watershed[2]. When more than 9% of the watershed is impervious cover, storm water is likely to be a significant contributor to water quality concerns. When less than 9% of the watershed is impervious cover, water quality impairments are likely to be caused by other factors. Based on this principle, MassDOT assessed whether storm water from their property has the potential to cause the impairment of the receiving water body. Consistent with findings by EPA and others, when the watershed had less 9% impervious cover, MassDOT concluded that storm water was not the likely cause of the impairment.

First, MassDOT calculated the percent IC of the water body's entire contributing watershed and the local watershed (called subwatershed in this analysis) to determine whether storm water has a potential to cause the impairments of the receiving water body. In cases where it was determined that storm water was a potential cause of the impairment, MassDOT calculated how much of the 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 directly discharging to the water body segment to identify MassDOT's target reduction.

MassDOT's existing effective impervious cover reduction was calculated by applying impervious cover removal rates to existing BMPs based on their size and contributing watershed. BMP performances were derived from EPA Region 1's Storm Water Best Management Practices (BMP) Performance Analysis report and engineering judgment. When the reduction in effective impervious cover achieved by the existing BMPs is equal to or greater than the target reduction, no further measures are proposed. When this is not the case, MassDOT considered additional BMPs in order to meet the targeted reduction.

The assessments being submitted herein represent MassDOT's initial application of the impervious cover approach to assessing the potential impact of storm water to impaired water bodies. As such, MassDOT welcomes comments or suggestions from USEPA on

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[2] ENSR 2006. *Stormwater TMDL Implementation Support Manual for US EPA Region 1.* ENSR International & EPA Region 1, Boston, MA. Available at http://www.epa.gov/region1/eco/tmdl/regionalpgrfs.html

this approach and its application to these water bodies. MassDOT is open to modifying this approach based on feedback from US EPA.

As described in Appendix L-5 of BMP 7U (included in MassDOT's previous submittal, dated 7/23/10), MassDOT has developed initial schedules for the implementation of any BMPs that may be warranted as a result of its assessments under BMPs 7U and 7R. MassDOT is committed to implementing new BMP recommendations as soon as practicable, following the issuance of each semi-annual report to the EPA. As shown in the attached reports, MassDOT proposes to implement structural BMPs for the Blackstone River (MA51-03) and Burncoat Pond (MA51012) (Attachment 1). MassDOT will immediately begin the process of implementing the new BMPs, as set forth in Appendix L-5. DOT has completed contracted with two design firms who will develop design and construction documents for the proposed BMPs.

As described in our quarterly submittal, in addition to the implementation of statewide "retrofit" projects, MassDOT is also continuing to seek opportunities to implement structural BMPs as part of planned construction projects (as described in Appendix L-5). MassDOT's new "Impaired Waters Program for Programmed Projects" is a new initiative which ensures that every construction project under design has been assessed for the impact of highway storm water on impaired waterbodies.

The first step in implementing this initiative was to educate project planners and designers. During an aggressive fall training season, MassDOT has provided instruction on the new Impaired Waters Program to projects, engineering, planning, and design professionals in MassDOT and companies that consult for MassDOT. These trainings focused on educating the designers on MassDOT's new initiative for programmed projects, including the requirement that any new structural BMPs that may be warranted and practicable, be incorporated into the final project design for each construction project. To date these trainings have reached over 130 in-house staff and 108 consultants, representing 63 different engineering and design firms.

This program requires Project Designers to identify the impairment status of waterbodies receiving runoff from areas of proposed projects during the 25% design stage through a standardized water quality form. Designers will then work with the Environmental Services Section to ensure that the relevant water body impairments (including any TMDL reports governing the water body) are adequately addressed by storm water BMPs. An example of including BMPs into programmed projects is discussed in the Cambridge Reservoir – Upper Basin assessment included in this submission. MassDOT has identified three BMPs that could be included in bridge project work on Route 2 and Route 2A that will address water quality from the road corridors in the area.

To date MassDOT has received water quality forms for 70 projects under this new initiative. Drainage upgrades will be realized as part of the 2011 Statewide Transportation Improvements Program. Additionally, DOT has facilitated a review of all

FY2011 repaving jobs to determine the need for structural BMPs. By adding structural BMPs as part of repaving contracts, DOT will more efficiently and quickly address the water quality impacts.

Structural BMPs installed or included in design as part of MassDOT's Impaired Waters Program for Programmed Projects will be summarized in MassDOT's NPDES annual reports. MassDOT will coordinate the Programmed Projects Initiative with its on-going assessments under BMP 7U and 7R of the Storm Water Management Plan (SWMP) to ensure consistency in its assessments.

MassDOT welcomes any input or feedback from the EPA on the assessments included in this and all future progress reports. If you have any questions or concerns, or would like to meet to discuss this submittal, please feel free to contact me at (617) 973-7419.

Sincerely,

Henry Barbaro

Henry Barbaro
Supervisor of Wetlands & Water Resources
Henry.Barbaro@state.ma.us

cc: Kathleen Woodward, Esq., EPA Region I
Al Caldarelli, Esq., MassDOT

Massachusetts Department of Transportation
Highway Division

Attachment 1:
Impaired Segments Assessments with Discharges from MassDOT Outfalls

Impaired Waters Assessment for Blackstone River (MA51-03)

Impaired Waterbody

Blackstone River (Segment MA51-03)

Impairments

Mass DEP 2008 303d List: unknown toxicity, priority organics, metals, unionized ammonia, nutrients, organic enrichment/low dissolved oxygen, flow alteration[1], other habitat alterations[1], pathogens, suspended solids, turbidity, objectionable deposits[1]

Mass DEP 2010 Draft 303d List Changes: unionized ammonia removed.

Relevant Water Quality Standards: Water Body Class: B (warm water, CSO)

- 314 CMR 4.05 (3)(b)(1)(a) Dissolved Oxygen. Shall not be 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)(b) Bacteria. 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 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.
- 314 CMR 4.05 (5)(b) Bottom Pollutants or Alterations. All surface waters shall be free from pollutants in concentrations or combinations 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)(a) Aesthetics. All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris,

[1] impairments are non-pollutant impairments

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 (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 Total Maximum Daily Load (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 best available technology economically achievable (BAT) for non publicly owned treatment works (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.

Site Description

Blackstone River Segment MA51-03 is a 10.8-mile segment of the Blackstone River that extends from the confluence of the Middle River and Mill Brook (just downstream of the American Steel Dam) in Worcester to the Fisherville Dam in Grafton. The total Blackstone River watershed area upstream of the Fisherville Dam is 62,650 acres and the portion of this watershed that contributes directly to Segment MA51-03 (the subwatershed) is 6,370 acres.

Within the Segment MA 51-03 watershed, MassDOT owns Highway 146, Route 20 and Interstate I-90. Blackstone River Segment MA51-03 parallels Highway 146 for much of its reach and passes underneath Highway 146, Route 20, and I-90 approximately six times. In this area of Worcester and Millbury, Highway 146 is a divided highway with four lanes of traffic (two northbound lanes and two southbound lanes). MassDOT implemented roadway construction improvements for Highway 146 from 1997 through 2005. As a result, much of the storm water infrastructure for this roadway includes structural storm water best management practices (BMPs) such as grass swales, infiltration basins, and dry ponds. Figure 1 delineates the total Blackstone River watershed upstream of the Fisherville Dam, the Segment MA51-03 subwatershed, and the location of the MassDOT roads.

Storm water from approximately 116 acres of MassDOT roads discharges directly to this segment of the Blackstone River. Approximately 94% of that area flows through storm water structural BMPs prior to discharging to the river. The storm water systems are comprised of a combination of piped collection systems, surface swales, and detention and infiltration systems with well-established vegetation. Several systems include BMPs in series, providing additional treatment of storm water prior to discharge. These BMPs are generally sized to store/treat approximately one inch or more runoff over their contributing impervious watersheds and many have additional storage and outlets designed for flood control. The areas not treated by BMPs include portions of the main travel lanes, the Route 20 bridge over the Blackstone River, and the Highway 146 interchange cloverleaf.

Assessment under BMP 7U for Impairments not Covered by a TMDL

There are no final TMDLs for impairments for this segment of the Blackstone River. MassDOT assessed the 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.

For this segment, MassDOT used EPA Region I's Impervious Cover (IC) Method, described in EPA's Stormwater TMDL Implementation Support Manual (ENSR 2006), to assess potential storm water impacts on the impaired water and evaluate the level of impervious cover reduction required to ensure that storm water is not the cause of the impairments. MassDOT has adopted its method for addressing impaired waters without a TMDL based on USEPA's recent memorandum regarding the appropriateness of the Impervious Cover approach to assessing the impacts of storm water and identifying quantifiable targets for mitigating the impacts of storm water (EPA 2010a). Consistent with findings of EPA and others, when a watershed had less than 9% impervious cover, MassDOT concluded that storm water was not the likely cause of the impairment.

Impervious Cover Analysis

The impervious cover model (ICM) relates an aquatic system's health (i.e., state of impairment) to the percentage of impervious cover 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 impervious cover 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.

The relative portion of a watershed's impervious cover can be used as an effective means of determining aquatic system health. Urbanization, primarily through the construction of impervious cover, causes progressive hydrologic, physical, water quality and biological impacts to aquatic health. Agricultural and other land-modifying activities can also contribute significantly to aquatic health degradation. Increasing impervious cover reduces the amount of infiltration/recharge and increases the amount of runoff. As a result, the stream experiences more extreme and variable flows including lower low flows, due to reduced baseflow, and higher high flows, due to large stormwater runoff volumes.

Physical impacts associated with IC are directly related to modification in stream hydrology. For example, flooding causes channel enlargement and incision, while low flows can result in warmer in-stream temperatures. Water quality impacts are due primarily to direct conveyance of additional materials into the stream with stormwater runoff. Lastly, biological impacts are the result of degradation of hydrology, physical, and water quality conditions in the stream ecosystem. Impervious cover serves as an excellent surrogate for many types of stormwater-related impairments because it relates primary causal factors to specific impairments.

Research indicates that a decline in stream quality occurs when impervious cover (IC) for a watershed exceeds 10% and that severe impairment can be expected when the IC exceeds 25%. A pilot study performed applying the IC method for several impaired waters in New England (ENSR 2005) found that "Based on extensive data and the best information available, it appears that if the IC target is met (by reducing actual IC, reducing directly connected IC, and/or other measures), stormwater-impaired waters will be brought back into compliance with water quality standards (WQSs)".

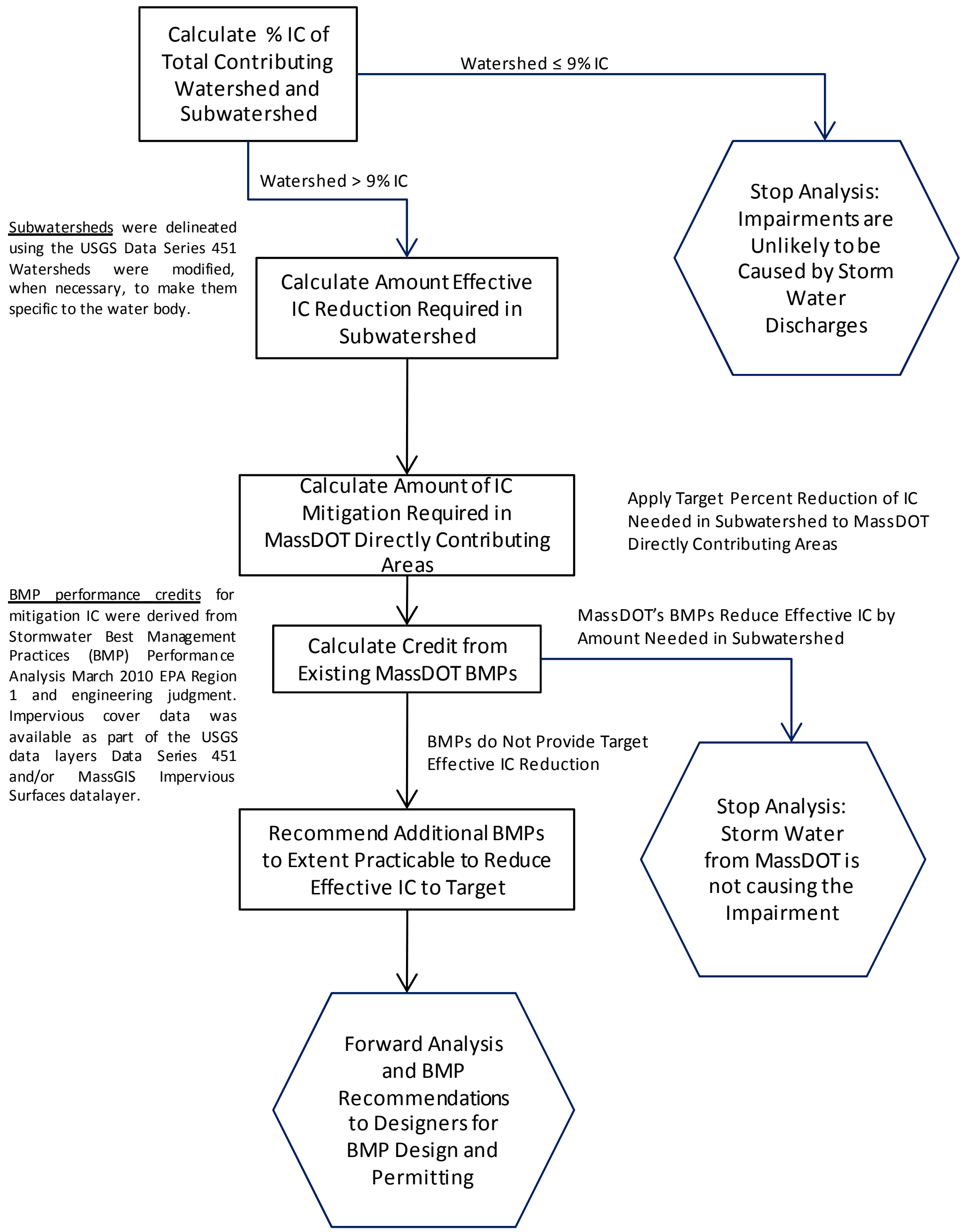
The appropriateness of this approach to assessing the impacts of storm water and identifying quantifiable targets for mitigating the impacts of storm water has recently been affirmed by US EPA (EPA 2010a).

EPA recommends a target of 9% impervious cover in a watershed (below 10%). When more than 9% of the watershed is impervious cover, storm water is likely to be a significant contributor to water quality concerns. When less than 9% of the watershed is impervious cover, water quality impairments are likely to be caused by other factors. Based on this principle, MassDOT assessed whether storm water from their roadways/properties has the potential to cause the impairment of the receiving water body. The approach MassDOT used to perform the assessment is outlined in the flowchart below.

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 downstream end of impaired segment) and that of the local watershed contributing directly to the impaired segmented (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. The USGS Data Series watersheds were modified, when necessary, to make them specific to the water body. Impervious cover data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces datalayer. 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 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.

MassDOT then calculated the effective impervious cover reduction afforded by the existing structural BMPs currently incorporated into the storm water 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 2010b) and engineering judgment. 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 parameters to the total upstream contributing watershed of the impaired water (i.e., Blackstone River watershed, upstream of the Fisherville Dam):

Total Contributing Area		
Area	62,650	acres
Impervious Cover (IC) Area	11,900	acres
% Impervious	19%	

Because the total contributing watershed includes more than 9% impervious cover, the impairments are assumed to be at least partially related to storm water. Analyzing the subwatershed to the impaired water provides the following results:

Subwatershed		
Watershed Area	6,370	acres
Impervious Cover (IC) Area	1,410	acres
Percent Impervious	22%	
IC Area at 9% Goal	573	acres
Necessary Reduction % in IC	59%	

Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	116	acres
MassDOT's Required Reduction in Effective IC (59% of DOT Directly Contributing IC)	69	acres

The subwatershed is also greater than 9% impervious which indicates that the storm water from the subwatershed is also likely contributing to this segment's impairments. The subwatershed needs to reduce its effective IC by 59% to reach the 9% goal. Therefore, MassDOT should reduce its effective IC by the same percentage. MassDOT has 116 acres of IC directly contributing to the impaired water and therefore needs to remove the effect of 59% of that area, or 69 acres of IC.

Figures 2a, 2b, and 2c show MassDOT's roads and related watersheds that contribute directly to the impaired segment MA51-03. Also shown are Mass DOT's outfalls and existing BMPs. Information for existing BMPs was available from design plans associated with the 1997-2005 roadway construction and additional information was collected during multiple site visits.

The existing BMPs that mitigate potential storm water quality impacts prior to discharge to Blackstone River Segment MA51-03 include infiltration basins, dry ponds (extended detention), and grass swales. These 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 areas associated with the existing BMPs are general hydrologic group B (sand and loam) and group C (silt, loam, and clay) soils or urban fill. Urban fill was conservatively assumed to have drainage properties similar to those of a group C soil.

The following table shows the BMPs, the respective area of IC they treat, their calculated IC reduction credit percentage, and the resulting IC area reduction. Certain storm water systems include multiple BMPs that act in series to treat storm water runoff, for example BMP 3a and BMP 3b. The existing BMPs process storm water runoff from a total of 109.9 acres of impervious cover and are calculated to remove the effect of 68.1 acres of impervious cover. Existing BMPs, therefore, are very close to meeting the IC mitigation target for MassDOT's directly contributing roads (69 acres).

BMP Name	BMP Type	IC Area Treated (acres)	Percent Reduction of Effective IC	Reduction of Effective IC (acres)
BMP 1	Infiltration Basin	5.4	34%	1.8
BMP 3a	Infiltration Basin	8.8	60%	5.3
BMP 3b	Infiltration Basin		83%	2.9
BMP 4	Dry Pond	2.9	38%	1.1
BMP 6a	Infiltration Basin	8.0	18%	1.4
BMP 6b	Infiltration Basin		19%	1.2
BMP 6c	Infiltration Basin		94%	5.0
BMP 7a	Dry Pond	6.6	45%	3.0
BMP 7b	Dry Pond		47%	1.7
BMP 8	Infiltration Basin	8.4	94%	7.9
BMP 9	Infiltration Basin	5.4	89%	4.8
BMP 10	Dry Pond	16.5	21%	3.5
BMP 11	Dry Pond	4.3	35%	1.5
BMP 12	Grass Swale	0.5	47%	0.2
BMP 13	Grass Swale	2.8	16%	0.5
BMP 14	Grass Swale	0.2	47%	0.1
BMP 15	Grass Swale	0.1	47%	0.0
BMP 19	Dry Pond	2.0	44%	0.9
BMP 21	Infiltration Basin	4.2	100%	4.2
BMP 25	Grass Swale	0.3	47%	0.1
BMP 26	Infiltration Basin	8.3	50%	4.1
BMP 27	Infiltration Basin	24.1	68%	16.3
BMP 33	Grass Swale	0.9	49%	0.4
Total		**109.9**		**68.1**

Note: The percent reduction of effective IC is dependent on BMP type, size relative to the IC that they process, and local soil conditions. BMP performances were derived from EPA Region 1's Stormwater Best Management Practices (BMP) Performance Analysis report (EPA 2010b) and engineering judgment.

Recommendations

MassDOT has existing BMPs in-place that mitigate potential water quality impacts for the majority of the storm water runoff from their roadways/properties before this storm water discharges to Blackstone River Segment MA51-03. The existing BMPs include infiltration basins, dry ponds, and grass swales. Combined, they process 109.9 acres of MassDOT storm water runoff, reducing the effective impervious cover area of MassDOT storm water discharges to the river by 68.1 acres. This falls just short of the target of 69 acres of required mitigation, as outlined in the Impervious Cover Analysis above.

Therefore, MassDOT proposes to increase the effectiveness of its existing BMPs. There are several options for meeting the 9% effective IC goals including reducing IC, construction of new BMPs and modifying existing BMPs to operate more effectively. Modifying existing BMPs would be the most cost effective method of increasing storm water impact mitigation for the MassDOT roadways/properties. Therefore, MassDOT proposes to convert one of the existing dry ponds into an infiltration basin. This will further reduce the overall effective impervious cover by an additional

0.9 acres or more, depending on which existing pond is selected and how it is modified. One or more dry ponds can be converted to an infiltration basin by modifications to the outlet structure. Specifically, the low level outlets would be eliminated and then a new high level outlet would be added for flood control. The soils of the pond bottom would be evaluated for infiltration potential and infiltration rates would be considered when choosing which pond to modify and sizing the new outlet structure. MassDOT will relay this recommendation and data collected as part of this assessment immediately to their designers for BMP design and construction.

Conclusions

This assessment for segment MA51-03 of the Blackstone River has shown that the existing BMPs treating MassDOT's roadways/properties fall just short of providing adequate mitigation for storm water discharge water quality and fail to fully address the river segment's impairments. Therefore, MassDOT proposes to convert one or more dry ponds to infiltration basins in order to achieve the target reduction of IC. This change will improve the overall treatment efficiency of the existing BMPs to sufficiently treat the storm water and meet the mitigation goal.

MassDOT will continue to implement non-structural BMPs that reduce potential pathogen loading. In particular, MassDOT commits to conduct IDDE field efforts by the end of 2010. In addition, MassDOT will re-evaluate the potential need for structural BMPs to address pathogen loading when road work is conducted. This is consistent with an iterative adaptive management approach to addressing pathogen impairments. In addition, MassDOT will also re-visit the use of structural BMPs if a wasteload allocation is assigned in association with future TMDL development.

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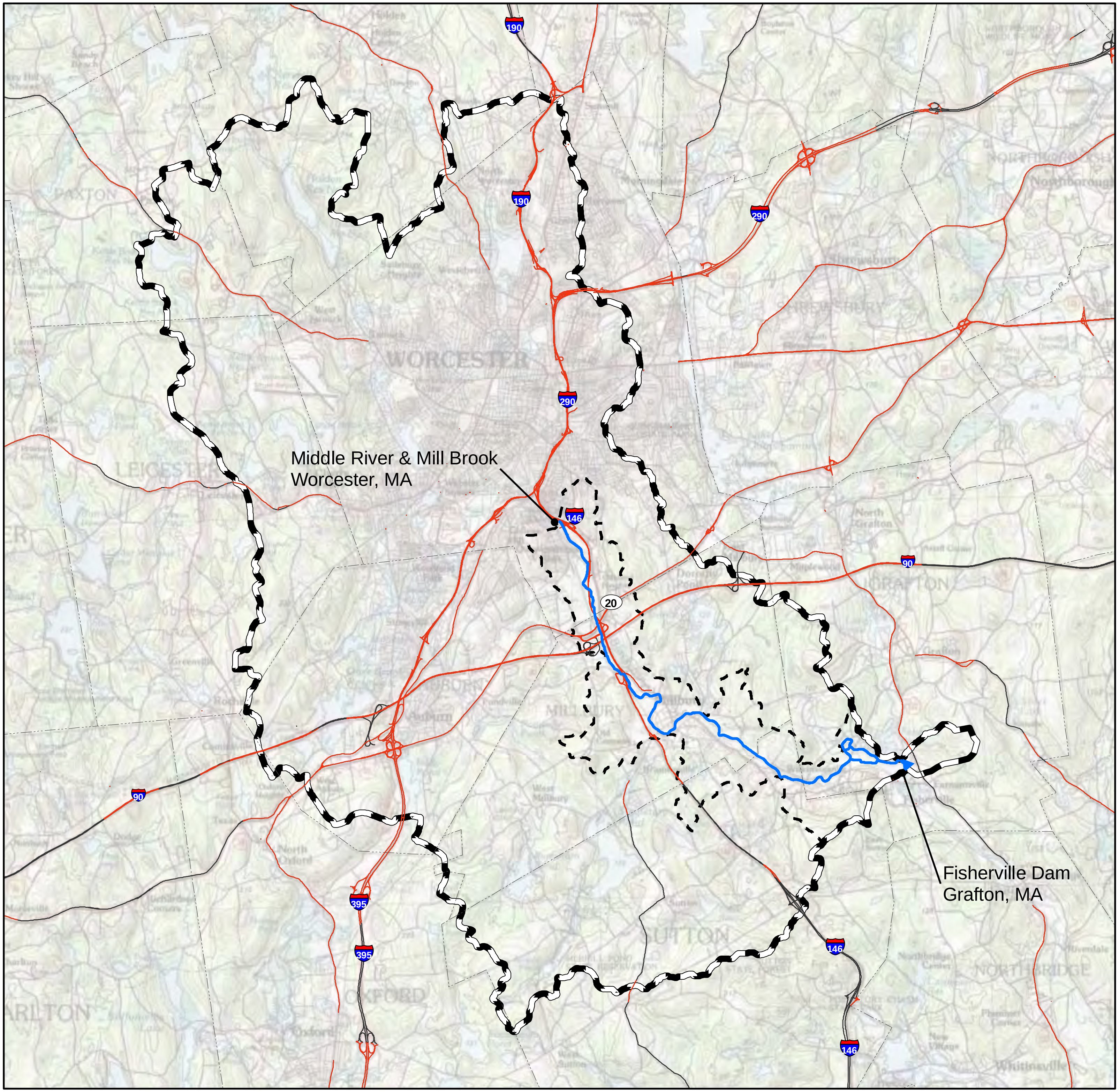

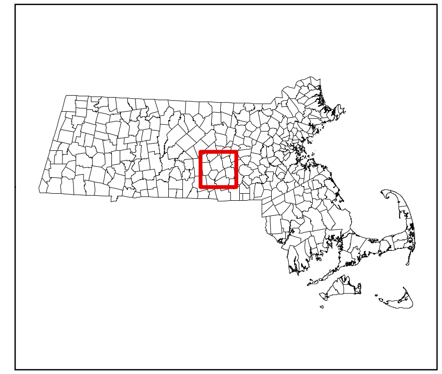

MA51-03

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

Upstream Blackstone Watershed

Segment MA51-03 Subwatershed

N

0 75 150 Miles

<u>Figure 1</u>

Blackstone River Watershed MA51-03

December 2010

Moving Massachusetts Forward. massDOT

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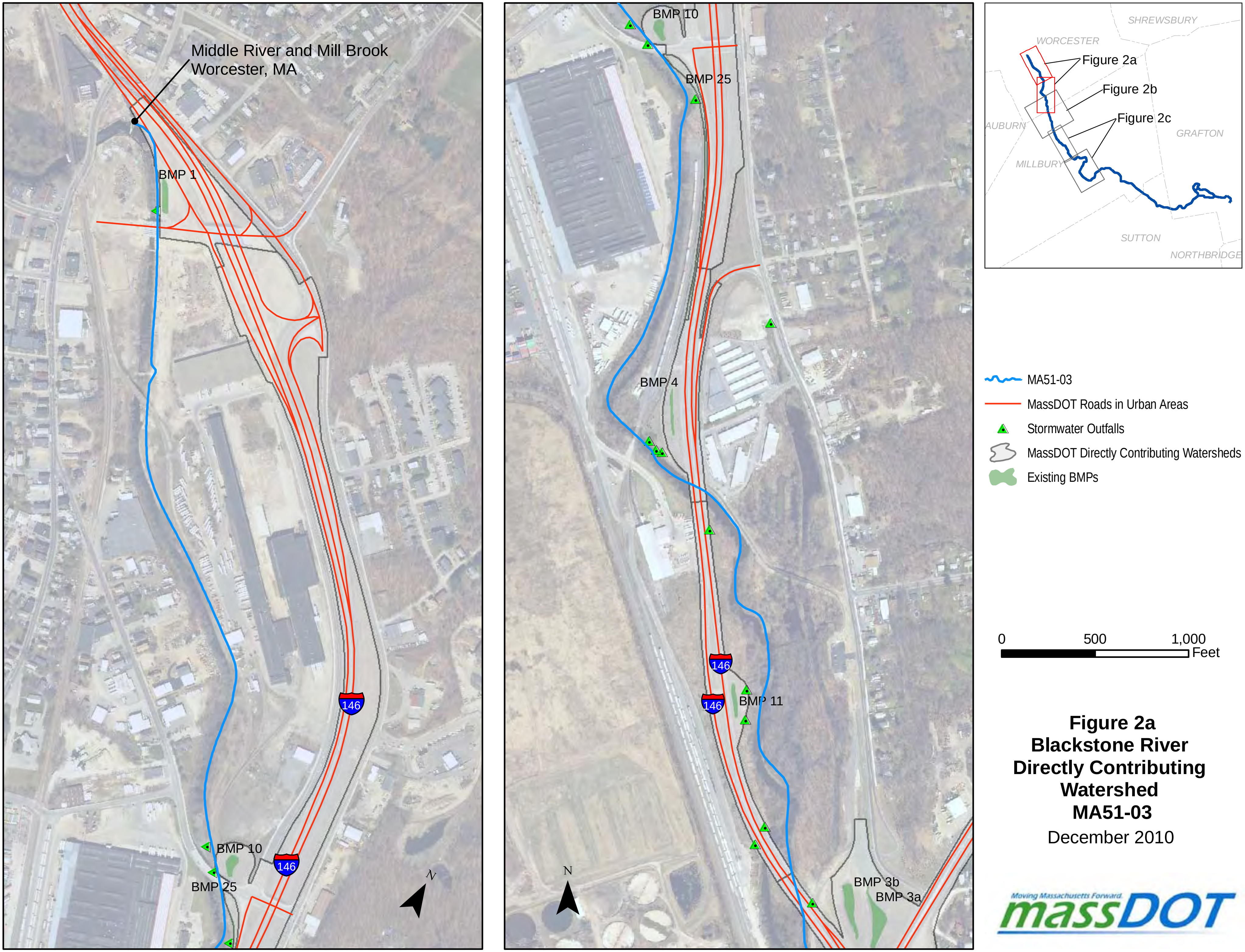
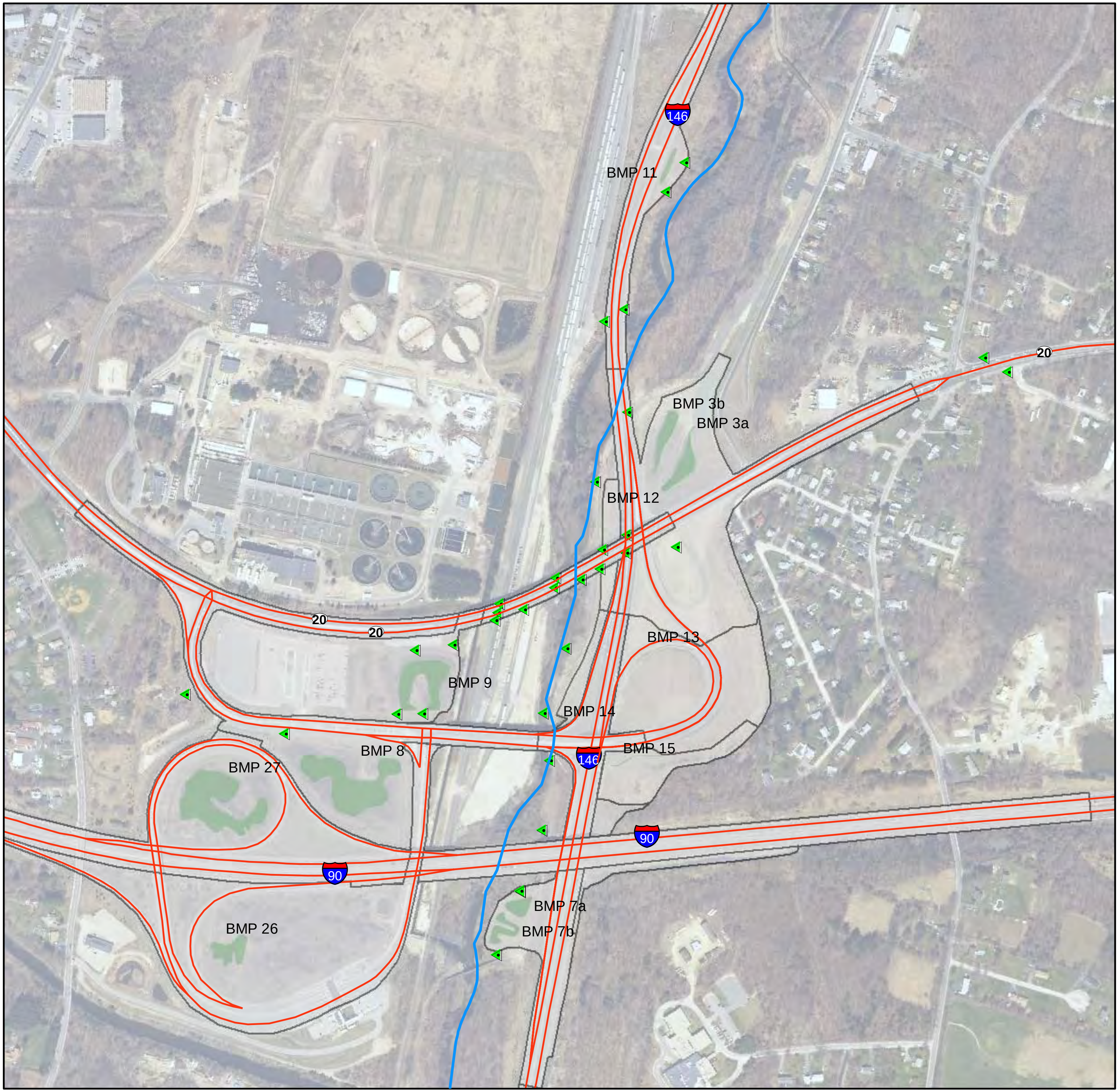
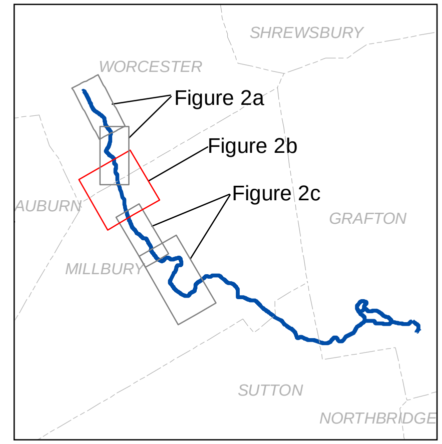


