Sustainable Water Management Initiative Pilot Project Phase 2

Completed for

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Section 1 Executive Summary

The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) and its agencies[1] developed the Sustainable Water Management Initiative (SWMI) Permitting Framework to help balance ecological and human water needs through the regulation of water withdrawals under the Water Management Act (WMA).[2] The EEA commissioned a Pilot Project to test implementation of the SWMI Framework on four public water suppliers (PWSs) that have WMA permits. The results will inform EEA and its agencies and guide the development of regulations. This document presents the Draft Final Report for Phase 2 of this Pilot Project.

The EEA formally issued the Final SWMI Framework on November 28, 2012. The Framework characterizes river basins throughout the Commonwealth and establishes requirements for permitting under the WMA. The Framework will require all WMA permit holders to evaluate options to minimize existing water withdrawal impacts. Those permit holders requesting an increase to permitted water withdrawals above an established baseline will need to implement mitigation measures to offset those increased volumes, commensurate with the impacts of the withdrawals. The Framework also describes WMA permitting for surface waters with similar minimization and mitigation requirements. Section 2 of this report provides a more detailed overview of the SWMI Framework.

The EEA engaged in this Pilot Project to test implementation of the SWMI Framework on the following PWSs:

- Town of Amherst Department of Public Works (DPW) Water Division
- Danvers-Middleton Water Divisions
- Dedham-Westwood Water District
- Town of Shrewsbury Water Department

The Pilot Project consisted of two phases. Phase 1, conducted between April and June, 2012, focused on the evaluation of minimization and mitigation options to reduce the impacts of groundwater withdrawals on streamflows in accordance with the Draft SWMI Framework. Section 2 of this report provides a brief summary of Phase 1; detailed discussion of Phase 1 may be found in the Draft Phase 1 Report, submitted to MassDEP on June 30, 2012.

Phase 2 of the SWMI Pilot Project, described in detail in this report, encompassed the following elements:

[1] The EEA oversees the following Commonwealth environmental, natural resource and energy regulatory agencies: the Departments of Agricultural Resources, Conservation and Recreation, Energy Resources, Environmental Protection, Fish and Game, and Public Utilities.

[2] See Appendix A for a Glossary of terms and acronyms used throughout this report.

1. Coordination and meetings – MassDEP and the Pilot Team held the following series of meetings (described further in Section 2):

    a. Mock Consultation Meetings with Shrewsbury Water Department.

    b. Site-Specific Study Meetings with Amherst Water Division and with Shrewsbury Water Department.

    c. Meetings with the SWMI Pilot Stakeholder Committee.

2. Development of a SWMI evaluation data checklist – The Pilot Team developed a checklist for use by MassDEP and PWSs to help prepare for a permit application. This draft checklist is introduced in Section 2 of the report, with the list attached as Appendix D. The checklist is based on the data collected during Phase 1 and Phase 2 of the Pilot Project.

3. Supplement to the Phase 1 report (as discussed in Section 3), including:

    a. Incorporation of comments received by MassDEP into the Phase 1 Report, and distribution to PWSs and the Stakeholders Committee.

    b. Clarification of the terms "minimization" and "commensurate with impact" as used in the SWMI context. Essentially, SWMI requires minimization of withdrawals and minimization of impacts from withdrawals, before considering mitigation of remaining impacts. Also, the SWMI Framework provides for options for PWSs to consider site-specific analyses to more precisely identify impacts, to in turn more closely define the appropriate level of mitigation (also see discussion of site-specific study options in Section 6).

    c. Development of a refined mitigation credit system that requires demand management in preference to other directly quantifiable offsets, and direct offsets in preference to indirect offsets. The refined credit system also provides a more simplified "indirect credit" scoring matrix for mitigation actions that do not have a readily quantifiable effect on offsetting or reducing withdrawals.

    d. Identification of a process for selecting and planning mitigation measures over the 20-year term of a WMA permit. Essentially, the SWMI process will require PWSs to develop a Mitigation List (included in the permit application) documenting a suite of feasible mitigation measures that could ultimately offset proposed withdrawals above baseline volumes. As actual withdrawal volumes approach baseline (or subsequent target thresholds set on the basis of approved mitigation actions), SWMI will require a PWS to develop a detailed Mitigation Plan, specifying how and when the supplier will implement

measures from the Mitigation List so that offsets keep pace with increases in demand.

4. Description of a methodology to evaluate optimization of existing water sources and to evaluate alternative sources. Section 4 summarizes the methodology for this "desktop pumping evaluation" procedure. Elements include identification of data sources, evaluation of available withdrawal data, and development of a hierarchy for ranking water sources to meet the SWMI Framework goals. Phase 1 of the Pilot Project applied a comparable methodology during assessment of minimization options for each pilot PWS.

5. Completion of a mock permitting exercise and consultation with EEA agencies. The Shrewsbury Water Department was selected for a mock permitting and consultation exercise. MassDEP and the project team held meetings with Shrewsbury Town staff to discuss minimization and mitigation options that would work in Shrewsbury. Section 5 documents the outcome of this non-binding permitting exercise including the SWMI-related permit conditions, feasible minimization and mitigation activities, and a possible implementation schedule for Shrewsbury. Some of the findings of that exercise included:

    a. The mock process time frame appeared to reasonably corroborate the consultation time frame outlined in the SWMI Framework documentation.

    b. The process requires adequate preparation by the permittee. Contemplated workshops for providing guidance on SWMI should stress this consideration, and provide resources to assist PWSs to prepare for the consultation process.

    c. EEA should provide guidance on how PWSs can document water needs in cases where DCR cannot calculate a new Water Needs Forecast.

    d. The GWLs should not be further modified, even though there is no ability to backslide from a GWL5.

    e. EEA should provide guidance for addressing proposed mitigation actions other than those currently listed in the existing SWMI offset/mitigation table.

    f. EEA should consider providing guidance for the amount of preparatory work required to document feasibility of an option proposed for inclusion on a Mitigation List.

    g. EEA should consider provisions for some flexibility in the timing of mitigation implementation, to provide for required time to design,

permit, and fund the action(s). Timing of mitigation activity may also depend in some cases on formal action through the Town Meeting process.

h. EEA should consider provision of guidance on sharing mitigation credits between multiple WMA permit holders.

6. Provision of a methodology to provide site specific studies, in lieu of the data and/or modeled withdrawal/impact relationships that underlie the SWMI Framework. EEA and its agencies committed to establish a process within the Framework that provides the opportunity for a WMA permit holder to provide site-specific evaluations to demonstrate that local conditions may significantly differ from those reflected in the Framework. Section 6 describes the general scope of site-specific evaluations, which could be conducted along one of two tracks:

   Track 1) review/refine data inputs to the USGS modeling.

   Track 2) determine actual streamflow and impacts through independent streamflow and habitat assessments.

   A PWS could choose a site-specific study option under either track, after weighing potential benefits and costs and could also return to the SWMI Framework if desired.

7. Exploration of pilot site-specific studies. The Shrewsbury Water Department and Amherst Water Division were selected to participate in discussions of site-specific evaluations. These discussions were held to identify options to demonstrate that local conditions may be significantly different from those reflected in the SWMI Framework.

   a. Section 7 discusses options considered within Track 1, including:

      i. A review of actual data that might be different than the estimated data used to develop BC and GWL categories under the SWMI Framework (e.g., actual pumping records vs. pumping values used in SWMI, changes to withdrawals in subbasins); and

      ii. Identification of other options that might be different from how the SWMI Framework is applied (e.g., the confined aquifer in Amherst influences the impact of the groundwater withdrawal on the stream).

   b. Sections 8 and 9 consider the suite of site-specific study options that Shrewsbury and Amherst could undertake, including both Track 1 and Track 2 options.

8. Development of recommendations, discussed in Chapter 10, including:

    a. The preparation of more detailed guidance for WMA permittees to cover situations that did not come up in the Pilot communities, including periodic updates of the guidance to reflect "lessons learned" during the initial experience in implementing the SWMI process.

    b. Outreach to additional stakeholders including public water suppliers, environmental groups and consulting engineers.

    c. The development of guidance materials for PWSs participating in the permit consultation process.

    d. Further efforts to resolve issues still outstanding including tracking of stormwater credits, enhancement of location adjustment factors, and addition of other site specific methodologies and further guidance on how PWSs will be expected to apply these methodologies in lieu of the SWMI "model" for defining impacts and corresponding mitigation actions.

Section 2 Introduction and Overview

The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) and its agencies developed the Sustainable Water Management Initiative (SWMI) Permitting Framework to help balance ecological and human water needs through the regulation of water withdrawals under the Water Management Act (WMA).[1] The EEA has engaged in this Pilot Project to test implementation of the SWMI Framework on four public water suppliers (PWSs) that have WMA permits. The four PWSs are:

- Town of Amherst Department of Public Works (DPW) Water Division
- Danvers-Middleton Water Divisions
- Dedham-Westwood Water District
- Town of Shrewsbury Water Department

The EEA oversees the Commonwealth's six environmental, natural resource and energy regulatory agencies including the Departments of Agricultural Resources, Conservation and Recreation, Energy Resources, Environmental Protection, Fish and Game, and Public Utilities. The Massachusetts Department of Environmental Protection (MassDEP) oversees and enforces SWMI with input from the Department of Conservation and Recreation (DCR) and the Department of Fish & Game's Division of Fish and Wildlife (DFW).

The Pilot Project consists of two phases. MassDEP selected the Team of Comprehensive Environmental Inc. in association with Tighe & Bond (Pilot Team) to complete both Phases. The Team conducted Phase 1 between April 30, 2012 and June 30, 2012 and focused on the evaluation of minimization and mitigation options to reduce the impacts of groundwater withdrawals on streamflows in accordance with the Draft SWMI Framework. The Team submitted the draft Phase 1 Report to MassDEP on June 30, 2012.

This draft report describes the activities and findings of Phase 2 of the SWMI Pilot Project and focuses on the following:

- Evaluating and developing tools to help PWSs through the SWMI permitting process. Examples include procedures for performing a desktop pumping evaluation and a checklist for information compilation and permit application preparation under the SWMI Framework.
- Testing the permitting process by conducting a pilot PWS consultation and by evaluating what a site-specific study could look like if a PWS wanted to pursue alternatives to the SWMI Permitting Framework and the science behind it.

The EEA funded the SWMI Pilot Project. The results will guide EEA and its agencies in the development of regulations.

[1] See Appendix A for a Glossary of terms and acronyms used throughout this report.

2.1 Summary of SWMI

The EEA and its agencies formally issued the Final SWMI Framework on November 28, 2012. The agencies intend the Framework to help balance ecological and human water needs through the regulation of water withdrawals. The Framework characterizes river basins throughout the Commonwealth and establishes requirements for permitting under the WMA.

Specifically, the Framework will require all WMA permit holders to evaluate options to minimize existing water withdrawal impacts. Those permit holders requesting an increase to permitted water withdrawals above an established baseline volume will need to offset those new withdrawal volumes, depending on the characteristics and categorization of the basin(s) where their wells are located. While the primary focus is on groundwater withdrawals, the Framework also includes a transition rule for surface waters with similar minimization and mitigation requirements.

2.1.1 Basin Characterization and Categorization

The SWMI Framework categorizes major basins and subbasins to help establish the level of mitigation and improvement that will be required of PWSs under the WMA permitting process. A request for increased withdrawal or the periodic WMA permit renewal process will trigger the application of this Framework. There are 1,395 nested subbasins delineated within the state of Massachusetts. (MWI Report) (See Appendix B - References)

Basin/subbasin characterization and categorization includes the following elements:

> **Safe Yield** – Safe yield has been calculated for each major basin to determine the maximum amount of water that may be withdrawn during drought conditions while maintaining sufficient water in streams and rivers for environmental protection.
>
> **Biological Categories** – The SWMI Framework groups subbasins into five Biological Categories (BCs) that represent an estimate of existing aquatic habitat integrity of the receiving streams and rivers. The Framework based this classification on the findings of two scientific studies completed by USGS in cooperation with EEA Agencies.[2]
>
> The Framework uses fish communities as a surrogate for aquatic habitat integrity based on statistical analyses developed in the USGS studies. USGS identified a set of regression equations (sometimes referred to as the "SWMI Model") that describe relationships between fluvial fish abundance and variations in flow, percent of impervious cover and natural basin characteristics.

[2] *Indicators of Streamflow Alteration, Habitat Fragmentation, Impervious Cover, and Water Quality for Massachusetts Stream Basins* (2009) and *Factors Influencing Riverine Fish Assemblages in Massachusetts* (2011).

BCs range from Category 1, which represents high quality aquatic habitats, relatively un-impacted by human alteration, to Category 5, which represents a significant decline in fluvial fish populations and aquatic habitat.

Groundwater Withdrawal Levels – (formerly referred to as Flow Levels or FLs) SWMI also categorizes subbasins into five Groundwater Withdrawal Levels (GWLs) that represent the percent alteration of natural August median flows due to groundwater withdrawals within and upstream of the subbasin.

The percent alteration assumes each gallon of water withdrawn from the basin by public and private groundwater supplies, but not surface water withdrawals, results in a direct and equal decrease in streamflow. GWL1 represents the least impact to, or alteration of, streamflow, with less than 3% of the August unimpacted streamflow withdrawn. GWL5 represents the greatest impact to, or alteration of, streamflow, with 55% or more of the August streamflow withdrawn. SWMI identifies the percent alterations that define each GWL based on the level of withdrawal/alteration that would cause the BC to backslide one category (e.g., go from BC 1 to BC 2) with impervious cover set to one percent.

Although SWMI uses August flow alteration to define the subbasin GWL, the Framework also includes guidelines for allowable alteration of unimpacted median flow in five seasons (July-August-Sep; October-November; December-January-February; March-April; and May-June) for GWL 1, 2 and 3 subbasins.

2.1.2 Application of SWMI

The SWMI Framework will apply when a permit holder requests an increase in its permitted withdrawal volume above an established baseline or when its WMA permit is up for renewal. The process is as follows for PWS permit holders:

Step 1 - DCR will develop a 20-year Water Needs Forecast (WNF) for the communities served by the PWS.

Step 2 - MassDEP will check the volume requested against the DCR projections and the basin safe yield to determine whether the total approved and requested withdrawals in the basin will exceed the safe yield.

Step 3 - MassDEP will calculate the PWS's baseline[3] withdrawal and compare it to the water withdrawal requested to determine the PWS's permit review tier as follows:

[3] Baseline was defined as the volume withdrawn in compliance with the Act during the calendar year 2005, the average volume withdrawn in compliance with the Act from 2003 to 2005, or the registered volume, whichever is the highest. The baseline under the SWMI Framework will add 5% to the higher of 2003-2005 average use, or 2005 use. If baseline is the registered volume, no additional percentage can be added. See Glossary in Appendix A.

- Tier 1 – No additional withdrawal request above baseline.
- Tier 2 – Additional withdrawal request above baseline and no change in GWL or BC.
- Tier 3 – Additional withdrawal request above baseline will change GWL and/or BC.

The permit review tier will then establish the requirements of the WMA permit based on the subbasin's BC and GWL, including any requirements for minimization or mitigation measures to offset withdrawals. WMA Permit Conditions 1-8 (refer to Appendix C) will apply to all WMA permits.

Table 2-1 outlines potential minimization and mitigation options that a PWS may consider to address its WMA permit review requirements. Additional requirements (separate from GWL 4 or 5 considerations) also apply for PWSs if there are quality natural resources (e.g., BC 1, 2, and 3 and/or coldwater fishery resource) present within the basin.

Table 2-1. Minimization and Mitigation Options

Minimization	Mitigation
1. Optimization of existing resources; 2. Use of alternative sources; 3. Interconnections with other communities or suppliers; 4. Releases from surface water impoundments; 5. Outdoor water restrictions tied to streamflow triggers (e.g., greater restrictions on outdoor watering than is currently applied); 6. Implementation of reasonable conservation measures; 7. New England Water Works Association Best Management Practice (BMP) toolbox; 8. Other measures that return water to the subbasin.	1. Instream flow improvements through release of surface waters; 2. Wastewater improvements including additional septic or treated groundwater discharge and I/I removal; 3. Stormwater/impervious cover improvements including recharge, adoption of a stormwater utility, adoption/implementation of MS4 requirements, reduction of impervious cover; 4. Water supply management including adoption of an enterprise account; 5. Habitat improvement including improving habitat connectivity, restoration of stream buffers; 6. Demand management to reduce water withdrawals.

Source: Table 5 and Table 6 of the Final SWMI Framework

2.2 Summary of Pilot Project Phase 1

Phase 1 of the SWMI Pilot Project identified existing and potential minimization and mitigation options to reduce the impacts of water supply withdrawals in the four pilot communities. Minimization options were identified and discussed in terms of their feasibility and ability of the PWS to implement the option. Mitigation options included development of a draft crediting system that could be used to quantify withdrawal offsets commensurate with the PWSs withdrawal 'ask' above baseline. Section 4.0 and Appendix E of the SWMI Pilot Project Phase 1 Report identified the methods for applying these credits. The methods include both a direct quantitative approach (Section 4.0) where the volume of water saved or put back into the ground was directly quantified, and an indirect quantitative approach (Appendix E) where a qualitative scoring system was applied to various measures based on the anticipated improvement to the impacted stream and then correlated with a volume based on the August median streamflow of the impacted stream.

The Phase 1 Report included consideration and application of "Location Adjustment Factors" to certain mitigation actions that involved recharge of groundwater. These Location Adjustment Factors provided more credit to mitigation actions that were implemented upstream or within the Zone II of the withdrawal point and were applied to the existing and potential credits in the Phase 1 Report. The location factors are still under consideration by EEA as to how or whether they will be applied or included in the final SWMI regulations. Alternative Location Adjustment Factors were developed during the Phase 2 mock permitting exercise summarized in Section 5 of this report.

Existing and potential mitigation offsets were then estimated for each Pilot PWS assuming the entire population could be reached through various measures. This provided a menu of options and anticipated credits that a PWS could choose from to negotiate measures to offset its withdrawal request during permitting, recognizing that some refinements to the potential offsets would be needed.

Phase 1 of the Pilot Project involved two meetings with each of the PWSs, one meeting with each of the local watershed groups and one stakeholder meeting to collect and present the findings as the study was performed.

2.3 SWMI Pilot Project Phase 2 Overview

The scope of the Phase 2 Pilot Project included:

1. Provide supplemental activities from Phase 1 – The team incorporated comments received by MassDEP into the Phase 1 Report before submittal to PWSs and the Stakeholders Committee.

2. Provide options for desktop pumping evaluation, optimization, and evaluating alternative sources – A methodology was summarized, including identification of data sources and development of a hierarchy for ranking

water sources, to meet the SWMI Framework goals of minimizing impacts to coldwater fishery resources and more impacted streams. This methodology captured the process that was applied during assessment of minimization options for each pilot PWS during Phase 1. Section 4 of this report describes these options in detail.

3. Mock permitting exercise and consultation with EEA agencies – The Shrewsbury Water Department was selected to run through a mock permitting and consultation exercise. MassDEP and the project team held three meetings with Shrewsbury Town staff to discuss minimization and mitigation options that would work in Shrewsbury. Section 5 presents a summary of this mock permitting exercise

4. Site-Specific Study – The Shrewsbury Water Department and Amherst Department of Public Works Water Division were selected to participate in discussions of site-specific evaluations. These discussions were held to identify options to demonstrate that local conditions may be significantly different from those reflected in the SWMI Framework. The options considered included:

    a. A review of actual data that might be different than the estimated data used to develop BC and GWL categories under the SWMI Framework (e.g., actual pumping records vs. pumping values used in SWMI, changes to withdrawals in subbasins); and

    b. Identification of other options that might be different from how the SWMI Framework is applied (e.g., the confined aquifer in Amherst influences the impact of the groundwater withdrawal on the stream).

    Danvers-Middleton was also considered under this component of the study, to evaluate how recent changes in withdrawals in the subbasin (e.g., discontinuation of the Town of Reading wells) impact the BC and GWL.

    Sections 6 through 9 of this report provide a description of the site-specific studies.

5. Create a SWMI evaluation data checklist – The Pilot Team developed a checklist for use by MassDEP and PWSs to help prepare for a permit application. It includes a listing of the type of data that should be reviewed to prepare an application. This draft checklist is included in Appendix D. The checklist is based on the type of data collected during Phase 1 and Phase 2 of the Pilot Project. Appendix E contains an annotated bibliography of all data and documents collected during the Pilot Project.

6. Coordination and meetings – MassDEP and the Pilot Team held a series of meetings as follows:

    a. Mock Consultation Meetings – Three meetings were held with the Shrewsbury Water Department and staff from several EEA agencies to identify minimization and mitigation measures to be included in a mock permit. The meeting process and feedback obtained were used to develop a framework for the agency consultation process to be used with applicants under the SWMI Permitting Framework to ensure effective communication between state agencies and the PWSs. Refer to Section 5 for recommendations on the agency consultation process.

    b. Site-Specific Study Meetings – Two meetings with Amherst Water Division and one meeting with Shrewsbury Water Department were held to discuss options for conducting a site-specific evaluation of the PWS's streamflow and habitat conditions. EEA agency staff as well as local stakeholders attended these meetings.

    c. SWMI Pilot Stakeholder Committee Meeting – One meeting was held with the SWMI Pilot Stakeholder Committee prior to the drafting of this report, to obtain technical and policy guidance and to identify areas of agreement and areas for further exploration. Stakeholder Committee Meeting summary notes are included in Appendix F.

7. Prepare Phase 2 Draft and Final Reports – This Draft Report was developed to summarize the results of Phase 2 of the Pilot Project. The report includes recommendations provided in Section 10.

Section 3 Phase 1 Supplement

This section supplements the Sustainable Water Management Initiative (SWMI) Pilot Project Phase 1 Draft Report by providing clarification on the terms 'minimization' and 'commensurate with impact.' It also presents an alternative method to evaluate mitigation credits than was provided in the Phase 1 Report. The mock permitting consultation exercise with Shrewsbury described in Section 5 uses this alternative crediting method.

Participants in the review of the Phase 1 Draft Report, the Phase 2 mock consultation sessions, and the site-specific study evaluations raised many questions and concerns regarding the evaluation and application of minimization and mitigation options. While the Phase 1 Report did evaluate minimization and mitigation options for each Pilot public water supplier (PWS), it did not specifically define the extent to which a PWS must evaluate and implement minimization options or what is considered "commensurate with the impact of withdrawal."

The Phase 1 and Phase 2 process also raised questions on the calculation and application of mitigation credits as included in the Phase 1 Report, indicating a need for further clarification on how to consider and credit demand management, direct mitigation (e.g., groundwater recharge) and indirect mitigation (e.g., habitat improvements) in an overall plan to reduce impacts to streams.

The following sections address these concerns. Section 3.1 provides further definition of key terminology in the SWMI Framework. Section 3.2 provides a refinement of the methodology applied to crediting mitigation measures.

3.1 Clarification of Terms

3.1.1 Minimization

Under the SWMI Permitting Framework, all Water Management Act (WMA) permit holders are required to minimize existing impacts to the greatest extent feasible. Depending on permit review Tier and Groundwater Withdrawal Level (GWL), minimization will consist of two categories of measures: those specified by Standard Permit Conditions, and those specified as Special Conditions. The permitting review Tier is defined based on the amount of the withdrawal request above the baseline volume: Tier 1 review applies when a withdrawal request does not exceed baseline; Tier 2 review applies when a withdrawal request exceeds baseline but does not cause backsliding of the Biological Category (BC) or GWL; and Tier 3 review applies when a withdrawal request exceeds baseline and results in backsliding.

The GWL is based on the estimated alteration of August median streamflow from the withdrawal, with the least impact identified as GWL1 and the greatest impact as GWL5.

Under these definitions, SWMI requires the following:

- PWSs in all permitting Tiers, regardless of the subbasins' GWL, are required to minimize their withdrawal impact by meeting WMA standard permit conditions.

- PWSs located in GWL4 or 5 subbasins (i.e., where withdrawal impacts are estimated to alter August median flow by more than 25%) are subject to special conditions that require them to evaluate further minimization options.
- PWSs in permitting review Tiers 2 and 3 are required to mitigate commensurate with withdrawal impact if the withdrawal is located in a BC1, 2 or 3 subbasin, a GWL4 or 5 subbasin, or if a coldwater fishery resource (CFR) is present.

3.1.1.1 WMA Standard Permit Conditions

All permitting review tiers must minimize their existing withdrawal impacts through the following:

- Achieve 65 residential gallons per capita day (RGPCD) water use;
- Achieve 10% unaccounted-for water (UAW);
- Institute nonessential outdoor water use restrictions seasonally, either calendar based or streamflow based; and
- Implement best management practices such as frequent leak detection, meter repair/replacement, and public education programs.

3.1.1.2 Special Conditions

In addition to meeting the WMA Standard Permit Conditions (refer to Appendix C), any PWSs with groundwater withdrawals in GWL4 and 5 subbasins must evaluate ways to further minimize their existing flow impact to the greatest extent feasible (considering level of improvement, costs, the purview that is under the authority of the permittee and using an adaptive management approach based on site specific conditions). The PWS would develop and implement a minimization plan that considers flow improvement and practicability. The minimization plan should have little impact on overall system reliability or cost, with the added benefit of reducing potential withdrawal impacts on the environment and should include the following minimization options:

1) Optimization of existing sources and/or use of alternative sources, including existing interconnections, to meet seasonal needs – Suppliers would be required to conduct a desktop pumping evaluation, and have an agency consultation if a CFR is present, to determine if existing alternative sources or interconnections with less seasonal impacts could be used, or if their wells could be pumped in a seasonal pattern that would shift pumping in summer from wells in more highly impacted subbasins to those in less impacted subbasins (optimization), within the constraints of cost and system management (e.g., well capacity, water quality treatment, demand patterns). Generally, pumping wells in subbasins with higher streamflow would be favored over wells in subbasins with lower streamflow.

2) Releases from surface water impoundments – In communities with surface water impoundments located in or upstream of the same subbasin(s) as their wells, and that have the capacity for releases, suppliers would determine if releases could be made to improve downstream flows without compromising other in-lake uses (for example,

significant impacts to water supply, recreation, or ecology), and if so, to develop and implement a release plan subject to Massachusetts Department of Environmental Protection (MassDEP) approval.

3) Other measures that reduce withdrawals or improve flow in the same sub-basin as those withdrawals – Suppliers would be asked to review the NEWWA Toolbox[1] and consider any other practicable measures outlined therein, or any other measures they identify, that reduce withdrawals or otherwise improve flow in their GWL4 and 5 subbasins.

3.1.2 Commensurate with Impact

Under the SWMI Framework, permittees requesting withdrawals above baseline must mitigate impacts "commensurate with impact from additional withdrawal." The Framework provides a mitigation crediting system (revised, as discussed in Section 3.2), that is based on the requested withdrawal volume above baseline. However, there may be cases where the impact of withdrawal may be less than proportional to the withdrawal. In such cases, alternative methodology may be warranted, to allow more effective characterization of the level of mitigation needed.

For the purposes of the Phase 1 Pilot Project, the level of mitigation required to 'mitigate commensurate with the impact of withdrawal' was based on the volume of the requested withdrawal above the baseline volume. For example, a PWS with a baseline of 1 mgd requesting 1.5 mgd, and subject to Tier 2 or 3 permitting review within a GWL 4 or 5, would be required to mitigate 0.5 mgd. The mitigation credit system presented in the Phase 1 Report assigned volume credits to all direct and indirect mitigation options for direct application to the required mitigation volume.

Under Phase 2, the level of mitigation required is still based on the volume of the requested withdrawal above the baseline volume. However, application of the site-specific studies raised questions on the level of mitigation required under various site-specific scenarios. As one example, if a PWS could demonstrate that the actual impact on August median flow was less than the full withdrawal amount during August, then "mitigation commensurate with impact" would imply mitigation based on less than the full withdrawal.

Under the SWMI Framework, for these site-specific scenarios, mitigation measures determined by SWMI Tier and GWL (e.g., mitigation of the request above baseline) would not apply. Instead, site-specific findings and recommendations would be incorporated into the permittee's water withdrawal permit and mitigation requirements may be reduced to be commensurate with the "lower level of impact" demonstrated. In cases where actual streamflow needs are defined (as through an instream flow study – see discussion in Section 6), mitigation could require maintaining the identified/target streamflows (e.g., by implementing outdoor water use conservation measures at low flow

[1] The NEWWA Toolbox is a useful reference which provides many BMPs water suppliers can use to evaluate the potential for minimizing impacts.

triggers). Mitigation could also include habitat improvement measures that could result in increased streamflow and reduced number of days where streamflow triggers are tripped.

Mitigation requirements would be negotiated with the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) agencies during the permitting process.

3.2 Revised Mitigation Credit Method

The Phase 2 mock consultation process with Shrewsbury (see Section 5) raised many questions and concerns regarding the calculation and application of mitigation credits commensurate with the impact of the withdrawal request. These included conflicting opinions regarding methods to quantify stormwater recharge and demand management credits, as well as concerns about logistical and administrative burdens for PWSs, MassDEP, and other EEA agencies in implementing, tracking, and enforcing certain measures over the lifetime of a permit. EEA was also interested in simplifying the indirect crediting method presented in Appendix E of the Phase 1 Report. In response, EEA staff members met internally during Phase 2 of the Pilot Project to develop an alternative crediting system that considered how to credit demand management, direct mitigation measures and indirect mitigation measures.

This modified credit system uses a combination of direct offset volume calculations for those measures that lend themselves to easier mitigation volume calculations (e.g., wastewater returns) and a qualitative offset credit system adapted from the methodology discussed in Appendix E of the Phase 1 Report.

The revised mitigation credit approach would require applicants subject to mitigation to develop a Mitigation List during the permit application process, to be included in the permit. This list will specify some combination of demand management, direct mitigation (quantifiable on a volumetric basis) and indirect mitigation actions (quantifiable using a credit system representing non-volumetric environmental/habitat improvements). The list will only include measures that the supplier demonstrates are feasible and commensurate with the full volume by which the permit exceeds baseline.

Prior to being given permission to pump volumes that exceed baseline, suppliers would use their Mitigation List to develop a detailed Mitigation Plan, commensurate with the volume above baseline that they anticipate needing during the permit term. MassDEP would work with suppliers on the required timeframe for completing mitigation activities and would most often require such measures to be completed prior to increasing withdrawals. The Plan would be reviewed as needed to ensure that mitigation is occurring commensurate with increases over baseline. If demand turns out to exceed baseline by more than anticipated in the initial Mitigation Plan**,** additional mitigation activities would be required commensurate with the additional volumes.

Mitigation activities in order of MassDEP preference include:

1) Demand Management
2) Direct Mitigation
3) Indirect Mitigation

A Mitigation Plan would only be required if and when pumping volumes exceed baseline volumes. To the fullest extent practicable, a PWS would implement direct mitigation measures before applying indirect mitigation measures. If the full volume of anticipated demand above baseline cannot be mitigated with direct credits, the remainder would be mitigated through indirect credits, such as stream habitat improvements, measures to improve water quality, and measures to protect water supplies.

Each of these mitigation options is discussed further below.

3.2.1 Demand Management

Demand management is generally the most cost-effective and environmentally sound strategy for balancing water supply demands and streamflow protection. Therefore, demand management is afforded the highest priority during permitting. During the permit application or renewal, suppliers can estimate the volume by which they expect to use demand management activities to reduce system demands to levels below those calculated in the 20-year forecast, which assume 10% UAW and 65 RGPCD.

Despite having a water needs forecast and withdrawal request that exceeds baseline, a supplier can demonstrate that the estimated savings from demand management activities will achieve one or more of the following:

1) Keep demand below baseline for the life of the permit,
2) Delay the point at which demand is expected to exceed baseline, relative to the 20-year forecast, and
3) Reduce the ultimate demand over baseline relative to the 20-year forecast

Under this crediting system, demand would be checked annually and reviewed in detail at each 5-year review by MassDEP. To the extent that the supplier's predictions about demand reduction hold true, the supplier may never be required to develop a detailed Mitigation Plan, may be able to delay the development of a Mitigation Plan, and/or may be able to reduce the volume requiring mitigation under the Mitigation Plan (see Table 3-1 for example scenarios).

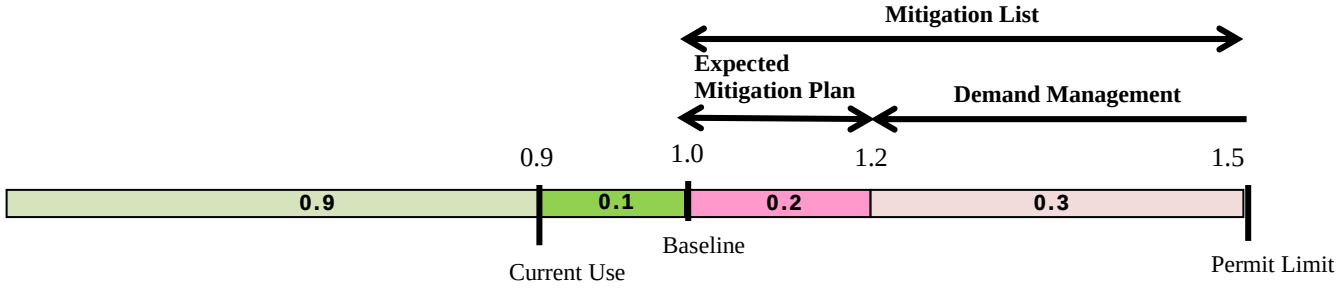
3.2.2 Direct Mitigation

Direct mitigation is the second highest priority for achieving mitigation commensurate with the impact of the withdrawal. It must be a volume that can be credibly quantified and generally consists of measures that will have a direct impact on the stream either by replenishing groundwater recharge or increasing streamflows. During the Phase 2 Pilot Project, EEA identified three primary areas for achieving direct mitigation credits, as described below. Note that direct mitigation credits will not necessarily be limited to these and other direct mitigation credits may be considered. Also note that within the Phase 2 Pilot Project, credits were only offered for direct mitigation measures implemented within Town boundaries. This approach was taken to avoid double counting of credits between Towns.

Table 3-1: Scenarios illustrating the role of demand management relative to mitigation requirements for the 20-year permit period

	All Units are mgd								
A	B	C	D	E	F	G	H	I	J
Scenario	**Baseline (BL)**	**Current Use**	**Current Use Status**	**20-year Permit Limit**	**Demand Management (DM) Estimate**	**Mitigation List Volume (E - B)**	**Mitigation Plan Volume (E - B - F)**	**Volume of mitigation avoided by demand management**	**When must mitigation plan be implemented?**
I	1	0.9	below BL	1.5	0.5	0.5	0	0.5	never, unless savings from DM are less than estimated and use exceeds BL
II**	1	0.9	below BL	1.5	0.3	0.5	0.2	0.3	not until use exceeds BL
III	1	1	at BL	1.5	0.2	0.5	0.3	0.2	Immediately, b/c current use is at BL
IV	1	1.1	above BL	1.5	0.1	0.5	0.4	0.1	Immediately, b/c current use already over BL

**See example schematic below



A Mitigation Plan will be required for the first 5-year period during which estimated demand will exceed baseline, commensurate with demand above baseline anticipated during the permit term (0.2 MGD). The community may delay all mitigation requirements for as long as demand management activities keep demand below baseline. Additionally, demand management is expected to keep actual use below 1.2 mgd through the life of permit, thereby avoiding 0.3 mgd of mitigation. (If actual use does exceed 1.2 mgd, further mitigation commensurate with those volumes will be required.)

3.2.2.1 Wastewater Return

Wastewater returns include discharges from septic systems or wastewater treatment facilities. Credits would be provided for existing and future wastewater returns and should consider the impacts to water quality.

a. Existing Septic Return – Existing septic returns located anywhere within the subbasin(s) where the wells are located (measured as above the subbasin outlet or "pour point" and hydrologically connected), and within the town boundaries, can be considered quantifiable mitigation. The estimated septic return values as cited in the Massachusetts Water Indicators (MWI) Report cannot be used with this approach because they are calculated by subbasin and not by town. However, the methodology used in the MWI Report to estimate septic return volume can be applied by communities during the permit renewal process.

b. Future Wastewater Return – Credits for future wastewater returns within Town boundaries would be subject to a location adjustment factor. The location adjustment factors proposed and used during the Phase 2 Pilot Project are presented in Table 3-2.

Table 3-2. Location Adjustment Factors for Mitigation Credits[1]

Location of Mitigation	Adjustment Factor
Within or upstream of subbasin or within the Zone II	100%[2]
Within the Major Basin	50%
Outside of the Major Basin	10%

[1]These location adjustment factors are for mitigation actions implemented within the Town boundaries.
[2]Subject to Water Quality Consideration.

3.2.2.2 Releases

A PWS may have control over an impoundment that could be used to supplement downstream low flow conditions through controlled releases. Such opportunities are expected to be relatively rare, due to factors such as reservoir safe yields; ecological, infrastructure and recreation considerations for the impoundment; structural limitations of the dam; as well as other factors. However, if the capability and opportunity exist, such releases could be considered for direct mitigation credit.

In particular, releases should be evaluated for their ability to reduce the extent and the number of days a year that extreme low flow conditions occur downstream of the impoundment, relative to natural conditions. The implementation plan for such releases would need to be worked out on a case-by-case basis, along with the equivalent volume of credit counted toward the required mitigation.

3.2.2.3 Stormwater Recharge

Direct mitigation credit can be allowed in cases where large areas of impervious surfaces directly connected to a municipal stormwater collection system are redeveloped/rerouted so stormwater from these surfaces directly recharges the aquifer. Soils must be shown to have sufficient infiltration capacity and annual recharge volumes must be credibly calculated. Credit will be limited to annual recharge under natural conditions (i.e. "supercharging" the aquifer will not be awarded additional credit). Credits for stormwater recharge would be subject to the location adjustment factors.

3.2.3 Indirect Mitigation

The EEA has developed a simplified "indirect mitigation" scoring matrix, adapted from the indirect offset volume calculation methodology included in Appendix E of the Phase 1 Report. The modified matrix provides a method to determine the number of "soft" credits a PWS would need to mitigate its withdrawal volume request above baseline. To determine the number of indirect mitigation credits needed for a particular application, the PWS first determines the total withdrawal request above baseline, and whether or not the total withdrawal request above baseline is greater than 5% of the August Median Flow and/or causes backsliding. It then determines and deducts the portion of that increased withdrawal volume mitigated through demand management or direct credit mitigation. The remaining volume must be mitigated through indirect credits. Refer to Table 3-3 to determine the credits needed for various withdrawal scenarios.

Table 3-3. Indirect Credit Requirements

Volume of *indirect mitigation** above baseline (mgd)	Credits required if *total withdrawal request above baseline* is less than 5% of August Median Flow and does not cause backsliding	Credits required if *total withdrawal request above baseline* is greater than 5% of August Median Flow or causes backsliding (or both)
0 to <0.1	10	20
0.1 to <0.2	20	40
0.2 to <0.3	30	60
0.3 to <0.4	40	80
0.4 to <0.5	50	100
0.5 to <0.6	60	120
0.6 to <0.7	70	140
0.7 to <0.8	80	160
0.8 to <0.9	90	180
0.9 to <1	100	200
1.0 or more	case by case	case by case

*The indirect mitigation volume represents the portion of the total withdrawal request above baseline that is not "covered" by demand management or direct credit mitigation such as a treated wastewater return, and therefore requires indirect mitigation. For example:

Baseline = 3.5 mgd
20-yr forecast plus buffer = 4.0 mgd
Total withdrawal request = 0.5 mgd (4 – 3.5 = 0.5)

Demand management estimate = 0.25 mgd
Direct mitigation = 0.05 mgd
Indirect mitigation = 0.2 mgd (0.5 – 0.25 – 0.05 = 0.2)

Indirect credits needed = 30 or 60 depending on whether the total withdrawal request above baseline is less than or greater than 5% of August Median Flow or causes backsliding.

The number of credits an applicant can obtain through indirect mitigation measures is based on a credit scoring matrix. The scoring matrix proposed and used during the Phase 2 Pilot Project is shown in Table 3-4.

Table 3-4. Indirect Mitigation Scoring Matrix								
Category	**Mitigation Action**	**Instream Flow Improvement (max 10)**	**Aquatic Habitat[1] Improvement (max 30)**			**Water Supply Protection (max 10)**	**Generic Total Score**	**Permit Specific Adjustments**
			Water Quality[2] Improvement (max 10)	**Habitat Improvement (max 10)**	**Stream Continuity Improvement (max 10)**			
Habitat Improvement	Remove a dam or other flow barrier[3]	5	5	5	10		25	During agency consult total score may be adjusted based on site specific information such as the location or scale of the activity.
Habitat Improvement	Culvert replacement to meet stream crossing standards		5	5	10		20	
Habitat Improvement	Streambank restoration		5	10			15	
Habitat Improvement	Stream channel restoration			10	5		15	
Habitat Improvement	Stream buffer restoration		5	10			15	
Habitat Improvement	Other habitat restoration project			10			10	
Habitat Improvement	Install and maintain a fish ladder[3]				10		10	
Habitat Protection	Acquire property in Zone I or II					10	10	
Stormwater	Stormwater bylaw with recharge requirements	5	5				10	
Stormwater	Stormwater utility meeting environmental requirement[4]	5	5				10	
Stormwater	Implement MS4 requirements[4]		10				10	
Habitat Improvement	Establish/contribute to aquatic habitat restoration fund			5			5	
Habitat Protection	Acquire property for other natural resource protection		5				5	
Wastewater	Infiltration/Inflow removal program	5					5	
TBD	Other project proposed by applicant	TBD[5]	TBD[5]	TBD[5]	TBD[5]	TBD[5]	TBD	
							165	

1. Aquatic habitat improvement can include instream water quality improvement, stream corridor habitat improvement, stream continuity improvement and cold water fishery improvement.
2. Water quality improvement can include reduction in cultural-source sediments, reduction in other pollutants, or -for CFR - mitigation of thermal impacts.
3. More credits can be considered if on a coldwater fishery resource.
4. Must result in increased recharge to get credit.
5. No benefit = 0 credits; Indirect benefit/improvement = 5 credits; Direct benefit/improvement = 10 credits

Section 4 - Optimization of Existing Sources and Evaluation of Alternative Sources

The Sustainable Water Management Initiative (SWMI) Permitting Framework requires any Water Management Act (WMA) permit application for a withdrawal in a Groundwater Withdrawal Level (GWL) 4 or 5 subbasin to develop a plan to minimize the impact of the existing withdrawal on streamflow and aquatic habitat to the greatest extent feasible considering cost, improvement expected, and the practicality of implementation. As part of this plan, the public water supplier (PWS) must evaluate optimization of existing resources and the use of alternative sources. This Section identifies analytical tools and data requirements for source optimization and the evaluation of alternative sources.

Sections 4.1 through 4.3 offer an overview of the potential tools and information that water system operators can gather and consider when preparing a desktop pumping evaluation or source optimization evaluation. Section 4.4 presents guidance on ranking existing and alternative sources.

4.1 Source Optimization/Desktop Pumping Evaluation

Source optimization evaluations are intended to identify operational changes to minimize impact on subbasin streamflow. The PWS would use a Desktop Pumping Evaluation to assess whether the impact of the withdrawal on the streamflow in the subbasin can be decreased by modifying well withdrawal operations without significantly altering the PWS's ability to feasibly meet demand.

In addition to the general requirement for source optimization, the SWMI Framework specifies that where a GWL4 or 5 subbasin also contains a Coldwater Fishery Resource (CFR), the evaluation must include a "Desktop Pumping Evaluation" and consultation with agencies to minimize the impact of withdrawals on the CFR.[1] In developing the pilot project, the study team has recognized that the source optimization process essentially consists of a desktop pumping evaluation. Therefore, in subbasins with CFRs, the required "source optimization/desktop pumping evaluation" simply introduces the minimization of impact on CFRs as an additional criterion for the evaluation.

[1]The Massachusetts Division of Fish and Wildlife (MassWildlife) defines a CFR as a stream that meets at least one of the following criteria:

1. Brook, brown or rainbow trout reproduction has been determined.
2. Slimy sculpin, longnose sucker, or lake chub are present.
3. The water is part of the Atlantic salmon restoration effort or is stocked with Atlantic salmon fry or parr.

MassWildlife has identified streams considered CFRs based on annual fish samples. As of 2011, nearly 900 streams had been identified as CFRs throughout the Commonwealth. This list continually evolves as new fish sampling is done each year. The list of identified CFRs is available on the SWMI Interactive Map, Revised November 27, 2012; however, it is not available as a MassGIS datalayer.

The SWMI Framework does not provide guidance for how to perform Source Optimization/Desktop Pumping evaluations. However, as articulated in the SWMI Pilot Phase 2 Scope of Work and discussion with agencies during the study, the EEA agencies do not intend these evaluations to involve groundwater modeling or fieldwork. In addition, the optimization evaluations are intended to:

1. Include an evaluation of the potential to preferentially pump wells near enough to surcharged streams to take advantage of induced infiltration.
2. Assess withdrawals between subbasins, and not between individual wells within a subbasin, unless a CFR is present.

4.2 Data Collection for Source Optimization

As noted above, the desktop pumping evaluation focuses on review of existing information, and does not require additional modeling or field work. The type and level of detail of available information will vary by water supply. Some water systems will have detailed background information about all of their water supply wells including test data, water quality analyses, yield information, and withdrawal and drawdown histories. Other systems may only have basic information such as a well log and well construction detail. This section of the report provides a general methodology that captures common data and data sources that may be available and relevant to review PWS operations as they relate to the SWMI Framework. The data sources can be divided into three main categories: regulatory and environmental information, well and aquifer characteristics, and operational information.

4.2.1 Regulatory and Environmental Information

Regulatory and environmental information will determine the required level of analysis of the potential impacts and mitigation of the water withdrawal. Regulatory information includes data required to determine the SWMI criteria and designated permit review tier for the subbasin(s) in which the PWS has groundwater withdrawals. Regulatory and environmental data and data sources are summarized in Table 4-1. The subbasin flow data (Items 5–9) are nested data, meaning that they represent cumulative withdrawals and discharges from within the subbasin and upstream subbasins.

Table 4-1. Regulatory Data Sources

Item	Parameter	Source
1	Subbasin ID	SWMI Interactive Map
2	Biological Category (BC)	SWMI Interactive Map
3	Groundwater Withdrawal Level (GWL)	SWMI Interactive Map
4	Cold Water Fisheries (CFR) Designation	SWMI Interactive Map/MassWildlife
5	Unaffected August Flow (mgd)	USGS MWI Report
6	August WMA Groundwater Withdrawals (mgd)	USGS MWI Report
7	August Private Well Withdrawals (mgd)	USGS MWI Report
8	August Septic and Groundwater Discharge Permit Returns (mgd)	USGS MWI Report
9	August NPDES Discharges (mgd)	USGS MWI Report
10	Location of water resources	MassGIS
11	Streamflows of adjacent waterways	USGS gauging stations

4.2.2 Water Supply Source Information

The PWS will need to gather information for each groundwater supply well and surface water reservoir within the PWS's system. Tables 4-2 and 4-3 summarize the data required and potential sources of information for groundwater sources and surface water sources, respectively.

Table 4-2. Well and Aquifer Characteristics Data Sources

Item	Parameter	Source
1	Well Location	MassGIS/PWS
2	Existing groundwater withdrawals	ASRs
3	Distance from stream	MassGIS/ Survey
4	Distance and location within watershed from waterbodies	MassGIS
5	Authorized withdrawals	WMA Permit/ Registration Statement/ IBTA Authorization
6	Average monthly withdrawal	ASRs
7	Pump depth/pump capacity	Well logs
8	Well type	Well logs
9	Pumping operation including pump size	Well logs/Pump test report
10	Well yield	Pump test report
11	Specific capacity	Pump test report
12	Static water level	Pump test report
13	Pumping water level	Pump test report
14	Drawdown	Pump test report
15	Cone of depression	Pump test report
16	Zone II Delineation	Pump test report
17	Residual drawdown	Pump test report
18	Well recovery time	Pump test report
19	Watershed area	Zone II Delineation
20	Groundwater levels	USGS sources (http://waterwatch.usgs.gov/?m=real&r=ma; http://groundwaterwatch.usgs.gov/StateMaps/MA.html)/ Pump test reports / Monitoring well data
21	Water quality	Water monitoring reports
22	Aquifer characteristics including size, depth, confining layers, transmissivity, storativity	Zone II Delineation Report/ Groundwater Hydraulic Analysis
23	Pumping impacts to adjacent water resources	Pumping Test Reports
24	Rainfall recharge rate	Zone II Delineation Report

Table 4-3. Surface Water Supply Characteristics Data Sources		
Item	**Parameter**	**Source**
1	Surface water supply location	MassGIS/PWS
2	Authorized withdrawals	WMA Permit/ Registration Statement/ IBTA Authorization
3	Average monthly withdrawal	ASRs
4	Pump capacity	Pump test report
5	Firm yield	USGS Factors Affecting Firm Yield and Refinement of Firm Yield Estimator Reports/System specific studies
6	Watershed area	Streamstats
7	Water quality	Water monitoring reports

4.2.3 Operational Data

Each PWS takes into consideration multiple variables in determining the optimal operation of its system. The SWMI Framework requires the PWS to also account for the additional variables of CFR and streamflow impacts. Potential operational factors and data sources are summarized in Table 4-4.

Table 4-4. Operational Data Sources		
Item	**Parameter**	**Source**
1	All sources within the PWS, including Groundwater and Surface Water sources	MassGIS/PWS
2	Surface water supply characteristics, including firm yield, water quality, treatment needs	PWS
3	Available interconnections including potential for increasing purchases through interconnections and costs of purchased water	PWS
4	Treatment requirements	Water quality reports/PWS
5	Seasonal demand needs	ASRs
6	Facility requirements for increased withdrawals	PWS/CIP
7	Staffing constraints	PWS
8	System component energy needs (pumping/treatment)	PWS
9	System component operational costs (chemical, energy, staff)	PWS

Operational decisions can have a significant impact on capital costs as well as operational costs. Cost information may not be readily available for capital expenditures that may be required to alter the water supply operations. However, a PWS can determine relative costs of alternatives considered.

4.3 Optimization/Evaluation Methodology

The following methodology applies to the collected data to assess the PWS's use of its sources to meet SWMI objectives: optimization of withdrawals to minimize impacts on CFRs and streamflow. The SWMI Framework generally requires preference for withdrawals that meet one or more of the following criteria:

- Use surface water storage.
- In a CFR, withdraw from wells with less direct impact on streamflow during low flow periods.
- Withdraw from basins with larger natural median August flow such that the percent alteration resulting from the withdrawal is minimized (unless the change in withdrawal would result in an increase in the established GWL).
- Withdraw from wells with less direct impact on streamflow during low flow periods.

The desktop pumping analysis/source optimization analysis proceeds in phases:

- Phase 1 assesses the water supply sources with respect to the SWMI Framework priorities
- Phase 2 assesses the capability of the water supply sources to support the additional withdrawal, based on authorized withdrawals, pumping capacity, treatment capacity and aquifer characteristics
- Phase 3 assesses operational and financial constraints to increasing withdrawals
- Phase 4 assesses the potential to tap other sources to supplement the groundwater sources, including surface water supplies and interconnections.

4.3.1 Phase 1 Assess sources with respect to the SWMI Framework

The optimization process should rank the PWS's groundwater supplies in preferential order for pumping during low flow periods based on the SWMI Framework criteria described below.

Determine withdrawal impact on CFR

The impact of the withdrawal from a well is considered to be directly proportional to the proximity of the well to the waterbody designated as a CFR. The analysis should assess each groundwater well for its proximity to a CFR, location in relation to the headwaters of the CFR, and if the well is located upgradient of an impoundment. The ranking should give preference to a withdrawal located outside of a subbasin with a CFR. If that is not possible, then preference should be given to a well(s) furthest from the CFR, or furthest downstream within the watershed, or upgradient of a large impoundment. The wells closest to the CFR, closest to the headwaters or not in proximity to an impoundment should be considered for decreased pumping during the summer low flow period.

Compare subbasin August flows

Subbasins with a higher unaffected August flow will be better able to absorb a withdrawal than basins with a lower August flow. The analysis should compare estimated

unaffected subbasin streamflows and give preference to increasing withdrawals in subbasins with the highest August flow. The MWI Report, Table 1-2. "Water-use information for Massachusetts stream basins" provides estimates of the unaffected August outflow for each subbasin.

Determine if a subbasin is surcharged

A surcharged stream has flow that is positively impacted (with regards to water quantity) by wastewater returns from both groundwater and surface water discharges. To determine if a subbasin streamflow is surcharged, the PWS should use the following equation to estimate the surcharge factor:

$$surcharge\ factor = \frac{estimated\ unaffected\ subbasin\ streamflow - withdrawals + wastewater\ discharges}{estimated\ unaffected\ subbasin\ streamflow}$$

If the surcharge factor is greater than 1, then the subbasin is surcharged. As the August low flow period is the prime season of concern, the data for August should be used. The MWI Report, Table 1-2. "Water-use information for Massachusetts stream basins" provides estimates of withdrawals, wastewater discharges and estimated unaffected August outflow for each subbasin.

The optimization analysis should give preference to withdrawals during low flow periods from subbasins with highest August flow accounting for surcharge.

Determine withdrawal impact on subbasin GWL and BC

A main goal of SWMI is to maintain healthy watersheds and minimize backsliding. The evaluation of alternative withdrawal operations should include a determination of whether the alternative results in backsliding. The following methodology should be used to assess whether an additional withdrawal from wells within a subbasin will result in backsliding to a higher GWL or BC.

Although there are several factors that influence streamflow beyond water withdrawals, optimizing operation of the existing sources to minimize the percent streamflow alteration is one method to minimize and offset the impacts of withdrawals. The following sections provide a methodology for assessing the impact of a PWS's withdrawals on a subbasin's GWL and BC designations.

GWL Designations

The SWMI Framework designates the Subbasin GWL based on the percent alteration of unaffected August median flow due to groundwater withdrawals. The SWMI Framework determines the natural or unaffected flow using the USGS Sustainable Yield Estimator (SYE).

SWMI determines the percent alteration of August median flow by dividing the Total Estimated August withdrawals (Estimated Groundwater Withdrawals and Estimated

Private Well Withdrawals) by the August unaffected flow, which presumes a 1:1 relationship between withdrawals and streamflow reduction. Based on a relationship between percent alteration and Biological Categories (BCs), SWMI establishes GWL classifications presented in Table 4-5.

Table 4-5. Groundwater Withdrawal Level (GWL) Determination

GWL	Alteration of Unimpacted August Median Flows Due to Groundwater Withdrawal
1	0 to <3%
2	3 to <10%
3	10 to <25%
4	25 to <55%
5	≥ 55%

The following methodology allows PWS to determine the available flow within each subbasin that can be withdrawn without increasing the subbasin's GWL designation (backsliding). Consistent with the SWMI methodology, the evaluation should be performed at a subbasin level.

Step 1 – Data Collection

Of the sources listed in Table 4-1 (Regulatory Data Sources), the PWS should use the following data sources (at a minimum) to evaluate the available withdrawals within each subbasin at its current GWL designation.

- SWMI Interactive Map
- USGS Indicators of Streamflow Alteration Report (MWI Report)

From these sources, pertinent information for each watershed includes:

- Subbasin
- Subbasin GWL Designation
- Subbasin GWL Max % Alteration
- Est. August Unaffected Streamflow (U)
- Est. August Groundwater Withdrawals (mgd)
- Estimated August Private Well Withdrawals
- Total August Groundwater Withdrawals

Step 2 – Identify subbasin location(s) and current subbasin GWL

Using the online SWMI Interactive Map, identify the subbasin that each withdrawal point is located in and note the subbasin's current GWL designation. Identifying the subbasin that each source is located in is important as the SWMI model and the following methodology evaluates withdrawals on a subbasin level.

Step 3 – Determine Available Withdrawals within the Subbasin at Current GWL Designation

The PWS should use the following equation to estimate available withdrawals, without resulting in backsliding:

*Maximum Available Subbasin Withdrawals = (% Alteration for Current Subbasin GWL Designation * Estimated August Unaffected Streamflow) - (Total Estimated August Groundwater Withdrawals)*

To complete this equation, use the following data:

- Current GWL designation (see Step 2)
- *% Alteration of Unimpacted August Median Flows for Current Subbasin GWL Designation* (use maximum % alterations from Table 4-5)
- *Estimated August Unaffected Streamflow* and *Total Estimated August Groundwater Withdrawals* (USGS Indicators of Streamflow Alteration (MWI Report) Appendix 1, Table 1-2.)

Obtain the Estimated August Unaffected Streamflow (U) from Table 1-2 of the MWI Report, referring to the worksheet tab entitled "Aug, all basins", in the "Estimated August Unaffected Streamflow (U) (ft^3/s)" column. Convert the value from ft^3/s to mgd by multiplying the value by 0.6463. Also obtain the Total Estimated August Groundwater Withdrawal values used by SWMI for each subbasin, from the same MWI Report Table. Note the August Groundwater Withdrawal values need to account for both estimated groundwater withdrawals from PWSs and private wells. Therefore, sum the reported "Estimated August Groundwater Withdrawals (Mgal/d)" and "Estimated August Private Well Withdrawals (Mgal/d) to determine the Total Estimated August Groundwater Withdrawals (mgd) value for use in the above equation.

The resulting value represents the available withdrawals (mgd) remaining within the subbasin that will not result in the subbasin backsliding to a higher GWL.

Step 4 – Compare Available Withdrawals by Subbasin and Incorporate Results into Source Optimization Plan

As long as the PWS withdraws less water than that which is available at the subbasin's current GWL designation, the GWL designation will not backslide. The PWS's optimization plan should give preference to withdrawals from basins that meet this criterion.

BC Designations

The PWS can identify the current subbasin BC designation using the on-line SWMI Interactive Map. The SWMI Framework designates the Subbasin BC based on the percent alteration of the range of fluvial fish relative abundance. As described in the Final SWMI Framework, the BC determination is based on a model developed by USGS which established the relationship between fluvial fish relative abundance and variations in flow, percent of impervious cover, and natural basin characteristics (drainage area,

channel slope, percent sand and gravel). The SWMI Framework establishes each BC classification, presented in Table 4-6, to correspond to different fluvial fish relative abundance with changes in flow and/or impervious surfaces.

Table 4-6. Biological Category (BC) Determination

BC	Biological Alteration
1	<5%
2	5 to <15%
3	15 to <35%
4	35 to <65%
5	≥ 65%

It is anticipated that a publically available tool for calculating BC based on the above variables will be available prior to promulgation of SWMI related regulations. The PWS's optimization plan should give preference to withdrawals from basins that do not result in backsliding of the subbasin's BC designation.

Assess well specific information for documented impact or lack of impact on adjacent resources

For purposes of the Source Optimization/Desktop Pumping evaluation, it is assumed that a well in closer proximity to a stream or CFR will have a greater impact than a well located farther away, unless the results of site specific analyses, such as pump tests, indicate otherwise. Therefore, assessment of whether withdrawal operations can be optimized to minimize impact to streams or CFRs requires examining available well-specific information for documented impacts (or documented lack of impact) on adjacent resources. For example, the PWS could review the results of pump tests (if available) to assess whether the withdrawal has an impact on adjacent water resources. If pump test results indicate that a well has a direct impact on a CFR or other water resource, then the preference ranking of the well would decrease. If pump test results or other analyses indicate that the well is in a confining aquifer and does not impact a nearby CFR or other water resource, then the preference ranking of this well would increase.

4.3.2 Phase 2 Assess the capability of the water supply source to support the additional withdrawal

The results of the Phase 1 assessment identify the preferential use of groundwater sources based on SWMI Framework criteria, without consideration of other well-specific factors. Phase 2 of the source optimization/desktop pumping analysis includes an evaluation of the capability of the water supply source to support the additional withdrawal, based on authorized withdrawals, pumping capacity, treatment capacity and aquifer characteristics.

Compare the proposed withdrawal to the authorized withdrawal

The PWS should compare the current withdrawal from the groundwater supply sources within each subbasin to the Authorized Withdrawals from the WMA Registration Statements, WMA Permits, and Interbasin Transfer Authorizations. Any proposed

increase in withdrawals from the groundwater sources will need to remain within the authorized withdrawals. This could restrict the use of sources identified as "preferred" under Phase 1.

Compare the proposed increased withdrawal to the pumping capacity

The use of a groundwater source may be restricted by the capacity of its pumps. The PWS should compare the proposed increased pumping rate to the rating of the existing pump to confirm if the infrastructure exists to pump at the proposed rate. Also, if the pumping rate increases, the Zone II may be required to be increased. If a Zone II is required to be expanded, there may be issues with respect to land ownership and land use.

Compare the proposed increased withdrawal to the treatment capacity

The PWS should review records to identify potential water quality issues with the use of the groundwater source. If the source is treated, then the capacity of the water treatment infrastructure should be assessed to confirm that it can treat the potential increased withdrawal.

Identify other aquifer characteristics that may impact the well capacity

The PWS should identify if there is other well-specific or aquifer-specific data that may influence consideration of the supply for increased withdrawal. Concerns may include safe yield, recovery period, or well efficiency. These concerns should be identified when considering the source for increased withdrawal.

Optional Information regarding USGS Modeling Tools:

While the desktop pumping analysis is meant to be completed without the use of modeling, there are a few computer models available that may be considered by the Massachusetts Department of Environmental Protection (MassDEP) or the PWS to further evaluate the potential impacts of altering existing operations. These models are briefly described below.

MODFLOW is the U.S. Geological Survey's three-dimensional finite-difference groundwater model first published in 1984. Although originally conceived solely as a groundwater-flow simulation code, MODFLOW's modular structure has provided a robust framework for integration of additional simulation capabilities that build on and enhance its original scope. The family of MODFLOW-related programs now includes capabilities to simulate coupled groundwater/surface-water systems, solute transport, variable-density and unsaturated-zone flow, aquifer-system compaction and land subsidence, parameter estimation, and groundwater management.

MODOPTIM is a non-linear ground-water model calibration and management tool that simulates flow with MODFLOW-96 as a subroutine. Water levels, discharges, water quality, subsidence, and pumping-lift costs are the five direct observation types that can be compared in MODOPTIM. Differences between direct observations of the same type can be compared to fit temporal changes and spatial gradients. Water levels in pumping

wells, wellbore storage in the observation wells, and rotational translation of observation wells also can be compared.

GSFLOW was developed to simulate coupled groundwater/surface-water flow in one or more watersheds by simultaneously simulating flow across the land surface, within subsurface saturated and unsaturated materials, and within streams and lakes. Climate data consisting of measured or estimated precipitation, air temperature, and solar radiation, as well as groundwater stresses (such as withdrawals) and boundary conditions are the driving factors for a GSFLOW simulation. GSFLOW can be used to evaluate the effects of such factors as land-use change, climate variability, and groundwater withdrawals on surface and subsurface flow. The model incorporates well documented methods for simulating runoff and infiltration from precipitation; balancing energy and mass budgets of the plant canopy, snowpack, and soil zone; and simulating the interaction of surface water with groundwater, in watersheds that range from a few square kilometers to several thousand square kilometers, and for time periods that range from months to several decades. An important aspect of GSFLOW is its ability to conserve water mass and to provide comprehensive water budgets.

The Web-Based STRMDEPL08 evaluates four analytical solutions that simulate streamflow depletion by a nearby pumping well. The web-based version was written to provide an easier interface to the analytical solutions with more convenient units and simplified output. The four analytical solutions describe:

(1) pumping from an aquifer with a stream that fully penetrates the aquifer with no streambed resistance between the stream and the aquifer

(2) pumping from an aquifer with a stream that fully penetrates the aquifer with streambed resistance between the stream and the aquifer

(3) pumping from an aquifer with a partially penetrating stream with streambed resistance

(4) pumping from a leaky aquifer with a stream in the overlying aquitard (Hunt, 2003).

Model output is given as a table of days of pumping and streamflow depletion in cubic feet per second.

4.3.3 Phase 3 Assess operational and financial constraints to increasing withdrawals

The PWS should consider operational and financial constraints in the assessment of water supply sources. Operation considerations include age of the equipment and available staffing. Financial considerations include cost per million gallons of water produced and increased costs related to operational or capital needs to change existing operations. These costs would account for increased energy consumption or chemical usage, required for increased pumping or treatment requirements.

4.3.4 Phase 4 Assess the potential to use surface water supplies and interconnections.

Water suppliers may have an opportunity to actively select/operate their various supply sources to optimize withdrawals in order to reduce streamflow impacts, as withdrawals

from some wells may have a greater streamflow impact than others. Phases 1 through 3 described above assess withdrawals from wells. Phase 4 focuses on all other available water supply sources, including surface water supplies and purchasing water through existing interconnections.

Assess surface water supplies

Systems that operate a combination of surface water and groundwater sources sometimes have the opportunity to optimize the operation of existing sources by using groundwater withdrawals and storing water in reservoirs during higher flow periods and then using surface water from reservoir storage during critical low flow periods. Therefore, a PWS should assess the potential to withdraw water from the available surface storage during low flow periods. Surface water supplies should be assessed for the following factors:

- Authorized withdrawals
- Safe yield
- Water quality including available treatment capacity
- Pumping capacity
- Reservoir releases

These factors can be used to determine the viability of the surface water sources for increased withdrawal in the low flow period.

Assess interconnections

Similar to the approach for evaluating the operation of existing sources, the PWS should evaluate interconnections for the potential to supplement its supply. The donor PWS's sources will also need to be evaluated based on their relative streamflow impact with a focus on the ability to provide additional water without increasing the GWL or BC, or impacting CFRs.

Factors to be considered for assessing options for increasing purchased water from available interconnections include:

- Available infrastructure
- Available agreements (e.g., emergency only)
- Ability of donor PWS to supply additional water without backsliding GWL or BC in their water supply subbasins
- Water quality/treatment needs
- Cost per million gallons
- Impact to system operations
- Regulatory constraints, including donor PWS's authorized withdrawals, IBTA concerns

Each existing interconnection should be assessed to determine if the potential exists to increase purchased water without affecting the subbasins of the interconnection PWS.

4.4 Ranking Existing and Alternative Sources

Water suppliers may have an opportunity to actively select/operate their various supply sources to optimize withdrawals in order to reduce streamflow impacts, as withdrawals from some wells may have a greater streamflow impact than others. Using the above methodology, a PWS should evaluate all available sources and develop a rank of water supply sources to be used during low flow periods to minimize impacts on CFRs and streamflow. Furthermore, this analysis should rank alternative sources that are less environmentally harmful. Less environmentally harmful is defined as a source that is in a GWL 1, 2, or 3 subbasin and does not cause that subbasin to change GWL. Withdrawals should be ranked preferentially from:

1. Subbasins with larger natural median August flow such that the percent alteration resulting from the withdrawal is minimized (except where the change in withdrawal would result in an increase in the established BC or GWL)
2. Subbasins in which streamflow is surcharged by discharges that exceed withdrawals
3. Subbasins that have existing capacity in their permitted withdrawals, pumping infrastructure and treatment infrastructure
4. Sources that have a reasonable cost per million gallons that can be borne by the rate payers
5. In a CFR, sources located furthest away from the CFR, further downstream in the subbasin, or upgradient of an impoundment that may minimize the impacts of the withdrawals

4.5 Pilot PWS Evaluation

The Phase 1 Pilot Study assessed the available water supplies for each pilot community for minimizing impacts by optimizing use of the existing sources. The above methodology captures the process that was used in these evaluations.

