Cost-Effective Permit Renewal in a Shared Source Subbasin for Southwick and West Springfield

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Department of Environmental Protection

Submitted by:

Town of Southwick, MA

Town of West Springfield, MA

Abt Associates Inc.

Pioneer Valley Planning Commission

Executive Summary

The Southwick Department of Public Works (SDPW), West Springfield Department of Public Works (WSDPW), Abt Associates and Pioneer Valley Planning Commission (PVPC) (the Project Team) are pleased to submit this final report in satisfaction of the Water Management Act (WMA) Grant. The project's objectives were to assess the implications of the revised WMA regulations (the Regulations) on the planning, operations and management of the water resources of the Town of Southwick, Massachusetts (Southwick) and the Town of West Springfield, Massachusetts (West Springfield), and to identify cost-effective ways to meet human and environmental water needs. This final report summarizes the findings of our assessment. In addition, we implemented a water use survey in the towns to inform the development of a water conservation program which we also present in this report. Finally, we presented project results to the public for each town. For Southwick, we presented in a recorded, public meeting. For West Springfield, the presentation was recorded and later televised. Water conservation program materials and the public meeting presentation slides are provided as attachments to this report and are available on Abt Associates and PVPC websites.[1] Data presented in this report are from SDPW or WSDPW unless otherwise noted.

The Commonwealth of Massachusetts (the Commonwealth) promulgated revisions to the Water Management Act (WMA) regulations (the Regulations) in 2014 that seek to balance protecting the health of water bodies with meeting the needs of communities for water by implementing sustainable water management. The revisions include changes to the Massachusetts Department of Environmental Protection (MassDEP) process for reviewing and granting water withdrawal permits and actions required to minimize the existing impact of withdrawals and mitigate the impact of increases in withdrawals.

Both towns derive the majority of their water supply from the same source subbasin – the Great Brook subbasin or subbasin 19078 – located in Southwick. We provide a brief summary of each town's water supply and demand before reviewing applicable regulations and actions to meet those regulations. The Regulations applicable to Southwick and West Springfield have four primary elements:

1. Standard permit conditions: All permittees must meet three categories of standard conditions: 1) two performance standards – maximum of 65 residential gallons of water use per capita per day (RGPCD), and maximum of 10% unaccounted-for-water (UAW), 2) water conservation best management practices and 3) limits on non-essential, outdoor water use.

2. Coldwater Fish Resources (CFRs): CFRs are smaller tributary streams that contain the conditions for and/or have existing populations of coldwater fish. These streams play a key role in supporting the ecological health and hydrological function of watersheds. Permittees with withdrawals in subbasins with CFRs must consult the Commonwealth and evaluate reducing impacts through pumping optimization and use of existing, alternative sources.

3. Minimization of existing impacts: MassDEP has identified subbasin 19078 as August net groundwater depleted (ANGD), meaning that the net of groundwater withdrawals and groundwater returns are 25 percent or more of the subbasin unimpacted flow in the month of August. Permittees with sources in ANGD subbasins have to minimize "existing impacts to the greatest extent feasible." Minimization actions may include optimizing the operation of existing water supplies, using alternative sources including interconnections, additional conservation measures beyond the standard permit conditions, and water releases and returns.

[1] See www.abtassociates.com/wma and www.pvpc.org

4. Mitigation of withdrawals above "baseline": In 2014, MassDEP allocated "baseline withdrawals" to each permittee based on one of three methods outlined in the Regulations. Permittees requesting withdrawals above baseline in their permit renewal and new permit applications will have to mitigate the withdrawals above baseline "commensurate with impact" *prior* to those withdrawals. The WMA guidance specifies planning priorities (MassDEP, 2014). First, all feasible options for demand management must be implemented. If mitigation is still required, then direct mitigation should be prioritized over indirect actions. Direct mitigation is defined as actions whose impact can be volumetrically quantified while indirect actions are given credit on a points-based system.

Southwick

SDPW supplies approximately 72% of the town population with drinking water. During 2011-2015, residential use was the largest customer group at 71% of the total demand. On average, customers use 44% more water in the summer than in the winter. Southwick has two main sources of water supply: two wells in subbasin 19078 provide an average of 76 percent of the demand, and water purchased from Springfield Water and Sewer Commission (SWSC) provide the remainder. Exhibit 36 below summarizes actions available for SDPW to meet the Regulations.