Figure 2a
Blackstone River
Directly Contributing
Watershed
MA51-03
December 2010





MA51-03
MassDOT Roads in Urban Areas
Stormwater Outfalls
MassDOT Directly Contributing Watersheds
Existing BMPs

N

0 500 1,000 Feet

Figure 2b
Blackstone River
Directly Contributing
Watershed
MA51-03

December 2010

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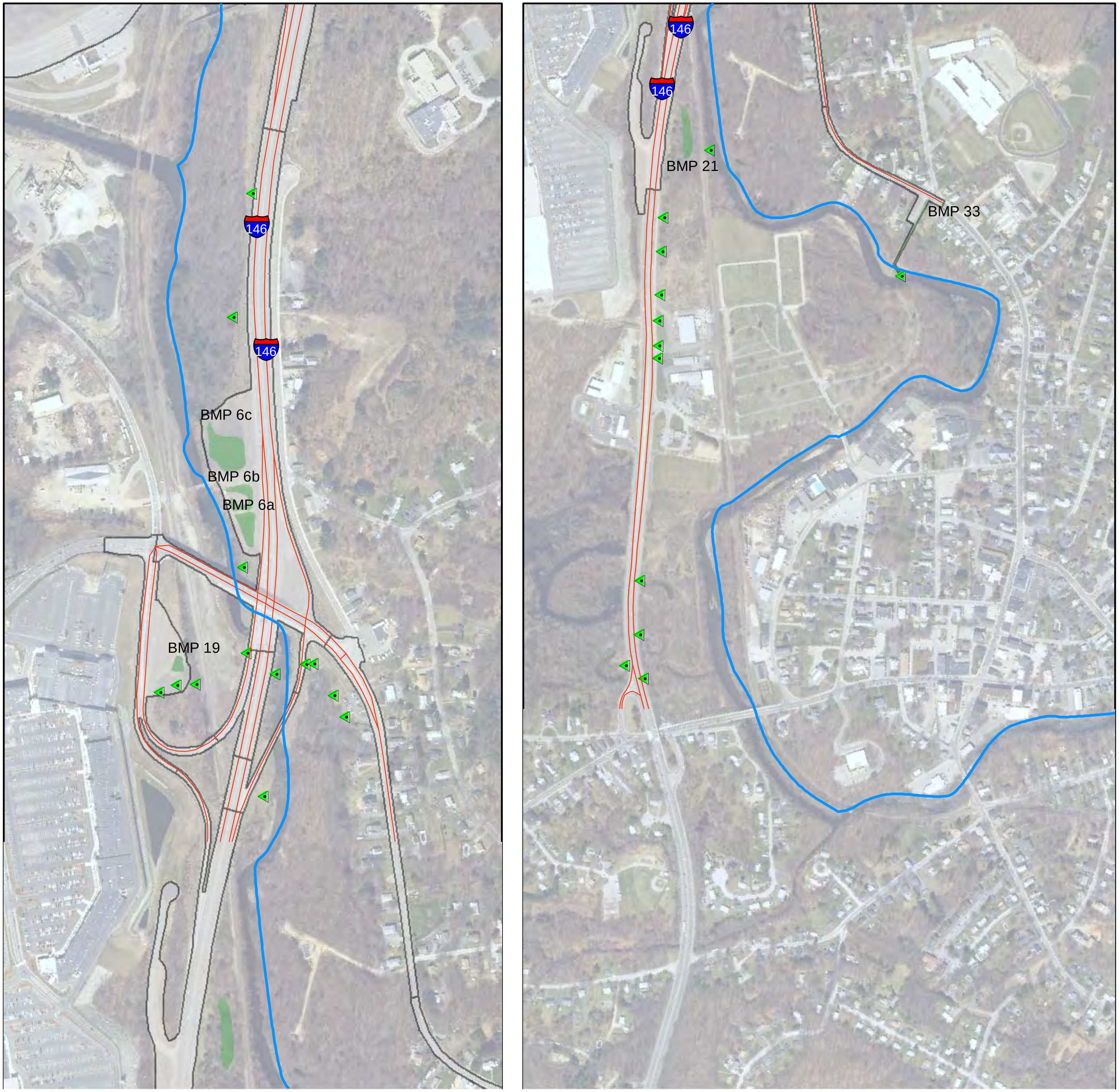

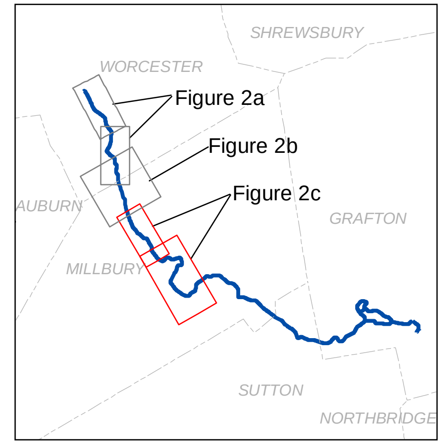

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MassDOT Roads in Urban Areas
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N

0 500 1,000 Feet

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Blackstone River
Directly Contributing
Watershed
MA51-03

December 2010

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Impaired Waters Assessment for Burncoat Park Pond (MA51012)

Impaired Waterbody

Burncoat Park Pond (Segment MA51012)

Impairments

Mass DEP 2008 303d List: noxious aquatic plants, turbidity

Mass DEP 2010 Draft 303d List Changes: none

Relevant Water Quality Standards – Water Body Class: B

- 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.

Site Description

Burncoat Park Pond (MA51012) is a 6.3 acre pond located in Worcester just north of Interstate 290 (I-290) with a 271-acre contributing watershed (Figure 1). MassDOT owns I-290 and North Service Road, both of which are within the Burncoat Park Pond watershed. North Service Road is adjacent to Burncoat Park Pond on the southern side of the pond. I-290 parallels the North Service Road to the south. I-290 is elevated and its abutment slopes steeply down to the North Service Road.

Based on an automated review of GIS data and MassDOT's Appendix L-1 of Impaired Waterbodies included in BMP 7U (dated July 22, 2010), it was originally determined that MassDOT has one outfall within 500 feet of Burncoat Park Pond. A field investigation on November 3, 2010 found that MassDOT roadways drain to Burncoat Park Pond through four outfalls, two of which are MassDOT outfalls (AECOM ID 14156.4 and 14157.4), while the other two (AECOM ID 14159.4 and 14158.4) are City of Worcester outfalls (Figure 2).

Outfall 14156.4 collects storm water runoff from North Service Road between the intersection of North Parkway and the North Service Road (at the east) and the high point on North Service Road approximately 250 feet to the west. North Service Road is bounded by curbing which directs all storm water to two catch basins that discharge through Outfall 14156.4 directly into the pond. MassDOT's contributing area to this outfall is approximately 0.55 acres of paved roadway.

Outfall 14157.4 collects storm water from the elevated portion of I-290 (0.45 acres of MassDOT roadway) and the vegetated area between I-290 and the North Service Road (1.5 acres vegetated) through a catch basin located within the vegetated area. Runoff from the paved roadway and shoulder drains to a catch basin on I-290 that discharges to a headwall structure within the vegetated area. The headwall structure provides detention control which results in sediment removal. Runoff that reaches the vegetated area via the headwall structure flows overland for a minimum of 100 feet before reaching the catch basin that connects directly to Outfall 14157.4. For this flow path, which drains 0.45 acres of MassDOT property, the vegetated area serves as a filter strip that traps sediment and allows for infiltration.

Outfall 14159.4 is a City of Worcester structure that collects storm water from the ramp between North Parkway and North Service Road. Approximately 0.1 acre of paved Mass DOT roadway drains directly to a Worcester catch basin on Route 70 that discharges through Outfall 14159.4 directly to Burncoat Park Pond.

Outfall 14158.4 is a City of Worcester structure that collects storm water from Worcester's Route 70 and from MassDOT's exit ramp (Exit 20) from I-290 West. Approximately 0.7 acres of MassDOT paved roadway and 1.4 acres of MassDOT vegetated shoulder/median drain to this outfall. The paved exit ramp is bounded by curbing and runoff is discharged directly to a catch basin on the exit ramp, which flows via City of Worcester infrastructure directly to Burncoat Park Pond at Outfall 14158.4.

The vegetated median south of the exit ramp (located between I-290 and the exit ramp) contains vegetated swales and filter strips, however it does not receive much (if any) runoff from paved portions of I-290 or the exit ramp.

Assessment under BMP 7U for Noxious Aquatic Plants and Turbidity

The impairments for noxious aquatic plants and turbidity have 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).

The impairment for noxious aquatic plants in Burncoat Park Pond is potentially related to excess nutrients (phosphorous). The pond's impairment for turbidity likely originates from either suspended sediments or phytoplankton growth in the pond associated with excessive phosphorus loading. Storm water runoff is a likely source of both sediments and phosphorus to Burncoat Park Pond.

For this water body, MassDOT used EPA Region I's Impervious Cover (IC) Method, described in EPA's Stormwater TMDL Implementation Support Manual (ENSR 2006), to assess potential storm water impacts on the impaired water and evaluate the level of impervious cover reduction required to ensure that storm water is not the cause of the impairments. MassDOT has adopted its method for addressing impaired waters without a TMDL based on USEPA's recent memorandum regarding the appropriateness of the Impervious Cover approach to assessing the impacts of storm water and identifying quantifiable targets for mitigating the impacts of storm water (EPA 2010a). Consistent with findings of EPA and others, when a watershed had less than 9% impervious cover, MassDOT concluded that storm water was not the likely cause of impairment.

Impervious Cover Analysis

The impervious cover model (ICM) relates an aquatic system's health (i.e., state of impairment) to the percentage of impervious cover 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 impervious cover 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.

The relative portion of a watershed's impervious cover can be used as an effective means of determining aquatic system health. Urbanization, primarily through the construction of impervious cover, causes progressive hydrologic, physical, water quality and biological impacts to aquatic health. Agricultural and other land-modifying activities can also contribute significantly to aquatic health degradation. Increasing impervious cover reduces the amount of infiltration/recharge and increases the amount of runoff. As a result, the stream experiences more extreme and variable flows including lower low flows, due to reduced baseflow, and higher high flows, due to large stormwater runoff volumes.

Physical impacts associated with IC are directly related to modification in stream hydrology. For example, flooding causes channel enlargement and incision, while low flows can result in warmer in-stream temperatures. Water quality impacts are due primarily to direct conveyance of additional materials into the stream with stormwater runoff. Lastly, biological impacts are the result of degradation of hydrology, physical, and water quality conditions in the stream ecosystem. Impervious cover serves as an excellent surrogate for many types of stormwater-related impairments because it relates primary causal factors to specific impairments.

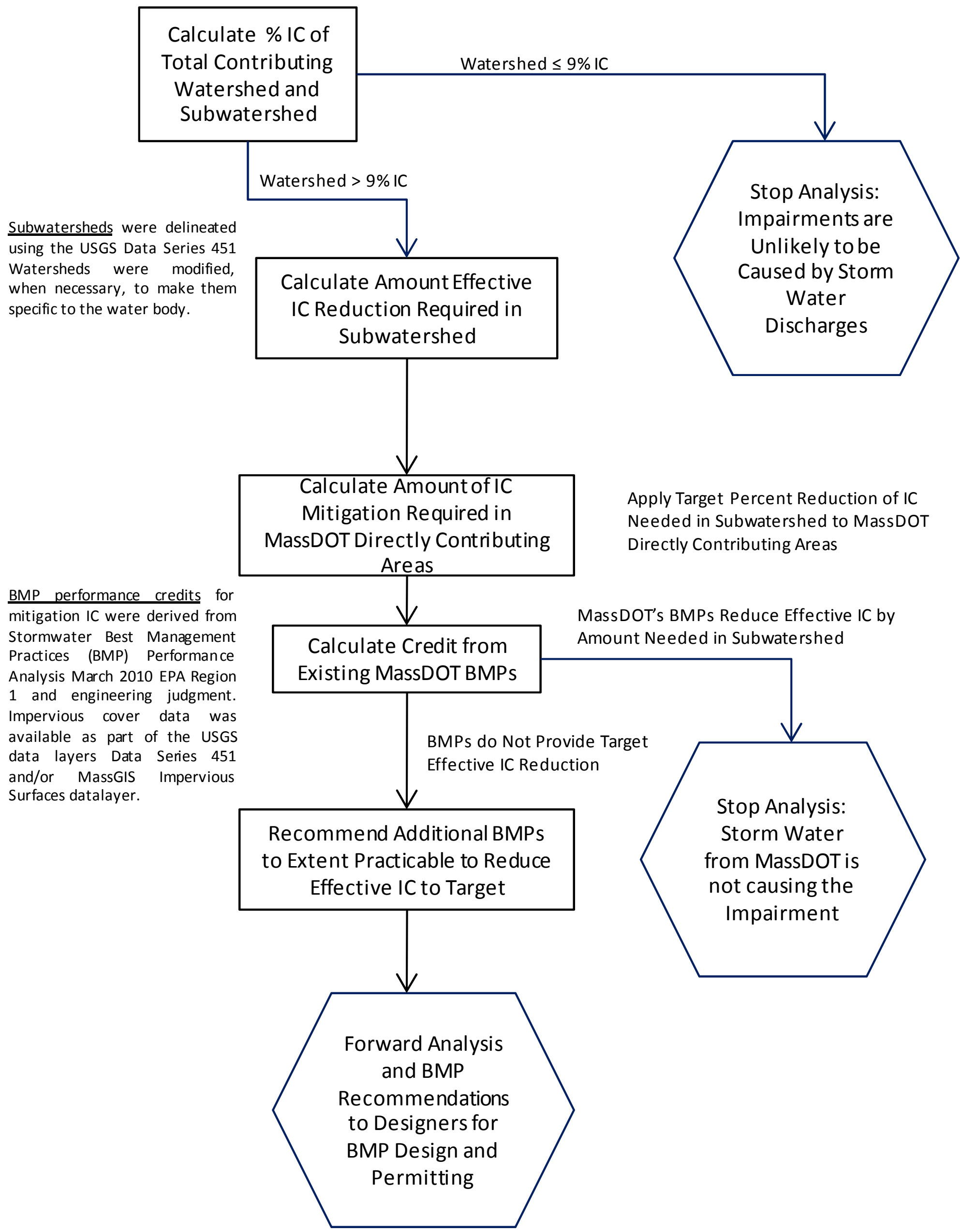
Research indicates that a decline in stream quality occurs when impervious cover (IC) for a watershed exceeds 10% and that severe impairment can be expected when the IC exceeds 25%. A pilot study performed applying the IC method for several impaired waters in New England (ENSR 2005) found that "Based on extensive data and the best information available, it appears that if the IC target is met (by reducing actual IC, reducing directly connected IC, and/or other measures), stormwater-impaired waters will be brought back into compliance with water quality standards (WQSs)".

The appropriateness of this approach to assessing the impacts of storm water and identifying quantifiable targets for mitigating the impacts of storm water has recently been affirmed by USEPA (EPA 2010a).

EPA recommends a target of 9% impervious cover in a watershed (ENSR, 2006). When more than 9% of the watershed is impervious cover, storm water is likely to be a significant contributor to water quality concerns. When less than 9% of the watershed is impervious cover, water quality impairments are likely to be caused by other factors. Based on this principle, MassDOT assessed whether storm water from their roadways/properties has the potential to cause the impairment of the receiving water body. The approach MassDOT used to perform the assessment is outlined in the flowchart below.

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 downstream end of impaired segment) and that of the local watershed contributing directly to the impaired segmented (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. The USGS Data Series watersheds were modified, when necessary, to make them specific to the water body. Impervious cover data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces datalayer. 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 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.



MassDOT then calculated the effective impervious cover reduction afforded by the existing structural BMPs currently incorporated into the storm water 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 2010b) and engineering judgment. 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:

Watershed		
Watershed Area	271	acres
Impervious Cover (IC) Area	93.4	acres
Percent Impervious	34.5%	
IC Area at 9% Goal	24.4	acres
Necessary Reduction % in IC	74%	

Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	1.8	acres
MassDOT's Required Reduction in Effective IC (74% of DOT Directly Contributing IC)	1.3	acres

The watershed is greater than 9% impervious which indicates that the storm water is likely contributing to the impairment. The watershed needs to reduce its effective IC by 74% to reach the 9% goal. Therefore, MassDOT's target reduction is to reduce its effective IC by the 74%. MassDOT has 1.8 acres of IC directly contributing to the impaired water. MassDOT needs to remove the effect of 1.3 acres of IC.

MassDOT has existing BMPs that mitigate potential storm water quality impacts prior to discharge to Burncoat Park Pond. The filter strip, which functions similarly to a dry pond and is located between I-290 and the North Service Road (BMP 1), currently provides infiltration and vegetative uptake of pollutants to mitigate storm water impacts from 0.45 acres of MassDOT impervious cover; thereby reducing the effective impervious cover by 0.43 acres. The other existing vegetated swales and filter strips treat runoff from the grassed area between I-290 and the exit ramp. While these structures reduce the overall storm water runoff and associated pollutant load, they do not reduce the effective impervious cover in the watershed as currently configured. Therefore, the total mitigation of impervious surface achieved by MassDOT's BMPs (0.43 acres) is less than the target of 1.3 acres.

Existing BMPs

BMP Name	**BMP Type**	**IC Area Treated (acres)**	**Percent Reduction of Effective IC***	**Reduction of Effective IC (acres)**
BMP 1	Filter Strip/ Dry Pond	0.45	94%	0.43
Total		**0.45**		**0.43**

* The percent reduction of effective IC is dependent on BMP type, size relative to the IC that they process, and local soil conditions. BMP performances were derived from EPA Region 1's Stormwater Best Management Practices (BMP) Performance Analysis report (EPA 2010b) and engineering judgment.

Recommendations

Since the total mitigation of impervious surface achieved by MassDOT's BMPs is less than the target of 1.3 acres, MassDOT considered locations for additional BMPs. The vegetated area located to the north of the exit ramp (and bounded on the north by Holland Rink Playground) could be modified to act as an infiltration basin. The modifications would include re-routing runoff from the exit ramp and providing treatment through the proposed infiltration basin for storm water from the exit ramp prior to discharging to the City of Worcester catch basin which discharges to Outfall 14158.4 (BMP 2; Figure 2). In addition, MassDOT could modify the vegetated slope between I-290 and the North Service Road to act as a dry pond and collect, pre-treat, and convey storm water from I-290 prior to discharging to Outfall 14157.4 (BMP 3; Figure 2).

Installing BMPs in these locations, in conjunction with the existing filter strip, will reduce the overall effective impervious cover by 1.1 acres. While the proposed BMPs do not meet the target IC reduction of 1.3 acres, the BMPs represent the maximum treatment practicable given the existing site constraints.

Proposed BMPs

BMP Name	BMP Type	IC Area Treated (acres)	Percent Reduction of Effective IC*	Reduction of Effective IC (acres)
BMP 2	Infiltration Basin	0.36	94%	0.34
BMP 3	Filter Strip/ Dry Pond	0.68	47%	0.32
Proposed BMPs		**1.04**		**0.66**
Existing BMPs		0.45		0.43
Total		**1.49**		**1.09**

* The percent reduction of effective IC is dependent on BMP type, size relative to the IC that they process, and local soil conditions. BMP performances were derived from EPA Region 1's Stormwater Best Management Practices (BMP) Performance Analysis report (EPA 2010b) and engineering judgment.

In addition to these proposed structural BMPs, MassDOT implements non-structural BMP programs in accordance with its existing Storm Water Management Plan (SWMP).

In summary, the proposed and existing BMPs include:

- MassDOT proposes to re-route runoff from the exit ramp through the existing swales and filter strips BMPs which would reduce the effective impervious cover by 0.32 acres.
- MassDOT proposes to install an infiltration basin in the vegetated area located to the north of the exit ramp to treat the runoff from the exit ramp in series with the existing swales and filter strips. This will reduce effective impervious cover by an additional 0.34 acres.
- Existing BMPs located in between I-290 and North Service Road effectively reduce the existing impervious cover by 0.43 acres.

MassDOT will relay the recommendation for proposed BMPs and data collected as part of this assessment immediately to their designers for BMP design and construction.

Conclusions

Approximately 1.8 acres of MassDOT impervious cover contributes storm water directly to Burncoat Park Pond. An existing filter strip reduces the effective impervious cover by 0.43 acres. In order to further reduce MassDOT's contribution to the effective impervious cover within the Burncoat Park Pond watershed, MassDOT is proposing modification of existing vegetated swales and filter strips, as well as installation of a new infiltration basins, to reduce the effective impervious cover contribution from MassDOT by more than 60% (1.1 acres). The proposed BMPs represent the maximum treatment practicable given the existing site constraints. Coupled with existing non-structural BMP practices, storm water contributions of pollutants from MassDOT property will be reduced to the maximum extent practicable.

Furthermore, MassDOT commits that if the City of Worcester (through MassDOT contracts) or MassDOT conduct future work along Interstate 290 or the North Service Road, MassDOT will determine whether additional structural BMPs to address the impairments are practicable.

References

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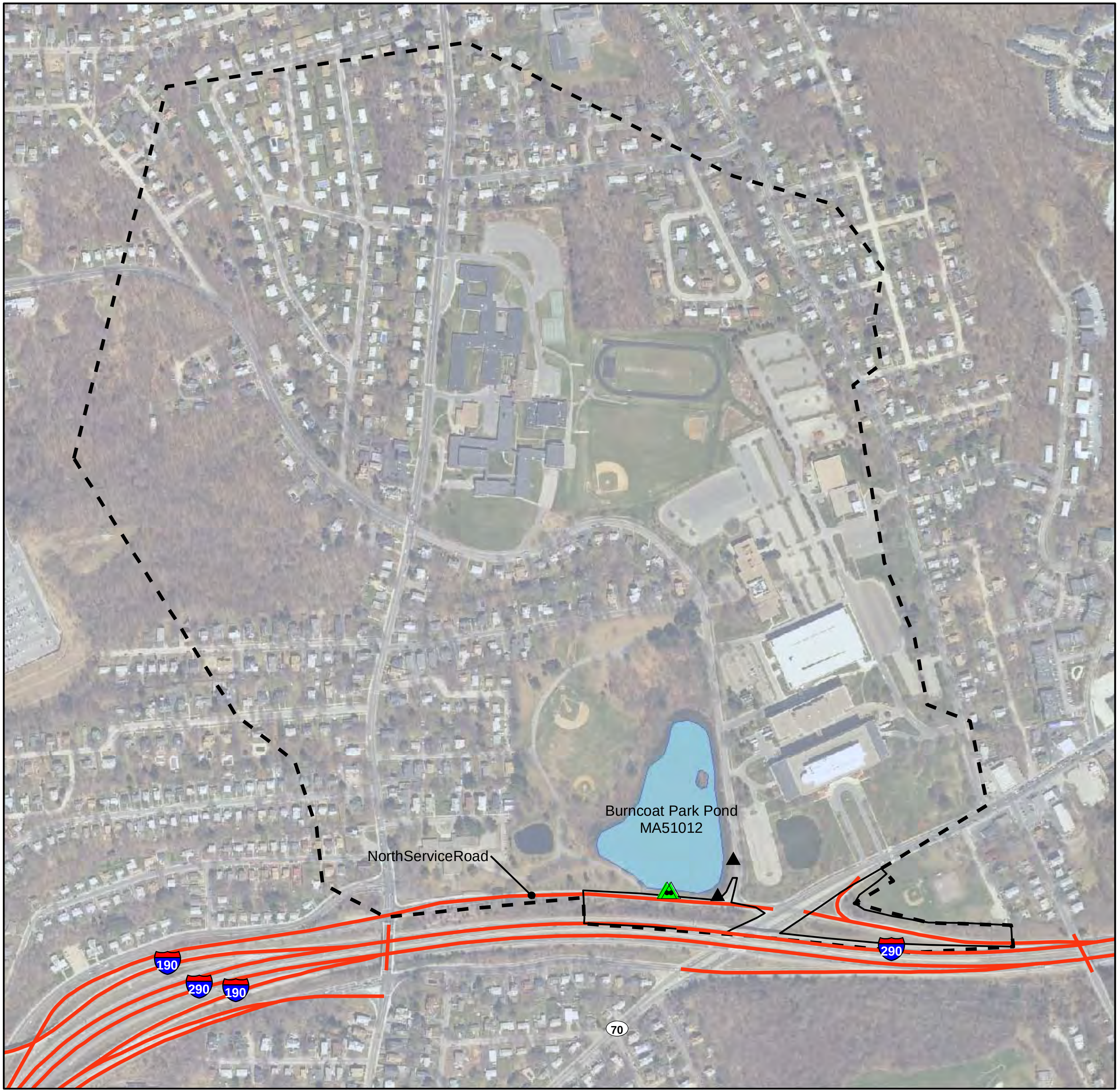

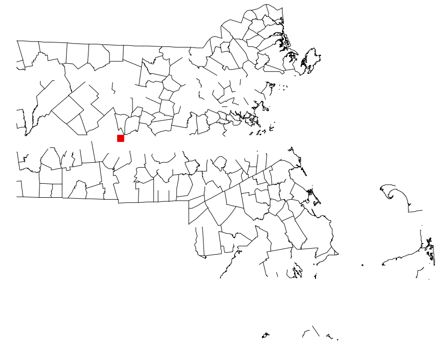

MassDOT Outfall

City of Worcester Outfall

Impaired Water Bodies

MassDOT Roads in Urban Areas

MassDOT Roads

MassDOT Watershed

Total Watershed

**Proposed stormwater infrastructure locations are estimated.

N

500 250 0 500 Feet

Figure 1
Burncoat Park Pond
MA51012

Interstate 290
Worcester, MA

December 2010

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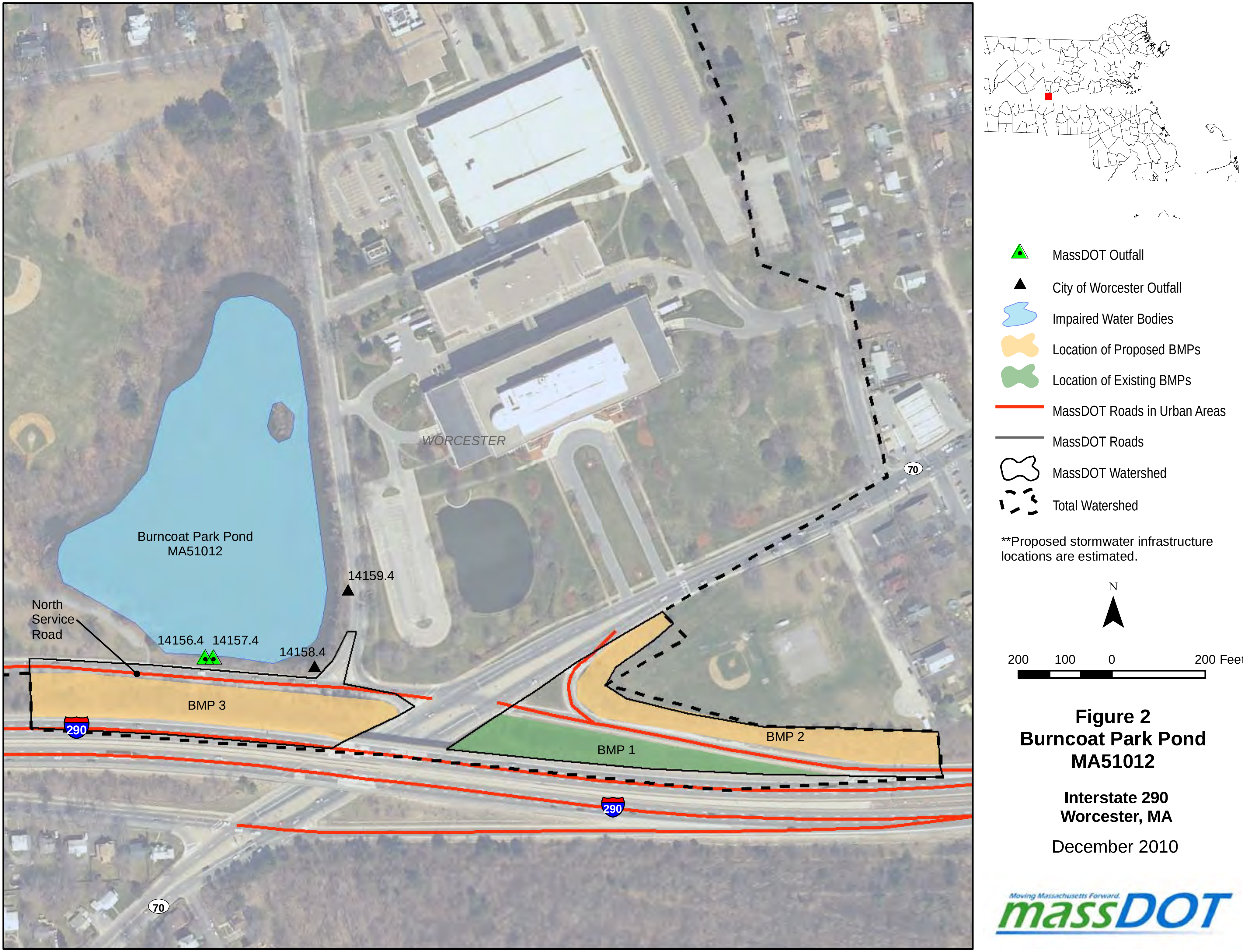

Figure 2
Burncoat Park Pond
MA51012

Interstate 290
Worcester, MA

December 2010

massDOT Moving Massachusetts Forward.