Section 5 Mock Permitting and Consultation Process

Under Phase 2 of the Sustainable Water Management Initiative (SWMI) Pilot Project, the Shrewsbury Water Department was selected to participate in a mock permitting exercise, including consultation sessions with the Executive Office of Energy and Environmental Affairs (EEA) agencies, to test the application of the SWMI Framework.

The consideration of potential withdrawal minimization and offset measures presented in the Pilot Project Phase 1 Report was advanced through the mock consultation process with Shrewsbury. This section documents the outcome of this non-binding permitting exercise including the SWMI-related permit conditions, feasible minimization and mitigation activities, and a possible implementation schedule for Shrewsbury.

5.1 Purpose

The purpose of the mock permitting exercise is to test the application of the SWMI Permitting Framework and its consultation process in a non-binding setting. The exercise is based on the mock conditions established for Shrewsbury during Phase 1 of the Pilot Project. Conditions include Shrewsbury Water Department requesting a total authorized withdrawal volume of 5.28 mgd from its six groundwater supply wells located in Subbasins 23002 and 23008 of the Blackstone River Basin. This volume request is 1.37 mgd above Shrewsbury's baseline of 3.91 mgd. The focus of the mock permitting exercise was to identify possible options for minimizing existing impacts and mitigating the impacts of this 1.37 mgd withdrawal request above baseline, consistent with Permit Review Tier 2 of the SWMI Framework.[1]

5.2 Summary of Consultation Meetings

The mock permitting exercise included three consultation sessions between the Shrewsbury Water Department and staff from the following EEA agencies: Massachusetts Department of Environmental Protection (MassDEP) Water Management Program, MassDEP Central Regional Office Drinking Water Program, Massachusetts Department of Conservation and Recreation (DCR) Office of Water Resources, and Massachusetts Department of Fish and Game Division of Fisheries and Wildlife (MassWildlife). Shrewsbury's drinking water consultant, Tata and Howard, Inc. of Marlborough, Massachusetts was also present during each of the consultation meetings.

Mock consultation sessions were held on October 17, 2012, October 31, 2012, and December 11, 2012 at the Shrewsbury Town Hall. Meeting summary notes from all mock consultation sessions are included in Appendix G.

The first consultation session provided an overview of the Pilot Project Phase 1 Report. The meeting also included a briefing on potential minimization activities, alternative

[1]Note: During Phase 1 of the Pilot Project, Shrewsbury was in Permit Review Tier 3 under the Draft SWMI Framework classifications; however, this changed to Tier 2 under the Final SWMI Framework classifications released during Phase 2.

sources, and mitigation activities applicable to Shrewsbury as taken from the Phase 1 Report.

The second and third mock permitting/consultation meetings further explored the feasibility of implementing these options for minimization, alternative sources, and mitigation. This evaluation included the amount of credit and associated costs, which are important decision factors for Shrewsbury to select appropriate options.

During these sessions, consultation participants discussed methods for crediting various mitigation options. Participants critiqued some of the methods and values used in the Phase 1 report, specifically the large volume credits assigned to outdoor watering restrictions and stormwater bylaws. EEA staff in consultation with its consultants developed an alternative crediting system outside of and parallel to the consultation sessions. EEA presented this alternative crediting system at the third mock consultation session. The alternative crediting system uses a combination of direct volume reductions through demand management and groundwater recharge, with indirect credits based on a scoring system applied to meet the balance of the required mitigation. Refer to Section 3.0 for a full discussion of the alternative crediting system methodology.

Based on these consultation sessions and the revised crediting system, the consultation participants identified the following minimization and mitigation options for inclusion in Shrewsbury's mock permit:

Minimization: The following minimization options were identified for Shrewsbury:

- Minimization of Existing Impacts: No options were identified that would minimize existing withdrawal impacts on streamflow.
- Alternative Sources: No feasible alternative sources were identified that were less harmful to the environment.
- Minimization of Additional Withdrawal Impacts: Increased withdrawal from the Home Farm Wellfield was determined to be the most feasible alternative for obtaining Shrewsbury's increased withdrawal request considering streamflow impact, cost and ability to implement.

Mitigation: The following mitigation options were identified for Shrewsbury:

Demand management:

- Restrict outdoor watering to twice a week, rather than three days a week

Direct mitigation credits:

- Account for existing septic system returns
- Account for future wastewater recharge at the SAC site
- Account for recharge from past roof leader disconnections

Indirect mitigation credits:

- Implement stormwater bylaw
- Implement stormwater utility
- Implement MS4 requirements
- Implement I/I removal program
- Remove Poor Farm Brook Dam

The credits identified by this consultation process were not enough to mitigate Shrewsbury's withdrawal request "commensurate with impact." Shrewsbury would need to identify additional mitigation options to receive a permit for the full withdrawal request volume.

The remainder of this section discusses the mock consultation process and outcome in more detail.

5.3 Shrewsbury's Mock Permit

5.3.1 SWMI-Related Permit Conditions

The SWMI Framework bases the required level of minimization and mitigation on the Water Management Act (WMA) permit holder's permitting Tier, groundwater withdrawal level (GWL) and the withdrawal ask in relation to the baseline demand. The Baseline demand for a system is determined by the greater of the 2003–2005 annual average demand plus a growth factor of 5% or the 2005 actual demand plus a growth factor of 5%. Furthermore, the baseline cannot be lower than the system's existing registered volume or higher than the existing total authorized volume. In addition, the baseline demand cannot be more than the DCR's 20-year demand projection for the community. Table 5-1 illustrates the baseline demand calculation for Shrewsbury.

Table 5-1. Shrewsbury – Baseline Demand

Item	Quantity (mgd)
Registered Volume	2.64
Total Authorized Volume	3.91
DCR Projection	5.28
2003 Demand	3.51
2004 Demand	3.62
2005 Demand	3.89
2003 – 2005 Avg. Demand	3.65
2005 Demand + 5%	4.08
Proposed Baseline	**3.91**

As shown in the Table, Shrewsbury's Baseline demand is 3.91 mgd, as limited by the current Total Authorized Withdrawal volume. During Phase 1 of the Pilot Project, Shrewsbury elected to use a pilot withdrawal request equal to the full DCR projection of 5.28 mgd. This withdrawal request would be 1.37 mgd above Baseline, which is more than 5% of the unaffected August median flow in either subbasin from which Shrewsbury withdraws water. Because both of the subbasins from which Shrewsbury withdraws water are within the most impacted category, Groundwater Withdrawal Level 5 (GWL5), the additional withdrawal request would not cause the subbasins to "backslide." In addition, both of these subbasins also contain cold water fisheries (i.e., quality natural resources).

Shrewsbury's Pilot withdrawal request of 5.28 mgd results in a Tier 2 Permit Review under a mock permit application. Under the SWMI Framework, as a Tier 2/GWL 5 review with a quality natural resource in the subbasin, Shrewsbury is required to:

- Comply with applicable provisions of Standard Conditions 1-8
    1. Source Protection
    2. Firm yield for surface water supplies
    3. Wetlands and vernal pool monitoring (if applicable)
    4. Residential use less than 65 gallons/capita/day
    5. Unaccounted for water less than 10%
    6. Seasonal limits on nonessential outdoor water use
    7. Water conservation measures
    8. Offset Feasibility Study
- Minimize the impact of existing withdrawals on streamflow to the greatest extent feasible considering cost, level of improvement achievable and ability to implement.
- Minimize the impact of additional withdrawals on streamflow to the greatest extent feasible.
- Demonstrate that there is no feasible alternative source that is less environmentally harmful.
- Implement mitigation measures that are commensurate with impact of their increased withdrawals.

This mock permitting exercise implemented a consultation process to evaluate options and subsequently select those measures that would minimize the impact of existing withdrawals on stream flow and aquatic habitat to the greatest extent feasible, and provide mitigation commensurate with the impact from additional withdrawals.

5.3.2 Minimization of Existing Impacts

Under the SWMI Framework, all WMA permit holders with sources located in GWL4 or 5 subbasins must minimize existing flow impacts to the greatest extent feasible considering level of improvement, costs, the purview that is under the authority of the each permittee and the use of adaptive management approaches based on site specific conditions. Under this requirement, Shrewsbury would develop and implement a minimization plan that considers flow improvement and practicability. The minimization plan is intended to apply to sources within different subbasins and not between individual wells within a subbasin unless there is a coldwater fishery resource (CFR) present. The minimization plan should have little impact on overall system reliability or cost, but would provide a benefit of reducing potential withdrawal impacts on the environment.

The Phase 1 Pilot Report evaluated the following potential actions for inclusion in Shrewsbury's minimization plan:

Optimization of Groundwater Withdrawals. Figure 5-1 at the end of this section shows Shrewsbury's sources and the subbasins in which they are located (23002 and 23008). As reported in the Phase 1 report, Shrewsbury has limited opportunity to modify the operation of their existing sources to reduce the impact on streamflow and habitat. The Home Farm and Lambert Wells are located in a downstream subbasin to the Sewell Well and, therefore, withdrawals from these wells would theoretically result in less August flow alteration under the SWMI Framework model. These slight differences in theoretical streamflow depletion are not expected to equate to significant differences in fish habitat, particularly because of the attenuating effect of Lake Quinsigamond.

Purchase Treated Water from Worcester. This option was eliminated during the first mock consultation session as a feasible option because of issues related to the Interbasin Transfer Act (IBTA) across multiple basins. This option would be very difficult to permit, would require and depend on Worcester's participation in the permit process, and it would likely result in a permit requirement to make releases from its impoundments. In addition, the existing interconnection would require significant and costly additions and upgrades to be capable of transferring the water to Shrewsbury.

Purchase Treated Water from Boylston. Although there is an existing interconnection with Boylston and water has been purchased by Shrewsbury in the past, this option was eliminated during the first mock consultation session as a feasible option because Boylston indicated that it does not have excess supply.

Surface Water Releases. This option was eliminated during the first mock consultation session as a feasible option because there are no surface water impoundments located in Shrewsbury in or upstream of their source's subbasins from which releases could improve downstream flows.

In summary, Shrewsbury has no operational options to pump their existing wells in a seasonal pattern that would shift pumping in summer from wells in more highly impacted subbasins to those in less impacted subbasins. In addition, Shrewsbury has no feasible access to existing alternative sources or interconnections with less seasonal impacts, and no opportunities for surface water releases.

Minimization of Shrewsbury's existing withdrawal impacts will focus on meeting the WMA standard permit conditions of 65 residential gallons per capita daily water use and 10% unaccounted-for water, instituting nonessential outdoor water use restrictions seasonally, and implementing best management practices such as frequent leak detection, meter repair/replacement, and public education programs. Shrewsbury could also review the NEWWA Toolbox and consider any other practicable measures outlined that could reduce withdrawals or otherwise improve flows in their GWL5 subbasins.

5.3.3 Minimization of Impact from Additional Withdrawals

In addition to minimizing existing impacts, Shrewsbury must select an alternative for its additional withdrawal request that minimizes streamflow impact to the greatest extent feasible. The Phase 1 Report evaluated options for developing new alternative sources for

each of the Pilot PWSs. Figure 5-1 shows the locations of potential alternate sources and interconnections evaluated during Phase 1 and 2.

A brief summary of the alternative sources evaluated for providing Shrewsbury's additional requested supply is included below. More detail for each alternative is provided in the Phase 1 report.

Increased Withdrawal from Home Farm Wellfield – The total WMA authorized volume from Shrewsbury's existing sources is 3.91 mgd on an annual average basis. The approved maximum daily rate of the individual sources totals 9.81 mgd, but is restricted to a combined 7.87 mgd by a specific 5.4 mgd IBTA limit on maximum day withdrawals from the Home Farm Wellfield. This alternative consists of increasing the WMA annual withdrawal limit from existing sources to provide the additional 1.97 mgd requested by the Town. The resulting annual average permit limit would therefore be 5.28 mgd, still significantly below the sources approved maximum daily rate. If the resulting maximum daily demand approaches 7.87 mgd, an increase in the Town's IBTA permit would be required. However, Shrewsbury did not anticipate that an increase in the IBTA permit limit would be required during the requested WMA permit review period. A significant benefit of this alternative is that the infrastructure and source protection policies are already in place to provide the additional supply. The Home Farm Wellfield is located in a BC5/GWL5 subbasin so increased withdrawals will not result in backsliding. Lake Quinsigmond will help attenuate low flow impacts at the subbasin pour point.

Worcester's Shrewsbury Well. This well is owned by the City of Worcester and is located in a subbasin that is a GWL1; however, the proposed withdrawals from this well would cause the subbasin to backslide to a GWL5. Sampling during a pump test identified a water quality issue, with iron and manganese detected at levels above their secondary maximum contaminant levels.

Masonic Well Site. This potential well site is located in a subbasin in the Concord River Basin that is a GWL4. The only true benefit of this site would be to have a source that is outside of the Blackstone Basin and would not be an IBTA issue. However, preliminary testing indicated that wells on this site would be low yielding and the requested flow would increase flow alteration in the subbasin from 38% to 54%, just short of backsliding. The estimated capital costs for development of a new bedrock well was approximately $1 Million including test well exploration, installation of a production well, infrastructure, pump station, chemical feed system, electrical service, instrumentation and controls. In addition, the necessary land use article to develop wells on this property did not get approved at Town Meeting.

Oak Island Well Site. This potential well site is located in the same GWL5 subbasin as the Town's existing Home Farm and Lambert Wellfields. Water quality issues were identified during a pump test. Iron and manganese were both high and treatment would be required. Manganese treatment produces sludge, requiring consideration of additional space, disposal, and cost issues. The shallow aquifer (groundwater at 8') and proximity to Lake Quinsigmond also raise the concern that the well could be under the influence of surface water and therefore subject to the surface water treatment rule. In addition, MassDEP has rejected this site in the past because the 400' Zone I radius would extend to

private properties and to DCR's boat launch and parking lot. Property rights would also need to be obtained to travel and install infrastructure through the existing power easement for access to the well. A wellfield might be a more feasible option as this would reduce the Zone I radius to 250'; however, the cost, water quality and access issues would remain.

SAC Well Site. This potential well site is located in a subbasin that is a GWL2 that would backslide to a GWL5 if a well was installed to achieve the proposed additional withdrawals. MassDEP also rejected the SAC site in the past due to the IBTA issue. The Town is still considering this site for use as a groundwater recharge site.

In summary, the consultation process identified increased withdrawals from the Home Farm Wellfield as the feasible alternative for providing the requested increased withdrawal that minimizes streamflow impact to the greatest extent feasible.

5.3.4 Demonstration of No Feasible Less Environmentally Harmful Alternative

As a Tier 2 Permit Review with a requested additional withdrawal more than 5% of unimpacted August median flow, Shrewsbury must also demonstrate that there is no feasible alternative source that is less environmentally harmful than the source(s) being permitted. Of the options evaluated for Shrewsbury only purchasing treated water from the surface water sources in Worcester or from the Massachusetts Water Resources Authority (MWRA) were determined to be from a source that is less environmentally harmful. During the mock consultation process, the Worcester Interconnection option was determined to be infeasible due to cost and permitting constraints as described above and in the Phase 1 report. The MWRA interconnection option would be easier to permit under the IBTA than Worcester, but was also considered infeasible due not only to MWRA's rates and buy-in fee, but also the technical and financial constraints to providing needed delivery infrastructure through the Towns of Southborough and Northborough (see Phase 1 report).

5.3.5 Mitigation

During the Phase 2 Pilot Project, EEA developed an alternative mitigation crediting system, which is presented in Section 3.0. Following this crediting system, the SWMI Framework would require Shrewsbury to develop a Mitigation List and a Mitigation Plan to show how it will mitigate its withdrawal request above baseline commensurate with impact. The Mitigation List will include the mitigation options available, and credits to be received if implemented, in order to cover the entire withdrawal volume request above baseline. Shrewsbury may not have to implement all mitigation measures on this Mitigation List, because the anticipated permit would only stipulate implementation to meet actual demand.

The Mitigation List will specify a combination of demand management actions, direct mitigation actions (credited on a volumetric basis) and indirect mitigation actions (credited using a credit system representing non-volumetric environmental/habitat improvements) that the PWS has demonstrated are feasible.

EEA has established that demand management is the highest priority during permitting because it is often the most cost-effective and environmentally sound strategy for balancing water supply demands and streamflow protection. Therefore, in its crediting system, EEA provides for PWSs to receive credit through three options in order of preference: demand management, direct mitigation measures, and indirect mitigation measures.

To meet the mitigation requirements of its mock permit conditions, Shrewsbury must develop a Mitigation List which will include a combination of feasible direct and indirect mitigation actions whose credits will provide offset for the 1.37 mgd withdrawal request above Baseline. In addition, Shrewsbury could develop a Demand Management Plan to estimate the volume reduction expected to be achieved through demand management measures that have been (or will be) implemented.

This section describes the specific actions and corresponding credits identified as feasible for Shrewsbury during the mock consultation process.

5.3.5.1 Demand Management

The Town of Shrewsbury has been implementing demand management and conservation activities for a number of years. These include:

- Implementation of outdoor water restrictions when a State of Water Supply Conservation or a State of Water Supply Emergency is declared. Shrewsbury requires odd/even watering, with no watering on Mondays, between May and September.
- Application of a conservation fee to developers with new development connecting to the water supply. The fee pays for conservation kits, including pistol grips, faucet aerators and low flow showerheads that are handed out to the public. The fee also pays for water conservation education materials. Shrewsbury does not operate a rebate program.
- Application of conservation rates for both residential and commercial customers. All customers are billed quarterly.
- Ongoing implementation of a program to upgrade customer meters to radio-read. Approximately one third of Shrewsbury's customers are metered with radio-read devices.

During Phase 2 of the Pilot Project, Shrewsbury analyzed the reduction in demand experienced in Town since implementation of its outdoor watering restrictions. EEA reviewed the information and agreed that 0.15 mgd was a credible estimate for volume saved with the implementation of one day less watering, and 0.25 mgd with two days less watering (if the Town should choose to implement this demand management measure).

EEA also acknowledged Shrewsbury's proposed efforts to continue to expand the use of radio-read meters in Town. Although future savings may be difficult to estimate for such a demand management action, EEA has stated it would consider credit requests based on credible estimates of potential savings.

The total estimated savings identified during the mock consultation process from demand management equals 0.15 mgd.

5.3.5.2 Direct Mitigation

Direct mitigation credits available for Shrewsbury include existing septic system returns, future wastewater recharge at the SAC Site, and recharge from its roof leader disconnection program. Existing septic system returns will be credited at 100% for those systems located within and upstream of the source subbasin and within the Town. The calculation for qualifying systems in Shrewsbury equals 0.048 mgd.

The SWMI Framework will provide credit for future wastewater returns based on the volume returned, with application of location adjustment factors presented in Table 5-2. Minimal additional credit is anticipated from future installation of new septic systems. Shrewsbury has potential future wastewater credit from use of the SAC site for treated wastewater returns. Figure 5-2 at the end of this section shows the application of these location adjustment factors for the Town of Shrewsbury. The Phase 1 report listed the recharge volume provided for the SAC Site as 0.3 mgd. This volume could be credited at 100% due to the location of the site upstream of the source subbasin's pour point. However, any recharge within or upstream of the sources' subbasin would be subject to water quality considerations.

Table 5-2. Location Adjustment Factors for Mitigation Credits [1]

Location of Mitigation	Adjustment Factor
Within or upstream of subbasin or within the Zone II	100% [2]
Within the Major Basin	50%
Outside of the Major Basin	10%

[1]These location adjustment factors are for mitigation actions implemented within the Town boundaries.
[2]Subject to Water Quality Consideration.

Shrewsbury can also obtain credits from past redevelopment and recharge projects. The recharge credit would be subject to the same location adjustment factors presented in Table 5.2. The recharge volume associated with past roof leader recharge projects as outlined in the Phase 1 Report, but with the revised location adjustment factors applied, is 0.001 mgd. Shrewsbury has also required more recharge on redevelopment projects; however, the information was not available for the Phase 1 or 2 Report. Shrewsbury can provide this information in the future for additional mitigation credit.

The total direct mitigation credits identified equal 0.349 mgd.

5.3.5.3 Indirect Mitigation

As described in Section 3.0, indirect mitigation credits are based on a point system, rather than a volumetric credit system (see Table 3-3). The volume requiring indirect mitigation

is calculated by subtracting the estimated demand management and direct mitigation volumes from the request above baseline. For Shrewsbury, this means a volume of 0.871 mgd must be mitigated through indirect measures, computed as follows:

Withdrawal request above baseline	1.370 mgd
Demand management estimate	- 0.150 mgd
Direct mitigation	- 0.349 mgd
Volume to offset by indirect mitigation	0.871 mgd

The unaffected August median flows for the subbasins from which Shrewsbury withdraws water are 3.95 mgd (Subbasin 23002) and 0.93 mgd (Subbasin 23008). This volume of 0.871 mgd represents 22% and 94% of the unaffected August median flow of the subbasins, respectively. The volume is greater than 5% of the August median flows; therefore, according to the indirect mitigation credit system, Shrewsbury must achieve 180 credits from indirect mitigation measures.

The Pilot Project identified several indirect mitigation measures that Shrewsbury could implement to receive credit based on benefits or improvements to streamflow, aquatic habitat, and water supply protection. These measures include:

- passing a stormwater bylaw in Town (10 credits),
- establishing a stormwater utility in Town (10 credits),
- complying with MS4 requirements (10 credits),
- implementing I/I removal activities (5 credits), and
- removing the Poor Farm Brook Dam (25 credits).

These measures provide a total of 60 indirect credits. This leaves 120 credits that Shrewsbury would need to be achieve through additional indirect mitigation measures.

5.3.5.4 Total Mitigation Credits

Table 5-3 summarizes the mitigation options and credits identified for Shrewsbury during the mock consultation process. As explained above, based on the volume credits identified for demand management and direct mitigation, Shrewsbury would have to achieve 180 credits via indirect mitigation measures. However, only 60 credits worth of indirect measures were identified during the mock consultation process. Shrewsbury could explore achieving the remaining 120 credits through additional indirect mitigation measures such as culvert replacements, streambank restoration, and other habitat improvement projects.

Table 5-3. Shrewsbury Mock Mitigation Options and Credits	
Measure	**Credit**
Demand Management	
Outdoor watering restriction of 2 days/week	0.15 mgd
Demand Management Total	**0.15 mgd**
Direct Mitigation	
Existing septic system returns	0.15 mgd
Wastewater recharge at SAC Site	0.3 mgd
Recharge from roof leader disconnections	0.001 mgd
Direct Mitigation Total	**0.349 mgd**
Indirect Mitigation	
Implement stormwater bylaw	10 credits
Implement stormwater utility	10 credits
Implement MS4 requirements	10 credits
Implement I/I removal program	5 credits
Removal of Poor Farm Brook Dam	25 credits
Indirect Mitigation Total	**60 credits**

If additional indirect measures are not feasible, Shrewsbury would need to re-evaluate its suite of demand management and direct mitigation measures. The PWS could use the table in the indirect credit point system to show that 60 credits provides an offset of up to 0.3 mgd, leaving 0.571 mgd requiring mitigation (0.871 mgd – 0.3 mgd). Shrewsbury could offset this volume with additional demand management or direct mitigation actions. For example, some of this mitigation may be achievable by documenting the stormwater returns provided by recharge systems installed to serve recent redevelopment projects as described in Section 5.3.4.2. Shrewsbury would have to provide credible calculations of directly connected impervious surfaces that were redeveloped so stormwater from these surfaces now directly recharges the aquifer. Location adjustment factors would apply to this direct mitigation credit.

5.4 Shrewsbury's Mock Implementation Schedule

The SWMI Framework will be implemented through the WMA permitting process. MassDEP will revise the current WMA regulations to incorporate the new SWMI-related permit requirements including minimization and mitigation. The following outlines a proposed schedule for implementation of Shrewsbury's mock permit requirements for feasible minimization and mitigation.

5.4.1 Minimization

Shrewsbury should provide a Minimization Plan to MassDEP during the WMA permit application process. Under the SWMI Framework, Shrewsbury would submit this plan approximately 9 to 12 months in advance of the current permit expiration date. Shrewsbury's plan would include minimization actions contained in WMA Standard Conditions 1-8 as well as any additional actions from the NEWWA Toolbox that could help minimize impacts from existing withdrawals. Shrewsbury would then implement the Minimization Plan immediately upon receipt of an approved WMA permit. These actions

would not only minimize impacts but may also increase the length of time before withdrawals would exceed Shrewsbury's Baseline volume.

5.4.2 Demand Management

Shrewsbury should also provide a Demand Management Plan to MassDEP during the WMA permit application process, approximately 9 to 12 months in advance of the current permit expiration date. The plan would include a list of those demand management activities that Shrewsbury intends to implement as well as an estimate of the expected water savings for each activity. Shrewsbury's plan would include a revised outdoor watering restriction of 2-days per week (1 day less than what it currently allows) with an estimated water savings of 0.15 mgd. Shrewsbury would implement the Demand Management Plan immediately upon receipt of an approved WMA permit.

5.4.3 Direct and Indirect Mitigation

At the time of permit application or renewal, MassDEP will compare a PWS's total requested permit volume (based on a 20-year water needs forecast) to its Baseline volume. If the permit volume exceeds Baseline and requires mitigation, the PWS must develop a Mitigation List during the permit application process, to be included in the permit. The list will specify the combination of direct and indirect mitigation actions that the PWS has demonstrated are feasible and commensurate with the full volume by which the requested permit volume exceeds baseline.

When a permit is issued, it would stipulate that prior to pumping volumes that exceed baseline, the PWS will develop a detailed Mitigation Plan based on the Mitigation List, commensurate with the volume above Baseline that it anticipates needing during the permit term. The PWS would work with MassDEP to establish the required timeframe for completing mitigation activities. In most cases, the timeframe would require completion of such measures prior to increasing pumping. MassDEP would review the Mitigation Plan periodically over the permit term to ensure that mitigation occurs commensurate with increases over Baseline. The permit would require implementation of additional Mitigation Plan activities as required to keep pace with increases in demand above Baseline.

To the fullest extent practicable, the Mitigation Plan would prioritize direct mitigation measures, such as wastewater returns and releases from surface water impoundments, over indirect measures. If the full volume of anticipated withdrawals above Baseline cannot be mitigated with direct credits, the remainder would be mitigated through indirect credits, such as stream habitat improvements, measures to improve water quality, and measures to protect water supplies.

For Shrewsbury's mock permit-required mitigation, the community would provide a Mitigation List to MassDEP during the WMA permit application process, approximately 9 to 12 months in advance of its current permit expiration date. During the permit renewal process, Shrewsbury would estimate its expected demand over the first 5-year period of its permit, and if those demands are expected to increase withdrawals above Baseline, a Mitigation Plan will be submitted to MassDEP. The Mitigation Plan would

document those mitigation measures within the Mitigation List that will be implemented over the initial 5 years period. At the 5-year permit review, the PWS and EEA will again review the expected demands for the next 5-year period, and if necessary, prepare a Mitigation Plan for mitigation measures to be implemented during those next 5 years.

Under SWMI, the permit process will not require a PWS to implement mitigation actions until its projections show they actually need the increased withdrawal volume. A PWS should monitor water withdrawals over time, and prepare for mitigation activities when withdrawals are approaching, and can be expected to exceed, the Baseline volume.

5.4.4 Proposed Implementation Process

Table 5-4 presents a draft process for implementing minimization and mitigation options. The process is proposed to carry a PWS through the permitting process after it has determined its Permit Review Tier based on its withdrawal request above Baseline and the GWL of its subbasins.

Table 5-4. Draft Minimization and Mitigation Implementation Process

Step	Action
Step 1.	If Tier 1 Permit Review, PWS prepares and submits a Minimization Plan to MassDEP approximately 9 to 12 months in advance of the current permit expiration date. If Tier 2 or 3 Permit Review, PWS prepares and submits to MassDEP a Minimization Plan, a Mitigation List, a Mitigation Plan if required, and a Demand Management Plan (optional) identifying the selected feasible options and how they will be implemented. These items are to be submitted to MassDEP approximately 9 to 12 months in advance of the current permit expiration date.
Step 2.	PWS participates in the consultation process with the EEA agencies on the proposed minimization, mitigation, and demand management options/plans.
Step 3.	MassDEP issues a 20-year WMA Permit.
Step 4.	PWS implements the Minimization Plan and Demand Management Plan immediately upon issuance of the WMA permit.
Step 5.	If a Mitigation Plan was submitted for the first 5-year period, the PWS implements that Plan upon issuance of the WMA permit. If no Mitigation Plan was submitted for the first 5-year period, the PWS continuously monitors withdrawals and compares to the Baseline volume. - If monitoring indicates withdrawals are projected to exceed the Baseline volume, the PWS notifies MassDEP and consults with the EEA agencies to develop a Mitigation Plan to be implemented to offset withdrawals above the Baseline.
Step 6.	At the end of each 5-year period, MassDEP conducts 5-year permit review which will evaluate: - Effectiveness of demand management plan implementation - Projected demands for next 5-year period
Step 7.	If demand reductions are not observed as predicted in the demand management plan, additional mitigation requirements will be applied. If projected demands indicate withdrawals will further exceed the Baseline volume, the PWS works with MassDEP and EEA agencies to develop a new Mitigation Plan to be implemented to offset withdrawals for the next 5-years.

For most communities, the DCR prepares the 20-year Water Needs Forecast in 5-year increments. This information will give the community/PWS an estimate of when an actual increase in withdrawal volume may be needed. When drafting its Mitigation Plan, a PWS should account for the anticipated growth that will drive the demand increase. In addition, MassDEP conducts 5-year compliance reviews to ensure compliance with permit terms and conditions and the goals of the WMA program. During these 5-year reviews, MassDEP will review a PWS's current withdrawal volumes and its Water Needs Forecast, and evaluate the effectiveness of implemented minimization and mitigation actions to ensure that the SWMI-related permit conditions and goals are also being met.

While mitigation planning will begin during the permitting process, mitigation implementation will depend on increasing water use and when withdrawals are expected to exceed Baseline. PWS monitoring and regular agency reviews should ensure that mitigation is applied when needed and as appropriate.

5.5 Recommendations for Consultation Process

This section discusses issues identified during the consultation process, recommendations for addressing those issues, and other considerations.

5.5.1 Consultation Process Timeline

Community representatives participating in the mock consultation sessions expressed major concern throughout the process with the level of effort and time required on the part of Town and PWS staff to prepare for and participate in sessions. PWSs would benefit from a consultation process that starts well in advance of the permit expiration date and that provides adequate time between sessions for them to review and evaluate their SWMI requirements and their minimization and mitigation options.

The Final SWMI Framework states, "Between 12 and 9 months in advance of the basin expiration date, staff would schedule individual town consultation sessions for permittees with withdrawals that impact Quality Natural Resource Areas or GWL 4/5." Under this scenario, consultation sessions would be held over a 3 month period. Based on the number of meetings and the time between each of the meetings held during Phase 2 of the Pilot Project, three sessions held over three months would be adequate to address most permit requirements. Minimization and mitigation options will vary greatly for each permittee, so the Pilot Study team does not recommend setting a minimum or maximum number of consultation sessions. However, the team recommends completing the process within the three-month time frame.

5.5.2 Consultation Preparation

The Final SWMI Framework also states that an "Outreach Workshop" will be held 12-15 months in advance of basin permit expirations and that during subsequent individual consultation sessions, "A consultation session worksheet (to be developed) would have previously been discussed and distributed at the Outreach Workshop. This worksheet will include information permit holders will bring to, or at least be prepared to discuss at, their individual consultation session if one is required."

The Pilot Team highly recommends that EEA hold SWMI educational workshops and seminars throughout the state, open to all PWSs, to educate them on their SWMI-related requirements. Draft "consultation session worksheets" should be reviewed at these workshops in addition to the basin-specific "Outreach Workshops." The importance of providing as much information as possible in advance of consultation sessions cannot be stressed enough. Consultation sessions will be more productive if PWSs are aware of their requirements and come to the sessions prepared with information and data relevant to potential minimization and mitigation options.

5.5.3 DCR Projections and Effect on Withdrawal Requests

Throughout the Pilot Project, EEA stated that it does not agree with Shrewsbury's Pilot withdrawal request of 5.28 mgd. While this volume is equal to DCR's current Water Needs Forecast for the Town of Shrewsbury, EEA has said that this projection is no longer appropriate because it is based on older demand and population projections, and Shrewsbury's population and water demands have been declining.

MassDEP and EEA will need to address situations where the PWS's "ask" is larger than what EEA thinks the supplier needs. Guidance should be provided so that PWSs know what documentation is needed (e.g., commercial/business development growth projections) and would be accepted by DCR/EEA, to justify increased demand projections.

Presently, DCR is unable to calculate a new Water Needs Forecast for Shrewsbury because its unaccounted-for-water (UAW) is too high. MassDEP and EEA will need to address those situations where DCR cannot forecast demands for PWSs with high UAW, and provide guidance for how this will affect the volume a PWS can request above its baseline. The agencies should provide guidance on how the PWS can demonstrate need under this scenario.

5.5.4 Inability to Backslide from a GWL 5

If a PWS withdraws water from a BC5 or GWL5 subbasin, as most are, there is no "backslide" because this is the most impacted level. No matter what the withdrawal request is, some PWSs will never get to a Tier 3 Permit Review (highest level of review). The Watershed Groups have stressed their concern with this issue; however, the requirements for PWSs in a Tier2/BC5 or GWL5 Permit Review or a Tier 3 Permit Review are not that different, particularly if the withdrawal request is greater than 5% of the unimpacted August flow. Additionally, the EEA agencies have stressed throughout the process that the primary goal is to prevent worsening conditions rather than trying to get back to pre-colonial conditions. The Pilot Team recommends keeping the levels as they are rather than trying to modify the levels further.

5.5.5 Other Mitigation Measures

EEA should provide information on how it will address situations when a PWS proposes a mitigation action not listed on the existing SWMI offset/mitigation table.

5.5.6 Mitigation Implementation

Mitigation measures such as habitat improvements, stormwater improvements, or wastewater improvements will require significant resources and time for planning and implementation. In some cases, legal procedures and local legislative action will govern the feasibility and pace of implementation. For example, Shrewsbury explained that in the case of potential groundwater recharge at the SAC site, they would need to get Town Meeting approval for land purchase and land use. In addition, the community would need to provide significant education and outreach to the Town's citizens on the operation of such groundwater recharge facilities. Water ratepayers will want to know what effect/reduction in impact the required mitigation measures will have. All of these things will take time to implement and will need to be factored into the development of a Mitigation Plan.

EEA should consider development of guidance on the amount of preparatory work that needs to be completed for a mitigation measure, before the PWS can list that proposed measure as a "feasible" option on its Mitigation List, or advance the measure to its Mitigation Plan.

5.5.7 Commensurate Mitigation Unavailable

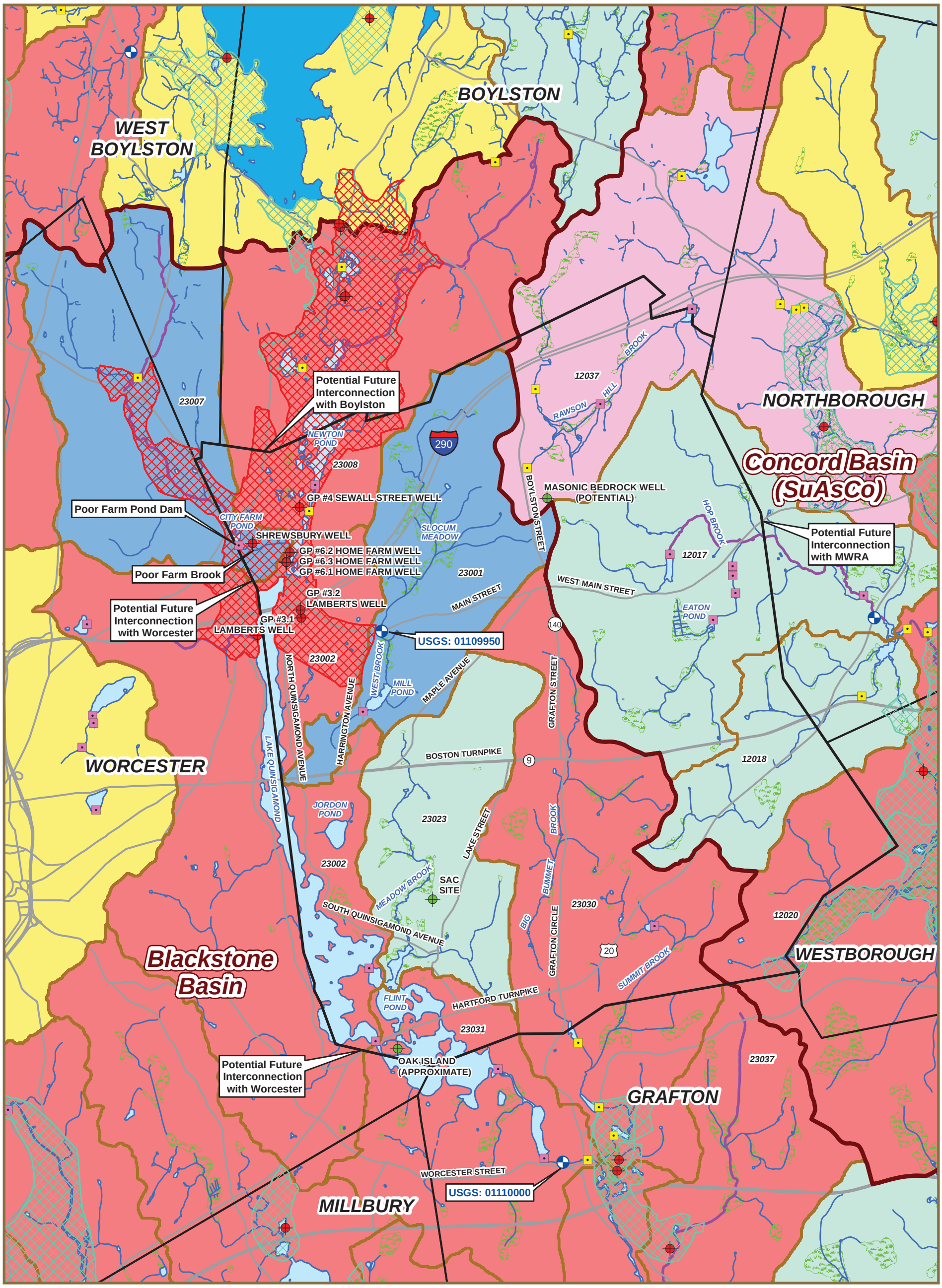
During the mock permitting exercise EEA and the Town of Shrewsbury were unable to develop a Mitigation List commensurate with impact from increased withdrawals utilizing the proposed SWMI methodology. Guidance is needed regarding how this situation would be handled during a real permit consultation.

5.5.8 Mitigation Timing

The SWMI Framework requires mitigation measures be implemented prior to increased withdrawals above baseline. Given the time required to design, permit, fund and implement several of the potential mitigation measures, flexibility is needed to provide for increases in demand while mitigation is being implemented. Timing of mitigation activity may also depend in some cases on formal action through the Town Meeting process. Flexibility regarding timing will be particularly true during the initial SWMI permit review period.

5.5.9 Sharing Mitigation Credit

EEA should consider development of guidance on how mitigation credits can be shared or divided between multiple WMA permit holders. Shrewsbury has expressed interest in removing the Poor Farm Dam; however, it would need to do it in partnership with the City of Worcester because although the dam is located in Shrewsbury, it is owned by Worcester. Under the proposed indirect mitigation credit system, 25 credits would be awarded for dam removal. Questions arose as to who would receive the credit and/or how those credits could be divided between Shrewsbury and Worcester.



LEGEND

- USGS Data Collection Station
- Community Groundwater Well
- Potential Community Groundwater Well

Dam Locations

- Private
- Public
- Shrewsbury Wellhead Protection Areas- Zone II
- Wellhead Protection Areas - Zone II
- Major Basin Boundary
- Subbasin Boundary

Groundwater Withdrawal Levels (GWLs)

- 1 0-3%
- 2 3-10%
- 3 10-25%
- 4 25-55%
- 5 >55%

Hydrography

- Pond, Lake
- Reservoir
- Wetland
- Stream, Brook
- Coldwater Fishery Resource
- Town Boundary

N W E S

0 1,500 3,000 4,500 6,000 7,500 Feet

0 0.25 0.5 0.75 1 Miles

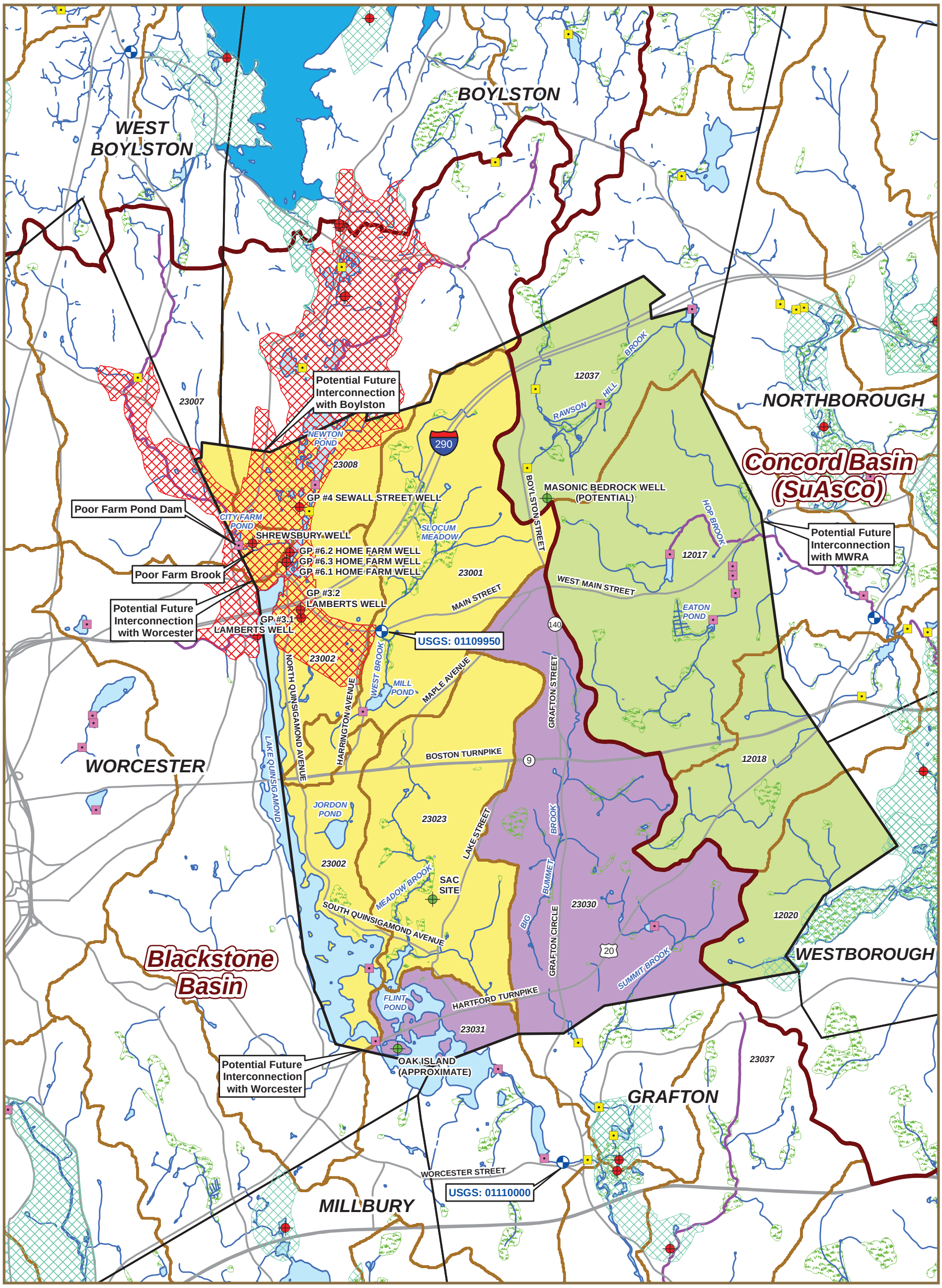
Massachusetts Department of Environmental Protection (MassDEP)
Sustainable Water Management Initiative (SWMI) Pilot Project

Figure 5-1
Existing and Potential Alternate sources

Shrewsbury, Massachusetts
December 2012

Comprehensive Environmental Incorporated

Tighe&Bond



LEGEND

- Community Groundwater Well
- Potential Community Groundwater Well
- USGS Data Collection Station

Dam Locations

- Private
- Public
- Shrewsbury Wellhead Protection Areas- Zone II
- Wellhead Protection Areas - Zone II
- Major Basin Boundary
- Subbasin Boundary

Mitigation Areas Relative to Withdrawal

- Within or Upstream of Subbasin - 100% Credit
- Watershed Basin - 50% Credit
- Out of Watershed Basin - 10% Credit

Hydrography

- Pond, Lake
- Reservoir
- Wetland
- Stream, Brook
- Coldwater Fishery Resource
- Town Boundary

N W E S

0 1,500 3,000 4,500 6,000 7,500 Feet

0 0.25 0.5 0.75 1 Miles

Massachusetts Department of Environmental Protection (MassDEP)
Sustainable Water Management Initiative (SWMI) Pilot Project

Figure 5-2

Location Adjustment Factors

Shrewsbury, Massachusetts
December 2012

Comprehensive Environmental Incorporated

Tighe&Bond

Section 6 Site-Specific Evaluations

Through the application of the USGS studies cited in Section 2, the Sustainable Water Management Initiative (SWMI) Permitting Framework categorizes subbasins into biological categories (BCs) and groundwater withdrawal levels (GWLs) (formerly referred to as flow levels or FLs). These categories help establish the level of mitigation that public water suppliers (PWSs) must achieve under the Water Management Act (WMA) permitting process. The Framework acknowledges that "The biological categories are based in part on a statewide model (using actual data) that has been scientifically peer reviewed and validated. However, the variables within the model are either measured from GIS large-scale overlays (impervious surface, watershed area, wetland area) or are themselves modeled (August flow alteration)." Therefore, during discussions with the Sustainable Water Management Advisory Committee, the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) and its agencies committed to establish a process within the Framework that provides the opportunity for a WMA permit holder to do site-specific evaluations of data inputs and its subbasin's streamflow and aquatic habitat conditions.

Where a WMA permit holder seeks an alternative approach for the sustainable management of its water resources, the SWMI Framework provides an option to demonstrate that local conditions may significantly differ from those reflected in the Framework. During Phase 2 of the Pilot Project, EEA identified two tracks by which site-specific evaluations could be conducted: Track 1) review/refine data inputs to the USGS Model; and Track 2) determine actual streamflow and impacts through independent streamflow and habitat assessments. Using either track, a permit holder may demonstrate that its local conditions are different from those reflected in the SWMI BC and GWL maps. The Tracks, and options within each Track, are discussed in more detail below.

6.1 Track 1 – Review/Refine Data Inputs to the USGS Model

In the SWMI Framework, mitigation is based on a PWS's withdrawal volume and the impact those withdrawals will have on August median streamflow. A USGS model was used to estimate values for natural August median streamflow, groundwater withdrawals, impervious cover, and basin characteristics, which were then used within the SWMI Framework to determine percent alteration of streamflow caused by withdrawals. Within the SWMI Framework, it is assumed that the estimated natural August median flow accurately represents what is needed to maintain the ecological health of the stream. August median flow is then the bar by which groundwater withdrawals are evaluated.

A Track 1 Site-Specific Evaluation would allow a PWS to review the data that went into the USGS model for accuracy and to input actual PWS or basin-specific data to determine alterations to streamflow and GWLs. Through this evaluation and corresponding modification of data inputs, the PWS may demonstrate less of an impact on August median flow alteration which could result in a reclassification of a subbasin's GWL. This may subsequently reduce a PWS's mitigation requirements under the SWMI

Framework. Potential options for reviewing the data inputs to the SWMI model include those listed in Table 6-1.

Table 6-1. Track 1 Site-Specific Evaluation Options	
Option	**Description**
A	Review actual monthly withdrawal data and compare to the 2000-2004 model input period to adjust BC and/or GWL.*
B	Determine subbasin characteristics and adjust impact on streamflow. Consider: 1. Aquifer characteristics – including transmissivity, aquifer storage, streambed characteristics, presence of confining layers and other boundary conditions 2. Well locations – such as distance to stream and proximity to impoundment 3. Pumping patterns – this information can be used to more accurately estimate the impact of well withdrawals on August median streamflow and either reduce the estimated flow alteration or relocate the point of impact to a downstream subbasin.
C	Verify accuracy of other model variables to adjust BC and/or GWL, including: 1. Impervious Cover 2. Basin Characteristics (i.e., drainage area, channel slope, % sand and gravel)
D	Run SYE at individual well (field) locations (to distinguish from subbasin pour points)

*Appendix H of this report details a methodology to conduct such an evaluation for Option A and Section 7 provides the results of evaluations conducted for the four Pilot PWSs.

6.2 Track 2 – Determine Actual Streamflow and Impacts through Independent Study

A Track 2 Site-Specific Evaluation could be conducted in situations where a PWS does not agree that the estimated August median flow accurately represents the streamflow needed to support suitable biological habitat or the actual streamflow that exists in its stream. This type of evaluation would no longer use the USGS model and estimated August median flow, but would "replace" it with an instream flow study or other type of site-specific study. A PWS can evaluate actual streamflow data and withdrawal impacts, if appropriate data is available, and compare this data to the USGS's estimated August median flow and other flows from the SYE, or it can conduct an instream flow study to identify what streamflow aquatic organisms need and what flows are currently present.

Study results from this Track provide for the determination of withdrawal impacts not to an averaged median value, but to established streamflow needs. In lieu of mitigation measures determined by SWMI Tier and GWL, MassDEP would incorporate the site-specific study findings and recommendations into the permittee's water withdrawal permit and require mitigation commensurate with the "lower level of impact" demonstrated. This process may then result in a lower level of mitigation than required under the application of the SWMI model. Mitigation could require maintaining the identified/target streamflows (e.g., by implementing outdoor water use conservation measures at low flow triggers). Mitigation could also include habitat improvement

measures that would result in increased streamflow, where needed, and reduced number of days where streamflow triggers are tripped. Mitigation requirements would be negotiated with the EEA agencies during the permitting process.

Table 6-2 presents two options for determining actual streamflows and impacts within a Track 2 Site-Specific Evaluation.

Table 6-2. Track 2 Site-Specific Evaluation Options

Option	Description
A	Determine streamflow impacts downstream of withdrawal points from existing data through the following steps: 1. Examine USGS stream gage data (or other flow monitoring data), if available 2. Compare actual flow data to SYE/MWI estimated flows 3. Account for septic system return flow data, treated wastewater groundwater discharge return flow data or NPDES surface water discharge return flow data 4. Evaluate effect of increased pumping on daily flows 5. Evaluate effect of increased pumping on drought flows
B	Conduct streamflow and habitat assessment: 1. Compare streamflow requirements for species of concern to actual streamflows present. (The study could also compare both of these to the SYE unimpacted flow to evaluate differences.) 2. Select fish species for modeling and identify aquatic habitat needs for those species of concern. a) Assess habitat and stream conditions (instream transect data collection including velocity, flow, substrate, cover) b) Determine Habitat Suitability Curves for species of concern c) Conduct habitat modeling – PHABSIM, MesoHABSIM, wetted perimeter, etc.

Types of instream flow studies (as referenced in Option B) are discussed further below.

6.2.1 Instream Flow Study Methods

The EEA and its agencies developed the SWMI Framework to help balance ecological and human water needs through the regulation of water withdrawals. The practice of setting standards that maintain minimum streamflows has long been in use; however, the concept of maintaining a range of flows necessary to protect aquatic life and habitat may be more beneficial to the overall health of the stream.

Instream flow methods generally fall into two main groups:

1) **Standard setting** or rule of thumb methods. These do not typically require significant field efforts and as a result are less expensive and quicker to perform than incremental methods (described below). Standard setting methods are used to set low streamflow thresholds for summer and sometimes other seasons. They are either based on statistical analysis or on using the shallowest point of the river (i.e., a riffle) as a compliance point. Most are conservative and therefore protective of fisheries and other aquatic life.

2) **Incremental** or site-specific methods. These methods are more commonly used in controversial situations and where various restoration options are evaluated. They are based on specific fish or habitat needs, have a much more intensive data collection component and use complex modeling tools.

The most common and accepted standard setting method used in the eastern United States is the Wetted Perimeter Method. The most well-known and widely used incremental method is the Instream Flow Incremental Methodology (IFIM). Both are discussed further below, with a typical scope of work for performing each method provided in Appendix I.

6.2.1.1 Wetted-Perimeter

The wetted-perimeter (or wetted-width) method is used to determine a streamflow recommendation for low flow periods, based on adequate fish rearing and migration flows. The method assumes a correlation between the wetted perimeter (e.g., portion of the channel that is wet) and fish habitat, with a reduction in wetted width resulting in a loss of fish habitat.

The wetted-perimeter is measured from the water's edge at one bank to the water's edge at the other bank at different streamflows over a number of site visits. Graphs are developed to show the relationship between actual streamflow and wetted perimeter and to identify the inflection point, where the graph levels out (e.g., when no longer rapidly gaining wetted width with increases in streamflow). Ten or more field visits may be needed at different streamflows to determine the inflection point. The inflection point is where habitat is considered stable and becomes the streamflow recommendation.

This method is simpler and less costly than site-specific methods such as the Instream Flow Incremental Method, but may result in a more conservative low flow standard.

6.2.1.2 Instream Flow Incremental Method (IFIM)

IFIM is a series of computer-based models developed by the U.S. Fish and Wildlife Service which calculate how much fish habitat a stream will gain or lose as streamflow increases or decreases. This method takes into account the differing habitat requirements of different fish species, or different life stages within a given species. For example, different fish species and each life stage may need different depths and velocities.

IFIM typically uses four variables (depth, velocity, substrate and cover) representing site-specific streamflow and habitat conditions, which are input into the group of models. The calibrated models will then calculate what flows the targeted fish and life stages prefer based on the depths and velocities they prefer. (Washington IFIM FAQs 2010)

Two models typically used in IFIM studies are PHABSIM (Physical Habitat Simulation) and MesoHABSIM (Mesohabitat Simulation). MesoHABSIM is an adaptation of the PHABSIM model. It replaces the highly detailed microhabitat survey of a few short sampling sites typically performed with a micro-scale model with mesohabitat mapping

of whole-river sections. The MesoHABSIM scale of simulation may match restoration and system analyses more closely, because it provides information for the whole stream. Both models assume that the availability of habitat correlates with population of the targeted species and both evaluate habitat change relative to streamflow.

6.3 Why Consider Site-Specific Evaluations

A site-specific evaluation is optional under the SWMI Framework. The EEA has included this alternative approach to allow a WMA permit holder the opportunity to evaluate impacts based on actual withdrawal data and/or actual streamflow and habitat assessments. Such site-specific information can provide for a more in depth, localized analysis to better manage water use and ecosystem health at a specific location. Site-specific evaluations will be done at the permittee's expense so, in addition to knowing *how* to conduct a Site-Specific Evaluation, it is just as important for PWSs to understand *why* a Site-Specific Evaluation should be considered.

Each PWS system will involve its own unique issues. If a PWS knows or believes its site-specific conditions vary significantly from the estimated or modeled conditions used in the USGS studies, then the PWS should consider conducting a Site-Specific Evaluation. A Site-Specific Evaluation may demonstrate that a PWS's site-specific conditions have less impact on estimated natural August median flow or little impact on actual streamflow. A PWS should consider existing site-specific data and/or subbasin conditions that could potentially demonstrate lower impacts than those estimated in the USGS model. PWSs should also carefully weigh the costs of implementing mitigation under the SWMI Framework to the costs and potential benefits of conducting Site-Specific Evaluations. This section discusses some of the site-specific conditions and potential mitigation costs that should be considered when deciding to conduct a Site-Specific Evaluation.

The following are some possible site-specific conditions that may warrant further investigation with a site-specific approach:

- Actual pumping is likely different than that used in the USGS model (2000-2004 period). The USGS model applied a peak demand curve to pumping values across the state. The applied curve showed peak demands in the summer months, however, some communities may experience peak flows during a different period, as is the case with Amherst which experiences higher demands beginning in the fall due to the colleges and reduced groundwater withdrawals in the summer due to the use of its surface water supply during that time.
- Withdrawals in or upstream of the subbasin have significantly decreased since the 2000-2004 period used in the USGS model. For example, if groundwater wells are no longer used they could influence the percent alteration of the streamflow such that the GWL could shift to a lower classification reducing the minimization and mitigation requirements.

- Impervious cover, drainage area, channel slope, and percent sand and gravel are anticipated to be different from those values used in the model.
- Groundwater wells are located within a confined aquifer. A confined aquifer may change the pour point of the subbasin in which the wells are located, or buffer the impacts to the nearest stream. If the pour point is changed to a larger stream, the percent alteration of that stream may be lower, which could reduce mitigation requirements. This could be confirmed through testing to confirm the extent of the confined aquifer, pump tests and modeling to evaluate the lag time to stream impacts caused by the confined aquifer, and/or evaluation of actual USGS gage data compared to USGS modeled August median flows.
- Groundwater wells are located next to a surface water. In this case, the surface water body may buffer the impacts of the withdrawal on the stream, as the surface water provides a 'reservoir' from which the wells may be drawing. This could be confirmed with pumping tests and modeling to evaluate the extent of impact on the stream, and/or evaluation of actual USGS gage data compared to USGS modeled August median flows.
- Past pumping records showed minimal impact on stream. Further pump tests and modeling can be used to support initial findings.
- There is evidence that there is adequate streamflow to sustain fish and habitat populations. In this case, an incremental site-specific study can be performed to determine actual fish and habitat needs for comparison to actual streamflows.

Average costs estimates for performing various levels of site-specific studies are provided in Table 6-3. Note that actual costs will vary depending on the level of existing data available. However, the approximate costs listed in the table can be used as a baseline for comparing site-specific options with minimization and mitigation options under the SWMI Framework.

Mitigation costs will also vary depending on the level of mitigation required under the SWMI Framework and the PWS's approach to meeting the mitigation volume.

During the Phase 2 site-specific study meetings, it was assumed that if a PWS chooses to go through any one of these options, and the outcome shows that the SWMI Framework is actually the least mitigation required, the PWS can return to its original SWMI Framework required mitigation. However, all mitigation options will be subject to MassDEP review and approval.

Table 6-3. Comparison of Site-Specific Approaches					
Approach	**Applicability**	**Advantages**	**Disadvantages**	**Possible Outcomes**	**Average Cost[1]**
Review and Compare Actual Pumping Data to USGS Modeled Data	• Pumping does not follow traditional summer peaking • Known withdrawal decrease in or upstream of the subbasin • Use of surface water supplies in summer to supplement wells	• Paper exercise using readily available information • Low cost		• No change • Improvement in GWL or BC Category • Reduced mitigation	<$5,000
Review and Compare Impervious Cover, Drainage Area, Channel Slope, and Percent Sand & Gravel	• Anticipate actual conditions are better than those used in the model		• Data was obtained from readily available state-wide maps, so true differences may require some field validation, which can be more time consuming and costly to collect	• No change • Improvement in GWL or BC Category • Reduced mitigation	$10,000-$20,000
Identify Subbasin Characteristics Through Past Studies & Existing Information	• Wells are within a confined aquifer • Wells are located next to a large water body • Past pump test shows no stream impact	• Paper exercise using readily available information • Low cost		• May redefine subbasin pour point & extend area qualifying for 100% mitigation credits • Improvement in GWL or BC Category • Reduced mitigation	$5,000-$10,000
Compare USGS Gage with USGS Unimpacted Flows & Pumping Records	• Wells are within a confined aquifer, next to a large water body, or pump data indicated there is no stream impact • Gage is readily available	• Paper exercise using readily available information • Lower cost than pumping tests and modeling		• Reduced percent alteration of August median flow • Improvement in GWL or BC Category • Reduced mitigation, but extent unknown	$5,000

[1] Costs are estimated order of magnitude ranges based on an outside consulting engineer being hired to do the analysis. If in-house resources exist or if the outside engineer is performing other related services, these costs are likely less but depend on the specific situation and its complexity, the existence of USGS gage data and other unknown factors. These costs should be compared to the potential benefits.

Perform Pump Test & Modeling to Define Lag Time	• Wells are within a confined aquifer • Wells are located next to a large water body • Past pump test shows no stream impact	• Less expensive than IFIM study	• More costly than paper exercise • Risk that results may not show less impact to August median flow	• Reduced percent alteration of August median flow • Improvement in GWL or BC Category • Reduced mitigation, but extent unknown • If impact is consistent with SWMI – full mitigation	$50,000+
Identify Habitat Streamflows Through Wetted-Perimeter Method	• Mitigation under SWMI Framework is very costly • No other options to show reduced impact to streams • Believe habitat needs may be less than SWMI prediction	• Identifies streamflow requirements based on habitat needs, rather than USGS model assumptions • Less expensive than IFIM habitat study	• May not show less of an impact than the USGS model and still have to mitigate to same level	• If habitat needs are met - reduced mitigation • Habitat needs are not met – develop mitigation program with MassDEP or revert back to SWMI Framework	$25,000-$50,000
Identify Habitat Streamflows Through IFIM	• Mitigation under SWMI Framework is very costly • No other options to show reduced impact to streams • Believe habitat needs may be less than SWMI prediction • Pumping does not follow traditional summer peaking • Known withdrawal decrease in or upstream of the subbasin	• Identifies streamflow requirements based on habitat needs, rather than USGS model assumptions	• Labor intensive & expensive • Could spend a lot of money and still have to mitigate to same level	• Habitat needs are met - reduced mitigation • Habitat needs are not met – develop mitigation program with MassDEP or revert back to SWMI Framework	$50,000-$100,000

Section 7 Results of Site-Specific Pilot PWS Data Reviews

As described in Section 6, the SWMI Framework provides an option to demonstrate that local conditions may significantly differ from those reflected in the Framework. EEA has identified two tracks by which site-specific evaluations could be conducted:

> Track 1) review/refine data inputs to the USGS Model; and
>
> Track 2) determine actual streamflow and impacts through independent streamflow and habitat assessments.

Using either track, a permit holder may demonstrate that its local conditions are different from those reflected in the SWMI BC and GWL maps. This Section discusses the Pilot Project application of the option under Track 1, under which the PWS may refine the inputs to the USGS models (Sustainable Yield Estimator - SYE - and Massachusetts Water Indicators – MWI) based on site specific data reviews.

Appendix H provides general background about the SWMI Framework and the modeling upon which biological categories (BC) and groundwater withdrawal levels (GWL) are based, and how a PWS can either validate or develop a more accurate designation of BC and/or GWL for a specific water supply subbasin. The Appendix H methodology is applied in this Section to each of the Pilot Project water supply systems to illustrate the development of a site specific refinement of the data inputs to the SWMI framework models.

In applying the methodology from Appendix H to the four Pilot Project communities, the following should be noted:

- While not incorporated in the development of BC/GWL determinations, the MWI Report identified returns from wastewater related discharges including septic systems, permitted groundwater discharges and National Pollutant Discharge Elimination System (NPDES) surface water discharges. A site specific study may include consideration of these flows.
- As noted in Appendix H, withdrawal data in the MWI Report were generally based on annual average withdrawals over 2000-2004. Correspondence from the MassDEP indicates that withdrawals from wells that did not have withdrawal data reported for the entire period were averaged only over the time period that data were reported, resulting in some withdrawals being averaged over less than five years. Furthermore, MassDEP noted that withdrawal volumes reported for wells that were inactive for a portion of the year were not included in the five year average. As discovered when evaluating the four Pilot communities this can lead to some inaccuracies in the average withdrawals used for BC/GWL determination.
- The wastewater discharge data for permitted groundwater discharges and NPDES surface water discharges was generally based on reported August median discharges, where available, for the same 2000-2004 timeframe. Discharges from

septic systems were calculated by multiplying the estimated 2000 population served by septic systems in the subbasin by a constant year-round discharge rate of 57 gallons per capita per day, which is 85% of the average annual, statewide residential withdrawal rate of 67 gallons per capita per day.

Appendix H of this report describes how PWSs can validate the BC and/or GWL designation of a subbasin using actual, or more accurate, data in lieu of the estimated values used for the statewide classification effort. Although any of the cited variables can be adjusted, the use of actual vs. estimated 2000 – 2004 August groundwater withdrawal data is expected to be the most likely variable to have an impact on subbasin classification.

The following sections present the results of the USGS model review evaluation described in Appendix H as applied to the Amherst, Danvers-Middleton, Dedham-Westwood, and Shrewsbury PWSs.

7.1 Amherst

All of Amherst's groundwater sources are located within Lawrence Swamp in Subbasin 14061 of the Connecticut River Basin. Amherst's groundwater withdrawals account for the majority of estimated withdrawals in this subbasin. Amherst also uses surface water supplies (Atkins Reservoir and Pelham Reservoir System) to satisfy water supply demands; however, surface water withdrawals are not accounted for in the BC/GWL determination or the below analysis.

Annual Data

Table 7-1 summarizes the total annual average withdrawals from each of Amherst's groundwater sources for 2000 through 2004 compared with the USGS model.

Table 7-1. Amherst Subbasin 14061 - Average Annual Withdrawals (mgd)

Source	2000		2001		2002		2003		2004		5-Year Average	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model
Well #1 -01G	0.460	0.230	0.526	0.263	0.560	0.280	0.521	0.261	0.392	0.196	0.492	0.246
Well #2 -04G		0.230		0.263		0.280		0.261		0.196		0.246
Well #3 -02G	1.002	1.002	1.010	1.010	1.040	1.040	0.979	0.979	1.083	1.083	1.022	1.022
Well #4 -05G	0.114	0.114	0.201	0.201	0.325	0.325	0.152	0.152	0.213	0.213	0.201	0.201
Well #5 -06G	0.035	0.035	0.118	0.118	0.077	0.077	0.082	0.082	0.025	0.025	0.067	0.067
										Total	**1.783**	**1.783**

Note that Amherst's ASRs report the withdrawals for Well #1 and Well #2 as a combined withdrawal volume associated with Well #1. The USGS model attributes 50% of the reported withdrawals to Well#1 and 50% of the reported withdrawals to Well#2. Since both wells are in the same subbasin this does not impact the subbasin's BC or GWL.