1. Standard permit conditions require implementing nonessential outdoor water use restrictions. For Southwick this restriction is watering one day per week between 5pm and 9am. This restriction will support the goal to achieve the 65 RGPCD performance standard. However additional measures will be needed to meet 65 RGPCD including a water conservation program with customer education and rebates for water efficient fixtures and appliances. Based on the survey of Southwick water customers, we designed a rebate program and education materials to support the implementation of both the rebate program and the nonessential outdoor water use restrictions. We recommend implementing the rebate portion of the program as an on-going program with an annual maximum number of rebates to offset revenue losses over time through gradual changes in the Water Division budget and/or water sales to new customers.
2. and 3. CFR and minimization involve consultation with Department of Fish and Wildlife (DFW) and MassDEP, respectively, to determine the extent of actions necessary to meet those requirements. These two requirements are subbasin specific and the necessary actions may be cooperatively implemented with WSDPW. We used the Environmental Protection Agency's Watershed Management Optimization Support Tool (WMOST) to screen the cost-effectiveness of available options to meet various streamflow targets. The modeling results showed that demand management beyond the standard permit conditions[2] in combination with surface water releases are the most cost-effective option for meeting streamflow targets. The model estimated the maximum required water to store in order to meet targets. The maximum volume is within the current operating range of Congamond Lakes (i.e., does not flood shoreline septic systems and does not require lowering of weir). Therefore, we recommend a detailed, feasibility study to confirm the modeling assumptions and results.

   In case surface water releases are not feasible, we also ran the model without the water storage option to evaluate the next set of cost-effective actions. Along with additional water conservation, the solution was

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[2] WMOST is a cost minimization model and does not account for impacts to revenue from demand reduction when selecting cost-effective options. However, demand management is the highest priority action under the Regulation and should be considered before other actions. Therefore, we calculated the demand reductions available from a rebate program beyond the 65 RGPCD if the annual rebate program recommended under the standard permit conditions is kept in place over the 20-year lifetime. Smaller reductions under demand management included a 2% annual increase in water prices and additional reduction in UAW.

purchasing water from SWSC. The model found this more cost-effective than stormwater BMPs, aquifer storage and recovery and direct, nonpotable water reuse. Both surface water releases and SWSC are shown in the table below but one may be sufficient to meet CFR and minimization requirements.

4. Mitigation requirements are also outlined in Exhibit 36. Southwick's baseline is 0.69 MGD and the maximum permit renewal is 0.73 MGD. Southwick's recent demand (2011-2015) at 0.65 MGD is close to the baseline; therefore, we recommend submitting a mitigation plan for the maximum of 0.04 MGD. If volume beyond 0.73 MGD is needed in the future, SDPW must submit a new permit request. All volume under that permit will require mitigation. As such, we provide mitigation options beyond the 0.04 MGD requirement under the permit renewal. Similar to CFR and minimization, surface water releases may be used to meet mitigation requirements. In case surface releases are not available, purchasing SWSC water is still available but expensive. Therefore, we recommend starting to track existing projects that qualify for mitigation credits and including them in the mitigation plan unless surface releases are verified prior to plan submission. These actions may serve to reduce volume of water needing to be purchased from SWSC in case surface releases are infeasible or insufficient.

Exhibit 1: Potential Actions and Associated Reduction and Credits for Southwick

Requirement	Action	Demand Reduction/ Credit (MGD)
Standard permit conditions (Nonessential water use)	Outdoor water use restrictions	0.025 - 0.065
Standard permit conditions (65 RGPCD)	Water conservation program (rebate, education)	0.011 - 0.036
CFR/ minimization/ mitigation	Surface water releases from Middle Pond of Congamond Lakes	May meet some or all requirements; need feasibility study
CFR/ minimization/ mitigation	Purchase water from SWSC	No current limit; more expensive than surface water releases
Minimization (mitigation[3])	Continuance of water conservation program over entire, 20-year permit	0.014 - 0.056
Minimization/ mitigation	Infiltration-based stormwater practices	0.151 (additional expected under MS4 program)
Mitigation	Wastewater returns via septic	0.020[4] (50% of future withdrawals if customers are same percent septic)
Mitigation	Culvert replacement	up to 0.150
Mitigation	Stormwater bylaw	up to 0.100
Mitigation	Private well bylaw update	up to 0.100
Mitigation	Acquire and protect land in Zone I/II (under consideration)	up to 0.100
Total reduction/credit beyond surface releases and SWSC water		**~0.70-0.75[5]**

3 We estimated that water conservation options will be exhausted in meeting 65 RGPCD and minimization requirements; therefore, we do not anticipate additional availability meeting mitigation requirements.

4 Value based on assumption of mitigating 0.04 MGD and current septic percentage of SDPW customers.

5 The minimum and maximum values listed in the table reflect 5- and 20-year savings estimates. The individual minimum and maximum values do not necessarily sum to the total minimum and total maximum values because some savings estimates are dependent on each other. For example, the savings from meeting 65 RGPCD is smaller for the 20-year estimate because greater long-term savings are expected from outdoor use restrictions resulting in lower water savings requirements for meeting the 65 RGPCD.

In summary, SDPW should pursue the following actions:

- Continue with implementation of nonessential outdoor water use restrictions including private well bylaw;
- Initiate an annual rebate program with customer education;
- Conduct a feasibility study for surface water releases from Congamond Lakes in collaboration with WSDPW;
- Initiate tracking of projects that qualify for minimization and/or mitigation credits including working across departments to identify these projects (e.g., stormwater, culvert replacement and land acquisition) and acquire the necessary data to calculate the credit;
- Apply for an implementation grant to fund the rebate program and feasibility study under next year's WMA Program (request for proposals is expected in August or September 2016).