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Impaired Waters Assessment for Cambridge Reservoir Upper Basin (MA72156)

Impaired Waterbody

Cambridge Reservoir, Upper Basin (Segment MA72156)

Impairments

Mass DEP 2008 303d List: turbidity, aquatic plants (macrophytes)

Mass DEP 2010 Draft 303d List Changes: no changes

Relevant Water Quality Standards: Water Body Class: A

- 314 CMR 4.05 (3)(a)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.

Site Description

The Cambridge Reservoir Upper Basin is the portion of the Cambridge Reservoir located in the Towns of Lincoln and Lexington. The Cambridge Reservoir Upper Basin has a surface area of 44 acres and a contributing watershed area of 2,277 acres. There are no other upstream contributing drainage areas.

MassDOT property in the watershed includes portions of Route 2A, Route 95 from north of Route 2A to Route 2, and Route 2 which traverses the southern boundary of the reservoir (Figure 1). In addition there are interchanges at both Route 2A and Route 2, and a rest area on the northbound side of Route 95 just south of Route 2A. MassDOT owns at least 24 outfalls that discharge to the reservoir directly or to a reach of a small drainageway that then discharges to the Cambridge Reservoir Upper Basin (Figure 2). The drainageway, which runs from Route 2A to the reservoir, has been channelized and culverted along the southbound side of Route 95. For purposes of this assessment, discharges to this drainageway are functionally considered direct discharges to the Cambridge Reservoir Upper Basin. An overview and details of the direct drainage watersheds and outfalls are presented in greater detail below.

<u>Collection Area 1</u>

As shown on Figure 2a, the discharge associated with the Route 2A/95 southeast cloverleaf section enters a forested wetland area which overflows to a small, shallow concrete collection area south of the southeast cloverleaf (Collection Area 1). The collection area collects runoff from the cloverleaf, the ramp, and the rest area to the south. This small collection area appears to provide no treatment and the overflow discharges under Route 95 directly to the channelized section of the southbound drainageway which runs along Route 95 to the Cambridge Reservoir Upper Basin.

Southbound Drainageway

Runoff from the remaining three cloverleafs (southwest, northwest, and northeast) at the Route 2A/Route 95 exchange are hydraulically connected to each other and ultimately discharge to the southbound drainageway after being detained within the cloverleaf wetlands (Figure 2a). Drainage from the northeast cloverleaf section, including both ramps and the cloverleaf itself, is directed via a culvert to the northwest cloverleaf. There, it joins drainage from the northwest cloverleaf section including a small section of the outside ramp, the entire inside ramp, a section of Route 2A, both triangle sections, and the cloverleaf itself. There is a small, deep vegetated collection area (Collection Area 2) in the triangle to the west of the cloverleaf that likely provides some detention but does not receive drainage from any impervious areas. A brook moves from north to south through this cloverleaf to the southwest cloverleaf where it combines with runoff from the southwest cloverleaf ramps and a section of Route 2A. The combined runoff then directly drains to the southbound drainageway. An approximately 100 yard section of the drainageway runs through a culvert parallel to Route 95 before the brook reaches the Cambridge Reservoir Upper Basin.

Runoff from a portion of the Route 2A East to Route 95 South entrance ramp and Route 95 Southbound enters the southbound drainageway from the eastern side through a series of 5 outfalls (Figure 2a). Each of these outfalls captures drainage from between 100 and 300 feet of the entrance ramp.

Additionally, runoff from a section of the northbound lanes of Route 95 and a portion of the rest area is collected and piped under Route 95 into the southbound drainageway.

Further south, runoff from another section of the northbound lanes of Route 95 flows through four outfalls located north of Lincoln Street (Figure 2b) that discharge to a large culvert under the highway, transporting runoff from the northbound side of Route 95 to the brook just downstream of the culverted section of the southbound drainageway.

Cambridge Reservoir Upper Basin

South of where the southbound drainageway enters the Reservoir, a single outfall discharges directly to the Cambridge Reservoir Upper Basin. This outfall serves 4 catch basins that drain approximately 1,000 feet of the northbound lanes of Route 95 south of Lincoln Street via two outfalls south of Lincoln Street (Figure 2b) and a culvert under the highway.

Intersection of Route 2 and Route 95

Two outfalls collect storm water from Route 95 south and discharge to a wooded area adjacent to the highway (Figure 2b). Observation of both flow paths to the reservoir suggest that flows typically infiltrate prior to reaching the reservoir. Additionally, three outfalls drain catch basins located on the exit ramp from Route 95 South to Route 2 West (Figure 2b). These three outfalls collect runoff from an approximately 750 foot stretch of the exit ramp and are conveyed to the reservoir.

Route 2

Three catch basins individually discharge along the causeway formed by Route 2 as it passes between the Upper Basin and the Middle Basin portions of the Cambridge Reservoir (Figure 2b). These three outfalls collect runoff from approximately 300 feet of the westbound lanes of Route 2. Because these outfalls enter the Upper Basin at a location very near the outlet to the Middle Basin of the Cambridge Reservoir, it is likely that during times of active withdrawal of water from the reservoir (summer and fall), water discharging from these outfalls does not mix with the Upper Basin reservoir water but rather is transported to the Middle Basin reservoir. However, during the winter and spring when the reservoir is refilling, water from these outfalls is more likely to circulate through the Upper Basin reservoir and play a role in Upper Basin reservoir water quality.

Assessment under BMP 7U for Nutrients and Other Habitat Alterations Impairments

The impairments for the Cambridge Reservoir Upper Basin (turbidity, aquatic plants (macrophytes)) have 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.

Excessive turbidity in the Cambridge Reservoir Upper Basin likely originates from inorganic sediment originating in storm water or resuspended from the reservoir and/or organic sources related to phytoplankton growth in the reservoir associated with excessive phosphorus loading. Both sediment and phosphorus are present in typical highway runoff; there are likely many other sources in the watershed as well.

The impairments for noxious aquatic plants may also be related to the input of both nutrients and sediments to the Cambridge Reservoir Upper Basin. The input of nutrients and sediments is directly related to the amount of impervious cover in the watershed.

For this water body, MassDOT used EPA Region I's Impervious Cover (IC) Method described in EPA's Stormwater TMDL Implementation Support Manual (ENSR 2006), to assess potential storm water impacts on the impaired water and evaluate the level of impervious cover reduction required to ensure that storm water is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed had less than 9% impervious cover, MassDOT concluded that storm water was not the likely cause of the impairment.

Impervious Cover Analysis

The impervious cover model (ICM) relates an aquatic system's health (i.e., state of impairment) to the percentage of impervious cover 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 impervious cover 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.

The relative portion of a watershed's impervious cover can be used as an effective means of determining aquatic system health. Urbanization, primarily through the construction of impervious cover, causes progressive hydrologic, physical, water quality and biological impacts to aquatic health. Agricultural and other land-modifying activities can also contribute significantly to aquatic health degradation. Increasing impervious cover reduces the amount of infiltration/recharge and increases the amount of runoff. As a result, the stream experiences more extreme and variable flows including lower low flows, due to reduced baseflow, and higher high flows, due to large stormwater runoff volumes.

Physical impacts associated with IC are directly related to modification in stream hydrology. For example, flooding causes channel enlargement and incision, while low flows can result in warmer in-stream temperatures. Water quality impacts are due primarily to direct conveyance of additional materials into the stream with stormwater runoff. Lastly, biological impacts are the result of degradation of hydrology, physical, and water quality conditions in the stream ecosystem.

Impervious cover serves as an excellent surrogate for many types of stormwater-related impairments because it relates primary causal factors to specific impairments.

Research indicates that a decline in stream quality occurs when impervious cover (IC) for a watershed exceeds 10% and that severe impairment can be expected when the IC exceeds 25%. A pilot study performed applying the IC method for several impaired waters in New England (ENSR 2005) found that “Based on extensive data and the best information available, it appears that if the IC target is met (by reducing actual IC, reducing directly connected IC, and/or other measures), stormwater-impaired waters will be brought back into compliance with water quality standards (WQSs)”.

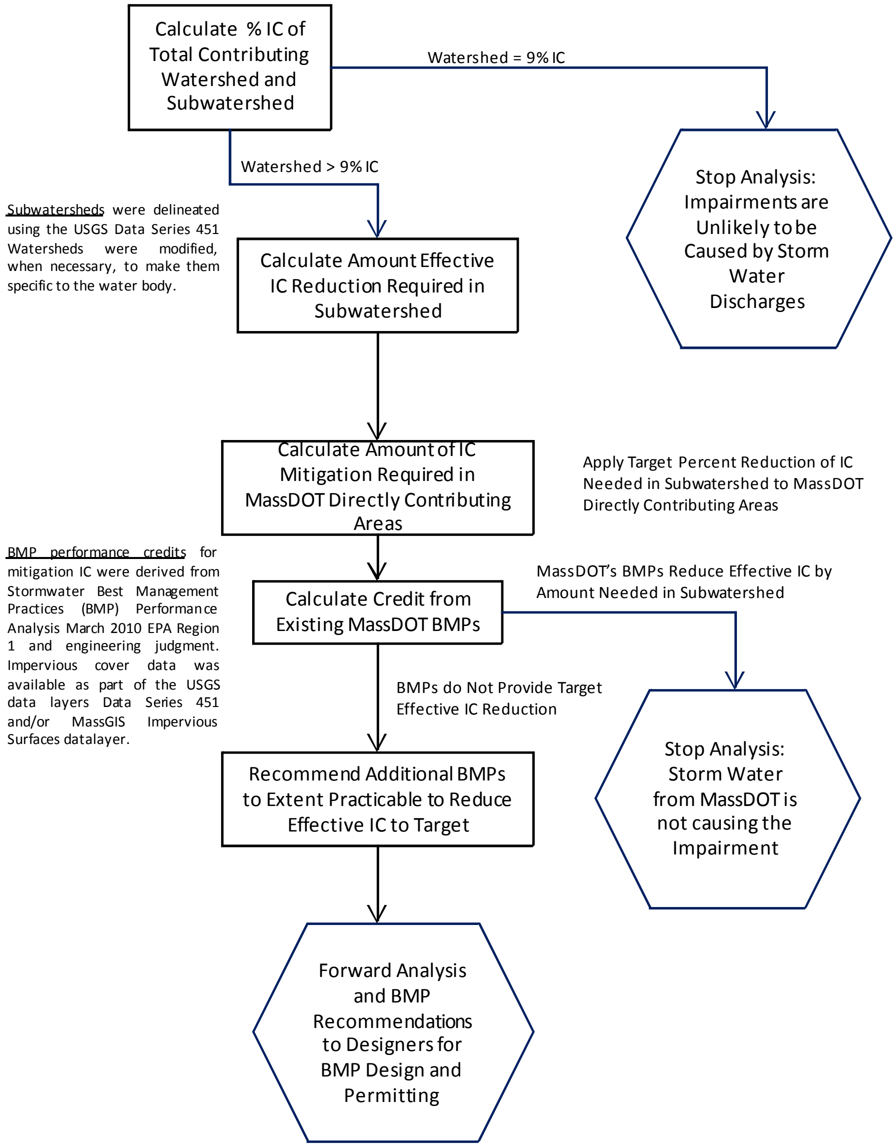
The appropriateness of this approach to assessing the impacts of storm water and identifying quantifiable targets for mitigating the impacts of storm water has recently been affirmed by USEPA (EPA 2010a).

EPA recommends a target of 9% impervious cover in a watershed (ENSR, 2006). When more than 9% of the watershed is impervious cover, storm water is likely to be a significant contributor to water quality concerns. When less than 9% of the watershed is impervious cover, water quality impairments are likely to be caused by other factors. Based on this principle, MassDOT assessed whether storm water from their roadways/properties has the potential to cause the impairment of the receiving water body. The approach MassDOT used to perform the assessment is outlined in the flowchart below.

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 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 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. The USGS Data Series watersheds were modified, when necessary, to make them specific to the water body. Impervious cover data was available as part of the USGS data layers Data Series 451 and MassGIS’s impervious surfaces datalayer. 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 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.

MassDOT then calculated the effective impervious cover reduction afforded by the existing structural BMPs currently incorporated into the storm water 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 2010b) and engineering judgment. 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.


Calculate % IC of Total Contributing Watershed and Subwatershed
Watershed = 9% IC
Stop Analysis: Impairments are Unlikely to be Caused by Storm Water Discharges
Watershed > 9% IC
Subwatersheds were delineated using the USGS Data Series 451 Watersheds were modified, when necessary, to make them specific to the water body.
Calculate Amount Effective IC Reduction Required in Subwatershed
Calculate Amount of IC Mitigation Required in MassDOT Directly Contributing Areas
Apply Target Percent Reduction of IC Needed in Subwatershed to MassDOT Directly Contributing Areas
BMP performance credits for mitigation IC were derived from Stormwater Best Management Practices (BMP) Performance Analysis March 2010 EPA Region 1 and engineering judgment. Impervious cover data was available as part of the USGS data layers Data Series 451 and/or MassGIS Impervious Surfaces datalayer.
Calculate Credit from Existing MassDOT BMPs
MassDOT's BMPs Reduce Effective IC by Amount Needed in Subwatershed
Stop Analysis: Storm Water from MassDOT is not causing the Impairment
BMPs do Not Provide Target Effective IC Reduction
Recommend Additional BMPs to Extent Practicable to Reduce Effective IC to Target
Forward Analysis and BMP Recommendations to Designers for BMP Design and Permitting

Using this approach, MassDOT derived the following site parameters to the total contributing watershed of the impaired water (Cambridge Reservoir Upper Basin):

Watershed		
Watershed Area	2,277	acres
Impervious Cover (IC) Area	288	acres
Percent Impervious	12.6%	
IC Area at 9% Goal	205	acres
Necessary Reduction % in IC	29%	

Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	34	acres
MassDOT's Required Reduction in Effective IC (29% of DOT Directly Contributing IC)	10	acres

The watershed is greater than 9% impervious which indicates that the storm water is likely contributing to the impairment. The watershed needs to reduce its effective IC by 29% to reach the 9% goal. Therefore, MassDOT should reduce its effective IC by the same percentage. MassDOT needs to remove the effect of 10 acres of effective IC.

Existing BMPs

MassDOT has several existing BMPs that mitigate potential storm water quality impacts prior to discharge to the Cambridge Reservoir Upper Basin including infiltration basins and grass swales. These 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 areas associated with the existing BMPs are general hydrologic group B (sand and loam) and group C (silt, loam and clay) soils or urban fill. Urban fill was conservatively assumed to have drainage properties similar to those of a group C soil.

BMP 1, 2, 3

Three of the four cloverleaf areas at the intersection of Routes 95 and 2A contain shrub/forested wetland areas (Figure 3). It is likely that these areas were formed when the interchange was constructed and may represent borrow pits from the construction of the ramps. These areas act as infiltration basins during much of the year and as detention basins during high flow periods. An effective IC removal efficiency of 97% has been assigned to these basins. Collectively these basins treat 11.9 acres of impervious cover and remove 11.5 acres of impervious cover from the MassDOT direct drainage.

BMP 4

The triangular area east of the ramp from Route 2A East to Route 95 South currently has a small infiltration area (Figure 3). As it is currently configured, it is assumed to provide limited pollutant removal and has been assigned an effective IC removal efficiency of 97%. This basin treats 0.27 acres of impervious cover and effectively removes 0.26 acres of impervious cover from the MassDOT direct drainage.

BMP 5 and 6

South of the rest area there is a series of two infiltration basins with an outfall structure discharging to a ditch east of the ramp from Route 95 Northbound to 2A Eastbound (Figure 3). They collect drainage from 3.6 acres of impervious cover that includes a section of Route 2A, the ramp from Route 95 NB to Route 2A Eastbound, a portion of the rest area, and a small section of Route 95 Northbound. BMP 5 and 6 have been assigned effective IC removal efficiencies of 68% and 34%, respectively. These BMPs treat 3.6 acres of impervious cover and removes 1.8 acres of impervious cover from the MassDOT direct drainage.

BMP 7 and 8

On Route 95 southbound north of the exit ramp to Route 2 West, there are two smaller outfalls (Figure 3a). These outfalls appear to conduct rather low volumes of water and discharge approximately 150 feet from the reservoir. Observation of both flow paths to the reservoir suggest that flows typically flow overland through the forested area and infiltrate prior to reaching the reservoir. BMP 7 and 8 have been assigned effective IC removal efficiencies of 56% and 89%, respectively. These BMPs treats 0.8 acres of impervious cover and removes 0.5 acres of impervious cover from the MassDOT direct drainage.

The following table shows the BMPs, the respective area of IC they treat, their calculated IC reduction credit percentage, and the resulting IC area reduction. Collectively, these existing BMPs provide treatment for 16.6 acres of impervious cover and, based on their sizing and type, reduce the directly contributing impervious cover by 14.1 acres. This reduction exceeds the effective impervious cover necessary to meet the IC mitigation target for MassDOT's directly contributing roads (10 acres).

Existing BMPs

BMP Name	BMP Type	IC Area Treated (acres)	Percent Reduction of Effective IC*	Reduction of Effective IC (acres)
BMP 1	Wetland/ Infiltration Basin	7.2	97%	7.0
BMP 2	Wetland/ Infiltration Basin	2.6	97%	2.5
BMP 3	Wetland/ Infiltration Basin	2.1	97%	2.0
BMP 4	Infiltration Basin	0.3	97%	0.3
BMP 5	Infiltration Basin	0.5	68%	0.4
BMP 6	Infiltration Basin	3.1	34%	1.4
BMP 7	Infiltration Area	0.6	56%	0.3
BMP 8	Infiltration Area	0.2	89%	0.2
Total		**16.6**		**14.1**

* The percent reduction of effective IC is dependent on BMP type, size relative to the IC that they process, and local soil conditions. BMP performances were derived from EPA Region 1's Stormwater Best Management Practices (BMP) Performance Analysis report (EPA 2010b) and engineering judgment.

Conclusions

This assessment for Segment MA72156 of the Cambridge Reservoir Upper Basin has shown that the existing BMPs treating MassDOT's roadways/ properties provide adequate mitigation for storm water discharge water quality and address the segment's impairments. As described above, an evaluation of impervious cover and existing BMPs concluded that MassDOT reduces the effective IC in the direct watershed by more than enough to reach the 9% impervious goal.

The following table shows the effective IC removal of the existing and proposed BMPs.

Impervious Cover Reduction

IC in Directly Contributing Watershed	34	acres
Required Reduction in Effective IC	10	acres
IC Effectively Reduced by Existing BMPs	14	acres
IC Remaining to Mitigate	0	acres

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 road work is conducted. This is consistent with an iterative adaptive management approach to addressing impairments. In addition, MassDOT will also re-visit the use of structural BMPs if a wasteload allocation is assigned in association with future TMDL development.

While additional BMPs were not concluded to be necessary as part of this assessment, BMPs will likely be installed as part of the Route 2 and 2A bridge projects. In conjunction with DOT's new Impaired Waterbody Program, DOT has included a Programmed Projects Initiative to address runoff to impaired waters. This initiative works in concert with improvements determined necessary during these impaired water body assessments. Design of improvements to MassDOT roads will include a review of the drainage and its potential impacts on impaired waters. Roads that drain to impaired waters will strive to address impacts as part of the construction project. Based on a preliminary analysis, three areas have been identified where infiltration BMPs will be considered as part of the bridge projects:

- Route 2A Bridge Project: MassDOT will evaluate installing an infiltration basin to capture runoff from the northern portion of rest area on Route 95 at Route 2A, a portion of the ramp, and the overflow from the cloverleaf to the north. Also MassDOT will evaluate improving a small BMP located in the triangle formed by the entrance ramp from Route 2A East to Route 95 South, the exit ramp Route 95 South to Route 2A East and Route 95 South. The improved BMP would allow an infiltration basin to capture runoff from two outfalls to the southbound drainageway from the entrance ramp from Route 2A East to 95 South.
- Route 2 Bridge Project: MassDOT will evaluate installing an infiltration trench to capture runoff from three outfalls to the Upper Cambridge Reservoir from the exit ramp from Route 95 South to Route 2 West.

Structural BMPs installed or included in design as part of MassDOT's Impaired Waterbody Program for Programmed Projects will be summarized in MassDOT's annual reports.

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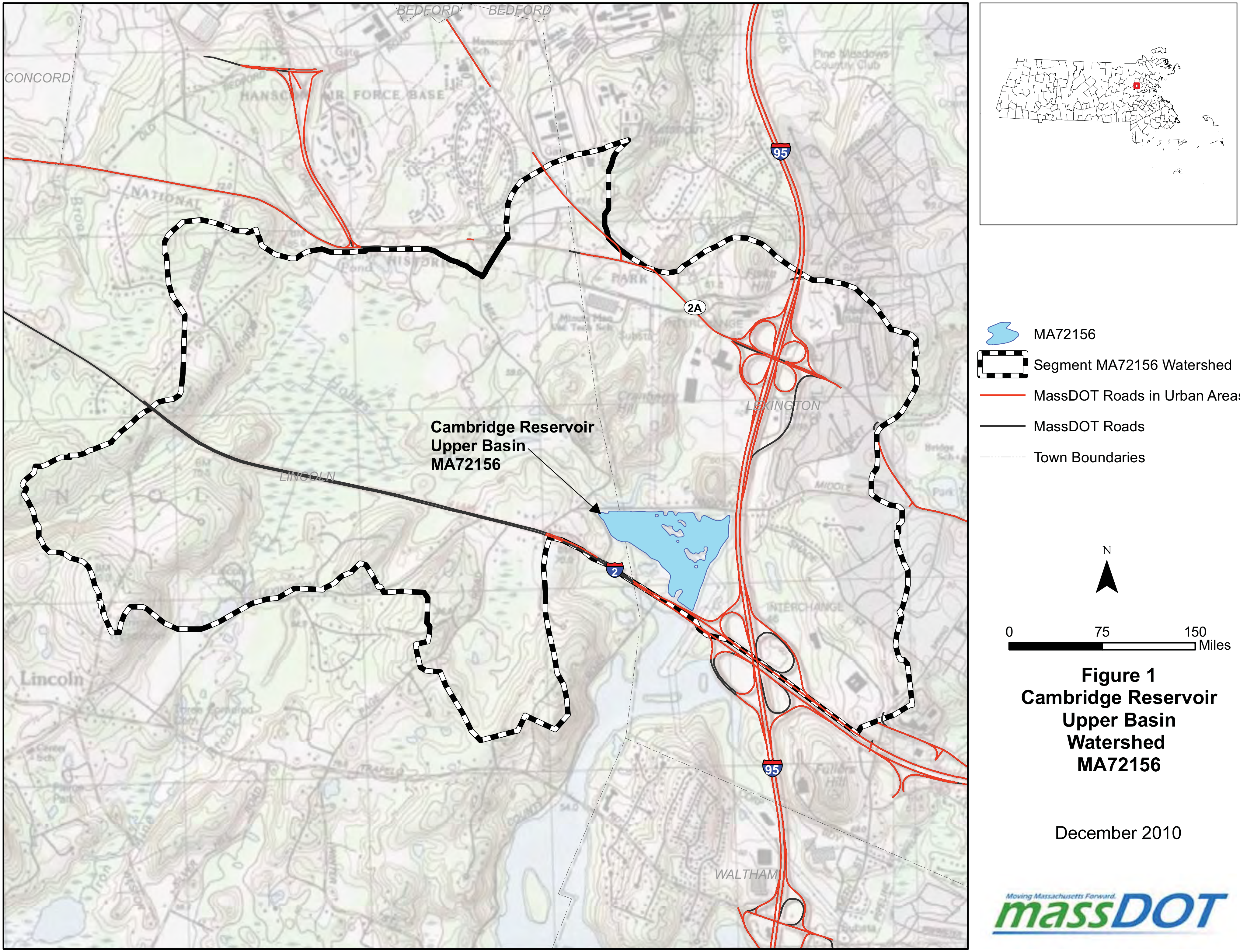

Figure 1
Cambridge Reservoir Upper Basin Watershed MA72156

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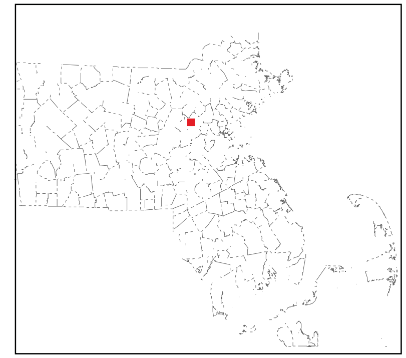