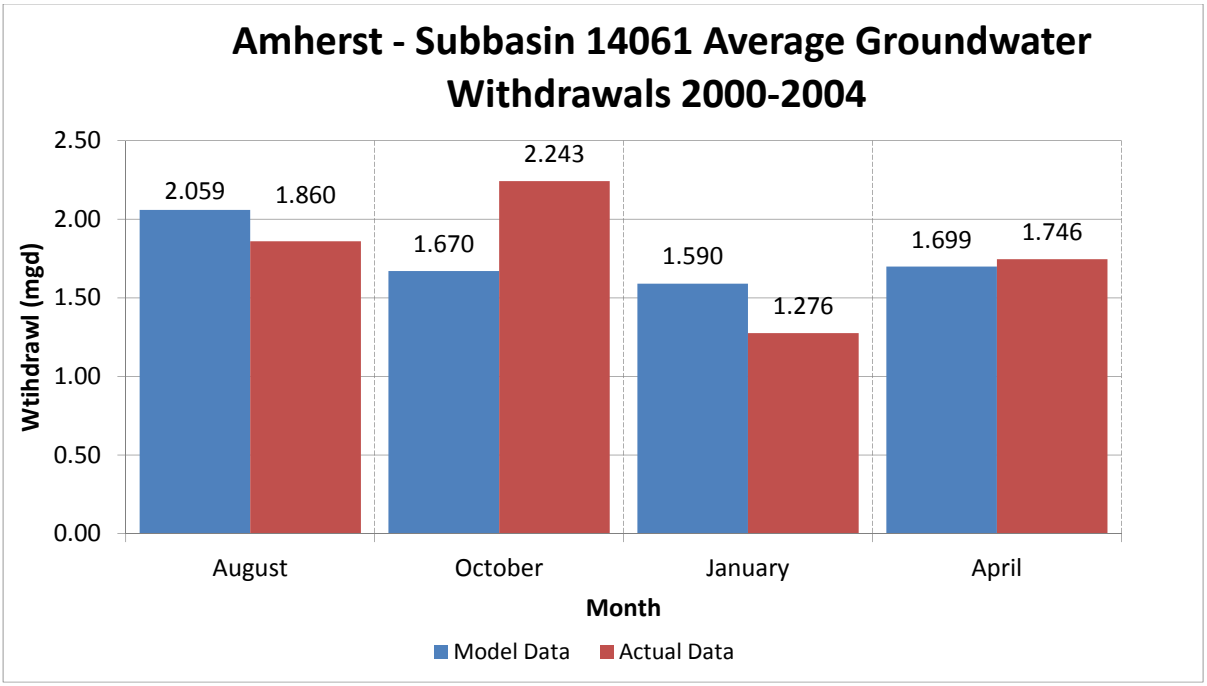
As illustrated in Table 7-1, the USGS model accurately reflects Amherst's annual average withdrawals from subbasin 14061.

Seasonal Data

As described in Section 7.1 of this report, the MWI Report disaggregated the annual withdrawal data reported from the SYE model into monthly values by averaging the annual withdrawals and applying a monthly peaking factor. The resulting average monthly withdrawals were compared to estimated median monthly natural flow in determining the SWMI BC and GWL.

Figure 7-1 compares the estimated monthly withdrawals used for BC/GWL determination with actual monthly withdrawals from Amherst's groundwater sources. Although BC/GWL determination is based on August withdrawals, the Figure compares data for each of the four months used in the MWI analysis: January, April, August and October.

Figure 7-1
Amherst – Subbasin 14061 Average Groundwater Withdrawals 2000-2004



As illustrated, the approach used in determining the SWMI GWLs resulted in significant inaccuracy in the estimated seasonal withdrawals in Amherst. August withdrawals, which are used in the BC and GWL determinations, were overestimated by approximately 10%. January withdrawals were overestimated by approximately 20% and October withdrawals were underestimated by approximately 35%.

The differences in seasonal withdrawals are likely due to the fact that Amherst largely uses surface water supplies to provide base demand throughout the summer. Furthermore, Amherst's largest customer is UMass Amherst, accounting for more than 50% of the annual consumption (2011 CCR). The water use pattern associated with a college campus (with consumption dropping significantly over the summer and in the month of January during winter break) can explain the differences in withdrawals for the months of January and August.

Similarly, as illustrated in the above figure, Amherst's actual groundwater withdrawals in October are higher than the value predicted with state-wide monthly peaking factors. Amherst's groundwater withdrawals in October significantly increase due to students returning to UMASS and Amherst's surface water reservoirs typically being taken offline as a result of reduced storage and poor water quality.

BC and GWL Impact

As noted above, Amherst's groundwater sources are located within Lawrence Swamp in Subbasin 14061 and account for the majority of estimated withdrawals in this subbasin. Table 7-2 illustrates the impact that differences between Amherst's modeled and actual groundwater withdrawals would have upon the monthly percent flow alteration in this subbasin.

Table 7-2. Impact of Adjusted Withdrawals on % Flow Alteration - Subbasin 14061

Month	Unaffected Median Flow (mgd)	Model Groundwater Withdrawals (mgd)	Amherst Withdrawals (mgd)		Adjusted Groundwater Withdrawals (mgd)	% Flow Alteration	
			Model	Actual		Model	Adjusted
August	2.31	2.34	2.06	1.86	2.14	101%	93%
October	3.30	1.90	1.67	2.24	2.47	57%	75%
January	8.67	1.80	1.59	1.28	1.49	21%	17%
April	20.91	1.99	1.70	1.75	2.04	10%	10%

However, based on information contained in the Amherst Hop Brook Zone II Studies, there is a confining layer within Amherst's aquifer that transfers the impact of Amherst's withdrawals to the downstream subbasin below the confining layer. As part of the Amherst site-specific study evaluations conducted in Phase 2 of the Pilot Project, MassDEP determined that the confining layer extends to the downstream end of subbasin 14056, coincident with the Hop Brook confluence with Fort River. Therefore, the impact of withdrawals from Amherst's wells is exhibited in subbasin 14064. Due to concerns that the SWMI process does not account for the reduced impact of the withdrawals within subbasin 14061 and per MassDEP's request, the impact of using actual withdrawal data on the BC and GWL designation of both subbasin 14061 and 14064 were evaluated as part of this task.

Table 7-3 reflects the confined aquifer condition by assessing the impact of the adjusted withdrawals on the downstream subbasin 14064.

Table 7-3. Impact of Adjusted Withdrawals on % Flow Alteration - Subbasin 14064							
Month	Unaffected Median Flow (mgd)	Model Groundwater Withdrawals (mgd)	Amherst Withdrawals (mgd)		Adjusted Groundwater Withdrawals (mgd)	% Flow Alteration	
			Model	Actual		Model	Adjusted
August	9.55	2.47	2.06	1.86	2.27	26%	24%
October	15.41	2.01	1.67	2.24	2.58	13%	17%
January	40.49	1.91	1.59	1.28	1.59	5%	4%
April	110.69	2.11	1.70	1.75	2.15	2%	2%

The Unaffected Median Flow and Model Groundwater Withdrawals in Tables 7-2 and 7-3 were derived from the MWI Report, Appendix 1 Table 1-2. Amherst's modeled and actual withdrawals were taken from Figure 7-1. The Adjusted Groundwater Withdrawal was calculated by adjusting the Model Groundwater Withdrawal by the difference between Amherst's modeled and actual withdrawals. The % flow alteration is the ratio of model or adjusted groundwater withdrawals to the unaffected median flow in the subbasin.

BCs are based on percent biological alteration as determined by impervious cover and flow alteration. Based on model data, Subbasin 14061 is designated as BC5 and is therefore not considered a Quality Natural Resource. Subbasin 14064 is designated as BC4 based on model data and is also not considered a Quality Natural Resource. As noted above, the regression equation used to determine the BC designation for each subbasin was not publically available at the time of this report. However, based on consultation with MassDEP, both of the subbasins' BC designations do not change when evaluated using the actual 2000-2004 groundwater withdrawals.

Using USGS model data, the subbasin in which Amherst's withdrawals are located (14061) is designated as GWL5. As indicated above, the corrected Amherst withdrawal data reduces the estimated August Median Flow alteration in subbasin 14061 from 101% to 93%. This reduction is not sufficient to change the GWL designation of Subbasin 14061 to GWL4. The SWMI Framework does not provide a quantitative alteration criteria based on median flows for GWL4 or GWL5 subbasins in the non-August months. However, it can be noted that the Subbasin 14061 flow alteration is greater than the seasonal alteration criteria for GWL3 subbasins in October and January and equal to the maximum seasonal alteration criteria for GWL3 in April.

As determined during the site-specific study evaluations for Amherst, the confining layer in Subbasins 14061 and 14056 results in the potential for impacts from Amherst's groundwater withdrawals being exhibited and assessed in the Fort River subbasin (Subbasin 14064) rather than in the Hop Brook subbasins. Using USGS model data, Subbasin 14064 is designated as GWL4. Using the corrected Amherst withdrawal data on subbasin 14064 would reduce the August Median Flow alteration in Subbasin 14064 from 26% to 24%. This would change the GWL designation for this subbasin from GWL4 (25 to <55% alteration) to GWL3 (10 to <25% alteration). It should be noted that the downstream subbasin GWL designation will be impacted by correcting the upstream withdrawal data regardless of the confining layer issue.

Subbasin 14064 flow alteration is less than the seasonal alteration criteria for GWL3 subbasins in August, January, and April and greater than the maximum seasonal alteration criteria for October. The permitting implication of the change in GWL is discussed in detail in Section 8.1.2.

7. 2 Danvers-Middleton

The data review for Danvers-Middleton included an evaluation of the impact on BC and GWL determination from 1) use of actual versus estimated 2000-2004 withdrawal data and 2) use of current (2007-2011) versus historical withdrawal and wastewater return data for Danvers and upstream water use points. These evaluations are each described in the following subsections.

7.2.1 Comparison of Actual Data versus USGS Model

Both of Danvers-Middleton groundwater sources are located along the Ipswich River within the Ipswich River Basin and Subbasin 21019. The portion of the groundwater withdrawals within the subbasin attributable to Danvers-Middleton is very small and has very little impact on the GWL determination in this subbasin. Danvers-Middleton also uses surface water supplies (Middleton Pond, Emerson Brook Reservoir, and Swan Pond) to satisfy water supply demands; however, surface water withdrawals are not accounted for in the BC/GWL determination or in the below analysis.

Annual Data

Table 7-4 summarizes the total annual average withdrawals from each of Danvers' groundwater sources for 2000 through 2004.

Table 7-4. Danvers - Subbasin 21019 Average Annual Withdrawals (mgd)

Source	2000		2001		2002		2003		2004		5-Year Average	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model
Well#1 -01G	0.030	0.030	0.022	0.022	0.192	0.192	0.040	0.040	-	0.000	0.057	0.057
Well#2 [1] -02G	0.000	0.000	0.064	0.064	0.317	0.317	0.119	0.119	0.116	0.116	0.123	0.123
										Total	**0.180**	**0.180**

1. Per note on ASR: 2001 and 2002 Total Withdrawals via estimated pump curve (no meter).

A "-" indicates that the source was not included on the ASR.

A notation on the 2001 and 2002 ASR indicates that Well #2 did not have a meter installed and the total withdrawal for these years was approximated via an estimated pump curve. Though not indicated in the above table, the SYE database indicates that Well #1 is an emergency source in 2003 and the 2003 ASR does not indicate the source's status. Well #1 is not included in the 2004 ASR, however the SYE database indicates the source is an emergency source and attributes zero withdrawals to it. The SYE database also indicates that Well #1 North Replacement and Well #1 South Replacement are active sources in 2003 and 2004; however these sources are not included on the ASRs. As the SYE database attributes zero withdrawals to each of these sources over 2003-2004 they

are not included in the above table as this would not impact the average annual flows or the subbasin's BC or GWL. There are no entries for these sources prior to 2003.

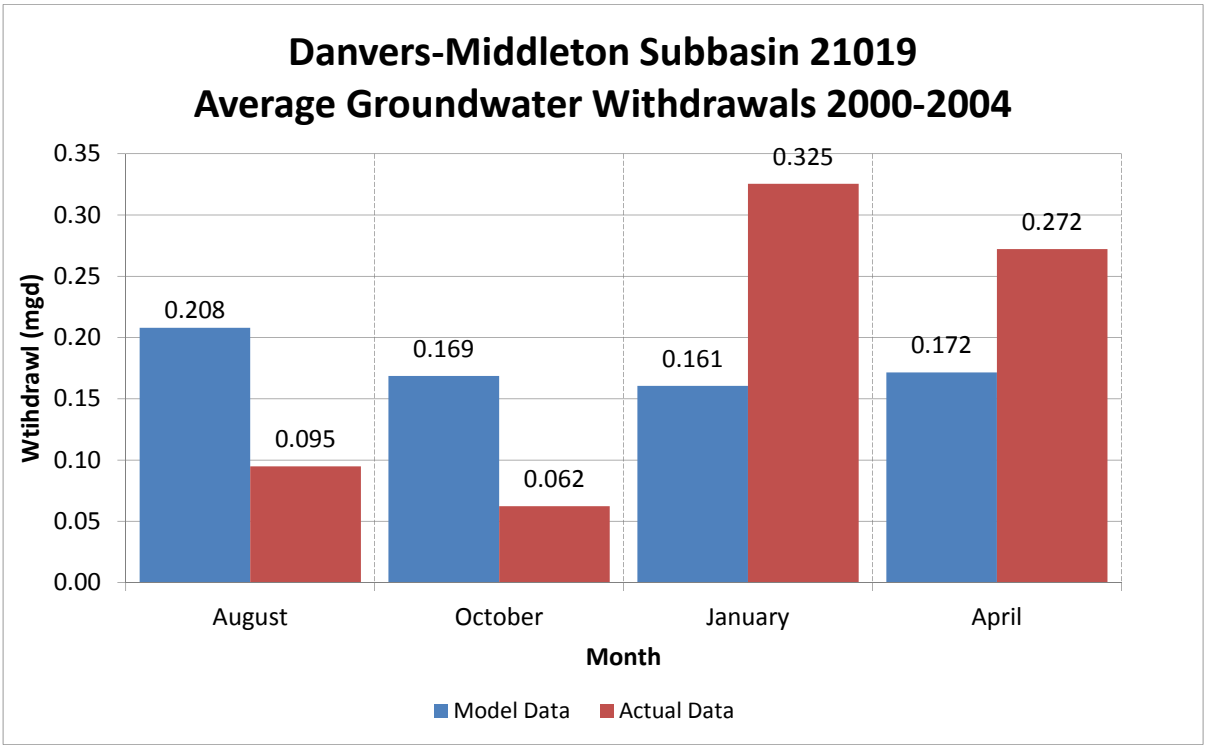
As illustrated in Table 7-4, the USGS model accurately reflects Danvers-Middleton's annual average withdrawals from Subbasin 21019.

Seasonal Data

As described in Section 7.1, the MWI Report disaggregated the annual withdrawal data reported from their SYE model into monthly values by averaging the annual withdrawals and applying a monthly peaking factor. The resulting average monthly withdrawals were compared to estimated median monthly natural flow in determining the SWMI BC and GWL categories.

Figure 7-2 compares the estimated monthly withdrawals used for BC/GWL determination with actual monthly withdrawals from Danvers' groundwater sources. Although BC/GWL determination is based on August withdrawals, Figure 7-2 compares data for each of the four months used in the MWI analysis: January, April, August and October.

Figure 7-2
Danvers-Middleton – Subbasin 21019 Average Groundwater Withdrawals 2000-2004



As illustrated above, the approach used in determining the SWMI GWLs resulted in significant inaccuracy in the estimated seasonal withdrawals in Danvers-Middleton. August withdrawals used in the BC and GWL determinations were overestimated by more than double the actual withdrawals. October withdrawals were also overestimated by 63% and January and April withdrawals were significantly underestimated by approximately 102% and 59%, respectively.

The differences in seasonal withdrawals are likely due to the fact that Danvers-Middleton's current WMA Permit contains a Streamflow Maintenance Plan that incorporates operating restrictions for groundwater withdrawals based on flow at the USGS stream gage on the Ipswich River at South Middleton. The plan includes seasonal threshold flows which determine if and when the wells must be shut off, pumped only every other day, or may be used at their full approved rates. As a result of the seasonal threshold flows, Danvers uses the groundwater sources in non-summer months and maximizes use of the surface waters from May through October. The effect of the seasonal flow restrictions is evident in Figure 7-2 as groundwater withdrawals significantly increase in non-summer months (January and April) and decrease in summer months (August and October).

BC and GWL Impact

Table 7-5 illustrates the impact that the differences between Danvers-Middleton's modeled and actual groundwater withdrawals would have upon the monthly percent flow alteration for Subbasin 21019.

Table 7-5. Impact of Adjusted Withdrawals on % Flow Alteration – Subbasin 21019

Month	Unaffected Median Flow (mgd)	Model Groundwater Withdrawals (mgd)	Danvers-Middleton Withdrawals (mgd)		Adjusted Groundwater Withdrawals (mgd)	% Flow Alteration	
			Model	Actual		Model	Adjusted
August	8.27	7.29	0.21	0.09	7.18	88%	87%
October	12.72	5.93	0.17	0.06	5.82	47%	46%
January	44.24	5.65	0.16	0.33	5.81	13%	13%
April	115.32	6.23	0.17	0.27	6.33	5%	5%

The Unaffected Median Flow and Model Groundwater Withdrawals were derived from the MWI Report, Appendix 1 Table 1-2. Danvers-Middleton's modeled and actual withdrawals were taken from Figure 7-2. The Adjusted Groundwater Withdrawal was calculated by adjusting the Model Groundwater Withdrawal by the difference between Danvers-Middleton's modeled and actual withdrawals. The percent flow alteration is the ratio of model or adjusted groundwater withdrawals to the unaffected median flow in the subbasin.

In general, the BCs are based on the percent biological alteration as expressed by impervious cover and flow alteration. Based on model data, Subbasin 21019 is designated as BC5 and is therefore not considered a Quality Natural Resource. As noted above, the regression equation used to determine the BC designation for each subbasin

was not publically available at the time of this report. However, based on consultation with MassDEP, Subbasin 21019's BC designation does not change when evaluated using the actual 2000-2004 groundwater withdrawals.

As shown above, the corrected Danvers-Middleton withdrawal data slightly decreased the estimated August Median Flow alteration in Subbasin 21019 from 88% to 87%. The SWMI Framework does not provide a quantitative alteration criteria based on median flows for GWL4 or GWL5 subbasins in the non-August months; however, it can be noted that the Subbasin 21019 flow alteration is greater than the seasonal alteration criteria for GWL3 subbasins in October and January and less than the GWL3 maximum seasonal alteration criteria for April.

Furthermore, other withdrawals within Subbasin 21019 include recently retired withdrawals by the Town of Reading and reduced withdrawals in Wilmington. The impact of these reduced withdrawals on the subbasin's GWL is presented in Section 7.2.2.

7.2.1 Comparison of Current versus Historical Data

During Phase 2 of the Pilot Project, the Pilot team was asked to review and evaluate changes in water volumes of specific water use points in and upstream of the Danvers-Middleton PWS groundwater withdrawal wells to determine if there have been significant changes since 2000-2004. (This evaluation was not conducted for the other three Pilot PWSs.) The 2000-2004 timeframe was used in models to determine the GWL and BC for the watershed subbasins. Water use conditions assessed for this task included specific PWS withdrawals, as well as wastewater returns from groundwater discharges and NPDES surface water discharges.

This review assessed changes in the water withdrawals to determine if the changes in water use conditions would result in a significant change to the flow alteration and resulting GWL and BC of the Danvers-Middleton PWS groundwater withdrawal subbasin (21019). This analysis is discussed below.

Water Use Points

The SWMI Framework determines the GWL of each subbasin based on the estimated percent alteration of the subbasin's unaffected August median flow. The unaffected flow is determined using the SYE model at the exit (pour point) of the subbasin and includes the flow from any upstream subbasins. Based on the delineation of the upstream contributing watershed to Subbasin 21019 provided by MassDEP, the pour point for the subbasin is coincident with the PWS's most downgradient groundwater withdrawal point within the subbasin. It should be noted that delineating the upstream contributing watershed by a groundwater withdrawal point does not capture the portions of the source's Zone II that may encompass additional contributing subbasin(s) area(s).

Danvers' sources are located within the Ipswich River Basin. The Ipswich River forms the Danvers–Middleton town line. The groundwater sources for the Danvers Water Division (DWD) are all located along the Ipswich River at the Middleton town line

within Subbasin 21019, which is designated as BC5 and GWL5. Both wells are located along a portion of the Ipswich River that flows northeast. The contributing upstream drainage area was delineated from Well #1 North Replacement, the most downgradient groundwater withdrawal source within Subbasin 21019.

Figure 7-3 at the end of this section illustrates that the contributing upstream drainage area extends approximately ten miles west and includes the headwaters of the Ipswich River. The approximately 53.5 square mile watershed encompasses Subbasins 21073, 21074, 21076, 21077, 21012, 21013, and a portion of Subbasin 21019. The area contains nearly the entire town of Wilmington and North Reading and portions of Reading, Woburn, Burlington, Billerica, Tewksbury, Andover, North Andover, Lynnfield, Peabody, Danvers, and Middleton. Table 7-6 provides a summary of the towns and groundwater withdrawal points located within the upstream contributing area of Subbasin 21019.

Table 7-6. Groundwater Withdrawal Points within Subbasin 21019 Upstream Contributing Area		
Town	**PWS Point**	**Subbasin**
Burlington	None	n/a
Woburn		
Billerica		
Tewksbury		
Andover		
N. Andover		
Middleton		
Wilmington	Aldrich Rd. GP Well	21076
	Shawsheen Ave. GP Well	21076
	Chestnut St. GP Well	21077
	Chestnut St. GP Well #1A	21077
	Butters Row GP Well #1	21077
	Butters Row GP Well #2	21077
	Town Park GP Well	21077
	Barrows Wellfield	21073
	Salem St. Wellfield	21073
	Browns Crossing Wellfield	21073
	Browns Crossing Replacement Wellfield	21073
Reading	Revay Well #1	21074
	Well #15	21074
	Well #3	21074
	Well #13	21074
	Well #2	21074
	Well #66 8	21074
	Well #82 20	21074
	B Line Well	21074
	Town Forest	21074
North Reading	Stickney Well	21074
	Railroad Bed Wells	21073
	Lakeside Blvd. Well #2	21073
	Lakeside Blvd. Well #3	21073
	Lakeside Blvd. Well #4	21073
	Route 125 Well	21073
	Central St. Wellfield	21073
Lynnfield	Glen Drive Well #1	21013
	Glen Drive Well #2	21013
	Glen Drive Well #3	21013
	Glen Drive Well #4	21013
	Main St. GP Well	21013
Peabody	Pine St. GP Well	21012
	Johnson St. GP Well	21012
Danvers	Well #1	21019
	Well #2	21019
	Well #1 North Replacement	21019
	Well #1 South Replacement	21019

Subbasin 21019 is estimated to have an 88% alteration of unaffected August median flow based on groundwater withdrawals from the 2000-2004 timeframe and is therefore designated a GWL5 subbasin (greater than 55% alteration). However, changes in withdrawals since 2004 within the nested subbasins listed in Table 7-6 may result in a revision of the GWL determination for Subbasin 21019. The following sections identify changes in withdrawals and discharges that have occurred since the 2000 to 2004 timeframe used to develop the GWL and BC designations for Subbasin 21019. This updated information was used to evaluate the impact on the GWL and BC designation for Subbasin 21019.

Changes in Withdrawals

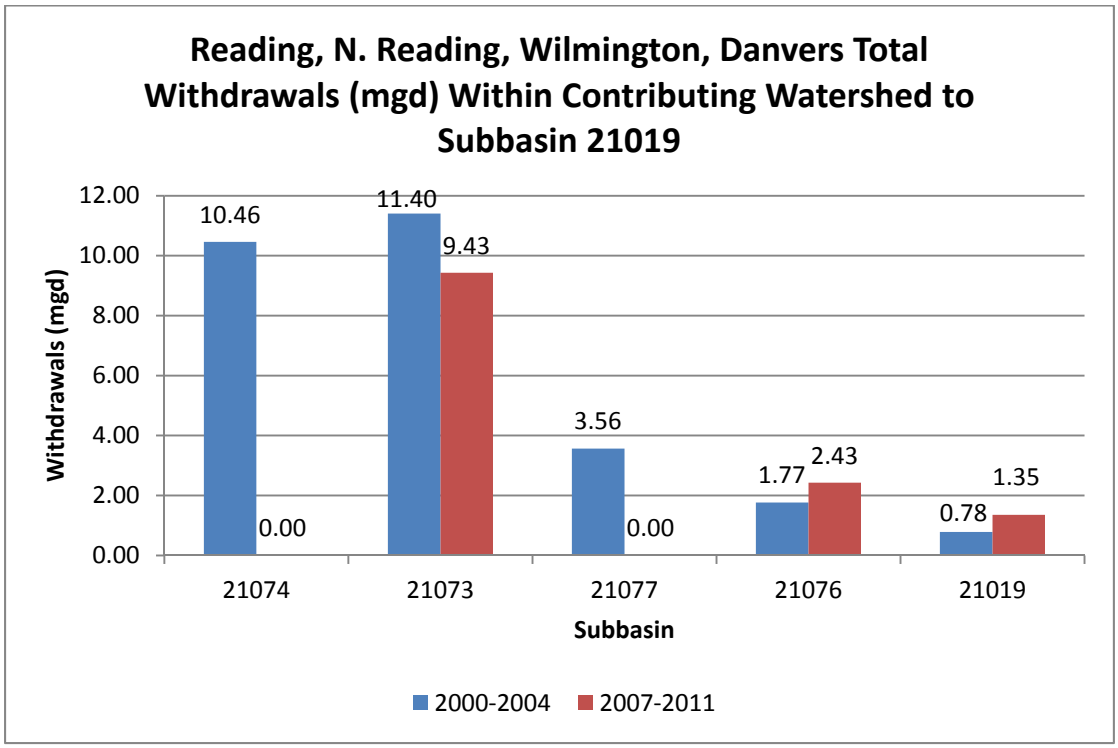
Four PWSs in the contributing watershed to Subbasin 21019 were assessed for this task. The ASRs for the Towns of Reading, North Reading, Wilmington and Danvers were reviewed to identify changes in groundwater withdrawals that may affect the GWL or BC designation of the subbasin that includes the DWD's groundwater sources. Though there are other withdrawal points within the upstream contributing area to Subbasin 21019 (see Figure 7-3), these PWSs were selected in consultation with MassDEP, based on the knowledge that significant changes to the operation of the Reading and Wilmington water supply sources have occurred since 2004.

The evaluation used the ASRs to identify the following

- New groundwater withdrawals sources or sources that had become inactive or abandoned, and
- Sources whose withdrawals have significantly been reduced; or used on rare occasion to provide emergency supply.

Consistent with the SWMI Framework, which averages data over a five year period (2000-2004), changes in withdrawals were evaluated using the most recent five year time period for which data was available (2007-2011). Figure 7-4 compares the total subbasin withdrawals from Reading, North Reading, Wilmington, and Danvers for this latest five year period with the corresponding figures for the 2000-2004 period.

Figure 7-4
Reading, North Reading, Wilmington, Danvers – Total Withdrawals within Contributing Watershed to Subbasin 21019



As indicated in Figure 7-4, withdrawals in upstream subbasins 21074, 21073 amd 21077 decreased significantly. Increases were seen in Subbasin 21076 and 21019 . There were no withdrawals from Subbasins 21074 or 21077 during the 2007-2011 timeframe. Total withdrawals from 2007-2011 within Subbasin 21073 decreased by 17% when compared to total withdrawals from 2000-2004. Total withdrawals in Subbasin 21076 increased in the 2007-2011 timeframe by 37% and total withdrawals in Subbasin 21019 (where all of Danvers-Middleton's groundwater sources are located) increased by 73%.

Table 7-7 presents the annual average withdrawals by subbasin for both time periods. As indicated in the Table, the most significant decrease in withdrawals may be attributed to the Towns of Reading (Subbasin 21074) and Wilmington (Subbasin 21077).

Reading's decreased water withdrawals in the Ipswich River is attributed to its recently joining the MWRA Water Works System. In 2005, Reading was accepted as a full member of the MWRA Water Works Systems and in 2006, Reading began purchasing water from MWRA. Reading joined MWRA to address demand needs and to relieve stress on the Ipswich River from water withdrawals. Reading is permitted to buy 219 MG per year and up to 3.8 mgd from May through October (MWRA Advisory Board). As noted above, Reading's withdrawals in the Ipswich River Basin (Subbasin 21074) have been eliminated in 2007-2011 and it purchased 100% of its supply from MWRA.

The Town of Wilmington suspended use of its drinking water supply wells located in the Maple Meadow Brook aquifer after groundwater contamination from the Olin Chemical property was identified in late 2002. By suspending use of these wells located in

Subbasin 21077, Wilmington's withdrawals in the Ipswich River Basin have been eliminated in 2007-2011.

Public water supply sources in North Reading remained the same over the two timeframes analyzed. Differences in water use can be attributed to a moderate increased reliance on purchased water from Andover in the 2007-2011 timeframe.

Table 7-7. 2000-2004 vs 2007-2011 Average Annual Withdrawals by Subbasin

Subbasin	PWS	MassDEP ID	Point Name	Subbasin Average Annual Withdrawals (mgd)	
				2000-2004	2007-2011
21074	Reading	3246000-03G	Revay Well # 1	2.092	0.000
		3246000-04G	Well #2		
		3246000-05G	Well# 3		
		3246000-06G	B Line Well		
		3246000-07G	Town Forest		
		3246000-08G	Well # 82 20		
		3246000-09G	Well # 66 8		
		3246000-10G	Well # 13		
		3246000-11G	Well # 15		
	N. Reading	3213000-06G	Stickney Well	0.000	0.000
Subbasin 21074 Total:				**2.092**	**0.000**
21073	N. Reading	3213000-01G	Railroad Bed Wells	.0598	.0496
		3213000-02G	Lakeside Blvd. Well # 2		
		3213000-03G	Lakeside Blvd. Well # 3		
		3213000-04G	Central St. Wellfield		
		3213000-05G	Route 125 Well		
		3213000-07G	Lakeside Blvd. Well # 4		
	Wilmington	3342000-02G	Barrows Wellfield	1.683	1.391
		3342000-01G	Brown's Crossing Wellfield		
		3342000-08G	Salem St. GP Well		
		334200-11G	Brown's Crossing Replacement	n/a	
Subbasin 21073 Total:				**2.280**	**1.886**
21077	Wilmington	3342000-03G	Chestnut St. GP Well	0.713	0.000
		3342000-04G	Town Park GP Well		
		3342000-09G	Butters Row GP Well #2		
		3342000-07G	Butters Row GP Well #1		
		3342000-10G	Chestnut St. Well # 1A		
21076	Wilmington	3342000-05G	Shawsheen Ave. GP Well	0.353	0.485
		3342000-06G	Aldrich Rd. GP Well		

As indicated in Table 7-7, Brown's Crossing Replacement wellfield in Wilmington is the only withdrawal source that was added during 2007-2011. Construction on this wellfield began in 2010. This wellfield replaced the Brown's Crossing Wellfield, which had reached the end of its useful life. There were no other changes in source status in Wilmington between the 2000-2004 and 2007-2011 time periods. Review of Wilmington's ASRs indicated that groundwater withdrawals steadily decreased from 2000-2011 and was increasingly supplemented with purchased water from the Woburn and Burlington Water Departments and MWRA.

7.2.3 Changes in Discharges

The Pilot Project evaluated changes in both surface and groundwater discharges within the upstream contributing area as potential credit offset options. Figure 7-5 at the end of this section depicts groundwater and surface water discharge points.

Surface Water Discharges

Surface water discharges are regulated by the U.S. Environmental Protection Agency (EPA) and MassDEP under the NPDES program which requires all municipal, industrial, and commercial facilities that discharge wastewater directly from a point source into a receiving water body to obtain a NPDES permit. NPDES wastewater permits fall into two categories: municipal and industrial. Each category is then subdivided into major (large discharges) and minor (small discharges). Major municipal discharges include all facilities with design flows of greater than 1 mgd and facilities with EPA/State approved industrial pretreatment programs. Major industrial facilities are determined based on specific rating criteria developed by the EPA and the state. In addition to Major and Minor discharge permits, there are also Individual and General NPDES permits. An Individual NPDES permit is one that has been issued for a single facility, while a General NPDES Permit covers all facilities of a certain type in a given state.

NPDES-permitted surface water discharges provide minimal opportunity for direct groundwater recharge; however, these discharges directly augment streamflows. Depending on the geologic setting, these augmented streamflows may in turn augment groundwater recharge. The water quality of these discharges is regulated by the NPDES permit. The analysis presented herein focused only on water quantity contributions.

The 2000-2004 NPDES surface water discharge values used by the USGS model were obtained from Table 1-2 in Appendix 1 of the MWI Report. This document indicated that there were zero surface water discharges during 2000-2004 timeframe within the upstream contributing area for subbasin 21019.

The Pilot Project reviewed multiple sources to identify changes in NPDES discharges since 2004. Data from EPA's FRS Facilities State Single File CSV Download was used to identify Major and Non-Major NPDES discharges within the upstream contributing watershed. Data was downloaded for the Commonwealth of Massachusetts and filtered to display only those towns within the upstream contributing area. According to this data, there were no active Major or Non-Major NPDES permits issued within Andover, Danvers, Middleton, North Reading, Reading, or Wilmington during 2007-2011.

Individual NPDES discharges were further evaluated using a list of Massachusetts Final NPDES Individual Permits, maintained by EPA. Review of this data indicated that there were no active Individual NPDES permits during 2007-2012.

General NPDES Permit discharges regulate a multitude of discharges and water re-use. For this task, only discharges permitted under the Potable Water Treatment Facility NPDES General Permit were evaluated as these discharges have potential to augment streamflow. The EPA's Notice of Intent Archive of Potable Water Treatment Facility General Permit (PWTF GP) database was used to identify discharges permitted during 2007-2011. The results of this evaluation are summarized below in Table 7-8.

Table 7-8. Changes in PWTF GP Surface Water Discharges

Facility	Town	Subbasin Location	Average Monthly Discharge (gpd)
Butters Row WTF	Wilmington	21107	165,000
E.H. Sargent WTF	Wilmington	21107	174,000
Winona Pond WTF	Peabody	21012	185,203

As shown above, surface water discharges within the upstream watershed that can be attributed to WTFs under the PWTF NPDES GP total 524,203 gpd. Of that, 0.339 mgd is discharged within Subbasin 21107 and 0.185 mgd is discharged into Subbasin 21012. Generally, discharges from a WTF are generated from sedimentation basin cleaning and filter backwash that are equalized and discharged from a settling lagoon. Water from the lagoon is slowly decanted over the settled residuals, resulting in an intermittent discharge. These NPDES discharges were not included in the 2000-2004 data. These discharges result in an additional 0.524 mgd of wastewater returns from NPDES permitted surface water discharges in Subbasin 21019 that were not accounted for in 2000-2004.

Groundwater Discharges

In Massachusetts, groundwater discharges are regulated primarily by two programs depending on the quantity of effluent to be discharged. Flows less than 10,000 gpd are treated via septic systems and fall under the jurisdiction of the local Board of Health under Title 5 (310 CMR 15). Septic system discharges provide localized direct groundwater recharge opportunities. Flows greater than 10,000 gpd are regulated under the MassDEP's groundwater disposal program (314 CMR 5). MassDEP-regulated groundwater discharges require treatment and also provide direct groundwater recharge. Changes in both septic system discharges and MassDEP regulated groundwater discharges were evaluated as part of this task.

Septic System Discharges

The 2000-2004 Estimated August Septic System Discharges were obtained from Table 1-2 of Appendix 1 of the MWI Report. Based on this data, the 2000-2004 Estimated August septic system discharge for Subbasin 21019 was determined to be 2.262 mgd. Discharges from septic systems were calculated by multiplying the estimated year 2000 population served by septic systems in the subbasin by a constant year-round discharge rate of 57 gallons per capita per day, which is 85% of the average annual, statewide residential withdrawal rate of 67 gallons per capita per day, as determined by MassDEP.

To determine if significant changes to the septic system discharges have occurred, each community that is wholly or partially contained within the upstream contributing watershed was contacted to determine whether there have been any changes to the sewershed since 2004 that impact groundwater discharges (Adamski, T. Phone Notes). A summary of this evaluation is provided below in Table 7-9.

Table 7-9. Summary of Sewer/Septic System Discharges within Upstream Contributing Watershed

Town	Wastewater Disposal Method	Changes since 2004?
Wilmington	Sewer - MWRA	No
Reading	Sewer - MWRA	No
Woburn	Sewer - MWRA	No
Burlington	Sewer - MWRA	No
Peabody	Sewer - SESD	No
Danvers	Sewer - SESD	No
Middleton	Sewer – SESD & Septic	No
North Reading	Septic	No
Lynnfield	Septic	No
Tewksbury	Sewer-Lowell & Septic	Yes
Andover	Sewer-GLSD & Septic	No
North Andover	Septic	No
Billerica	Sewer – Billerica & Septic	Yes

MWRA = Massachusetts Water Resources Authority
SESD = South Essex Sewerage District
GLSD = Greater Lawrence Sanitary District

There has been minimal change to the method of sewage collection and disposal in the watershed communities since 2004. Andover extended sewers into the watershed area in the 2000-2004 timeframe, servicing approximately 100 parcels, but has not had any additional sewer extensions into the watershed since that time. Two communities did extend sewers into the watershed area contributing to Subbasin 21019 since 2004. Within the target watershed, the Town of Billerica has expanded its sewer system by approximately 1.8 miles to serve approximately 86 households. The expansion occurred within the eastern corner of the Town along Connolly Road, Farm Street, Branch Street, Olney Street, Green Street, Forest Street, Glade Street and Greenleaf Street and is located within the upstream contributing watershed to Subbasin 21019. Furthermore, over the past 10 years, Tewksbury has extended its sewer system along Main Street to serve

approximately 43 buildings; all located within the contributing watershed to Subbasin 21019.

The changes in septic system discharge flows were determined using 57 gallons per capita per day, the standard used in the MWI Report, and assuming an average of 3 persons per household. The reduction in septic system contribution to groundwater recharge from the expansion of the Billerica and Tewksbury sewer systems is equivalent to approximately 0.022 mgd.

MassDEP Regulated Groundwater Discharges

The Pilot Project also identified changes to groundwater discharges from facilities with MassDEP-issued groundwater discharge permits by comparing discharges used in the USGS model to 2007-2011 data for the upstream contributing area. Based on consultation with MassDEP, the Pilot Project obtained a list of facilities used in the USGS model to determine the 2000-2004 average August groundwater discharge values. Using this list and MassGIS data layer "MassDEP Ground Water Discharge Permits" to identify current groundwater dischargers, a list of facilities within the contributing watershed to Subbasin 21019 was developed.

Groundwater Discharge Monitoring Reports (GWD Reports) were requested from MassDEP for each of the facilities identified. The GWD Reports provided for the facilities showed facilities generally sampled effluent flow one random day per month. Based on a review of these reports and data provided by MassDEP, it appears that the USGS model used the five-year average of the value that was recorded during the one day of sampling in August. Note that if the discharge on the one day in August when sampling was performed was unusually high or low, the data may be skewed and may not accurately reflect the August average discharge. However, this is the best available data to determine groundwater discharge contributions from these sources.

The GWD Reports cover nine facilities in the Towns of Andover, Middleton, North Reading and Wilmington. Reports were reviewed to identify changes in groundwater discharges since 2000-2004. As the SWMI Framework uses data over a five-year period (2000-2004), changes in discharges were evaluated over the most recent five year time period with available data (2007-2011). Consistent with the SWMI methodology, the value reported in each facility's GWD Reports during the one day of sampling in August for each year within the 2007-2011 period was averaged over the years that a facility was in existence and was discharging under a GWD permit during that period.

Table 7-10 compares the average August discharges from 2000-2004 to those from 2007-2011 on a subbasin level.

Table 7-10. Subbasin 21019 – Average August Discharge 2000-2004 vs 2007-2011			
Subbasin	**Facility**	**Subbasin August Average Discharge (mgd)**	
		2000-2004[1]	**2007-2011**
21073	Greenbriar Estates Condos[1]	**.080**	**0.109**
	US Postal Service		
	Meadowview Care & Rehab Center[3,4]		
	Colonial Drive Condo		
	Park Colony Condos		
	Edgewood Luxury Apartments[4]	n/a[2]	
21074	Wilmington Realty Trust[5,6]	**0.006**	**0.018**
	Regency Place[2]	n/a[2]	
21019	Fuller Pond Village	**0.040**	**0.042**
	Middleton Marketplace[1]		
Total:		**0.125**	**0.165**

[1]Monthly Maximum GWD Reports were provided. As such, the five-year average for these facilities is based on the reported August maximum flow
[2] Facility did not have a discharge permit over the 2000-2004 time period
[3] Formerly known as Sunbridge Care
[4]GWD Reports reported monthly average discharge volumes. The actual August average discharge was used.
[5]Formerly known as Ametek
[6]Wilmington Realty Trust did not perform any sampling in August 2008. The average August discharge was calculated based on the four years for which August discharge data was available.

The average August discharge within Subbasin 21073 increased approximately 36% from 0.080 mgd to 0.109 mgd. Within Subbasin 21074, the average August discharges increased by 200% from 0.006 mgd to 0.018 mgd. There was no significant change observed regarding the average August discharges within Subbasin 21019. In summary, the change in returns from groundwater discharges to the contributing watershed of Subbasin 21019 increased by 0.040 mgd since 2000-2004.

The increase in discharges within Subbasins 21073 and 21074 are attributed to the two new groundwater discharge permits that have been issued since 2000-2004. Edgewood Luxury Apartments, located in Subbasin 21073, began discharging under a GWD permit in 2009 and Regency Place, located in Subbasin 21074, began discharging in 2008.

The following sections evaluate how changes in withdrawals located in the contributing upstream watershed affect Subbasin 21019's BC and GWL designations.

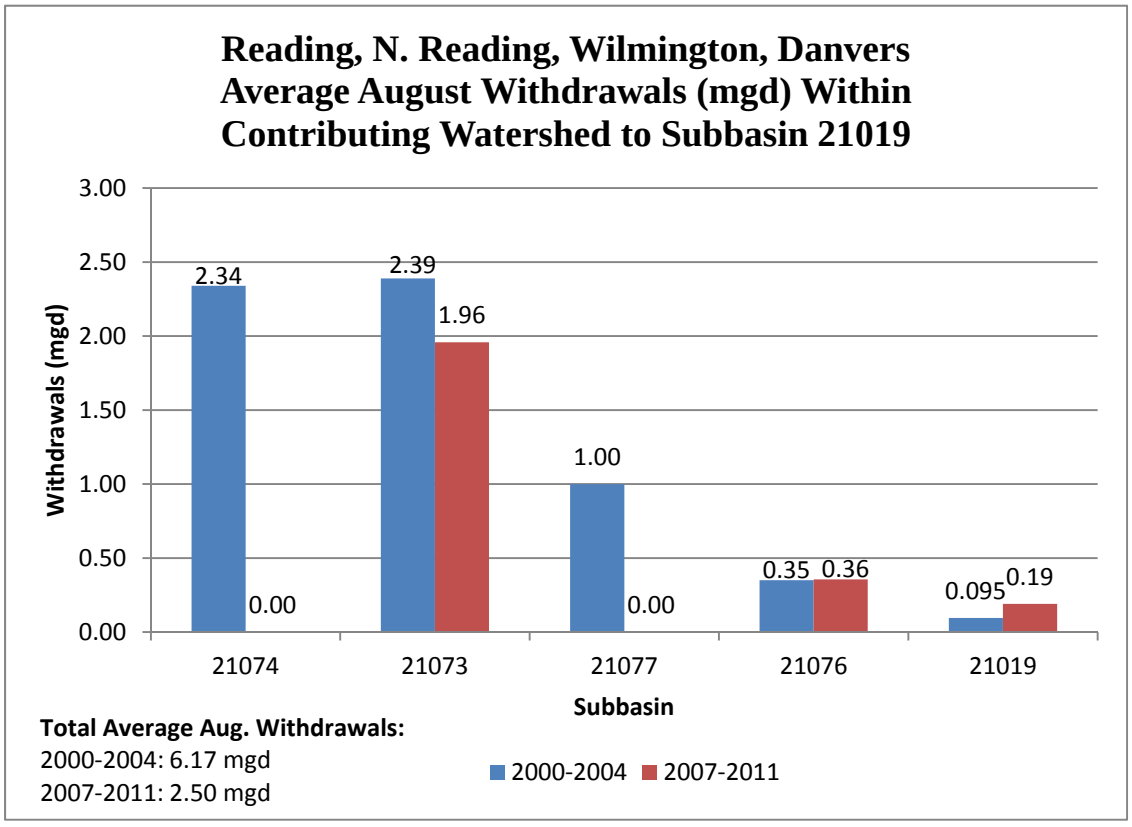
7.2.4 Impact on GWL Designation

Per Table 1-2 of Appendix 1 of the MWI Report, the USGS model used 7.29 mgd as the total estimated August groundwater withdrawals to determine the GWL of Subbasin 21019. This value represents the withdrawals for all WMA permitted wells and estimated private well withdrawals in Subbasin 21019 and contributing upstream subbasins. As

discussed in Section 7.2.2, this Pilot has reviewed more recent data for the estimated August groundwater withdrawals for the upstream withdrawal points located in Reading, North Reading, and Wilmington to determine their impact on Subbasin 21019's GWL.

Figure 7-6 presents the 2000-2004 Average August withdrawals based on actual withdrawal data and 2007-2011 average August withdrawals within upstream nested subbasins attributable to Reading, North Reading, and Wilmington to gauge the impact that recent changes in withdrawals may have on the GWL designation. As indicated on Figure 7-6, 2007-2011 average August withdrawals in three upstream subbasins decreased significantly compared to the 2000-2004 actual average August withdrawals.

Figure 7-6
Reading, North Reading, Wilmington, and Danvers Average August Withdrawals within Contributing Watershed to Subbasin 21019



Based on review of ASRs for Reading, North Reading, Wilmington, and Danvers-Middleton the average August withdrawal attributed to these communities decreased from 6.17 mgd from 2000-2004 and to 2.50 mgd from 2007-2011.

To compare the data and the resulting impact on GWL and BC, the withdrawals for Danvers, Reading, North Reading and Wilmington were calculated in three ways:

1. USGS model values, determined by multiplying the 2000-2004 Annual Average withdrawals by the August seasonal peaking factor of 115.5%;
2. Actual average August withdrawals from ASRs from the 2000-2004 timeframe; and
3. Actual average August withdrawals from ASRs from the 2007-2011 timeframe.

In order to determine the value of other withdrawals in the subbasin, the sum of Reading, North Reading, Wilmington, and Danvers USGS model withdrawals (6.056 mgd mgd) was subtracted from the USGS model Total Estimated August Groundwater Withdrawals (7.29 mgd). The remainder of 1.234 mgd was attributed to other PWSs within the contributing area including Lynnfield and Peabody and private well withdrawals. The results of these calculations are presented in Figure 7-7 and Table 7-11.

Figure 7-7 and Table 7-11 compare the GWL designation for Subbasin 21019 under the three scenarios described above. The unaffected August flow at the pour point of this subbasin is 8.27 mgd. Withdrawals greater than 55%, or approximately 4.6 mgd, result in a GWL5 designation for the subbasin. Using estimated or actual 2000-2004 data, the GWL for Subbasin 21019 was GWL5. Using 2007-2011 data, the GWL for subbasin 21019 is GWL4.

The GW Withdrawals bars in Figure 7-7 illustrate August withdrawals under the three demand scenarios and the portion of those estimated withdrawals attributed to Danvers' wells and those in Reading, North Reading, and Wilmington. Other withdrawals represented in Figure 7-7 consist of the remaining WMA permitted groundwater withdrawals and private wells in and upstream of Subbasin 21019, including the sources located in Lynnfield and Peabody.

Figure 7-7
Danvers Flow Level Determination – Subbasin 21019 – 2000-2004 (model and actual) vs 2007-2011

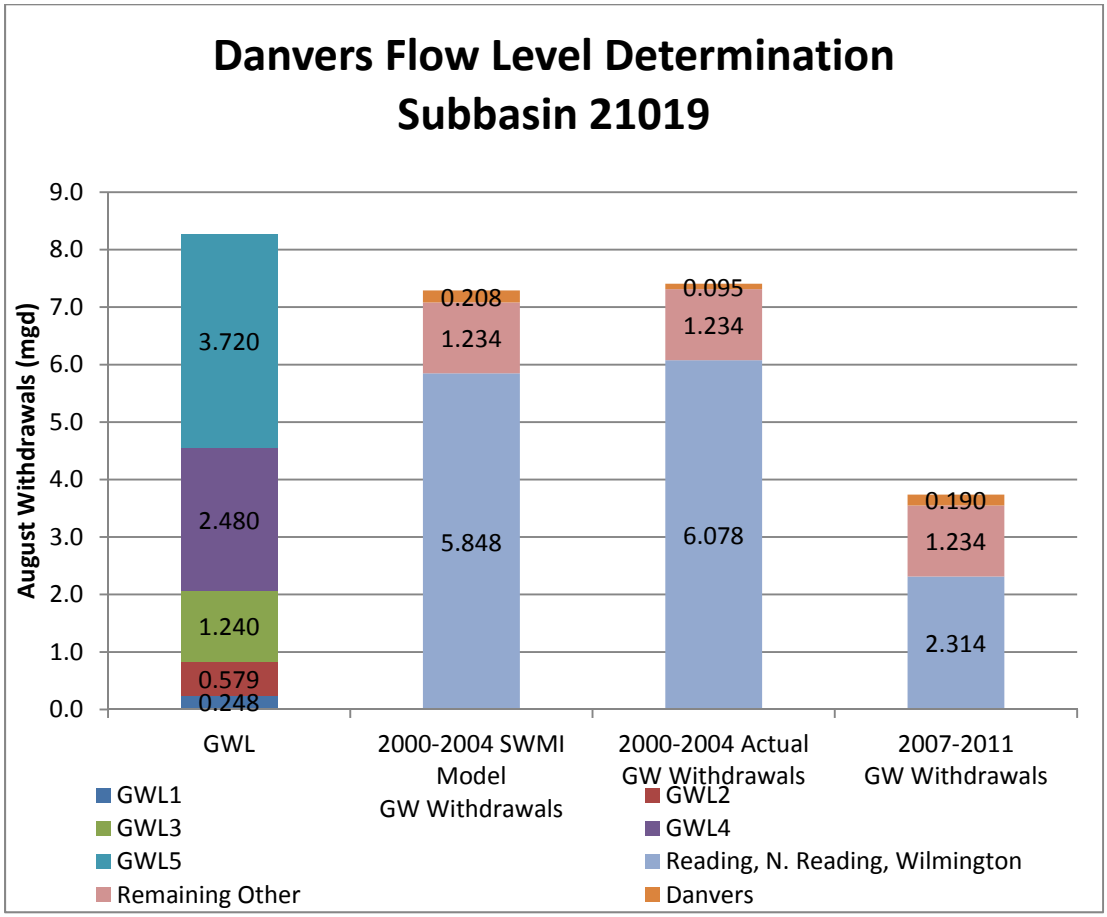


Table 7-11. Danvers – GWL Determination			
Criterion	**2000-2004 Model**	**2000-2004 Actual**	**2007-2011**
Unaffected August Flow (mgd)	8.27		
Danvers Average August Withdrawal (mgd)	0.208	0.095	0.190
Adjusted Estimated Total August Groundwater Withdrawals used in GWL Designation (mgd)	7.29	7.407	3.739
August Flow Alteration (%)	88%	90%	45%
Groundwater Withdrawal Level	5	5	4

As illustrated by Figure 7-7 and Table 7-11, using both 2000-2004 actual and USGS model withdrawal data, Subbasin 21019 is estimated to have greater than 55% alteration of unaffected August median flow and is designated as a GWL5 subbasin. However, using the 2007-2011 withdrawal data decreases the percent alteration of August flow to 45% and changes the subbasin's GWL designation to GWL4.

7.2.5 Impact on BC Determination

Using 2000-2004 withdrawal data, Subbasin 21019 is designated as BC5. As noted above, the regression equation used to determine the BC designation for each subbasin was not publically available at the time of this report. However, in general, BCs are based on the percent biological alteration as expressed by impervious cover and flow alteration caused by groundwater withdrawals. Based on consultation with MassDEP, Subbasin 21019's BC designation does not change when evaluated based on the significantly reduced withdrawals observed over the 2007-2011 timeframe for the communities of Danvers, Middleton, Reading, North Reading, and Wilmington. As the large decrease in groundwater withdrawals did not impact the subbasin's BC designation, it is likely that percent impervious cover within the subbasin is the controlling factor in determining the BC designation.

7.3 Dedham-Westwood

The Towns of Dedham and Westwood are served by the Dedham-Westwood Water District (DWWD). Dedham-Westwood's groundwater sources are from Subbasins 21036 and 21113, located in the Charles River Basin, and Subbasins 21040 and 21108, located in the Boston Harbor/Neponset Basin.

Annual Data

Tables 7-12, 7-13, 7-14, and 7-15 summarize the total annual average withdrawals from each of the four subbasins.

Table 7-12 Dedham-Westwood - Neponset River Basin - Subbasin 21107 - Average Annual Withdrawals (mgd)

Source	2000		2001		2002		2003		2004		5-Year Average	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model
White Lodge Well #1 (-06G)	0.648	0.648	0.666	0.666	0.624	0.624	0.684	0.684	0.605	0.605	0.645	0.645
White Lodge Well #5 (-13G)	0.896	0.896	0.899	0.899	0.881	0.881	0.968	0.968	0.749	0.749	0.879	0.879
										Total	**1.524**	**1.524**

Table 7-13. Dedham-Westwood - Neponset River Basin - Subbasin 21040 - Average Annual Withdrawals (mgd)												
Source	2000		2001		2002		2003		2004		5-Year Average	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model
White Lodge Well #2 (-07G)	0.623	0.623	0.514	0.514	0.601	0.601	0.477	0.477	0.531	0.531	0.549	0.549
White Lodge Well #3 (-08G)	0.221	0.221	0.392	0.392	0.342	0.342	0.339	0.339	0.339	0.339	0.327	0.327
White Lodge Well #4 (-09G)	0.418	0.418	0.649	0.649	0.352	0.352	0.458	0.458	0.840	0.840	0.544	0.544
										Total	**1.419**	**1.419**

Table 7-14. Dedham-Westwood - Charles River Basin - Subbasin 21113- Average Annual Withdrawals (mgd)												
Source	2000		2001		2002		2003		2004		5-Year Average	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model
Well A2 (-01G)	0.038	0.038	0.000	0.000	0.000	I	I	I	I	I	0.008	0.019
Well B1 (-02G)	0.126	0.126	0.207	0.207	0.242	0.242	0.238	0.238	0.131	0.131	0.189	0.189
Well B2 (-14G)	-	-	-	-	-	0.000	0.000	0.000	0.047	0.047	0.009	0.016
Well D1 (-03G)	0.321	0.321	0.298	0.298	0.220	0.220	0.311	0.311	0.151	0.151	0.260	0.260
Well D2 (-15G)	-	-	-	-	-	0.000	0.012	0.012	0.276	0.276	0.058	0.096
Well E (-04G)	0.399	0.399	0.333	0.333	0.286	0.286	0.219	0.219	0.071	0.071	0.262	0.262
Well E1 (-16G)	-	-	-	-	-	0.000	0.016	0.016	0.272	0.272	0.058	0.096
Well E2 (-17G)	-	-	-	-	-	0.000	0.021	0.021	0.366	0.366	0.077	0.129
Well F (-05G)	0.441	0.441	0.285	0.285	0.362	0.362	0.361	0.361	0.308	0.308	0.351	0.351
										Total	**1.271**	**1.417**

Note: I indicates "Inactive" source. In all instances SYE database note the status and attributes 0 withdrawals to these sources. A "–" indicates the source was not included in the ASR and/or the SYE Database.

Table 7-15. Dedham-Westwood - Charles River Basin - Subbasin 21036- Average Annual Withdrawal (mgd)												
Source	2000		2001		2002		2003		2004		5-Year Average	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model
Rock Meadow Well 11 (-10G)	0.000	0.000	0.062	0.062	0.089	0.089	0.004	0.004	0.007	0.007	0.032	0.032
Dover Road Well (-11G)	-	A	-	A	-	A	-	A	-	A	0.000	0.000
Rock Meadow Tubular Wells (-12G)	-	I	-	I	-	I	-	I	-	I	0.000	0.000
										Total	**0.032**	**0.032**

Note: I indicates "Inactive" source. A indicates "Abandoned Source. A "-" indicates the source was not included in the ASR and/or the SYE Database.

The 2004 ASR reported the 2004 annual withdrawal for White Lodge Well #5 as 288 MG; however, the reported monthly numbers sum to 273.464 MG. As such, the corrected annual total was recorded above in Table 7-12 and used throughout this exercise. Note the model also used the corrected sum, as confirmed via the SYE database.

As illustrated in Table 7-14, there are differences between the actual and modeled 5-year average annual withdrawals from Subbasin 21113. These differences are due to the methodologies used to calculate the average rather than differences in the annual withdrawal data. The USGS model determined the 5-year average for a source by averaging withdrawals only over the years the source was active, resulting in averages of variable years. If a well was active but reported zero withdrawals it was included in the average. For example, the total withdrawal for Well B2 was averaged over three years, as the well was only active during 2002-2004.

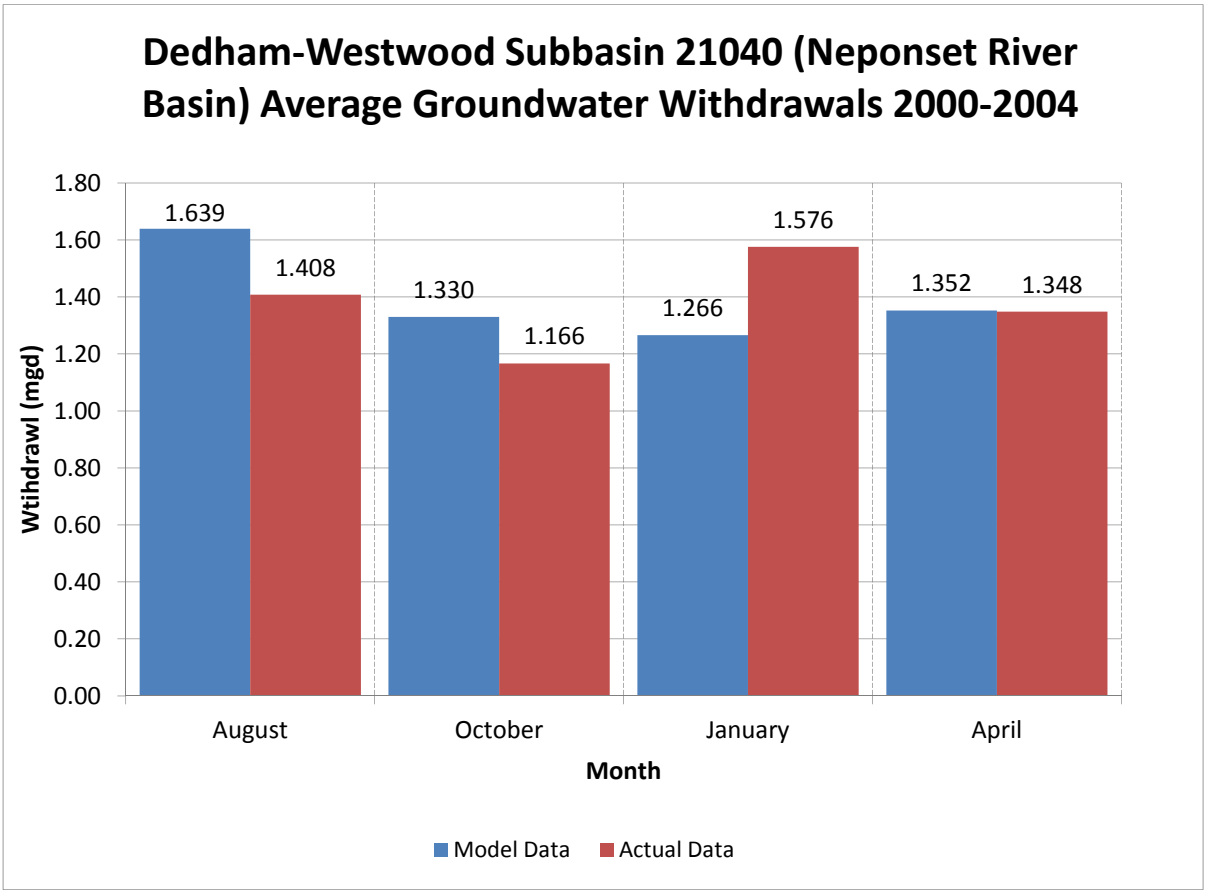
In contrast, when evaluating the actual withdrawal data the total withdrawals for each source over the 2000-2004 period were averaged over five years, regardless of whether the source was inactive or had no data reported. This method is considered to more accurately reflect average groundwater withdrawals over the five year period and was used in this Pilot to assess the impact of actual groundwater withdrawals on BC and GWL.

Seasonal Data

As described in Section 7.1, the MWI Report disaggregated the annual withdrawal data reported from their SYE model into monthly values by averaging the annual withdrawals and applying a monthly peaking factor. The resulting average monthly withdrawals were compared to estimated median monthly natural flow in determining the BC and GWL categories.

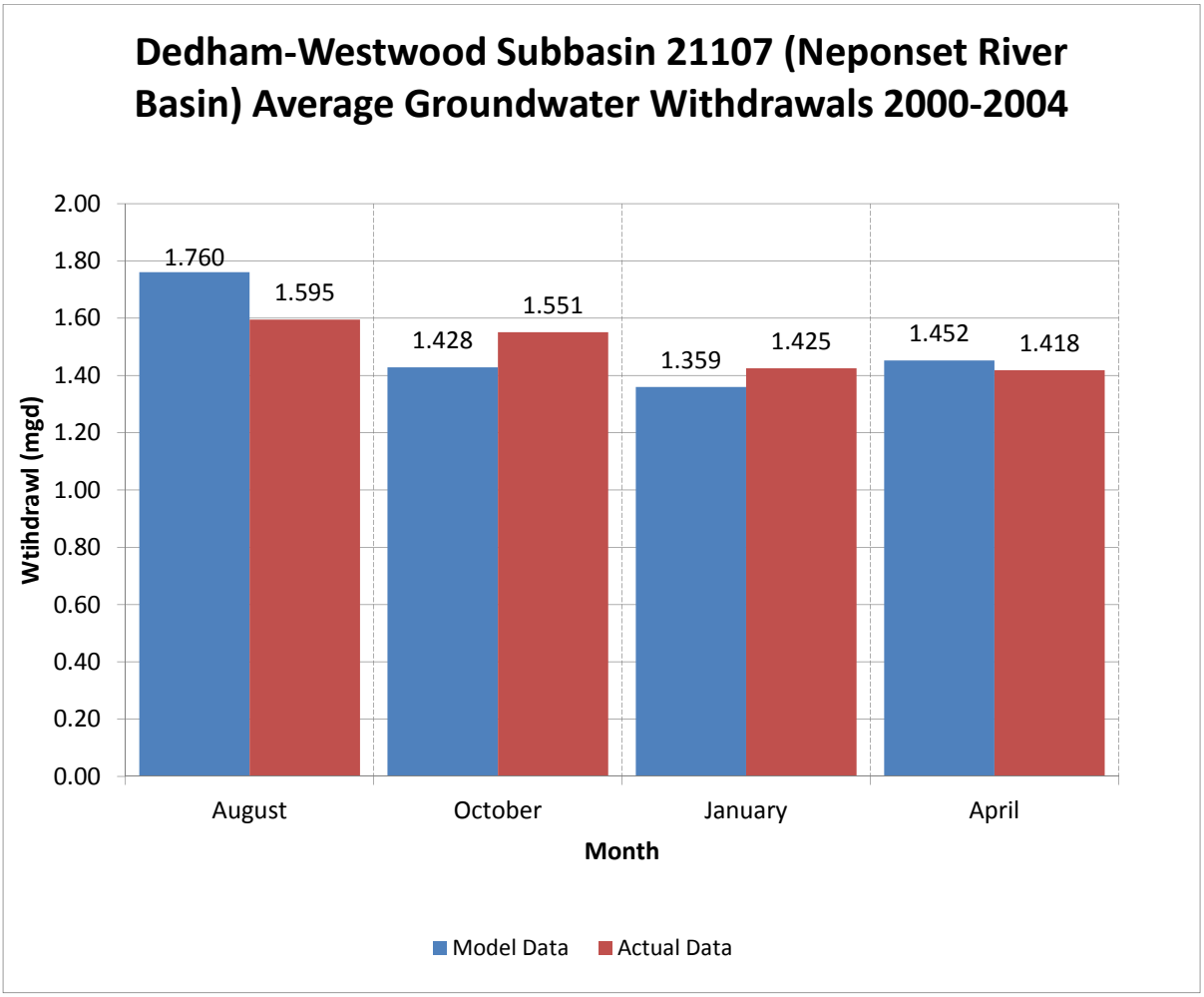
The below figures compare the estimated monthly withdrawals used for BC/GWL determination with actual monthly withdrawals from Dedham-Westwood's groundwater sources. Although BC/GWL determination is based on August withdrawals, the figures compare data for each of the four months used in the MWI analysis: January, April, August and October.

Figure 7-8
Dedham-Westwood – Subbasin 21040 Average Groundwater Withdrawals 2000-2004



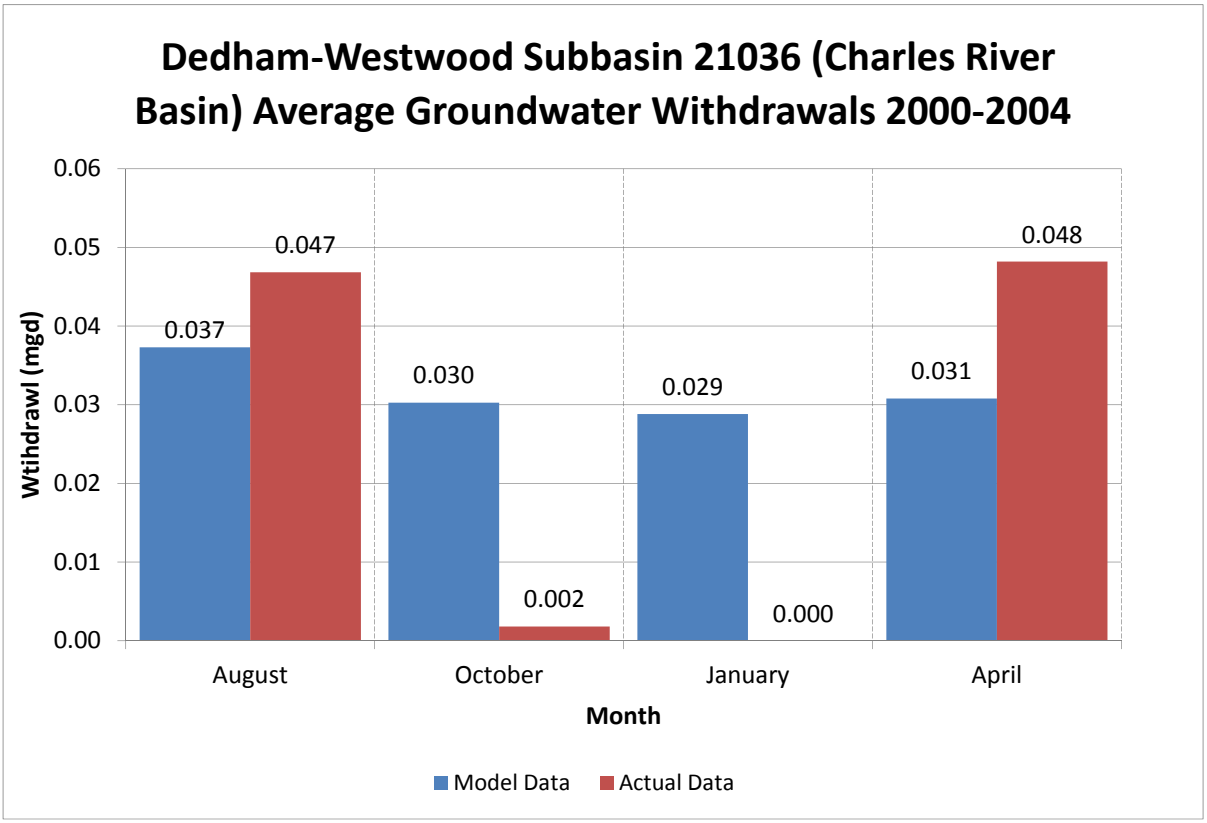
As Subbasin 21040 flows into Subbasin 21107, withdrawals from Subbasin 21040 affect flow alteration in both subbasins. As illustrated, the approach used in determining the GWLs resulted in inaccuracy in the estimated seasonal withdrawals in Subbasin 21040. August withdrawals were overestimated by approximately 14% and October withdrawals were overestimated by 12%. January withdrawals were underestimated by approximately 25%. The model was consistent with actual withdrawals for April.

Figure 7-9
Dedham-Westwood – Subbasin 21107 Average Groundwater Withdrawals 2000-2004



Subbasin 21107 contains White Lodge Well #5 which the PWS is precluded from operating during low-flow conditions. As illustrated above, August withdrawals were overestimated by approximately 10%. October and January withdrawals were underestimated by approximately 9% and 5%, respectively. April flows were overestimated by approximately 2%.

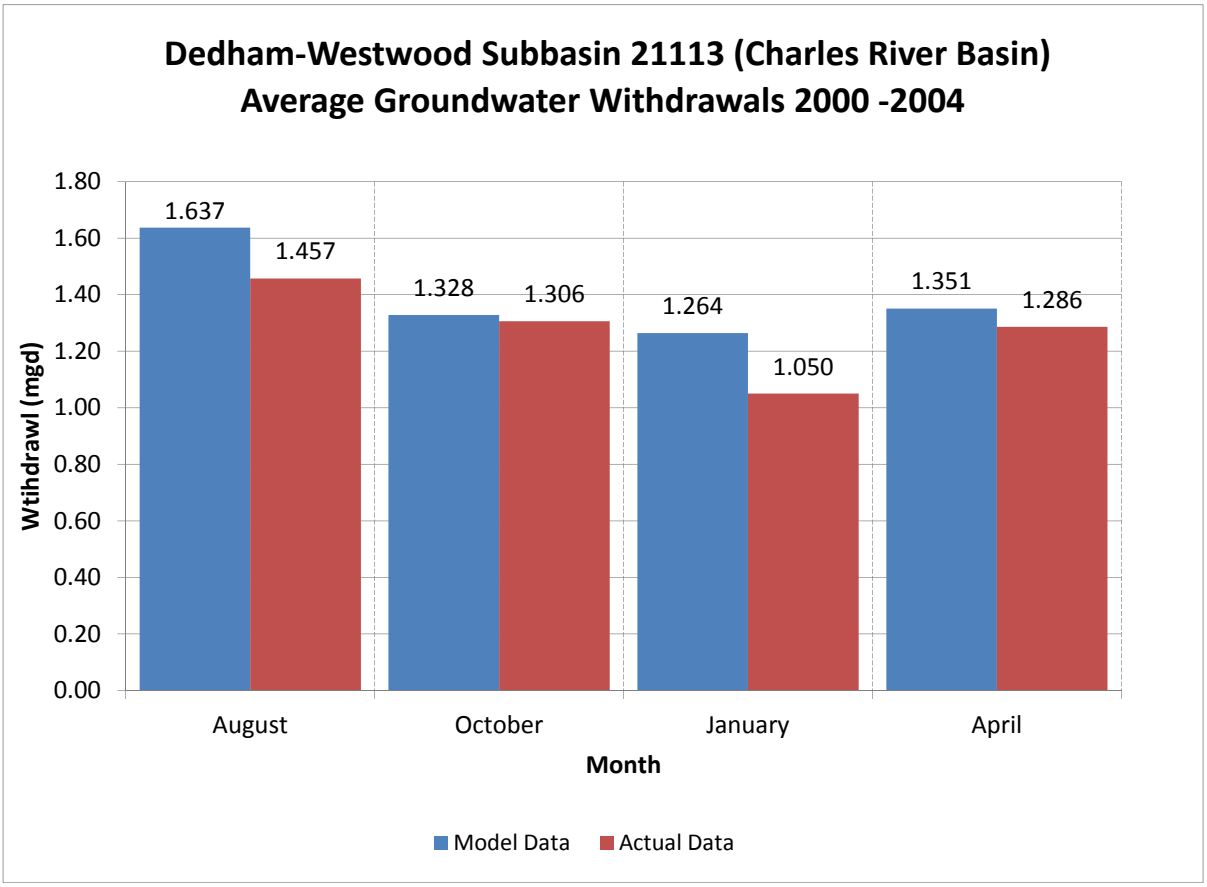
Figure 7-10
Dedham-Westwood – Subbasin 21036 Average Groundwater Withdrawals 2000-2004



During 2000-2004, Subbasin 21036 contained one active source [Rock Meadow Well 11 (-10G)]. As such, the above figure is based solely on the withdrawals of this one source. Additionally, as Subbasin 21036 flows into Subbasin 21113, the Rock Meadow Well withdrawals affect flow alteration in both subbasins. As illustrated, the approach used in determining the GWLs resulted in inaccuracy in the estimated seasonal withdrawals in Subbasin 21036. August and April withdrawals were underestimated by approximately 26% and 57%, respectively, and January and October withdrawals were far overestimated as the source was barely used in these months.

Rock Meadow Well 11 is high in iron, manganese, and color and is therefore only used as a last resort during periods of high demand. As noted above, the model data significantly overestimates January and October use and underestimates April and August use. This withdrawal pattern of long periods of inactivity followed by periods of withdrawals explains these discrepancies.

Figure 7-11
Dedham-Westwood – Subbasin 21113 Average Groundwater Withdrawals 2000-2004



Subbasin 21113 is located along the main stem of the Charles River and therefore this subbasin has an order of magnitude greater flow than the upstream Rock Meadow Well subbasin. However, there are also more withdrawals upstream of these sources. As illustrated above, August withdrawals were overestimated by approximately 11% and January withdrawals were overestimated by 17%. April and October withdrawals were also overestimated, though to a lesser degree. As noted earlier, the methodology used by the USGS model to determine the average annual withdrawal for each source only averages the withdrawals over the time period that the source was active. In the case of Dedham Westwood there are several wells that were only active for a portion of the 2000-2004 period. The USGS model only utilizes the average withdrawals from these wells during the period they were active. For example, if a well was active for one year with a withdrawal rate of 1 mgd, the USGS model assumes that the average withdrawal rate is 1 mgd. The actual data presented above would consider the average withdrawal from this well to be 0.2 mgd. This may explain why the monthly withdrawals predicted by the USGS model are consistently higher than those determined from actual withdrawal data, as illustrated by the above figure.

BC and GWL Impact

Tables 7-16, 7-17, 7-18, and 7-19 illustrate the impact that the differences between Dedham-Westwood's modeled and actual groundwater withdrawals would have upon the monthly percent flow alteration for each subbasin.

Table 7-16. Impact of Adjusted Withdrawals on % Flow Alteration – Subbasin 21107 (Neponset River Basin)

Month	Unaffected Median Flow (mgd)	Model Groundwater Withdrawals (mgd)	DWWD Withdrawals (mgd)		Adjusted Groundwater Withdrawals (mgd)	% Flow Alteration	
			Model	Actual		Model	Adjusted
August	17.58	11.68	1.76	1.59	11.52	66%	66%
October	34.29	9.52	1.43	1.55	9.64	28%	28%
January	110.52	9.08	1.36	1.43	9.14	8%	8%
April	155.04	10.00	1.45	1.42	9.96	6%	6%

Table 7-17. Impact of Adjusted Withdrawals on % Flow Alteration – Subbasin 21040 (Neponset River Basin)

Month	Unaffected Median Flow (mgd)	Model Groundwater Withdrawals (mgd)	DWWD Withdrawals (mgd)		Adjusted Groundwater Withdrawals (mgd)	% Flow Alteration	
			Model	Actual		Model	Adjusted
August	17.53	9.93	1.64	1.41	9.70	57%	55%
October	27.72	8.10	1.33	1.17	7.94	29%	29%
January	95.31	7.72	1.27	1.58	8.03	8%	8%
April	147.96	8.50	1.35	1.35	8.51	6%	6%

Table 7-18. Impact of Adjusted Withdrawals on % Flow Alteration – Subbasin 21113 (Charles River Basin)

Month	Unaffected Median Flow (mgd)	Model Groundwater Withdrawals (mgd)	DWWD Withdrawals (mgd)		Adjusted Groundwater Withdrawals (mgd)	% Flow Alteration	
			Model	Actual		Model	Adjusted
August	40.32	21.68	1.64	1.46	21.50	54%	53%
October	66.35	17.67	1.33	1.31	17.65	27%	27%
January	224.96	16.86	1.26	1.05	16.64	7%	7%
April	339.54	18.57	1.35	1.29	18.50	5%	5%

Table 7-19 Impact of Adjusted Withdrawals on % Flow Alteration – Subbasin 21036 (Charles River Basin)							
Month	Unaffected Median Flow (mgd)	Model Groundwater Withdrawals (mgd)	DWWD Withdrawals (mgd)		Adjusted Groundwater Withdrawals (mgd)	% Flow Alteration	
			Model	Actual		Model	Adjusted
August	0.41	0.10	0.04	0.05	0.11	24%	26%
October	0.68	0.08	0.03	0.00	0.05	12%	8%
January	2.75	0.08	0.03	0.00	0.05	3%	2%
April	4.74	0.09	0.03	0.05	0.11	2%	2%

The Unaffected Median Flow and Model Groundwater Withdrawals were derived from the MWI Report, Appendix 1 Table 1-2. Dedham-Westwood's modeled and actual withdrawals were taken from Figures 7-8 through 7-11. The Adjusted Groundwater Withdrawal was calculated by adjusting the Model Groundwater Withdrawal by the difference between Dedham-Westwood's modeled and actual withdrawals. The percent flow alteration is the ratio of model or adjusted groundwater withdrawals to the unaffected median flow in the subbasin.

In general, the BCs are based on the percent biological alteration as expressed by impervious cover and flow alteration. Based on model data, all of Dedham-Westwood's groundwater sources are located in BC5 category subbasins. As noted above, the regression equation used to determine the BC designation for each subbasin was not publically available at the time of this report. However, based on consultation with MassDEP, the BC designation of Subbasins 21036, 21113, 21040, and 21107 does not change when evaluated using the actual 2000-2004 groundwater withdrawals.

Subbasins 21107 and 21040 are both located in the Neponset River Basin and are designated as GWL5, indicating an alteration of >55% of the median August Streamflow. Using the corrected withdrawal data for Subbasin 21107 did not affect the flow alteration in any month. Using the corrected information for Subbasin 21040 slightly decreased the August Median Flow alteration from 57% to 55%, while not affecting the flow alteration percentage in the remaining months.

Subbasin 21113 and Subbasin 21036, both located within the Charles River Basin, are designated as GWL4 and GWL3, respectively. Using the corrected withdrawal data decreased the August Median Flow alteration for Subbasin 21113 from 54% to 53% and had no effect upon the percentage alteration for the remaining months. Using corrected withdrawal data for Subbasin 21036 slightly increased the August Median Flow alteration in Subbasin 21036 from 24% to 26%, which changes the GWL designation for this subbasin from GWL3 (10 to <25% alteration) to GWL4 (25 to <55% alteration). Under the SWMI Framework, a PWS increasing withdrawals in a subbasin with a GWL4 is required to minimize existing impacts to the greatest extent feasible and mitigate impacts commensurate with the impacts from additional withdrawals. A review of the 2005-2010 ASRs indicates that DWWD's withdrawal points within Subbasin 21036 (Dover Well and Rock Meadow Tubular Wells) are both inactive/abandoned or are only used to collect MassDEP-required quarterly monitoring samples. As there are no current

or anticipated withdrawals by DWWD within this subbasin, the change from GWL3 to GWL4 of subbasin 21036 does not affect the DWWD's permitting process.

7.4 Shrewsbury

Shrewsbury's water supply wells are located in the Blackstone River Basin within Subbasins 23008, 23002, and 23023.

Annual Data

Tables 7-20, 7-21 and 7-22 below summarize the total annual average withdrawals by subbasin for each of Shrewsbury's groundwater sources for 2000 through 2004.

Table 7-20. Shrewsbury - Subbasin 23002 Average Annual Withdrawals (mgd)

Source	2000		2001		2002		2003		2004		5-Year Average	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model
Home Farm 6.1 (-07G)	0.592	0.592	1.150	1.972	1.334	1.334	1.580	1.580	0.939	0.939	1.119	1.283
Home Farm 6.2 (-08G)	1.957	1.957	1.672	1.672	0.948	0.948	0.742	0.742	0.941	0.941	1.252	1.252
Home Farm 6.3 (-0G)	-	-	-	-	-	-	-	0.000	0.395	0.395	0.079	0.198
Lambert #3.1 (-04G)	0.338	0.338	0.411	0.411	0.296	0.296	0.248	0.248	0.403	0.403	0.339	0.339
Lambert #3.2 (-05G)	0.155	0.155	0.074	0.074	0.145	0.145	0.166	0.166	0.087	0.087	0.125	0.125
										Total	**2.915**	**3.198**

Table 7-21. Subbasin 23008 Average Annual Withdrawals (mgd)

Source	2000		2001		2002		2003		2004		5-Year Average	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model
Sewall #4 (-02G)	0.703	0.703	0.867	0.867	0.859	0.913	0.744	0.744	0.865	0.865	0.808	0.819
Sewall #5 (-06G)	0.002	0.002	0.000	0.000	0.001	0.001	0.000	A	A	A	0.001	0.001
										Total	**0.808**	**0.820**

Table 7-22.Subbasin 23023 Average Annual Withdrawals (mgd)												
Source	2000		2001		2002		2003		2004		5-Year Average	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model
South Street (-16G)	I	I	I	I	I	I	I	A	I	A	0.000	0.000
Oak Street (-03G)	I	E	I	E	I	E	I	A	A	A	0.000	0.000

Note: I indicates "Inactive" source. E indicates "Emergency" source. A indicates "Abandoned Source. In all instances SYE database note the status and attributes 0 withdrawals to these sources. A "-" indicates the source was not included in the ASR and/or SYE database.

As indicated in the above tables, discrepancies in the data were observed regarding the 2002 annual withdrawals for Sewall #4 (Table 7-21) and the 2001 annual withdrawals for Home Farm Well 6.1 (-07G) (Table 7-20). The 2002 ASR incorrectly sums the monthly withdrawals for Sewall #4 and reports an incorrect annual withdrawal of 333.361 MG (0.913 mgd). The correct sum of the monthly withdrawals is 313.361 MG (0.859 mgd). The corrected sum was used in this exercise to determine the actual withdrawals over the 2000-2004 time period; however, the SYE database used the incorrect sum. Using the corrected annual withdrawal data, the 5-year average for the Sewall #4 source slightly decreased from 0.819 mgd (model data) to 0.808 mgd (actual data).

The 2001 ASR indicates that 419.919 MG (1.150 mgd) was withdrawn from Well Home Farm 6.1 in 2001; however, the SYE database and model input used 719.919 MG (1.972 mgd) as the annual withdrawal, likely as a result of human error. Using the corrected annual withdrawal data, the 5-year average for the Home Farm Well 6.1 decreased from 1.283 mgd (model data) to 1.119 mgd (actual data).

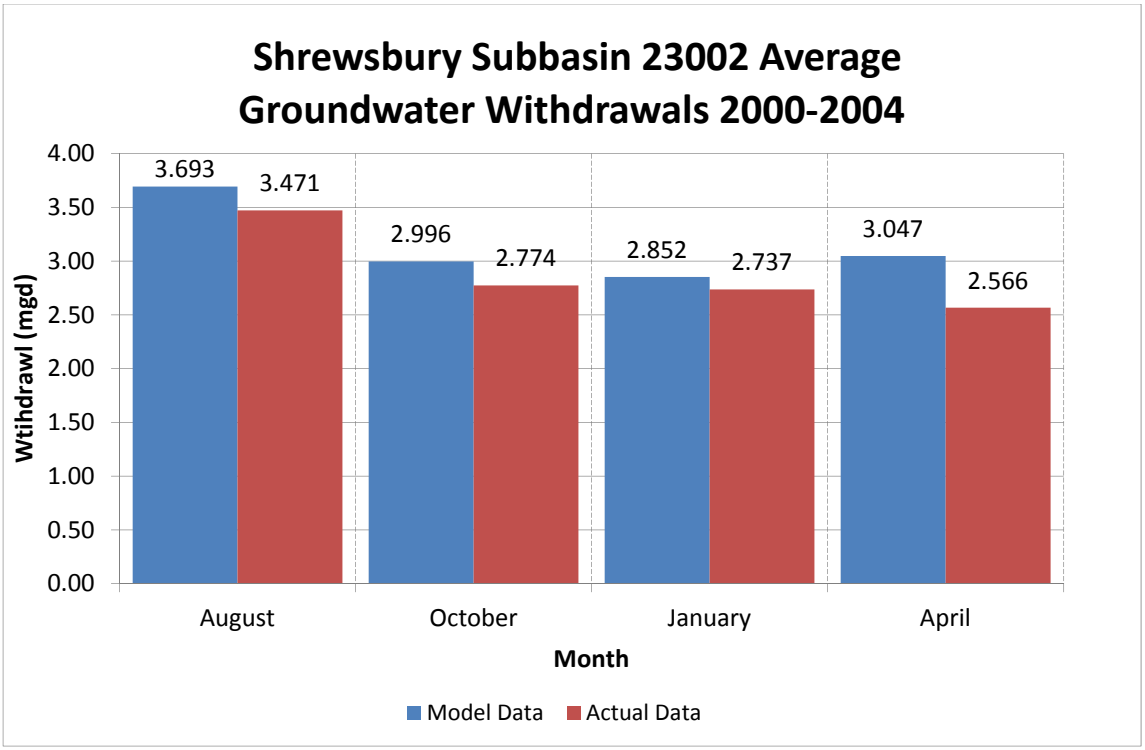
Other discrepancies were observed regarding the status of certain sources. Noted differences include the status of the Oak Street and Sewall #5 Sources. The ASRs report the Oak Street well as an inactive source (with zero withdrawals) from 2000 through 2003, noting it is an abandoned source in 2004. The SYE database (and model input) indicates the source is an emergency source from 2000 through 2002, noting it is an abandoned source in 2003, thus the average is only calculated over the three years the source was listed as active. Similarly, the 2003 ASR indicates that Sewell #5 is an active source in 2003 with no withdrawals; however, the SYE database indicates the source is an abandoned source in 2003.

Seasonal Data

As described in Section 7.1, the MWI Report disaggregated the annual withdrawal data reported from their SYE model into monthly values by averaging the annual withdrawals and applying a monthly peaking factor. The resulting average monthly withdrawals were compared to estimated median monthly natural flow in determining the BC and GWL categories.

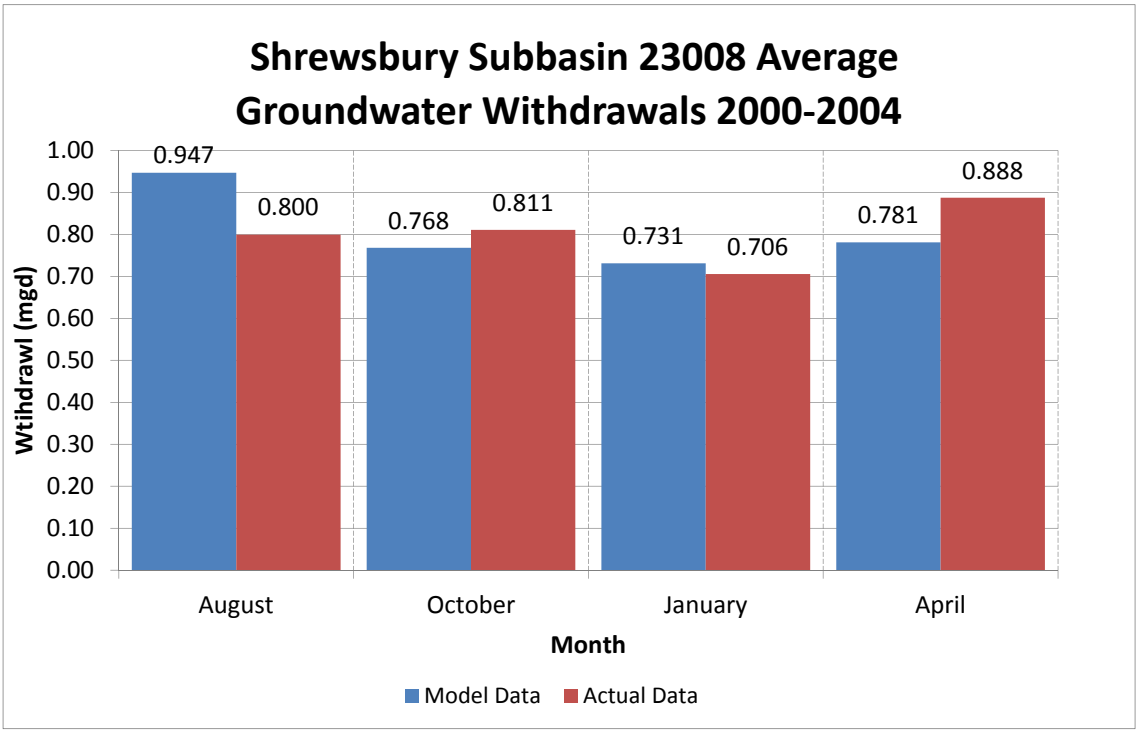
The below figures compare the estimated monthly withdrawals used for BC/GWL determination with actual monthly withdrawals from Shrewsbury's groundwater sources. Although BC/GWL determination is based on August withdrawals, the figures compare data for each of the four months used in the MWI analysis: January, April, August and October. There were no withdrawals recorded over the 2000-2004 time period from Shrewsbury's two sources located in Subbasin 23023 as they were inactive and eventually abandoned over the study period. As such, the sources within Subbasin 23023 are not assessed further.

Figure 7-12
Shrewsbury – Subbasin 23002 Average Groundwater Withdrawals 2000-2004



As illustrated in Figure 7-12, the approach used in determining the GWL for Subbasin 23002 (Home Farm and Lambert wells) was inaccurate, although not to the extent found for some of the other Pilot Project examples. August withdrawals, used in the BC and GWL determinations, were overestimated by approximately 6%. January withdrawals were overestimated by approximately 4% and October withdrawals were overestimated by approximately 7%; however, April withdrawals were overestimated by approximately 16%. As indicated earlier, some of the inaccuracy regarding the model data may be attributed to the incorrect annual withdrawal data that was input into the model for Home Farm 6.1.

Figure 7-13
Shrewsbury – Subbasin 23008 Average Groundwater Withdrawals 2000-2004



As illustrated above, the approach used in determining the GWL for Subbasin 23008 (Sewell Wells) resulted in significant inaccuracy in the estimated seasonal withdrawals. August withdrawals were overestimated by approximately 16% and April withdrawals were underestimated by 14%.

As indicated earlier, some of the inaccuracy regarding the model data may be attributed to the incorrect annual withdrawal data that was input into the model for Sewell #4. Some of this inaccuracy may also be attributed to the fact that Sewell Well #5 was abandoned (due to poor yield) during the 2000-2004 period and the well's authorized withdrawal volume was transferred to the Home Farm Wells. Furthermore, due to treatment operating constraints, the water from the Sewell wells can only be operated in conjunction with at least one of the Town's other wells; thus it always serves as a supplemental supply. This may explain why the actual groundwater withdrawals in August are much less than those predicted using the state-wide peaking factors. Note that as Subbasin 23008 flows into Subbasin 23002, the Sewell Well withdrawals affect flow alteration in both subbasins.

BC and GWL Impact

Tables 7-23 and 7-24 illustrate the impact that the differences between Shrewsbury's modeled and actual groundwater withdrawals would have upon the monthly percent flow alteration for Subbasins 23002 and 23008.

Table 7-23. Impact of Adjusted Withdrawals on % Flow Alteration – Subbasin 23008 (Sewall #4, Sewall #5)							
Month	Unaffected Median Flow (mgd)	Model Groundwater Withdrawals (mgd)	DWWD Withdrawals (mgd)		Adjusted Groundwater Withdrawals (mgd)	% Flow Alteration	
			Model	Actual		Model	Adjusted
August	0.93	1.47	0.95	0.80	1.32	158%	142%
October	1.25	1.22	0.77	0.81	1.27	98%	101%
January	3.49	1.18	0.73	0.71	1.16	34%	33%
April	9.10	1.29	0.78	0.89	1.39	14%	15%

Table 7-24. Impact of Adjusted Withdrawals on % Flow Alteration – Subbasin 23002 (Home Farm and Lambert)							
Month	Unaffected Median Flow (mgd)	Model Groundwater Withdrawals (mgd)	DWWD Withdrawals (mgd)		Adjusted Groundwater Withdrawals (mgd)	% Flow Alteration	
			Model	Actual		Model	Adjusted
August	3.96	5.16	3.69	3.47	4.94	131%	125%
October	5.38	4.23	3.00	2.77	4.00	79%	74%
January	14.50	4.03	2.85	2.74	3.92	28%	27%
April	36.17	4.44	3.05	2.57	3.95	12%	11%

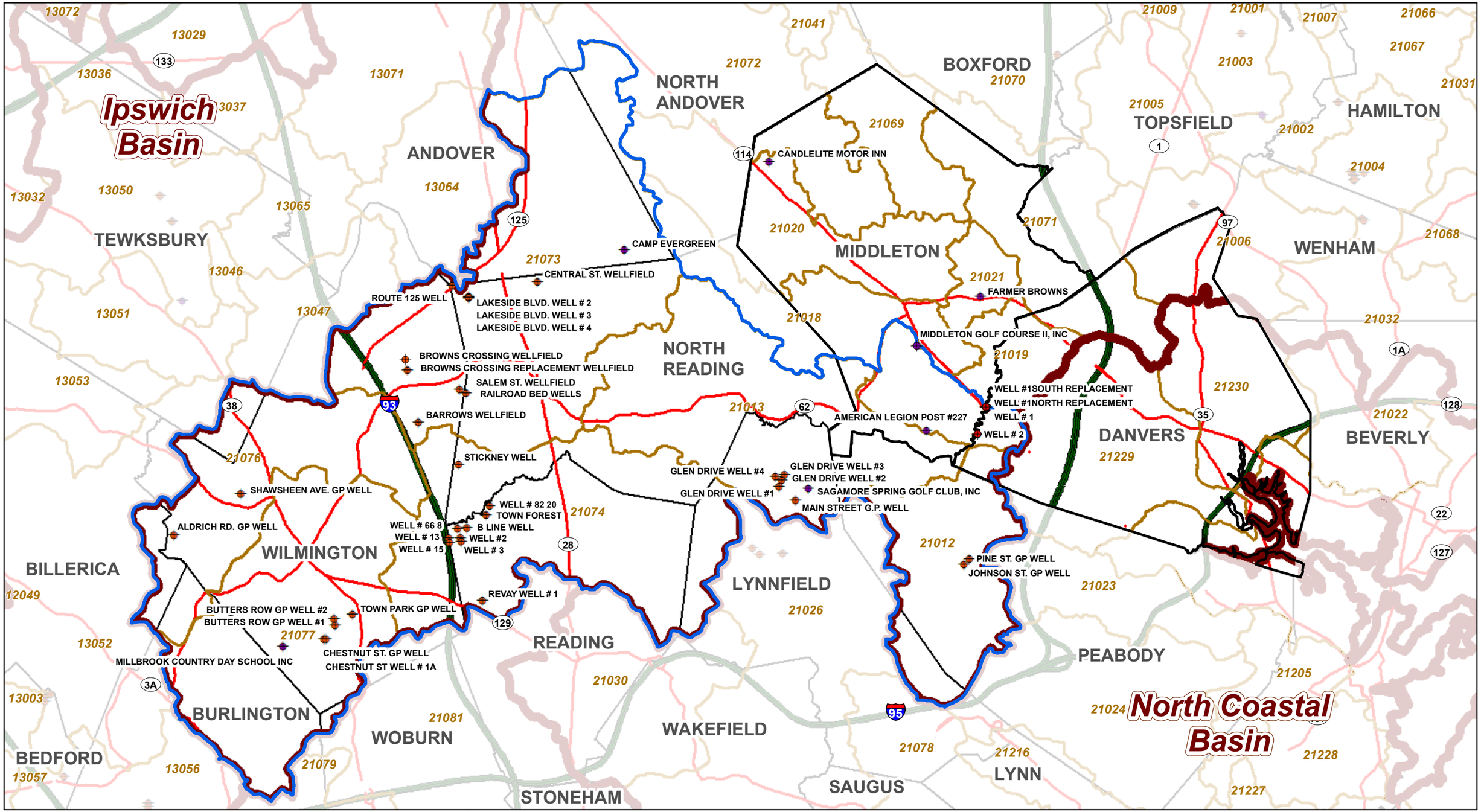
The Unaffected Median Flow and Model Groundwater Withdrawals were derived from the MWI Report, Appendix 1 Table 1-2. Shrewsbury's modeled and actual withdrawals were taken from Figures 7-12 and 7-13. The Adjusted Groundwater Withdrawal was calculated by adjusting the Model Groundwater Withdrawal by the difference between Shrewsbury's modeled and actual withdrawals. The percent flow alteration is the ratio of model or adjusted groundwater withdrawals to the unaffected median flow in the subbasin.

In general, the BCs are based on the percent biological alteration as expressed by impervious cover and flow alteration. Based on model data, all Shrewsbury's groundwater sources are located in BC5 category subbasins. As noted above, the regression equation used to determine the BC designation for each subbasin was not publically available at the time of this report. However, based on consultation with MassDEP, the BC designation of Subbasins 23008 and 23002 does not change when evaluated using the actual 2000-2004 groundwater withdrawals.

As shown above, the corrected withdrawal data reduces the estimated August Median Flow alteration in Subbasin 23008 from 158% to 142%. This reduction is not sufficient to change the GWL designation of the subbasin from GWL5 to GWL4. However; it can be noted that the Subbasin 23008 flow alteration is greater than allowable for GWL3 subbasins in October, January and April.

As indicated in Table 7-24, the corrected Shrewsbury withdrawal data reduces the estimated August Median Flow alteration in Subbasin 23002 from 131% to 125%, however this reduction is not sufficient to change the GWL designation of the subbasin

from GWL5 to GWL4. The flow alteration for subbasin 23002 is greater than the seasonal alteration criteria for GWL3 subbasins in October, January and April.



LEGEND

- Community Groundwater Well
- Non-Community Non-Transient Public Water Supply
- Non-Community Transient Public Water Supply
- Watershed Boundary
- Major Basin Boundary
- Subbasin Boundary
- Town Boundary

N, W, E, S

0 2,250 4,500 9,000 13,500 Feet

0 0.5 1 2 3 Miles

Figure 7-3
Massachusetts
Sustainable Water Management Initiative (SWMI) Pilot Program

WATER WITHDRAWALS MAP

Danvers - Middleton, Massachusetts

Comprehensive Environmental Incorporated | Tighe&Bond

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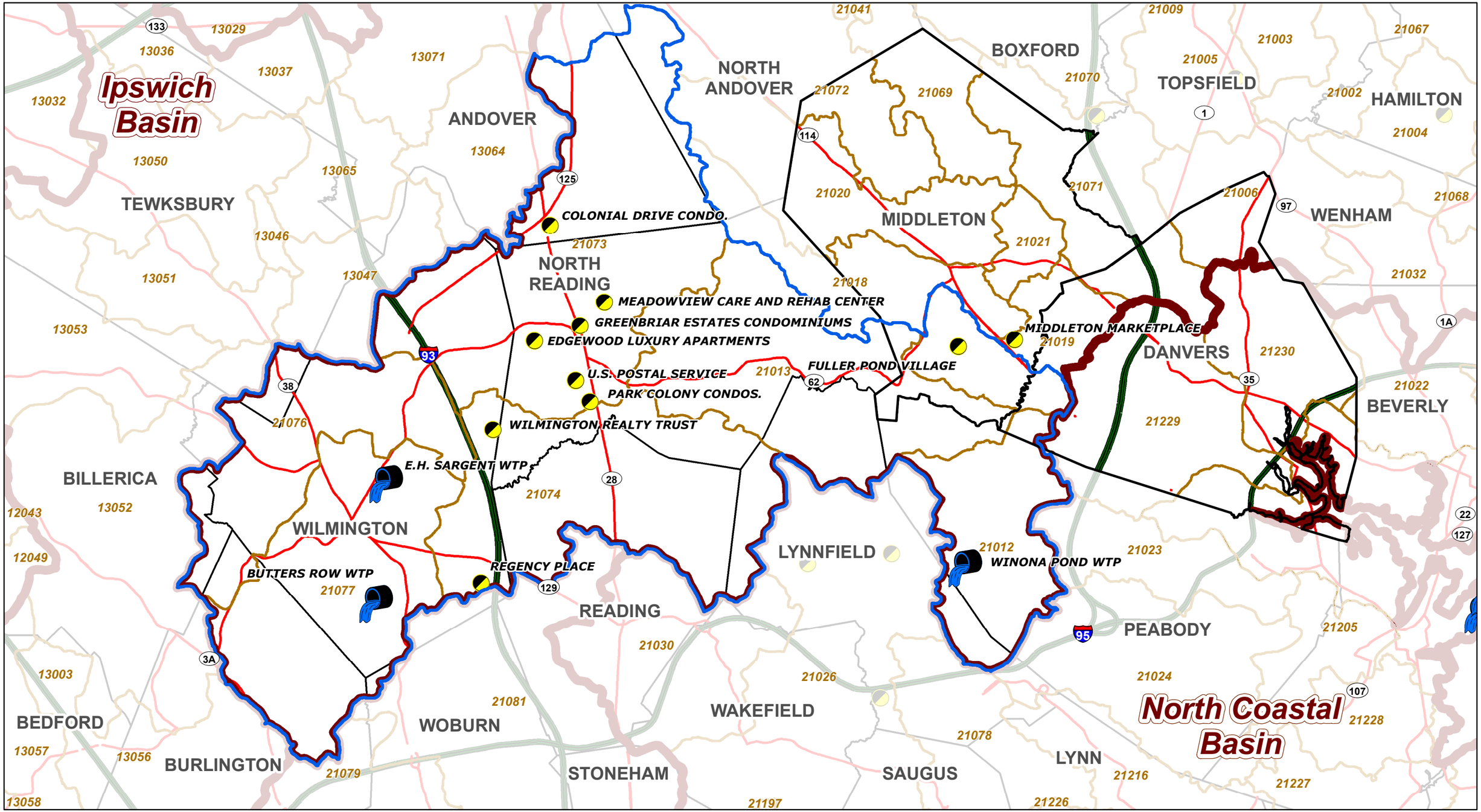


LEGEND

- NPDES Discharge
- Groundwater Discharges
- Major Basin Boundary
- Subbasin Boundary
- Watershed Boundary
- Town Boundary

N W E S

0 2,250 4,500 9,000 13,500 Feet

0 0.5 1 2 3 Miles

Figure 7-5
Massachusetts
Sustainable Water Management Initiative (SWMI) Pilot Program

WASTEWATER DISCHARGES MAP

Danvers - Middleton, Massachusetts

Comprehensive Environmental Incorporated — Tighe&Bond

V:\Projects\M\M0944\November_2012\WastewaterDischarges.mxd

Section 8 Site-Specific Evaluations – Options for Amherst

Under Phase 2 of the Sustainable Water Management Initiative (SWMI) Pilot Project, the Amherst Department of Public Works Water Division was selected to participate in an exercise to identify applicable Site-Specific Evaluation options that, if implemented, could change its SWMI requirements. This exercise included meetings between Town of Amherst Water Division staff and staff from the following Massachusetts Executive Office of Energy and Environmental Affairs (EEA) agencies: Massachusetts Department of Environmental Protection (MassDEP) Water Management Program, MassDEP Regional Drinking Water Programs, Massachusetts Department of Conservation and Recreation (DCR) Office of Water Resources, and Massachusetts Department of Fish and Game Division of Fisheries and Wildlife (MassWildlife). Members of the Amherst Water Supply Protection Committee and the Massachusetts Water Works Association also attended the meetings. Meeting summary notes are included in Appendix J.

This section documents the options identified for Amherst within each of the two Site-Specific Evaluation Tracks presented in Section 6: Track 1) review/refine data inputs to the USGS Model; and Track 2) determine actual streamflow and impacts through independent streamflow and habitat assessments.

The discussion below, together Section 7 of this report, identifies and explores in detail some of the evaluation options considered during Phase 2 activities. For these options, available water supply data enabled completing detailed analyses. For Amherst, these options fell under Track 1. Other potential options under Track 2 are identified, but not explored in depth because to do so would require considerable study beyond the scope of the Pilot Project. For these options identified but not implemented, a list of steps and cost estimates were developed.

Table 8-1 summarizes the options considered under each track with a more detailed discussion provided below.

Table 8-1. Summary of Site-Specific Approaches for Amherst Water Division			
Option	**Description**	**Outcome/Possible Outcomes**	**Cost[1]**
Track 1 Options: Review/Refine Data Inputs to the USGS Model			
Option A – Review actual monthly withdrawal data and compare to model input to adjust GWL	Amherst's peak groundwater withdrawals vary from USGS model due to increased college demand in fall and use of surface water supply in summer to offset groundwater withdrawals. If significant, the differences could result in change in BC or GWL.	Comparison and corrections for Amherst did not result in a change in BC or GWL.	<$5,000
Option B – Determine subbasin characteristics and adjust for impact on streamflow	Amherst's groundwater wells are located within a confined aquifer, which could change the pour point of the subbasin.	Review showed pour point of subbasin to Fort River rather than Hop Brook – increases area that receives 100% mitigation credit.	$10,000-$20,000
Track 2 Options: Determine Actual Streamflow and Impacts Through Independent Streamflow and Habitat Assessments			
Option A – Determine streamflow impacts downstream of withdrawal points from existing data	Graph actual USGS stream data and pumping records to determine actual impact on stream (SWMI assumes 1:1 ratio between withdrawal:stream impact) and/or use models to determine relationship between withdrawal and	Actual August median streamflows may be higher than unimpacted August median flows predicted using SYE. Actual impact may be less than the 1:1 ratio assumed by SWMI resulting in less mitigation.	$5,000
Option B – Conduct streamflow and habitat assessment	Perform a wetted perimeter or IFIM study to determine streamflow needed by habitat	The results of a site specific habitat study may show there is currently enough water in the stream to support habitat. It may also show there is not enough water with mitigation to be negotiated with MassDEP.	$25,000-$100,000

[1] Costs are estimated order of magnitude ranges based on an outside consulting engineer being hired to do the analysis. If in-house resources exist or if the outside engineer is performing other related services, these costs are likely less but depend on the specific situation and its complexity, the existence of USGS gage data and other unknown factors. These costs should be compared to the potential benefits.

8.1 Track 1 Options

8.1.1 Option A – Review actual monthly withdrawal data and compare to model input to adjust GWL

From data collected during Phase 1 and from discussions held during the site-specific study meetings with Amherst, it was noted that Amherst's demands do not follow typical summer peak demands as used in the USGS model. The population influx at the multiple colleges in Amherst influences the Water Division's peak demand periods with greater demand in September, rather than August. Use of the surface water supply during summer months also reduces summer withdrawals from groundwater sources.

The use of actual monthly withdrawal data in place of the estimated data used in the USGS model may demonstrate less impact to August median flow and lower the biological category (BC) or groundwater withdrawal level (GWL) for the subbasin in which Amherst's wells are located (Subbasin 14061). Figure 8-1 at the end of this section shows Amherst's sources and the subbasins in which they are located.

Section 7.1 of this Report documents the review of Amherst's actual August withdrawal volumes from 2000 through 2004. In summary, this review determined that using actual 2000-2004 groundwater withdrawal data did not result in a change in BC or GWL for Subbasin 14061.

8.1.2 Option B – Determine subbasin characteristics and adjust for impact on streamflow

Data collected during Phase 1 and discussions held during the site-specific study meetings with Amherst indicated that the subbasin from which Amherst's wells withdraw (Subbasin 14061) is located within a confined aquifer. Subbasin 14061 is a GWL5. Figures 2 and 3 of the 1989 report "Work Plan for Proposed Well No. 6, Lawrence Swamp" by Tighe and Bond, Inc., show generalized cross sections of the Hop Brook confined aquifer. These figures were reproduced from a previous study conducted by Geraghty & Miller, Inc., in 1979 entitled, "Hydrogeologic Investigation of the Lawrence Swamp Area, Amherst, Massachusetts." Although a complete copy of that report was not available, another figure from that report was obtained, entitled "Generalized Extent and Thickness of the Principal Aquifer in the Hop Brook Drainage Basin." This figure indicates that the confined aquifer has a discharge point at the confluence of Hop Brook and the Fort River. This discharge point is coincident with the downstream end of Subbasin 14056, where this subbasin discharges to Subbasin 14064. Subbasin 14064 is a GWL4. At the end of this section, Figure 8-2 includes this Hop Brook Drainage Basin figure and Figure 8-3 depicts an outline of the drainage basin's confined aquifer overlain with the subbasins' GWLs.

From this information, MassDEP concluded that the actual impacts of Amherst's groundwater withdrawals may be expressed in this downstream subbasin (14064) rather than in the subbasin in which the wells are located (14061). Consequently, withdrawal

impacts should be compared to the Fort River's August median flow rather than Hop Brook's. Since the Fort River has a higher August median flow than Hop Brook, withdrawal impacts may be less and therefore less mitigation may be required under the SWMI Framework. In addition, with the point of analysis of impacts changed to the downstream Subbasin 14064, the upstream area eligible for receiving 100% mitigation credit is expanded to include Subbasins 14055 and 14056.

Subbasin 14064

The Pilot team completed a similar data review as the one conducted in Option A (discussed above) to evaluate the impacts of Amherst's actual August withdrawal volumes (from 2000 through 2004) on the downstream subbasin (14064). This review determined that using actual 2000-2004 groundwater withdrawal data did not result in a change in BC; however it would reduce the August median flow alteration in subbasin 14064 from 26% to 24%. This would change the GWL designation for this subbasin from GWL4 to GWL3. (Refer to Section 7.1 of this report for the detailed analysis.)

Therefore, by using actual withdrawal data and by taking into account the effects of a confined aquifer, the subbasin of impact (Subbasin 14064) would change from a GWL4 to a GWL3 (see Table 7-3). However, Amherst's Pilot withdrawal request was 4.55 mgd, equal to its current total authorized volume, and 0.64 mgd above its baseline of 3.91 mgd.

Adding this 0.64 mgd withdrawal would increase the alteration of the subbasin's unaffected August median flow from 24% to 30% and would cause Subbasin 14064 to backslide from a GWL3 to a GWL4. According to Table 5 of the Final SWMI Framework, under this scenario, Amherst would become a Permit Review Tier 3 and still be required to mitigate commensurate with impacts and demonstrate no feasible alternative source that is less environmentally harmful.

It should also be noted that, because groundwater withdrawals impact the flow alteration of all downstream subbasins, the backsliding of Subbasin 14064 would occur by adjusting Amherst's 2000-2004 withdrawals to actual, regardless of whether the impact of the confining layer is considered. The impact of changing withdrawals, whether as a result of increased withdrawal requests or use of actual 2000-2004 withdrawal data, on downstream subbasins was not considered in this pilot analysis.

In this case study, there is no net benefit for Amherst to use site-specific information to adjust the withdrawals based on actual data, and to account for the withdrawal impact to the downstream subbasin based on consideration of the confined aquifer. Although Amherst's permit conditions do not change as a result of this analysis, philosophically SWMI is intended to avoid backsliding of BCs and/or GWLs.

Confined Aquifer Delineation

During the site-specific study meetings with Amherst, participants discussed the possibility that the confined aquifer discharges to the Connecticut River. Based on the geologic data it has, EEA has assumed that the confined aquifer discharges at the Fort

River. In this case, EEA would ask Amherst to conduct a study to determine the discharge point. The cost of such a study could cost $50,000 or more, but the benefits may include less mitigation required and further expansion of the upstream area eligible for receiving 100% mitigation credit, if the confined aquifer were demonstrated to discharge to the Connecticut River.

8.2 Track 2 Options

8.2.1 Option A – Determine streamflow impacts downstream of withdrawal points from existing data

As discussed in Section 8.1.2 above, it may be reasonable to assume that all impacts of groundwater withdrawals are expressed downstream of the confined aquifer (in Subbasin 14064). The SWMI GWL categorizations are determined based on the groundwater withdrawal as a percent of the August median flow of the impacted stream. This approach assumes a 1:1 relationship between groundwater withdrawal and streamflow impact (e.g., the streamflow will be directly altered by the amount of water withdrawn from groundwater). Amherst may choose to evaluate actual August median streamflows and its degree of streamflow alteration at this location using actual, site-specific (not estimated) data. Actual August median streamflows can be compared with unimpacted August median streamflows estimated using the SYE model. This may reveal higher streamflows than predicted. Impacts could be estimated through existing pumping records and groundwater modeling. This would require evaluation of all stream influences, including the operation of the surface water supply and inputs from septic systems and other groundwater discharges, as these will be reflected in any actual USGS stream gage data. Data that may be used in such an evaluation include:

1. Aquifer test data and results
2. Aquifer modeling (3D ModFlow model)
3. USGS stream gage data on the Fort River
4. Surface water withdrawal data
5. Reservoir outflow data (in order of priority)
    a. Measured stage/discharge data
    b. SYE modeled releases
    c. Actual reservoir operation data
6. Septic system return flow data (assuming no NPDES discharges)
7. Natural resource evaluation
8. Actual monthly groundwater withdrawals

The site-specific data and impacts can be used to identify appropriate mitigation measures.

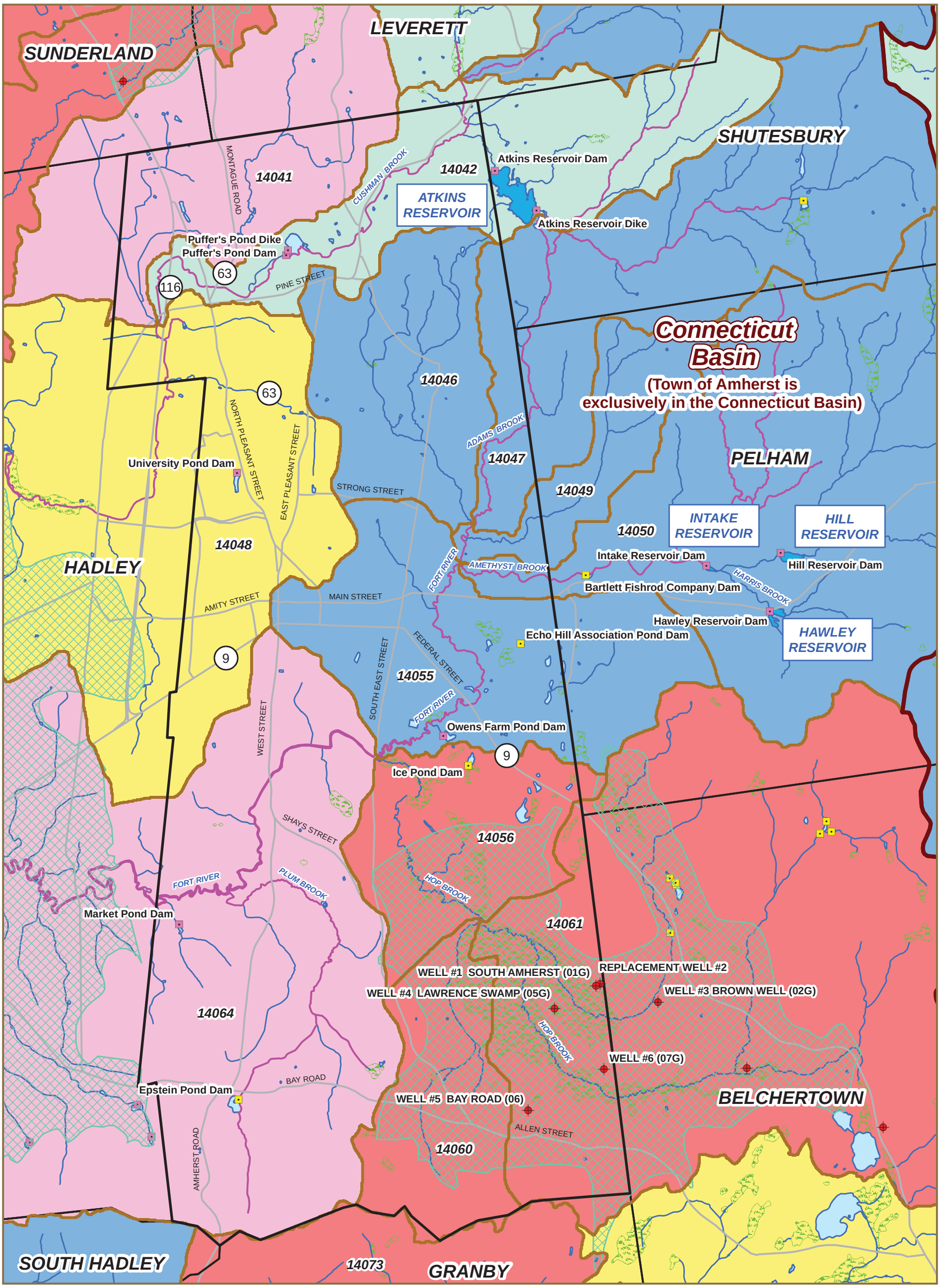
Review and analysis of existing data including USGS data, pumping records and SYE modeling is estimated to cost about $5,000. Groundwater modeling of the impacts is estimated to cost an additional $50,000 or more.

8.2.2 Option B – Conduct streamflow and habitat assessment

During the Site-Specific Study meetings held during Phase 2 of the Pilot Project, EEA staff determined that a wetted-perimeter study would be an applicable instream flow methodology for Amherst to use to determine streamflow requirements in the Fort River. Amherst could also choose to perform an IFIM study at a higher cost (refer to Appendix I).

The wetted-perimeter methodology was described in Section 6.2.1.1 in this report and has estimated costs of $25,000-$50,000. For Amherst, this would include establishing transects across the Fort River and taking measurements from water's edge to water's edge at various streamflows. Results of the analysis would determine recommended streamflows to keep the streambed wetted.

Mitigation based on a wetted-perimeter analysis could include requirements for maintaining the identified streamflows, which could likely start with outdoor water use restrictions at low flow triggers. A stream gage would be needed to monitor for these more localized streamflow triggers. Amherst would also need to monitor how often it hits the new streamflow triggers and review/revise mitigation based on that information. Amherst does not currently implement outdoor watering restrictions, so improvements to streamflow may be seen quickly should they be implemented in the future. If improvement is not evidenced in correlation with outdoor watering restrictions, additional habitat improvement measures that could result in increased streamflow and/or reduced number of days where streamflow triggers are tripped could be implemented.



LEGEND

- Community Groundwater Well

Dam Locations

- Private
- Public
- Wellhead Protection Areas - Zone II
- Subbasin Boundary
- Major Basin Boundary

Groundwater Withdrawal Levels (GWLs)

- 1 0-3%
- 2 3-10%
- 3 10-25%
- 4 25-55%
- 5 >55%

Hydrography

- River, Pond or Lake
- Reservoir
- Wetland
- Stream, Brook
- Coldwater Fishery Resource
- Town Boundary

N
W E
S

0 2,000 4,000 6,000 8,000 Feet

0 0.5 1 1.5 Miles

Massachusetts Department of Environmental Protection (MassDEP)
Sustainable Water Management Initiative (SWMI) Pilot Project

Figure 8-1

Water Supply Sources and Subbasins

Amherst, Massachusetts
December 2012

Comprehensive Environmental Incorporated

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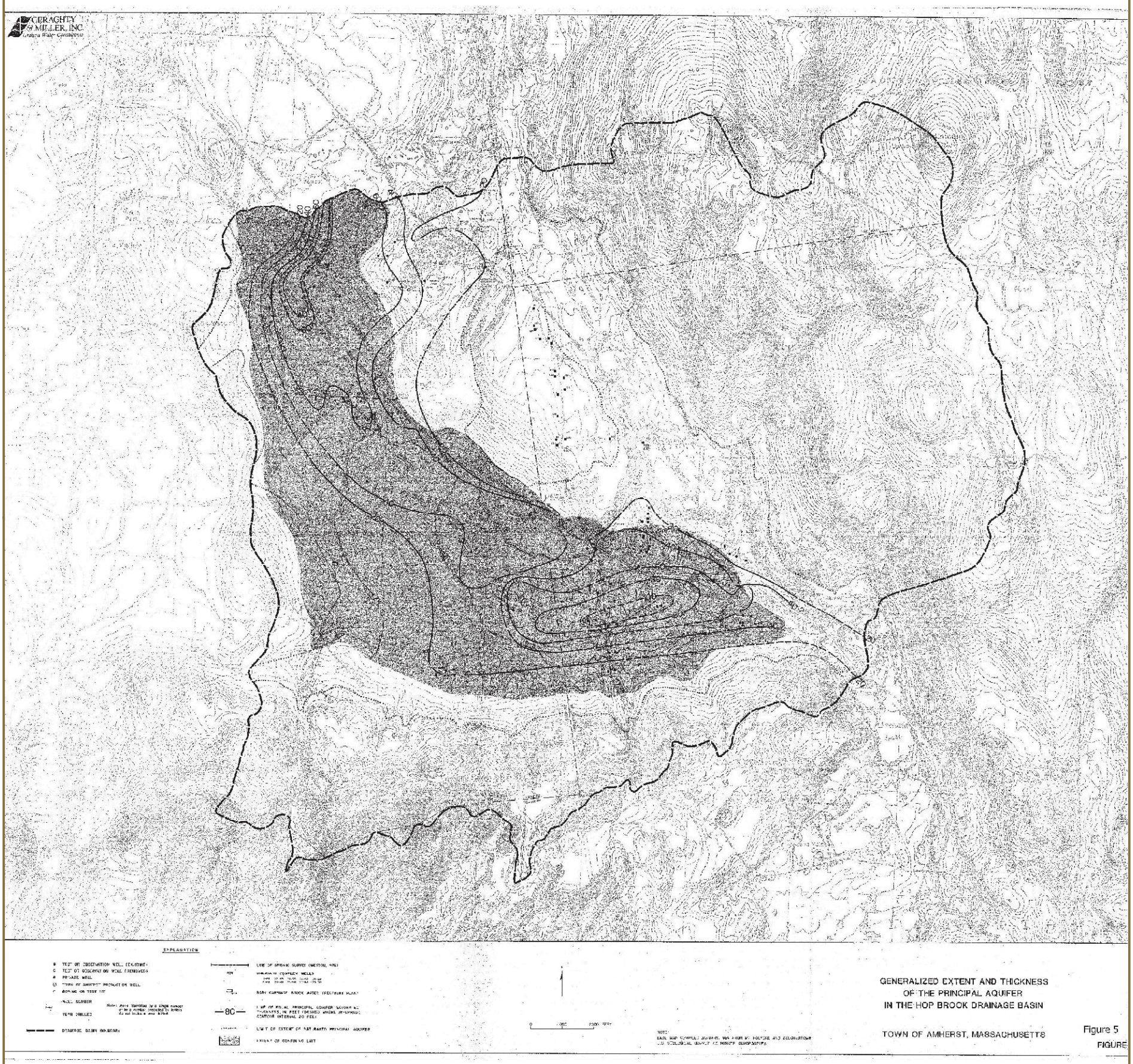


LEGEND

- Drainage Basin Boundary
- -80- Line of Equal Principal Aquifer Saturated Thickness, In Feet (Dashed Where Inferred) Contour Interval 20 Feet
- ····· Limit of Extent of Saturated Principal Aquifer
- Extent of Confining Unit

N
W E
S

Scale: As Noted on Figure

Massachusetts Department of Environmental Protection (MassDEP)
Sustainable Water Management Initiative (SWMI) Pilot Project

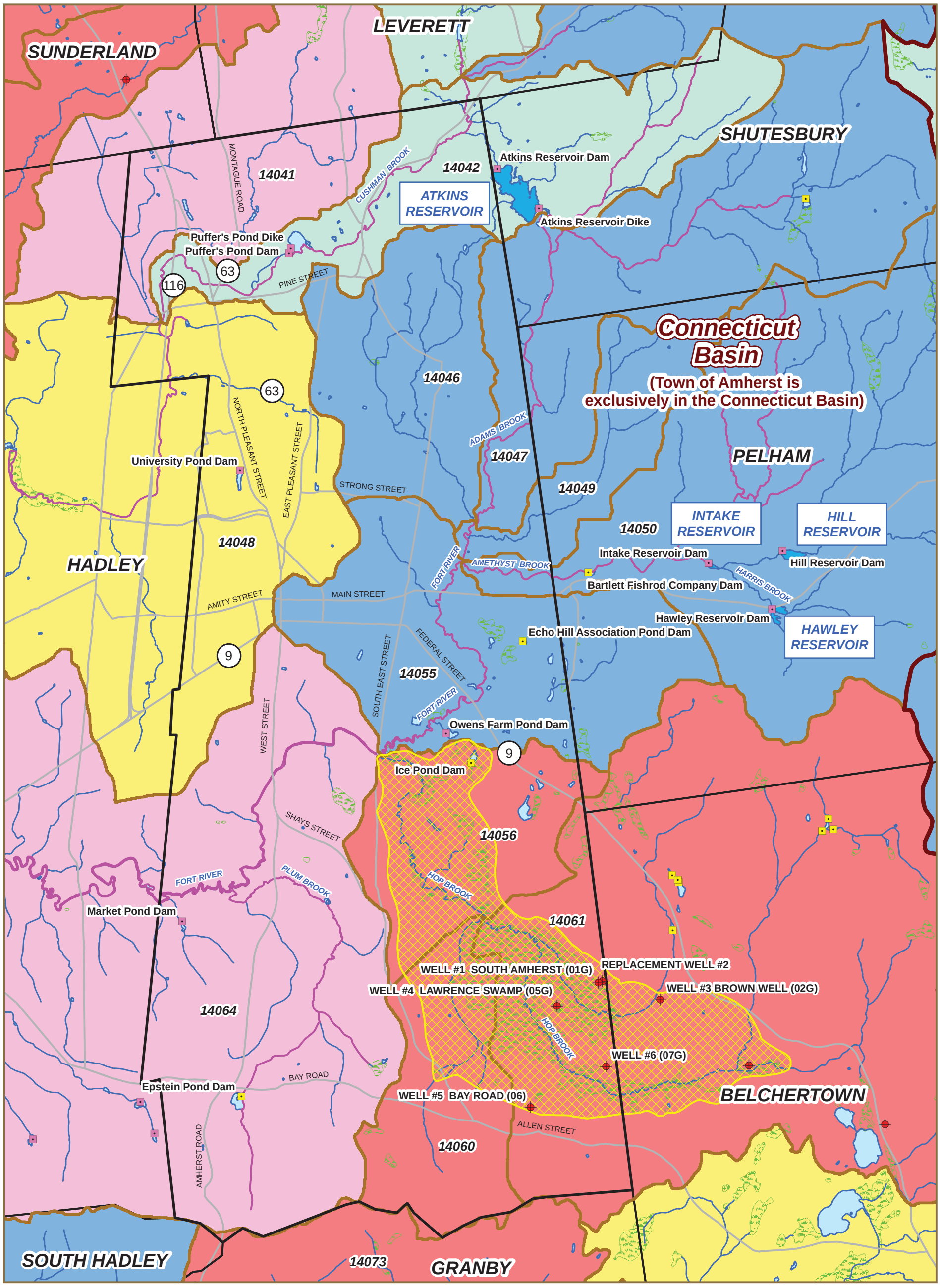
Figure 8-2

Hop Brook Drainage Basin

Amherst, Massachusetts
December 2012

Comprehensive Environmental Incorporated

Tighe&Bond



LEGEND

- Community Groundwater Well

Dam Locations
- Private
- Public
- Extent of Confined Aquifer
- Major Basin Boundary
- Subbasin Boundary

Groundwater Withdrawal Levels (GWLs)
- 1 0-3%
- 2 3-10%
- 3 10-25%
- 4 25-55%
- 5 >55%

Hydrography
- River, Pond or Lake
- Reservoir
- Wetland
- Stream, Brook
- Coldwater Fishery Resource
- Town Boundary

N W E S

0 2,000 4,000 6,000 8,000 Feet

0 0.5 1 1.5 Miles

Confined Aquifer Source:
Extent of Confined Aquifer is based on the boundary depicted in the figured titled Generalized Extent and Thickess of the Proncipal Aquifer in the Hop Brook Drainage Basin by Geraghty & Miller, Inc.

Massachusetts Department of Environmental Protection (MassDEP)
Sustainable Water Management Initiative (SWMI) Pilot Project

Figure 8-3
Hop Brook Confined Aquifer and GWLs

Amherst, Massachusetts
December 2012

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Section 9 Site-Specific Evaluations – Options for Shrewsbury

Under Phase 2 of the Sustainable Water Management Initiative (SWMI) Pilot Project, the Shrewsbury Water Department was selected to participate in an exercise to identify applicable Site-Specific Evaluation options that, if implemented, could change its SWMI requirements. This exercise included a meeting between Town of Shrewsbury staff and staff from the following Massachusetts Executive Office of Energy and Environmental Affairs (EEA) agencies: Massachusetts Department of Environmental Protection (MassDEP) Water Management Program, MassDEP Regional Drinking Water Programs, Massachusetts Department of Conservation and Recreation (DCR) Office of Water Resources, and Massachusetts Department of Fish and Game Division of Fisheries and Wildlife (MassWildlife). Shrewsbury's drinking water consultant, Tata and Howard, Inc. of Marlborough, Massachusetts was also represented at the meeting with Shrewsbury. Meeting summary notes are included in Appendix K.

This section documents the options that were identified for Shrewsbury within each of the two Site-Specific Evaluation Tracks presented in Section 6: Track 1) review/refine data inputs to the USGS Model; and Track 2) determine actual streamflow and impacts through independent streamflow and habitat assessments.

The discussion below, together Section 7 of this report, identifies and explores in detail one of the evaluation options considered during Phase 2 activities. For this option, available water supply data enabled completing detailed analyses. For Shrewsbury, this option fell under Track 1. Other potential options under Tracks 1 and 2 are identified, but not explored in depth because to do so would require considerable study beyond the scope of the Pilot Project. For these options, lists of steps and cost estimates were developed.

Table 9-1 summarizes the options considered under each track with a more detailed discussion provided below.

Table 9-1. Summary of Site-Specific Approaches for Shrewsbury Water Department			
Option	**Description**	**Outcome/Possible Outcomes**	**Cost[1]**
Track 1 Options: Review/Refine Data Inputs to the USGS Model			
Option A – Review actual monthly withdrawal data and compare to model input to adjust GWL	Actual monthly pumping distribution may vary from the distribution curve used in the model. If significant, the differences could result in change in BC or GWL.	Comparison and corrections for Shrewsbury did not result in a change in BC or GWL.	<$5,000
Option B – Determine subbasin characteristics and adjust for impact on streamflow	Lake Quinsigamond may buffer impacts to stream. Use existing data (e.g., pump tests, boring logs, USGS gage data) to assess impacts at the Lake outlet and/or evaluate impacts through modeling.	May show less of an impact to August median flow and reduce mitigation requirements.	$10,000-$20,000
Track 2 Options: Determine Actual Streamflow and Impacts Through Independent Streamflow and Habitat Assessments			
Option A – Determine streamflow impacts downstream of withdrawal points from existing data	Review actual USGS gage data and compare with SYE model unimpacted flow. Combined with actual withdrawal impact analysis on stream considering buffering effects.	May show actual August median flow is higher than SYE model unimpacted flow. May show less of an impact to August median flow and reduce mitigation requirements.	$5,000
Other Site Specific Analyses – Poor Farm Brook	Assess impacts of withdrawal from Home Farm wells on Poor Farm Brook flows. If impacts are found, conduct a site-specific study on the brook to assess habitat needs.	If Shrewsbury's wells are impacting Poor Farm Brook and a site-specific study shows mitigation is needed, Shrewsbury may negotiate mitigation with MassDEP.	$25,000-$100,000

[1] Costs are estimated order of magnitude ranges based on an outside consulting engineer being hired to do the analysis. If in-house resources exist or if the outside engineer is performing other related services, these costs are likely less but depend on the specific situation and its complexity, the existence of USGS gage data and other unknown factors. These costs should be compared to the potential benefits.

9.1 Track 1 Options

9.1.1 Option A – Review actual monthly withdrawal data and compare to model input to adjust GWL

The use of actual monthly withdrawal data in place of the estimated data used in the USGS model may demonstrate less impact to August median flow and lower the biological category (BC) or groundwater withdrawal level (GWL) for the subbasins in which Shrewsbury's wells are located (23002 and 23008, refer to Figure 5-1 at the end of Section 5 of this report). Section 7.4 of this Report documents the review of Shrewsbury Water Department's actual August withdrawal volumes from 2000 through 2004. In summary, this review determined that using actual 2000-2004 groundwater withdrawal data did not result in a change in BC or GWL for Subbasins 23002 and 23008.

9.1.2 Option B – Determine subbasin characteristics and adjust for impact on streamflow

Data collected during Phase 1 and discussions held during the site-specific study meeting with Shrewsbury indicated Lake Quinsigamond could have a significant buffering effect on the monthly flow alteration at the pour point of Subbasin 23002. Subbasin 23002 is one of the subbasins from which Shrewsbury's wells withdraw and it is a BC5/GWL5.

Existing pump tests, boring logs, USGS gage and other data could be evaluated to assess the degree of withdrawal impacts at the Lake Quinsigamond outlet rather than assuming a 1:1 relationship between groundwater withdrawal and streamflow impact. The impacts could also be assessed through modeling to explore whether the lake has a buffering effect on withdrawals. The degree of impact would be applied to the unimpacted August median flow estimated using the SYE model. Potential outcomes of such an evaluation could show less of an impact to August median flow, which could result in a change of GWL for Subbasin 23002. This may reduce the SWMI-related mitigation requirements.

9.2 Track 2 Options

9.2.1 Option A – Determine streamflow impacts downstream of withdrawal points from existing data

For reasons similar to those discussed in Section 9.1.2, Shrewsbury may choose to evaluate actual August median streamflow and its degree of streamflow alteration downstream of Lake Quinsigamond using actual, site-specific (not estimated) data. The methodology for performing this analysis could include:

1. Download daily streamflow values from USGS web site for the North Grafton gage (01110000) on the Quinsigamond River
2. Obtain daily unimpacted streamflow estimates from USGS SYE runs

3. Run each set of data (actual gage and SYE unimpacted daily flows) through Indicators of Hydrologic Alteration (IHA) program (IHA is a statistical model using streamflow values)
4. Export IHA results into Excel – graph data for comparison

Figure 9-1 at the end of this section shows the locations of the subbasin pour-point and the North Grafton USGS Gage 01110000. The USGS gage is located downstream of Hovey Pond Dam on the Quinsigamond River and has a period of record from 1939 to today.