MA72156

Stormwater Outfalls

MassDOT Directly Contributing Watersheds

MassDOT Roads in Urban Areas

MassDOT Roads

Town Boundaries

600 300 0 600 Feet

N

Figure 2
Cambridge Reservoir
Upper Basin
MA72156

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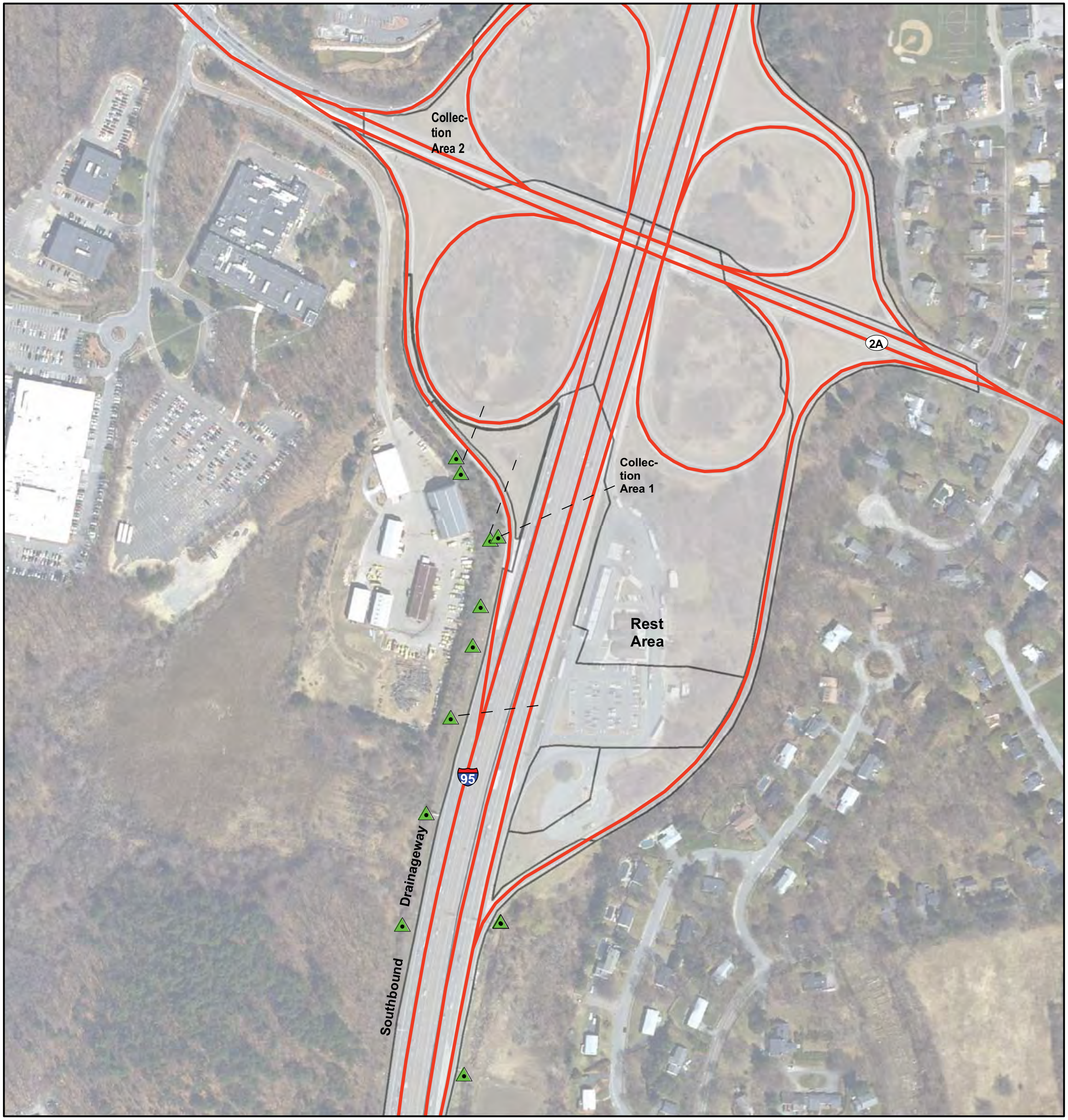

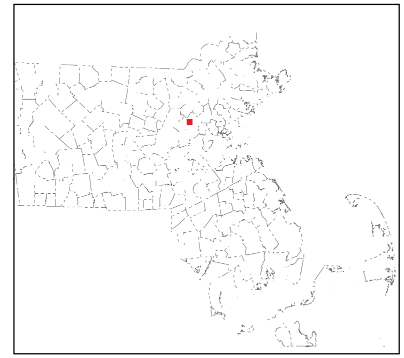

Stormwater Outfalls

Pipe/Culvert

MassDOT Directly Contributing Watersheds

MassDOT Roads in Urban Areas

MassDOT Roads

**Stormwater infrastructure locations are estimated.

400 200 0 400 Feet

N

Figure 2a
Cambridge Reservoir
Upper Basin
MA72156

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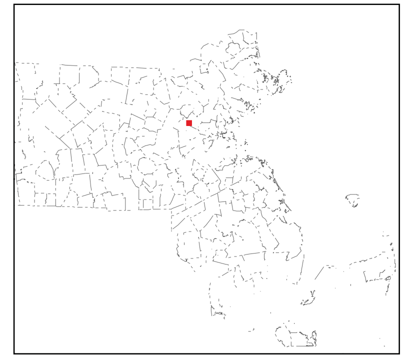

MA72156

Stromwater Outfalls

Pipe/Culvert

MassDOT Directly Contributing Watersheds

MassDOT Roads in Urban Areas

MassDOT Roads

**Stormwater infrastructure locations are estimated.

400 200 0 400 Feet

N

Figure 2b
Cambridge Reservoir
Upper Basin
MA72156

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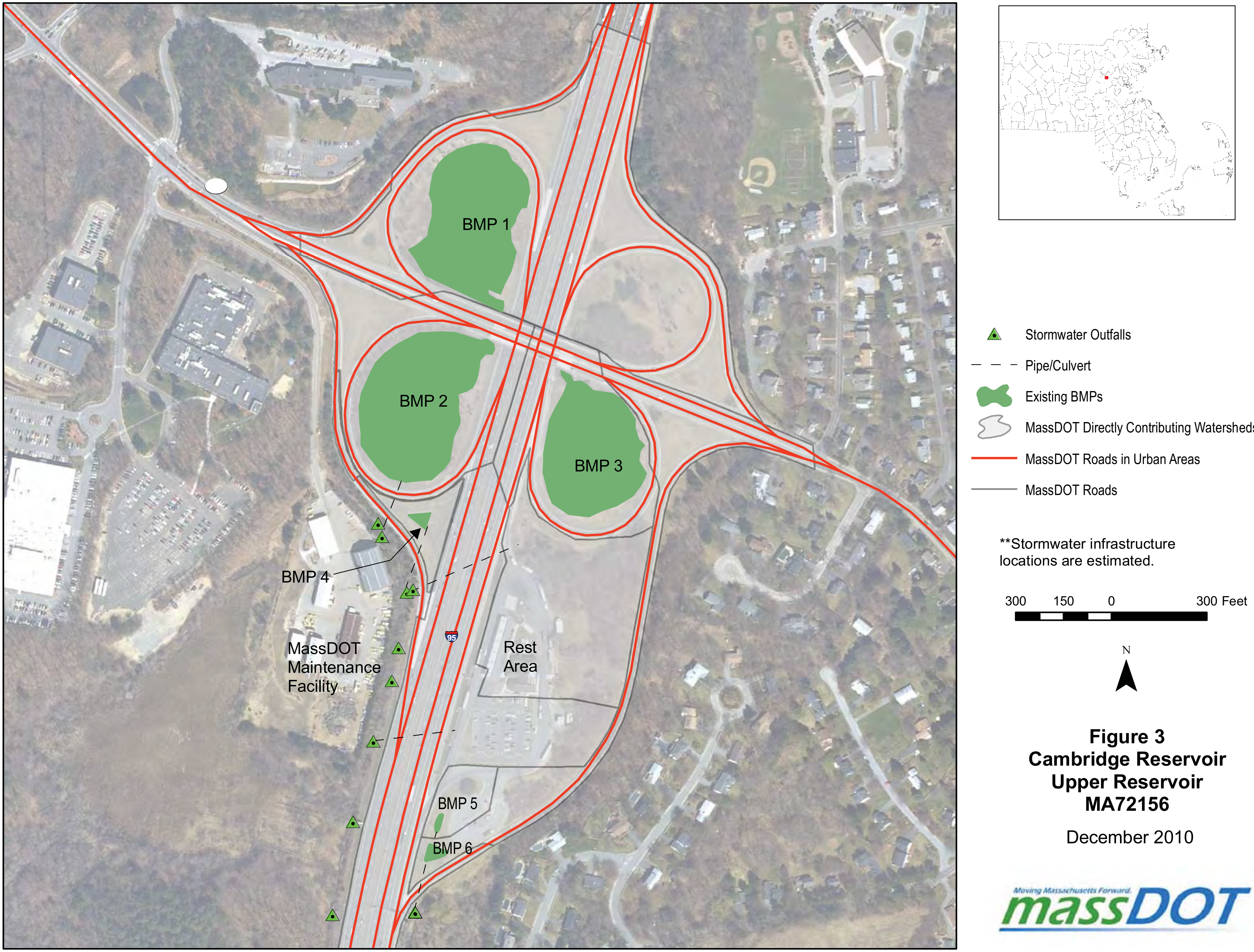

Figure 3
Cambridge Reservoir
Upper Reservoir
MA72156

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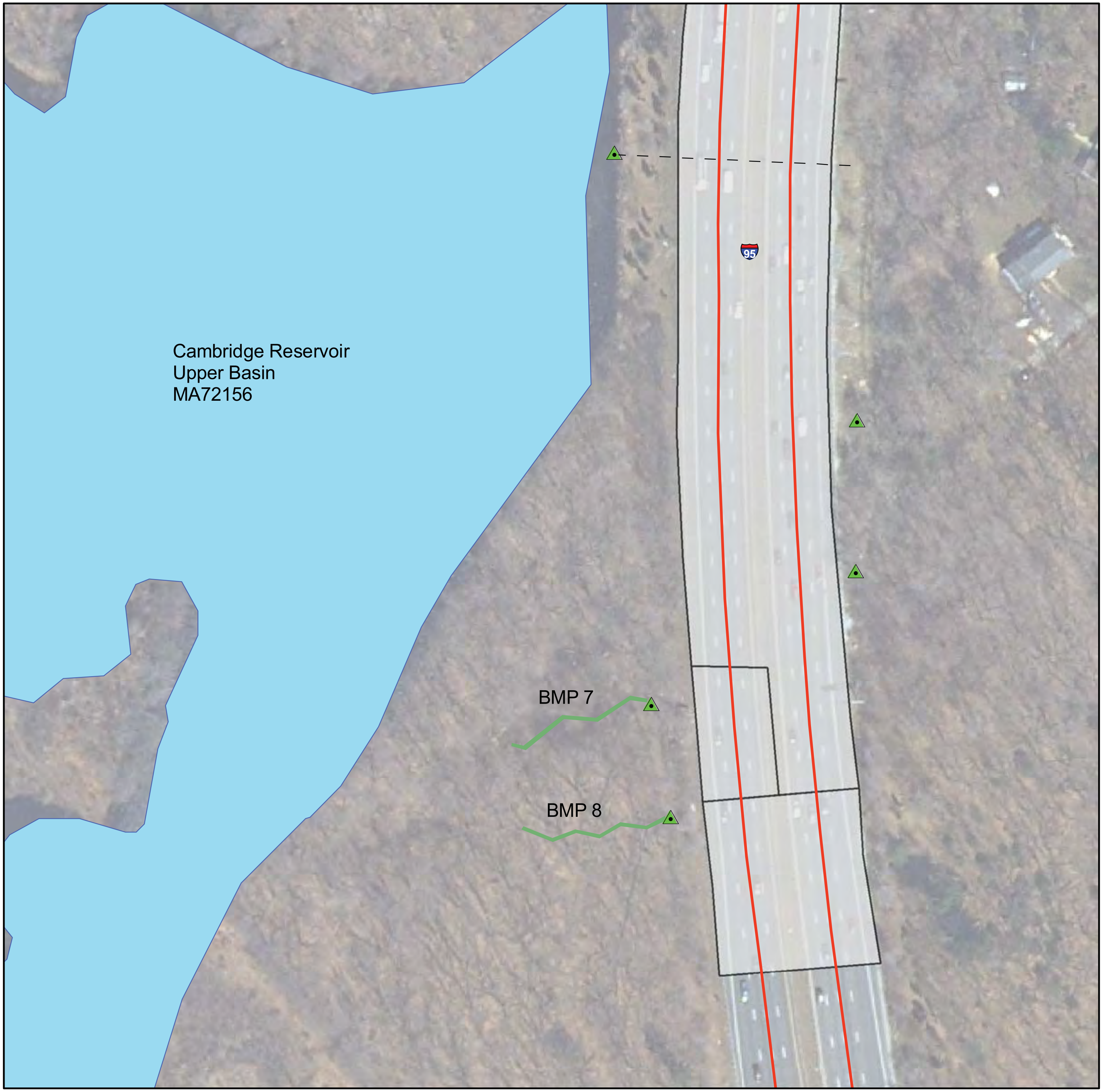

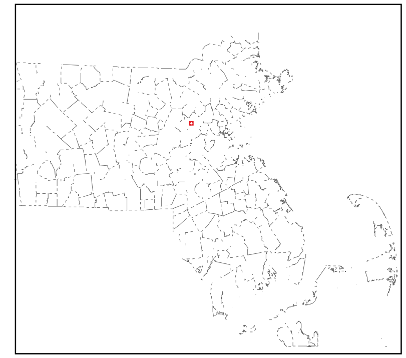

Stormwater Outfalls

Pipe/Culvert

Existing BMPs

MassDOT Directly Contributing Watersheds

MassDOT Roads in Urban Areas

MassDOT Roads

**Stormwater infrastructure locations are estimated.

100 50 0 100 Feet

N

Figure 3a
Cambridge Reservoir
Upper Reservoir
MA72156

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Impaired Waters Assessment for Quinebaug River (MA41-01)

Impaired Waterbody

Quinebaug River (Segment MA41-01)

Impairments

Mass DEP 2008 303d List: metals, pathogens

Mass DEP 2010 Draft 303d List Changes: The following Impairments were added in the Draft 2010 Integrated List of Waters: mercury in fish tissue, fecal coliforms, ambient bioassays – chronic aquatic toxicity, fishes bioassessments, lack of coldwater assemblage. Metals and pathogens were removed.

Relevant Water Quality Standards: Water Body Classification: Class B, Cold Water Fishery

- 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.
- 314 CMR 4.05(3)(a)4 – Bacteria. 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.
- 314 CMR 4.05(3)(b)2 – Temperature. Shall not exceed 68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring. Where a reproducing cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community shall not be exceeded and the natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3°F (1.7°0C) in rivers and streams designated as cold water fisheries nor 5°F (2.8°C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month); in lakes and ponds the rise shall not exceed 3°F (1.7°C) in the epilimnion (based on the monthly average of maximum daily temperature); natural seasonal and daily variations that are necessary to protect existing

and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any use assigned to this Class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions, or growth of aquatic organisms.

Site Description

Quinebaug River Segment MA41-01 is a 9.8-mile segment of the Quinebaug River that extends from the Outlet of Hamilton Reservoir in Holland to the Sturbridge Waste Water Treatment Plant (WWTP) in Sturbridge. The total Quinebaug River watershed area upstream of the Sturbridge WWTP is 41,650 acres and the portion of this watershed that contributes directly to Segment MA41-01 (the subwatershed) is 8,913 acres.

MassDOT owns Routes 84 and 20, both of which are within the Quinebaug River watershed. Based on an automated review of GIS data and MassDOT's Appendix L-1 of Impaired Waterbodies included in BMP 7U (dated July 22, 2010), it was originally determined that MassDOT has approximately 15 outfalls within 500 feet of the Quinebaug River. A field investigation on November 10, 2010 verified that MassDOT urban roadways drain to the river through five outfalls (Figure 2).

Assessment for Metals (Mercury), Bioassays-Chronic Aquatic Toxicity, Fish Bioassessments, Lack of Coldwater Assemblage and Pathogens (Fecal Coliform) Under BMP 7U

The impairments for Metals, Pathogens, Fecal Coliforms, Ambient Bioassays – Chronic Aquatic Toxicity, Fishes Bioassessments, and Lack of Coldwater assemblage have 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).

For this segment, MassDOT used EPA Region I's Impervious Cover (IC) Method, described in EPA's Storm water TMDL Implementation Support Manual (ENSR 2006), to assess potential storm water impacts on the impaired water and evaluate the level of impervious cover reduction required to ensure that storm water is not the cause of the impairments. Consistent with findings of EPA and others, when a watershed had less than 9% impervious cover MassDOT concluded that storm water was not the likely cause of the impairment.

Impervious Cover Analysis

The impervious cover model (ICM) relates an aquatic system's health (i.e., state of impairment) to the percentage of impervious cover 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 impervious cover 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.

The relative portion of a watershed's impervious cover can be used as an effective means of determining aquatic system health. Urbanization, primarily through the construction of impervious cover, causes progressive hydrologic, physical, water quality and biological impacts to aquatic health. Agricultural and other land-modifying activities can also contribute significantly to aquatic health degradation. Increasing impervious cover reduces the amount of infiltration/recharge and increases the amount of runoff. As a result, the stream experiences more extreme and variable flows including lower low flows, due to reduced baseflow, and higher high flows, due to large storm water runoff volumes.

Physical impacts associated with IC are directly related to modification in stream hydrology. For example, flooding causes channel enlargement and incision, while low flows can result in warmer in-stream temperatures. Water quality impacts are due primarily to direct conveyance of additional materials into the stream with storm water runoff. Lastly, biological impacts are the result of degradation of hydrology, physical, and water quality conditions in the stream ecosystem. Impervious cover serves as an excellent surrogate for many types of storm water-related impairments because it relates primary causal factors to specific impairments.

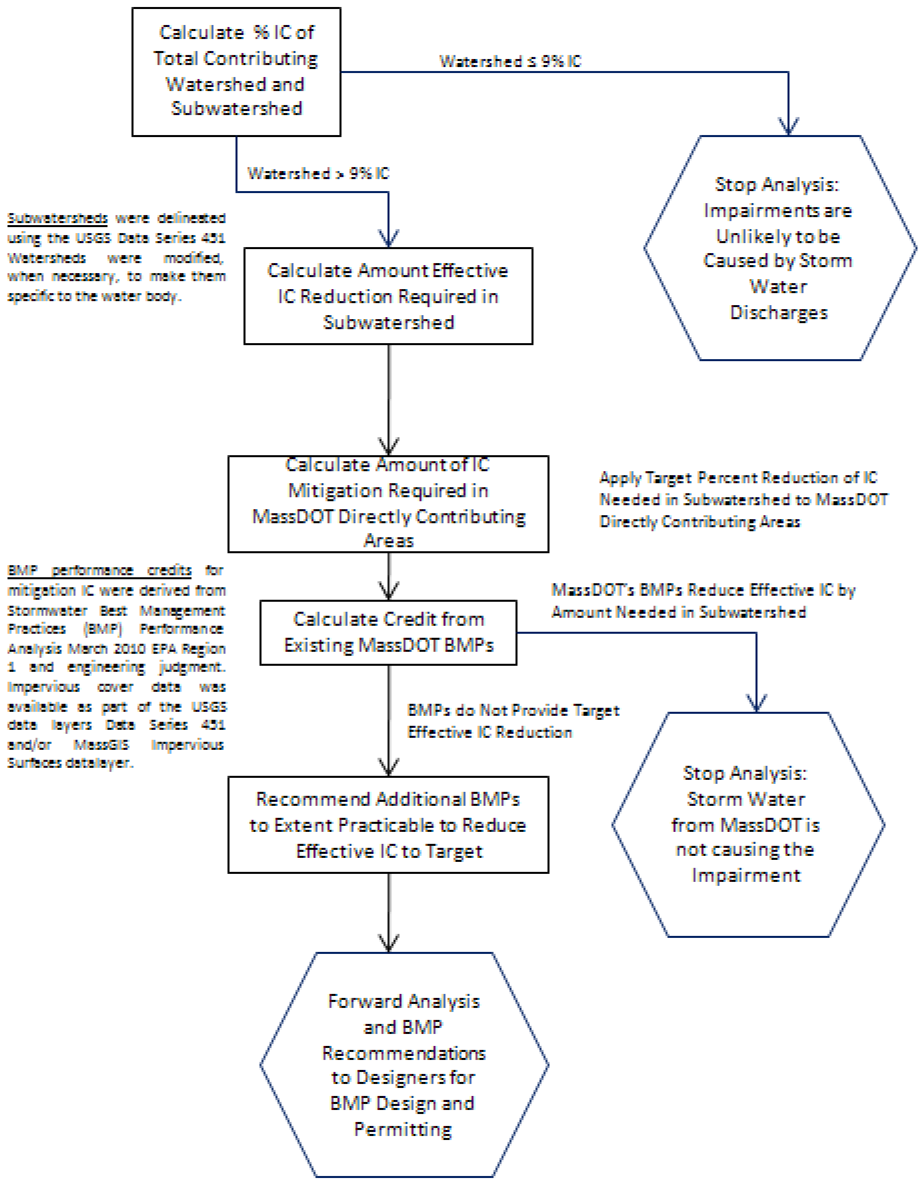
Research indicates that a decline in stream quality occurs when impervious cover (IC) for a watershed exceeds 10% and that severe impairment can be expected when the IC exceeds 25%. A pilot study performed applying the IC method for several impaired waters in New England (ENSR 2005) found that "Based on extensive data and the best information available, it appears that if the IC target is met (by reducing actual IC, reducing directly connected IC, and/or other measures), storm water-impaired waters will be brought back into compliance with water quality standards (WQSs)".

The appropriateness of this approach to assessing the impacts of storm water and identifying quantifiable targets for mitigating the impacts of storm water has recently been affirmed by USEPA (EPA 2010a).

EPA recommends a target of 9% impervious cover in a watershed (ENSR, 2006). When more than 9% of the watershed is impervious cover, storm water is likely to be a significant contributor to water quality concerns. When less than 9% of the watershed is impervious cover, water quality impairments are likely to be caused by other factors. Based on this principle, MassDOT assessed whether storm water from their roadways/properties has the potential to cause the impairment of the receiving water body. The approach MassDOT used to perform the assessment is outlined in the flowchart below.

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 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 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. The USGS Data Series watersheds were modified, when necessary, to make them specific to the water body. Impervious cover data was available as part of the USGS data layers Data Series 451 and MassGIS's impervious surfaces datalayer. 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 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.



MassDOT then calculated the effective impervious cover reduction afforded by the existing structural BMPs currently incorporated into the storm water 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 2010b) and engineering judgment. 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 upstream contributing watershed of segment MA41-01 of the Quinebaug River:

Total Contributing Area		
Area	41,650	acres
Impervious Cover (IC) Area	1,665	acres
% Impervious	4%	

The subwatershed also includes less than 9% impervious cover:

Subwatershed		
Watershed Area	8,913	acres
Impervious Cover (IC) Area	428	acres
Percent Impervious	4.8%	
IC Area at 9% Goal	na	acres
Necessary Reduction % in IC	0%	

Reductions Applied to DOT Direct Watershed		
MassDOT's IC Area **Directly** Contributing to Impaired Segment	29	acres
MassDOT's Required Reduction in Effective IC	0	acres

Because the total contributing watershed and subwatershed includes less than 9% impervious cover, the impairments listed for segment MA41-01 of the Quinebaug River (mercury in fish tissue (metals), bioassays - chronic aquatic toxicity, fish bioassessments, lack of coldwater assemblage) are unlikely to be caused by storm water runoff.

Additionally, the low percent of IC indicates that the impairment for pathogens is less likely to be related to storm water runoff from IC. 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, 1999a), but they are not always directly related to IC (CWP 2003)." MassDOT's property with IC directly adjacent to Quinebaug River is only a fraction (less than 1%) of the total in the watershed. The small area operated by MassDOT in combination with the positive relationship between IC and pathogens suggests that storm water from MassDOT is not the cause of the pathogen impairment.

Despite this, MassDOT has committed to reviewing this area by the end of the year for potential illicit connections through its IDDE program. The IDDE review will ensure that illicit connections on MassDOT property are not a source of pathogen loading. Results of this review will be included in the next NPDES annual report (to be submitted on April 30th 2011).

Furthermore, in accordance with the MassDOT's existing Storm Water Management Plan (SWMP), MassDOT implemented a variety of non-structural BMP programs. Such programs can help reduce potential pathogen impairments to the Quinebaug River. MassDOT believes these measures are sufficient to ensure that storm water from MassDOT is not causing the impairment for pathogens and is not recommending additional structural BMPs.

Conclusions

As described above, an evaluation of impervious cover area in the total watershed concluded that approximately 4% of the watershed area is considered impervious. This total percent impervious cover is below the 9% threshold. Based on this finding, MassDOT has concluded that storm water runoff is the not the cause of the impairments for mercury in fish tissue (metals), bioassays - chronic aquatic toxicity, fish bioassessments, and lack of coldwater assemblage.

Based on the low percent impervious cover in the watershed and the small proportion of the watershed that discharges from MassDOT to this segment of the Quinebaug, MassDOT has further concluded that discharges from MassDOT do not cause the pathogen impairment. Therefore, no structural BMPs are proposed.

MassDOT will continue to implement non-structural BMPs that reduce potential pathogen loading. In particular, MassDOT commits to conduct IDDE field efforts by the end of 2011. MassDOT will re-evaluate the potential need for structural BMPs to address pathogen loading when road work is conducted. This is consistent with an iterative adaptive management approach to addressing pathogen impairments. In addition, MassDOT will also re-visit the use of structural BMPs if a wasteload allocation is assigned to them through later TMDL development.

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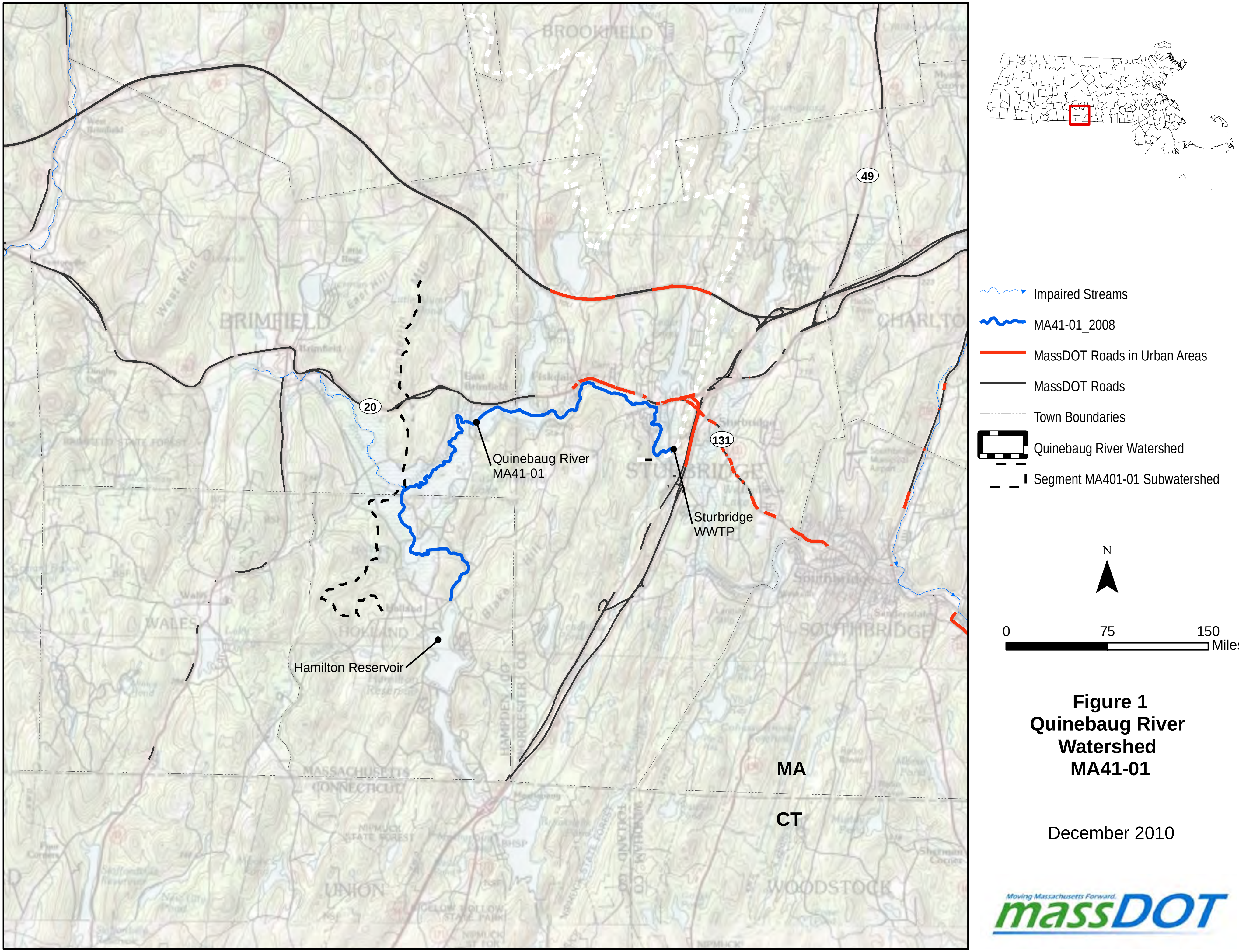

Figure 1
Quinebaug River
Watershed
MA41-01

December 2010

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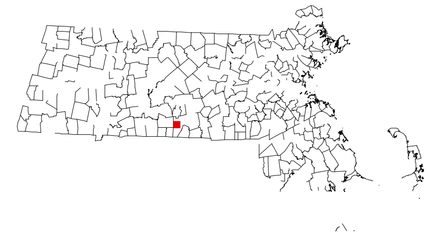

Stormwater Outfalls
Impaired Stream Segments
MA41-01
Impaired Water Bodies
MassDOT Roads in Urban Areas
MassDOT Roads
Town Boundaries

N

900 450 0 900
Feet

Figure 2
Quinebaug River Watershed
MA41-01

December 2010

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massDOT

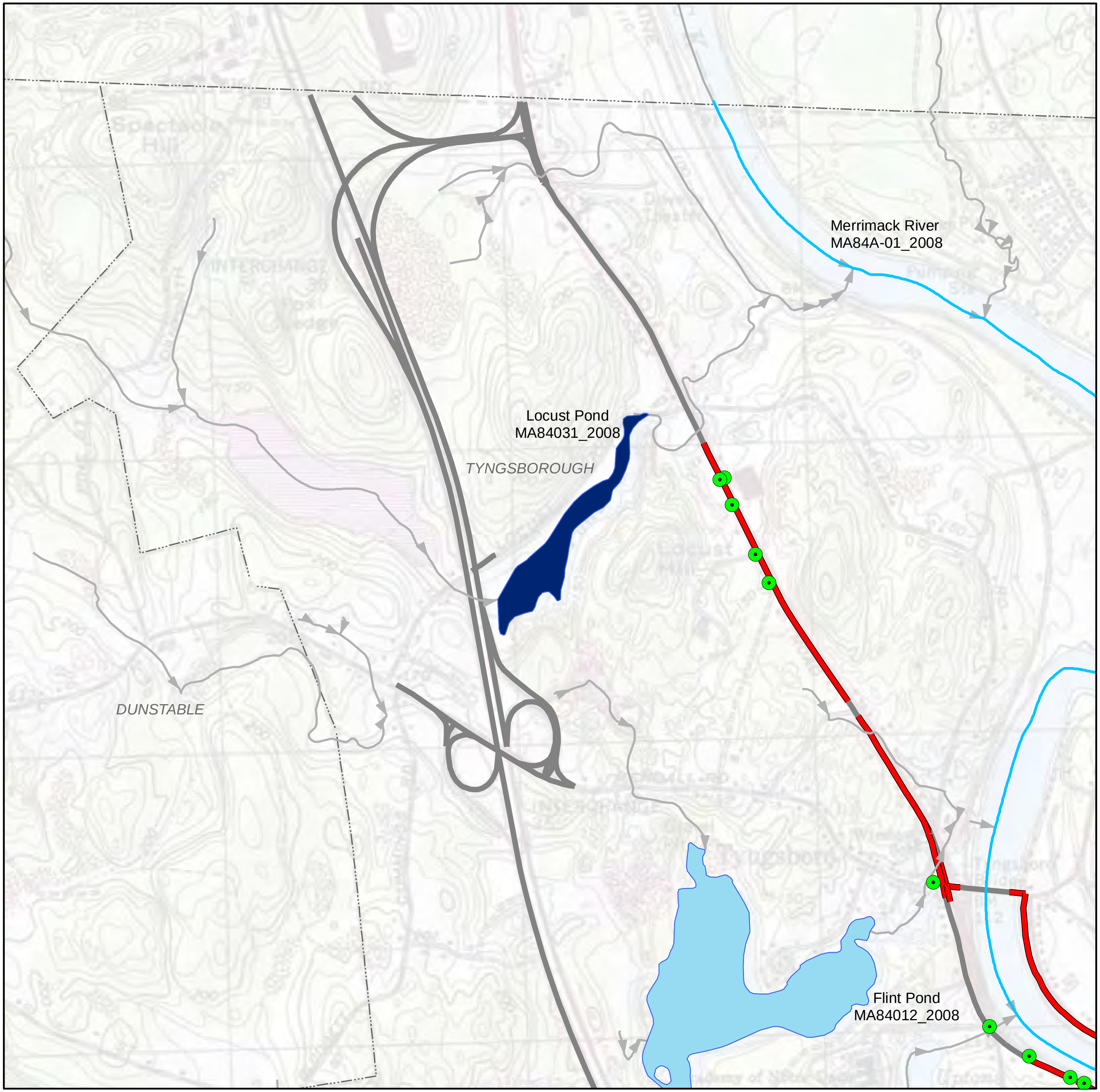
Attachment 2:
Assessments which Identified no Discharges from MassDOT Outfalls to Impaired Segments under Review

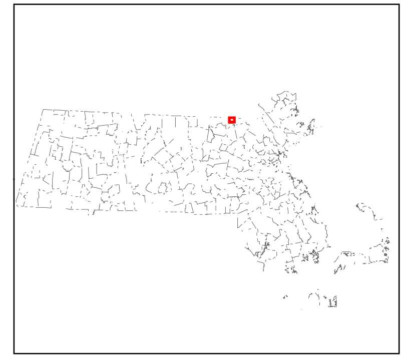
Under Step 2 of BMP 7U, MassDOT committed to map the locations of MassDOT outfalls relative to 303(d) waters. This step included "*performing a desktop review of the sub-basin of the 303(d) water body to determine the specific locations of MassDOT outfalls and their receiving waters. This procedure will help determine whether MassDOT's outfalls in fact are potentially discharging into the water body at issue, and will identify the number of outfalls that may need to be addressed through a mitigation plan. If MassDOT concludes, based on its mapping, that MassDOT's outfalls clearly are not discharging to the 303(d) water, it will document the basis for the conclusion and will conduct no further assessment of the water body at issue*." Step 2 of BMP 7R includes a similar desktop review.