The above methodology would compare actual flows with SYE estimated unimpacted flows to determine whether the August median flow is truly impacted and to what degree, whether by withdrawals or development. Further analysis could be performed to determine the effects of Shrewsbury's pumping on the stream, including review of pump tests and modeling that account for the buffering effect of the lake as described above. The modeling could also be used to determine the effects of increased pumping under various flow conditions. This combined analysis can be used to identify appropriate mitigation measures.

9.3 Other Site-Specific Analyses – Poor Farm Brook

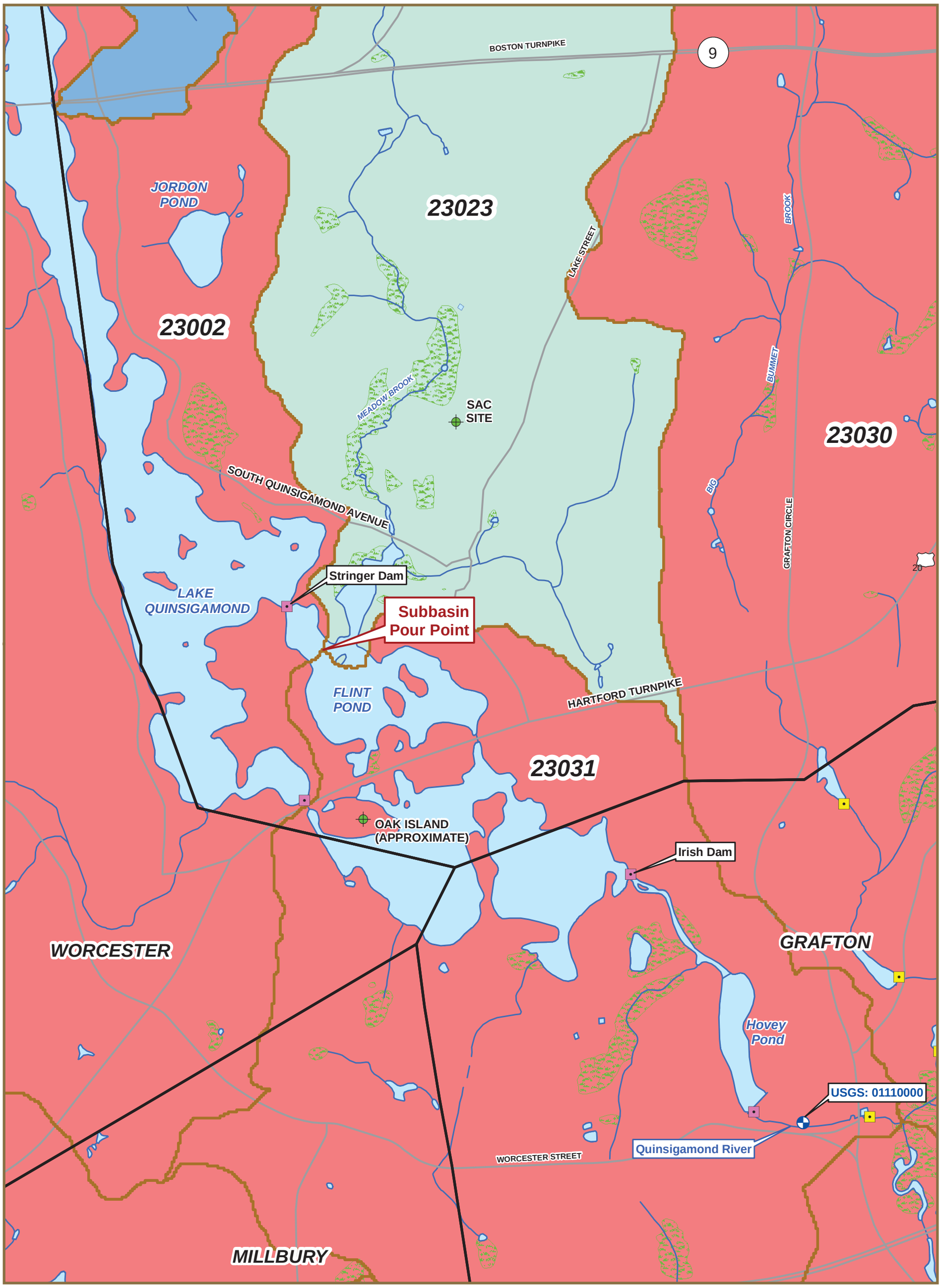
The reach of Poor Farm Brook located between City Farm Pond and the Shrewsbury wells has been observed to go dry in the past. This reach is not located in the same subbasin as Shrewsbury's wells, but rather in an upgradient subbasin (23007). Figure 9-2 at the end of this section shows the location of this reach in relation to Shrewsbury's water supply wells.

The EEA agencies including MassDEP, DCR, and MassWildlife have expressed concerns in the past, prior to the SWMI process and Final Framework, that pumping from Shrewsbury's wells may impact this reach and would require further evaluation and possibly mitigation when Shrewsbury renews its Water Management Act permit.

Since Poor Farm Brook is not located within the same subbasin as Shrewsbury's sources or in a downgradient subbasin from Shrewsbury's wells, a Site-Specific Study on Poor Farm Brook does not fall under one of the Site-Specific Evaluation Tracks (Track 1 or 2) discussed above and in Section 6 of this report, as it would not alter the BC or GWL of the withdrawal subbasin under the SWMI Framework. Studying Poor Farm Brook to assess how to address low-flow impacts would be an additional requirement specific to Shrewsbury. Upstream of the brook is the Worcester Country Club where there are additional withdrawal points and a dam and impoundment.

EEA would require Shrewsbury to determine what role the Home Farm Wells play in reducing streamflow in Poor Farm Brook. Shrewsbury may be required to collect additional data to determine the cone of influence for the wells and whether it reaches the brook. If data shows the wells impact the brook, a full site-specific study that evaluates specific streamflow and habitat needs for targeted fish species may be required followed

by mitigation depending on the results. A study of this type could cost $50,000-$100,000. If the wells have no impact on the brook, no additional action may be required by Shrewsbury for Poor Farm Brook. If mitigation is required, it would be negotiated with MassDEP, but could possibly include removal of the Poor Farm Dam and/or stream channel restoration along the brook.



LEGEND

- USGS Data Collection Station
- Community Groundwater Well
- Potential Community Groundwater Well

Dam Locations

- Private
- Public
- Subbasin Boundary

Groundwater Withdrawal Levels (GWLs)

- 1 0-3%
- 2 3-10%
- 3 10-25%
- 4 25-55%
- 5 >55%

Hydrography

- Pond, Lake
- Reservoir
- Wetland
- Stream, Brook
- Town Boundary

N W E S

0 500 1,000 1,500 2,000 2,500 Feet

0 0.1 0.2 0.3 0.4 0.5 Miles

Massachusetts Department of Environmental Protection (MassDEP)
Sustainable Water Management Initiative (SWMI) Pilot Project

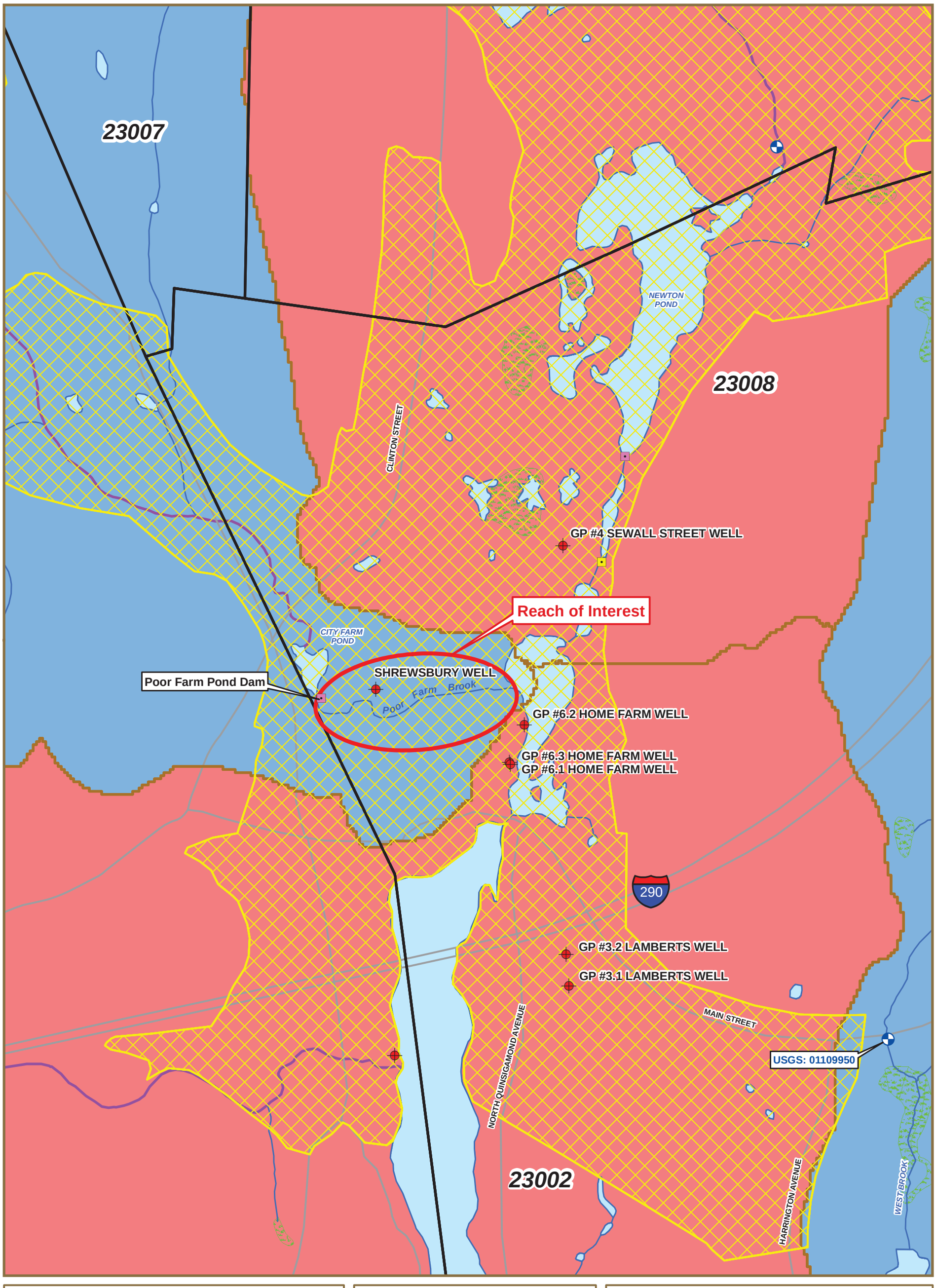
Figure 9-1

Impact Assessment Area Downstream of Lake Quinsigamond

Shrewsbury, Massachusetts
December 2012

Comprehensive Environmental Incorporated

Tighe&Bond



LEGEND

- USGS Data Collection Station
- Community Groundwater Well

Dam Locations

- Private
- Public
- Shrewsbury Wellhead Protection Areas- Zone II
- Major Basin Boundary
- Subbasin Boundary

Groundwater Withdrawal Levels (GWLs)

- 1 0-3%
- 2 3-10%
- 3 10-25%
- 4 25-55%
- 5 >55%

Hydrography

- Pond, Lake
- Reservoir
- Wetland
- Stream, Brook
- Coldwater Fishery Resource
- Town Boundary

N W E S

0 500 1,000 1,500 2,000 Feet

0 0.1 0.2 0.3 0.4 Miles

Massachusetts Department of Environmental Protection (MassDEP)
Sustainable Water Management Initiative (SWMI) Pilot Project

Figure 9-2

Impact Assessment Area for Poor Farm Brook

Shrewsbury, Massachusetts
December 2012

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Section 10 Recommendations

The Massachusetts Executive Office of Energy and Environmental Affairs' (EEA's) Final Sustainable Water Management Initiative (SWMI) Framework focuses on the impact of water withdrawals on streamflows. The Framework was developed over several years of intensive study and stakeholder interactions. Phase 1 of the Pilot study identified many of the potential implementation issues, while Phase 2 of the Pilot tested the process in four communities with existing Water Management Act (WMA) permits.

These phases together provide considerable information to support crafting reasonable, effective regulations under the next stage of the process. However, further work will be required to lay the groundwork for implementing the SWMI Framework, including public outreach to various affected groups and the development of more detailed guidance for WMA permit holders to use in complying with future permit requirements and requests. The continued implementation process may also require some iterations on the part of the EEA agencies in testing different scenarios on the ground, with subsequent refinement of the regulations and guidance.

Future steps should consider:

10.1 Preparation and Update of Guidance Documents

The four Pilot communities represented many variations on core issues to be addressed by the SWMI process, and provided an opportunity for agencies, water suppliers, and other stakeholders to understand how site-specific permitting might work and how the permit process would proceed. However, as permits come up for renewal, the Massachusetts Department of Environmental Protection (MassDEP) and the other EEA agencies will likely encounter more and more issues that will require resolution, based on specific circumstances found in other communities and specific experience in applying the Framework to different permit holders. The regulations should balance the need for predictability with flexibility for EEA agencies and public water suppliers to work together to find compliance solutions. In addition, the Pilot Team recommends that EEA consider developing not only initial guidance materials to accompany new regulations, but also regularly update guidance to reflect the unavoidable "learning curve" associated with any new regulatory initiative. There are several options for such updates. For example, updates could be provided on an annual basis, covering issues encountered during the previous year, or they could be provided in the form of topic-specific "white papers" as specific issues are encountered and resolved.

Specific topics for additional guidance, preferably within or prior to the regulations, include:

1. Clarification of Minimization requirements. It is still not clear in the SWMI Framework the extent to which minimization plans are required to consider sources and interconnections not yet constructed or permitted.

2. How to evaluate the feasibility of implementing releases from surface waters in order to improve down-stream flow and mimic the natural hydrological regime while adequately providing for public water supply.
3. How to determine approved credits for mitigation measures not currently listed in the SWMI offset/mitigation table.
4. How to allocate "shared" credits for mitigation that is undertaken by multiple water suppliers, or that impacts subbasins in which more than one water supplier withdraws water.

10.2 Outreach to the Additional Stakeholders

The Pilots involved a number of stakeholders, including agency staff, environmental groups and public water supplier representatives. The Pilot Team believes that there are many other entities that will be directly affected by the SWMI process in the future that are not so well-informed as the original stakeholder group. Significant, long-term efforts will be needed to inform these potentially interested parties of the underlying rationale of the SWMI Framework and ensuing regulations, and to familiarize them with the process and its components. We suggest development of a series of outreach materials that are published on EEA websites, geared to be simple orientation materials for those who are unfamiliar with the process, its acronyms and the issues. Targeted outreach to consulting engineers, other water works and wastewater trade associations and public works trade associations may be helpful.

10.3 Recommendations for Consultation Process

Below is a summary of the issues and recommendations provided in Section 5 of this report regarding the consultation process.

- Consultation Process Timeline. PWSs would benefit from a consultation process that starts well in advance of the permit expiration date and that provides adequate time between sessions for them to review and evaluate their SWMI requirements and their minimization and mitigation options.
- Consultation Preparation. The Pilot Team highly recommends that EEA hold SWMI educational workshops and seminars throughout the state, open to all PWSs, to educate them on their SWMI-related requirements.
- DCR Projections and Effect on Withdrawal Requests. MassDEP and EEA will need to address situations where the PWS's "ask" is larger than what EEA thinks the supplier needs. Guidance should be provided so that PWSs know what documentation is needed (e.g., commercial/business development growth projections) and would be accepted by DCR/EEA, to justify increased demand projections. In addition, MassDEP and EEA will need to address those situations where DCR cannot forecast demands for PWSs with high UAW, and provide guidance for an alternative method for intractable UAW.
- Inability to Backslide from a GWL 5. If a PWS withdraws water from a BC5 or GWL5 subbasin, as most are, there is no "backslide" because this is the most impacted level. No matter what the withdrawal request is, some PWSs will never

get to a Tier 3 Permit Review (highest level of review). The Pilot Team recommends keeping the levels as they are rather than trying to modify the levels further.

- Other Mitigation Measures. EEA should provide information on how it will address situations when a PWS proposes a mitigation action not listed on the existing SWMI offset/mitigation table.
- Mitigation Implementation. Mitigation measures such as habitat improvements, stormwater improvements, or wastewater improvements will require significant resources and time for planning and implementation. In some cases, legal procedures and local legislative action will govern the feasibility and pace of implementation. EEA should consider development of guidance on the amount of preparatory work that needs to be completed for a mitigation measure, before the PWS can list that proposed measure as a "feasible" option on its Mitigation List, or advance the measure to its Mitigation Plan.
- Mitigation Timing. The SWMI Framework requires mitigation measures be implemented prior to increased withdrawals above baseline. Given the time required to design, permit, fund and implement several of the potential mitigation measures, flexibility is needed to provide for increases in demand while mitigation is being implemented. EEA should provide detailed guidance regarding the timing for mitigation measure implementation.
- Sharing Mitigation Credit. EEA should consider development of guidance on how mitigation credits can be shared or divided between multiple WMA permit holders.

10.4 Issues to Resolve

In addition to these education and outreach issues, the Pilot Team observed a few areas that may need additional detailing that could not be done as a part of these pilot phases. Specifically, the Team recommends further study of the assignment of Stormwater Credits and the application of Location Adjustment Factors in developing mitigation strategies. In addition, further exploration is warranted into other Site-Specific Methods besides IFIM and Wetted Perimeter. These are discussed briefly below.

- Stormwater Credits should be further explored to identify methods that communities can use to prove that their programs are effective. Identifying an effective approach to crediting stormwater improvements proved a particularly difficult aspect of the Pilot Project, in that revised regulations from EPA are still in process and could not be used to inform the pilot. It is important that EEA identify acceptable methods to quantify how potential stormwater management activities add to streamflow, to better quantify this mitigation measure.
- Location Adjustment Factors need more work in that there are some areas where septic system or groundwater discharge returns are not credited to any public water supplier, specifically those discharges that lie outside the subbasin of any public water supply wells and outside permittees' town boundaries.

- Site-Specific Methods should be further explored in the ongoing process to provide better guidance to communities wishing to use the option of a site-specific study. While the Pilot Project has identified some potential site-specific methods, there may be additional approaches that merit consideration. Furthermore, additional several "unknowns" will need to be resolved for PWSs to feel comfortable exploring the option of site specific studies, including:
    - what the actual costs will be for various types of studies, under various withdrawal/impact scenarios;
    - what the specific proof of compliance will include; and
    - what other more direct methods are available that water suppliers can use to determine if Site-Specific Study options will be cost-beneficial.

Resolution of these issues will likely require the same iterative process that is needed to hone the rest of the implementation procedures.

Appendix A –

Glossary

Appendix A
Glossary

ASR – Annual Statistical Report

Baseline – The 2003-2005 average use plus 5% or 2005 use plus 5%, whichever is greater, provided that:

1) baseline is not greater than the 20-year demand projections on which the new or renewed permit is based, in which case baseline equals the demand projection;
2) baseline is not less than the registered volume, in which case baseline equals the registered volume;
3) usage during the 2003-2005 baseline period was equal or less than the authorized volume. If usage during the baseline period was above the authorized volume, then baseline equals the authorized volume.

BC - Biological Categories – Subbasins have been categorized into five biological categories (BCs) that represent existing aquatic habitat integrity of the receiving streams and rivers in these basins. Categories range from Category 1, which represents high quality aquatic habitats, relatively un-impacted by human alteration, to Category 5, which represents a severe decline in fluvial fish populations and aquatic habitat.

BMP – Best Management Practice

CCR – Consumer Confidence Report – A public water supplier's annual water quality report

CFR - Coldwater Fishery Resource – A water that meets at least one of the following criteria:

1. Brook, brown or rainbow trout reproduction has been determined;
2. Slimy sculpin, longnose sucker, or lake chub are present;
3. The water is part of the Atlantic salmon restoration effort or is stocked with Atlantic salmon fry or parr.

cfs – cubic feet per second

cfsm – cubic feet per second per square mile

CIP – capital improvement plan

CWMP – Comprehensive Wastewater Management Plan

DCR – Massachusetts Department of Conservation and Recreation

DER – Massachusetts Division of Ecological Restoration

DWWD – Dedham Westwood Water District

EPA – U.S. Environmental Protection Agency

gpd – gallons per day

gpdim – gallons per day per inch-diameter mile. The inch-diameter miles is the length of sewer as miles times the diameter of the pipe in inches.

GWD Reports – Groundwater Discharge Monitoring Reports – Annual reports for facilities with MassDEP-issued groundwater discharge permits

GWL – Groundwater Withdrawal Level (formally Flow Level or FL) – Subbasins have been categorized into five groundwater withdrawal levels (GWLs) that represent the percent alteration of natural August median flows due to groundwater withdrawals within the basin. GWL1 represents the least impact to or alteration of streamflow, with less than 3% of the streamflow withdrawn, and GWL5 represents the greatest impact to or alteration of streamflow, with 55% or more of the streamflow withdrawn. The percent alterations due to groundwater withdrawal used to define each flow level were established based on the level of withdrawal/alteration that caused the BC to backslide one category (e.g., go from BC1 to BC2).

GSFLOW – groundwater model that simulates coupled groundwater/surface-water flow in one or more watersheds by simultaneously simulating flow across the land surface, within subsurface saturated and unsaturated materials, and within streams and lakes.

IBTA – Interbasin Transfer Act

I/I – Infiltration and Inflow

Impervious – Used in reference to surfaces resistant to the movement or passage of water. Impervious surfaces can include asphalt, concrete, rooftops, and highly compacted soils.

Infiltration – Extraneous groundwater that enters the sewer system through sources such as defective pipes, pipe joints and manhole walls.

Inflow – Extraneous water that enters a sewer system through direct sources such as catch basins, manhole covers, cross connections with storm drains, sump pumps, foundation drains and downspouts.

IFIM – Instream Flow Incremental Methodology – IFIM is a streamflow and habitat assessment process developed by the U.S. Fish and Wildlife Service that includes data collection, computer modeling, and stakeholder involvement. A series of computer-based models calculate how much fish habitat a stream will gain or lose as streamflow increases or decreases taking into account that different fish species and life stages may need different depths and velocities.

LAF – Location Adjustment Factor

Less environmentally harmful – A source that is not in a GWL 4 or 5, and with excess capacity where additional withdrawal would not result in backsliding to a more altered groundwater level

MassDEP – Massachusetts Department of Environmental Protection

MesoHABSIM – Mesohabitat Simulation model used in IFIM studies

MG – million gallons

MGD – million gallons per day

MODFLOW – USGS modular three dimensional finite difference flow model for solving groundwater flow equations.

MODOPTIM - is a non-linear ground-water model calibration and management tool that simulates flow with MODFLOW-96 as a subroutine.

MS4 – Municipal Separate Storm Sewer System, a conveyance that is owned by a state, city, town, village, or other public entity that discharges to waters of the U.S.; designed or used to collect or convey stormwater; not a combined sewer; and not part of a sewage treatment plant

MWI – Massachusetts Water Indicators (USGS Scientific Investigations Report 2009-5272)

MWRA – Massachusetts Water Resources Authority

NEWWA – New England Water Works Association

NPDES – National Pollutant Discharge Elimination System, the permit program that controls water pollution by regulating point sources discharging pollutants into waters of the United States, as authorized by the Clean Water Act

Percent Alteration of August Median Flow – calculated for a subbasin by dividing Groundwater Withdrawals in August (mgd) by the August Unaffected Median Flow (mgd) and multiplying the value by 100.

Permitting Tiers – MassDEP will calculate a PWS's baseline withdrawal and compare it to the water withdrawal requested to determine the PWS's permit review tier as follows:

- Tier 1 – no additional withdrawal request above baseline.
- Tier 2 – additional withdrawal request above baseline and no change in GWL or BC.
- Tier 3 – additional withdrawal request above baseline will change GWL and/or BC.

PHABSIM – Physical Habitat Simulation model used in IFIM studies

PWTF GP – Potable Water Treatment Facility NPDES General Permit

PWS – public water supply

Q50 – a flow that is exceeded 50% of the time

Q75 – a flow that is exceeded 75% of the time

Q90 – a flow that is exceeded 90% of the time (a low flow)

Quality Natural Resources – If a source is located in a BC 1, 2, or 3 or in a coldwater fishery resource area.

RGPCD – Residential Gallons Per Capita Day, daily consumption of water by the residential sector

SESD – South Essex Sewerage District

sqmi – square mile

Surcharge Factor – $\frac{\text{estimated unaffected subbasin streamflow} - \text{withdrawals} + \text{wastewater discharges}}{\text{estimated unaffected subbasin streamflow}}$

If the surcharge factor is greater than 1, then the subbasin is surcharged.

STRMDEPL08 – USGS computer program that estimates streamflow depletion by a pumping well

SSES – Sanitary Sewer Evaluation Survey

SWMI – Sustainable Water Management Initiative

Surface Water Transition Rule – Current data do not allow surface water withdrawals to be taken into account in estimates of monthly flow alteration. The rule will require applicants to comply with standard conditions 1-8 and mitigate impacts commensurate with withdrawal impacts. A drought and demand management plan and an evaluation of implementing releases will also be required if deviating from standard conditions 1-8 or if requesting a withdrawal amount greater than baseline.

SY - Safe Yield – is calculated as 55% of the drought basin yield (monthly drought year flows) plus reservoir storage volumes. (The environmental protection factor is the remaining 45%.) Safe yields have been calculated for major basins to determine the maximum amount of water that may be withdrawn for water supply use while maintaining sufficient water in streams and rivers for environmental protection.

SYE – Sustainable Yield Estimator

U – Estimated August Unaffected Flow

UAW – unaccounted-for-water

UMass – University of Massachusetts Amherst

USGS – United States Geological Survey

WMA – Water Management Act

WMA Permit Conditions 1-8 – 1) source protection; 2) firm yield for surface water supplies; 3) wetland and vernal pool monitoring; 4) 65 RGPCD; 5) 10% UAW; 6) seasonal limits on nonessential outdoor water use; 7) water conservation requirements; and 8) mitigation measures for withdrawals that exceed baseline.

WRC – Massachusetts Water Resources Commission

WTF – water treatment facility

WTP – water treatment plant

WWTF – wastewater treatment facility

WWTP – wastewater treatment plant

Appendix B –

References

Appendix B
References

Section 2

(MWI Report) Weiskel, P.K., S.L. Brandt, L.A. DeSimone, L.J. Ostiguy, and S.A. Archfield. "Indicators of Streamflow Alteration, Habitat Fragmentation, Impervious Cover, and Water Quality for Massachusetts Stream Basins: U.S. Geological Survey Scientific Investigations Report 2009–5272." 2010. 70p.

(USGS, SIR 2011-5193) Armstrong, D.S., T.A. Richards, and S.B. Levin. "Factors influencing riverine fish assemblages in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2011–5193." 2011. 58p.

(Final SWMI Framework) MassDEP. "Massachusetts Sustainable Water Management Initiative Framework Summary." Final. November 28, 2012. 40 p.

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(MWI Report) Weiskel, P.K., S.L. Brandt, L.A. DeSimone, L.J. Ostiguy, and S.A. Archfield. "Indicators of Streamflow Alteration, Habitat Fragmentation, Impervious Cover, and Water Quality for Massachusetts Stream Basins: U.S. Geological Survey Scientific Investigations Report 2009–5272." 2010. 70p.

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(Final SWMI Framework) MassDEP. "Massachusetts Sustainable Water Management Initiative Framework Summary." Final. November 28, 2012. 40 p.

(SWMI Interactive Map) MassDEP Water Management Program. SWMI Interactive Map. Web. Accessed October 2012. http://www.mass.gov/dep/water/resources/swmi.htm.

(MWI Report) Weiskel, P.K., S.L. Brandt, L.A. DeSimone, L.J. Ostiguy, and S.A. Archfield. "Indicators of Streamflow Alteration, Habitat Fragmentation, Impervious Cover, and Water Quality for Massachusetts Stream Basins: U.S. Geological Survey Scientific Investigations Report 2009–5272." 2010. 70p.

(MODFLOW) USGS. MODFLOW: 3D Finite-Difference Groundwater Flow Model. Web. Accessed November 2012. http://water.usgs.gov/nrp/gwsoftware/modflow.html.

(MODOPTIM) USGS. MODOPTIM: A General Optimization Program for Ground-Water Flow Model Calibration and Ground-Water Management with MODFLOW. Web. Accessed November 2012. http://pubs.usgs.gov/sir/2006/5009/.

(GSFLOW) USGS. Coupled Ground-water and Surface-water Flow Model. Web. Accessed November 2012. http://water.usgs.gov/nrp/gwsoftware/gsflow/gsflow.html.

(STRMDEPLO8) USGS. STRMDEPLO8- An Extended Version of STRMDEPL with Additional Analytical Solutions to Calculate Streamflow Depletion by Nearby Pumping Wells. Web. Accessed November 2012. http://pubs.usgs.gov/of/2008/1166/.

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(Final SWMI Framework) MassDEP. "Massachusetts Sustainable Water Management Initiative Framework Summary." Final. November 28, 2012. 40 p.

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(Final SWMI Framework) MassDEP. "Massachusetts Sustainable Water Management Initiative Framework Summary." Final. November 28, 2012. 40 p.

(Washington IFIM FAQs 2010) Washington State Department of Ecology. "Frequently Asked Questions on IFIM." Revised February 2010. 4p.

Section 7

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(MWI Report) Weiskel, P.K., S.L. Brandt, L.A. DeSimone, L.J. Ostiguy, and S.A. Archfield. "Indicators of Streamflow Alteration, Habitat Fragmentation, Impervious Cover, and Water Quality for Massachusetts Stream Basins: U.S. Geological Survey Scientific Investigations Report 2009–5272." 2010. 70p.

(SWMI Interactive Map) MassDEP Water Management Program. SWMI Interactive Map. Web. Accessed October 2012. http://www.mass.gov/dep/water/resources/swmi.htm.

(SYE Database) "MA SYE Water-Use Database" [Database File]. Provided by Thomas Lamonte. MassDEP/Water Management Program. June 2012.

(2011 CCR) Town of Amherst Department of Public Works. "2011 Water Quality Report." PWS ID 1008000. 4 p.

(Danvers WMA Permit) MassDEP. "Modified Water Management Act Permit for Danvers Water Department." Permit #9P-3-17-071.01 for 1991-2009. March 23, 2006. 18p.

(MWRA Advisory Board) Massachusetts Water Resources Authority Advisory Board. "Summary of MWRA Board of Directors' Meeting – November 16, 2005." Web. Accessed November 2012. http://archives.lib.state.ma.us/bitstream/handle/2452/36643/ocm21020471-2005-11-16.pdf?sequence=1

(Adamski, T. Phone Notes) Adamski, Tracy. Tighe & Bond, Inc. Notes regarding Telephone Interviews with Communities About Changes in Wastewater Discharges. 1 p.

(GWD Reports) MassDEP. "Discharge Monitoring Reports" for Reporting Years 2000-2011 (if available) for the following facilities (Permit ID):

- Wilmington Realty Trust f/k/a Ametek (34)
- Greenbriar Estates (45)
- Colonial Drive Condos (96)
- Park Colony Condos (142)
- Fuller Pond Village (250)
- Meadowview Care and Rehab f/k/a Sunbridge Care and Rehab (642)
- US Postal Service (662)
- Middleton Marketplace (752)
- Edgewood Luxury Apartments (832)
- Regency Place (843)

Section 8

(Tighe and Bond 1989 Report) Skiba, Catherine. Tighe & Bond, Inc. "Work Plan for Proposed Well No. 6, Lawrence Swamp, Amherst, Massachusetts." 8-1A. August 1989. 94p.

Appendix C –

WMA Permit Conditions 1-8

Appendix C
Water Management Act
Permit Conditions for Public Water Supply Permits

1. Ground Water Supply Protection Requirements/Surface Water Supply Protection Requirements

- PWS ground water sources must have Zone II delineations and Wellhead Protections in place.
- PWS surface water sources must have a Surface Water Supply Protection Plan in place.
- Water companies or authorities must demonstrate best efforts to meet these requirements.

2. Firm Yield Analysis for PWS Surface Water Supply

- PWS surface water sources must have a firm yield analysis based on the drought of record.
- PWS's with a Drought Management Plan may base firm yield on a less severe drought.

3. Wetlands and Vernal Pool Monitoring

- Wells located within an ACEC or Priority Habitat area, may be required to conduct wetlands hydrology monitoring. MassDEP reserves the right to modify the permit to address observed impacts.

4. Performance Standard for Residential Gallons Per Capita Day Water Use (RGPCD)

- The RGPCD performance standard for all PWS permittees is 65 gallons.
    - Not applied on the Cape, Island and in select seasonal communities because large seasonal population fluctuations make calculating RGPCD unreliable
- Permittees that cannot comply within 2 years must implement either their own RGPCD plan or MassDEP's RGPCD Functional Equivalence Plan and comply within 3 additional years.
- Permittees unable to meet the std. within 5 years must implement the MassDEP's RGPCD Plan.

5. Performance Standard for Unaccounted for Water (UAW)

- The UAW performance standard for all PWS permittees is 10% of total water withdrawal.
- Permittees that cannot comply within 2 years must implement either their own UAW plan or MassDEP's UAW Functional Equivalence Plan and comply within 3 additional years.
- Permittees unable to meet the std. within 5 years must implement the MassDEP UAW Plan.

6. Seasonal Limits on Nonessential Outdoor Water Use (see Table 1 in Appendix G of the Final SWMI Framework for additional detail on the New Proposed Seasonal Limits on Nonessential Outdoor Water Use)

- Seasonal restrictions are in place from May 1st through September 30th.
- Permittees choose either calendar-based restrictions throughout the season, or restrictions implemented whenever streamflow falls below an aquatic base flow (ABF) trigger or the 7-day low flow statistic trigger at an assigned USGS local stream gage
- ABF triggers are based on groundwater withdrawal levels that are protective of
    - habitat for fish spawning during the spring, and
    - flows for fish rearing and growth during the summer.
- The restrictions required vary based on the permittee's RGPCD water use.
- A low flow trigger has been proposed in the SWMI process.

7. Water Conservation Requirements (see Table 2 in Appendix G of the Final SWMI Framework for additional detail regarding Water Conservation Requirements in PWS Water Management Permits)

- Permittees must implement measures based on the Water Resources Commission Water Conservation Standards, July 2006, including:
    - water audits and leak detection, metering, pricing, residential and public sector conservation, industrial/commercial conservation, lawn/landscape conservation, and education/outreach

8. Water Withdrawals that Exceed Baseline Withdrawal Volumes (baseline has been proposed to be redefined through the SWMI process)

- Baseline cannot be lower than the registered volume
- For permittees holding a permit for withdrawals in excess of their registered volume,
    - Baseline cannot be greater than
        - the 2005 permitted volume, or
        - the renewed 20-year WMA permitted volume.
- For permittees whose actual withdrawals between 2003 and 2005 were greater than the registered volume and lower than the lowest applicable permit volume, baseline is the greater of
    - 2005 use +5%, or
    - 2003-2005 average use +5%.
- Permittees with withdrawals in two basins will be regulated by baseline withdrawal volumes calculated for each basin, and for system-wide withdrawal volumes.
- Permittees with withdrawals projected to exceed the baseline withdrawal volume will evaluate measures to mitigate withdrawals in excess of the baseline.
    - Implementation of mitigation measures will be required prior to withdrawals exceeding the baseline (see Table 6 - Offset and Mitigation, on Page 28 of the Final SWMI Framework).

Appendix D –

Draft SWMI Evaluation Checklist

Appendix D
Draft SWMI Evaluation Checklist

This draft checklist provides a list of potential data and reports that may be useful to a Public Water Supplier during a SWMI Evaluation. The list is based on the data collected during the Pilot Project Phases 1 and 2. The list was cross-referenced with relevant options from the New England Water Works Associations/Massachusetts Water Works Association Toolbox of BMPs for Water Resource Management (NEWWA toolbox).

Agency Provided Reports and Data (if available/applicable):

☐	Baseline Volume
☐	Groundwater Withdrawal Level (for each subbasin)
☐	Biological Category (for each subbasin)
☐	Coldwater Fishery Resources
☐	DCR Water Needs Forecast
☐	Interbasin Transfer Act Application/Approval
☐	Watershed and Subbasin Boundaries
☐	Massachusetts Stormwater Management Handbook
☐	U.S. Geological Survey (USGS) reports
☐	MWRA Study of Local Sources of Water Supply in Non-MWRA Supplied Communities
☐	Local, State, and/or National Census Data

Water Supply Documents (if available/applicable):

☐	Pump Tests Data and Analysis
☐	Zone I and II Delineation Information
☐	Annual Statistical Reports
☐	Water Management Act Permit
☐	Water Management Act Registration
☐	Water System Master Plan
☐	Water Rates and Billing Structure
☐	Interconnections/Mutual Aid Agreements
☐	Water Use Restriction Bylaws/Regulations
☐	Map of Water System
☐	Private Well Regulations
☐	Indoor and Outdoor Demand Management/Water Conservation Efforts (i.e., retrofits, grants, rebates, education programs, volume savings, costs, etc.)
☐	Results of Water Audits, leak detection efforts and associated repairs
☐	Industrial/Commercial/Institutional water audits; process and other demand management for ICI Users
☐	Cooperative agreements with agricultural, golf courses, nurseries, and industrial users
☐	Information and Cost Estimates for Proposed Water System Improvements (treatment and distribution)
☐	Water Supply Alternatives Studies
☐	Drought Management Plan
☐	Well Operation Plans/Procedures
☐	Surface Water Operation Plans/Procedures
☐	Treatment System Operation Plans/Procedures
☐	Groundwater and/or hydrologic models
☐	Well Logs
☐	Historical Operations Data and Monitoring Records
☐	Sanitary Survey
☐	Water Demand Projections/Studies
☐	Reservoir Firm Yield Studies; Reservoir Management Plans, Size, Capacity
☐	Water Bank and/or Water Enterprise Fund Information

Wastewater Documents (if available/applicable):

☐	Sewer System/Wastewater Master Plan
☐	Sewer Regulations
☐	Wastewater Facilities Plan
☐	Infiltration and Inflow Data, Investigations, Reports (including private); Sewer Evaluation Surveys
☐	Map of Sewer System - wastewater collection and disposal systems
☐	Sewer Rates and Billing Structure
☐	Wastewater Flows Analysis/Metering Data Review/Flow Monitoring Programs
☐	Comprehensive Wastewater Management Plans and Environmental Impact Reports
☐	Wastewater Treatment Plant Flows
☐	Wastewater Allocation Study
☐	Wastewater Reuse Feasibility Studies/Reuse Permits
☐	Sewer Bank and/or Wastewater Enterprise Fund Information
☐	Groundwater discharge permits and groundwater discharge reports (including private)
☐	NPDES Surface water discharge permits and reports (including private)

Stormwater Documents (if available/applicable):

☐	Stormwater System Data/Map
☐	NPDES Stormwater General Permit (MS4)
☐	NPDES Phase II MS4 Annual Reports
☐	NPDES Discharge Monitoring Reports
☐	Stormwater Management Plan/Bylaw/Rules and Regulations (with recharge requirements)
☐	Stormwater Infiltration BMPs (list, location, and recharge volume calculations)
☐	Stormwater Utility Fund Information

Habitat Documents (if available/applicable):

☐	Existing reports or data describing instream aquatic habitat characteristics
☐	Inventory of road crossings over streams and culvert types
☐	Information on fish ladders within basin and subbasin(s)
☐	Fisheries Restoration Studies
☐	Inventory of Dams
☐	Dam Inspection Reports/Dam Removal Feasibility Studies/data on potential undammed stream miles if dam(s) removed, Cost Estimates for Dam Removals
☐	Inventory of unprotected lands (including those located within Zone IIs or within Reservoir Watersheds)
☐	Data on Culvert Ratings and Culvert Replacement Projects
☐	Documentation on degraded stream buffers/proposed projects for stream buffer restoration

General Town/Community Documents (if available/applicable):

☐	Groundwater/Aquifer/Surface Water Protection Regulations, Bylaws, and/or Overlay Districts
☐	Open Space and Recreation Plan
☐	Documentation of other Water Conservation Efforts (i.e., efforts by ICI users)
☐	Inventory of Municipal Buildings to be retrofit with water-saving devices
☐	Wetlands Protection Bylaw/Regulations
☐	Zoning Map/Bylaws
☐	Other local bylaws regulating land development/LID/BMPs
☐	Other Groundwater Discharge Permits/NPDES Discharge Permits within town/upstream of withdrawal points

Appendix E –

Annotated Bibliography

Appendix E
Annotated Bibliography for Phase 1 and 2 of SWMI Pilot Project

Agency/Other Reports and Data

1. **MassDEP. "Guidelines for Performing Infiltration /Inflow Analyses and Sewer Evaluation Survey." 1993. 81p.**
   This report summarizes guidelines for assessing infiltration and inflow into sanitary sewer systems.

2. **Waldron, M.C., Archfield, S.A. "Factors Affecting Firm Yield and the Estimation of Firm Yield for Selected Streamflow Dominated Drinking Water Supply Reservoirs in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006-5044." 2006. 39p.**
   This report presents data on reservoir characteristics and firm yield for many public water supply systems in MA

3. **Barlow, Lora K., L.M. Hutchins, and L.A. DeSimone. "Water Withdrawals, Use, and Wastewater Return Flows in the Concord River Basin, Eastern Massachusetts, 1996-2000: U.S. Geological Survey Scientific Investigations Report 2008–5158." 2009. 134p.**
   A copy of this report, commonly referred to as the "USGS Concord River Basin Report" was downloaded from the USGS website. This report provided detailed information regarding wastewater return flows which provided the basis for determining the percentage of wastewater return for various uses.

4. **Weiskel, P.K., S.L. Brandt, L.A. DeSimone, L.J. Ostiguy, and S.A. Archfield. "Indicators of Streamflow Alteration, Habitat Fragmentation, Impervious Cover, and Water Quality for Massachusetts Stream Basins: U.S. Geological Survey Scientific Investigations Report 2009–5272." 2010. 70p.**
   A copy of this report, commonly referred to as the "USGS Water Indicators Report" was downloaded from the USGS website at http://pubs.usgs.gov/sir/2009/5272/. This report is the basis for the development of Biological Categories and Groundwater Withdrawal Levels (GWL) (f/k/a Flow Levels) for 1400 subbasins in Massachusetts. Groundwater withdrawal and discharge data and the Unaffected August Flow values utilized by the SWMI model to determine the GWL were obtained from Table 1-2 of Appendix 1 of this Report. SWMI subbasin GIS data is also provided in Appendix 2 of this Report.

5. **Archfield, S.A., R.M. Vogel, P.A. Steeves, S.L. Brandt, P.K. Weiskel, and S.P. Garabedian. "The Massachusetts Sustainable-Yield Estimator: A decision-support tool to assess water availability at ungauged stream locations in Massachusetts, Scientific Investigations Report 2009-5227." 2010. 41p.**
   A copy of this report, commonly referred to as the "USGS SYE Report" was downloaded from the USGS website. This report is the basis for the development of Safe Yield for the major basins in Massachusetts and includes information on wastewater discharges.

6. **Armstrong, D.S., T.A. Richards, and S.B. Levin. "Factors influencing riverine fish assemblages in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2011–5193." 2011. 58p.**
   A copy of this report, commonly referred to as the "USGS Fish and Flow Study" was downloaded from the USGS website. This report establishes a relationship between August flow alteration and biological integrity.

7. **Levin, S.B., Archfield, S.A., and Massey, A.J. "Refinement and Evaluation of the Massachusetts Firm Yield Estimator Model Version 2.0: U.S. Geological Survey Scientific Investigation Report 2011-5125." 2011. 62p.**
   This report presents data on reservoir characteristics and firm yield for several additional public water supply systems in MA.

8. **MassDEP. "Massachusetts Sustainable Water Management Initiative Framework Summary." Draft. February 3, 2012. 55p.**
   This document describes the concepts and framework for MassDEP's proposed Sustainable Water Management Initiative and how it will affect WMA permit reviews and is the basis for this pilot project.

9. **Sutherland, Roger C., P.E. "Methods for Estimating the Effective Impervious Area of Urban Watersheds." Watershed Protection Techniques. 2(1): 282-284.**

10. **EPA FRS Facilities State Single File CSV Download. USEPA. May 19, 2012. Web. Accessed June 1, 2012.**
http://www.epa.gov/enviro/html/frs_demo/geospatial_data/geo_data_state_single.html
GIS data for major and non-major NPDES dischargers.

11. **MassDEP Water Management Program. "SWMI Interactive Map." Web. Accessed October 2012.**
http://www.mass.gov/dep/water/resources/swmi.htm.

12. **MassDEP. "Massachusetts Sustainable Water Management Initiative Framework Summary." Final. November 28, 2012. 40p.**
This document describes the concepts and framework for MassDEP's Sustainable Water Management Initiative and how it will affect WMA permit reviews and is the basis for this pilot project.

13. **EPA Massachusetts Final Individual Permits. USEPA. Web. Accessed November 2012.**
http://www.epa.gov/region1/npdes/permits_listing_ma.html
Used to identify NPDES dischargers with Individual Permits.

14. **EPA Massachusetts NOI Archive: Potable Water Treatment Facility General Permit. USEPA. Web. Accessed November 2012.** http://www.epa.gov/region1/npdes/noiarchive-pwtfgp.html
Used to identify NPDES WTF dischargers with General Permits.

15. **"MA SYE Water-Use Database" [Database File]. Provided by Thomas Lamonte. MassDEP Water Management Program. June 2012.**
This statewide, spatially referenced database contained groundwater and surface-water withdrawals and groundwater discharges from 2000-2004. This is commonly referred to as the SYE Database and contains the data utilized by the SWMI model. This information is only available upon request from MassDEP.

AMHERST

Water Supply Documents:

1. **Skiba, Catherine. Tighe & Bond, Inc. "Work Plan for Proposed Well No. 6, Lawrence Swamp, Amherst, Massachusetts." 8-1A. August 1989. 94p.**
   This report documents the site evaluation, pump test, well installation, groundwater sampling, and Zone II definition for a new well located in Lawrence Swamp. The report was provided by Tighe & Bond, Inc.

2. **Tighe & Bond, Inc. "New Source Approval – BRP WS 19 Amherst Well No. 6 and Belchertown Well P.S. #1. Department of Public Works. Amherst, Massachusetts. Volume I." October 1992. 93p.**
   New Source Approval Application for Amherst Well #6 and Belchertown Well PS #1 for pumping rates of 900 gpm each. Application includes aquifer pumping test data and analysis, Zone II and III delineations, groundwater monitoring program, and wellhead protection through zoning and non-zoning controls.

3. **Tighe & Bond, Inc. "New Source Approval – BRP WS 19 Amherst Well No. 6 and Belchertown Well P.S. #1. Department of Public Works. Amherst, Massachusetts. Volume II." October 1992. 369p.**
   Volume II includes Appendices A through E for the New Source Approval Application for Amherst Well #6 and Belchertown Well PS #1. These Appendices include well logs, analytical methods for determining aquifer parameters, aquifer performance test drawdown and recovery data, test data curves and analytical results, and water quality data.

4. **MassDEP. "Water Demand Projections from Amherst's 1993 WMA Permit for years 1993-2012." 1993. 4p.**
   Calculations used for projections were provided by Kim Longridge of DEP WERO for the Pilot Project.

5. **Couture, Thomas. Tighe & Bond, Inc. Letter regarding "Supplemental Information Pumping Test Report >70 gpm, PWS ID#1008000 Amherst & PWS ID# 1024000 Belchertown." 8-1E. February 23, 1993. 5p.**

6. **Couture, Thomas. Tighe & Bond, Inc. Supplemental Submission to MassDEP regarding "Amherst Well #6 Zone II Delineation PWS ID#1008000 Response to MassDEP Zone II." 8-1G. May 5, 1994. 47p.**

7. **Couture, Thomas. Tighe & Bond, Inc. Submittal to MassDEP regarding "Zone II Approval, Amherst Wells #1 through #6, PWS ID#1008000." 8-1F. June 29, 1994. 16 p.**

8. **MassDEP. "Zone II for Amherst 1008000 Well #1, 3, 4, 5, 6, Replacement Well #2, Daigle Well. Amherst/Belchertown Water Department 1008000-01G, 02G, 05G, 06G, 07G, 08G, 1024000-05G." July 29, 1994. 1p.**
   Map showing the Zone II boundary and public water supply sources that are associated with it at the date of printing.

9. **Couture, Thomas. Tighe & Bond, Inc. Letter regarding "Pumping Test Report, Increased Safe Yields, Amherst Wells #3 and #4, Revised Zone II, PWS-ID# 1008000 GW03, 04." 8-1H. May 31, 1995. 82p.**

10. **Skeels, Jason. Survey Map "Atkins Reservoir, Amherst, Massachusetts." Map is based on surveying performed by Stephen Salvini and Jason Skeels in June of 1996. Scale 1" = 100'. January 9, 1997. 1p.**

11. **Skeels, Jason. Survey Map "Hills Reservoir, Pelham, Massachusetts." Map is based on surveying performed by Arthur Usher and Jason Skeels in July of 1995. Scale 1" = 40'. January 14, 1997. 1p.**

12. **Skeels, Jason. Survey Map "Hawley Reservoir, Pelham, Massachusetts." Map is based on surveying performed by Arthur Usher and Jason Skeels in August of 1995. Scale 1" = 40'. January 15, 1997. 1p.**

13. **Skeels, Jason. Survey Map "Intake Reservoir, Pelham, Massachusetts." Map is based on surveying performed by Stephen Salvini and Jason Skeels in June of 1996. Scale 1" = 20'. January 21, 1997. 1p.**

14. **Amherst DPW Water Division. "Public Water Supply Annual Statistical Report" Reporting Years 2000-2011. PWS ID 1008000.**
    These reports were used to determine the actual PWS groundwater withdrawals. For Phase 2, 2000-2004 withdrawal data was compared to those predicted by the model.

15. **MassDEP. "Source Water Assessment and Protection (SWAP) Report for Amherst DPW Water Division." April 3, 2002. 11p.**

16. **Town of Amherst. "Handbook for Water Supply Emergencies for Atkins Reservoir." September 2002. 43p.**
This handbook serves as the emergency response contingency plan and outlines the actions to take in an event of a water emergency, either short-term or long-term at the Atkins Reservoir in order to provide potable water in sufficient quantity to water users. The handbook covers routine problems, minor emergencies, major emergencies, natural disasters, and nuclear disasters/terrorist acts.

17. **Tighe & Bond, Inc. "Town of Amherst Surface Water Supply Protection Plan for Atkins Reservoir." Prepared for MassDEP Bureau of Resource Protection and U.S. EPA Region I. March 2003. 165p.**
The purpose of this report was to improve protection efforts within the Atkins Reservoir watershed, which is located primarily in the Town of Shutesbury, with small portions also located in the Towns of Amherst, Leverett, and Pelham. The report includes five maps and seven written summaries related to surface water protection and education.

18. **Dumais, Omer. Tighe & Bond, Inc. Letter to Amherst DPW regarding "Well #5 Pump Replacement Recommendation." April 11, 2005. 5p.**
The letter presents recommendations for the pump replacement at Well #5 due to an air entrainment problem.

19. **Haas, Glenn. MassDEP. "Water Management Act Registration for Amherst DPW Water Division." Registration #10600802 for 2008-2017. December 31, 2007. 8p.**

20. **Chelminski, Michael, R. Stantec Consulting Services. "Site Reconnaissance, Preliminary Evaluation, and Cost Estimates for Dam Removal: Bartlett Fish Rod Co. Dam Pelham, Massachusetts." June 2009. 19 p.**
This report was prepared for MassDER to document the dam's condition, a proposed removal approach, and an evaluation of and process for restoration.

21. **Cabral, Deirdre. MassDEP. "Sanitary Survey Report and Notice of Non-Compliance for Amherst DPW Water Division." NON-WE-10-5D003. January 5, 2010. 27p.**
This report includes the system description, findings and compliance plan based on a September 15, 2009 Sanitary Survey. It is also a Notice of Noncompliance for violations identified during the Sanitary Survey.

22. **Cabral, Deirdre. MassDEP. "Water Management Act Permit Amendment for Amherst DPW Water Division." Permit #9P-1-06-008.01 for 1994-2013. October 15, 2010. 20p.**

23. **Town of Amherst DPW Water Division. "Status of Water Saving Devices in Municipally-Owned Public Buildings." October 2010. 1p.**

24. **Amherst Board of Health. "Regulations for Private Wells." Adoption Date October 20, 2008. Amended Date February 22, 2011. Effective Date March 15, 2011. 11p.**
These regulations were obtained by the Amherst Board of Health. The regulations govern permits, well location and use, water quantity, water quality, well construction, and decommissioning requirements for private drinking water wells.

25. **Belchertown Water District. "Public Water Supply Annual Statistical Report Reporting Year 2011." PWS ID 1024000. 2011. 39p.**

26. **Hadley Highway and Water Department. "Public Water Supply Annual Statistical Report Reporting Year 2011." PWS ID 1117002. 2011. 38p.**

27. **Amherst DPW Water Division. "Metered Finished Water Use for Calendar Year 2011." 2011.**
This is an excel file provided by the DPW that shows the water usage calculation and number of accounts for 2011 as reported in their ASR.

28. **Amherst Department of Public Works. "2011 Water Quality Report." PWS ID 1008000. 4p.**
    This is Amherst's 2011 Consumer Confidence Report (CCR) which includes information on Amherst's seasonal demand regarding their water supply.

29. **Amherst DPW Water Division. "Emergency Response Plan." 254p.**

30. **Amherst Water Distribution Map. Amherst GIS. May 2012.**
    Map of the water distribution system including raw and finished water lines, service lines, gates, blowoffs, hydrants, meter pits, supply wells, and storage tanks.

31. **McClellan, John. Tighe & Bond, Inc. Memorandum to Amy Lane/Town of Amherst regarding "Nielsen Property Well Development Timeline and Costs." May 8, 2012. 12p.**
    This memorandum summarizes previous well exploration results and provides a list of permits and an Opinion of Probable Costs relative to well development.

32. **Amherst Utility System Viewer. Amherst GIS. May 11, 2012. 2p.**
    This was a print-out from Amherst GIS system that a portion of the Town's water distribution system. The print-out was marked up to depict the location of two existing interconnections to the Town of Hadley.

33. **Lane, Amy. Amherst DPW Water Division. Email correspondence from Amy Lane to Tracy Adamski of Tighe & Bond regarding "UMASS Conservation Efforts." May 16, 2012. 3p.**

34. **Amherst Watershed Properties Map. Amherst GIS. May 18, 2012.**
    Map of the watershed properties.

35. **Town of Amherst DPW Water Division. "Summary of Watershed Land Acquisitions by the Town of Amherst, 2003 to present." 1p.**

36. **Osborne, Jeffrey. "Town of Amherst Water Division General Operating Procedures." 1p.**
    Memo from the Water Division Director with brief descriptions sources, treatment, and tanks.

37. **Small, Ezra. UMass Amherst. "Showerhead Proposed Savings." Received June 4, 2012. 3p.**
    This excel spreadsheet provides calculations used in a proposal made to the UMass Director of Residence Life to replace existing 2.5 gpm showerheads in all residence halls with 1.5 gpm showerheads.

38. **Cajigas, Jessica. Comprehensive Environmental Inc. Memorandum Summarizing SWMI Pilot Project Phase 2 – Amherst Site-Specific Study Meeting. October 23, 2012. 5p.**
    This draft memorandum summarizes the discussion regarding the Amherst Site-Specific Study. The draft memo explains that the SWMI process does not currently account for the reduced impact of Amherst's withdrawals on the Hop Brook associated with the confining unit and notes the extent of the confining unit within Amherst's aquifer.

Wastewater Documents:

1. **Town of Amherst. "Sewer Regulations of the Town of Amherst, Massachusetts, Volume VII." Rules and Regulations Governing the Use of Common Sewers. Effective July 1, 1973. 8p.**

2. **Town of Amherst DPW Sewer Division. "Table 2 1999 Orchard Valley I/I." January 6, 2000. 1p.**
   This table provides a list of houses in the Orchard Valley subdivision with suspected drains or sump pumps tied into the sanitary sewer system.

3. **CDM. "Town of Amherst, Massachusetts Sewer Extension Master Plan Final Report." October 2005. 86p.**
   This report identifies areas in need of centralized wastewater collection, prioritizes areas for implementation, and identifies solutions for wastewater handling.

4. **CDM. "Town of Amherst, Massachusetts Sewer Extension Master Plan Draft Report." August 2011. 112p.**
   This draft report is intended to update and revise the recommendations from the October 2005 Sewer Extension Master Plan.

5. **Harrington, Brian D. MassDEP WERO. "Individual Reclaimed Water Use Permit. Class C Water Use. Permit No. #914-0. October 23, 2011 – October 23, 2016." September 23, 2011. 10p.**
   MassDEP permit to UMass-Amherst, Central Heating Plant for the use of reclaimed water originating from the Amherst WWTP and then further treated at UMass Reclaimed Water Intake/Treatment System for the purpose of boiler make up water.

6. **CDM Smith. "Draft Report: Wastewater Reuse Feasibility Study." Prepared for Town of Amherst, Massachusetts. January 2012. 182p.**
   This draft report evaluates wastewater reuse options related to the existing reverse osmosis (RO) system operated by Siemens Water Technologies Corporation at the University of Massachusetts (UMass) campus. Report states that relocation of the RO system to the wastewater treatment plant may not be the most viable alternative to meet Town and UMass needs.

7. **Amherst Sewer Distribution System Map. Amherst GIS. May 2012.**
   Map of the sewer distribution system including force main sewer lines, active sewer lines, missing and abandoned lines, sewer line cleanouts, pump stations, and residential and commercial pumps.

8. **Town of Amherst DPW Sewer Division. Unnamed table. June 1, 2012. 1p.**
   This table summarized sewer system projects, estimated I/I removal and project costs undertaken by the DPW Sewer Division from 2003 to 2012.

9. **Town of Amherst DPW Sewer Division. "Slip Line Projects." June 4, 2012. 1p.**
   This table provides a list of Amherst DPW priority areas for slip lining sewer lines to address infiltration.

Stormwater Documents:

1. **Maps of "Town of Amherst Drainage System." March 2011. 80p.**
   The maps depict locations of catch basins, drain manholes, stormwater outfalls, culverts, drain lines, dams, retention ponds, water bodies, and wetlands.

General Town of Amherst Documents:

1. **Town of Amherst Board of Health. "Aquifer Protection Floor Drain & Manure Regulations in the Aquifer Recharge Area (Zone II)." Public Health Regulations. Revised and Adopted April 11, 2000. 4p.**
   These regulations are intended to protect aquifer recharge areas (those areas identified in the Amherst Zoning Bylaw and Official Zoning Map as the Aquifer Protection zoning district) from leaching of stored animal manure.

2. **Town of Belchertown Board of Health. "Groundwater and Recharge Protection Regulation." May 30, 2002. 6p.**
   Regulation includes land use prohibitions within Zone IIs and/or Interim Wellhead Protection Areas, and all designated wetland buffer zones.

3. **Town of Amherst. "Open Space and Recreation Plan 2009 Update." 2009. 105p.**
   This plan provides an assessment of existing conditions and trends in Amherst, identifies the community's current open space and recreation goals, conservation and recreation needs, and objectives.

4. **Town of Amherst Planning Department. "Town of Amherst Centers & Outlying Zoning Map." October 2010.**

5. **Town of Amherst. "General Bylaws of the Town of Amherst, Massachusetts." May 2011. 96p.**
   Bylaws governing all general aspects of the Town, including wetlands protection.

6. **Town of Amherst Planning Department. "Town of Amherst Zoning Map." June 2011. 1p.**

7. **Town of Amherst. Section 3.25 of the Amherst Zoning Bylaw regarding "Aquifer Recharge Protection District." Amended through November 2011. 7p.**
   This section of the bylaw establishes an Aquifer Recharge Protection (ARP) District and designates prohibited and restricted uses within the district for the purpose of preventing contamination of ground and surface waters flowing into the aquifer of Lawrence Swamp.

8. **Amherst Conservation Commission. "Town of Amherst Wetland Protection Bylaw." 8p.**
   Bylaws governing stormwater management and land development within the Town to help safeguard environmental resources.

9. **Amherst Conservation Commission. "Town of Amherst Wetland Protection Bylaw Regulations." Amended January 17, 2012. 36p.**
   Regulations to back the Wetlands Protection Bylaw governing protection of environmental resources within the Town.

DANVERS-MIDDLETON

Water Supply Documents:

1. **Chiang, T.T. and P.C. Bucknam. Whitman & Howard, Inc. "Report on Size and Capacity of Reservoir No. 12 for the Town of Danvers, Massachusetts." October 1981. 33p.**
   This report provides the results of a feasibility study of Reservoir No. 12 (Emerson Brook Reservoir).The report indicates the reservoir will provide an additional yield of about 1.2 mgd to the existing yield of surface water supplies in Middleton and Danvers.

2. **Stone & Webster Civil and Transportation Services, Inc. "Massachusetts Water Resources Authority Study of Local Sources of Water Supply in Non-MWRA Supplied Communities: Community Report for the Towns of Danvers and Middleton." MWRA Contract #5006. March 16, 1992. 57p.**
   The MWRA supported this study of the water supply system for the Towns of Danvers and Middleton because of their spatial proximity to the MWRA distribution system and the possibility that they might request water from MWRA in the future. The study was intended to assess the short and long term water supply condition of these towns, identify possible contamination threats, and possibly help them reduce or eliminate these threats.

3. **Whitman & Howard. "Town of Danvers Water Supply Alternatives." July 7, 1992. 100p.**
   This report includes discussions on supply conservation, demand conservation, alternate groundwater sources, additional withdrawals from existing wells, feasibility and costs of pumping wells to treatment plant, additional surface water withdrawals, interconnections with Beverly and Peabody, and establishing an interconnection with MWRA.

4. **Yarsites, Robert A. and J. M. Beekman. Whitman & Howard. Letter to Danvers Director of Public Works regarding "Boston Brook." October 17, 1995. 6p.**
   This letter summarizes findings of an investigation into whether or not the Town-owned land along Boston Brook at Curtis Pond should continue to be held by the Town as a potential water supply resource. The final recommendation was to release the property based mostly on the cost to develop the site and repair/rebuild the dam.

5. **DeNatale, Douglas and R. A. Yarsites. Whitman & Howard. Letter to Danvers Director of Public Works regarding "Fracture Trace Analysis." February 28, 1996. 4p.**
   This letter summarizes findings of the fracture-trace analysis completed in the Towns of Danvers and Middleton to identify areas that might be favorable for developing municipal, bedrock water supply wells. Ten areas were identified as being favorable for bedrock test well exploration.

6. **Town of Danvers and Town of Middleton. "Danvers/Middleton Water Contract." August 4, 1997. 15p.**
   This document is the contract between the Town of Danvers and the Town of Middleton stipulating how the Town of Danvers sells water and services to the Town of Middleton for sale to Middleton customers and is compensated by the Town of Middleton.

7. **Town of Danvers. "Rules & Regulations Water Division." Revised February 27, 1998. 9p.**
   Rules and regulations pertaining to service connections, water meters, service renewal, home pools, billing and rates, emergencies, water shut-off, and others.

8. **S E A Consultants, Inc. "Town of Danvers, Massachusetts Drought Management Plan." June 29, 2000. 37p.**
   A 1999 settlement agreement with MassDEP required Danvers complete this Drought Management Plan which includes discussions on: water sources, system demand history, history associated with drought issues; data monitoring; drought stage triggers, communication; and mitigation.

9. **Danvers Water Department. "Public Water Supply Annual Statistical Report" Reporting Years 2000-2011. PWS ID 3071000.**
   These reports were used to determine the actual PWS groundwater withdrawals. For Phase 2, 2000-2004 withdrawal data was compared to those predicted by the model.

10. **North Reading Water Department. "Public Water Supply Annual Statistical Report" Reporting Years 2000-2011. PWS ID 3213000.**

These reports were used to review how changes in withdrawals within subbasin 21019's upstream contributing watershed have changed since the 2000-2004 period.

11. **Reading Water Department. "Public Water Supply Annual Statistical Report" Reporting Years 2000-2011. PWS ID 3246000.**
    These reports were used to review how changes in withdrawals within subbasin 21019's upstream contributing watershed have changed since the 2000-2004 period.

12. **Wilmington Water Department. "Public Water Supply Annual Statistical Report" Reporting Years 2000-2011. PWS ID 3342000.**
    These reports were used to review how changes in withdrawals within subbasin 21019's upstream contributing watershed have changed since the 2000-2004 period.

13. **MassDEP. "Discharge Monitoring Reports" for Reporting Years 2000-2011 (if available) for the following facilities (Permit ID):**
    - Wilmington Realty Trust f/k/a Ametek (34)
    - Greenbriar Estates (45)
    - Colonial Drive Condos (96)
    - Park Colony Condos (142)
    - Fuller Pond Village (250)
    - Meadowview Care and Rehab f/k/a Sunbridge Care and Rehab (642)
    - US Postal Service (662)
    - Middleton Marketplace (752)
    - Edgewood Luxury Apartments (832)
    - Regency Place (843)

    Used to identify changes in groundwater discharges since 2000-2004.

14. **DeNatale, Douglas. Earth Tech, Inc. "New Source Final Report Gravel-Packed Replacement Wells for Well No. 1, Danvers Water Department, Middleton, Massachusetts." February 2002. 345p.**
    This report documents the results of two prolonged pumping tests to evaluate the suitability of two new replacement wells at Well #1. The report indicates the replacement wells can yield a combined 675 gpm.

15. **S E A Consultants, Inc. "Water Supply Operations Plan for Danvers, Massachusetts." March 2002. 68p.**
    This report reviews the existing operational approach for utilization of the available water sources, demonstrates the adequacy or shortfalls of that operational approach, and presents an updated operational strategy to optimize the water supplied while balancing environmental impacts.

16. **Carnevale, Richard M. City of Peabody Department of Public Services. Letter regarding "Water System Interconnections – Mutual Aid." August 1, 2002. 13p.**
    This letter was intended to update existing records on the interconnection between Peabody and Danvers. The letter includes attached schematics, photographs, and spreadsheets on the existing interconnections.

17. **Danvers DPW. List of Danvers Tie-Ins (interconnections) with Beverly, Salem, and Peabody. Date Unknown. 1p.**
    This list provided by Danvers DPW staff includes the Town, Location, Size, and Pressure of 17 interconnections (4 with Beverly, 6 with Salem, and 7 with Peabody).

18. **Earth Tech, Inc. "Test Well Investigation and Preliminary Prolonged Pumping Tests: Danvers State Hospital, Danvers, MA and Richardson Property, Middleton, MA." October 2002. 131p.**
    The report documents the test well program undertaken in 2001 to identify an additional source of water supply for the Town of Danvers. A total of 13 test well sites were tested on the Danvers State Hospital Property in Danvers and the Richardson Property in Middleton.

19. **S E A Consultants, Inc. "Water Distribution Facilities Plan and Capital Improvement Program for Danvers, Massachusetts." December 2003. 116p.**
    This report formulates a long-range plan for water supply, storage, distribution, and operations which will correct existing deficiencies and meet requirements for projected water demands into the future. It reviews the existing system, population projections, water requirements, and recommended improvements.

20. **Danvers Water Department. "Community Water System Vulnerability Assessment." June 21, 2004. 23p.**
This is Danvers' Vulnerability Assessment as required by the Public Health and Security and Bioterrorism Act of 2002 which addresses pipes, physical barriers, water collection, treatment, storage, distribution facilities, automated systems, and chemical use, storage, and handling.