Appendix L-1 of the June 8, 2010 submittal to the court, as part of the CLF vs. MassDOT lawsuit, identified waterbodies that potentially receive runoff from MassDOT urban roads and included Category 4a and 5 impaired waterbodies. In 2009, USGS published a new GIS datalayer of nested sub-basins[3]. These new, more detailed sub-basins allowed AECOM to, in most cases, define the specific watershed to an individual impaired segment when developing Appendix L-1. In some cases the sub-basin continued to include more than one impaired waterbody (and other non-impaired waterbodies) and, therefore, AECOM has been reviewing these sub-basins to identify which of the sub-basin's receiving waters do potentially receive DOT discharge from urban area roads and which do not. AECOM reviewed each sub-basin in detail and identified waters that do not receive direct discharge from MassDOT. For outfalls which are marked as potentially discharging to a receiving water, future field work will document whether the discharge reaches the impaired water body.

The figures in this section summarize this quarter's desktop review and those receiving waters that have been identified as not receiving DOT discharges during this more detailed review. The figures show the impaired waterbody segment being assessed in dark blue. The other impaired waterbody segments within the sub-basin are in bright blue. MassDOT urban area roads are indicated in red with the outfalls identified as green circles.

[3] MassGIS states the purpose of the datalayer as follows: "This data layer was created in cooperation with the Environmental Protection Agency (EPA) to assist local communities in environmental planning and storm water runoff studies. The purpose of this data layer is to provide basin boundaries and impervious surface data at a more discretized scale than is available with current Watershed Boundary Dataset (WBD) subdivisions." The GIS layer is available at http://water.usgs.gov/GIS/metadata/usgswrd/XML/ds451_subbasins.xml.





Town Boundaries
Stormwater Outfalls
Non-Impaired Stream Segments
Impaired Stream Segments
Impaired Stream Being Assessed
Impaired Water Bodies
Impaired Water Body Being Assessed
MA DOT Roads
MA DOT Urban Area Roads

1,000 500 0 1,000 Feet

N

MA84031_2008

Locust Pond

Merrimack

November 2010

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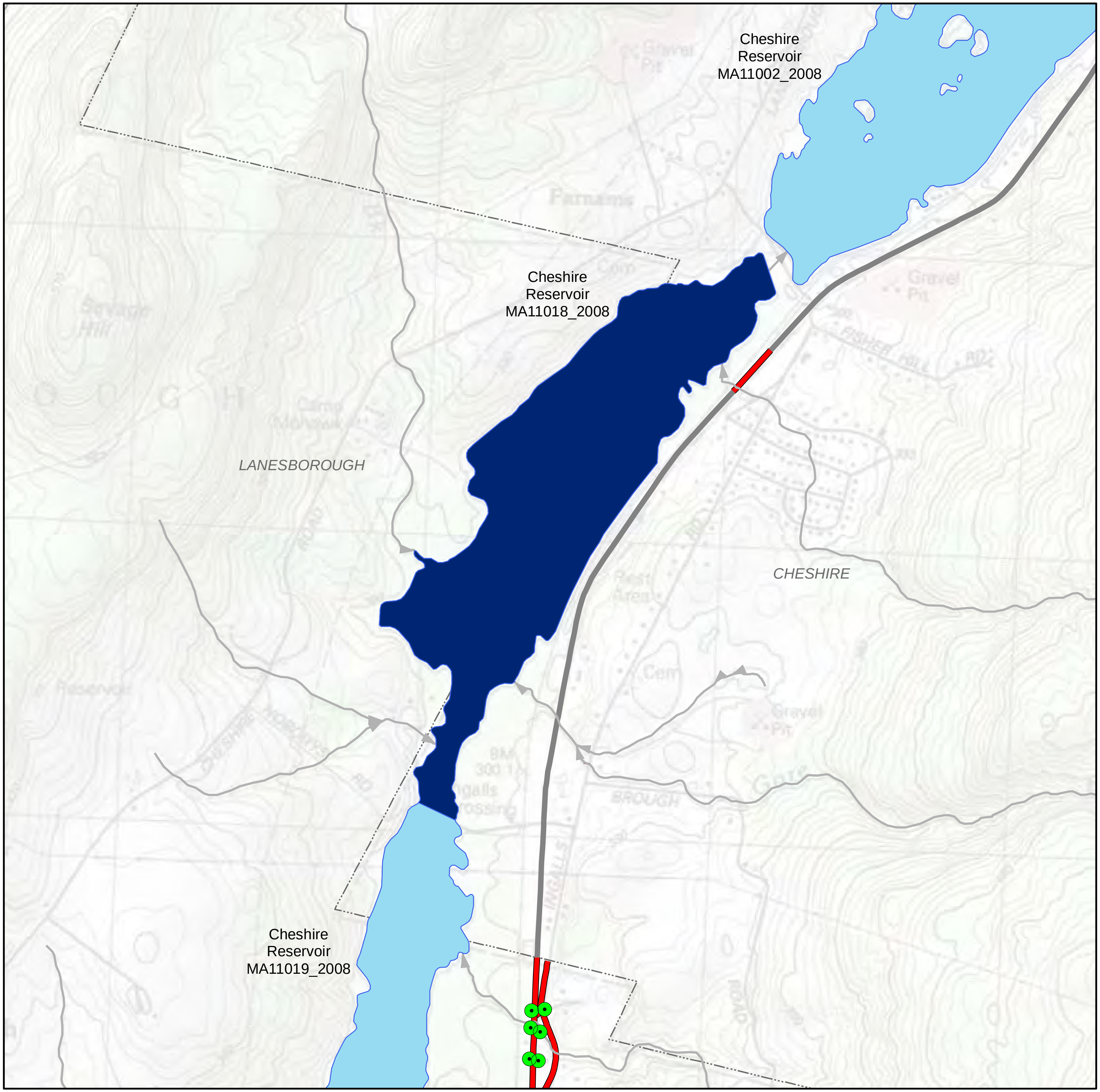

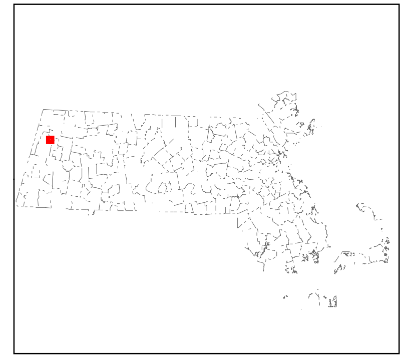

Town Boundaries
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Impaired Stream Segments
Impaired Stream Being Assessed
Impaired Water Bodies
Impaired Water Body Being Assessed
MA DOT Roads
MA DOT Urban Area Roads

1,000 500 0 1,000 Feet

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MA11018_2008

Cheshire Reservoir

Hoosic

November 2010

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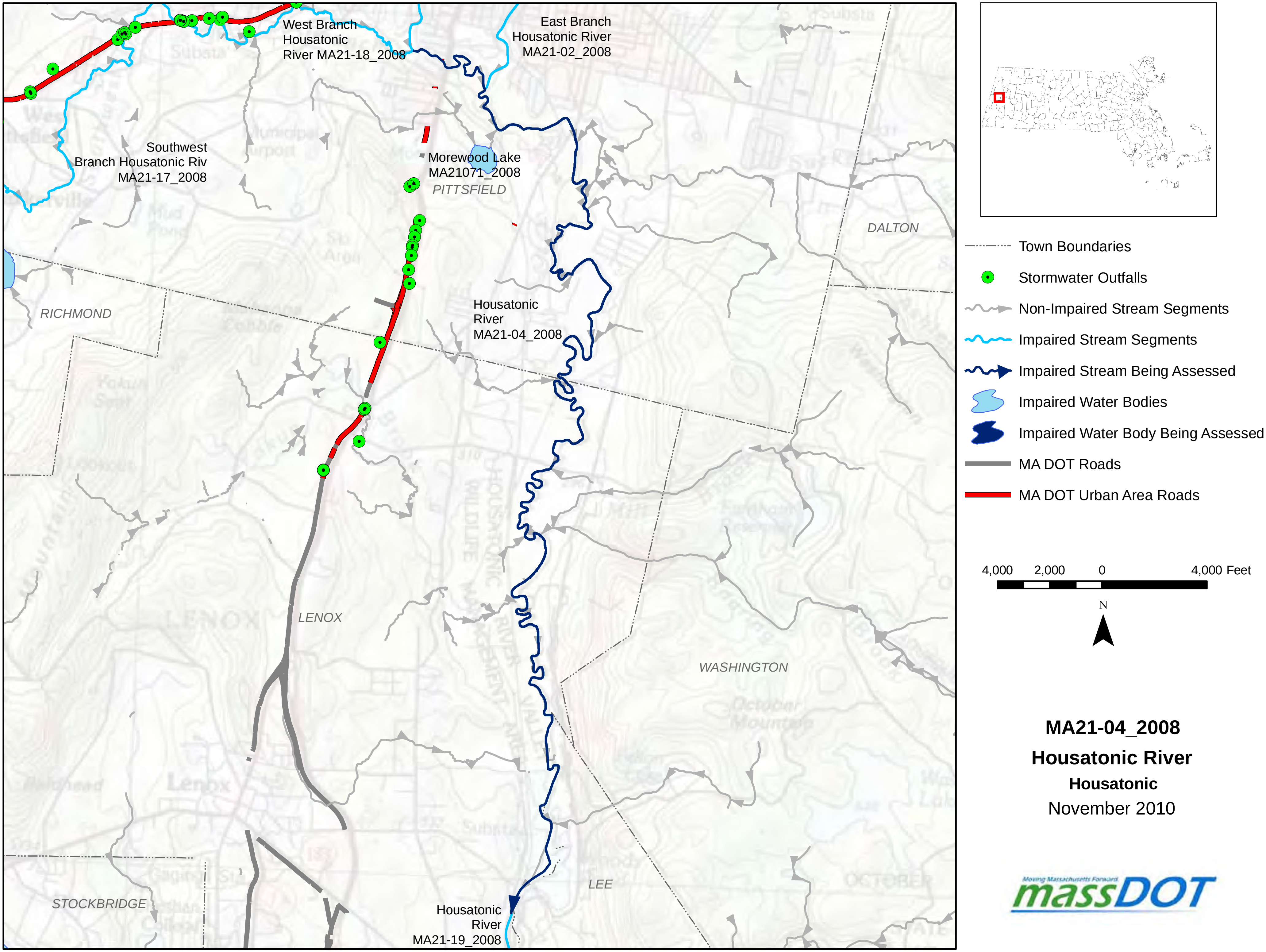

MA21-04_2008

Housatonic River

Housatonic

November 2010

massDOT

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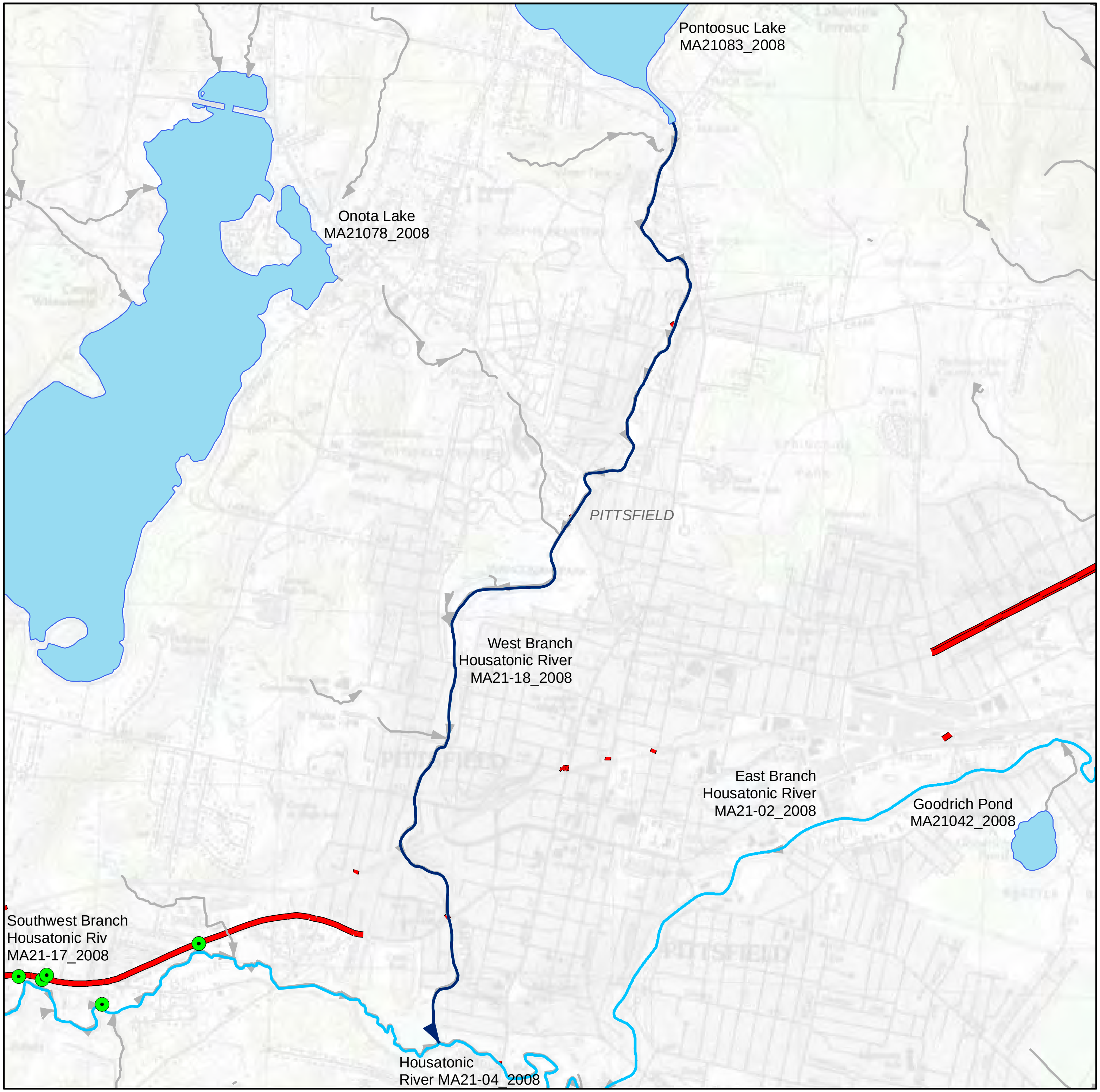

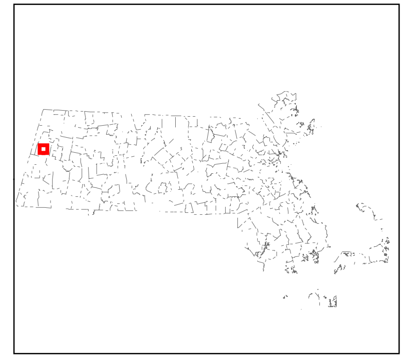

Town Boundaries
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Impaired Stream Segments
Impaired Stream Being Assessed
Impaired Water Bodies
Impaired Water Body Being Assessed
MA DOT Roads
MA DOT Urban Area Roads

2,000 1,000 0 2,000 Feet

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MA21-18_2008

West Branch Housatonic River

Housatonic

November 2010

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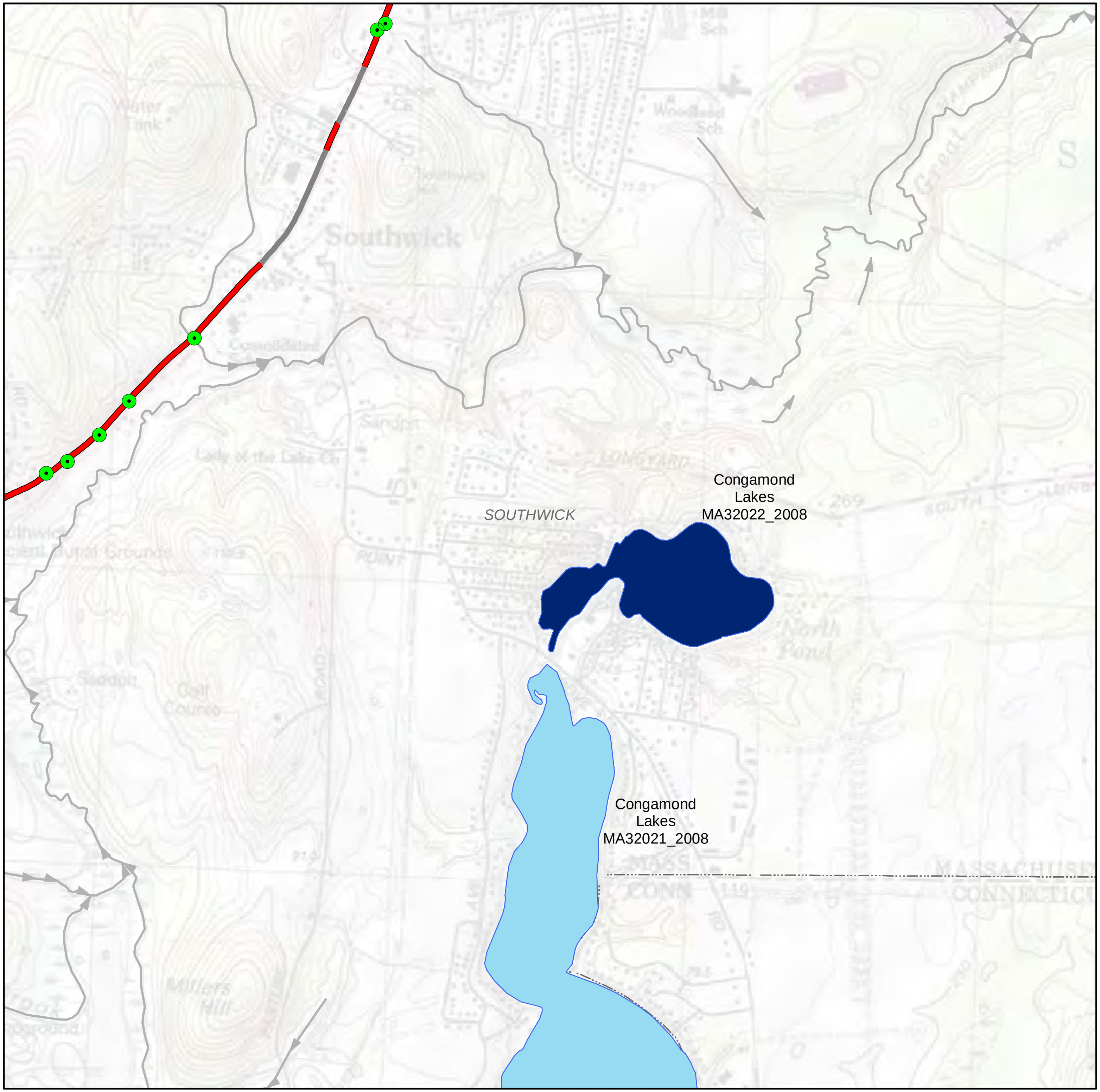

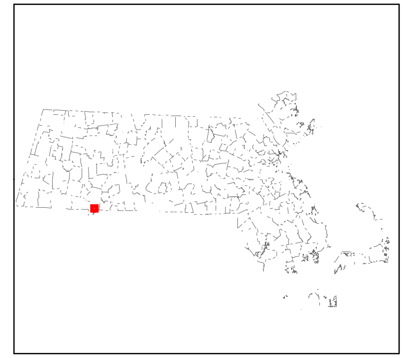

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Impaired Water Bodies
Impaired Water Body Being Assessed
MA DOT Roads
MA DOT Urban Area Roads

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MA32022_2008

Congamond Lakes

Westfield

November 2010

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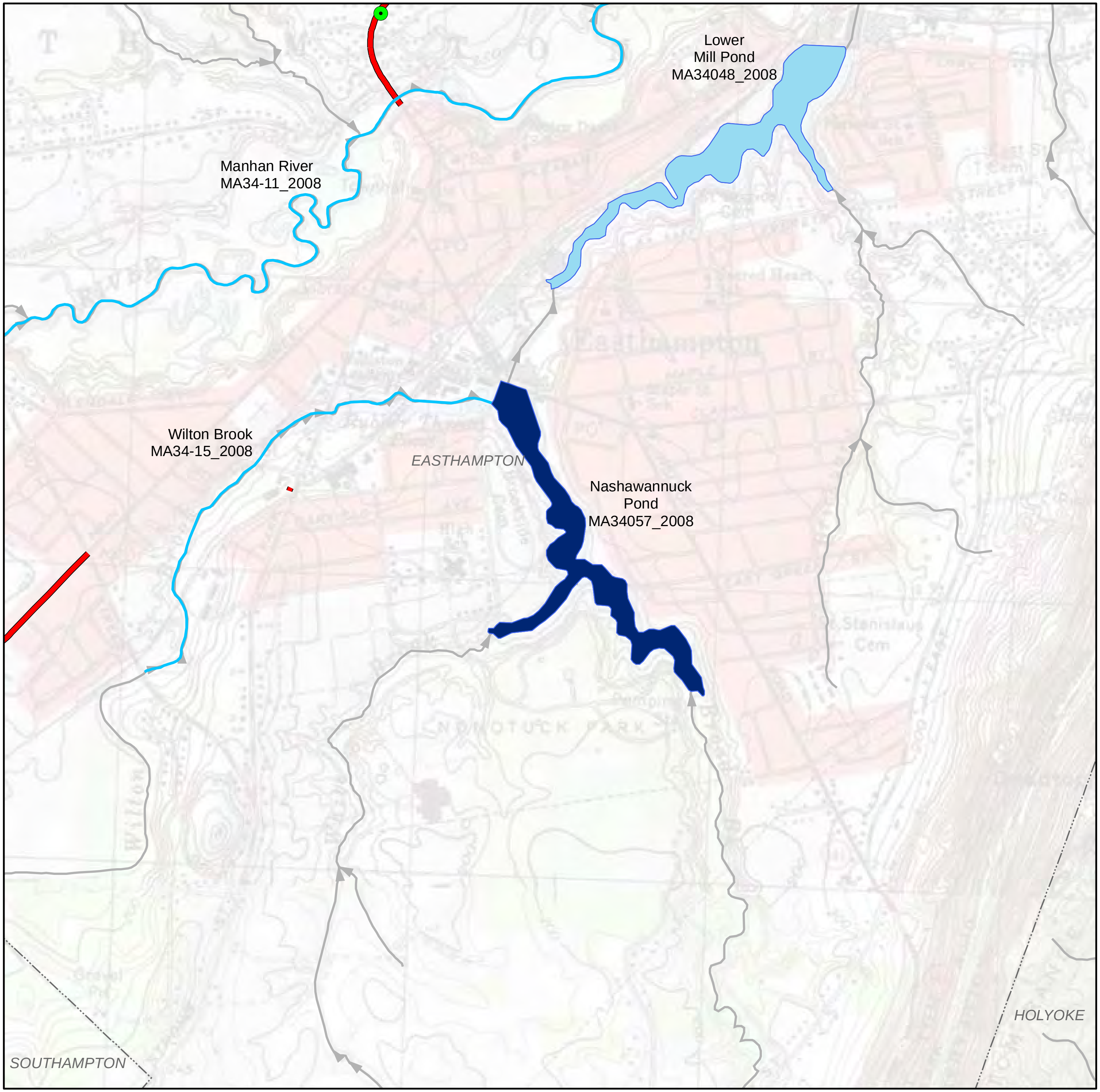

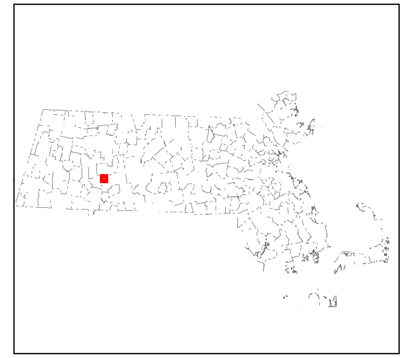

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Impaired Water Bodies
Impaired Water Body Being Assessed
MA DOT Roads
MA DOT Urban Area Roads

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Nashawannuck Pond

Connecticut

November 2010

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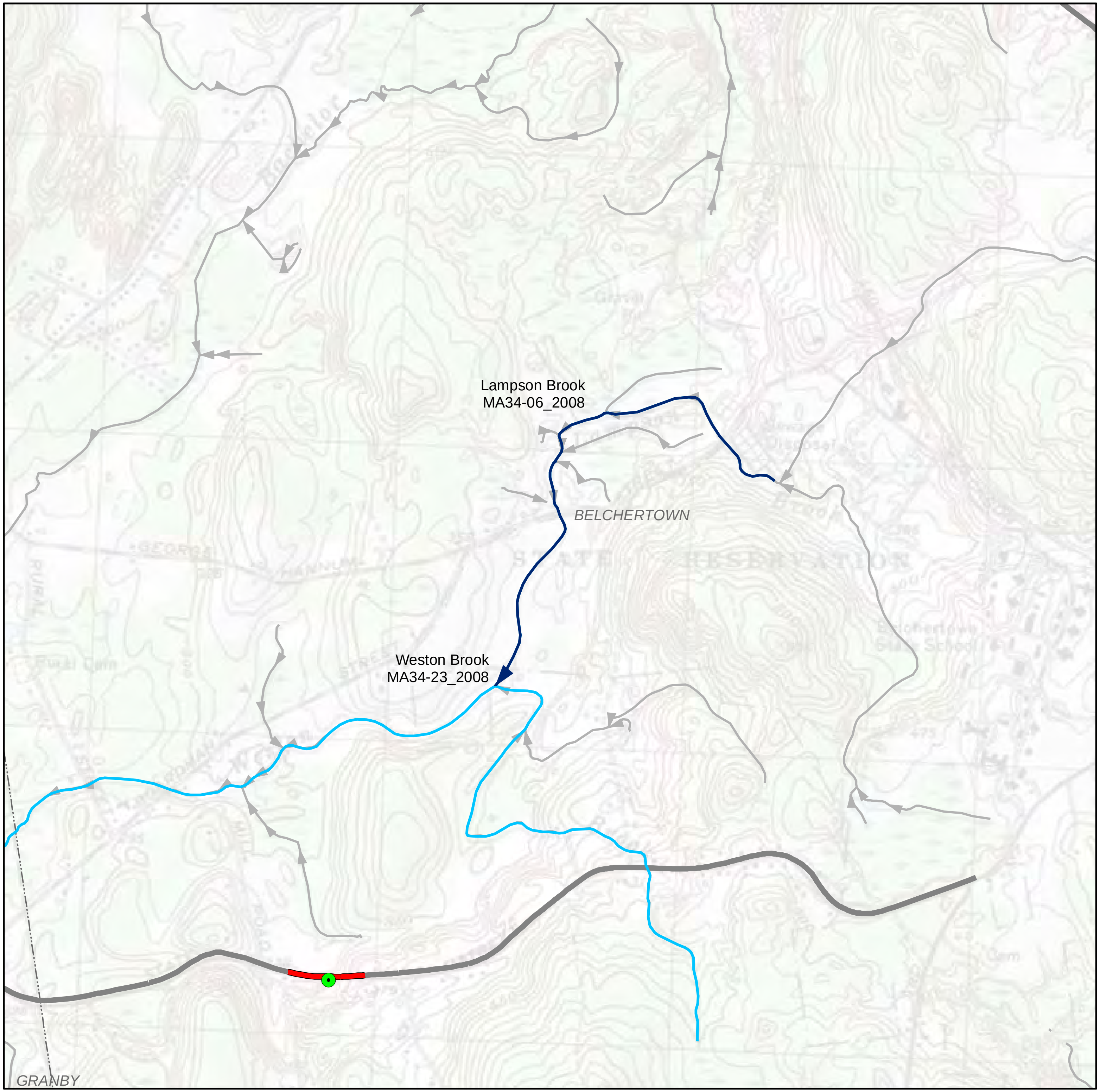