21. **S E A Consultants, Inc. "Emerson Brook Reservoir Expansion – Summary for Pre-Filing Meeting." 2004. 4p.**
Summary provided as a brief description of the proposed Emerson Brook Reservoir Expansion project for the pre-filing meeting which was held as an introduction to the project for regulators. The project proposed to increase storage in the reservoir by raising the height of the existing dam by 5 feet.

22. **S E A Consultants, Inc. "Emerson Brook Reservoir Pre-Filing Report for Danvers." November 2004. 65p.**
This report describes the proposed expansion of the Emerson Brook Reservoir including project history and need, project alternatives, conceptual design, ecological characterization and impact, and potential mitigation.

23. **BETA Group, Inc. "Danvers Water Department Emergency Response Plan." December 15, 2004. 64p.**
This emergency response plan is separated into two components: the treatment system and the distribution system. The treatment system consists of operations at the Russell Water Treatment Facility and the Greensand Water Treatment Facility, and the water quality of the surface water supplies. The distribution system consists of the storage tanks, transmission mains, service connections, booster stations, and water quantity of wellheads and surface water supplies.

24. **Middleton Water Department. "Public Water Supply Annual Statistical Report" Reporting Years 2004-2011. PWS ID 3184000.**

25. **MassDEP. "Modified Water Management Act Permit for Danvers Water Department." Permit #9P-3-17-071.01 for 1991-2009. March 23, 2006. 18p.**

26. **Lehane, Michael. Murphy, Hesse, Toomey & Lehane, LLP. Letter from Town Counsel to Danvers Town Manager regarding "Final Decision approving Settlement Agreement." March 31, 2006. 28p.**
This letter provides the approved Settlement Agreement between Danvers and Middleton; the Ipswich River Watershed Association, Inc., Essex County Greenbelt Association, and Twelve Citizens; and MassDEP regarding Danvers' Water Management Act Permit. The letter also includes the Modified Water Withdrawal Permit.

27. **Zessoules, Nick and T. Mahin. MassDEP. "Sanitary Survey Report for Middleton Department of Public Works." September 11, 2006. 9p.**
This report includes the system description, findings and compliance plan based on an August 29, 2006 Sanitary Survey.

28. **Haas, Glenn. MassDEP. "Water Management Act Registration for Danvers Water Department." Registration #31707101 for 2008-2017. December 31, 2007. 8p.**

29. **Monnelly, Anne. MassDCR. "Danvers-Middleton Final Water Needs Forecast." June 9, 2009. 5p.**

30. **Jean, Hilary and T. Mahin. MassDEP. "Sanitary Survey Report for Danvers Department of Public Works." September 3, 2010. 11p.**
This report includes the system description, findings and compliance plan based on a Sanitary Survey conducted on July 14 and 15, 2010.

31. **Town of Danvers Water Division. "Annual Water Report – Water Testing Performed in 2010." PWS ID#: 307 1000. 6p.**
This is Danvers' 2010 CCR which includes information on how Danvers provides treatment for their water supply.

32. **Town of Danvers. "Water & Sewer Rates." Effective July 1, 2011. 1p.**

33. **Heidell, Pam. MWRA Policy and Programming Manager. Email correspondence from Pam Heidell to Page Czepiga of Tighe & Bond regarding approximate MWRA Entrance Fees. June 1, 2012. 1p.**
This email includes guidance related to estimating MWRA entrance fee. Approximates entrance fee at $5M/mgd.

34. **Adamski, Tracy; Czepiga, Page. Tighe & Bond, Inc. Memorandum regarding Telephone Interview with Rick Rodgers, Town Engineers. June 14, 2012. 2p.**
This memo summarizes information obtained during a phone interview regarding Danvers' water distribution system and the potential for interconnections.

35. **Town of Danvers. "Final Report for the Danvers Water Conservation Grant Project. Project Number 09-04/WCG. April 2, 2010-June 30, 2012." June 15, 2012. 10p.**
This report documents Danvers' efforts under the MassDEP Water Conservation Grant Program including additional conservation outreach and education, and an updated water conservation rebate program.

36. **Adamski, Tracy. Tighe & Bond, Inc. Notes regarding Telephone Interviews with Communities About Changes in Wastewater Discharges. 1 p.**
Phone notes from contacting each community to determine whether there have been any changes to the sewershed since 2004 that impact groundwater discharges within upstream contributing watershed to subbasin 21019.

37. **Massachusetts Water Resources Authority Advisory Board. "Summary of MWRA Board of Directors' Meeting – November 16, 2005." Web. Accessed November 2012.**
http://archives.lib.state.ma.us/bitstream/handle/2452/36643/ocm21020471-2005-11-16.pdf?sequence=1
This document provided the amount of water that Reading is permitted to purchase from MWRA. Used in evaluation of Reading's groundwater withdrawals and source operation.

38. **Wilmington Water Department Public Notice. "Chemical Found in Four Inactive Wells in Wilmington – Water Supply from Maple Meadow Brook Aquifer Suspended Pending Further Tests." Web. Accessed November 2012.**
http://www.town.wilmington.ma.us/pages/WilmingtonMA_Health/Public%20Driking%20Water%20Supply%20Info2.pdf
This public notice provided information on the operation of the Town's sources in Maple Meadow Brook Aquifer, specifically when they were removed from service due to concerns from contamination due to Olin Corporation.

Wastewater Documents:

1. **Town of Danvers. "Regulation of Sewer Use Bylaw." Date Unknown. 15p.**
This bylaw regulates the use of public and private sewers and drains, the installation and connection of building sewers, and the discharge of waters and wastes into the public sewer system.

2. **CDM. "Town of Danvers Wastewater Facilities Plan." 1997. 131p.**
This plan evaluates the present and future needs of the wastewater collection system within the Town of Danvers. It addresses two main issues: the capability of the existing wastewater collection facilities to convey current and future design flows to the SESD interceptor and treatment facility, and the feasibility of sewering unsewered areas which are presently being served by subsurface disposal systems.

3. **CDM. "Town of Danvers, Massachusetts South Essex Sewerage District House to House Inspection Program Report." March 2003. 100p.**
This report presents the findings of the 1998 inspection program and recommends a program for removing identified private inflow sources from the Town of Danvers sanitary sewer system.

4. **CDM. "South Essex Sewerage District, Danvers, Massachusetts, Infiltration/Inflow Investigation." March 2003. 96p.**
This report summarizes the results of a gauging and flow isolation program conducted for the South Essex Sewerage District in Danvers which included flow monitoring, analysis of data, flow isolation, and internal TV inspection.

5. **South Essex Sewerage District. "Sewer Use Regulations." Revision 11.03. Effective Date February 15, 2006. 57p.**
The South Essex Sewerage District sewer use regulations apply to all users of the wastewater treatment plant, whether inside or outside of the district, with a goal of complying with the Federal Water Pollution Control Act, and General Pretreatment Regulations.

6. **Worrall, Eric. MassDEP NERO. "Groundwater Discharge Permit. Permit No. #250-4. June 2, 2009 – June 2, 2014." June 2, 2009. 20p.**
   MassDEP permit to Fuller Pond Village Condominium Trust to discharge into the ground a treated effluent from the wastewater treatment facility located at Fuller Pond Condominiums in Middleton, MA.

7. **Worrall, Eric. MassDEP NERO. "Groundwater Discharge Permit. Permit No. #752-1. October 21, 2010 – October 21, 2015." October 21, 2010. 13p.**
   MassDEP permit to DSM Realty, Inc., to discharge into the ground a treated effluent from the wastewater treatment facility located at Middleton Market Place in Middleton, MA.

8. **Taubert, Alan. South Essex Sewerage District. "CY 2011 Flows & Loads Final Report." January 25, 2012. 86p.**
   This report provides the flows and loads account and entity distribution basis for the annual SESD budget. It includes a schematic of the SESC collection system and other supporting documentation.

9. **Duffield, Martha. Danvers Engineering. Email correspondence from Martha Duffield to Gabrielle Belfit of Tighe & Bond regarding status of I/I reports after 2003. June 6, 2012. 2p.**
   Ms. Duffield reported on the status of work completed since 2003, one for cleaning and tving and one for repairs, and that two articles at town meeting have passed for continuation of I/I work.

Danvers Stormwater Documents:

1. **Marquis, Wayne P. Town of Danvers. "NPDES PII Small MS4 General Permit Annual Reports." Nos. 1-9. March 2004 - March 2011.**
   Annual reports for Years 1-9, covering March 2004 through March 2012 and documenting progress made by the Town on stormwater BMPs to date.

2. **EPA Region I GIS Center. "Waterbody Assessment and TMDL Status, Danvers MA." EPA. Map Tracker ID 6678. February 25, 2010. 1p.**
   Map showing the location and status of 305(b) and 303(d) listed waters within the Town.

3. **EPA Region I GIS Center. "Summary of Waterbody Assessment and TMDL Status in Massachusetts, Danvers MA." EPA. February 25, 2010. 2p.**
   Table summarizing the status of 305(b) and 303(d) listed waters within the Town.

4. **EPA Region I GIS Center. "Impervious Cover & Watershed Delineation by Subbasin or GWCA, Danvers MA." EPA. Map Tracker ID 4291. March 3, 2010. 1p.**
   Map showing impervious cover and watershed boundaries within the Town.

5. **EPA Region I GIS Center. "Impervious Cover Statistics, Danvers MA." EPA.**
   Database providing impervious cover sizes and land use by basin within the Town.

6. **MassDEP, Bureau of Resource Protection – Watershed Management. "BRP WM 08A, NPDES Stormwater General Permit Notice of Intent for Discharges from Small Municipal Separate Storm Sewer Systems (MS4s)." Town of Danvers. July 22, 2003. 7p.**
   Notice of Intent for the Town stormwater discharges from its MS4.

7. **EPA New England. "NPDES Phase II Stormwater Program Automatically Designated MS4 Areas, Danvers Massachusetts." September 30, 2002. 1p.**
   Map showing the urbanized area and default Phase II coverage within the Town.

8. **CDM. "Town of Danvers Massachusetts, Stormwater Management Plan." July 2003. 34p.**
   Stormwater Management Plan (SWMP) outlining a plan for reducing stormwater pollutant discharges from the Town's MS4 as required by the EPA NPDES program.

9. **Town of Danvers. "Proposed Stormwater Management and Land Disturbance Bylaw." Adopted May 16, 2011. 11p.**

Bylaws governing stormwater management and land development within the Town to help safeguard environmental resources.

10. **Town of Danvers. "Regulations Governing Stormwater Management Under the General Bylaws of the Town of Danvers, Chapter XXXIX: Stormwater Management and Land Disturbance Bylaw." Adopted March 29, 2012. 29p.**
    Regulations to back the Stormwater Management and Land Disturbance Bylaw governing stormwater management and land development within the Town.

Middleton Stormwater Documents:

1. **Singer, Ira S. Town of Middleton. "NPDES PII Small MS4 General Permit Annual Reports." Nos. 2-9. April 2004-May 2012.**
   Annual reports for Years 2 through 9, covering April 2004 through May 2012 and documenting progress made by the Town on stormwater BMPs to date.

2. **EPA Region I GIS Center. "Waterbody Assessment and TMDL Status, Middleton MA." EPA. Map Tracker ID 6678. February 25, 2010.**
   Map showing the location and status of 305(b) and 303(d) listed waters within the Town. **1p.**

3. **EPA Region I GIS Center. "Summary of Waterbody Assessment and TMDL Status in Massachusetts, Middleton MA." EPA. February 25, 2010. 2p.**
   Table summarizing the status of 305(b) and 303(d) listed waters within the Town.

4. **EPA Region I GIS Center. "Impervious Cover & Watershed Delineation by Subbasin or GWCA, Middleton MA." EPA. Map Tracker ID 4291. March 3, 2010. 1p.**
   Map showing impervious cover and watershed boundaries within the Town.

5. **EPA Region I GIS Center. "Impervious Cover Statistics, Middleton MA." EPA.**
   Database providing impervious cover sizes and land use by basin within the Town.

6. **MassDEP, Bureau of Resource Protection – Watershed Management. "BRP WM 08A, NPDES Stormwater General Permit Notice of Intent for Discharges from Small Municipal Separate Storm Sewer Systems (MS4s)." Town of Middleton. June 30, 2003. 7p.**
   Notice of Intent for the Town stormwater discharges from its MS4.

7. **EPA New England. "NPDES Phase II Stormwater Program Automatically Designated MS4 Areas, Middleton Massachusetts." November 14, 2002. 1p.**
   Map showing the urbanized area and default Phase II coverage within the Town.

General Town of Danvers Documents:

1. **Town of Danvers. "Planning Board Rules and Regulations Governing the Subdivision of Land in Danvers, Massachusetts." Adopted September 10, 1979. 116p.**
   Bylaws governing construction of subdivisions within the Town.

2. **Town of Danvers Department of Planning and Human Services. "Wetlands Bylaw and Wetlands Bylaw Regulations." March 2003. 41p.**
   Bylaws and regulations outlining for protecting wetlands within Town boundaries. Bylaws have been incorporated into the general bylaws while regulations are a stand-alone document.

3. **Town of Danvers. "2009 Open Space and Recreation Plan." 2009. 125p.**
   This is Danvers's sixth Open Space and Recreation Plan which focuses the networks of open space including contiguous properties and greenbelts. The plan provides an inventory of existing open space and recreation facilities and recommends strategies for acquisition, use and protection of open space and conservation land.

4. **Town of Danvers. "Zoning Bylaws." January 25, 2010. 162p.**
   Bylaws governing zoning restrictions, land use, and structure locations within Town.

5. **Town of Danvers. "By-Laws of the Town of Danvers, Massachusetts, Adopted 1951." Revised through May 17, 2010. 86p.**
   Bylaws governing all general aspects of the Town, including wetlands protection and water system connections.

6. **Town of Danvers. "Zoning Map with Groundwater Protection District." Town of Danvers GIS. Revised September 28, 2010. 1p.**
   Map showing zoning districts within Town in support of the Zoning Bylaws.

General Town of Middleton Documents:

1. **Town of Middleton. "Chapter 250 Subdivision of Land." Adopted March 25, 1987. 20p.**
   Bylaws governing construction of subdivisions within the Town.

2. **Town of Middleton. "Water Use Restriction Bylaw." June 1, 2005. 4p.**
   At the May 10, 2005 Annual Town Meeting, the Tow of Middleton adopted this addition to the General By-Laws: "Chapter V – Water Conservation. Section 1: Water Use Restriction." Restrictions are in effect whenever there is in force a State of Water Supply Conservation or State of Water Supply Emergency.

3. **Town of Middleton. "Irrigation/Outside Water Usage Bylaw." June 1, 2005. 2p.**
   At the May 10, 2005 Annual Town Meeting, the Tow of Middleton adopted this addition to the General By-Laws: "Chapter V – Water Conservation. Section 2: Irrigation/Outside Water Usage." This By-law is in effect from May 1st to September 30th of each year and makes it unlawful to undertake outside watering of vegetation between the hours of 8:00am to 7:00pm using town water or private well water through a sprinkler or lawn irrigation system. The By-law is superseded in the event of a State of Water Supply Conservation or State of Water Supply Emergency.

4. **Town of Middleton. "Chapter 235 Zoning." Adopted November 29, 2005, amended May 13, 2008. 52p.**
   Bylaws governing zoning restrictions, land use, and structure locations within Town.

5. **Town of Middleton. "Private Water Supply Systems." Amendments noted where applicable. Adopted by the Board of Health October 1, 2008. 20p.**

6. **Town of Middleton. "Zoning Map of Middleton Massachusetts." Revised January 1, 2010. 1p.**
   Map showing zoning districts within Town in support of the Zoning Bylaws.

7. **Fullerton, Derek. Middleton Board of Health. Email correspondence regarding those sections of the Middleton Irrigation/Outside Water Usage Bylaw that were overturned in 2011. May 7, 2012. 2p.**
   At the 2011 Town Meeting those portions of the Middleton Irrigation/Outside Water Usage Bylaw that referred to "private well users" were deleted.

Ipswich River Watershed Association Documents:

1. **Inter-Fluve. "South Middleton Dam, Ipswich River Partial Feasibility Study Phase I Technical Memorandum." 2010. 28p.**
   This report discusses the benefits of removing the South Middleton Dam and future studies needed to prepare for its removal. It also identifies the options for managing the impounded sediment at the dam and identifies alternative water supply sources for the fire suppression system of Bostik, Inc.

2. **Mackin, Kerry. IRWA. "Comments on Danvers Pilot Project Meeting." Received June 26, 2012. 3p.**
   This document contains comments sent to the Pilot Project Team from Kerry Mackin of the Ipswich River Watershed Association regarding the Danvers Watershed Group Meeting held on June 18, 2012.

DEDHAM-WESTWOOD

Water Supply Documents:

1. **Dedham-Westwood Water District. "White Lodge Water Treatment Plant." 1987. 6p.**
   This document provides a summary of the White Lodge Water Treatment Plant including its construction, general operation, visitation areas, and hydraulic profile.

2. **Weston and Sampson. "Rock Meadow Well Water Treatment Feasibility Study Preliminary Draft." October 1989. 30p.**

3. **Anderson-Nichols & Company, Inc. "Report on Extended Pump Test Fowl Meadow Aquifer." April 1990. 364p.**
   This report contains findings from the December 1989 extended pump test and recommends that DWWD seek approval for a total yield of 800 gpm or approximately 1.15 mgd.

4. **Anderson-Nichols & Company, Inc. "Zone II Delineation Study Fowl Meadow Aquifer." February 1991. 246p.**
   This report contains findings from the Zone II Delineation Study for the Fowl Meadow Well and White Lodge Wellfield.

5. **Weston & Sampson. "Dedham-Westwood Water District Bridge Street Wellfield. Aquifer Pumping Test and Zone II Delineation." April 1991. 169p.**
   This report is the final Bridge Street Zone II Delineation Report submitted to MassDEP, which was required in order for DWWD to prepare to complete Well A-2. Well A-2 would be fed into the new Bridge Street Treatment Plant.

6. **Dedham-Westwood Water District "Bridge Street Water Treatment Plant." 1991. 8p.**
   This document provides a summary of the Bridge Street Water Treatment Plant including its construction, general operation, visitation areas, and hydraulic profile.

7. **Stone & Webster Civil and Transportation Services, Inc. "Massachusetts Water Resources Authority Study of Local Sources of Water Supply in Non-MWRA Supplied Communities: Community Report for the Towns of Dedham and Westwood." MWRA Contract #5006. February 26, 1992. 58p.**
   The MWRA supported this study of the water supply system for the Towns of Dedham and Westwood because of their spatial proximity to the MWRA distribution system and the possibility that they might request water from MWRA in the future. The study was intended to assess the short and long term water supply condition of these towns, identify possible contamination threats, and possibly help them reduce or eliminate these threats.

8. **Massachusetts Water Resources Commission. "Interbasin Transfer Application: Dedham-Westwood Water District Proposed Fowl Meadow Well, WRC Decision." 1992. 15p.**
   This documents provides the findings of the July 13, 1992 meeting of the WRC and states that the WRC has approved the interbasin transfer application with conditions concerning water conservation and requirements for streamflow measurements.

9. **Weston & Sampson. "Dedham-Westwood Water District Bridge Street Wellfield. Revised Report on Aquifer Pumping Test and Zone II Delineation." August 31, 1993. 177p.**
   This report is the revised final Bridge Street Zone II Delineation Report. It includes findings of the study and recommendation for groundwater protection. The study included data review, observation well installation, a constant-rate pumping test, and computer model simulations.

10. **Gottlieb, Andrew. MassDEP. "Water Management Act Permit for Dedham-Westwood Water District." Permit #9P-3-19-073.01 for 1993-2010. November 2, 1993. 8p.**

11. **Anderson-Nichols & Company, Inc. "Fowl Meadow Public Water Supply Well Site AN-1 Wetland Monitoring Program Water Elevation Readings. #1 – May 1994. #2 – June 1994." July 25, 1994. 60p.**
    This report contains the first and second monthly water elevation readings in accordance with Clean Water Act Permit No. 02254-9149 for the filling and replication of wetlands for the development of the new Fowl Meadow Well Site AN-1. The report also contains drilling logs for new piezometers installed.

12. **Anderson-Nichols & Company, Inc. "Report on AN-2A Test Well Exploration Fowl Meadow Aquifer. Dedham, Massachusetts." February 10, 1995. 147p.**
This report contains findings from the drilling of a 2.5-inch test well designated AN-2A to investigate the feasibility of developing an alternative well site to AN-1. The report recommends development of a final production well at the location of AN-1 in the Fowl Meadow Aquifer based on better aquifer transmissivity.

13. **Dedham-Westwood Water District. "Public Water Supply Annual Statistical Report" Reporting Years 2000-2011. PWS ID 3073000.**
These reports were used to determine the actual PWS groundwater withdrawals. For Phase 2, 2000-2004 withdrawal data was compared to those predicted by the model.

14. **Dedham-Westwood Water District. "Local Water Supply Management Plan." Date Unknown. 32p.**
This plan was prepared as part of the application process to the MWRA. The plan covers existing and potential water supplies and source water protection, existing regional or watershed plans, analysis of existing zoning and master planning documents, and future water and wastewater needs and alternatives for meeting those needs.

15. **CDM. "Dedham-Westwood Water District Water Conservation Plan Revised Report." November 16, 2005. 39p.**
This plan contains discussion on the current conservation program including planning; water audits and leak detection; metering; pricing; residential, public sector, agricultural, and industrial, commercial, and institutional water use; lawn and landscape conservations; and education and outreach. It also discusses planned enhancements such as a conservation fund, conservation coordinator, demonstration projects, and rebate programs.

16. **Weston & Sampson. "Dedham-Westwood Water District Water System Study." April 2007. 98p.**
This report contains the DWWD water system study and capital improvements plan. The report includes updates to the system's hydraulic model, updates to water system demands and 20-year projections, flow test results from the distribution system, options to eliminate identified deficiencies in the system, and recommended improvements.

17. **Weston & Sampson. "Dedham-Westwood Water District Pressure Zone Mapping." September 2007. 4p.**
The maps include the Westfield Intermediate Service Area, Sandy Valley High Service Area, High Rock High Service Area, and Burgess Avenue High Service Area.

18. **Haas, Glenn. MassDEP. "Water Management Act Registration for Boston Harbor for the Dedham - Westwood Water District." Registration #31907301 for 2008-2017. December 31, 2007. 8p.**

19. **Haas, Glenn. MassDEP. "Water Management Act Registration for Charles River for the Dedham-Westwood Water District." Registration #31707101 for 2008-2017. December 31, 2007. 8p.**

20. **Carroll, Anne. MassDCR. Letter from DCR to DWWD regarding "Temporary Allocation for Water Management Act Withdrawal Permits, 2010-2030." November 3, 2009. 2p.**
This letter explains that the data currently available do not allow for an estimate of future water needs for the DWWD supply system.

21. **MassDEP. "Wellhead Protection Zones Bridge Street Wells (PWS 3073000-01G, 02G, 03G, 04G, 05G, 14G, 15G, 16G, and 17G)." December 15, 2009. 1p.**
This map shows the Zone II boundary and public water supply sources for Bridge Street.

22. **MassDEP. "Wellhead Protection Zones White Lodge and Fowl Meadow (PWS 3073000-06G, 07G, 08G, 09G, 13G)." December 15, 2009. 1p.**
This map shows the Zone II boundary and public water supply sources for White Lodge and Fowl Meadow.

23. **Dewberry-Goodkind, Inc. "Dedham/Westwood Water District PWS ID# 3073000 Water System Emergency Response Plan." September 2010. 83p.**

24. **Jean, Hilary and T. Mahin. MassDEP. "Sanitary Survey Report for Dedham-Westwood Water District." December 17, 2010. 13p.**
This report includes the system description, findings and compliance plan based on a Sanitary Survey conducted on September 29, 2010.

25. **Weston & Sampson. "General Plan Sheet of Distribution System. Dedham/Westwood Water District. Sheet B-2." January 2011.**
The sheet shows the emergency interconnection to Norwood.

26. **Weston & Sampson. "General Plan Sheet of Distribution System. Dedham/Westwood Water District. Sheet C-3." January 2011.**
The sheet shows the regular service connection to MWRA.

27. **Weston & Sampson. "General Plan Sheet of Distribution System. Dedham/Westwood Water District. Sheet F-4." January 2011. 2p.**
The sheet shows the emergency interconnection to MWRA.

28. **Weston & Sampson. "General Plan Sheet of Distribution System. Dedham/Westwood Water District. Sheet G-2." January 2011. 1p.**
The sheet shows the emergency interconnection to Needham.

29. **Commane, Eileen. DWWD. Letter from DWWD to MWRA regarding "Water Supply Continuation Agreement." January 19, 2011. 16p.**
This letter includes a copy of the Water Supply Continuation Agreement between MWRA and the DWWD as well as a copy of the Supplemental Report and Attachments.

30. **Haas, Glenn. MassDEP. Letter regarding "Interim Water Management Act Permit in the Boston Harbor. Permit #I9P31907301." February 22, 2011. 2p.**
This letter explains the Permit Extension Act of 2010 and that the interim permit for DWWD will now expire on February 28, 2013.

31. **Gillen, Michele. MWRA. Letter from MWRA to DWWD regarding "Water Supply Continuation Agreement MWRA Contract No. W289." April 11, 2011. 5p.**
This letter includes a copy of the fully executed Water Supply Continuation Agreement between MWRA and the DWWD.

32. **Hamilton, Catherine. MassDEP. Letter to Dedham-Westwood Water District regarding "Wellhead Protection Best Effort Requirement Compliance, Wells 01G-19G." September 6, 2011. 2p.**
This letter, provided by MassDEP, explains that DWWD satisfies the wellhead protection conditions of its Water Management Act permit because it has met the Best Effort Requirements regarding Zone II protection in Westwood, Norwood, Milton, Dedham, and Canton. This document also contains a copy of the letter sent to the Town of Westwood as part of DWWD's "best efforts."

33. **Dedham-Westwood Water District. "Rules and Regulations." March 27, 2012. 36p.**
These rules and regulations also contain the schedule of water rates in Schedule A which were effective as of February 1, 2011.

34. **Weston & Sampson. "General Plan Sheet of Distribution System. Dedham/Westwood Water District." May 2012. 1p.**

35. **Commane, Eileen. Dedham-Westwood Water District. Email correspondence from Eileen Commane to Jessica Cajigas of CEI regarding "MWRA Water Rates." May 24, 2012.**

36. **Dedham-Westwood Water District. "Pumping History." June 4, 2012.**
DWWD provided this excel sheet with pumping records from the Neponset and Charles from 2003 through 2011.

37. **Dedham-Westwood Water District. "Rebate Program Information through 12/31/2011." June 4, 2012.**
DWWD provided this excel sheet with information on rebates for toilets, washing machines, urinals, rainbarrels, and rain sensors from 2007 through 2011.

38. **Commane, Eileen. Dedham-Westwood Water District. Email correspondence to Peter Galant of Tighe & Bond regarding incremental cost of water production at Fowl Meadow Wellfield, 2012. June 18, 2012.**

39. **Commane, Eileen. Dedham-Westwood Water District. Email correspondence to Peter Galant of Tighe & Bond regarding Fowl Meadow Well Shut-Off Days. June 19, 2012.**

Wastewater Documents:

1. **Town of Dedham. "Sewer Regulations." Updated 2006. 80p.**

2. **Doherty, John. CDM. "Town of Westwood, Massachusetts Wastewater Flows Analysis/Metering Data Review Final Report." June 2009. 87p.**
   This report presents the results of the I/I analysis, identifies sewers subject to higher amounts of I/I, and develops a prioritized plan to pursue I/I reduction where necessary.

3. **Town of Westwood. "Sewer System Map with Street Index." March 2010. 1p.**

4. **Worrall, Eric. MassDEP NERO. "Individual Groundwater Discharge Permit. Permit No. #905-0. October 14, 2010 – October 14, 2015." October 14, 2010. 14p.**
   MassDEP permit to Hale Reservation to discharge into the ground a treated effluent from the wastewater treatment facility located at Hale Reservation in Westwood, MA.

5. **MWRA. "2011 Water & Sewer Retail Rate Survey." Westwood (page 59). 2011. 1p.**
   This pages of the MWRA survey provides residential water and sewer rates for Westwood.

6. **Town of Westwood Department of Public Works Sewer Division. "Sewer System Rules and Regulations and Construction Standards." Draft. March 2011. 65p.**

7. **Weston & Sampson. "Report: Town of Dedham, MA Town-Wide Flow Monitoring Program." October 2011. 15p.**
   This report presents the analysis of flow metering results, provides estimates of peak infiltration/inflow and total inflow volume, and identifies areas that appear to contribute to excessive I/I.

8. **Town of Dedham. "Sewer Map Town of Dedham Norfolk County Massachusetts." May 2012. 1p.**

9. **Hornbrook, Michael. "Attachment 5 to MWRA Annual I/I Reduction Report for FY 11 I/I Reduction Status Update for Member Communities." 2012. 42p.**
   This report was downloaded from the MWRA website **(**http://www.mwra.state.ma.us/harbor/pdf/infinf11_att5.pdf) for the Dedham and Westwood summaries. Dedham summary includes reporting on 2008 contract, 2010 on-call sewer repairs project, and 2011 annual sewer system inspection program. Westwood summary includes report on house-to-house survey and town wide I/I study initiated in CY2010-2011 that included some cleaning and inspection work.

Dedham Stormwater Documents:

1. **Keane, Paul G. and William G. Keegah, Jr. Town of Dedham. "NPDES PII Small MS4 General Permit Annual Reports." Nos. 1-9. March 2003 - March 2012.**
   Annual reports of Years 1 through 9 covering March 2003 through March 2012 and documenting progress made by the Town on stormwater BMPs to date.

2. **EPA Region I GIS Center. "Waterbody Assessment and TMDL Status, Dedham MA." EPA. Map Tracker ID 6678. February 25, 2010. 1p.**
   Map showing the location and status of 305(b) and 303(d) listed waters within the Town.

3. **EPA Region I GIS Center. "Summary of Waterbody Assessment and TMDL Status in Massachusetts, Dedham MA." EPA. February 25, 2010. 2p.**
   Table summarizing the status of 305(b) and 303(d) listed waters within the Town.

4. **EPA Region I GIS Center. "Impervious Cover & Watershed Delineation by Subbasin or GWCA, Dedham MA." EPA. Map Tracker ID 4291. March 3, 2010. 1p.**
   Map showing impervious cover and watershed boundaries within the Town.

5. **EPA Region I GIS Center. "Impervious Cover Statistics, Dedham MA." EPA.**
   Database providing impervious cover sizes and land use by basin within the Town.

6. **MassDEP, Bureau of Resource Protection – Watershed Management. "BRP WM 08A, NPDES Stormwater General Permit Notice of Intent for Discharges from Small Municipal Separate Storm Sewer Systems (MS4s)." Town of Dedham. July 28, 2003. 7p.**
   Notice of Intent for the Town stormwater discharges from its MS4.

7. **EPA New England. "NPDES Phase II Stormwater Program Automatically Designated MS4 Areas, Dedham Massachusetts." October 4, 2002. 1p.**
   Map showing the urbanized area and default Phase II coverage within the Town.

8. **Town of Dedham. "Chapter XXXVI, Stormwater Management By-Law." Adopted April 9, 2001. 8p.**
   Bylaws governing stormwater management within the Town to help safeguard environmental resources.

9. **Town of Dedham. "Town of Dedham Drainage & Stormwater Management Design Standards." Revised July 31, 2002. 43p.**
   A document outlining required design standards for use during stormwater design.

10. **Town of Dedham. "Stormwater Management Rules and Regulations." Adopted May 23, 2002, Amended May 15, 2003. 18p.**
    Regulations to back the Stormwater Management By-Law governing stormwater management and land development within the Town.

Westwood Stormwater Documents:

1. **Walsh, Timothy, Christopher Gallagher, and Vicki Quiram. Town of Westwood. "NPDES PII Small MS4 General Permit Annual Reports." Nos. 1-9. March 2004 - March 2012.**
   Annual reports for Years 2 through 9 covering March 2004 through March 2012 and documenting progress made by the Town on stormwater BMPs to date.

2. **EPA Region I GIS Center. "Waterbody Assessment and TMDL Status, Westwood MA." EPA. Map Tracker ID 6678. February 25, 2010.**
   Map showing the location and status of 305(b) and 303(d) listed waters within the Town.

3. **EPA Region I GIS Center. "Summary of Waterbody Assessment and TMDL Status in Massachusetts, Westwood MA." EPA. February 25, 2010. 3p.**
   Table summarizing the status of 305(b) and 303(d) listed waters within the Town.

4. **EPA Region I GIS Center. "Impervious Cover & Watershed Delineation by Subbasin or GWCA, Westwood MA." EPA. Map Tracker ID 4291. March 3, 2010. 1p.**
   Map showing impervious cover and watershed boundaries within the Town.

5. **EPA Region I GIS Center. "Impervious Cover Statistics, Westwood MA." EPA.**
   Database providing impervious cover sizes and land use by basin within the Town.

6. **MassDEP, Bureau of Resource Protection – Watershed Management. "BRP WM 08A, NPDES Stormwater General Permit Notice of Intent for Discharges from Small Municipal Separate Storm Sewer Systems (MS4s)." Town of Westwood. July 16, 2003. 7p.**
   Notice of Intent for the Town stormwater discharges from its MS4.

7. **EPA New England. "NPDES Phase II Stormwater Program Automatically Designated MS4 Areas, Westwood Massachusetts." November 25, 2002. 1p.**
   Map showing the urbanized area and default Phase II coverage within the Town.

General Town of Dedham Documents:

1. **Town of Dedham. "Town Bylaws: Chapter 28: General Wetlands Protection By-law." Amended April 8, 2002. 5p.**
   Bylaw outlining protection of wetlands within Town boundaries. Bylaws have been incorporated into the general bylaws.

2. **Town of Dedham Board of Health. "Well Regulations: Private Water Supplies/Geo-Thermal Wells." Amended March 6, 2007. 7p.**

3. **Town of Dedham. "Open Space and Recreation Plan." August 2010. 223p.**
   This plan provides an assessment of existing conditions and trends in Dedham, and identifies the community's current open space and recreation goals, conservation and recreation needs, and objectives.

4. **Town of Dedham Department of Infrastructure Engineering. "Zoning Map, Town of Dedham, Norfolk County, Massachusetts." October 2010.**
   Map showing zoning districts within Town in support of the Zoning Bylaws.

5. **Town of Dedham. "Zoning By-Law." Revised November 2011. 106p.**
   Bylaws governing zoning restrictions, land use, and structure locations within Town.

General Town of Westwood Documents:

1. **Town of Westwood. "Westwood Board of Health Private Well Regulations." September 2007. 17p.**

2. **Town of Westwood. "General Bylaws and Charter." Revised October 2009. 81p.**
   Bylaws governing all general aspects of the Town.

3. **Town of Westwood. "Conservation Commission Wetlands Protection Bylaw." January 27, 2010. 19p.**
   Bylaws and regulations outlining for protecting wetlands within Town boundaries.

4. **Town of Westwood. "Zoning Bylaw of the Town of Westwood, Massachusetts." Adopted March 13, 1961, Amended May 2, 2011. 166p.**
   Bylaws governing zoning restrictions, land use, and structure locations within Town.

5. **Town of Westwood Planning Board. "Official Zoning Map with Street Index." May 2011. 1p.**
   Map showing zoning districts within Town in support of the Zoning Bylaws.

Neponset River Watershed Association Documents:

1. **Cooke, Ian (NRWA), L. Larson (MRWA), C. Pawlowski (FRWA), W. Roemer (NRWA), and S. Woods (WRWA). "Boston Harbor Watershed: Water Quality & Hydrologic Investigations." Project Number 2002-02/MWI. June 30, 2003. 377p.**
   This report summarizes the results of water quality and hydrologic investigations in the Boston Harbor Watershed, and recommends actions needed to restore natural resources and achieve water quality standards in the study area.

2. **GeoSyntec Consultants and Neponset River Watershed Association. "Summary of Public Water System Capacities and Issues for the Assessment of Water Sharing Options during Water Supply Emergencies." April 2007. 113p.**
   This report provides a regional assessment of current water supply sources, existing water supply distribution infrastructure, current inter-municipal water supply connections, constraints on water sharing, and existing water sharing agreements within the communities of Dedham, Westwood, Foxborough, Medfield, Norwood, Sharon, and Walpole.

3. **Pearlman, Steven. Neponset River Watershed Association. "Minimizing Municipal Costs for Infiltration & Inflow Remediation: A Handbook for Municipal Officials." June 30, 2007. 51p.**
   This document was designed to provide municipalities with assistance in planning for an effective I/I remediation program and identifying ways to finance I/I programs cost-effectively.

SHREWSBURY

Water Supply Documents:

1. **Shrewsbury Water Department. "Public Water Supply Annual Statistical Report" Reporting Years 2000-2011. PWS ID 2271000.**
   These reports were used to determine the actual PWS groundwater withdrawals. For Phase 2, 2000-2004 withdrawal data was compared to those predicted by the model.

2. **Haas, Glenn. MassDEP. "Water Management Act Registration for Shrewsbury Water & Sewer Department." Registration #21227101 for 2008-2017. December 31, 2007. 8p.**

3. **Monnelly, Anne. MassDCR. "Shrewsbury Final Water Needs Forecast." November 20, 2008. 3p.**

4. **Town of Shrewsbury. "Water Department Rules and Regulations for Water Line Installation." Revised February 6, 2009. 9p.**

5. **Town of Shrewsbury. "Shrewsbury Water Conservation Grant Project, Project Number 07-18/WCG." 2009. 28p.**
   This report was a deliverable to MassDEP under the Water Conservation Grant Program. The report documents Shrewsbury's efforts under the grant program to promote water conservation techniques and provide water conservation tools to residents.

6. **Tata & Howard. "Alternate Water Supply Study, Shrewsbury, Massachusetts." January 2010. 57p.**
   This study includes a review of existing and proposed system demands and an evaluation of alternatives for additional supply for the system to meeting projected demands. Alternatives include new sources in Shrewsbury, purchasing raw or finished water from Worcester, and purchasing finished water from Boylston, Northborough, and MWRA.

7. **Stone, Marielle. MassDEP. "Water Management Act Permit for Shrewsbury Water Department." Permit #9P4-2-12-271.01 for 2010-2029. February 26, 2010. 28p.**

8. **Town of Shrewsbury. "Emergency Response Plan for the Shrewsbury Water Department PWS ID 2271000." August 2011. 74p.**

9. **Tata & Howard. Map of "Recommended Improvements, Shrewsbury, Massachusetts." November 2011.**
   This map shows the water system including wells, treatment plants, water mains, tanks, high service areas, low service areas, and reduced high service areas. It also identifies recommended improvements, labeled as "Phase 1" or "Phase 2 Improvements", which came from various studies/reports.

10. **Bostwick, Robert. MassDEP. "Sanitary Survey Report for Shrewsbury Water Department." December 9, 2011. 32p.**
    This report includes the system description, findings and compliance plan based on a Sanitary Survey conducted on October 12, 2011.

11. **Boylston Water District. "Public Water Supply Annual Statistical Report Reporting Year 2011." PWS ID 2039000. 2011. 39p.**

12. **Tata & Howard. "Water Distribution System Study Update, Shrewsbury, MA, T&H No. 2373." April 2012. 103p.**
    This report updates the Town's water distribution system map and computer model and makes recommendations to meet Insurance Service Office fire flow recommendations. It also evaluates the ability of existing sources and storage facilities to meeting existing and future demands.

13. **Tozeski, Robert. Shrewsbury Water & Sewer Department. Memo to SWMI Pilot Project Team regarding "Shrewsbury Water Department and Wastewater Data." Provided on May 3, 2012. 3p.**
    The memo provides information on meter types, source capacities, customers, and septic systems. It also provides sewer and water rates effective April 1, 2011 and rates from 2008.

14. **Shrewsbury Water & Sewer Department. Memo to SWMI Pilot Project Team regarding Number of Water Conservation Devices Provided from 2008-2011. Provided on May 3, 2012. 3p.**
    This hand-written memo provides information on the numbers of low-flow pistol grips, showerheads, and faucet aerators handed out to residents between 2008 and 2011.

Wastewater Documents:

1. **Earth Tech, Inc. "Assabet River Consortium DEP/BRP Project No. CWSRF 424 Planning State Application Comprehensive Wastewater Management Plan/Environmental Impact Report." June 21, 2000. 460p.**
   This is the Assabet River Consortium's SRF Application for the CWMP/EIS for MassDEP and Water Pollution Abatement Trust review and approval.

2. **Earth Tech, Inc. "Comprehensive Wastewater Management Plan and Environmental Impact Report Phase I - Needs Analysis for the Assabet River Consortium." May 2001. 166p.**
   The Towns of Hudson, Maynard, Northborough, Shrewsbury, and Westborough, the City of Marlborough, and the Westborough Treatment Plant Board formed the Assabet River Consortium to address and study issues that affect them relative to wastewater treatment. Each community has wastewater flows to the treatment plant that discharge to the Assabet River. Because of concerns over nutrient discharges to the river, each community must do a CWMP/EIR, and this report serves as part of that requirement providing a summary of existing environmental and wastewater needs of the study area.

3. **Fay, Spofford & Thorndike. "Town of Shrewsbury Comprehensive Wastewater Management Plan/Environmental Impact Report Phase I – Needs Analysis Final." May 2001. 192p.**
   The report focused on wastewater disposal needs, and evaluation of the collection and transmission system, required treatment levels and technologies, effluent disposal options, residual handling and disposal options, and facility siting.

4. **Earth Tech, Inc. "Technical Memorandum to Phase I Needs Survey Assabet Consortium." October 2001. 221p.**
   This Technical Memorandum was written specifically to address comments received on the Phase I Needs Assessment for all Assabet River Consortium communities.

5. **Fay, Spofford & Thorndike. "Town of Shrewsbury Comprehensive Wastewater Management Plan/Environmental Impact Report Phase I – Needs Analysis Technical Memorandum Draft." October 2001. 73p.**
   This memo summarizes the comments made to MEPA as related to the Town of Shrewsbury's Phase I Report, including comments from DEP, community specific comments, and community specific comments from EPA.

6. **Fay, Spofford & Thorndike. "Town of Shrewsbury Comprehensive Wastewater Management Plan/Environmental Impact Report Phase II - Development and Screening of Alternatives." March 2002. 147p.**
   This report provides detail on wastewater minimization issues including infiltration/inflow policy, problems and studies; water reuse guidelines and opportunities; flow and waste reduction including water conservation, and stormwater recharge. The report assessed options for groundwater disposal sites of treated effluent from the Westborough WWTP.

7. **Earth Tech, Inc. "Comprehensive Wastewater Management Plan and Environmental Impact Report Phase II - Development and Screening of Alternatives Assabet Consortium." May 2002. 161p.**
   The Report includes a general discussion of potential technologies as it related to phosphorous removal from discharge to the Assabet River, discharge to groundwater sites, and reuse possibilities. An updated water balance was included in the report.

8. **Fay, Spofford & Thorndike. "Town of Shrewsbury Water and Sewer Commission, Shrewsbury, Massachusetts Wastewater Allocation Study." March 2005. 17p.**
   This report presents the findings of a study to determine the Town's total wastewater flow limit at the Westborough Wastewater Treatment Plant and to recommend allocation of the Town's remaining wastewater flow to the various needs areas in Town.

9. **Gates, Leighton & Associates. "Master Plan with Phasing, Lake Street Recreation." Map. Revised January 14, 2006. 1p.**
This map shows the layout for a proposed recreational master plan for town owned land at the SAC site including a 305,000 gallon per day wastewater treatment facility and disposal fields within the Blackstone River Basin.

10. **Fay, Spofford & Thorndike. "Town of Shrewsbury Comprehensive Wastewater Management Plan/Environmental Impact Report Phase III Alternatives Evaluation and Plan Selection." March 2007. 77p.**
This report provides detail on the evaluation of alternatives and the final recommended plan selection. The main components of the plan are a series of expansions and upgrades to the Towns wastewater collection system, continued use of individual septic systems, and proposed upgrades to the Westborough Wastewater Treatment Plant.

11. **Earth Tech, Inc. "Comprehensive Wastewater Management Plan and Environmental Impact Report Phase III - Draft Recommended Plan and Draft Environmental Impact Report, Program Manager's Report for the Assabet River Consortium." April 2007. 116p.**
This report summarizes the status of the recommended plan, flows, technologies evaluated, and costs for each of the Assabet River Consortium's members.

12. **Fay, Spofford & Thorndike. "Town of Shrewsbury Comprehensive Wastewater Management Plan/Environmental Impact Report Phase IV Final Report." September 2007. 200p.**
This report contains summaries of all previous CWMP phases including the recommended plan focused on the needs of Shrewsbury and the collection system needed to accommodate future flows.

13. **Earth Tech, Inc. "Comprehensive Wastewater Management Plan and Environmental Impact Report Phase IV - Final Recommended Plan and Final Environmental Impact Report for the Assabet River Consortium." October 2007. 202p.**
This report provides the final status of the recommended plan, flows, technologies evaluated, and costs for each of the Assabet River Consortium's members.

14. **Anderson, Paul. MassDEP. Letter to EOEEA Secretary Bowles regarding "Shrewsbury Comprehensive Wastewater Management Plan Phase IV, Final Environmental Impact Report." November 7, 2007. 2p.**
Letter certifies compliance with the Interim NPDES permit, and establishes Shrewsbury's flow limit at the Westborough Wastewater Treatment Facility to 4.39 mgd. The report indicates that by 2030 after I/I removal, the town expects the 4.39 mgd to be 2.47 mgd from residential properties, 1.33 mgd from commercial/industrials and 0.59 from I/I a net reduction of 0.77 mgd from 2007 average I/I flows.

15. **MassEOEEA. "Certificate of the Secretary of Energy and Environmental Affairs on the Special Procedure: Phase IV – Final Recommended Comprehensive Wastewater Management Plan." December 3, 2007. 11p.**
This letter certifies compliance of the Assabet River Consortium Phase IV Plan. EOEA comments on groundwater recharge of wastewater and stormwater as an important component of a watershed-based approach, in order to minimize the existing basin inflow/outflow imbalances affecting the river system.

16. **Weston & Sampson. "Report Town of Shrewsbury, MA Wastewater Capital Improvement Plan." November 2009. 34p.**

17. **Town of Shrewsbury. "Sewer Rates." Effective April 1, 2011. 1p.**

18. **Town of Shrewsbury Board of Sewer Commissioners. "Rules and Regulations for the Installation and Connection of Building Sewers and for the Use of Public Sewers." Revised April 13, 2011. 20p.**

19. **Weston & Sampson. "Final Report Town of Shrewsbury, MA Browning Road and Colton Lane Area Private Inflow Removal Program." July 2011. 44p.**
Report on work for Browning Road, and Colton Lane inflow removal program that included building inspections and smoke and dye testing. The report summarized results of the field work performed to identify sources of inflow to the collection system through sump pumps, floor drains, catchbasins, driveway drains and roof leaders.

20. **Weston & Sampson. "Final Report Town of Shrewsbury, MA Spring 2011 Town-Wide Flow Metering Project." November 2011. 147p.**
    This report presents analysis of flow metering results, identifies areas that appear to contribute excessive infiltration and inflow, and provides estimates of peak I/I and total inflow volume.

21. **Weston & Sampson. "Draft Report Town of Shrewsbury, MA 2011 Inflow Investigation." April 2012. 46p.**
    This report presents findings of the 2011 inflow investigation which included smoke and dye testing and building inspections in the Trowbridge Land and Washington Street area and the Summer Street and Francis Avenue area. The report also presents a cost-effectiveness analysis and preliminary design for rehabilitation of identified inflow sources.

22. **Weston & Sampson. "Town of Shrewsbury, Massachusetts Infiltration and Inflow (I/I) Identification and Rehabilitation Summary." Updated June 2012. 1p.**
    This is a summary of infiltration and inflow projects proposed and completed from 2010 through 2017.

Stormwater Documents:

1. **Morgado, Daniel, J. and Michael Hale. Town of Shrewsbury. "NPDES PII Small MS4 General Permit Annual Reports." Nos. 1-9. March 2003 - March 2012.**
   Annual reports for Years 1 through 9, covering March 2003 through March 2012 and documenting progress made by the Town on stormwater BMPs to date.

2. **EPA Region I GIS Center. "Waterbody Assessment and TMDL Status, Shrewsbury MA." EPA. Map Tracker ID 6678. February 25, 2010. 1p.**
   Map showing the location and status of 305(b) and 303(d) listed waters within the Town.

3. **EPA Region I GIS Center. "Summary of Waterbody Assessment and TMDL Status in Massachusetts, Shrewsbury MA." EPA. February 25, 2010. 2p.**
   Table summarizing the status of 305(b) and 303(d) listed waters within the Town.

4. **EPA Region I GIS Center. "Impervious Cover & Watershed Delineation by Subbasin or GWCA, Shrewsbury MA." EPA. Map Tracker ID 4291. March 3, 2010. 1p.**
   Map showing impervious cover and watershed boundaries within the Town.

5. **EPA Region I GIS Center. "Impervious Cover Statistics, Shrewsbury MA." EPA.**
   Database providing impervious cover sizes and land use by basin within the Town.

6. **MassDEP, Bureau of Resource Protection – Watershed Management. "BRP WM 08A, NPDES Stormwater General Permit Notice of Intent for Discharges from Small Municipal Separate Storm Sewer Systems (MS4s)." Town of Shrewsbury. July 29, 2003. 10p.**
   Notice of Intent for the Town stormwater discharges from its MS4.

7. **EPA New England. "NPDES Phase II Stormwater Program Automatically Designated MS4 Areas, Shrewsbury Massachusetts." November 20, 2002. 1p.**
   Map showing the urbanized area and default Phase II coverage within the Town.

8. **Town of Shrewsbury Engineering Department. "Stormwater Infiltration BMPs Approved by the Conservation Commission during Last 5 Years." May 10, 2012. 2p.**
   Handwritten list of infiltration BMPs installed in Town over the past 5 years.

General Town of Shrewsbury Documents:

1. **Town of Shrewsbury Planning Board. "Inclusionary Housing Submission Requirements, Procedures & Supplemental Regulations." Adopted November 2, 2006. 18p.**

2. **Town of Shrewsbury. "Chapter 43D Rules and Regulations." Revised January 7, 2008. 23p.**

3. **Town of Shrewsbury Planning Board. "Rules and Regulations Governing the Subdivision of Land in Shrewsbury, MA." Revised August 5, 2010. 42p.**
Bylaws governing construction of subdivisions within the Town.

4. **Town of Shrewsbury Planning Board. "Rules and Regulations Governing Special Permits & Site Plan Review in Shrewsbury, MA." Adopted April 7, 2011. 25p.**
Rules and regulations applying to projects requiring a special permit and/or site plan review by Town departments.

5. **Town of Shrewsbury. "Zoning Map." Revised May 16, 2011.**
Map showing zoning districts within Town in support of the Zoning Bylaws.

6. **Town of Shrewsbury. "Zoning Bylaw." Amendments through September 26, 2011. 150p.**
Bylaws governing zoning restrictions, land use, and structure locations within Town.

7. **Town of Shrewsbury. "General Bylaws of the Town of Shrewsbury Together with Town Meeting Act, Town Manager Act, and Acts of the Legislature Accepted by the Town." October 2011. 85p.**
Article 4-J "Water Department Assessments" provides for special assessments to meet costs related to laying pipes in public and private ways. Article 18 "Water Use Restrictions" allows the Town to regulate water use during a State of Water Supply Conservation and a State of Water Supply Emergency. Private wells are exempt from Article 18. Article 21 "Stormwater Management Bylaw" establishes stormwater management standards for the final conditions that result from development and redevelopment projects.

8. **Town of Shrewsbury Board of Health. "Regulations Regarding the Subsurface Disposal of Sanitary Sewage." Date Unknown. 2p.**

9. **Town of Shrewsbury. "Open Space and Recreation Plan." 2012. 139p.**
This plan provides an assessment of existing conditions and trends in Shrewsbury, and identifies the community's current open space and recreation goals, conservation and recreation needs, and objectives.

SITE-SPECIFIC STUDY DOCUMENTS

1. **Bovee, K.D. "Data Collection Procedures for the Physical Habitat Simulation System." U.S. Geological Survey, Biological Resources Division Mid-Continent Ecological Science Center. August 1997. 149p.**
   This report provides an overview of IFIM and PHABSIM and discusses data collection procedures and requirements.

2. **Mead, Jim. North Carolina Department of Environment and Natural Resources Division of Water Resources. "Procedures for Instream Flow Studies: Wetted Perimeter (WP) and Instream Flow Incremental Methodology (IFIM)." Revised December 1998. 9p.**
   This document describes a scope of work to conduct an IFIM instream flow study.

3. **North Carolina Department of Environment and Natural Resources Division of Water Resources. "Guidelines for Consultant Conducting Instream Flow Study Using the Wetted Perimeter Method." 12p.**
   This document describes a scope of work and model use to conduct a wetted perimeter instream flow study.

4. **Bovee, K.D, B.L. Lamb, J.M. Bartholow, C.B. Stalnaker, J. Taylor and J. Henriksen. "Stream Habitat Analysis Using the Instream Flow Incremental Methodology. U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD-1998-0004 Viii." 1998. 131p.**
   This report provides an overview of IFIM, background on model concepts, data requirements, calibration techniques, and quality assurance to help the technical user design and implement a cost-effective IFIM.

5. **Zappia, H. and D.C. Hayes. U.S. Geological Survey. "A Demonstration of the Instream Flow Incremental Methodology, Shenandoah River, Virginia." Water-Resources Investigations Report 98-4157. 1998. 30p.**
   This report documents the utility of IFIM as well as the instream flow issues in the Shenandoah River Basin.

6. **North Carolina Department of Environment and Natural Resources Division of Water Resources. "Techniques Manual." March 2000. 33p.**
   This document is a supplement to training and a reference for instream flow methods including data collection, processing, and analysis.

7. **Waddle, T.J., ed. U.S. Geological Survey, Fort Collins, CO. PHABSIM for Windows: User's Manual and Exercises." 2001. 288p.**
   This document provides an overview of IFIM and a more detailed explanation of the components of the PHABSIM model.

8. **The Nature Conservancy. "Indicators of Hydrologic Alteration: User's Manual." July 2001. 27p.**
   This document provides an overview of and explains updates to the IHA software program which is a tool for calculating hydrologic regime statistics.

9. **Gomez and Sullivan. "Saugus River Water Budget and Instream Flow Study." Prepared for Massachusetts Department of Environmental Management. June 2002. 227p.**
   This report describes the scientific process used to develop protected flows for the Lamprey Designated River. The study methodology used was IFIM and the model was PHABSIM

10. **Pyrce, R.S. Watershed Science Centre, Peterborough, Ontario. "Hydrological Low Flow Indices and their Uses." WSC Report No.04-2004. 2004. 33p.**
    This document provides an examination of the most common low flow indices and their uses including the various 7Q flows, other flow indices (e.g. 4Q3), and the flow duration indices. Instream flow methods and baseflow are also included in this report.

11. **Golder Associates Ltd. "Final Report: Lesser Slave River Instream Flows Needs Scoping Study." March 2004. 172p.**
    This report summarizes existing data on the Lesser Slave River; identifies potential data gaps necessary for completing an instream flow needs evaluation; provides a work plan for completing additional field work; and proposes a flow evaluation framework for assessing year-round instream flow needs.

12. **Chelan County Conservation District. "Entiat Water Resource Inventory Area (WRIA) 46 Management Plan, Chapter 5 - Instream Flows." October 2004. 25p.**
Chapter 5 of this report documents the use of IFIM and PHABSIM for setting instream flow recommendations for the WRIA watershed in Washington State.

13. **Montgomery Water Group, Inc. "Icicle Creek Target Flow Report for the USFWS Leavenworth National Fish Hatchery." December 2004. 23p.**
This report documents three approaches to evaluating target flows for Icicle Creek : hydrologic assessment methods (Tennant and Hatfield & Bruce methods), a physical based method using measured stream properties incorporated into the PHABSIM model, and a hydraulic analysis of the creek to estimate adult fish passage requirements.

14. **Hegy, T. Washington State Department of Fish and Wildlife. "Quilcene-Snow Watershed Wetted Width Study." January 2005. 26p.**
This report documents the use of the wetted width or wetted perimeter method to help state agencies develop instream flows.

15. **Tetra Tech/KCM. Technical Memorandum. Subject: Draft Final WRIA 54/57 Scope of Work for Instream Flow Assessment-Ecology Grant Nos. G0600279 (WRIA 54) and G0600203 (Lower WRIA 57). May 5, 2006. 6p.**
This document presents the scopes of work used to conduct Instream Flow Assessments for the Lower Spokane River and Tributaries and the Lower Section of the Middle Spokane River in Spokane, Washington.

16. **Peck, D.V., A.T. Herlihy, B.H. Hill, R.M. Hughes, P.R. Kaufmann, D.J. Klemm, J.M. Lazorchak, F.H. McCormick, S.A. Peterson, P.L. Ringold, T. Magee, and M. Cappaert. U.S. EPA Office of Research and Development. "Environmental Monitoring and Assessment Program-Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams." EPA/620/R-06/003. October 2006. 332p.**
This document describes field procedures used during the pilot study. The objective of the study was to develop appropriate scientific and technical tools for evaluating ecological conditions on regional and national scales.

17. **The Nature Conservancy. "Methods and Tools for Defining Environmental Flow." February 2008. 30p.**
This document is a presentation from the GEF IW: LEARN Regional Workshop on the Application of Environmental Flows in River Basin Management.

18. **Normandeau Associates, Inc., Rushing Rivers Institute, and University of New Hampshire. "Draft Lamprey River Proposed Protected Instream Flow Report." NHDES-R-WD-08-26. December 9, 2008. 223p.**
This report describes the study used to evaluate the relationship between streamflow regulation in the Saugus River and aquatic habitat needs. The study methodology used was IFIM and the model was MesoHABSIM.

19. **Vermont Agency of Natural Resources. "Report on Fish Study Methodology." March 2009. 19p.**
A report to the House Committee on Fish, Wildlife and Water Resources and the Senate Committee on Natural Resources and Energy of the Vermont General Assembly. The Agency of Natural Resources was required to provide a report to the legislature concerning the cost of "producing a fish study methodology" that is a more economical alternative than site-specific, habitat-flow studies such as the Instream Flow Incremental Methodology (IFIM). The impetus was to address the concerns of small hydro proponents over the cost of IFIM studies. This report includes cost estimates for two possible methodologies.

20. **Department of Ecology, State of Washington, Water Resources Program. "Instream Flow Study Methods Used in Washington State." July 2009. 4p.**
In Washington, the four most commonly used stream flow study methods are IFIM, Toe-width, Wetted width (wetted perimeter), and Hatfield and Bruce. This fact sheet describes and compares these four methodologies.

21. **EA Engineering, Science, and Technology, Inc. "Instream Flow Incremental Methodology (IFIM) Studies on the North Anna and Pamunkey Rivers, Virginia." Prepared for Dominion Resources Services, Inc. October 2009. 78p.**
This report documents the IFIM Study conducted on the North Anna and Pamunkey Rivers, and discusses the analysis and interpretation of results conducted in consultation with the Virginia Department of Environmental Quality, Department of Game and Inland Fisheries, and Department of Conservation and Recreation.

22. **Department of Ecology, State of Washington, Water Resources Program. "Frequently Asked Questions on IFIM." Revised February 2010. 4p.**
This fact sheet briefly describes IFIM, why it is used, how it is conducted, how data/results can be used, and advantages to using IFIM.

23. **New Hampshire Department of Environmental Services. "Methods for Estimating Instream Flow Requirements for Protection of Aquatic Life. WD-11-3. Guidance Document, 401 Water Quality Certification Program, Watershed Management Bureau, Department of Environmental Services." November 16, 2010. 35p.**
This document describes methods for estimating instream flow requirements that are used and accepted by the New Hampshire Department of Environmental Services including the New England Aquatic Flow Policy Method, the "November 2000 Modified Method," and IFIM.

24. **Rushing Rivers Institute. MesoHABSIM.org: Instream Habitat Simulation at River Scale. Web. Accessed August 31, 2012.** www.mesohabsim.org
This website describes the Mesohabitat Simulation Model.

Appendix F –

Pilot Stakeholder Committee Meeting – Draft Summary Notes

SWMI Pilot Project Phase 2
Pilot Steering Committee Meeting
Tuesday, October 16, 2012
1:30pm – 3:30pm
MassDEP, Room A/B, Boston, MA

Agenda

1:30PM **General SWMI Overview and Status Update – Beth Card**

1:40PM **Pilot Projects – Summary of Phase 1 Effort – CEI/TB Team and DEP**

- Data Collected
- Meetings with Pilot Groups
- Draft Phase 1 Report
- Key Mitigation Components

2:15 PM **Feedback on Phase 1 Report – Watershed Group and Water Supplier Reps.**

- General Questions
- Area Where Further Focus is Needed in Next Phase
- Recommendations for How Information is Used in SWMI Implementation

3:00PM **Phase 2 of SWMI Pilot Projects – CEI/TB Team and DEP**

- General Overview
- Mock Consultation and Evaluation of Potential Mitigation Plans (in concert with EEA Agencies)
- Site Specific Study (in concert with EEA Agencies)

3:30 PM **Wrap-Up and Next Steps**

SWMI Pilot Project Phase 2
Pilot Steering Committee Meeting
Tuesday, October 16, 2012
1:30pm – 3:30pm
MassDEP, Room A/B, Boston, MA

Sign-In Sheet

1.	Philip Guerin	MWRA / Worcester
2.	Pauline LaVaught	MassDEP
3.	Beth Card	MassDEP
4.	Julia Blatt	MA Rivers Alliance
5.	Tom Cooke	Neponset
6.	TOM LAMONTE	MASSDEP
7.	Jack Buckley	DFW
8.	Anne Carroll	DCR
9.	Sara Cohen	DCR
10.	Linda Hutchins	DCR
11.	Richard Friend	DEP
12.	Beth McCann	DEP
13.	Jen DiOrio	DEP
14.	Jessica Cajigas (DL)	CET
15.	Rebecca Balke (DL)	CEI
16.	Peter Galant (DL)	Tighe+Bond
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MEETING MEMO

ATTENDEES:	MassDEP: Beth Card, Richard Friend, Duane LeVangie, Tom Lamonte, Beth McCann, and Jen Durso MassDCR: Linda Hutchins, Anne Carroll, and Sara Cohen MassDFW: Jack Buckley Mass Water Works Association: Philip Guerin Mass Rivers Alliance: Julia Blatt Neponset River Watershed Association: Ian Cooke CEI: Rebecca Balke and Jessica Cajigas Tighe & Bond (T&B): Peter Galant
FROM:	Jessica Cajigas
SUBJECT:	SWMI Pilot Project Phase 2 – Pilot Steering Committee Meeting
JOB NUMBER:	282-4
MEETING DATE:	October 16, 2012, 1:30pm, MassDEP Boston

SWMI Status Update
A sign-in sheet was passed around and all attendees introduced themselves. Beth Card welcomed everyone and provided a general overview and status update on SWMI. Beth said the Phase 1 Draft Report was received in June and DEP's comments were incorporated before it was provided to the PWSs and Pilot Stakeholder Committee to review. The final package on the SWMI Framework has been with the governor's office and a Final Framework and response to public comment could be out within the next few weeks.

Beth gave an update on capital funding. For Fiscal Year 2013, about $1 million will be available to MassDEP. Most of that money may be used to fund a grant program to assist Towns and public water suppliers (PWSs) with SWMI planning and mitigation implementation. MassDEP is in the process of drafting an RFR to start that grant program.

Pilot Project – Summary of Phase 1 Efforts
CEI and T&B gave a presentation to review Phase 1 of the Pilot Project. Rebecca Balke gave a summary of data collected during Phase 1 and of the meetings held with the PWSs and watershed groups. Peter Galant gave an overview of the content of the Phase 1 Draft Report. He also stated the need for better clarification between minimization and mitigation, especially in terms of demand management. Julia Blatt said this distinction between minimization and mitigation has been discussed many times.

Peter explained that mitigation includes those components that are directly quantifiable in terms of gallons of water withdrawal offset and those that are not and therefore used an indirect and qualitative methodology. Peter also explained that the "Location Adjustment Factors" were included in the Draft Report as a way to define "commensurate with impact"; however, it will be a MassDEP policy decision on whether to use the location adjustment factors and/or what percentages would be used. Phil Guerin stated PWSs are concerned about water quality issues, especially if the "preferred option" (because it would get 100% credit) is for discharges and infiltration to occur upstream of and within the Zone II of supply wells.

Rebecca then described example calculations of mitigation credits and explained why the Pilot Team chose to calculate credits quantitatively. The NPDES Phase II Stormwater program is a qualitative program requiring regulated municipal separate stormwater sewer systems (MS4s) to meet six minimum measures with the overall goal to improve water quality. Because the Phase II program is qualitative and difficult to measure, each municipal program varies greatly, with some doing very little to improve their systems or water quality. A quantitative program could provide more opportunities for improving stream flows and measuring improvements while promoting greater equality in efforts amongst PWSs and predictability to

The above text summarizes the events of the meeting at the above date and time.
If this information is not correct, please contact me as soon as possible.

MEETING MEMO

the permitting process. Rebecca then walked through a demand management example for Shrewsbury using the distribution of low-flow showerheads. She stated that all the assumptions used for any calculation in the mitigation credits can be found in Section 4 of the Draft Report.

Rebecca then briefly described the qualitative assessment contained in Appendix E of the Draft Report. The qualitative assessments have been tied into a flow in order to provide a volume credit. Rebecca stated again the need for policy decisions regarding the use of the qualitative assessment including the scoring matrix and weighting factors.

Rebecca discussed the content of the Summary Matrix Table completed for each PWS in the Draft Report. Using Shrewsbury's Table 8–9 as an example, she explained how the numbers and volumes were calculated and why there are some blank fields in the tables.

Rebecca briefly reviewed the key comments received so far on the Phase 1 Draft Report from Shrewsbury and Dedham-Westwood Water District. During the Phase 2 meetings with Shrewsbury and Amherst, MassDEP and the Team will try to further clarify any questions they may have on their Summary Matrix Tables and on Appendix E.

Phil asked if, while trying to define "commensurate with impact," we adjusted for actual withdrawal impacts on the stream? Rebecca's said that during Phase 1 the Project Team used a one-to-one relationship between the withdrawal and stream; however, more detail on "commensurate with impact" will be done during Phase 2. Phil Guerin also mentioned that PWSs would want 100% credit, and would not want the use of location adjustment factors.

Julia said that she is working on a comment letter and has received a lot of feedback from many other watershed groups regarding the Phase 1 report and the SWMI Framework itself. Beth stated the finalization of the SWMI Framework will move forward and the pilot project will inform the regulations, and that Phase 1 comments should be mainly based on corrections and information to feed into Phase 2. They will not be going back and revising the Phase 1 report or Framework. Beth acknowledged that there are still many policy decisions needed. Julia stated that most of their concerns were that the options provided in the Draft Report do not live up to the "no backsliding" goal and do not live up to be "commensurate with impact." In particular she expressed concern that withdrawals from FL5 subbasins cannot cause backsliding and therefore are allowed to add 8% to their historical usage to define baseline demand and cannot require a Tier 4 permit review.