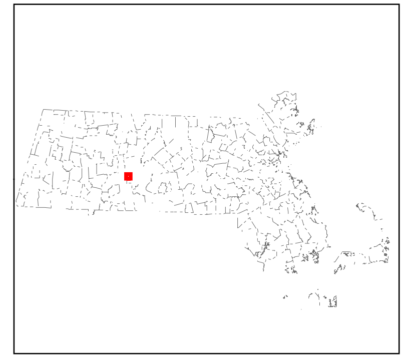

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Impaired Water Bodies
Impaired Water Body Being Assessed
MA DOT Roads
MA DOT Urban Area Roads

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MA34-06_2008

Lampson Brook

Connecticut

November 2010

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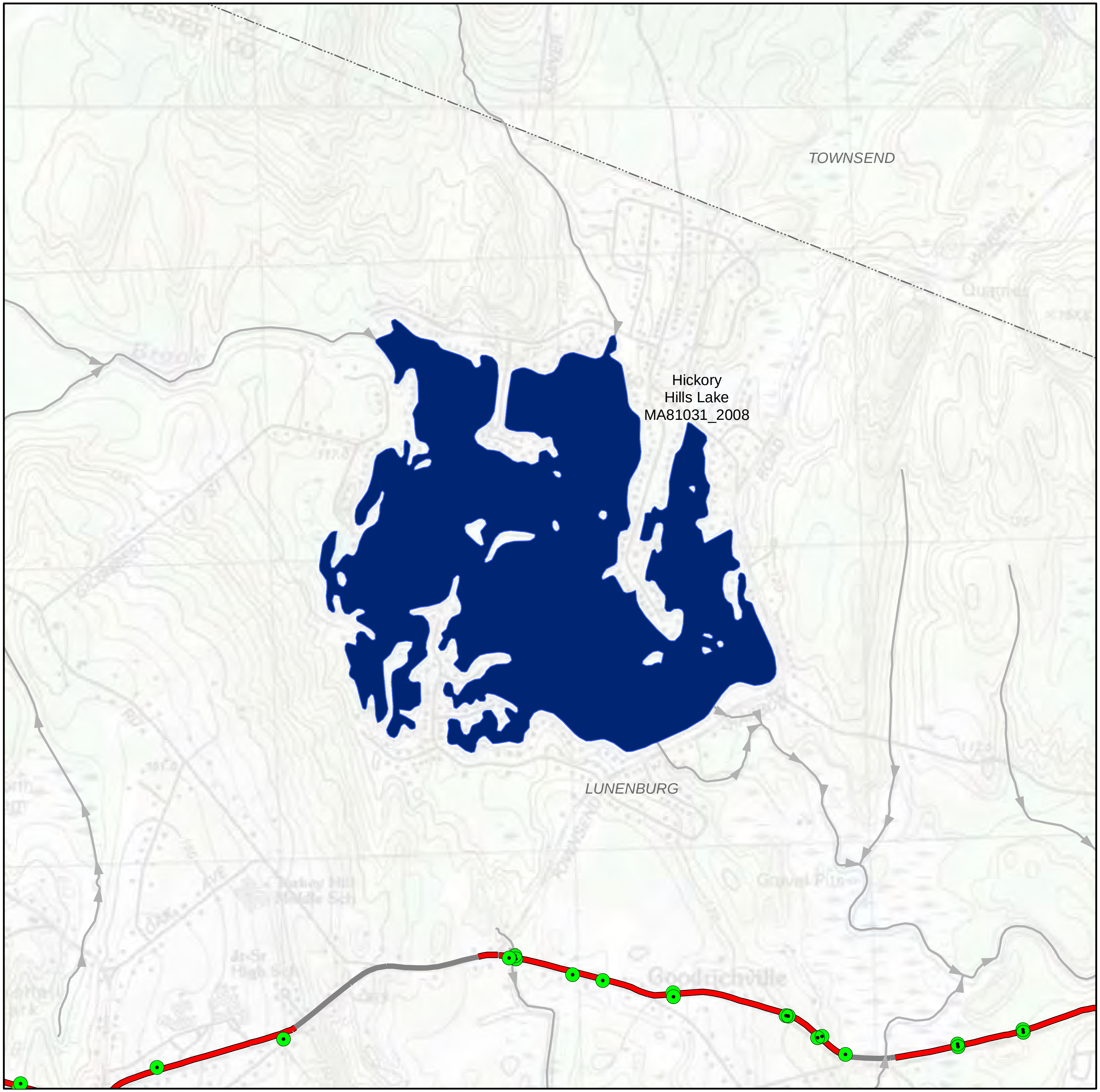

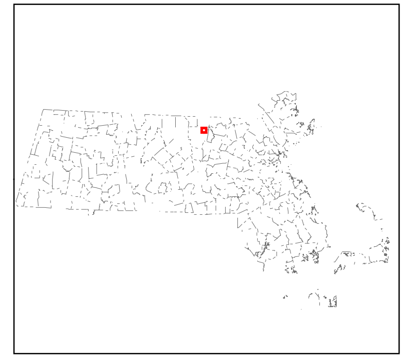

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MA DOT Urban Area Roads

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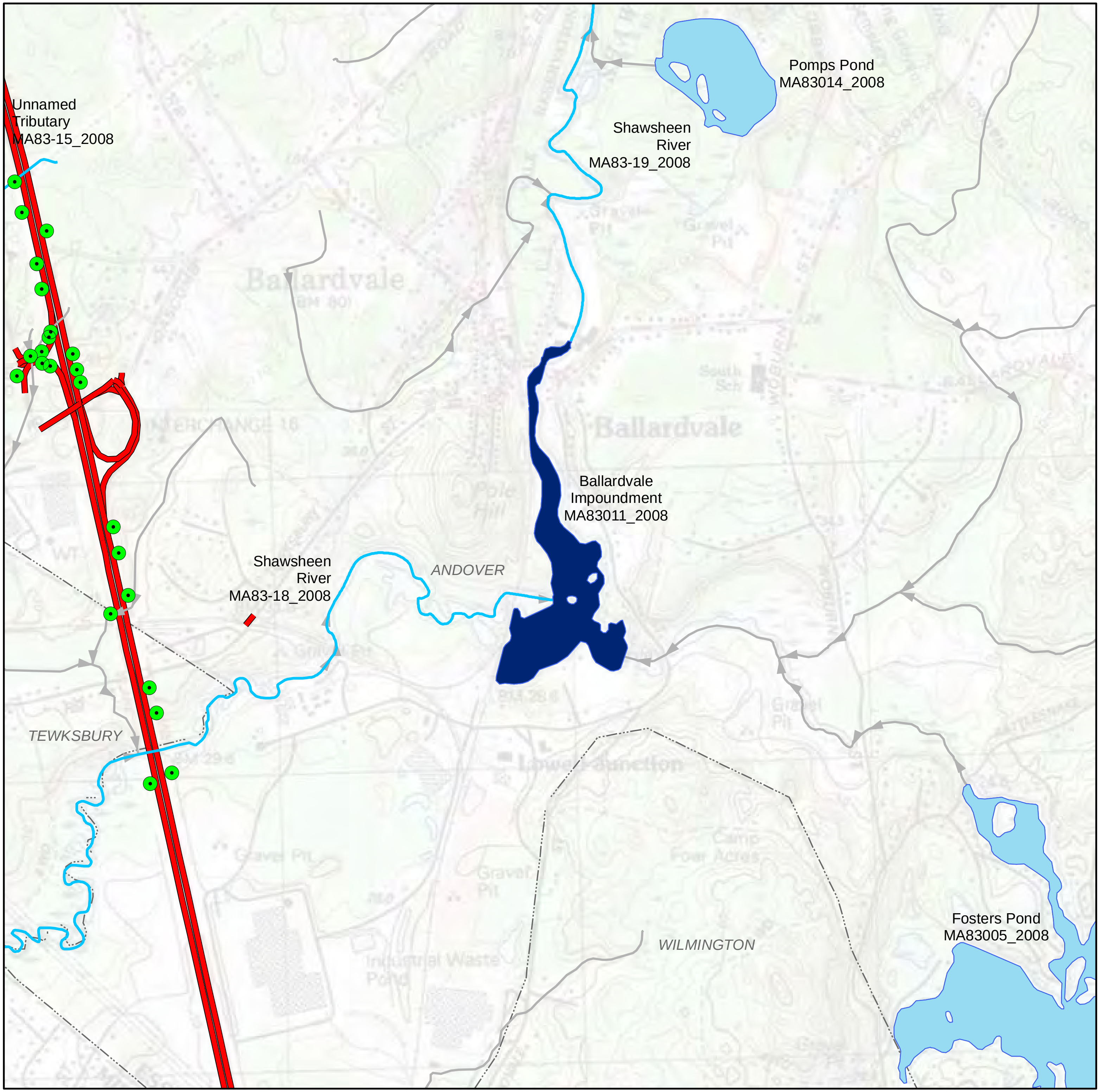
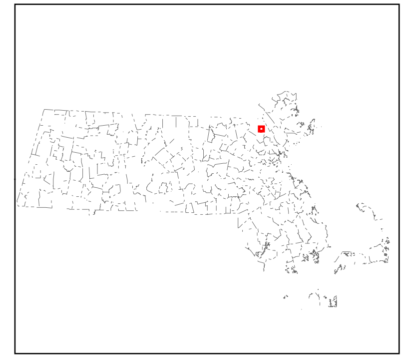
Hickory Hills Lake

Nashua

November 2010

massDOT





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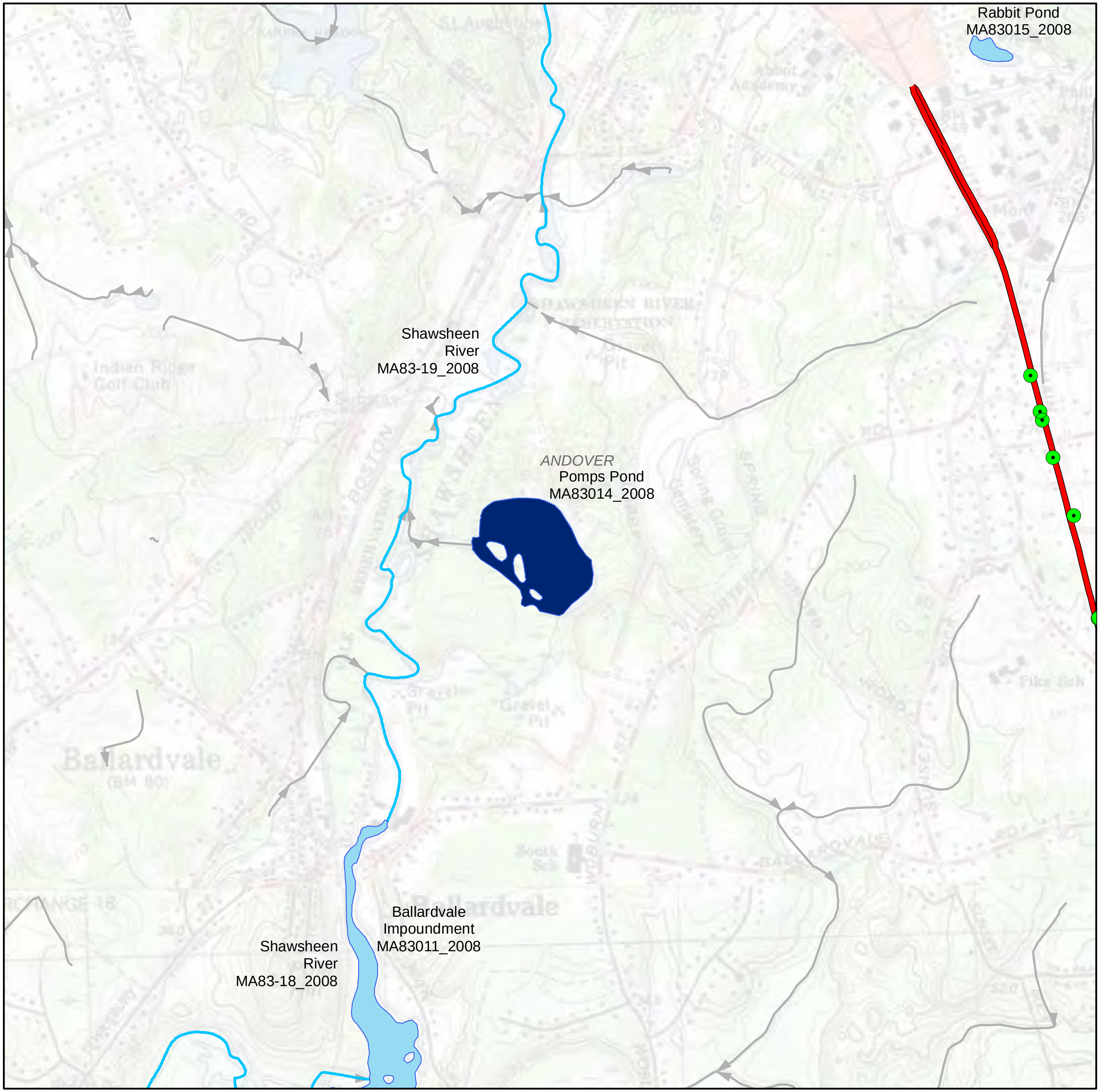
MA83011_2008

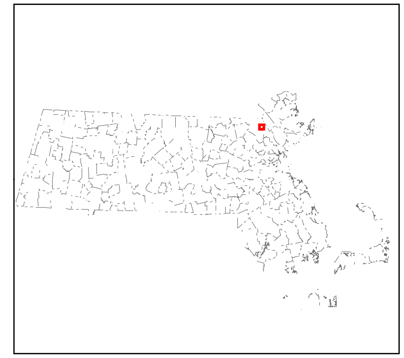
Ballardvale Impoundment

Shawsheen

November 2010

massDOT





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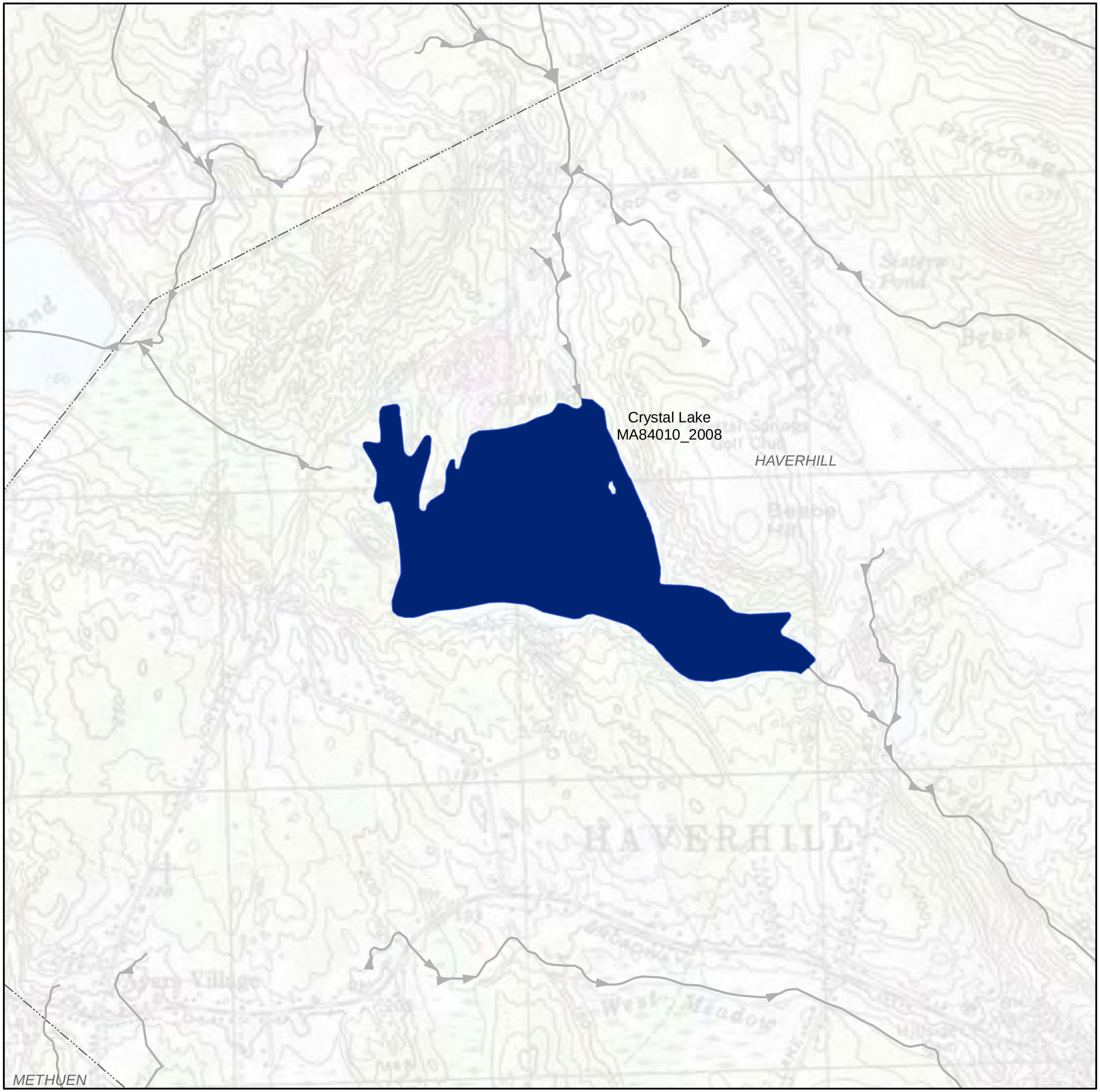
MA83014_2008

Pomps Pond

Shawsheen

November 2010



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Crystal Lake

Merrimack

November 2010

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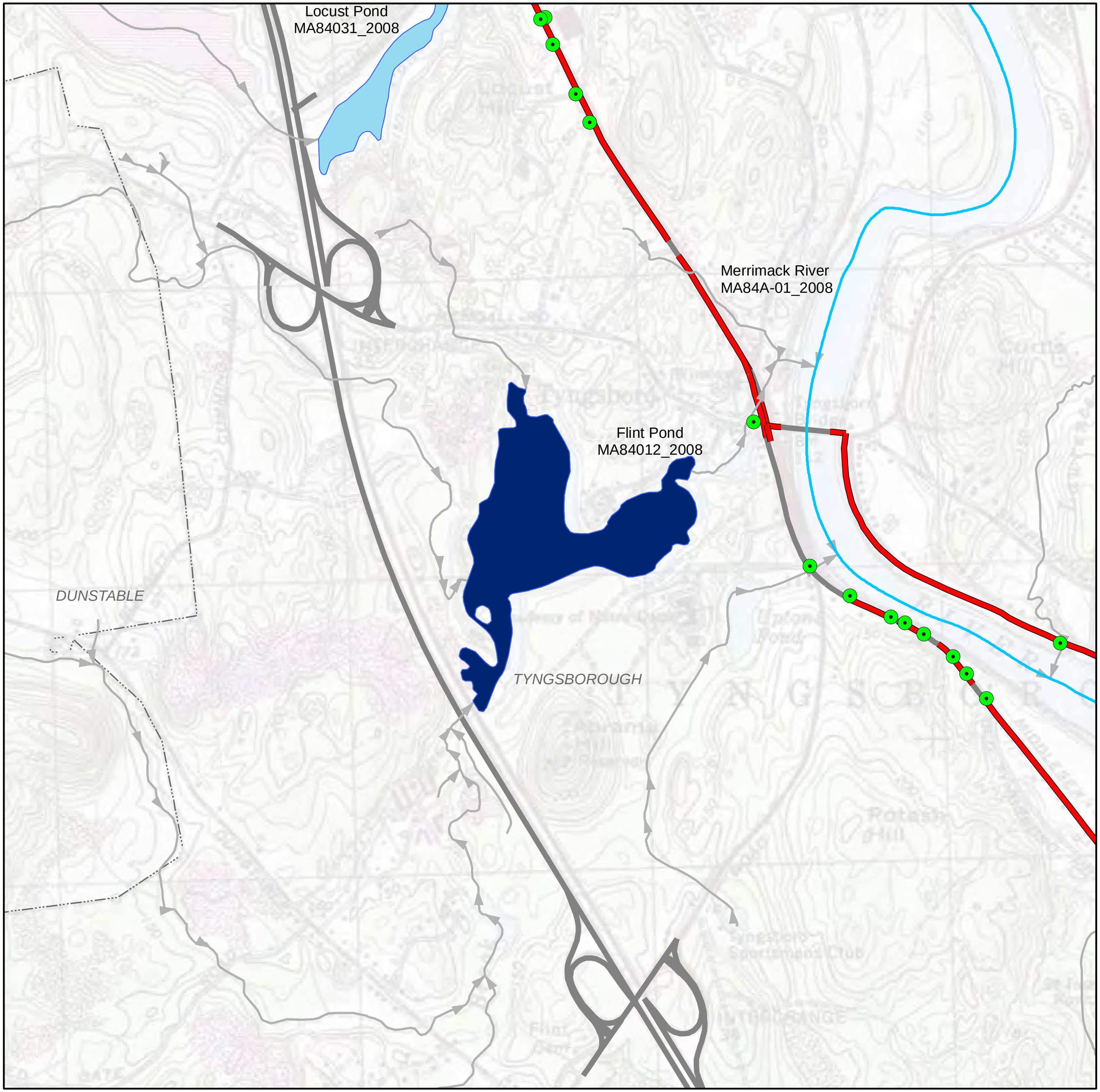

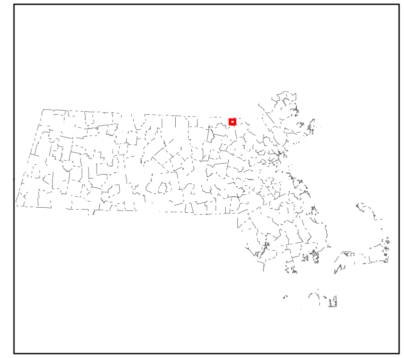

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MA DOT Urban Area Roads

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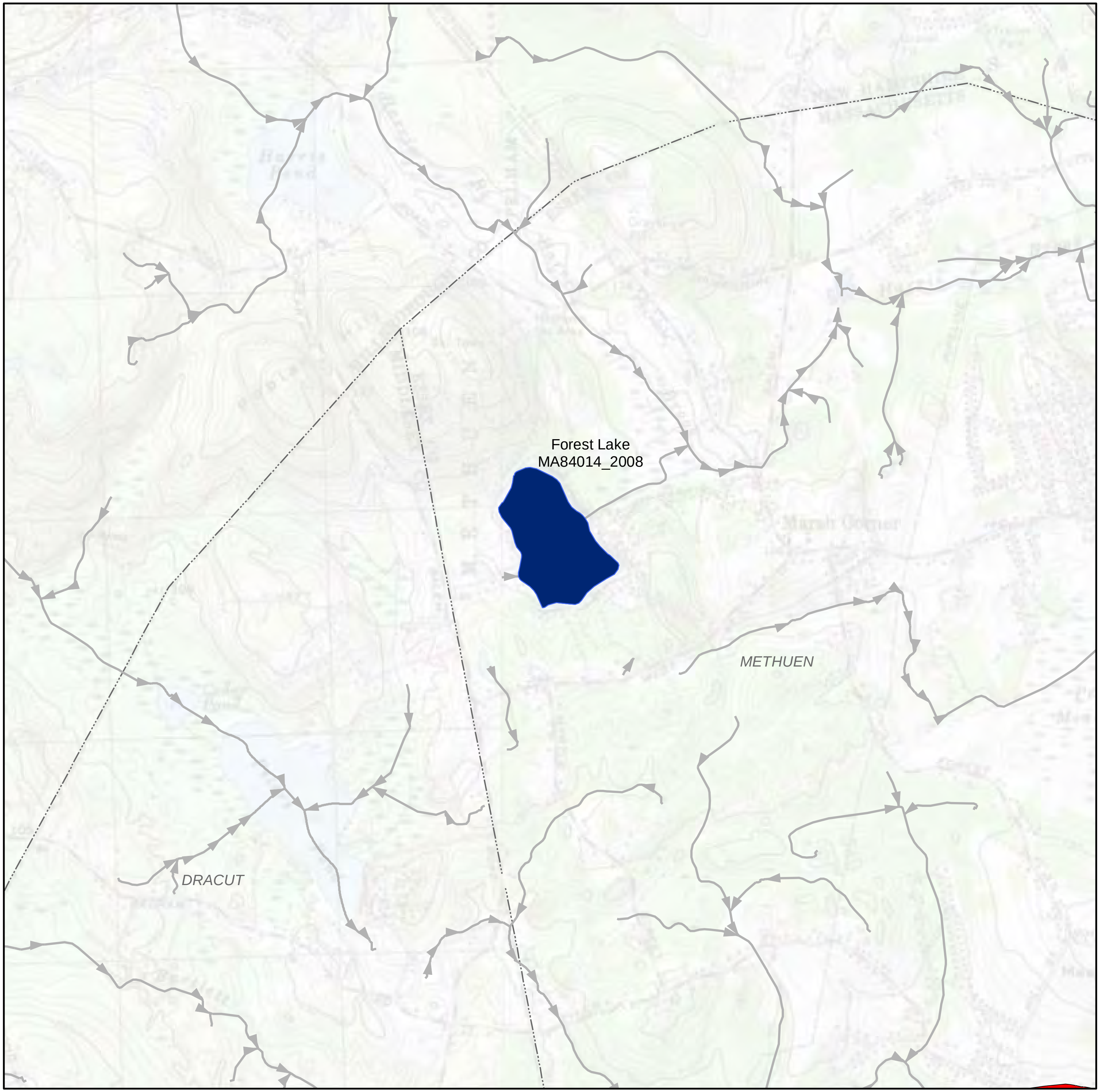
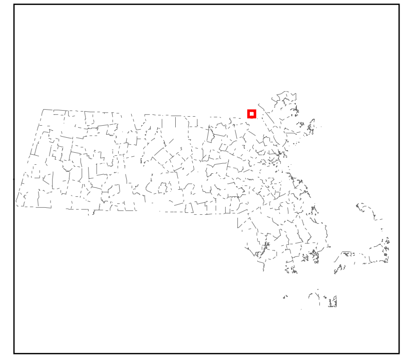
MA84012_2008

Flint Pond

Merrimack

November 2010





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MA DOT Roads
MA DOT Urban Area Roads

1,000 500 0 1,000 Feet

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Forest Lake

Merrimack

November 2010

massDOT

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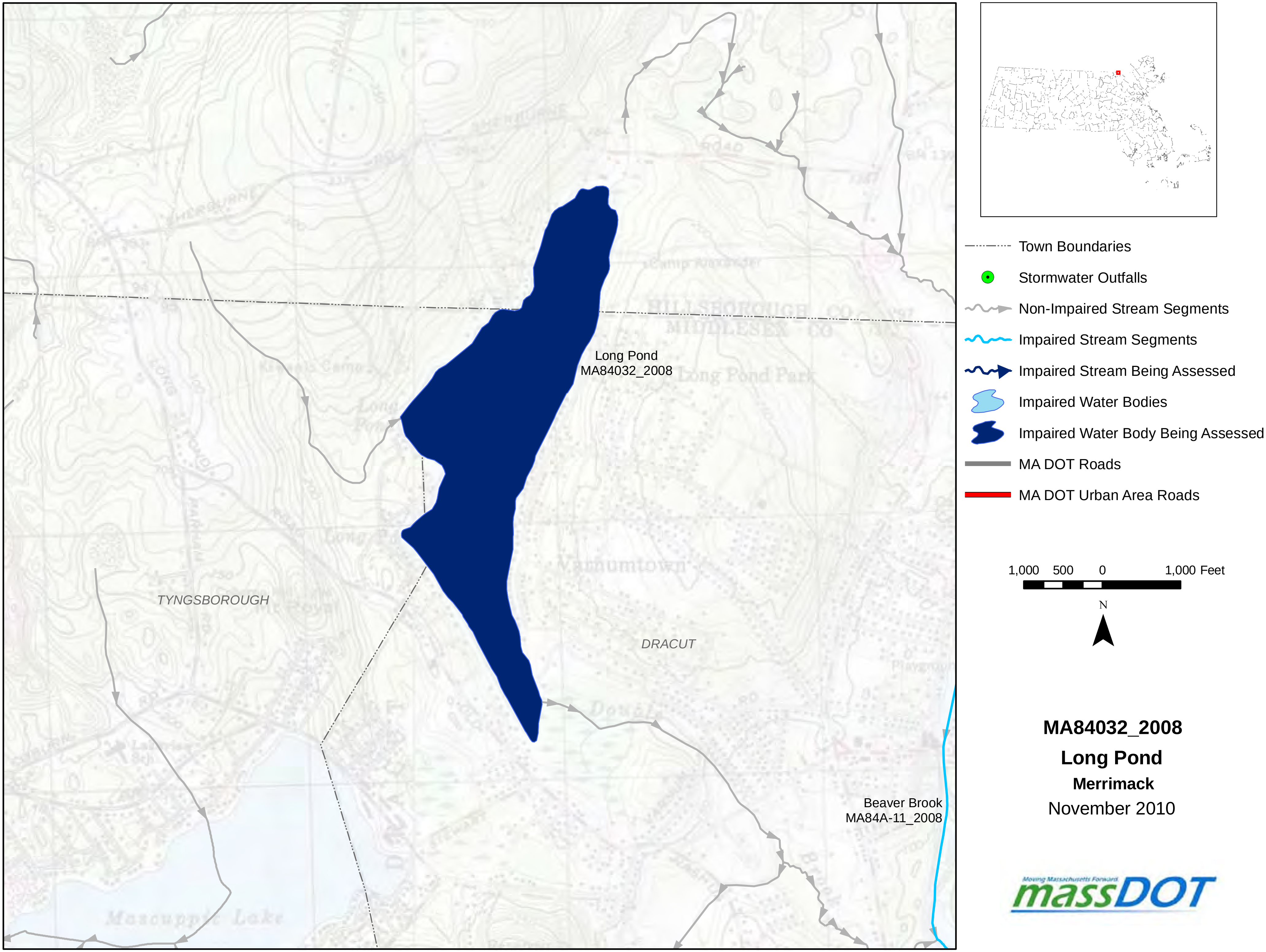

MA84032_2008

Long Pond

Merrimack

November 2010

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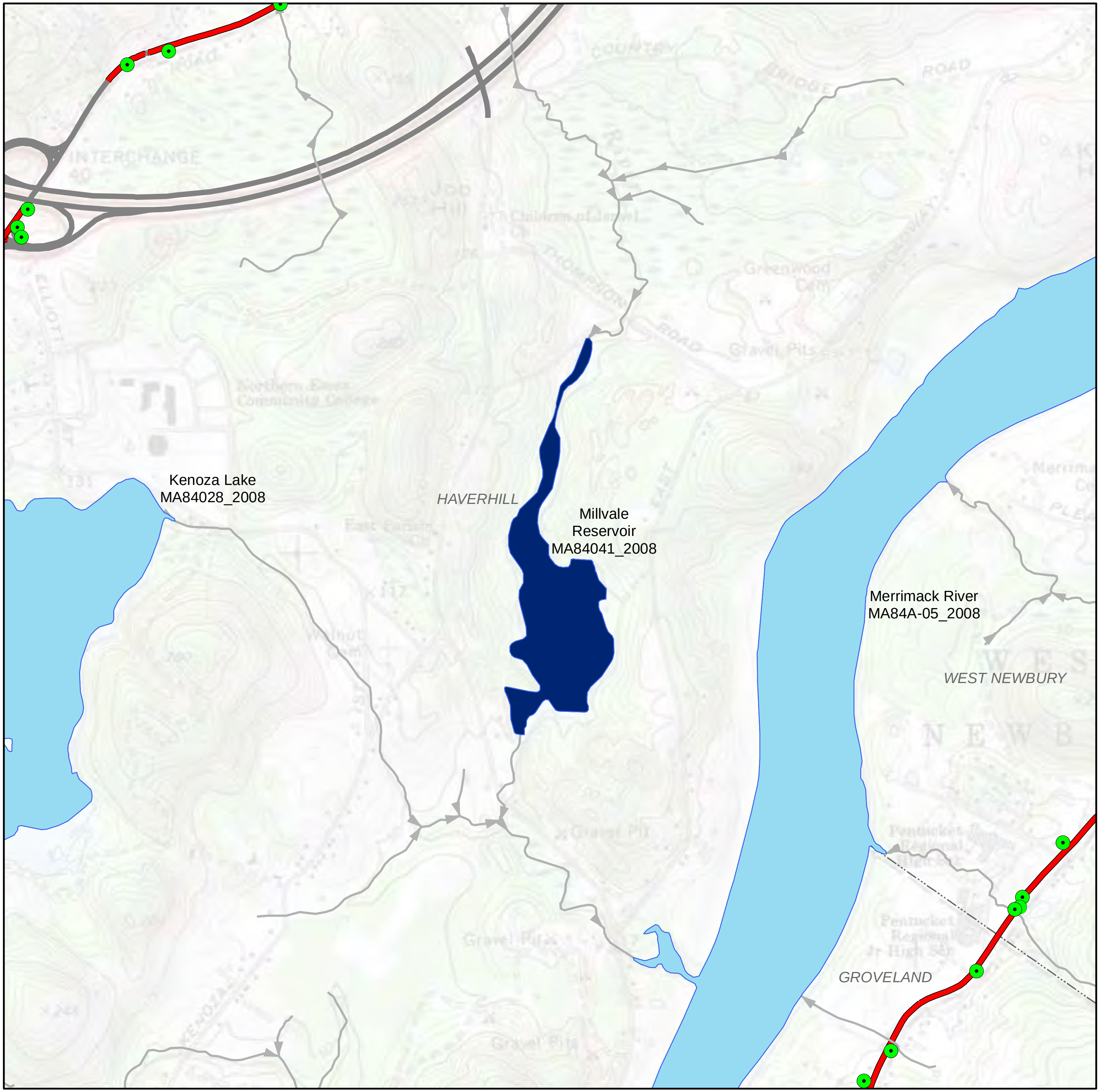

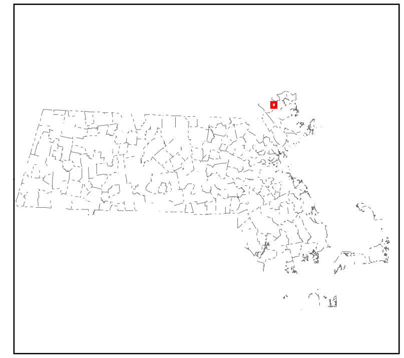

Town Boundaries
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Impaired Water Bodies
Impaired Water Body Being Assessed
MA DOT Roads
MA DOT Urban Area Roads

1,000 500 0 1,000 Feet

N

MA84041_2008

Millvale Reservoir

Merrimack

November 2010

massDOT

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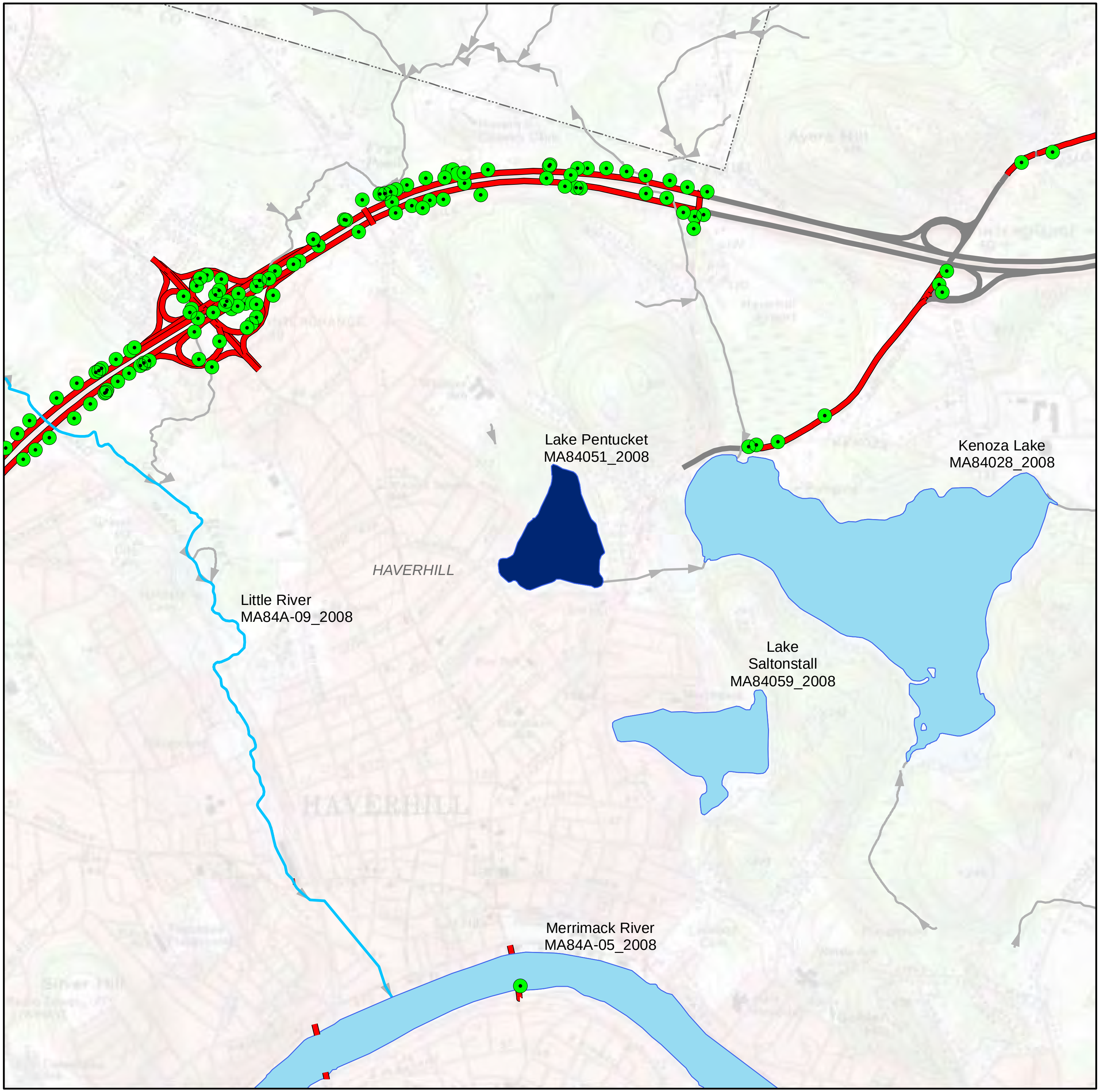
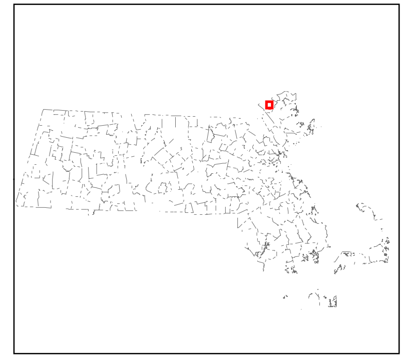




- Town Boundaries
- Stormwater Outfalls
- Non-Impaired Stream Segments
- Impaired Stream Segments
- Impaired Stream Being Assessed
- Impaired Water Bodies
- Impaired Water Body Being Assessed
- MA DOT Roads
- MA DOT Urban Area Roads

2,000 1,000 0 2,000 Feet

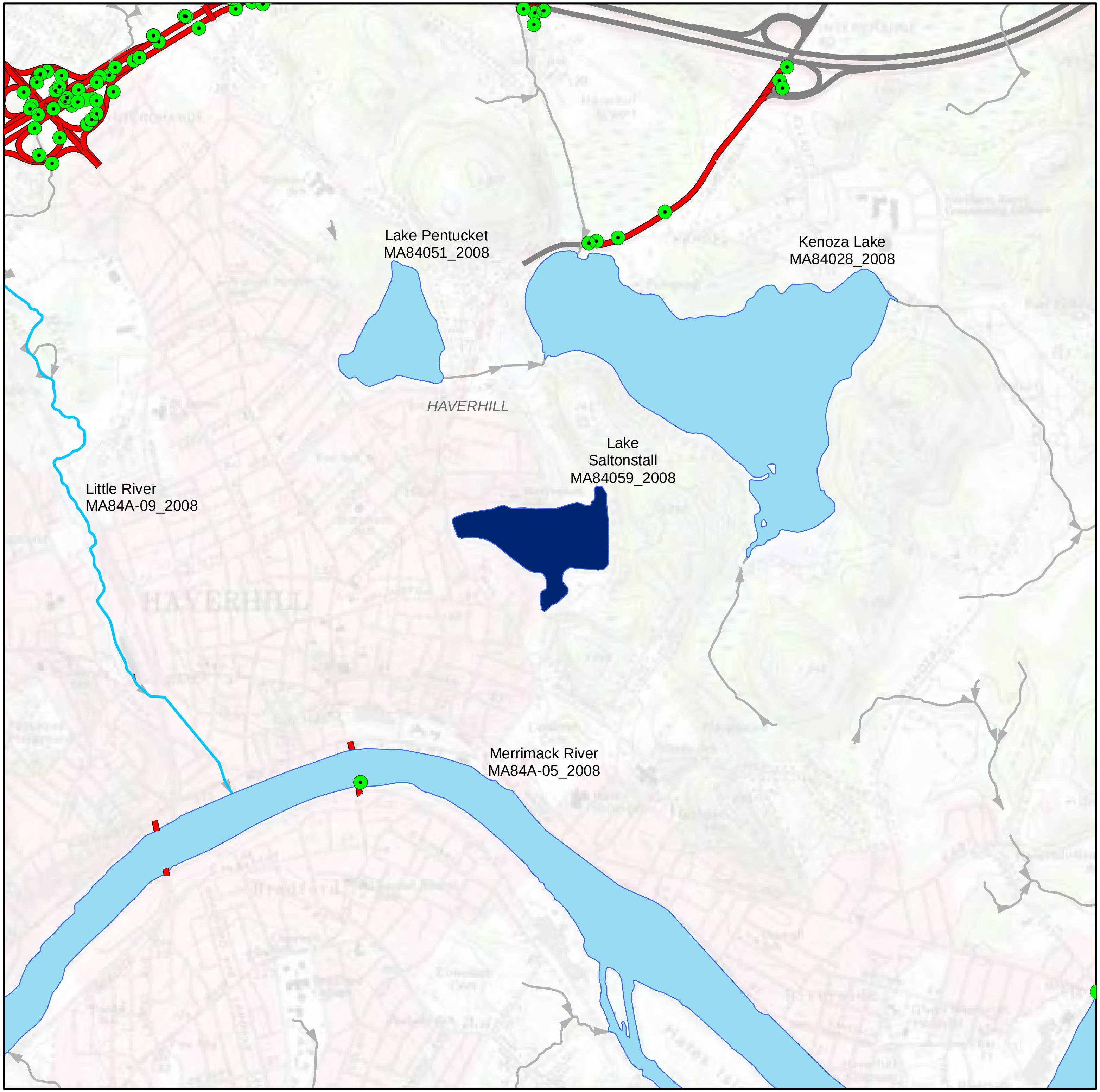
N

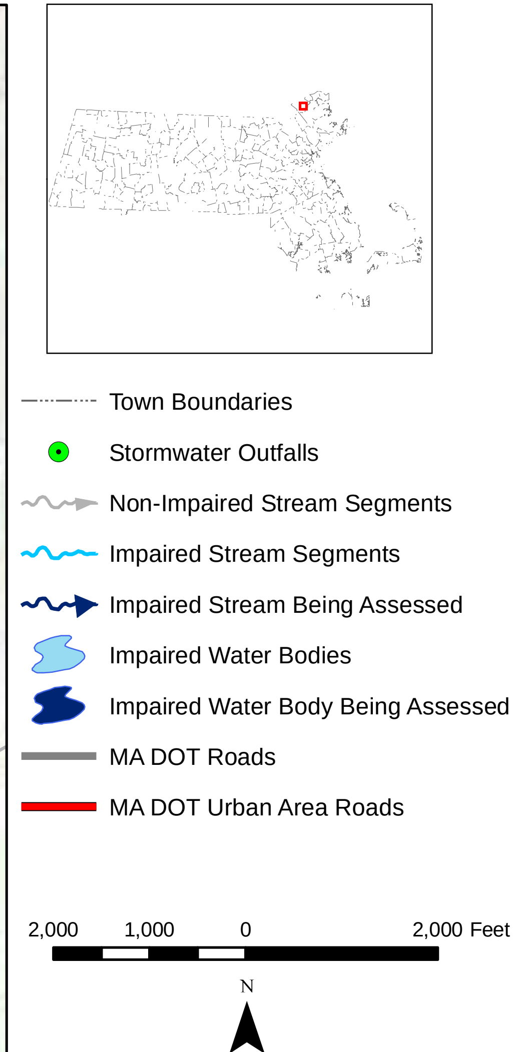
MA84051_2008

Lake Pentucket

Merrimack

November 2010





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Merrimack

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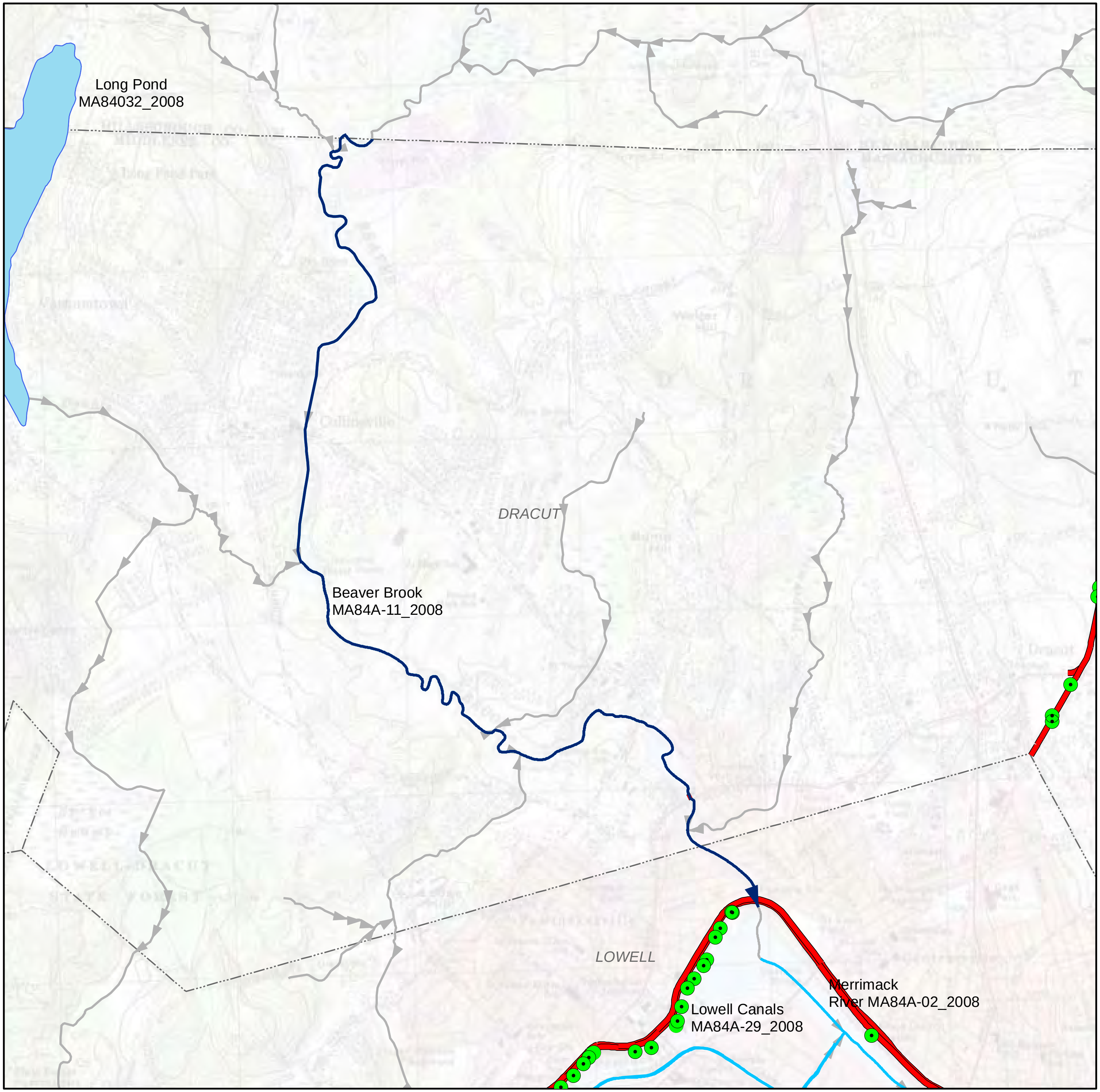

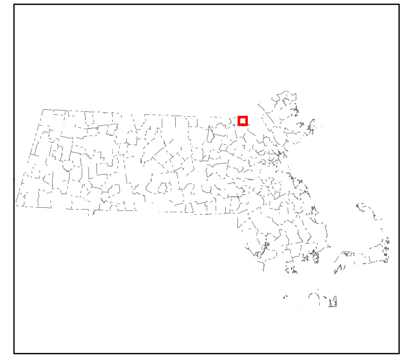

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Impaired Stream Segments
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Impaired Water Bodies
Impaired Water Body Being Assessed
MA DOT Roads
MA DOT Urban Area Roads

2,000 1,000 0 2,000 Feet

N

MA84A-11_2008

Beaver Brook

Merrimack

November 2010

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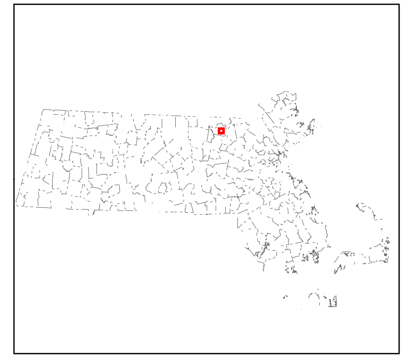

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Impaired Stream Segments
Impaired Stream Being Assessed
Impaired Water Bodies
Impaired Water Body Being Assessed
MA DOT Roads
MA DOT Urban Area Roads

1,000 500 0 1,000 Feet

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MA84A-19_2008

Martins Pond Brook

Merrimack

November 2010

massDOT
Moving Massachusetts Forward

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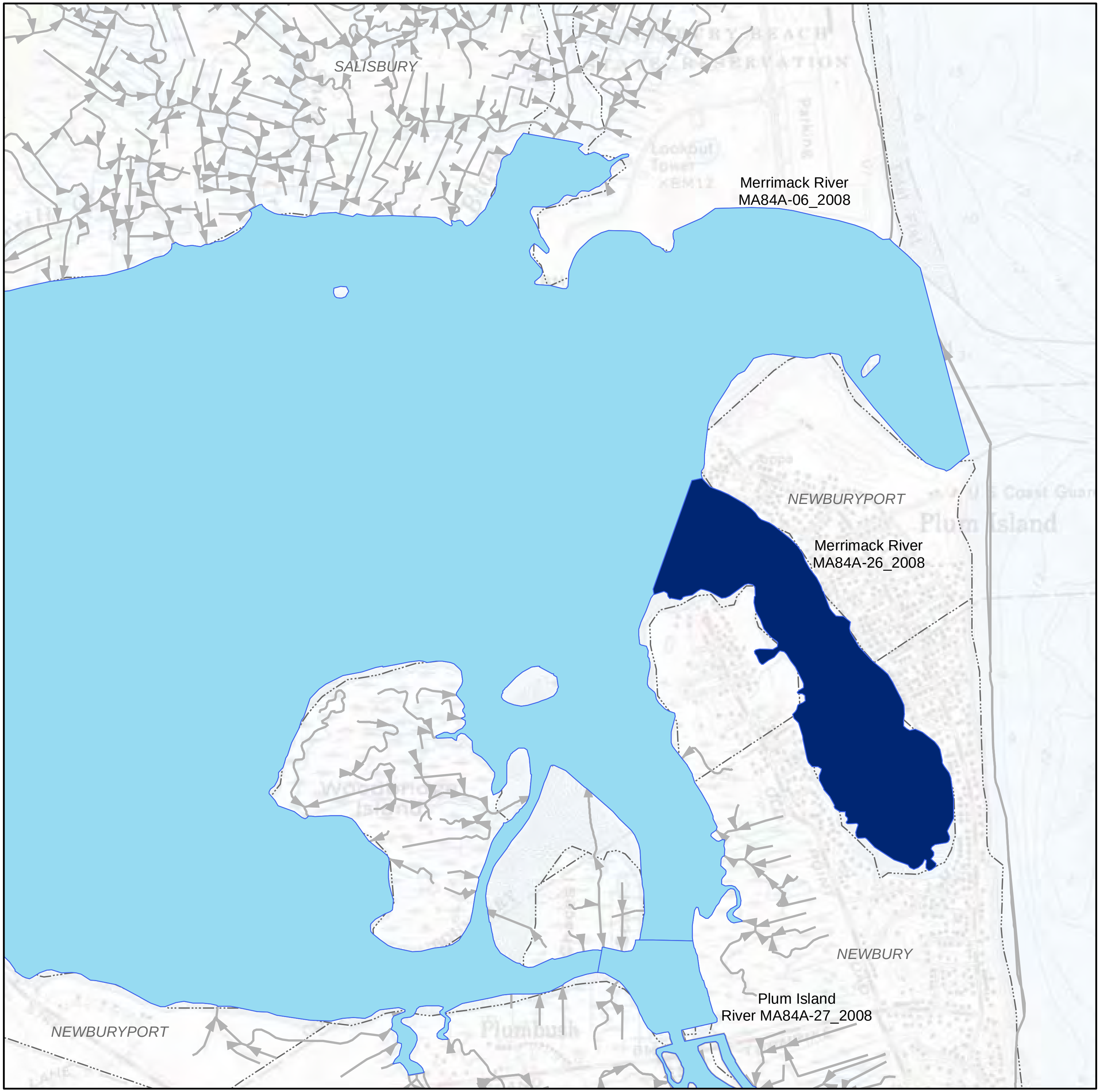

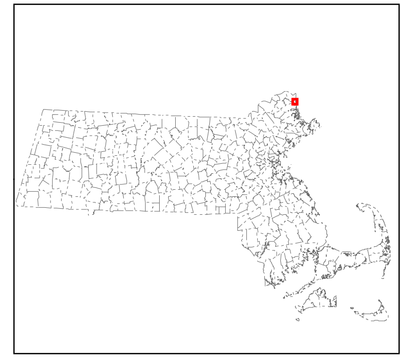

Town Boundaries
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Impaired Stream Segments
Impaired Stream Being Assessed
Impaired Water Bodies
Impaired Water Body Being Assessed
MA DOT Roads
MA DOT Urban Area Roads

1,000 500 0 1,000 Feet

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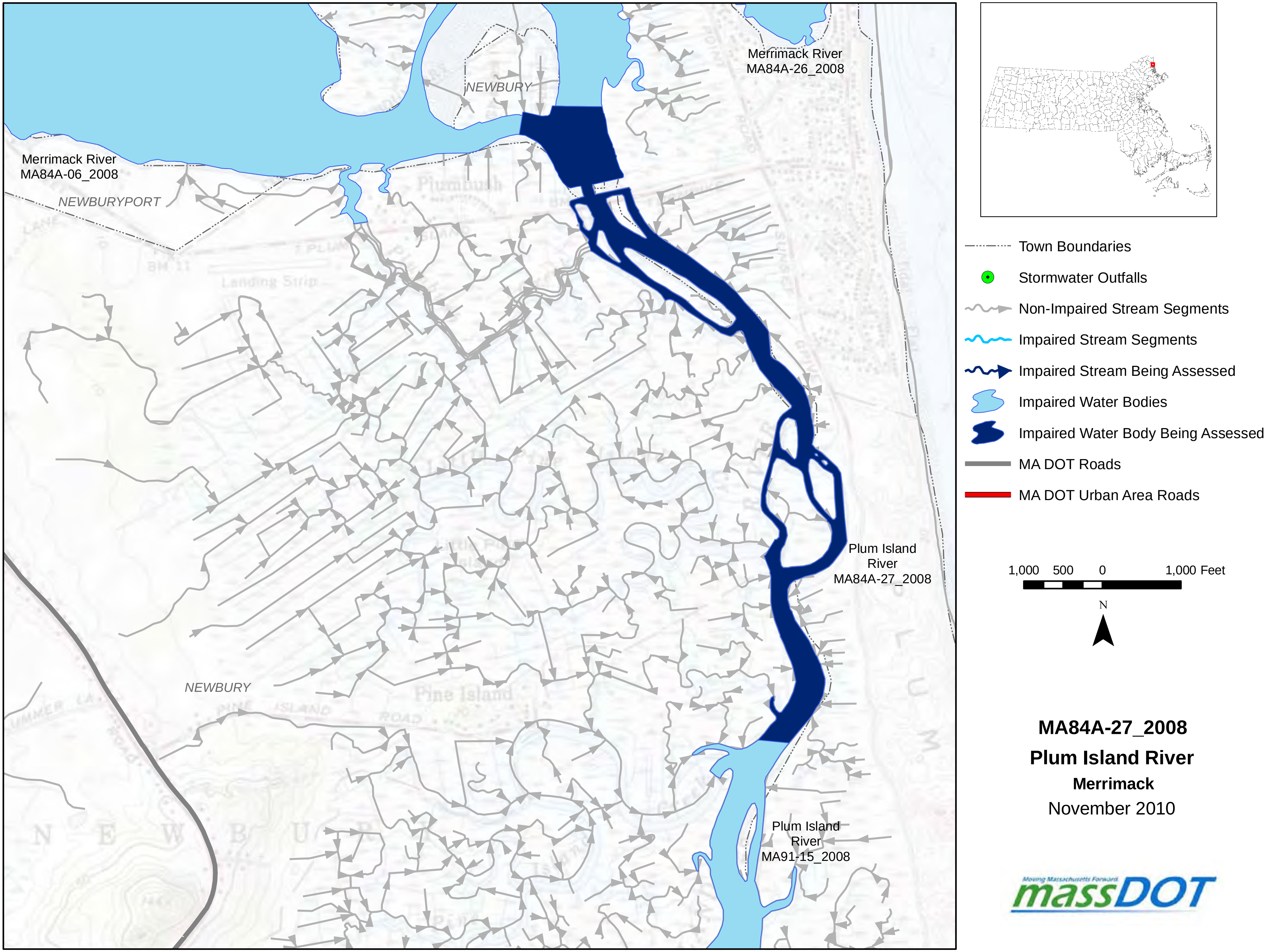
MA84A-26_2008