Ian Cooke asked what the process will be for answering these policy questions and whether there will be a public process involved. Beth said they will need a stakeholder group formed during the development of regulations and that a guidance manual will be issued to accompany the regulations. Beth said she foresees many opportunities for people to weigh in during this process.

Phil said his "take-home message" after reading the Draft Report was that the PWSs will have to spend a lot of money but they are not clear that they are addressing real problems and they're not sure that these measures are creating real solutions.

Ian discussed the value of measuring things versus estimating things, especially regarding demand management. He said that in the Phase 1 Draft Report the Project Team did a good job on metrics development but the calculations demonstrate the value of a toolkit to give to PWSs and demonstrates the difficulty of saying how successful any conservation measure will be. (How much of an impact will it have? How do you calculate how much water you can really save with showerhead retrofits? etc.) Ian suggested utilizing a PWS's actual withdrawal data and water savings and only requiring mitigation be implemented to offset actual demand increases. This would provide added incentive for demand management to potentially avoid the need to implement expensive mitigation measures. Ian also stated he

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MEETING MEMO

did not like the use of demand management as a mitigation measure. He would prefer to require PWSs to do a demand management plan or minimization plan.

Duane stated that PWSs don't have to do any mitigation until they reach the "ask" and that that may drive PWSs to implement conservation measures in order to stay below the "ask." The real discussion is how or when to count the demand management actions. Again, Ian stated he doesn't like conservation in the mitigation options.

Anne Carroll stated she liked the analysis of lost revenue and the demonstration that, unless PWSs change their rate structure, they can lose money. Ian disagreed citing in Sharon where their conservation efforts allow them to treat less water, use less energy, use less chemicals, etc., therefore their bills are lower. He did acknowledge that yes, they do have to increase their rates, but over time customer bills will decrease despite the rate increase because of the water savings. Phil stated the need to factor in Town growth including an increase in industrial and commercial users. Ian suggested tracking RGPCD over a 3 to 4 year period to evaluate the success of a water conservation program. Phil said 3-4 years would not be enough time and 10 years should be used before any measurement of success.

Julia listed some of the concerns that will be included in her comment letter:

- Do not like that if a PWS is in a flow level 5 and they can't backslide, they can never get to a Tier 4 Permit Review, even with a very large "ask."
- Do not like the lack of clear goals for minimization. For flow level 4 and 5, they would like to see a requirement for minimization plans. PWSs need to know how and when they have done enough. They would like to see a goal of 25% or less of a flow alteration, even if spread beyond the 20-year permit period.
- Similar comments regarding demand management as have been discussed already.
- Similar comments regarding mitigation as have been discussed already.
- They would like to see more discussion on surface water.
- They have concerns about water quality including wastewater discharges to streams.
- The Phase I report should describe whether mitigation or minimization alternatives are possible. Feasibility should be a MassDEP's decision. (Peter did state that any reference to feasibility due to cost of a particular action for a PWS was to be removed from the report as directed by MassDEP, however, some of them might have been missed.)
- They still don't like the baseline and don't like adding 5% while allowing backsliding.
- The watershed groups are really knowledgeable about their watersheds and the political issues and would like to be involved more in phase 2.

Phase 2 of Pilot Project

Rebecca continued the presentation discussing Phase 2. Task 1 includes incorporating comments from the Phase 1 Draft Report. Task 2 is a desktop study looking at which wells are more preferential to pump. Task 3 is the mock consultation process. Task 4 is the site-specific studies. Task 5 is a checklist of information needed to do a SWMI evaluation.

For the mock consultation, Shrewsbury will go through the process and discuss what really works for them and what an implementation schedule might look like.

For the site-specific studies, we will

- review actual pumping records to identify any differences from the Framework.
- look at site-specific conditions that may counter conclusions from the SWMI Framework such as confined aquifers or lagged impacts.
- look at changes to withdrawals and discharges in and upstream of Danvers-Middleton's subbasin.

The above text summarizes the events of the meeting at the above date and time.
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MEETING MEMO

- research habitat assessment methodologies and develop a scope of work and costs for an instream flow study.

Julia asked if NGOs have been invited to participate in the Phase 2 meetings. Duane said no, they have not been invited; however, Amherst has asked if members of a town committee could attend their site-specific study meeting. Some of those members will be in attendance.

Phil stated PWS's concerns over the significant costs of IFIM. They've been given estimates of $150,000 to conduct a study of this type. Beth acknowledged that IFIM can be expensive however, it is just one example of the site-specific study, it is not necessarily the end goal. Other options will be looked at. Peter said the question to focus on for the pilot is if you do a site-specific study, how will that affect your permit?

Phil stated that there were four variables in the SWMI model: impervious cover, slope, percent wetlands and withdrawals. He then asked if the review of model input was going to look at all of those? Peter answered no, only pumping records would be reviewed.

Peter asked MassDEP for clarification regarding the mock consultation process and development of mitigation measures "commensurate with impact" - should the Pilot Team use the existing methods as contained in the Phase 1 Draft Report? Beth and Duane both answered yes.

Sara Cohen said DCR is working on their comments to the Draft Report and that one of their suggestions will be to simplify Table E-2. They would prefer simpler and more predictable methods for quantifying indirect credits.

Peter referred to Section 9 of the Draft Report (Recommendations) and stated that how withdrawals from non-August months factor into the SWMI process needs to be considered.

Anne stated that she did not agree with the text in Section 9 regarding the IBTA, and she does not think that it conflicts with SWMI. DCR agrees with the need for goals for minimization and they agreed that PWSs would need to know when to stop. Anne also stated she was not sure where the New England Water Works Association's Toolbox fits into the minimization options. She agrees there are many good ideas in it, but most are repetitive to those minimization and mitigation measures already identified in SWMI.

Ian asked who comments should be addressed to and who he can talk to about questions he has on the Phase 1 Report. Beth said to send comments to her and that they will try to set up a conference call to go over questions.

Duane stated that the Phase 2 Draft Report will be submitted to MassDEP by the end of November.

Anne asked how the PWSs feel about the location adjustment factors. Phil said at a minimum, measures within the subbasin should be credited 100% whether upstream or downstream. Duane stated that Shrewsbury's comment letter said they would look for 100% credit town-wide. Julia said they do not want to miss opportunities to do good work anywhere in town and they do not want to be overly limiting. Anne said there is always an option to use another scale, such as the HUC 12 classifications.

The above text summarizes the events of the meeting at the above date and time.
If this information is not correct, please contact me as soon as possible.

Appendix G –

Mock Consultation Sessions – Draft Summary Notes

SWMI Pilot Project Phase 2
Mock Permitting Session
Wednesday, October 17, 2012
10:00am – 12:00pm
Town Hall, Meeting Room A
100 Maple Avenue, Shrewsbury, MA

AGENDA

1. Purpose of Mock Permitting Exercise

2. Overview of Phase 1 Report including:
    a. Intent of Report – Evaluate the application of SWMI
    b. Summary of Key Components

3. Discussion on Alternative Sources
    a. Summary of Options
    b. What is Shrewsbury's Preferred Option(s)?

4. Overview of Table 8-9 – Mitigation Summary Matrix
    a. Menu of Options (potential vs. realistic)
    b. Explanation of Existing and Potential Volume Calculations
    c. Explanation of Assumptions
    d. Which options are feasible, realistic, and commensurate for Shrewsbury?
    e. What can Shrewsbury realistically achieve with each option (e.g., number of homes reached)?

5. Next Steps
    a. Request Shrewsbury identify its options and realistic application numbers by October 24th
    b. CEI/T&B Team will calculate credits for preferred options for October 31st meeting

SWMI Pilot Project Phase 2
Mock Permitting Session
Wednesday, October 17, 2012
10:00am – 12:00pm
Town Hall, 100 Maple Avenue, Shrewsbury, MA

Sign-In Sheet

1.	Duane LeVangie	Mass DEP
2.	Barbara Kickham	Mass DEP
3.	Todd Richards	MADFW
4.	TOM LAMONTE	Mass DEP
5.	Richard Friend	Mass DEP
6.	Linda Hutchins	DCR ORR
7.	JACK PERREAULT	SHREWSBURY
8.	BOB TOZZICI	"
9.	Justine Evans	Tata + Howard
10.	Paul Howard	Tata + Howard
11.	PETER GALANT	Tighe + BOND
12.	Rebecca Balke	CEI
13.	Jessica Cajigas	CEI
14.	Anne Carroll	DCR Office of Water
15.	Paul Anderson	Mass DEP - CERO
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MEETING MEMO

ATTENDEES:	Town of Shrewsbury: Jack Perreault and Bob Tozeski Tata & Howard: Paul Howard and Justine Evans MassDEP Boston: Richard Friend, Duane LeVangie, Tom Lamonte MassDEP CERO: Barbara Kickham and Paul Anderson MassDCR: Linda Hutchins and Anne Carroll MassDFW: Todd Richards CEI: Rebecca Balke and Jessica Cajigas Tighe & Bond (T&B): Peter Galant
FROM:	Jessica Cajigas
SUBJECT:	SWMI Pilot Project Phase 2 – Mock Permitting Meeting #1
JOB NUMBER:	282-4
MEETING DATE:	October 17, 2012, 10:00am, Shrewsbury Town Hall

Purpose of Mock Permitting Exercise
A sign-in sheet was passed around and all attendees introduced themselves. Duane LeVangie started the meeting explaining that we will walk through a non-binding mock permit exercise for Shrewsbury for a withdrawal request of 5.3 MGD. There are three meetings scheduled for the mock permit and consultation process, although all three meetings may not be necessary. Duane confirmed with Shrewsbury and Tata and Howard that they have all seen a copy of the scope of work containing the details of this mock permitting exercise.

Overview of Phase 1 of Pilot Project
CEI and T&B gave an overview of Phase 1 of the Pilot Project. Rebecca Balke discussed the assumptions used in calculating minimization and mitigation credits, including those for quantitative and qualitative measures and the use of location adjustment factors, and emphasized that these were potential options for crediting mitigation actions for DEP to consider. The use of location adjustment factors are still under discussion and will be a MassDEP policy decision on whether and to what degree they will be used and included in the final regulations. For this mock permitting exercise however, we will use the location adjustment factors. Bob Tozeski asked about crediting existing efforts. Duane explained they will be credited, but MassDEP has not decided how far back in time they will go. This will be another policy decision; however, for this exercise we will go back to 2004.

Jack Perreault stated that the location adjustment factors are a major concern and he sees them as a "deal-breaker." There are political and economic factors to discuss. He would also have preferred to have had answers to the stated policy questions before starting Phase 2. These location adjustment factors and the final credit volumes have a huge impact and Shrewsbury has very little opportunity to do anything upstream of its wells. Jack stated he has an issue with going forward if the numbers don't mean anything. If they don't get 100% credit for mitigation measures they will not be able to do those actions, as there will be very little chance of getting approval at Town meeting if certain measures only get 25% credit.

Anne Carroll and Duane suggested that the mock permit process initially discuss the mitigation options that are realistic and feasible for Shrewsbury and wait to run the calculations at the end. After further discussion it was decided to run existing and alternative location adjustment factors. Duane explained the options mentioned at the pilot stakeholder committee meeting yesterday which included making the first two rows in the location adjustment factor table credited at 100%. (These include mitigation actions upstream of or within the Zone II of a well, and those within the same subbasin, but downstream of the well.) Rebecca said the Team can run any numbers they want at the end, we can run the existing location adjustment factors, we can run 100% credit, and any other scenarios that they may want.

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MEETING MEMO

Jack stated his concern about representing all public water suppliers (PWSs) during this mock permit process. He wants to figure out how SWMI implementation will impact all PWSs and Towns.

Peter Galant reviewed what Shrewsbury's mock permit would require under the SWMI framework with a withdrawal request ("ask") of 5.3 MGD. This "ask" places Shrewsbury in a Tier 3 permit review. Shrewsbury's wells are also in a flow level 5 subbasin with quality natural resources (i.e., cold water fishery). This scenario means their mock permit requirements would include Standard Conditions 1-8; Minimize existing impacts to the greatest extent feasible (considering cost, level of improvement and implementability); Demonstrate no feasible alternative source that is less environmentally harmful; and Mitigate commensurate with impact. Standard Conditions 1-8 already apply to Shrewsbury's existing permit. Shrewsbury will have to decide what minimization and mitigation measures would make sense to address those requirements.

Bob asked about the fact that they do not currently meet the requirement for 10% unaccounted for water, how this comes into play and what additional actions they may have to do to meet this. Duane said they would be required to meet the functional equivalency criteria. Paul Howard stated they are doing a water audit in Town and they suspect that the unaccounted for water is a metering issue rather than leakage.

Duane explained that DCR does not do Water Needs Forecasts if unaccounted for water is greater than 15%. Shrewsbury's unaccounted for water is much higher than this and in any future actual permit application, this issue would have to be addressed; however, this mock permit exercise will use the existing withdrawal request of 5.3, regardless of any future forecast.

Peter then discussed options for minimizing withdrawal impacts including increasing withdrawals from the existing sources, looking at alternative sources, and interconnections.

Bob stated that the Home Farm Wells have better water quality and better yield. The Town is also working on the property issue for the Masonic well site and it may be brought to the next town meeting. Linda asked about the Oak Island wells and whether these were an option. Bob stated there are several issues:

- There is a land acquisition problem with the Oak Island site since the state owns land there and operates a boat ramp.
- There is a water quality issue due to iron.
- The location is still in the Blackstone basin although it is a different subbasin, so there is still an Interbasin Transfer Act restriction.

Linda stated it would be better to spread out the impacts even if they are within the same basin. Linda encouraged Shrewsbury to pursue the land ownership issue further as she thinks the state may not have an issue. Paul Howard stated that there would still be a large concern over costs due to treatment needs. Duane asked if there was a volume approval from a pump test. Bob thought there was one between 400,000 and 500,000 gpd.

Peter asked if the SAC and Oak Island areas are still potentially feasible from the state's perspective. Barbara Kickham explained that approval would still have to go to the public comment process and they cannot really say if they are still on the table. For Oak Island, the MassDEP Central Regional Office probably would not approve it if the Zone I included the parking lot or the boat ramp. But if the state land alone was in the Zone I it may be okay. Barbara stated that the Masonic well location is in the Concord River Basin which is a stressed basin and OAR would have issues. Linda mentioned that the stressed basin designation may no longer be relevant under the new SWMI framework, thus may change how this well is viewed.

The above text summarizes the events of the meeting at the above date and time.
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MEETING MEMO

Anne asked if Shrewsbury was able to get an increase in the IBTA permit for the Home Farm Wells, would Shrewsbury be able to get all the water they need? Bob said he was not sure about "all," but it would be a significant amount more than now and likely enough to meet a 20 year needs forecast. Paul Howard mentioned that they have been looking at getting the Home Farm Wells back up to their original capacities. Due to the IBTA they cannot go over 5.84 despite the fact that the wells can do more. He stated that the wells have enough capacity to meet the ask, but more water would be needed at buildout.

Barbara reiterated that there would be significant comment from the watershed groups and that those groups would want more monitoring. Monitoring was previously included as just a finding of fact and not as a permit condition in Shrewsbury's existing permit. Duane said the permit would probably need to say something like "more monitoring would be required if they're going to pump more from the Home Farm Wells."

Discussion of Alternate Sources

Peter continued with a discussion of alternate sources. Purchasing raw water from Worcester was a less favorable option because the well is in a flow level 1 and taking that water would make it a flow level 5. Peter asked MassDEP if this "backslide" issue would take this option off the table? Bob stated Shrewsbury would like the water due to the good water quality from Worcester's "Shrewsbury Well."

Peter discussed additional options of interconnections including purchasing finished water from Worcester, Boylston, and MWRA. Paul Howard stated Worcester gave them a volume of 0.46 during the alternate water supply study they did. Worcester said it was a permit issue that limited this number. Duane does not think there really would be a permit issue, unless they went with water from Worcester's Shrewsbury Well. If Worcester sold them finished water it would be okay. Paul Howard stated that based on hydraulics and amount of water, Worcester has it to give. Linda stated there would be IBTA issues as well which would be difficult because of the Nashua Basin. Anne asked if annual purchased water cost would be an issue and Peter said the cost is about 10 times higher than the cost to produce their own water.

Duane stated the IBTA issue would be a double basin issue because they would be going from the Nashua to the Concord Basin. Peter stated this option was the only "less environmentally harmful "option because it is in a flow level one, but is this feasible? It may be infeasible because of the IBTA issue.

Anne asked about costs again. Bob said he'd have to look at the whole picture including constructing a well, future time and costs, etc.

Peter then discussed purchasing water from MWRA. There is a huge cost issue with this option. Anne asked if it is off the table due to cost? Bob stated it is very expensive to buy-in. In addition, due to the location of the connection, the need to construct transmission mains would be a large expense. And finally, there would be water quality problems associated with pH and MWRA's use of chloramines as a disinfectant. Linda and Anne both stated the IBTA approval needed for the MWRA water would still be required, but it would be easier to do. Paul Howard stated that $5.16 per gallon is the cost to buy into MWRA now. Duane said none of the options should be taken off the table, rather they should be explained in the report along with why they may not be a feasible option including costs and hurdles.

Peter stated that for this mock permit exercise, we will need to discuss what is feasible for Shrewsbury. Duane added that we also must think about build out and when that might occur. Paul Howard stated Shrewsbury still needs more water for true build out, but that may not be within the next twenty-year permit cycle. Peter stated without the restriction due to the IBTA the maximum day volume approved in the existing WMA permit would be 9.81.

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MEETING MEMO

Bob asked for confirmation that the Oak Island and SAC sites are still on the table for this mock exercise (in conjunction with maximizing the yield from the Home Farm Wells)? Linda stated Oak Island could be if there is just passive recreation in the Zone I and no boat ramp or roads. Bob stated the Town would prefer to develop its own sources over buying water from others. Paul Howard said this may be more expensive due to treatment costs needed for new sources in Shrewsbury. Todd Richards stated the items should still be on the table for the mock exercise, knowing that policy decisions will still need to be made sometime. (i.e., is backsliding from a flow level 1 a flow level 5 acceptable?)

Peter said homework for everyone is to give more thought on these alternative sources. What does the Town see as feasible? What does the state see as feasible? Can the state identify any permitting issues that could come up that would have to be addressed for the mock permit? Jack said he would like to know the "showstoppers "upfront, even for this mock exercise.

Linda said she knew that an industrial park in Town purchases water from Grafton and asked if this was an option for the Town? Jack and Bob both responded no, it is not an option.

Richard asked if any thought had been given to using Lake Quinsigamond as a surface water source? Paul Howard said there are significant surface water protection issues due to no control over uses. There are many recreational uses.

Overview of Mitigation Summary Matrix for Shrewsbury (Table 8-9)
Rebecca then discussed the mitigation options from Table 8–9. This table represents a menu of mitigation options. Rebecca walked through example calculations using the shower head distribution mitigation measure. Jack said he wants the potential numbers to be more realistic. Jack also pointed out the problems with having to get a plumbing permit to install some of the conservation devices. Rebecca stated the prices and costs used in calculations were based on several assumptions, such as the rebate amounts for washing machines and toilets, and these assumptions should be modified to represent what is feasible for Shrewsbury. Rebecca reviewed Table 8-9, explaining the qualitatively assessed components and why some of the fields in the table are blank.

Jack asked about the status of the Poor Farm Pond Dam removal. Todd did not have an update. Todd said the state would have to work very closely with the town on identifying dams for removal and culverts for replacement. He asked the town if they know of any culverts that are in need of replacement now.

Bob stated that Worcester owns the Poor Farm Pond Dam and asked if they were to take it down, who would get the credit? This is another policy decision that needs to be made by the State. Duane stated that there is a SWMI grant program being developed. It may be possible that in this situation, Shrewsbury and Worcester could team up and get the grant and take the dam down together.

Bob stated the last leak survey was completed in April 2010.

Peter said we need to pick a target number to have to achieve through mitigation. Duane and Linda said they do not agree with crediting existing outdoor watering restrictions at 862,000 gallons per day as shown in Table 8-9. Linda stated that she felt outdoor watering restrictions should be considered minimization of impacts, rather than mitigation. The group began reviewing each of the mitigation options presented in Table 8-9:

- Septic systems - new residential development would have to be on septic. All new industrial and commercial development would be sewered, plus any infill if the betterment has been paid.
- Groundwater Discharges - Jack said the groundwater discharge project at Lake Street Park would be done only if 100% credit was received.

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MEETING MEMO

- Infiltration and inflow – I/I is something the town needs to do anyway. The volumes for these credits are low due to the location adjustment factors and because only 50% of the volume removed is accounted for as sustainable
- Stormwater Bylaw – this measure does not use a location adjustment factor but it is based on build out. Redevelopment and retrofits are not included. This is a high ticket item due to be low-cost and high-volume potential. The credit assumes that the full recharge required of the bylaw is credited and does not adjust for recharge that is already occurring before development. Crediting only the recharge above what naturally occurs before the development would decrease this credit significantly, along with application of the location adjustment factor.
- Stormwater utility - Shrewsbury is in the process of forming a stormwater utility. The regulations have been in place since 2007. They are working with their consultant, Weston and Sampson and once the stormwater permit has been issued they will work on developing a program, setting fees, etc.
- Dam removal - the watershed groups were in favor of the dam removal project at Poor Farm Pond Dam.
- Monthly billing/radio-read meters - Duane asked about Shrewsbury's meter change out and the switch to monthly billing. Shrewsbury plans to replace all commercial meters this year and they are rolling over all residential meters as well. One third of all residential meters are complete. Shrewsbury bills quarterly now. They estimate in 3 to 5 years all residential meters will be radio read. Changing to monthly billing would still be expensive.

Next Steps/Action Items

- DEP will look at the existing volume credits in the summary matrix table and determine what adjustments they want to make. For example, how to handle the outdoor watering restrictions and stormwater credits presented in the table.
- Shrewsbury will rank the top 10 actions they would prefer to implement taking expected future development into account. Shrewsbury will also present realistic numbers for any of the options they identify.
- Shrewsbury will evaluate the land issues around the Oak Island site.
- CEI will calculate mitigation credits based on location factors.

The above text summarizes the events of the meeting at the above date and time.
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SWMI Pilot Project Phase 2
Mock Permitting Session
Wednesday, October 31, 2012
10:00am – 12:00pm
Town Hall, Meeting Room A
100 Maple Avenue, Shrewsbury, MA

AGENDA

1. Review Mock Permitting Conditions

2. Selection of Minimization Options for Mock Permit

3. Selection of Mitigation Options for Mock Permit
    a. Location Adjustment Factors – Phase 1 and Alternatives & Impact on Table 8-9
    b. Refinement of Stormwater Bylaw
    c. “Live” Calculations for Select Options and Impact on Table 8-9

4. Next Steps
    a. Final Calculations on Selected Options

SWMI Pilot Project Phase 2
Mock Permitting Session
Wednesday, October 31, 2012
10:00am – 12:00pm
Town Hall, 100 Maple Avenue, Shrewsbury, MA

Sign-In Sheet

1.	Duane LeVangie	Mass DEP
2.	Jessica Cajigas	CEI
3.	Todd Richards	MDPW
4.	Anne Carroll	MA DCR
5.	Justine Evans	Tata and Howard
6.	Paul Howard	Tata & Howard.
7.	Rebecca Balke	CEI
8.	PETER GALANT	TIGHE + BOND
9.	JACK PORROVECT	SHREWSBURY
10.	Bob Tozecki	Shrewsbury
11.	Tracy Adamski	Tighe i Bond
12.	Richard Friend	MA DEP
13.	Barbara Kickham	MA DEP
14.	Paul Anderson	Mass DEP - CERO
15.	Eileen Pannetier	CEI
16.	Linda Hutchins	DCR
17.		
18.		
19.		
20.		

MEETING MEMO

ATTENDEES:	Town of Shrewsbury: Jack Perreault and Bob Tozeski Tata & Howard: Paul Howard and Justine Evans MassDEP Boston: Richard Friend and Duane LeVangie MassDEP CERO: Barbara Kickham and Paul Anderson MassDCR: Linda Hutchins and Anne Carroll MassDFW: Todd Richards CEI: Eileen Pannetier, Rebecca Balke and Jessica Cajigas Tighe & Bond (T&B): Peter Galant and Tracy Adamski
FROM:	Jessica Cajigas
SUBJECT:	SWMI Pilot Project Phase 2 – Mock Permitting Meeting #2
JOB NUMBER:	282-4
MEETING DATE:	October 31, 2012, 10:00am, Shrewsbury Town Hall

Introductions
A sign-in sheet was passed around and all attendees introduced themselves. Peter Galant gave a brief review of the mock permitting conditions for Shrewsbury.

Minimization
Peter reviewed the list of minimization options for the mock permit and also reviewed which options were eliminated at the first mock consultation meeting as not feasible. These included obtaining water from Boylston and Worcester and wheeling MWRA water through Northborough. The task for today is to further discuss the feasibility of the remaining options for "inclusion" in the mock permit. Paul Howard noted that the Town of Northborough may seek to become 100% served by MWRA.

Home Farm Wells
Increasing the yield from the Home Farm Wells was identified as the preferred option for the Town at the last meeting. It is still considered feasible and would be a part of the mock permit. It was noted that an increase in the 5.4 mgd Interbasin Transfer Act (IBTA) maximum daily withdrawal volume from the Home Farm Wells would not likely be required until after this 20 year permit period.

Oak Island Well
Paul Howard provided a plan indicating the approximate well location for the Oak Island Well. An 8-inch well was installed and an extended pump test was conducted. The expected yield was about 0.6 mgd. Groundwater was detected at 8 feet. Linda Hutchins asked if MassDEP would approve a well in this location. Paul Howard said the site was rejected in the past because of the Zone I issues. Paul Anderson said the Zone I issue could be a "deal-breaker" because the 400'-radius would extend to private properties and to DCR's boat launch and parking lot. DCR would also need to approve the well location. Barbara Kickham said with a 400'-radius Zone I, MassDEP most likely would not approve it. She said a wellfield might be a better option as this would allow a 250'-radius instead. (A wellfield would require at least three shallow wells and the pumps would be restricted to a maximum depth of 28 feet.) In addition to the Zone I issues, an access easement would be required from the power company to bring electric service to the well site and for water main leaving the site.

Water quality was also an issue identified during the pump test. Iron and manganese were both high. Manganese was detected at 1.4 mg/L, but went down to 0.04 mg/L after pumping for 48 hours. Iron started at 1.2 mg/L and decreased to 0.45 mg/L. Treatment would be required and would most likely include greensand filtration or membrane filtration. Manganese treatment also produces sludge which would mean additional space, disposal, and cost issues. There is sewer available for wastewater disposal on Route 20.

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MEETING MEMO

Due to the shallow aquifer (groundwater at 8'), there is also the concern that the well(s) could be under the influence of surface water and therefore subject to the surface water treatment rule.

Paul Howard said the benefit of withdrawing 0.6 mgd would be outweighed by the costs associated with the required treatment, which he estimated at $4 to $5 million. However, the additional benefit is that this well would be located in a different subbasin so that Shrewsbury does not have all of its "eggs in one basket" and could possibly increase the area available for mitigation credits. IBTA issues would still apply however. Bob Tozeski stated that increasing the capacity at the Home Farm Wells would still be the preference to the town for operational reasons.

SAC Wells

Bob said the SAC Well was initially rejected by MassDEP due to the IBTA issue. The Town is still considering this site for use as a groundwater recharge site, but it would only complete such a project if it were to get full credit under SWMI and IBTA. This is the best site available for recharge with about 300,000-400,000 gpd. (There is an additional benefit to the Town for use of this site for athletic fields along with the recharge. If the well were constructed instead, the site could not be used for fields.)

The SAC is a social club that still holds functions on site. It is not a large group and is just barely hanging on financially. They have some odor and noise concerns about having a recharge facility on site. The neighbors also have aesthetic concerns particularly about the views of any facilities constructed on site. Jack Perrault said these concerns could be handled through public education and explaining what is involved with a groundwater discharge site. The Town may be interested in purchasing the rest of the SAC property should it be available (and funds available) in the future.

Peter said the SAC site is in a Flow Level (FL) 2 that would slide to a FL5 if a well was installed. He further explained that this option is supposed to be one that "minimizes impacts" but with backsliding, it does not really accomplish that.

Masonic Wells

The available water from a well on this site would be 0.2 mgd; however a second well would be required to get to that. This location is in the Concord River Basin so there would be no IBTA issue. The well on this site would also need a treatment plant and costs have been estimated to be about $1 million. Due to the low withdrawal volume, the only true benefit would be to have a source that is outside of the Blackstone Basin.

Worcester's Shrewsbury Well

This well is located in a subbasin that is a FL1. Use of this well would cause a slide to a FL5. The well is approved for 0.46 mgd. This option is a "no go" because of the backslide issue.

MWRA

MWRA has the water available; however it would be at a high cost to Shrewsbury. This option is the only one that is less environmentally harmful. This option is considered cost prohibitive to the Town, especially since there are also several complications with getting the water through Southborough and Northborough.

General Discussion

Purchasing treated water from Worcester was eliminated as a feasible option at the previous meeting because of the IBTA issue. This option would be very difficult to permit and it would require Worcester to be willing to go through the permit process.

Paul Howard stated they are looking at all of the Town wells and what can be done to get them back up to their approved yields. This includes the Home Farm Wells, Lambert Wells, and Sewell Well. In reality, Shrewsbury can live with their IBTA requirements now (5.4 million gallons per day limit) and ask for the

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MEETING MEMO

1.37 mgd in a permit. As long as they could maximize their existing sources and continue to keep their peak day down. The IBTA does not need to be adjusted until they approach that limit.

Peter reviewed the discussion stating the preference seems to be to get the Home Farm Wells up to capacity. Todd Richards stated he's concerned about eliminating MWRA because it is the only less environmentally harmful option. Paul Howard stated that the costs associated with this option are not just a one-time expense, but includes an annual cost that will impact rates and become a political issue.

Anne Carroll asked when options become cost prohibitive. Duane LeVangie stated that the cost of mitigation also needs to be included in determining whether something is cost prohibitive. For example, if Shrewsbury is considering a $12 million wastewater recharge facility to meet mitigation requirements, then the MWRA cost may not look as unattractive.

Mitigation

Rebecca Balke began the discussion on mitigation options. She referred everyone to Table 8–9 which has been redone to provide information on three scenarios of Location Adjustment Factors. She also described the new stormwater calculations provided, which were redone to show alternatives and to apply the location adjustment factors. The stormwater bylaw mitigation measure as presented assigns volume credits based on soil type and level of recharge required in bylaws. Currently, recharge is only required in areas subject to the Massachusetts Stormwater Handbook, which only applies to wetland areas. This requires recharge consistent with 'natural' or undeveloped conditions. Application of these recharge requirements to other areas are voluntary if the town chooses to implement a bylaw requiring it. The more aggressive recharge regulations would require additional recharge beyond that required in the Massachusetts Stormwater Handbook. Eileen Pannetier further clarified "aggressive recharge" in terms of converting future runoff into recharge. Anne said if we are evaluating future development with the bylaw in place, yes, this would improve recharge better than without the bylaw.

Duane said MassDEP has concerns on the logistics of managing many of the mitigation options, as they could be labor intensive for both public water suppliers (PWSs) and MassDEP. MassDEP is considering a qualitative assessment for the stormwater bylaw option and some of the other mitigation options too. Jack questioned how realistic and how practical some of the options will be. He stated that many of them just aren't going to happen. For example, Jack stated he has concerns about the lot sizes in Town and how much benefit a stormwater bylaw will get them.

Anne said she thinks the wastewater options are more feasible to do quantitatively. Existing septic system returns from within and upstream of the subbasin, including areas outside of Shrewsbury, equal 0.35 mgd. This 0.35 mgd will be credited as a wastewater return for purposes of this mock permit and consultation. Shrewsbury does not expect a lot of additional septic system development in the Home Farm Well subbasin. Reducing infiltration and inflow (I/I) into the municipal sanitary sewer system could also be used for mitigation. For purposes of this mock permit and consultation, I/I credits will be included for investments made during the past 5 years.

MassDEP is considering removing demand management from the mitigation options. Instead, demand management would benefit a PWS by lengthening the time before a PWS would exceed its baseline withdrawal, and therefore lengthening the time before it is required to implement mitigation measures. Duane said there are a lot of assumptions involved in the demand management calculations presented to date (e.g., assumes everyone is watering five days a week but in reality not everyone waters their lawn frequently). He also said that the savings of almost 863,000 gpd from a 3-day/week outdoor watering restriction (in Table 8-9) is not reflected in a reduction of withdrawal of an equal amount. Bob agreed, but said that the 863,000 gallons is evident when looking at shaving off peak demand.

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MEETING MEMO

Paul Howard stated the Town has been aggressive for 10+ years regarding demand management and they would want credit for that. They argued that PWSs that have done nothing previously will benefit over those that have been proactive. Duane disagreed stating that PWSs that have "done nothing" will be limited in their "ask" by 65 residential gallons per capita per day (RGPCD) and 10% unaccounted for water (UAW). If a PWS's numbers are up at 80 RGPCD, their ask will be limited to the registered volumes and/or the DCR projections. They will not be approved for higher volumes.

It was mentioned that EEA staff may not agree with the need of Shrewsbury's ask, as it may be higher than they really need. Barbara stated that based on the 2010 census, Shrewsbury's population has decreased and growth is expected to go down. MassDEP would like DCR to do a new projection for Shrewsbury's next permit, but they can't because Shrewsbury's UAW is too high. Anne said that next month DCR will talk to the Water Resources Commission regarding revised projections. If the UAW is too high, and a projection is done, it typically results in a projection that does not give a PWS enough water. A situation such as this makes it hard to tell when Shrewsbury would truly need an "ask" of 1.37 mgd; it could be 20 years from now or 30 years from now.

Bob asked about commercial growth and whether it is factored into projections. Duane said they do factor in commercial growth using employment projections. For this mock permitting exercise however, an "ask" of 1.37 mgd will at least tell Shrewsbury what they are "in for." Bob and Paul Howard do not think that an "ask" of 1.37 mgd is unreasonable. Duane said that Shrewsbury's RGPCD has gone from about 94 to about 58. If they asked for a projection now they would just receive an interim projection and interim allocation, with a requirement to get their UAW under control - at a minimum requiring functional equivalent.

Duane said MassDEP is still discussing demand management and how to factor in whether to credit it or use it to reduce the "ask." Bob said it would be impossible to track how many homes have been retrofitted with conservation devices on their own. Duane said that on one occasion, in Franklin, MassDEP adjusted the baseline based on water use restrictions in place. Shrewsbury implemented outdoor watering restrictions in 2001 however the restrictions have changed since, incorporating three days a week and including time of day restrictions. Duane said the Town could do a study to document the change in demand (actual withdrawals) that have resulted from demand management efforts/outdoor watering restrictions. MassDEP could adjust the baseline and reduce the amount required to mitigate based on the results of such a study.

Paul Howard said this could be done fairly easily. Jack asked who should do it. Duane said the town should conduct the study and provide the results to the pilot team to document. Anne said the results could act to increase the baseline and therefore increase the time before their withdrawals would go over baseline and increase the time before they would need to mitigate.

Duane recommended documenting demand management from 2002 to today however they may not count all of these years. The watershed groups would not want to include all these years. Peter said the timelines have been jumping around; baseline uses 2003 through 2005, while flow levels and biological categories used 2000 through 2004. For evaluating the effects on withdrawals from outdoor watering restrictions, he said to look at 1997 to 2005. Duane said in 2001 Franklin implemented one day/week watering and had a huge immediate impact on demand. They were able to increase their baseline by 200,000 gpd.

Peter said by using existing septic systems for a credit of 0.35 mgd and SAC groundwater recharge for a credit of 0.75 mgd, Shrewsbury would still need to mitigate 0.27 mgd. Duane said this volume could come from the demand management evaluation. He said if Shrewsbury went to two days/week outdoor watering they may accomplish that. The Town would have additional time to stay below their baseline, fine-tune their demand management, and put off mitigation.

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MEETING MEMO

Next Steps/Action Items

- Before the next meeting, EEA staff will discuss the crediting of qualitatively assessed options including a stormwater bylaw, stormwater utility, habitat improvements (especially dam removal), and enterprise funds.
- EEA will discuss the Location Adjustment Factors and a scoring system revision as well.
- Shrewsbury will work on the calculations for demand management/outdoor watering from 1997 through 2005.
- The scheduled November 13th meeting may become the Site-Specific Study meeting and the scheduled November 27th meeting would become the third mock consultation meeting. EEA will confirm this adjustment to the meeting schedule.

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SWMI Pilot Project Phase 2
Mock Permitting Session #3
Tuesday, December 11, 2012
10:00am – 12:00pm
Town Hall, Meeting Room A
100 Maple Avenue, Shrewsbury, MA

AGENDA

1. Final SWMI Framework

2. Selection of Minimization Options for Mock Permit
    a. Optimization of Home Farm Wells

3. Revised Crediting System
    a. Credit System for Indirect Mitigation Measures
    b. Location Adjustment Factors for Direct Mitigation Measures
    c. Crediting for Wastewater Returns
    d. Demand Management as Mitigation
        i. Results from Shrewsbury's Outdoor Watering Restrictions-Demand Reduction Study
        ii. Demand Management Plan and Mitigation Credits

4. Selection of Mitigation Options for Mock Permit (1.37 mgd)
    a. Direct Mitigation Options
        i. Credits for Existing Septic Systems
        ii. Wastewater Recharge at SAC Site
        iii. Demand Management
    b. Indirect Mitigation Options
        i. Stormwater Bylaw with Recharge Requirements
        ii. Stormwater Utility
        iii. Implement MS4 Requirements
        iv. I/I Removal
        v. Dam Removal
        vi. Other Habitat Improvement Projects?

SWMI Pilot Project Phase 2
Mock Permitting Session
Tuesday, December 11, 2012
10:00am – 12:00pm
Town Hall, 100 Maple Avenue, Shrewsbury, MA

Sign-In Sheet

1.	Tracy Adamski	Tighe & Bond	tjadamski@tighebond.com
2.	Jessica Cajigas	CEI	jcajigas@ceiengineers.com
3.	TOM LAMONTE	MassDEP	thomas.lamonte@state.ma.us
4.	Anne Carroll	MA DCR	anne.carroll@state.ma.us
5.	Richard Friend	MA DEP	richard.friend@state.ma.us
6.	JACK PERREAULT	SHREWSBURY	JPerreau@th.ci.shrewsbury.ma.us
7.	PETER GALANT	TIGHE+BOND	PJGALANT@TIGHEBOND.COM
8.	Rebecca Balke	CEI	rbalke@ceiengineers.com
9.	Linda Hutchins	DCR	linda.hutchins@state.ma.us
10.	Paul Howard	Tata & Howard	phoward@tataandhoward.com
11.	Bob Tozeski	Shrewsbury	rtozeski@th.ci.shrewsbury.ma.us
12.	Justine Evans	Tata+Howard	jevans@tataandhoward.com
13.	Anne LeVangie	MassDEP	
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MEETING MEMO

ATTENDEES:	Town of Shrewsbury: Jack Perreault and Bob Tozeski Tata & Howard: Paul Howard and Justine Evans MassDEP Boston: Richard Friend, Duane LeVangie, and Tom Lamonte MassDEP CERO: Barbara Kickham MassDCR: Linda Hutchins and Anne Carroll CEI: Rebecca Balke and Jessica Cajigas Tighe & Bond (T&B): Peter Galant and Tracy Adamski
FROM:	Jessica Cajigas
SUBJECT:	SWMI Pilot Project Phase 2 – Mock Permitting Meeting #3
JOB NUMBER:	282-4
MEETING DATE:	December 11, 2012, 10:00am, Shrewsbury Town Hall

Introductions
A sign-in sheet was passed around and Duane LeVangie thanked Shrewsbury for participating in the Pilot Project. He stated that the draft Phase 2 report would be submitted on December 28 with comments expected by January 18. He did acknowledge that Massachusetts Water Works Association requested additional time for review. Jack Perreault stated Shrewsbury would request additional time as well because written comments will need to be reviewed and approved by the Town Manager and the Board of Selectmen prior to submittal. He did not think they would have comments until after February. He said working around the schedules and agendas of the Board of Selectmen would take some time.

Final SWMI Framework
Duane began the discussion on the Final Framework released in November. Jack said he thought that the Pilot Project was going to guide the Final Framework and asked what the point of the Pilot was if the Framework has been finalized already. Duane explained that the Pilots were to inform the regulations not the Final Framework. The Framework summarizes the 2 1/2 year SWMI process with the stakeholder groups. The regulations are the next step. Anne Carroll added that the Framework only provides options, the regulations will provide details and clarifications based on the Pilots, including a definition of commensurate with impact, which are not in the Framework. A guidance document will also be released to accompany the regulations. Policy and technical decisions and costs related to implementation are not in the Framework, but will be included in the regulations and guidance document. EEA will get a better handle on these items through the Pilots.

Bob Tozeski said he felt there are a lot of unanswered questions and did not understand why the Framework would be released before those questions and policy decisions were answered. He agreed with Jack that the whole process has been rushed and feels that all the public water suppliers would also agree. Bob asked if there is a deadline for regulations. Duane said that there is not a hard deadline but draft regulations are expected to be released for public comment in the spring 2013 and final regulations are expected about a year from now, possibly between October and December 2013. There is a long internal process for drafting regulations.

Bob asked about Shrewsbury's current permit application which is in review. Duane said the development of SWMI regulations would not affect that permit, which would follow the current Water Management Act regulations.

Duane reviewed some of the changes in the Final SWMI Framework.

- Groundwater withdrawal level (GWL) is just a terminology change to replace the term “flow level” (or FL). Groundwater withdrawal level may not be the final term used in the regulations however.

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- The 8% increase to the baseline was removed, only a 5% increase will be added. This change does not affect Shrewsbury's baseline calculation used for the Pilot Project because it was always limited to the compliance volume of 3.91 mgd.
- The Streamflow Criteria were expanded to represent five seasons to more accurately reflect bioperiods and to include all months of the year.
- Additional language was added for site-specific studies which was lacking in the Draft Framework.
- Permit Review Tiers were combined into three tiers instead of four. Tier 1 is unchanged and is for withdrawal requests below baseline, Tier 2 is for requests above baseline that do not cause backsliding of Biological Categories (BCs) or GWLs (this was previously split into Tier 2 and Tier 3 to represent small and large requests), and Tier 3 is for requests above baseline that causes backsliding.

With this change Shrewsbury is now a Permit Review Tier 2 instead of a Tier 3. This is because the size of the request above baseline no longer matters unless it causes backsliding. Shrewsbury's permit requirements remain the same as before: standard conditions 1-8, minimize existing impacts to the greatest extent feasible, demonstrate no feasible alternative source that is less environmentally harmful, and mitigate commensurate with impact.

Minimization

Duane discussed the outcome of the minimization evaluations for Shrewsbury during Phase 1 and the first two mock consultation sessions. Because all of Shrewsbury's sources are in the same subbasin there is no alternative for operating the existing sources to minimize their impact on streamflow. There are no other less environmentally harmful alternative sources either. Therefore there are no additional minimization requirements for Shrewsbury to implement.

Mitigation

Credit System

Duane introduced a revised draft crediting system that could be implemented in order to determine mitigation commensurate with impact. This draft crediting system has not been vetted through EEA and is not considered final, but it is the system that will be used to document a mock permit and mock permit conditions for Shrewsbury for the Phase 2 draft report. In this crediting system, Public Water Suppliers (PWSs) can receive credit through three options in order of preference: demand management, direct mitigation measures, and indirect mitigation measures. Direct mitigation measures will be awarded credit based on volume recharged. Indirect mitigation measures will follow the new crediting system as presented.

Indirect Mitigation Credits

Duane described the indirect mitigation credit system and how to calculate the amount of indirect mitigation required. The amount of indirect mitigation required is calculated by first subtracting the estimated demand management volume from the request above baseline and then subtracting the volume available from direct mitigation. The remaining volume represents what needs to be mitigated through indirect measures. The table provided in the handout is used to look up the number of indirect credits required which depends on whether the volume of indirect mitigation is less than or greater than 5% of the August median flow.

Also in the handout is a table that lists the type of indirect mitigation measures that can be implemented as well as the number of credits awarded to each. Each measure can get up to a total of 50 credits. Those credits are divided among improvements to either in streamflow, aquatic habitat, or water supply

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protection. Five credits are awarded for indirect benefits/improvement and 10 credits are awarded for direct benefits/improvement. Additional credits can be considered if the benefit/improvement is to a Coldwater Fishery Resource. The points were assigned based on EEA staff's professional judgment.

Bob asked about credits for dam removal. Shrewsbury is planning to partner on a SWMI grant application with the City of Worcester to remove the Poor Farm Dam. Bob asked if Shrewsbury would have to share the credits for the dam removal with Worcester. Duane and Anne said that would have to be discussed.

Anne provided further clarification on the indirect credit system. The credits take into account the volume of the withdrawal request above baseline and the volume in relation to the August median flow. The proposed multipliers used in the credit system are based on the percent of the volume to be mitigated by indirect measures in relation to the August median flow. Bob asked how the August median flows were determined. Tom Lamonte and Anne explained that the August median flows are from the USGS study and are based on 44-years streamflow data. They are the modeled median flows for each subbasin in Massachusetts and represent un-impacted or 'pre-development' streamflows.

Direct Mitigation Credits

Duane described direct mitigation crediting including the revised location adjustment factors. The location adjustment factors are for mitigation actions implemented only within the Town boundaries. Any recharge within or upstream of the sources' subbasin would be subject to water quality considerations.

Direct credit for wastewater returns was discussed. Credits are based on the volume returned and the location where it is returned. During the last mock consultation session it was discussed that 0.35 mgd from upstream subbasins' septic returns would be credited to Shrewsbury. EEA has reevaluated this and reduced this credit to only consider returns within the Town's boundary to avoid double or triple counting credits if those returns were credited to Shrewsbury and to other PWSs located upstream.

Existing wastewater returns will be credited at 100% only for returns within and upstream of the source subbasin and within the Town. Credit for future wastewater returns will be credited by volume returned and with application of the location adjustment factors (100% within and upstream of the source subbasin, 50% within the major basin, and 10% outside of the major basin).

Jack stated he has never been in favor of the location adjustment factors and repeated his concerns that if they do not get full credit for all measures in Town, they will not get approval to implement anything. He feels that any recharge will help streams somewhere. He thought SWMI was looking into things holistically, and should therefore encourage all activities regardless of location.

Anne recommended that Jack continue to present that comment to EEA. Jack said that he has several times and he has never received comments back or any acknowledgement of his concerns. He asked if there was any information on receiving a response. Duane said all comments received have informed EEA's policy discussions but they have not talked about providing written responses back.

Paul Howard stated that most cities and towns don't become engaged until it directly affects them. That's why they are taking a lot of time in their review of SWMI and the Pilots, because they want to really represent all PWSs that aren't paying attention now. Paul feels Shrewsbury's concerns would be universal if all PWSs would comment.

Demand Management

Duane explained that demand management is what EEA wants PWSs to start with, then direct mitigation measures, and then finally indirect measures. Demand management is what public water suppliers know best.

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It is proposed that under SWMI, if a PWS wants to receive credit for demand management, a demand management plan would be required which estimates the volume of water that could be saved by implementing certain demand management activities. The estimated volume (mgd) would be subtracted from the withdrawal request above baseline, and the remaining volume is what would need to be mitigated via direct and indirect measures.

Barbara asked when the plan would be required and how often the plan would be reviewed. Duane said demands would be checked annually with ASRs and at 5-year permit reviews. Bob asked if expected population increases would be taken into account. Duane explained that the water needs forecast (WNF) is based on trending demands and population projections. Linda Hutchins said DCR could also work with the town to take into account expected/planned population and commercial growth. Anne added that the WNF calculation works with demand, population, and employment projections. If the town has been rezoned to encourage commercial/business development, the current methodology does not directly account for that, but the intent of the 5% buffer added to the baseline was to account for unanticipated water uses.

A demand management plan for Shrewsbury could include an estimate of savings from more stringent outdoor water use restrictions. EEA agreed with an estimated savings of 0.15 mgd for outdoor watering restrictions of two days per week for the mock permit. This was based on the demonstrated 0.3 mgd reduction in demand that was observed in Shrewsbury when restrictions were first implemented for odd-even watering. The demand management plan could also include additional measures that would help improve Shrewsbury's unaccounted-for-water, including expansion of radio read metering.

Mock Permit Credits

Direct mitigation credits available for Shrewsbury have been identified as existing septic system returns and wastewater recharge at the SAC Site. The existing septic returns were explained earlier and were 0.048 mgd when adjusted for town boundaries limited to upstream subbasins. The recharge volume provided for the SAC Site was listed as 0.3 mgd in the Phase 1 report. This volume could be credited at 100% due to the location of the site upstream of the subbasin's pour point. Jack asked if this could be confirmed, but Duane said this is a mock permit and not a commitment. The proposed crediting system has not been approved by EEA yet. Jack reiterated that if they knew more about what credit they would get for certain measures they would be more likely to implement them or at least to start the process that would be needed to implement them.

The mock permit credit for demand management was estimated at 0.15 mgd as explained earlier for outdoor watering restrictions, and direct mitigation credits total 0.348 mgd. Subtracting these volume credits from the withdrawal request above baseline of 1.37 mgd, this leaves 0.872 mgd required to be mitigated through indirect credits. Using the table in the handouts, 0.872 mgd is greater than 5% of the August median flow of the subbasins where Shrewsbury's wells are located, and this would mean that 135 indirect mitigation credits would have to be achieved in order to mitigate commensurate with impact.

Duane reviewed the identified indirect mitigation measures for Shrewsbury. These include stormwater bylaw, stormwater utility, MS4 requirements, I/I removal, and dam removal. Jack asked why the stormwater options were moved to the indirect table, stating that they receive almost no credit compared to what they were getting before. Duane said there was much discussion and disagreement over the calculations used in the Phase 1 report. The stormwater credits previously were based on buildout scenarios, and they were also very difficult to track, and presented an administrative burden to follow each project, to track how much is recharged, and where they were located.

Paul disagreed stating that with a stormwater bylaw in place it could be done. Developers would provide the information within permits as well as in plans and design specifications. A certain volume per acre could be agreed upon and applied to everyone. Jack said it is something they could track within their

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existing permit structure and added that they have already identified specific projects where redevelopment is improving recharge. Those projects could be easily quantified and credit applied.

Rebecca pointed out that the stormwater bylaw volumes in the Phase 1 report did not include location adjustment factors and that during the second mock consultation meeting, revised stormwater credits with location adjustment factors and considering various levels of credit (e.g., more stringent requirement than the Massachusetts Stormwater Policy) were presented.

Anne said they could look back at a case-by-case basis for existing projects and reevaluate credits under direct mitigation for such redevelopment projects. Therefore, additional direct mitigation credits could be received from stormwater retrofit and redevelopment projects and the existing roof leader disconnection program. Additional demand management or indirect mitigation credits were not identified for Shrewsbury. The Pilot report will be written to indicate a credit gap between required and identified mitigation measures.

Paul asked if the location adjustment factors apply to indirect mitigation measures and if 25 points were awarded per dam. Duane said location adjustment factors would not automatically be applied to indirect measures, and yes, the default is that each dam removed would get at least 25 points, however there is the qualifier that points can be adjusted up or down based on site-specific information. Paul again stated that SWMI should be holistic and all measures implemented would help somewhere. Even if a dam is removed in the Concord Basin in Shrewsbury, it would still benefit those downstream. Linda agreed stating that such actions could help the "dead beat dam" program by encouraging PWSs/municipalities to remove dams with safety issues that could also benefit streamflow, but private owners don't have the money.

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Appendix H –

SWMI Model Review Process

Appendix H

SWMI Model Review Process

The SWMI Framework characterizes subbasins throughout the Commonwealth based on biological categories (BC) and groundwater withdrawal level (GWL) criteria, and establishes requirements for public water suppliers (PWSs) under the Water Management Act (WMA) permitting process. Specifically, the Framework requires a PWS requesting an increase in permitted water withdrawals, or renewing a WMA permit, to minimize the impacts of existing water withdrawals and mitigate the impact of new withdrawal volumes on streamflow, with requirements varying by BC and GWL designation. The BC and GWL designation of each subbasin are therefore important criteria in determining WMA permit review requirements.

H.1 Background

The BC and GWL for each subbasin are functions of the percent alteration in the natural median August flow in the subbasin. The USGS Sustainable Yield Estimator (SYE) was used to estimate the natural median August Flow. This study found that the variables that correlate to natural August flow are:

- Drainage area
- Mean basin elevation
- Average annual precipitation
- Percent open water
- Percent wetlands
- Percent sand and gravel
- Average maximum monthly temperature
- Location

These variables are generally well known and confirmed throughout the Commonwealth. At the option of a PWS, a site-specific evaluation may review the inputs to the SYE and estimate of unaffected median August Flow in a subbasin.

In the 2010 *Indicators of Streamflow Alteration, Habitat Fragmentation, Impervious Cover, and Water Quality for Massachusetts Stream Basins* study (Massachusetts Water Indicators (MWI) Report), the USGS estimated alterations in subbasin streamflow using the SYE. As applied to SWMI, the study assumes that streamflow alteration for a given month is equal to the net water use in the subbasin for that month, excluding surface water withdrawals. The additional variables used to estimate alteration of August streamflow for BC/GWL determination are:

- WMA groundwater withdrawals
- Private well withdrawals
- Percent impervious cover

- Natural basin characteristics (i.e. drainage area, channel slope, and percent sand and gravel)

The MWI Report lists the estimates of natural or unaffected August flow, cumulative withdrawals (*i.e.,* including upstream subbasins), and discharges for each subbasin in a spreadsheet titled "Table_1-2_wateruse-feb-14-2011." (See Appendix 1 of the USGS MWI Report available at http://pubs.usgs.gov/sir/2009/5272/.)

The withdrawal data were generally based on annual average withdrawals over 2000-2004, as detailed in the MWI Report. Correspondence from the Massachusetts Department of Environmental Protection (MassDEP) regarding how the model calculates averages indicates that withdrawals from wells that were not active for the entire period were averaged only over the time period that they were active, resulting in averages of variable years. Furthermore, MassDEP noted that volumes reported by wells during periods they were inactive sources were discounted, meaning that the wells were not included in the average for the years in which they were inactive. This can lead to some inaccuracies in the average withdrawals used for BC/GWL determination.

To determine monthly flow alteration, the MWI Report disaggregated average annual groundwater withdrawals to monthly values using the peaking factors summarized in Table H-1.

Table H-1. Applicable Peaking Factors

Month	Percent of Annual Average Withdrawal
January	89.2
February	82.3
March	89.5
April	95.3
May	111.5
June	123.1
July	122.2
August	115.5
September	104.6
October	93.7
November	85.4
December	87.7

Source: MWI Report – Table 2

The regression equation used to determine BCs for each subbasin was not publicly available at the time of the SWMI Phase 1 Pilot Project Draft Report. The SWMI Framework designates the subbasin BC based on the percent alteration of the range of fluvial fish relative abundance. In addition to the alteration being dependent on the above variables associated with median August flow variation, the BC determination is also a function of percent impervious cover in a subbasin. A publicly available tool for calculating BC based on the above variables may be available prior to promulgation of

SWMI-related regulations. In general, the SWMI Framework designates BCs based on the percent biological alteration (based on regression equations that relate fish abundance to impervious cover and flow alteration). The BC and related biological alteration is presented in Table H-2.

Table H-2. Biological Category (BC) Determination	
BC	**Biological Alteration**
1	<5%
2	5 to <15%
3	15 to <35%
4	35 to <65%
5	≥ 65%

Source: Table 2 of SWMI Framework

The SWMI Framework designates Subbasin GWL based on the percent alteration of August median flow due to groundwater withdrawals as presented in Table H-3.

Table H-3. Groundwater Withdrawal Level (GWL) Determination	
GWL	**Alteration of Unimpacted August Median Flows Due to Groundwater Withdrawal**
1	0 to <3%
2	3 to <10%
3	10 to <25%
4	25 to <55%
5	≥ 55%

Source: Table 3 of SWMI Framework

The GWL can be determined for individual subbasins using Table H-3, the MWI data referenced above, and the following equation.

$$\%\ \textbf{August Flow Alteration} = \frac{\textbf{AWD} + \textbf{P}}{\textbf{U}}$$

Where: *AWD = Estimated August Groundwater Withdrawals*

P = Estimated Private Well Withdrawals

U = Estimated August Unaffected Streamflow

While August flow alteration is used to define the subbasin GWL, the SWMI Framework also includes guidelines for allowable alteration of unimpacted median flow in defined seasons or bioperiods for GWL 1, 2, and 3 subbasins: July-August-September, October-November, December-January-February, March-April and May-June. The August median streamflow alteration has been adopted as the July-August-September Streamflow Criterion. The seasonal streamflow criteria are listed in Table H-4. These values can be calculated using the same method described above for August flow alteration.

Table H-4. Seasonal Streamflow Criteria

Groundwater Withdrawal Levels	% Alteration of Estimated Unimpacted Monthly Flow from Ground Water Withdrawals				
	Jul-Aug-Sep	Oct-Nov	Dec-Jan-Feb	Mar-Apr	May-Jun
1	3%	3%	3%	3%	3%
2	10%	5%	3%	3%	5%
3	25%	15%	10%	10%	15%
4	Feasible Mitigation and Improvement				
5					

Source: Table 4 of SWMI Framework

The seasons identified for the seasonal streamflow criteria generally correspond to the four months that were analyzed in the MWI Report: January (December-January-February), April (March-April), August (July-August-September), and October (October-November). The only season not covered under the MWI analysis is May-June. The analysis presented compares the actual data versus model data for the four months (January, April, August, and October) for which data (such as unaffected median flows) was readily available.

MassDEP has determined BCs and GWLs for subbasins throughout the Commonwealth using the SWMI methodology. Results of this categorization are available on a SWMI Interactive Map available on the internet at http://www.mass.gov/dep/water/resources/swmi.htm.

H.2 Model Review Methodology

The following sections describe how PWSs can validate or refine the BC and/or GWL designation of a subbasin using actual or more accurate data than the estimated values used for the statewide classification effort. Although any of the above variables can be adjusted, the use of actual vs. estimated 2000-2004 groundwater withdrawal data is expected to be the most likely variable to have an impact on subbasin classification.

Step 1 – Data Collection

As the USGS model is based on the 2000-2004 average withdrawals multiplied by a monthly factor, actual withdrawal data can be collected and compared to the withdrawal data used by the USGS model to confirm the accuracy of this data.

Table H-5 summarizes the data that can be collected to compare the SWMI BC/GWL model input to the actual withdrawal information for each subbasin.

Table H-5. Model Data Input Review – Required Data

Data	Source
Subbasin number in which groundwater withdrawals are located	• SWMI Interactive Map
Estimated August Unaffected Flow in subbasin (U)	• MWI Report Appendix 1
2000–2004 annual average groundwater withdrawals used in USGS model	• MWI Report Appendix 1 • Sustainable Yield Estimator Database
Estimated August private well withdrawals used in USGS model	• MWI Report Appendix 1
2000–2004 actual monthly groundwater withdrawals for wells to be evaluated	• Annual Statistical Reports

Step 2 – Identify subbasin location(s).

Identify the subbasin in which each withdrawal point is located. The subbasin location can be determined by using the SWMI Interactive Map, available at http://www.mass.gov/dep/water/resources/swmi.htm. Identifying the subbasin that each source is located in is important, as the USGS model and the following methodology evaluates withdrawals on a subbasin level.

Step 3 – Data Recording

To determine the actual withdrawals over the 2000-2004 period, record the annual withdrawal data for each source over the five year period as reported in a PWS's annual statistical reports (ASRs). Perform this exercise on a subbasin level. Note annual withdrawal data is generally reported on the ASRs in million gallons (MG) per year (MGY) and should be converted to million gallons per day (mgd) by dividing the reported MGY by 365. For the purpose of this exercise, leap years (2000 and 2004) were not accounted for. A data collection template (example provided as Table H-6) can be used to facilitate data collection and analysis. Record the annual withdrawal (as reported on the ASR) for each source (mgd) and year in the "actual" column.

To collect the withdrawal information used by the USGS model, extract the annual withdrawal information for each source from the Sustainable Yield Estimator (SYE) Database. The SYE database reports annual withdrawal data in MGY and should be converted to mgd by dividing the reported MGY by 365 to facilitate future calculations

and data comparison. Record the annual withdrawal information from the SYE database for each source (mgd) and year in the "model" column.

If the ASR or SYE database reports that a status is inactive or abandoned, any reported withdrawals for that year should be discounted. Indicate the status of these sources with an I (inactive) or an A (abandoned) in the data collection template. Do not discount withdrawals from a source that is designated as an emergency source.

Table H-6: Template 1
Average Annual Groundwater Production (mgd)

	2000		2001		2002		2003		2004		Annual Average	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model
Well #1												
Well #2												
										Total		

To expedite data collection efforts, monthly withdrawal information can also be recorded from the ASRs at this time (see step 6).

Step 4 – Compare reported annual withdrawal to that used by USGS model (SYE Database).

Compare the reported annual withdrawals for each source to that from the SYE database and note any discrepancies. Theoretically, the numbers should be consistent; however discrepancies may exist between the two datasets regarding a source's status or the annual withdrawal information. Differences in a source's status between the actual data and data from the SYE database are important to note as this may affect how the annual average withdrawals are calculated, as discussed below.

Step 5 – Calculate the 2000-2004 average annual withdrawals for each subbasin.

As the USGS model is based on average annual withdrawals, calculate the average withdrawals for both the model data and the actual withdrawal data using the methodology described below. As the USGS model evaluates withdrawals on a subbasin level, perform this exercise on a subbasin level to remain consistent with the SWMI methodology.

Actual withdrawal data should be averaged over five years, regardless of whether a source was abandoned or inactive during a portion of the five year period. To determine the average using the actual data, sum the withdrawals reported for each year within the 2000-2004 period by source and divide the total by five. Enter this number into the "Annual Average – Actual" column of the data collection template. Once this has been performed for each source within the subbasin, total the annual average for each source to determine the 5-year average annual withdrawal for the subbasin. Record this number in the "Total" cell under the "Annual Average – Actual" column of the data collection template.

To determine the average using model data, sum the withdrawals reported for each year within the 2000-2004 period by source and divide the total by the number of years the source was active. Enter this number into the "Annual Average – Model" column. Once this has been performed for each source within the subbasin, total the Annual Average for each source to determine the 5-year average annual withdrawal used in the USGS model for the subbasin. Record this number in the "Total" cell under the "Annual Average – Model" column of the data collection template.

Step 6 – Calculate the monthly average withdrawals.

Actual monthly average withdrawals for April, August, October, and January are obtained to determine if the monthly average withdrawals predicted by the USGS model are significantly different. As the USGS model evaluates withdrawals on a subbasin level, perform this exercise on a subbasin level to remain consistent with the SWMI methodology.

Using the ASRs, record the total actual monthly withdrawals for each source over the 2000-2004 period for each of the months of January, April, August, and October. Note the monthly withdrawal data is generally reported on the ASR in MG per month and should be converted to mgd by dividing the reported MG by the number of days in each month. A data collection template (example provided as Table H-7) may be used to facilitate data collection and analysis. Sum the withdrawals over the 2000-2004 period for each month by source and record the result in the "Total (mgd)" row for each source. Combine the reported withdrawals for each source over the 2000-2004 period by month (i.e. sum the numbers contained in the "Total (mgd)" row in Table H-7) and divide the total by five to determine the 2000-2004 Average withdrawals (mgd) for each month.

As noted earlier, the USGS model applies the peaking factors listed in Table H-1 to the average annual withdrawals data to approximate the monthly withdrawals. To develop the 2000-2004 average withdrawal from the USGS model for the target months, apply the peaking factor for each month to the subbasin's average annual withdrawal in mgd that was calculated using the model data (determined in Step 5 and recorded in the Total cell under the "Annual Average – Model" Column of Template 1, Table H-6). The resulting number approximates the average monthly withdrawals that are used by the USGS model.

Table H-7: Template 2
Monthly Average Withdrawals - Actual Data

Month	Year	Well #1	Well #2	2000-2004 Average Subbasin Withdrawals (mgd)
January	2000			
	2001			
	2002			
	2003			
	2004			
	Total (mgd)			
	Average (mgd)			
April	2000			
	2001			
	2002			
	2003			
	2004			
	Total (mgd)			
	Average (mgd)			
August	2000			
	2001			
	2002			
	2003			
	2004			
	Total (mgd)			
	Average (mgd)			
October	2000			
	2001			
	2002			
	2003			
	2004			
	Total (mgd)			
	Average (mgd)			

Step 7 – Identify the Groundwater Withdrawals and Estimated Unaffected Median Flow values used by the model.

The Unaffected Median Flow and Groundwater Withdrawal information for each subbasin can be obtained from the MWI Report, Appendix 1, Table 1-2. The information from Table 1-2 can be input into Template 3 (Table H-8) to facilitate data collection and enable data analysis and calculations in excel.

Table H-8: Template 3

Month	Unaffected Median Flow (mgd)	Model Total Nested Groundwater Withdrawals (mgd)	PWS Withdrawals (mgd)		Adjusted Groundwater Withdrawals (mgd)	% Flow Alteration	
			Model	Actual		Model	Adjusted
August							
October							
January							
April							

Obtain the Estimated August Unaffected Streamflow (U) as reported in above referenced Table 1-2. This value is contained in the worksheet tab entitled "Aug, all basins", in the "Estimated August Unaffected Streamflow (U) (ft3/s)" column. Convert the value from ft^3/s to mgd by multiplying the value by 0.6463. Record the value on Template 3 in the "Unaffected Median Flow (mgd) column for the appropriate month. Repeat this for the remaining months of October, January, and April using the appropriate monthly data for each.

Simultaneously, obtain the monthly Groundwater Withdrawal values used by the model for each subbasin. Note that the monthly Groundwater Withdrawal values account for both estimated groundwater withdrawals from PWSs and estimated private well withdrawals. As such, sum the reported "Estimated August Groundwater Withdrawals (Mgal/d)" and "Estimated August Private Well Withdrawals (Mgal/d) and record the total in Template 3 as the "Model Groundwater Withdrawal (mgd)" for the month of August. Repeat this exercise for the remaining months of October, January, and April, using the appropriate monthly data for each.

Populate the PWS Withdrawals (mgd) column using the actual monthly withdrawal data and the approximated model monthly withdrawals, as determined in Step 6.

Step 8 – Adjust the Groundwater Withdrawals to reflect actual withdrawal data.

Adjust the monthly Model Groundwater Withdrawals used in the model to reflect the actual groundwater withdrawals, based upon the difference between the PWS's actual monthly withdrawal and the monthly withdrawal value used by the model (determined in Step 6), using the following equation.

Adjusted Groundwater Withdrawal = Model Wd – PWS(model) + PWS(actual)

Where: Model Wd = USGS Model total nested groundwater withdrawals (mgd)

PWS(model) = PWS withdrawals used in the USGS Model (mgd)

PWS(actual) = PWS actual 2000-2004 average withdrawals (mgd)

Record the adjusted groundwater withdrawal value in the "Adjusted Groundwater Withdrawals (mgd)" column in Template 3.

Step 9 – Determine the Median Flow Alteration for each month.

Determine the percent alteration of August flow as determined by the USGS model data by dividing the Model Groundwater Withdrawals for August (the sum of monthly and private well withdrawals, as reported in above referenced Table 1-2 and calculated in Step 8) by the August Unaffected Median Flow (mgd). Multiply the value by 100 to obtain the percent alteration and record the result in the "% Flow Alteration – Model" column of Template 3. Repeat this exercise for each month.

To determine the percent alteration of August flow based on actual withdrawal data, divide the Adjusted Groundwater Withdrawals for August (as determined in Step 8) by the August Unaffected Median Flow (mgd). Multiply the value by 100 to obtain the percent alteration and record the result in the "% Flow Alteration – Adjusted" column in Template 3. Repeat this exercise for each month.

Step 10 – Confirm or revise subbasin GWL designation based on actual withdrawal data.

Compare the percent alteration in the Median August Flow resulting from the use of actual withdrawal data to that resulting from the use of model data and determine the resultant GWL designation for both values using Table H-3 Groundwater Withdrawal Level (GWL) Determination. The August percent flow alteration using actual withdrawal data will either validate the GWL designation of the subbasin resulting from use of the model data or result in a revision to the subbasin's GWL designation.

Appendix I –

Generic Scopes of Work for Wetted Perimeter and IFIM

Generic Scope of Work
WETTED PERIMETER/HABITAT INFLECTION POINT (WP/HIP)

The following Scope of Work defines the steps to evaluate stream flows by the Wetted Perimeter (WP) Method. This method estimates the flow needed for habitat and fish species based on a calculated Habitat Inflection Point (HIP), which represents the magnitude of streamflow below which habitat can be lost. This relationship between channel wetted perimeter and discharge is used to define environmental (instream) flows in rivers. This approach assumes that there is a direct relationship between wetted perimeter and habitat availability. This process could be used to develop a baseline of the existing condition before an increase in withdrawal begins.

This method defines the response of the stream's wetted width to changes in flow/depth, which defines a site-specific component of stream habitat. It involves measuring designated stream segments at select transects, from water's edge to water's edge, over a number of gauging events that represent various water levels in the stream. The wetted perimeter as calculated from stream depth and width is then graphed versus concurrently measured flow magnitude. An inflection point in that graphed data indicates a point where habitat is stable and below which the width starts to rapidly decrease.

Note: The IFIM Method discussed later relies heavily on transect data for physical habitat assessment and employs sophisticated hydraulic habitat modeling techniques such as PHABSIM. Modeling within an IFIM analysis requires detailed hydraulic and morphological surveys, and knowledge of habitat preferences for the species of interest. For these reasons, the simpler approach based on examination of the wetted perimeter–discharge relationship has been used in many locations and provides an important screening tool. When used as a screening tool the field components of the WP/HIP should closely follow the requirement of the IFIM to ensure reproducible results.

The following outlines the technical components of the WP/HIP process to be used.

Task 1: Collect Field Data and Define Flow Needs

Data collection, reduction, and analysis should generally follow the protocols described in USGS Water-Supply Measurement and Computation of Streamflow Paper 2175. The following key elements are noted:

Identify Stream Transects – The wetted perimeter–discharge relationship is a basic tool in the 'transect' approach to environmental flow evaluations. The procedure requires deriving the relationship from channel cross-section surveys at several discharge levels. Transects are often located at various stream segments, predominantly riffle sites, or at other sites where fish passage is likely to be limited.

Preferably, transects should be located at riffle sites. A minimum of three transects should be included in stream segments with riffle sites to represent upstream, downstream and in-stream segments. If transects must be located at in pooled areas and areas with an irregular geometry, then more than one transect should be provided for that segment, to be representative of the cross section and stream. In addition to measuring cross-section geometry and flow, concurrent observations should be made to define parameters needed to support flow modeling using the

channel morphology and a flow equation such as the Manning equation. Substrate is also recorded at lower flow levels, particularly if the substrate is silt or sand.

The stream segment selected for analysis should represent a steady state reproducible discharge at the upstream and downstream boundaries and should limit secondary inputs such as small tributaries that could alter any cross-sectional discharge throughout the segment. Discharge or flow variations between transects should be within 10 percent of each other. Selection of the upstream segment should include the consideration that it will be used to characterize baseline conditions.

Data Collection at Transects – Take stream measurements for a minimum of 10 different flow events, over a range of flows/depths at each transect, including surveyed channel geometry, water depths and velocity measurements, and data on channel lining needed to support the use of the Manning's equation. Flow and wetted width data will be used to develop rating curves, to further support the inflection point evaluation. Measure minimum riffle depths during summer low flows. This is the depth a fish would have to swim through to migrate upstream and represents the deepest part of the shallowest section. A riffle depth is not measured during high flows when depth is not a concern for migration.

The shape of the relationship between wetted perimeter and discharge is a function of the geometry of the channel, and the manner in which discharge increases with depth. At low flows the velocity is low; as depth increases, flow velocity increases, with discharges generally increasing at a faster rate than depth. The nature of this relationship is described by the Manning equation:

$$v = (1.49/n)R^{2/3} S^{1/2}$$
$$Q = (1.49/n)A\ R^{2/3} S^{1/2}$$
$$S = [(Qn/(1.49\ A\ R^{2/3})]^2$$

Where: v = average channel velocity (ft/s)
Q = discharge rate for design conditions (cfs)
n = Manning’s roughness coefficient
A = cross-sectional area (ft^2)
R = hydraulic radius (ft)
P = wetted perimeter (ft)
S = slope of the energy grade line (ft/ft)

Habitat Flow Analysis – Develop a habitat inflection point flow graph for each monitoring transect. The wetted perimeter–discharge habitat inflection point or breakpoint will be used to define optimum and minimum flows for target fish species. Estimate discharges for a minimum of 25 values of depth using the Manning equation. Document all assumptions for Manning roughness coefficient and water surface slope. The channel geometry (wetted perimeter) and discharge data will be plotted. This will enable direct comparison(s) of the shapes and slopes of the wetted perimeter–discharge curves for the different channel geometries.

The focus of this task is to define the habitat inflection point or breakpoint for each stream segment, which is done by expressing each discharge and wetted perimeter value as a proportion of their respective measured or modeled maximum values. The inflection point is where the

slope of the graphed values change from a more vertical orientation to a more horizontal orientation and represents where a small change in discharge produces the same change in wetted perimeter. The inflection point represents a critical discharge, below which the habitat conditions for aquatic organisms (usually fish or macroinvertebrates) decrease. This method assumes that reductions in the wetted perimeter are correlated with losses in habitat quality. The instream flow value is derived from the inflection point.

Deliverable: The Task 1 Deliverable should include a summary of the Habitat Inflection Point analysis, with a description of the stream flow selected on the basis of this analysis. This information should be supported by a detailed summary the transect locations, habitat observations, and corresponding data files.

The purpose of each stream segment selected for inclusion in the analysis should detail how the segment relates to the proposed area of impact by stream flow alteration. For example, the segment upstream of the flow alteration area should be described to document how it represents the Baseline Condition of the stream with or without the proposed man-made changes in flow. Segments adjacent to or within the proposed area of stream flow alteration represent the direct impact zone, and a down-stream segment could represent net instream flow impacts including natural or man-made offsets. Assessments of the instream and downstream segments prior to increased withdrawals or offsets would provide benchmark conditions on which to evaluate future improvements that may increase low flows (e.g., recharge).

Task 2: Consider Other Influencing Factors

There are other factors that should be considered and evaluated when establishing low flow standards and appropriate mitigation. Following is a brief discussion of these factors.

Water Supply – Surface Water – Surface water supply withdrawals may influence stream flows throughout the year. The timing and influence of these withdrawals should be considered when collecting information to determine minimum instream flow requirements and potential mitigation measures. Surface water dams and scheduled releases can also influence these decisions. The minimum streamflow criteria developed should be used to help determine withdrawal limitations for surface waters, as well as groundwater supplies.

Water Supply – Groundwater – The indirect water-withdrawal via a groundwater supply well system results in a sustained withdrawal from a watershed groundwater, typically referred to as the Zone II. Groundwater withdrawals are limited by the hydraulic connection between the zone of influence and the stream at a specific location. These withdrawals may result in a reduction in base-flow during low-flow conditions and should be considered in setting and mitigating minimum instream flow standards. Further information is required to evaluate the net effects on groundwater watershed contributions to base-flow during low flow conditions.

Recreation – Recreational activities may require a minimum flow below which those activities are not possible. For example, canoe passage may not be possible in certain areas of a stream at low flows. Additionally, there are flows that are greater than a specified minimum flow, at which the recreation is possible, but water quality is substantially degraded. Optimal depths for canoeing are water depths greater than or equal to 0.5 feet. Optimal velocities range from

approximately 0.5 to 2.6 ft/s. All substrate types are assumed suitable for canoeing. Predominant changes in the watershed during period of record should be identified, which could have previously affected the recreational capacity/quality of the stream.

Aquatic Biota – Aquatic biota, such as selected fish species, are typically targeted for setting minimum streamflow requirements. They have specific habitat requirements for various life stages and activities including combinations of velocity, depth, and substrate, as well as other factors. When discharges are substantially altered, the appropriate combination of habitat characteristics necessary for success of these species may be reduced to levels that limit the population.

It is also important to realize that the current status of target species of interest, such as low numbers of fish or diminished diversity of species in a given segment may have no relation to flow alterations (i.e. increases or decreases). Other factors such as water quality, temperature, sedimentation or constant channel forming event can reduce the success of the species or population of interest and should be considered when deciding minimum streamflow requirements.

Mitigation Measures – Mitigating measures or offsets to identified impacts should be defined and quantified. These may include unique or site-specific hydrogeological settings that alter the level of impact, defined impact zones that do not lead to the degradation of the stream on the whole, or other measures such as institutional and regulatory changes that draw on new technologies or approaches that lead to quantifiable improvements in habitat and instream flow.

A Baseline Condition can provide the benchmark from which each “Alternative” is compared, and also detail a set conditions from which each “Mitigation Measure” is assessed to help quantify the net benefits. A Baseline Condition can be developed by selecting transects or a segment that represents a select habitat such as a riffle, pool or run habitat.

Deliverable: The Task 2 Deliverable should include a detailed summary of each factor that can alter streamflows and possible mitigation measures.

Task 3: Summary and Conclusions

WP/HIP provides a conservative cost-effective method and predictive tool for evaluating and identifying critical low-flow periods and corresponding stream segments at risk.

Following a detailed summary of Task 2, the conclusion should define potential influencing factors and how these can be mitigated. This discussion should identify and quantify any net changes in stream flow that may result from the potential influencing factors.

Generic Scope of Work
INSTREAM FLOW INCREMENTAL METHODOLOGY (IFIM)

The Instream Flow Incremental Methodology (IFIM) is a method for determining the relationship between stream flows and fish habitat. It is a series of computer-based models that are used to calculate how much fish habitat is gained/lost as stream flows increase/decrease. The following Scope of Work defines the IFIM process that uses various technical methodologies to evaluate changes in the amount of estimated usable habitat for various fish species as they relate to existing instream flow.

The IFIM method requires the collection of real-time hydraulic data based on accepted USGS stream gauging protocols in conjunction with a habitat simulation model contained in the Physical Habitat Simulation System (PHABSIM). The IFIM provides a framework for applying PHABSIM in a water resource decision setting. The two basic components of PHABSIM are the hydraulic and habitat simulations of a given stream segment. The PHABSIM hydraulic parameters mirror the USGS stream gauging protocol, and habitat suitability evaluation processes are applied to the same stream segments. The following outlines the technical components of the IFIM process to be used.

Note: For the purposes of this scope, the PHABSIM model is discussed, however, the MesoHABSIM model can also be used.

Task 1: Existing Conditions Data Collection

Data collection, reduction, and analysis should generally follow the protocols described in USGS Water-Supply Measurement and Computation of Streamflow Paper 2175. The following key elements are noted:

Stream Data Collection – The hydraulic evaluation/simulation is used to describe a stream segment having various combinations of depth, velocity, and channel index as a function of flow. Therefore the accuracy of the hydraulics analysis is the cornerstone of the IFIM. Stream segments are the basic habitat subdivisions of a river when using the IFIM. The characteristic features of stream segments are defined as uniform flow regime and geomorphology (slope, sinuosity, channel structure, geology and land use). Flow regime normally is the primary factor for selecting the segment boundaries. The goal is to define a steady-state, reproducible discharge at the upstream or downstream boundary of a segment. The segment should limit secondary inputs such that any cross-sectional discharge through the segment would be within 10 percent of the discharge of any other cross section in a segment. Selected segments should include sections of the stream both upstream of the study area to establish a baseline and within the anticipated zone of stream flow change or impact. These segments represent the boundaries for the proposed stream channel flow measurements.

Habitat Stream Segments – PHABSIM segments are subdivided by either mesohabitat types or reaches and should be consistent with the segment designated for instream flow measurements. Mesohabitat types typically are the same order of magnitude in length as the channel width and are defined by the local channel slope, shape, structure, flow depth, and flow velocity. Riffles, runs, pools, bars, and divided channels are some stream features that are commonly classified as

mesohabitat types. Each representative reach, will contain at least one mesohabitat type and will be typically one order of magnitude longer than the channel width for alluvial channels (10-15 stream widths in length). Data sampled at one or more reaches or at selected mesohabitats represent the hydraulic, geomorphologic, and habitat condition within the stream segment.

Deliverable: The Task 1 Deliverable will include a detailed summary of the selected Stream Flow Gauging and Habitat Segments to be used in the analysis. Segment specific information detailing location within the designated project area, purpose of selecting each segment and how the segment relates to the proposed area of stream flow alteration should be included.

Task 2: IFIM Instream Hydraulic Data Collection

Field Program – The instream flow monitoring technique to be used in the IFIM will be based on the USGS Water-Supply Measurement and Computation of Streamflow Paper 2175:

Volume 1 - Measurement of Stage and Discharge

a. Selection of gauging-station sites

b. Measurement of stage

c. Measurement of discharge

Volume 2 - Computation of Discharge

d. Computation of the stage-discharge relation

e. Computation of daily-discharge records

f. Presentation and publication of stream-gauging data

Discharge measurements will be made at various stages of the selected segment to define the relation between stage and discharge. Direct discharge measurements will be collected at specified intervals, during the designated study period of the low flow. These data will be used to verify the stage-discharge relation and to identify any change in the relation caused by changes in channel geometry and (or) channel roughness.

Deliverable: The Task 2 Deliverable will consist of a summary of the stream gauging results, include a discharge rating curve for each segment. Summary data on the gauge-height record will also be reduced to mean values for selected time periods. The mean discharge for each day and extremes of discharge for the year will also be reported. Discharge Rating Curves will usually be developed from a graphical analysis of the discharge measurements plotted on either rectangular-coordinate or logarithmic plotting paper.

Task 3: Physical Habitat Simulation System (PHABSIM)

The model is used to evaluate the hydraulics and habitat conditions for selected discharges. Task 2 data collected are used to calibrate the model. The PHABSIM models are developed to analyze and display the relationship between streamflow and physical habitat. The calibrated model is then used to simulate hydraulic conditions at selected flows other than those directly measured.

If the representative reach method is used, the PHABSIM model is used to further analyze channel geometry, flow, and habitat through transects and stream cells established in the reach and to determine the relationship between habitat and discharge for the reach. In the representative reach method, the sequence and spacing of mesohabitat types in the reach represent the sequence and spacing of mesohabitat types in the segment.

A “Baseline Condition” reach is then developed where transects and stream cells in each mesohabitat type are weighted according to the proportion of that mesohabitat type in the segment.

Task 2 data will form the basis of the hydraulic part of the PHABSIM model, which requires two types of data for flow in the stream: 1) channel structure, and 2) hydraulic variables. Channel-structure data include channel geometry and substrate classification and distribution, as well as other structures relevant to the issues being addressed. Hydrologic variables include water-surface elevation, width, depth, velocity, wetted perimeter, discharge, and surface area. Channel structure and hydraulic variables then can be used to generate a computerized “map” of a composite stream reach representing the study stream reach.

Hydraulic simulation with PHABSIM assumes that the channel geometry does not change with discharge over the range of flows simulated. The results of the hydraulic calculations are water-surface elevations and velocities. Water depths used in the habitat programs are calculated from the water-surface elevations simulated in the hydraulic programs and the channel geometry. The water-surface elevation for a simulated discharge at a transect is used for all the cells in that transect. Velocities vary from cell to cell in the transect, but in all cases should be calibrated to the Task 2 database.

Three methods are available in the model for calculation of the water-surface elevations: 1) direct stage-discharge relation or rating curve, 2) use of Manning’s equation, and 3) the step-backwater method. In both the direct stage-discharge relation method and the Manning equation method, transects are independent of each other. In the step-backwater method, transects are not independent of each other.

The PHABSIM model uses an empirically-derived rating curve to predict water-surface elevations from the stage-discharge relation.

The habitat part of the PHABSIM model requires hydraulic variables simulated in the hydraulic model and habitat suitability curves (HSC) developed by use of direct field observation. HSC’s and water-use flow requirements are combined with hydraulic conditions to rank the suitability of each stream cell in a computerized map for the aquatic biota or a water use of interest.

Typically, HSCs are classified into four categories on the basis of their method of development. Study-specific HSCs are prohibitively expensive to develop so “Source Curves” adapted from other representative streams should be validated and transferred.

Habitat modeling transforms the aforementioned channel characteristics into an index of available habitat using the HSCs. Weighting factors are multiplied by the surface area of the cell for a specified discharge, yielding the parameter of weighted usable area (WUA). A functional

relation between discharge and habitat availability is produced by calculating the WUA at multiple discharges.

In addition to WUA, each cell in the stream reach will be classified as being optimal, usable, suitable, or unsuitable for the species or water use of interest. The stream cells are classified in this manner by comparing the habitat variables (depth, velocity, substrate) within the cells at a given discharge to HSC.

Deliverable: The Task 3 Deliverable is a computerized habitat versus discharge function for each target species as generated by PHABSIM. The IFIM provides an assessment framework for interpretation of the PHABSIM. This habitat modeling will enable the user to analyze the existing flow regime for calibration and provide a predictive tool for net changes with anticipated flow changes.

Task 4: IFIM Alternative-Flow Scenarios

Alternative-Flow Scenarios – Development of alternative-flow scenarios will be based on the habitat requirement of select target species, sustainable instream flow, water uses, and the net effects through flow reduction and/or contributions. Usually, multiple scenarios are developed and the effects on habitat analyzed to assist in addressing water-use and instream-flow issues. The alternative flow scenarios are developed through changes in input parameters, such as reduced water withdrawals, enhanced contributions to base-flow and/or modified releases from impoundments.

Baseline Conditions – The Baseline Condition is developed by selecting transects for a segment that represent a select habitat such as a riffle, pool or run. The length of the Baseline Segment should be representative, and cell lengths should be defined so that each mesohabitat type represents the appropriate percentage of that habitat in the segment.

After the hydraulic model has been calibrated and low flow conditions simulated, the stage, velocity, depth, and substrate relations can then be used to determine the effect of different flows on various water uses and habitat availability. Flow requirements for water use and aquatic biota are typically developed for specific stream systems and study areas.

Water Supply Surface Water – The direct water-withdrawal via a surface water supply system comprises a quantifiable instream sustained flow decrease. These represent direct changes to instream flow that are compared to the PHABSIM modeling results.

Water Supply Groundwater – The indirect water-withdrawal via a groundwater supply well system results in a sustained withdrawal from a watershed groundwater, typically referred to as the Zone II. These withdrawals may result in a reduction in base-flow during low-flow conditions. Changes to instream flow are also compared to the PHABSIM modeling results.

Recreation – Recreational activities require a minimum flow below which those activities are not possible. For example, canoeing may not be possible at discharges that produce significant areas in the stream that do not allow canoe passage. Additionally, there are flows that are greater than

a specified minimum flow, at which the recreation is possible, but water quality is substantially degraded.

Optimal depths are water depths greater than or equal to 0.5 ft. optimal velocities range from approximately 0.5 to 2.6 ft/s. All substrate types are assumed suitable for canoeing.

Aquatic Biota – Aquatic biota, such as selected fish species, have specific habitat requirements for various life stages and activities. These requirements commonly are combinations of velocity, depth, and substrate, as well as other factors. When discharges are substantially altered, the appropriate combination of habitat characteristics necessary for success of these species may be reduced to levels that limit the population.

It is also important to realize that the current status of target species of interest, such as low numbers of fish or diminished diversity of species in a given segment may have no relation to flow alterations (i.e. increases or decreases). Other factors such as water quality, temperature, sedimentation or constant channel forming event can reduce the success of the species or population of interest.

PHABSIM Model Runs – After determining the relations between flow and available habitat through the PHABSIM model, the output provided by the PHABSIM model is only a small part of the information necessary for effective decision making and management of river resources. The output is considered an overall description of the habitat-discharge relation when viewed in reference to the stream segment. Other factors that should be considered during analysis include:

(1) various life stages, species, or water uses may require different amounts of water at different times of the year,

(2) a flow that maximizes habitat in one part of the stream may reduce habitat in another part of the same stream,

(3) increased flows may not increase habitat.

The primary output of PHABSIM is the Weighted Useable Area (WUA) and associated discharge; however, any input, calibration, or simulated data also can be used as an analysis tool. These may include:

- Water Supply Surface Water – The ability to withdraw water from a stream is limited by flow at a specific location and not flow within a stream reach. The hydraulic and flow simulations in the PHABSIM model are useful for determining flows at which the ability to withdraw water from a stream is limited.
- Water Supply Groundwater – The ability to water-withdrawal via a groundwater supply well system is limited by the hydraulic connection between the zone of influence and a stream at a specific location. Further information is required to evaluate the net effects on groundwater watershed contributions to base-flow during low flow conditions.
- Aquatic Biota – The total amount of suitable habitat available for a given a species, life stage, or group of species is dependent, at least in part, on the velocities, depths, and

substrate types required to support the organisms of interest. Habitat availability and suitability can be linked to in-stream flow and other factors like water quality.

- Mitigation Measures – Mitigating measures or offsets to identified impacts should be defined and quantified. These include unique or site-specific hydrogeologic setting, defined impact zones that do not lead to the degradation of the stream on the whole, or other measures such as institutional and regulatory changes that draw on new technologies or approaches that lead to quantifiable improvements in habitat and instream flow. The Baseline Condition scenario developed previously provides the benchmark from which each "Alternative" is compared, and also details a set condition from which each "Mitigation Measure" is assessed to help quantify the net benefits.

Deliverables: The Task 4 Deliverable will include a detailed summary of each alternative-flow scenario identifying the advantages and disadvantages of each. The end product will include an itemized comparison and ranking of each alternative.

Task 5: Summary and Conclusions

The IFIM using USGS stream gauging protocol provides a defensible set of quantified data on a given stream's characteristics to identify critical low-flow periods and corresponding stream segments at risk. PHABSIM provides a cost-effective method and predictive tool for evaluating incremental effects on habitat with changes in flow. The IFIM process identifies where flow reductions or conversely where additional flow contributions through mitigation measures would directly affect the water use, recreation and aquatic species criteria.

Following a detailed summary of the Task 4 results, the conclusion will define the selected preferred alternative. This discussion will identify and quantify any net changes in stream flow that may result from the alternative implementation and summarize the PHABSIM results that define the net potential impact from the proposed change, without mitigation, and with mitigation and offsets to the identified impacts. The evaluation of mitigation options should account for each mitigation measure on a "gallon by gallon" basis, to adequately account for returns to groundwater resulting from the selected measures (e.g., stormwater recharge, wastewater return flows, and other measures that potentially restore water to base flow).

Appendix J –

Amherst Site-Specific Study Meetings – Draft Summary Notes

SWMI Pilot Project Phase 2
Amherst Site-Specific Study Meeting
Tuesday, October 23, 2012
10:00am – 12:00pm
Town Room of Town Hall, 4 Boltwood Ave, Amherst, MA

AGENDA

1. Overview of Phase 1 Report including:
    a. Intent of Report – Evaluate the application of SWMI
    b. Summary of Key Components

2. Site-Specific Study
    a. Purpose
    b. Options – Within Tiers Table SWMI Framework
        i. Flow Level Evaluation
        ii. Review Model Inputs
        iii. Mitigation
    c. Options – Outside of Tiers Table SWMI Framework
        i. Flow Assessment
        ii. Habitat Assessment
        iii. Mitigation

3. Feedback
    a. Other ideas or data to consider?
    b. Are there any options Amherst would be interested in pursuing?

SWMI Pilot Project Phase 2
Amherst Site-Specific Study Meeting
Tuesday, October 23, 2012
10:00am – 12:00pm
Town Room of Town Hall, 4 Boltwood Ave, Amherst, MA

Sign-In Sheet

1.	Jessica Cajigas	CEI
2.	Rebecca Balke	CEI
3.	Jim Bumgardner	MassDEP
4.	Todd Richards	MDFW
5.	Duane LaVaught	MassDEP
6.	TOM LAMONTE	MASS DEP
7.	Richard Friend	MassDEP
8.	Kimberly Longridge	MassDEP
9.	JEFF OSBORNE	AMHERST DPW
10.	Amy Lane	Amherst DPW
11.	GUILFORD MOORING	Amherst DPW
12.	LYONS WITTEN	Amherst Water Supply Prot. Committee
13.	Linda Hutchins	MA DCR OWR
14.	John Tobiason	Amherst Water Supply Prot. Committee
15.	David Ziomek	Town of Amherst - Planning
16.	Jesse Schwalbaum	Amherst NSPC
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		
25.		

MEETING MEMO

ATTENDEES:	Town of Amherst DPW: Guilford Mooring, Amy Lane Rusieckia, Jeff Osborne Town of Amherst Planning: David Ziomek Amherst Water Supply Protection Committee: Lyons Witten, John Tobiason, and Jesse Schwalbaum MassDEP Boston: Richard Friend, Duane LeVangie, and Tom Lamonte MassDEP WERO: Kimberly Longridge and Jim Bumgardner MassDCR: Linda Hutchins MassDFW: Todd Richards CEI: Rebecca Balke and Jessica Cajigas
FROM:	Jessica Cajigas
SUBJECT:	SWMI Pilot Project Phase 2 – Amherst Site Specific Study Meeting
JOB NUMBER:	282-4
MEETING DATE:	October 23, 2012, 10:00am, Amherst Town Hall

Introductions
A sign-in sheet was passed around and all attendees introduced themselves. Duane LeVangie welcomed everyone and reviewed the agenda. Guilford Mooring suggested starting with the Phase 2 discussion and saving the overview of the Phase 1 Report for the end of the meeting as time allowed.

Site Specific Study
Duane began the Site-Specific Study discussion by stating that MassDEP heard Amherst's concerns about the SWMI process not accounting for the reduced impact of withdrawals on the Hop Brook associated with the confined aquifer. MassDEP pulled out some historic studies on the confined aquifer and agreed that the true impact of Amherst's withdrawals may not be felt in Hop Brook, but in the Fort River. The Fort River is in a different subbasin that is a Flow Level (FL) 4 instead of a FL5. This could expand the area able to receive 100% mitigation credit down to the Fort River, rather than limiting it to areas upstream of existing wells and or within the Zone II (based on the location adjustment factors in the Phase 1 report).

Duane explained that MassDEP is considering two options for a Site-Specific Study. Linda Hutchins then discussed the two options. Option 1 is to stay within the SWMI Framework but "sharpen the pencil" using a public water supplier's (PWS's) actual data compared with the data used in the USGS model. Examples for Amherst may include: 1) use Amherst's actual average monthly withdrawals in place of the SWMI average withdrawals which were based on a traditional water demand curve; 2) consider specific subbasin characteristics, like the presence of the confined aquifer, potentially expanding the area where 100% mitigation credit is provided.

Option 2 would be outside of the SWMI Framework. Examples may include: 1) evaluate the true impacts of Amherst's withdrawal on the Fort River by correlating withdrawal data with stream gage data collected on the Fort River between 1966 and 1996; and 2) conduct a site specific habitat assessment study such as Instream Flow Incremental Methodology (IFIM) or wetted perimeter. A site-specific study would provide a different way of assessing the impacts of withdrawals, not looking just at the August flow alteration, but also at impacts on fish.

Guilford asked if Amherst agreed to move the point of impact to the Fort River, would the presence of Hadley's wells in the Fort River have any affect. Guilford expressed concern about having to involve Hadley in this process. Tom Lamonte said that those withdrawals are already calculated into the SWMI model. The SWMI model takes into account all withdrawals within each subbasin. Richard Friend stated that the downstream subbasin, where Hadley's wells are located, is a FL4. But it is barely a FL4. Hadley would have to pump a lot more water from its wells before the subbasin would drop to a FL5. Hadley's

The above text summarizes the events of the meeting at the above date and time.
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pumping would not affect the subbasin where Amherst's wells are located. Linda said due to the confining layer, the subbasin where Amherst's wells are located are probably not a true FL5 because the impacts are felt downstream of that subbasin. Tom explained that the SWMI model is a state-wide level study that did not take into account these types of site-specific conditions.

Linda said Amherst also has USGS gage data available from a gage that was located just after the confluence of Hop Brook and the Fort River. Linda said one suggestion could be to use the wetted perimeter instream flow method along with the historical gage data to conduct a site-specific study.

John Tobiason asked if it is truly known that the discharge point of the confined aquifer is the Fort River. Richard explained that he located the Hop Brook Zone II Report completed by Tighe & Bond around 1992-1993 which contained a map of the confining layer. Based on this map, it is reasonable to assume the impacts would be felt in the Fort River (Richard will send Amherst a copy of the report electronically.) Jim Bumgardner pointed out that the map did not define the "pinch point" or end of the confined aquifer. MassDEP agreed that Amherst could collect additional data to further define the discharge point of the confined aquifer if they didn't agree with it terminating at the Fort River as presented in the options. However, this adds additional work and cost by the Town that would not be needed if Amherst agreed to use the Fort River as the point of impact.

Duane said there is no need for Amherst to make a decision now on which option it would pursue for a site-specific study since conducting an actual study is not part of the Pilot process. The Pilot will scope out a site-specific study such as what it might include and what it might cost. In a real permit situation, Amherst might not choose to do one. Rebecca Balke also stated that the ideas discussed today may not be the only options. John and Jim brought up the possibility of a larger confining layer and further defining the discharge point. Amherst may choose to pursue that for further study.

Todd Richards stated IFIM will not just give you more information and data, there is a public involvement process involved. IFIM does not provide a single solution, if provides information that will still need to be discussed and negotiated. Linda asked Amherst if they knew of any existing studies on the Fort River. Amy stated that Piotr Parasiewicz sent a letter to MassDEP regarding data from studies he has conducted; however, no reports have been provided to Amherst.

Tom stated that the two surface water sources could make things more complicated if Amherst were to choose a site-specific study outside of the SWMI Framework because it would look at actual streamflows, which account for all impacts including impervious surface/stormwater runoff and surface water withdrawals. Todd stated that the site-specific study does a better job of accounting; it provides better information and a more realistic scenario as opposed to the generic SWMI model. Amy asked why surface water was not included in the SWMI model, expressing concern that PWSs with only surface water supplies will not have to do anything. Linda stated that they tried to bring surface water into the study however the results and the flows were extremely variable and they could not be reliably estimated. Todd said that surface water suppliers will still have requirements even if they are in a FL1. The Surface Water Transition Rule will also require mitigation and minimization including Standard Conditions 1-8.

Tom stated that Amherst's reservoirs were included in a USGS study that came out last year. Amherst could use the data from that report for a site-specific study as well. Linda said the data regarding estimated reservoir outflows from the 1960s to the 1990s may be beneficial.

Amy expressed that it was important to Amherst to represent all PWSs during this Pilot. Amherst is fortunate to have a lot of studies and it may not have to pay a lot to do additional studies. Amy pointed out that other PWS may not have these and asked what those PWSs may have to pay to complete similar studies. Linda said many PWSs have their own well pump tests and reservoir studies and many may also have USGS gages located within their systems that they can use also.

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Duane said the Phase 2 Report will list the site specific options and costs, including a range of recommendations and options for consideration.

Linda said the end result of a site-specific study performed outside of the SWMI Framework could likely result in a streamflow trigger beginning with outdoor watering restrictions. If the outdoor watering restrictions were not enough to meet the goals, then additional minimization and mitigation measures would be required of the PWS. She said with a site-specific study, Amherst would be required to install a stream gage to monitor streamflows and to use as the basis for any streamflow triggers. A USGS gage could cost around $18,000 to install plus an additional $18,000 per year to maintain, publish data, and check the rating curves every year. Todd stated that this may be for a "Cadillac" stream gage and that simpler versions would cost less. Linda said the Lynn Water District maintains their gage very well and uses the streamflow data for triggered releases. Cohasset on the other hand has had problems maintaining their gage.

Jim said a potential upside of a site-specific study is that it may only require the implementation of streamflow triggers that Amherst would have to do anyway, without the need for additional mitigation. However, the actual requirements will not be known until the study is performed and there is the potential that additional requirements may be needed. Jim asked what other efforts may be required following a site-specific study. Todd said it has not been determined yet, it may just be demand management efforts including elimination of non-essential water use, but if streamflow was consistently low, additional habitat mitigation options may be required, for example. Richard said in its next permit, regardless of SWMI, Amherst would have to follow streamflow triggers or use the calendar method for outdoor watering. Duane stated if Amherst's RGPCD is less than 65 they could water seven days a week, but if RGPCD is greater than 65, they would have to follow streamflow triggers or water only two days per week.

Linda provided Amherst with a copy of MassDEP's draft ideas for a study scope of work for the options discussed above.

Overview of Phase 1 of Pilot Project

Rebecca gave an overview of Phase 1 of the Pilot Project. She gave a summary of the calculations and assumptions used in calculating minimization and mitigation credits, including those for quantitative and qualitative measures. She explained that the use of location adjustment factors was intended to be an example of a methodology for MassDEP to consider. The use of location adjustment factors is still under discussion and will be a MassDEP policy decision. Rebecca also gave a brief explanation of Appendix E and how it is used to quantify qualitative options.

Guilford expressed concerns over municipal enterprise funds. By state law Amherst can only have four enterprise funds and it cannot use money from one program to fund another program's efforts. For example, he was concerned about spending wastewater funds to implement an I/I reduction program to obtain SWMI credits for water supply withdrawal. Rebecca and MassDEP explained that the intent of SWMI is not to force communities to implement every option but to select options that work for them. Many communities already have I/I programs in place and MassDEP wanted to provide credit for those programs under the SWMI Framework. If that option does not work for Amherst or presents other conflicts, then Amherst does not need to consider it further.

Lyons asked if the baseline calculation will be a moving three-year average, changing as time goes by and as population changes. Duane said the baseline will stay as the 2005 withdrawals or the average from 2003 and 2005, with an additional 5% or 8%. Duane explained the percent increases were a policy decision to provide PWSs with some additional water buffer. The timeframe will remain the same because it corresponds with the USGS modeling effort and development of the Flow Level maps. The baseline would only likely change when the model is updated to reflect a more recent period. Lyons explained that those

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years were not typical for Amherst. UMass went through a big water conservation effort during this time period. He then asked if Amherst would get credit for efforts going back to 2003. Duane explained that all past conservation efforts help to keep the water consumption down, extending the time period before Amherst has to ask for more water above its baseline. This saves Amherst from having to mitigate sooner. Duane restated the baseline years will not change, however the percentages could change.

Amy expressed concerns about the watershed groups wanting the baseline to be as low as possible. Lyons stated that UMass is planning to increase its residential water users on campus, and explained that the population increase and associated increases in water demand are not in control of the Town. Duane said DCR would take that information into account in its demand projections. The water needs forecast would take into account any planned growth from UMass Amherst. Guilford pointed out that the Amherst Town Manager eliminated step rates because UMass Amherst said it was paying too much for water. As a result, water rates in town had to increase. Todd said this is an issue for state staff to discuss. Amy said water districts in the state would have a similar situation because they have less control over what the Town does.

Rebecca returned to the presentation and the overview of Amherst's pilot conditions which included an "ask" of 4.55 mgd. Amherst's baseline is 3.91 mgd; therefore, 0.64 mgd is the amount above baseline that Amherst would have to mitigate. This places Amherst in a Tier 3 permit review, which would require Amherst to comply with Standard Conditions 1-8; minimize existing impacts to the greatest extent feasible (considering cost, level of improvement and implementability); demonstrate no feasible alternative source that is less environmentally harmful; and mitigate commensurate with impact.

Rebecca explained that the Phase 1 report created a menu of options for minimization and mitigation and she then walked through an example calculation of a mitigation offset credit using the distribution of low flow shower heads.

Rebecca stated that each PWS will have to weigh the benefits and costs of conducting a site-specific study versus staying within SWMI. Rebecca asked Amherst what information, other than cost, they would need in order to make that decision sometime in the future.

Amy asked if the spreadsheets used in the Phase 1 report would be made available to PWSs in order to plan for and track their mitigation efforts. She thought it was a useful tool for PWSs as it contained all of the assumptions within so that PWSs did not have to look up various factors individually. Rebecca said it was the team's intent to develop this as a useable tool for MassDEP and PWSs, however the final decisions on how mitigation credits will be implemented have not been made yet. Tom said a PWS or town will have the flexibility to use their own assumptions and refine the calculations for its own conditions. Duane clarified that the Phase 1 report was done under the assumption of quantifying everything; however, this may not be the path that MassDEP follows. Quantifying everything may be difficult to implement and labor-intensive.

Guilford pointed out that it is labor intensive to track everything. For example, MassDEP required PWSs, including Amherst, to inventory every municipal building for water conservation devices to document which buildings had been retrofitted with these devices. It took Amherst eight weeks to complete. He is worried that they will be required to track everything under SWMI, and there has been no mention about the administrative costs related to such a requirement. Duane restated that a PWS will only need to track mitigation once its withdrawals go over its baseline. Jim agreed that if a requirement is written into a permit, for example to give out 1000 showerheads, he would expect to have to verify that 1000 showerheads have been given out.

Linda requested additional information from the consultant team on the credits for the dam removal.

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Lyons asked if SWMI is truly going to happen. Duane stated that it is on track to happen. This pilot is being conducted to inform the development of regulations. The regulations will involve a public process. The pilot will test and tweak the implementation and the assumptions to be used. The results and final policy decisions will factor into the final regulations.

Guilford expressed his concern that SWMI only addresses one thing that affects streamflow and fish - groundwater withdrawals. He said he feels that this was done because it is easier; however he has many concerns regarding water quality and the cost of implementation as well as the need to increase rates.

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SWMI Pilot Project Phase 2
Amherst Site-Specific Study Meeting #2
Friday, December 14, 2012
9:00am – 11:00am
Concord Room, MassDEP Central Regional Office, Worcester MA

AGENDA

1. Site-Specific Study Options
    a. Review Approaches
    b. Review Identified Options for Amherst

2. Discuss Amherst's Questions Regarding Site-Specific Studies

General Questions Regarding Site Specific Studies:

1. What happens to the information after the site specific study is concluded?
2. If the site specific study refutes the model's prediction, what will be the process for revising the biologic and/or flow categories on the maps?
3. Is there any consideration for there being no impact as a result of a confined aquifer? Why is the default an impact if there is no evidence (real) of an impact?
4. Is the SYE (used to determine unimpacted flows and the impacts of withdrawals) applicable in a sub-basin with a confined aquifer? (USGS should answer that question) If SYE is not applicable there may be a case to exempt the sub-basin from SWMI just as Cape Cod and coastal areas are exempt because SYE does not work in their circumstances.
5. If SYE is applicable then the STRMDEPL function should be applied as SYE notes that distance from a well to an impacted stream does matter. In this case the nearest well to the outlet of SB14056 is nearly 2.4 miles. The SYE report includes a chart showing that a well with a low diffusivity, 1,000 feet from a stream has an impact on the stream that is 75% of the withdrawal. For Amherst the nearest well is over 12,000 feet to the stream.

Questions RegardingAmherst Site Specific Study Options – Track 1:

1. How will the 'impacts of ground water withdrawal' be represented in the downstream subbasin?
2. How will the time-delay of the impacts on that aquifer be addressed?
3. How will the location of the impacts be evaluated? Will all withdrawals in the Lawrence Swamp aquifer be assessed at the exact pinchpoint of the confining layer?
4. How will this be addressed, globally, for similar situations?

Questions Regarding Amherst Site Specific Study Options – Track2:

1. If option 2 'assumes all impacts of groundwater withdrawal are expressed downstream of the confining unit', then how is this different than option 1?
2. What is done if some of the data needs aren't available?
3. Will the upstream and downstream be evaluated for all criteria – so that we have a baseline for our affects?
4. If Amherst doesn't have a SYE for unimpacted flow, how is this number determined? (I don't know if we have this yet).
5. What data does the habitat assessment, Habitat Suitability Index curve development, or PHABSIM require to develop and have a useful outcome?
6. Why not conduct actual fish counts rather than using modeling to determine impacts?
7. What is the cost of a study such as this, and what time/effort is required of the Town?
8. How would changes in our withdrawal be quantified for impacts i.e. how do we determine that our impacts are the cause of alteration?
9. Shouldn't there be other options aside from conservation measures or other mitigation for sample outcomes…what about exemption from these things if actual conditions are better than the model predicts?
10. Why is surface water brought in as a factor to evaluate. SWMI, as a whole, took a pass on surface water since the SWMI science is strictly groundwater based. It seems punitive to include surface water impacts for a site specific study when it is not considered anywhere else.
11. Why are they talking about more fish modeling? If fluvial fish abundance is the SWMI indicator of stream health it would seem the most direct and simplest (least costly) approach would be to do stream sampling at the appropriate time of year over a representative cross section of the sub-basin to determine existing conditions. Knowing what is actually present (versus modeled) would be a good starting point for decisions on what, if any, mitigation is needed.

SWMI Pilot Project Phase 2
Amherst Site-Specific Study Meeting #2
Friday, December 14, 2012
9:00am – 11:00am
Concord Room, MassDEP Central Regional Office, Worcester MA

Sign-In Sheet

1.	Jessica Cajigas	CEI	jcajigas@ceiengineers.com
2.	Richard Friend	DEP	richard.friend@state.ma.us
3.	Linda Hutchins	DCR	linda.hutchins@state.ma.us
4.	Jennifer Pederson	MWWA	Mwwa@verizon.net
5.	Amy Rusiecki	Amherst	rusieckia@amherstma.gov
6.	Guilford Mooring	Amherst	mooringg@amherstma.gov
7.	Duane LeVangie	Mass DEP	duane.levangie@state.ma.us
8.	Eileen Pannetier	CEI	epannetier@ceiengineers.com
9.	Philip Guerin	MWWA	guerinp@worcesterma.gov
10.	Laila Parker	DFG-DER	laila.parker@state.ma.us
11.	Todd Richards	NDFW	Todd.Richards@state.ma.us
12.			
13.			
14.			
15.			

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ATTENDEES:	Town of Amherst DPW: Guilford Mooring, Amy Lane Rusiecki, Mass Water Works Association: Jennifer Pederson and Philip Guerin MassDEP: Richard Friend and Duane LeVangie MassDCR: Linda Hutchins MassDFW: Todd Richards MassDER: Laila Parker CEI: Eileen Pannetier and Jessica Cajigas
FROM:	Jessica Cajigas
SUBJECT:	SWMI Pilot Project Phase 2 – Amherst Site-Specific Study Meeting #2
JOB NUMBER:	282-4
MEETING DATE:	December 14, 2012, 9:00am, MassDEP Worcester

Review of Site Specific Study Options

Duane LeVangie reviewed the two Tracks a public water supplier (PWS) could follow if it chooses to do a site-specific study. Duane also reviewed the options within each Track that could apply to Amherst Water Division.

Track 1. Within Track 1 (staying within the SWMI Framework using GWL, BC, and permitting tiers) one option is to review a PWS's actual 2000-2004 pumping records and compare the data to the estimated data that was used in the USGS model. The Pilot Team is checking these for each of the four pilot communities, including Amherst. Another option for Amherst is to account for lag time corrections for August flow alteration due to the confined aquifer. Amy stated that she understood spatially moving the subbasin of impact downstream, but she does not fully understand how time is factored in. How can it be determined when the impacts of pumping will be felt in a subbasin? Linda said this would be addressed later in the discussion.

For Track 1 site-specific evaluations, mitigation will still be required but it could be reduced or the geographic area eligible for 100% credit could expand. This could be the case for Amherst because moving the subbasin of impact will allow additional areas in Town to receive 100% mitigation credit based on the draft location adjustment factors.

Track 2. Track 2 site-specific evaluations include different methodologies to quantify actual streamflow and actual impacts from withdrawals. IFIM, wetted perimeter and MesoHABSIM approaches are some of the potential methodologies. Mitigation based on Track 2 studies could include outdoor watering restrictions tied to a local streamflow trigger on the Fort River and/or habitat improvements that could result in increased streamflow and reduced number of days where streamflow triggers are tripped. For Amherst there is a USGS gage in Northampton that would be the default location monitored for streamflow triggers in the Water Management Act permit. The alternative to use the actual flow needs for fluvial fish in the Fort River would be a more specific target for Amherst, even if there is a time lag between their pumping and the impacts occurring downstream. Habitat improvement mitigation measures could be beneficial for Amherst to look into.

Jen Pederson asked if there is an "out" for mitigation requirements if no impact is determined. Linda said there will always be an impact from withdrawals, they may be minor but there will always be some mitigation required for an increased withdrawal above baseline.

Phil Guerin said water from a confined aquifer may never contribute to streamflow. Linda and Richard said that existing data supports that the confined aquifer discharges to Fort River. Although it may not affect flow in Hop Brook adjacent to the wells, it does eventually contribute to streamflow in the Fort River.

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Linda said if he or Amherst is suggesting the confined aquifer discharges to the Connecticut River, EEA would ask Amherst to conduct a study and prove that. But based on the geologic data they have, EEA has assumed that the confined aquifer discharges at the Fort River. (Hadley's wells downstream on the Fort River are in unconfined conditions.)

Jen again asked if there is an "off-ramp" from the Framework. If a PWS does a Track 2 site-specific study option, then it is working outside of the USGS modeled August flows and impacts. The study will provide information on specific conditions (streamflow and impacts) and the PWS will have its mitigation based on those impacts. A PWS will be not be outside of the SWMI Framework if it does a site specific study. Linda said it may not be worth it for Amherst to do a Track 2 site-specific study option. Jen said their concerns are how it applies to all PWSs. Will there be a scope and a process for site-specific studies for everyone?

Todd and Linda both said the type of study and scopes of work for different studies would be dependent on specific conditions. The Framework and Phase 2 Report can't describe every potential situation. The Phase 2 pilot community site-specific studies include a confined aquifer situation (Amherst) and a withdrawal near a large surface water impoundment (Shrewsbury). During the permitting process a consultation session would be set up between the PWS and EEA agencies. If a PWS does not like the results of a site-specific study, it can go back to the USGS model and mitigation based on alteration of estimated August median flows. Jen said SWMI is no more predictable than before. Duane said the Pilots will inform the site-specific study options and costs of different options and the first few permits will be very helpful and informative. Linda said the Pilots have already been very helpful for bringing certain conditions to EEA's attention. For example, both Amherst and Shrewsbury have USGS gage data to help evaluate historical flows and compare to the SYE results.

Amherst's Questions Regarding Site-Specific Studies

The discussion moved to Amherst's submitted questions regarding site-specific studies. EEA will not redo the biological category (BC) or groundwater withdrawal level (GWL) maps based on a PWS's site-specific study data. The maps are based on 2000-2004 data, unless there are errors in that data those maps will not change. However, DEP will do a "findings of fact" and maybe over time will make modifications or eventual map updates. A site-specific study will just assess a PWS's actual impacts and mitigation requirements. Mitigation is only for the additional ask above baseline and not on historical pumping.

Use of the color red on the GWL maps is a public perception problem. Amherst stated that environmental groups are using the maps to say they do not want any more impervious cover in a "red area." Jen agrees with the public perception issue. Phil said it's just a new version of the stressed basins map.

Todd said these issues should be brought to EEA. Duane said it's a policy issue that has not been discussed yet. EEA could discuss a process where a PWS petitions EEA to review specific information and consider changes to the maps. Linda said if that were to happen, then environmental/watershed groups would be afforded the same opportunity.

Richard said basically every municipality with wells is in a GWL 4 or 5. Amy said if a PWS is going to put the money in to a study, they will want the results acknowledged somehow. Duane said it would be reflected in the permit but not necessarily in the maps. Richard said if the maps the maps were changed, they are no longer based on the model. There would be a ripple effect causing changes to everyone and every subbasin downstream. It was suggested to possibly hatch the color on the GWL map to represent a subbasin for which a site-specific study has been conducted or is in progress.

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Jen asked if most PWSs are aware of their own unique situations, such as having information that they are in a confined aquifer? Phil and Richard both said yes, they would know through drilling and pumping test information. There are not many confined aquifers in the state and the PWS would be aware of it.

Amy had asked if the SYE was applicable in a subbasin with a confined aquifer, and if not, would it be exempt from SWMI like Cape Cod is. Linda answered that the SYE is applicable but not very accurate in a confined aquifer subbasin. In Amherst's situation, the SYE would be more accurate in the downstream subbasin. Linda also said that no one is exempt from SWMI. The Cape and other areas with extensive sand and gravel glacial aquifers will have different approaches that may not be a streamflow approach. Jen said this will be an issue for the Cape because they have studies that show they have plenty of water to support their needs. Linda says that is why their approach will have to be different.

Guilford thinks there should be more time for the SWMI Framework to incorporate all of the exceptions that would warrant a site-specific study. Duane said it is not possible to say everything is site-specific and therefore no rules apply. There's a need for a Framework that can apply to all PWSs. If a PWS wants more water it can assess its impacts and then mitigate. The regulations will have general rules for site-specific studies if a PWS wants a different option. EEA is familiar with the Cape's issues and even on the Cape most of those PWSs will want their own site-specific rules as well. Linda said there are USGS groundwater models and EEA may use those in a USGS study on the Cape and Plymouth–Carver Aquifer to help with the new rules that will be needed within the SWMI Framework for these areas.

Amy had asked if StreamDeplete model could be applied in Amherst. Linda doesn't think it would in this situation and said Amherst would need a groundwater model to determine the lag time due to the confined aquifer. A groundwater model exists from Geraghty and Miller however it is quite old and would probably need to be recreated to be compatible with current computer operating systems. A groundwater model could cost around $50,000, but again, it is up to Amherst to decide if they want to pursue this as a site-specific study option. Amherst would not be required to do this. A groundwater model may only get Amherst a slightly lower August flow impact. They could just go with the Track 1 option presented where EEA agrees based on existing data that the confined aquifer discharges to Fort River. Additional study may not be worth the money. Richard explained that due to the confined aquifer, the downstream impact in Fort River would be very attenuated and the pumping differences from one month to the next may not be very visible (if 1 mgd pumped now, you would not see a corresponding 1 mgd drop in groundwater level or streamflow, but a gradual 1 mgd drop over time that may not be very visible.)

Guilford said due to their very deep water supply, groundwater model will not balance for them. A UMass professor in the hydrology department has tried and could not balance the model. Linda again suggests using the existing USGS gage data from the Fort River instead of modeling because the gage data reflects exactly what is in the river. Linda said the actual data can be used to calculate the actual August median flow and compare it to the SYE unimpacted flows and to Amherst's pumping records. A new percent alteration of August streamflow would be determined and a new GWL could be assigned. Alternatively, Amherst could assess flow needs for aquatic habitat under Option 2 and compare those to the actual historic data to assess impacts of their withdrawals. Mitigation for increased pumping above baseline would then be related to that.

Amy asked about Belchertown's Wells. How can the impacts from Amherst, Belchertown, and residential wells in Pelham be assessed? Linda said the model takes into account all upstream groundwater withdrawals. Based on the USGS study, Amherst contributes about 94% of the alteration to streamflow. Amherst would only have to mitigate its own impacts.

Phil asked where the USGS gage was located. It was located just downstream of the confluence of Hop Brook and Fort River. It contains data from 1966 to 1996. Jen asked if it would make sense to just renew the gage and redevelop the curve. Costs for the USGS to operate the gage would be about $18,000 to install

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and $18,000 to maintain it each year; however, Amherst could operate the gage at a lower cost with DER's assistance.

Jen asked if there will be a list of data acceptable to DEP for site-specific studies. She said PWSs need general guidelines of what DEP would want. The guidance document that will be drafted to accompany the regulations could contain such information. Jen said they do not want the default for a site-specific study to be IFIM. Todd said that it is not. EEA would also accept any of the Track 1 options (the "sharpening of the pencil" options) and the options that use existing data. IFIM is only one option for use in Track 2. Linda outlined the data requirements for an IFIM study, and how the data is analyzed to determine the amount of aquatic habitat available for target fish species at different flows. Todd said for IFIM, there's the model part but there's also the public participation and negotiation part that could add signification time and expense.

Linda said a wetted-perimeter study is also an option under Track 2. This is a cross-section analysis that can be used as a basis for streamflow triggers. The agencies will want a conservative application of the simplistic wetted perimeter method over the IFIM results. Wetted-perimeter uses riffle sites because they are most likely to dry out first. Transects of the streambed would be set up and measurements taken of the shape of the streambed at a couple of sites. If the entire base of the streambed is wetted, it is considered protective of aquatic habitat. The analysis includes determining streamflow at those levels where the streambed is wetted. Mitigation based on a wetted-perimeter analysis would include requirements for maintaining those identified streamflows. A threshold stream gage would be needed to monitor for these more localized streamflow triggers. Amherst could use the existing USGS gage data from the Fort River to estimate how often it would hit the new streamflow triggers and review/revise mitigation based on that information. Amherst does not currently implement outdoor watering restrictions. They just call the largest users and ask them to cut back when needed.

Eileen said very few PWSs will find it cost-effective to do a site-specific study unless they have existing groundwater models such as from a pump test. Linda felt that most systems will be able to use StreamDeplete for an Option 1 site-specific study and that the Wetted-Perimeter method is not costly. Duane said the Pilots will help determine costs of implementing and complying with the Framework. He then described the approach that EEA is drafting for the implementation of mitigation under SWMI. Full mitigation of the ask above baseline will start with demand management activities, then direct mitigation measures, then finally indirect mitigation measures. EEA proposes that demand management should happen first and will be monitored over time. Direct or quantifiable mitigation measures would be identified next, including wastewater returns, NPDES returns and stormwater retrofits/redevelopment with location adjustment factors applied. Indirect, non-quantifiable, mitigation measures would be the final options identified. Indirect measures will be credited based on a new scoring credit system and include habitat improvement measures, stormwater bylaws, etc. All mitigation efforts will be monitored at the five-year permit review. Demand management effectiveness will be evaluated and mitigation for the next five-year period will be reassessed.

Phil asked when a PWS can opt to conduct a site-specific study. Duane said at any time but typically it should be considered during the permit renewal process or at a 5-year review. Phil said site-specific studies will be costly. How can PWSs decide to do one when they do not know the benefits or the required mitigation yet? Phil said they need a sense of what mitigation would need to be done and what the costs will be over time.

Duane said Amherst and Shrewsbury both have mock "asks" above baseline that are very high. They typically expect to see smaller asks (0.2–0.5 mgd) and less mitigation required. Guilford pointed out that the baseline is actually taking away from their current permitted volume and requiring mitigation for volumes they already can take. Jen said the "ask" over the new baseline is a new concept for everyone even PWSs. Duane said Amherst's demands have gone down. Guilford explained that the reduced demands are due to UMass. Amherst used to have a stepped rate and UMass was a large percentage of revenues. When

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the state cut funds to UMass, UMass started a conservation program. Demands went down, but then UMass also got the Town to revoke the stepped rate. Now demands and revenues have declined. Duane said Amherst's baseline is still above their current demands and their ask should be reviewed based on this data. Richard said there are many PWSs that will have no ask above their baseline.

Linda said demand management from outdoor watering restrictions in the Phase 1 Pilot Project Report shows a very high potential for mitigation credits. Amy pointed out that the estimated savings need to be recalculated to reflect a more appropriate estimate of number of households in Town. Linda said in mitigation credits could be acquired through I/I removal, dam removal, and additional demand management measures.

Richard said UMass wants to increase reuse of water. Gilford said it is only used in boilers right now. If they can get classified as a "Class A Water." UMass can used it for chillers and for athletic fields.

Jen said she wants to hear about what fisheries information would be needed for a site-specific study, and Amy said she wants information on the options, such as wetted-perimeter , IFIM, etc., included in the Phase 2 report. Todd reviewed the data and steps for IFIM. Data would be collected to describe the habitats present in the stream and the streamflow needed to maintain those habitats. MesoHABSIM is a type of model that requires sampling of specific riffles, runs, etc. Jen asked about targeted species. Todd said that the Department of Fish and Wildlife has sampled for fish and based on this existing data these are the fish species that ought to be there. If there is no existing data, Todd said a PWS would have to sample if they are doing a site-specific study that requires the data. Todd continued to explain that IFIM models will identify flow requirements that will meet those targeted species habitat needs.

Phil asked why you wouldn't just sample the fish? Jen thought the goal of SWMI was to improve fluvial fish abundance/improve conditions. Guilford said counting the fish should matter, and after a PWS goes through all this and spends money on mitigation, they should expect to see more fish. Otherwise, a PWS will have no way to prove their efforts had any benefit, and they will have nothing to show their rate-payers that the expense was worth it.

Todd said the DFW does count fish and will continue to do so; however, EEA made a tool (the SWMI Framework) to be applied state wide. The Framework is not intended to return streams to pre-colonial conditions. The Framework will help to maintain existing conditions, minimize the impacts of existing withdrawals, and prevent further impacts by mitigating additional withdrawals. Todd stated the USGS model identified a significant relationship between impervious cover, groundwater withdrawals and fluvial fish abundance, but it is not a predictor of fish counts. Linda added that other departments and agencies are working on impervious cover and water quality issues that may not be directly addressed through SWMI. Phil asked how many fish counts have been done on the Fort River? Todd did not know but said they are not frequent enough to predict fish counts.

Jen reiterated her earlier point that PWSs will need more information to help them determine when to go through the site specific study process.

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Appendix K –

Shrewsbury Site-Specific Study Meeting – Draft Summary Notes

SWMI Pilot Project Phase 2
Shrewsbury Site-Specific Study Meeting
Tuesday, November 13, 2012
10:00am – 12:00pm
Town Hall, 100 Maple Avenue, Shrewsbury, MA

AGENDA

1. Site-Specific Study
    a. Purpose
    b. Options – Within Tiers Table SWMI Framework
        i. Flow Level Evaluation
        ii. Review Model Inputs
        iii. Mitigation
    c. Options – Outside of Tiers Table SWMI Framework
        i. Flow Assessment
        ii. Habitat Assessment
        iii. Mitigation
2. Feedback
    a. Other ideas or data to consider?
    b. Are there any options Shrewsbury would be interested in pursuing?

SWMI Pilot Project Phase 2
Shrewsbury Site Specific Study Meeting
Tuesday, November 13, 2012
10:00am – 12:00pm
Town Hall, 100 Maple Avenue, Shrewsbury, MA

Sign-In Sheet

1.	Jessica Cajigas	CEI
2.	Eileen Pannetier	CEI
3.	Linda Hutchins	DCR
4.	Richard Friend	DEP
5.	Todd Richards	MDFW
6.	Duane LeVangie	MassDEP
7.	Barbara Kickham	MassDEP
8.	Paul Howard	Tata & Howard
9.	TOM LAMONTE	MASSDEP
10.	Justine Evans	Tata + Howard
11.	JACK PERRAULT	SHREWSBURY
12.	Bob TUZESKI	Shrewsbury
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MEETING MEMO

ATTENDEES:	Town of Shrewsbury: Jack Perreault and Bob Tozeski Tata & Howard: Paul Howard and Justine Evans MassDEP Boston: Richard Friend, Duane LeVangie and Tom Lamonte MassDEP CERO: Barbara Kickham MassDCR: Linda Hutchins MassDFW: Todd Richards CEI: Eileen Pannetier and Jessica Cajigas
FROM:	Jessica Cajigas
SUBJECT:	SWMI Pilot Project Phase 2 – Site-Specific Study Meeting
JOB NUMBER:	282-4
MEETING DATE:	November 13, 2012, 10:00am, Shrewsbury Town Hall

Site-Specific Study Options
Linda Hutchins discussed the two options for site-specific study. Option 1 is to stay within the SWMI Model but "sharpen the SWMI pencil" using a public water supplier's (PWS's) actual data compared with the data used in the USGS model. This option would still use the flow levels (FLs) and biological categories (BCs) in SWMI but could change them for a PWS's subbasin as needed based on results. Examples for Shrewsbury may include: 1) use Shrewsbury's actual average monthly withdrawals in place of the SWMI average withdrawals which were based on a traditional water demand curve; 2) consider specific subbasin characteristics, like the presence of the lake, that were not accounted for in the SWMI model.

Option 2 would be outside of the SWMI Model, assessing environmental impacts in a more site-specific manner than the statewide model. For Shrewsbury, an appropriate scope of work would include evaluating the true impacts of Shrewsbury's withdrawals on the outlet of Lake Quinsigamond by examining USGS stream gage data collected on the Quinsigamond River downstream of the impoundments and comparing this to SYE estimated unimpacted streamflows at this location.

Poor Farm Brook
Streamflow impacts at Poor Farm Brook between City Farm Pond and the Shrewsbury wells have to be addressed. This is an outstanding issue on impact to a nearby water body that had been raised prior to the SWMI process. This reach of the brook has been observed to go dry in the past. The area has been mined for gravel, and the brook channel was likely altered and straightened during development of the surrounding industrial park. Shrewsbury needs to determine whether the Home Farm Wells are impacting streamflow, or if this is a naturally losing reach. Shrewsbury reported that during 2009 and 2010 they collected water level data using transducers and data loggers in two observation wells, plus manual water level measurements were made at other observation points during pumping and non-pumping periods. Bob Tozeski said the pond and brook run dry before it gets to the wells. This could be caused in part by upstream withdrawals from the Worcester Country Club. Paul Howard also said there is a dam and impoundment at the country club.

Linda said the main question to be answered is what role the Home Farm Wells play in the reduction of streamflow in the brook. There is a need to define the hydraulic connection between the wells to the brook. Linda showed USGS topographic maps from 1960 and 1974 which show a change over time to the channel. It is possible that the channel could have been artificially straightened and may have been dug too shallow to intercept the water table and remain saturated with streamflow. Linda said possible mitigation could include the removal of the Poor Farm Dam and/or stream channel restoration. Todd Richards said that because it is a fairly large dam, removing it will have an immediate effect on streamflow.

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Bob said between 2009 and 2010, data was collected from Poor Farm Brook between the pond and the lake. Monitoring included data loggers, staff gauges, monitoring wells, and piezometers. Monitoring was conducted under both pumping and non-pumping conditions. Barbara Kickham has copies of the data. DEP has requested an analysis of the data, due in February 2013. Linda said that this data and additional information from existing pump test results could be used in a site-specific study. This data could help determine the cone of influence for the wells and whether it reaches the brook. If the wells are impacting the brook, a full site-specific study that evaluates specific flow and habitat needs for targeted fish species would be required. If the wells have no impact on the brook, no additional action may be required for Poor Farm Brook; however, if Shrewsbury needed more mitigation under SWMI, it could still do the dam removal and/or the channel restoration. Shrewsbury does not own the dam or the land in this area and expressed this as a limitation for them in terms of mitigation.

Linda said Shrewsbury could contribute to a restoration fund with the Department of Ecological Restoration (DER) to do the work (dam removal or stream restoration) rather than Shrewsbury contracting the work out themselves. DER has been interested in this dam removal for a long time. Todd said it would cost more to fix the dam than to take it down and that DER has grant programs that may help. DER would probably look favorably on a partnership between Shrewsbury and Worcester to remove the dam.

Shrewsbury requested information on existing grant programs to help them fund mitigation such as the dam removal. The new SWMI Grant might work for it as well. While the timing of this year's grant could be too soon for permitting and removal, the grant could be used for initial planning and design purposes. The SWMI Grant program is expected to be a five-year program, so there may be future opportunities to apply for this grant.

"Within SWMI Model" Option

Linda returned to the presentation and the "within SWMI" options. The SWMI model used estimated data and used a lot of simplifying assumptions. It used a standardized withdrawal curve across the state. Shrewsbury could look at their actual withdrawal data and possibly tweak their FL based on actual August withdrawals. Modeling would be necessary to evaluate the effect of well withdrawals at the pour point of the subbasin; this would improve the assessment of August flow alteration, as the SWMI model did not account for the storage of Lake Quinsigamond and the underlying aquifer, and the seasonal management of the lake's water level.

"Outside SWMI Model" Option

Linda discussed the "outside SWMI" options, which she recommends over the "within SWMI" options for Shrewsbury. For this option, Shrewsbury could assess the impacts at the outlet of Lake Quinsigamond by comparing actual flows, as measured from a USGS gage, to the Sustainable Yield Estimator's (SYE's) un-impacted flows. The lake outlet flows to Irish Dam, then to Hovey Pond, and then to the Quinsigamond River. There is a USGS gage here on the river in North Grafton. There is a lot of data available that could help characterize the outflow of Lake Quinsigamond.

The drawdown of Lake Quinsigamond occurs at Irish Dam, but they have only been done as permitted for a few years now. Barbara said it would be good to know what Hovey Pond Dam is used for.

Linda said comparing the actual gage data to the estimated natural flow from the SYE will allow Shrewsbury to assess its actual impacts. Mitigation can then be tailored to be commensurate with those actual impacts. Preliminary review of the gage data shows monthly median streamflows near the estimated unimpacted flow values. Additional work would be needed to evaluate the impacts of pumping during low-flow and drought periods and how additional withdrawals from the Home Farm Wells would affect these

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downstream flows. Studies "Outside of the SWMI Model" can help determine the specific impacts to streamflow and mitigation requirements can be assessed to localized conditions.

General Discussion

Linda said in Option 1 (within SWMI), evaluations of their actual flows and actual impacts could allow them to reevaluate their flow level, since SWMI is based on August median flows. A change in FL could eliminate the requirement for mitigation. (However, if you get to a FL3, you would have to stay there to not require mitigation. But with Shrewsbury's requested withdrawal increase of 1.37 mgd, it is unlikely they'd stay a FL3 and would require mitigation anyway.)

Linda said in Option 2 (outside SWMI), evaluations of the actual river flows and actual pumping impacts could allow Shrewsbury to mitigate to actual impacts. This could include changing to outdoor watering restrictions based on a new streamflow trigger. Additional non-essential outdoor water use restrictions were discussed as potential mitigation during low flow conditions. Shrewsbury had tried implementing outdoor water use restrictions triggered by flow conditions at the Quinsigamond River Grafton gage, but changed to seasonal restrictions because of difficulties in implementing the trigger approach.

Paul asked who makes the decision of "within" or "outside SWMI." The decision to do a site-specific study would be made by the PWS. Whether to conduct a study using the "within SWMI" option or the "outside of SWMI" option, would also be decided by the PWS. A site-specific study is not required.

Bob said they have done a lot of monitoring and have spent a lot of money on Poor Farm Brook already. He would want to know how much more would be expected, including what new data would be required. Barbara has reviewed the existing data collected from two monitoring wells and piezometers located between the Home Farm Wells and Poor Farm Brook. She will share the information with DCR; however, she thought further study data would be required. Barbara also said Poor Farm Brook would be hard to model for several reasons including: the brook may be a naturally losing reach and it is in a very thick aquifer (one well is over 100 feet deep).

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