Merrimack River

Merrimack

November 2010



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Plum Island River

Merrimack

November 2010

massDOT Moving Massachusetts Forward

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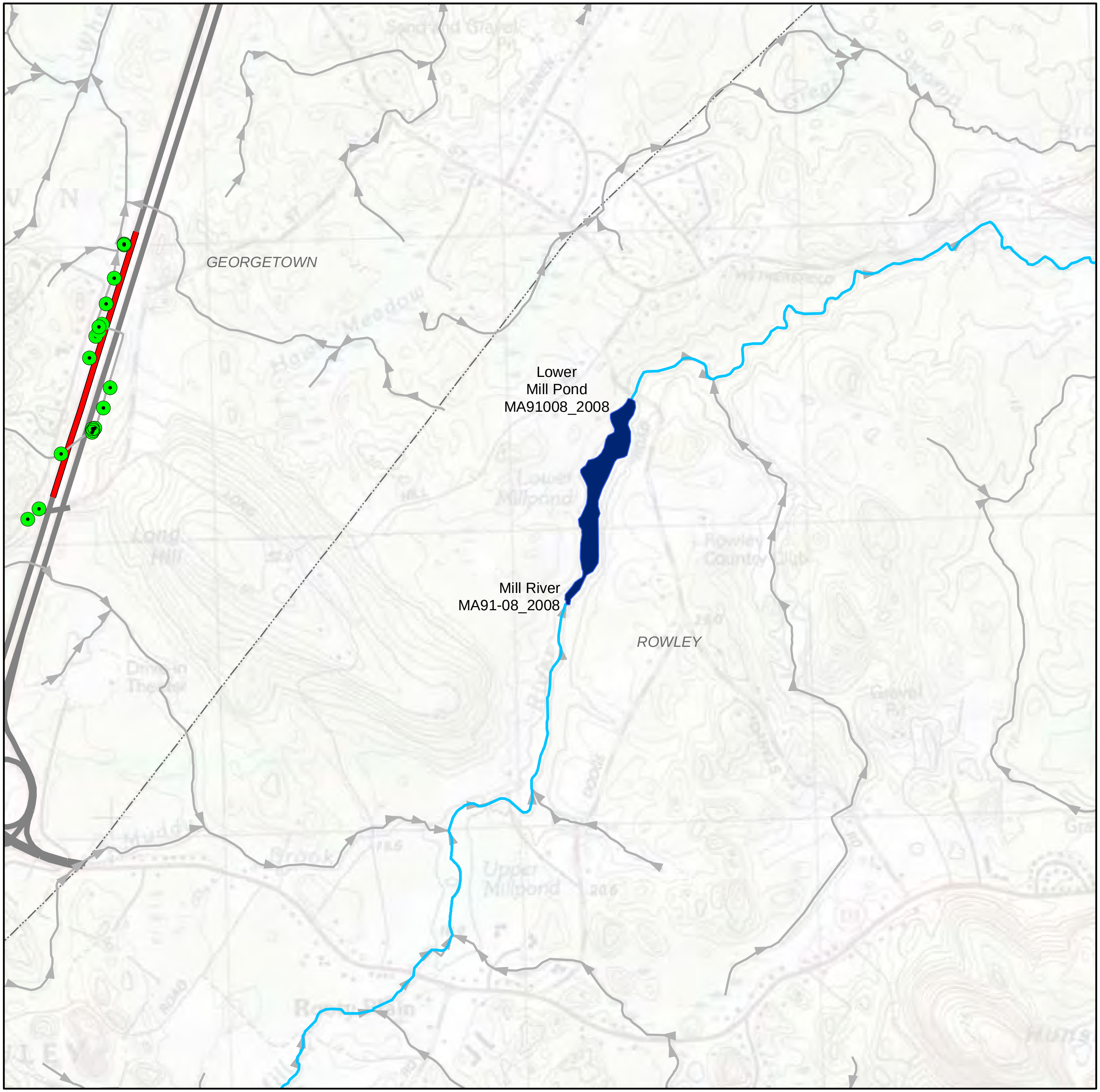

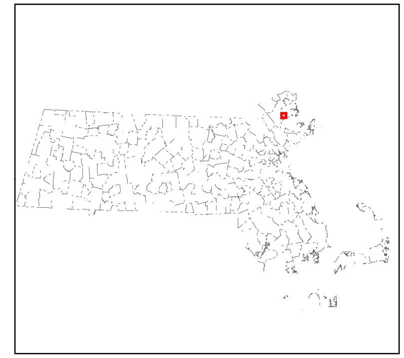

Town Boundaries
Stormwater Outfalls
Non-Impaired Stream Segments
Impaired Stream Segments
Impaired Stream Being Assessed
Impaired Water Bodies
Impaired Water Body Being Assessed
MA DOT Roads
MA DOT Urban Area Roads

1,000 500 0 1,000 Feet

N

MA91008_2008

Lower Mill Pond

Parker

November 2010

Moving Massachusetts Forward massDOT

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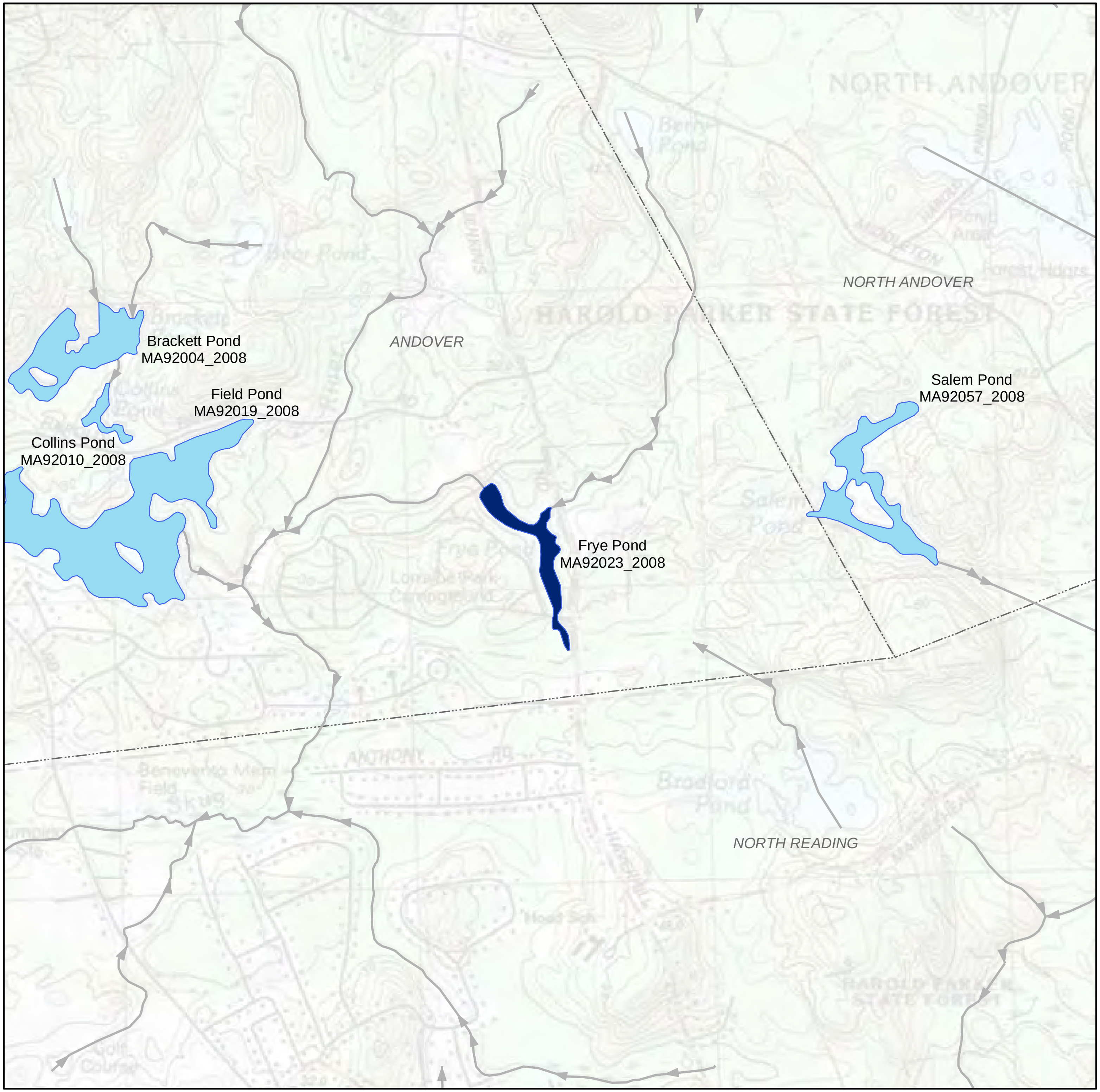
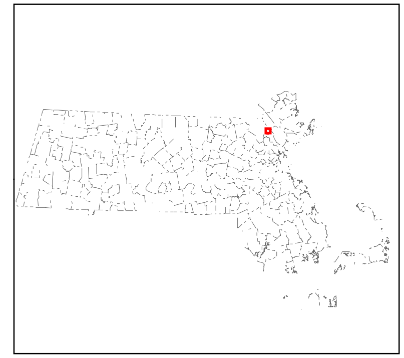




- Town Boundaries
- Stormwater Outfalls
- Non-Impaired Stream Segments
- Impaired Stream Segments
- Impaired Stream Being Assessed
- Impaired Water Bodies
- Impaired Water Body Being Assessed
- MA DOT Roads
- MA DOT Urban Area Roads

1,000 500 0 1,000 Feet

N

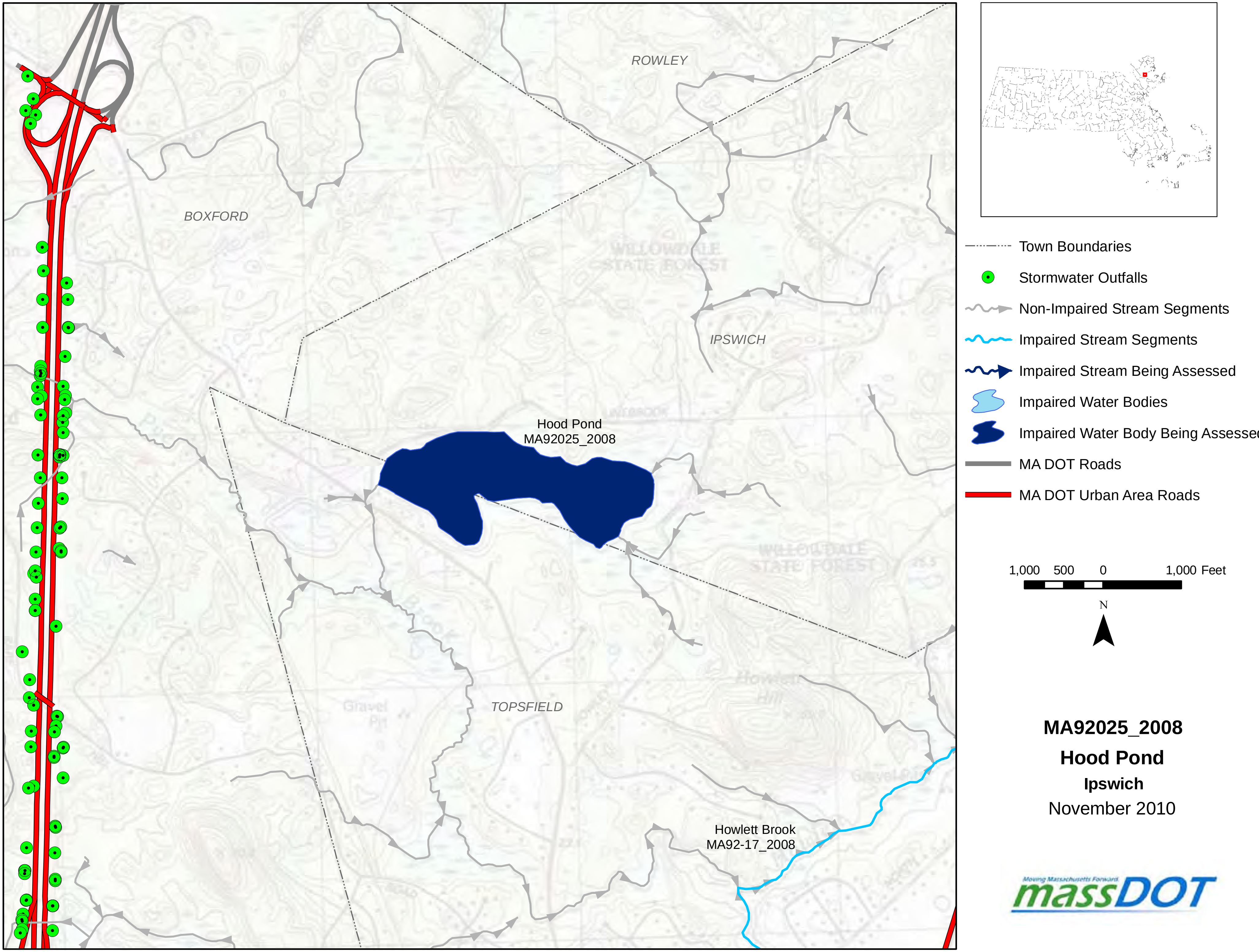
MA92023_2008

Frye Pond

Ipswich

November 2010

massDOT



MA92025_2008

Hood Pond

Ipswich

November 2010

massDOT

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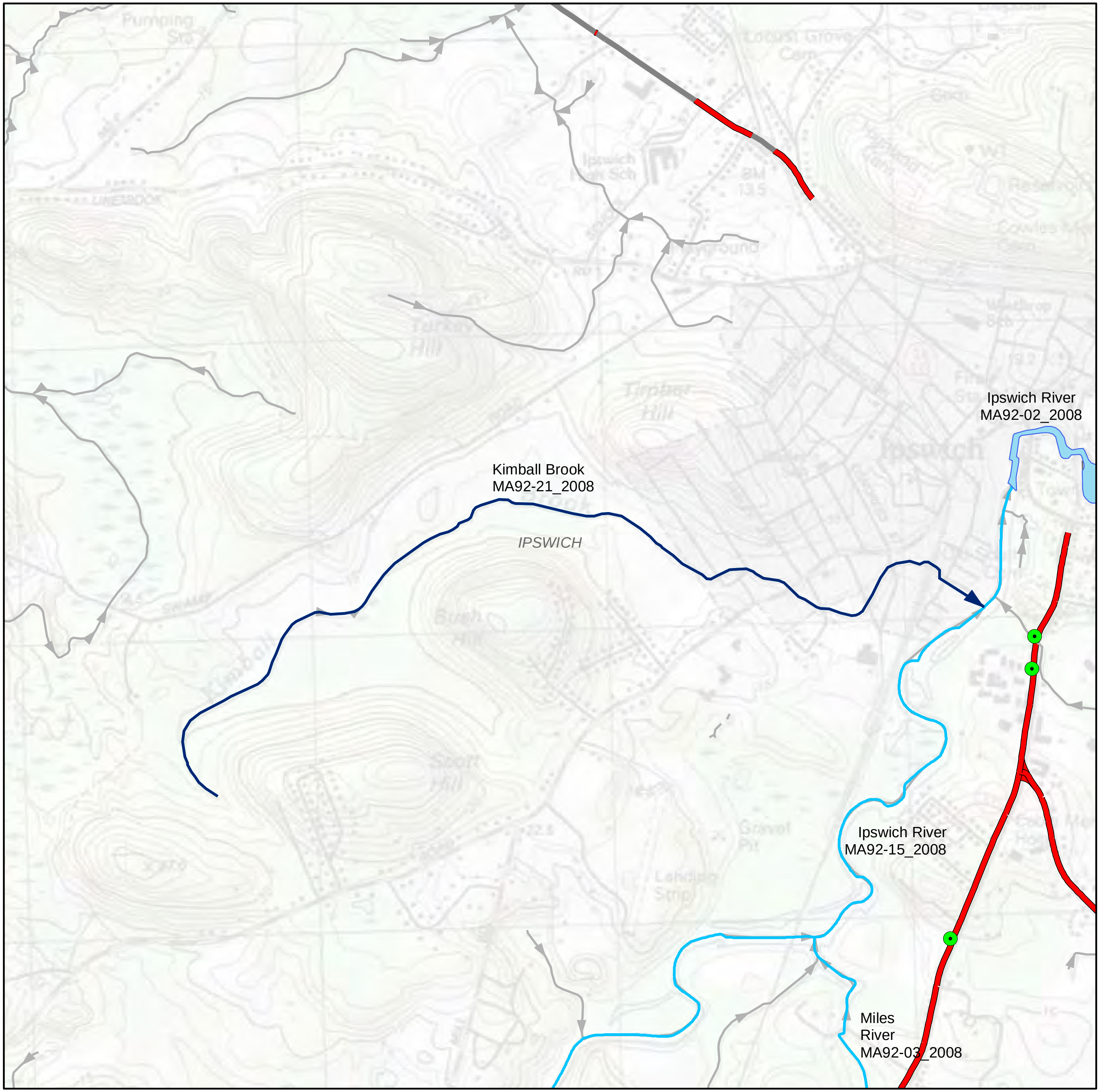

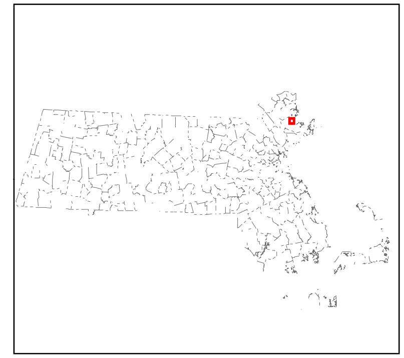

- Town Boundaries
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- Impaired Stream Segments
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1,000 500 0 1,000 Feet

N

MA92-21_2008

Kimball Brook

Ipswich

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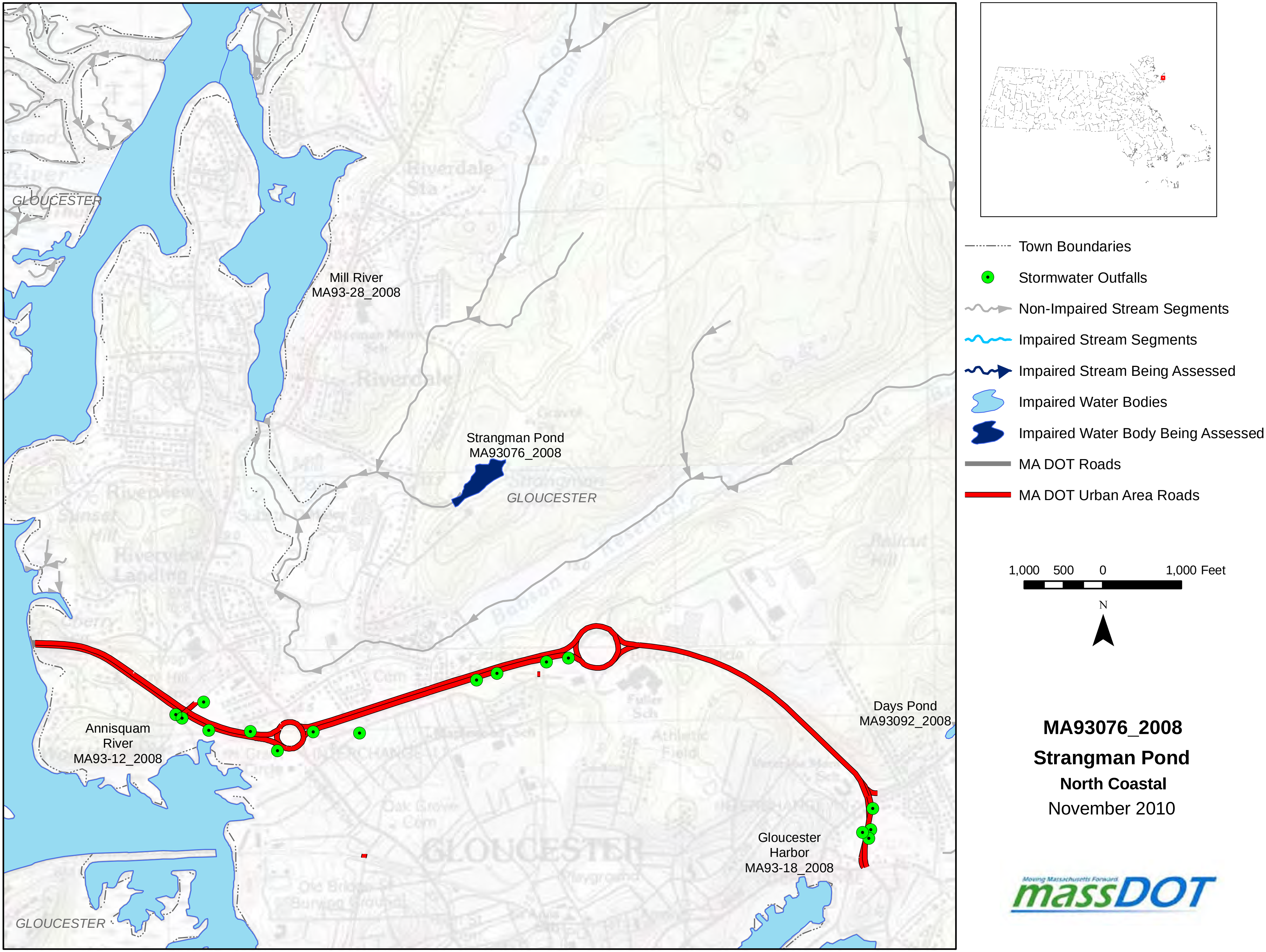

MA93076_2008

Strangman Pond

North Coastal

November 2010

massDOT

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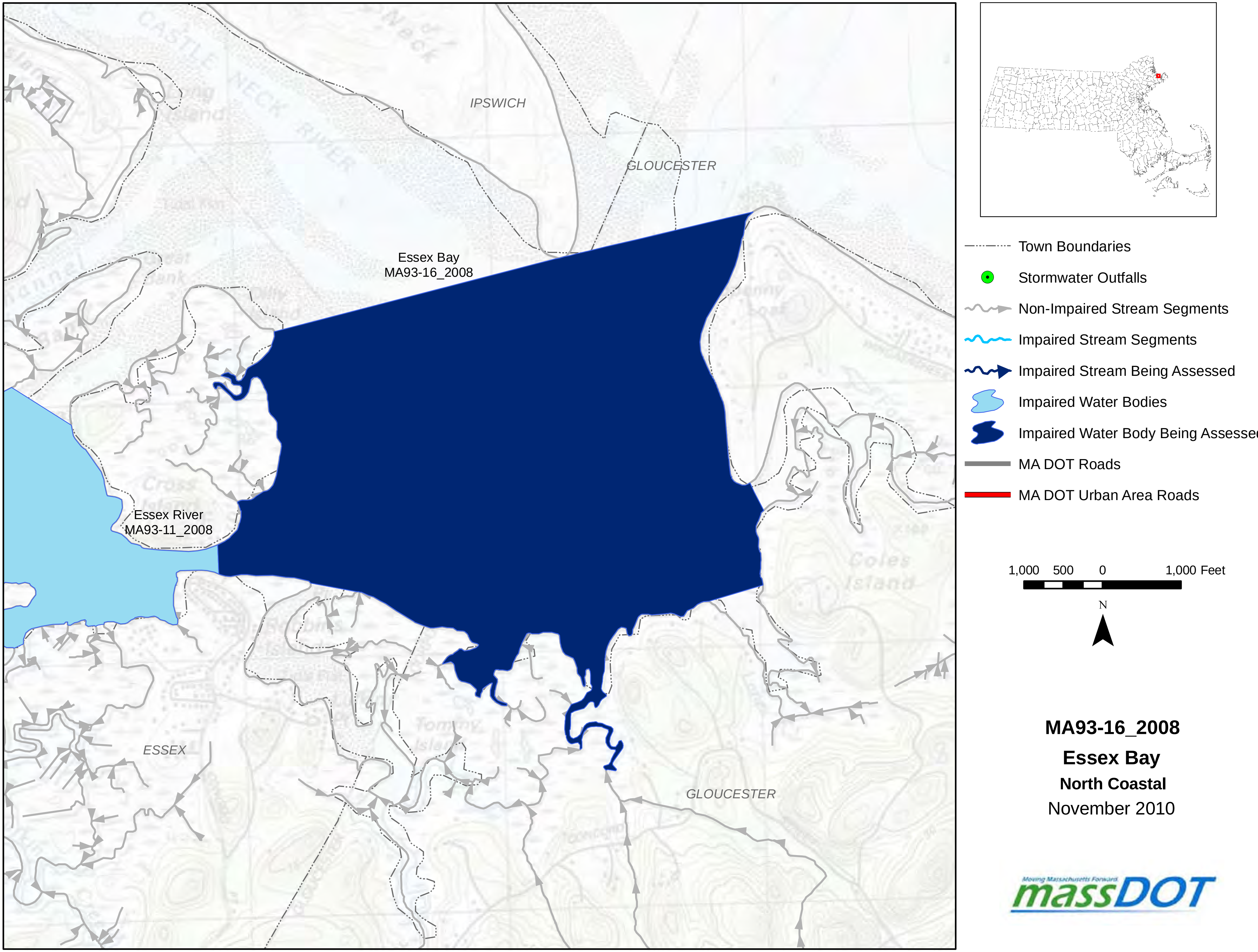


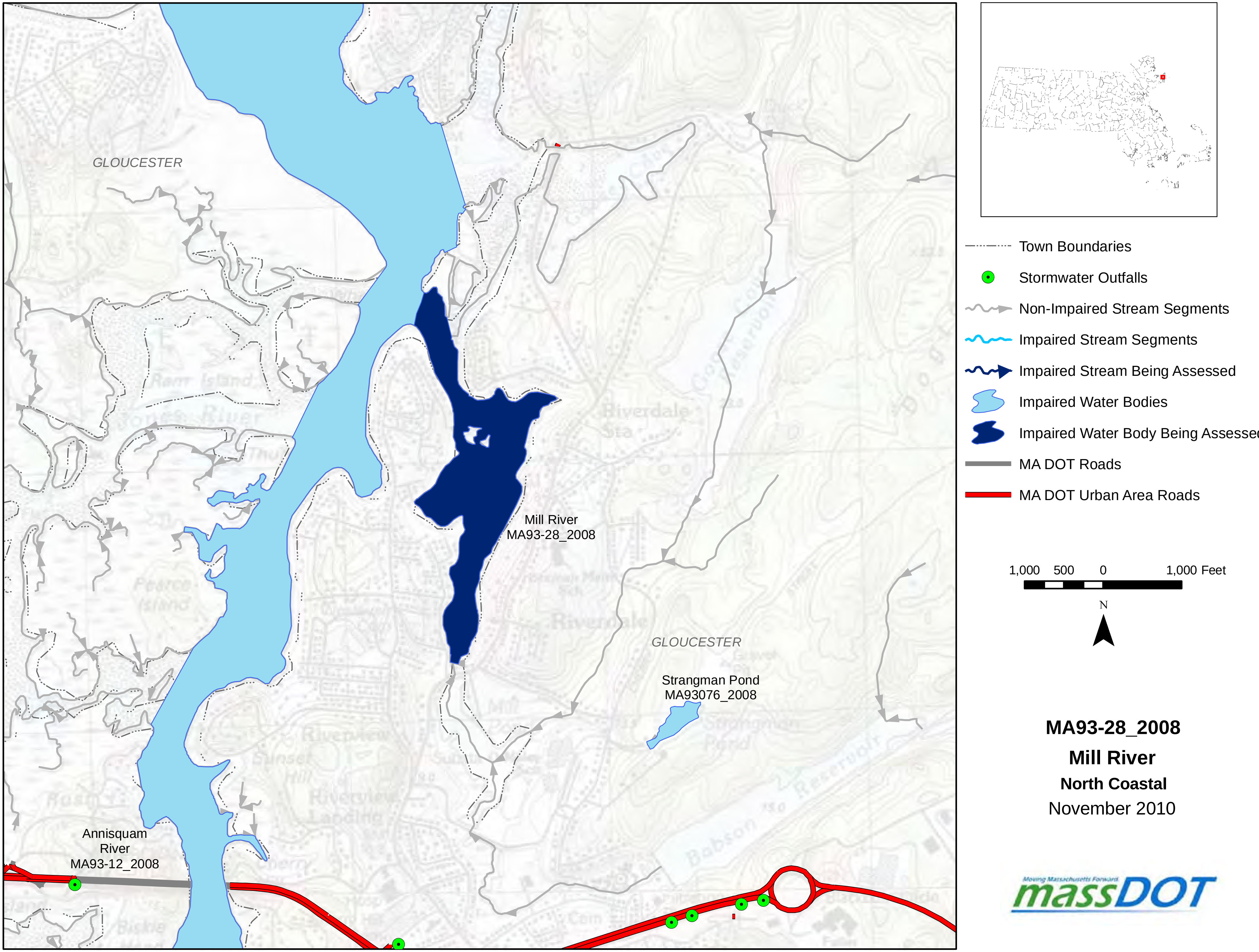
MA93-16_2008

Essex Bay

North Coastal

November 2010

massDOT



MA93-28_2008

Mill River

North Coastal

November 2010