Additional actions will depend on consultations with DFW and MassDEP. These additional actions will mainly entail submitting minimization and mitigation plans based on the consultations and options outlined in this report.

West Springfield

WSDPW supplies approximately 99% of the town population with drinking water. Based on data for 2011-2015, the majority of West Springfield demand is residential users (55%) while commercial and industrial users account for 30% of the demand. WSDPW customers use approximately 30% more water in the summer than winter. On average, groundwater from subbasin 19078 provides 97% of West Springfield's water supply. During 2011-2014, WSDPW purchased the remaining 3% of West Springfield's water supply from SWSC, on average, because the 16" water transmission main connecting the groundwater wells to the town could not meet the demand. In 2014, WSDPW replaced the 16" main with a 24" main, and WSDPW no longer needs to purchase Springfield water to meet demand. Exhibit 2 below summarizes actions available for WSDPW to meet the Regulations.

1. Standard permit conditions require implementing nonessential outdoor water use restrictions. For West Springfield this restriction is watering one day per week between 5pm and 9am. This restriction will support the goal to achieve the 65 RGPCD performance standard. However, additional measures will be needed to meet 65 RGPCD including a water conservation program with customer education and rebates for water efficient fixtures and appliances. Based on the survey of West Springfield's water customers, we designed a rebate program and education materials to support the implementation of both the rebate program and the nonessential outdoor water use restrictions. We recommend implementing the rebate portion of the program as an on-going program with an annual maximum number of rebates to offset revenue losses over time through gradual changes in the Water Division budget and/or increased water sales to new customers. An aggressive UAW program is also needed to reduce UAW below 10%. This program may be designed based on the Functional Equivalence Plan described in the WMA Guidance (MassDEP 2014).

   We note that in designing the rebate program we compared West Springfield's water rates to the three cost thresholds defined by the WMA Guidance. West Springfield's rates did not come close to any of the thresholds while Southwick's rates exceeded one threshold. In addition, WSDPW's UAW will require significant investment in infrastructure renewal. Therefore, we recommend a water rate study to determine a rate that will cover the full cost of water provision including meeting the standard permit conditions.

2. and 3. <u>CFR and minimization</u> involve consultation with Department of Fish and Wildlife (DFW) and MassDEP, respectively, to determine the extent of actions necessary to meet those requirements. These two requirements are subbasin specific and the necessary actions may be cooperatively implemented with SDPW. We used WMOST to screen the cost-effectiveness of available options to meet various streamflow targets. The modeling results showed that demand management beyond the standard permit conditions[6] in combination with surface water releases are the most cost-effective option for meeting streamflow targets. The model estimated the maximum required water to store in order to meet targets. The maximum volume is within the current operating range of Congamond Lakes (i.e., does not flood shoreline septic systems and does not require lowering of weir). Therefore, we recommend a detailed, feasibility study to confirm the modeling assumptions and results.

   In case surface water releases are not feasible, we also ran the model without the water storage option to evaluate the next set of cost-effective actions. Along with additional water conservation, the solution was purchasing water from SWSC. The model found this more cost-effective than stormwater BMPs, aquifer storage and recovery and direct, nonpotable water reuse. Both surface water releases and SWSC are shown in the table below but one may be sufficient to meet CFR and minimization requirements.

4. <u>Mitigation</u> requirements are also outlined in Exhibit 2. West Springfield's baseline is 4.45 MGD and the maximum permit renewal is 6.45 MGD. West Springfield's recent demand (2011-2015) was approximately 3.71 MGD. WSDPW may submit a mitigation plan for up to 2.00 MGD. If volume beyond 6.45 MGD is needed in the future, WSDPW must submit a new permit request. All volume under that permit will require mitigation. Similar to CFR and minimization, surface water releases may be used to meet mitigation requirements. In case surface releases are not available, purchasing SWSC water is still available but expensive. Therefore, we recommend starting to track existing projects that qualify for mitigation credits and including these projects in the mitigation plan unless surface releases are verified prior to plan submission. These actions may serve to reduce the required, purchased volume from SWSC in case surface releases are infeasible or insufficient.

[6] WMOST is a cost minimization model and does not account for impacts to revenue from demand reduction when selecting cost-effective options. However, demand management is the highest priority action under the Regulation and should be considered before other actions. Therefore, we calculated the demand reductions available from a rebate program beyond the 65 RGPCD if the annual rebate program recommended under the standard permit conditions is kept in place over the 20-year lifetime. Smaller reductions under demand management included a 2% annual increase in water prices and additional reduction in UAW.

Exhibit 2: Potential Actions and Associated Reduction and Credits for West Springfield		
Requirement	**Action**	**Demand Reduction/ Credit (MGD)**
Standard permit conditions- Nonessential water use	Outdoor water use restrictions	0.080 - 0.210
Standard permit conditions - 65 RGPCD	Water conservation program (rebate, education)	0.125 - 0.196
Standard permit conditions - 10% UAW	Increase UAW investments or implement Functional Equivalence Plan	0.194
CFR/ minimization/ mitigation	Surface water releases from Middle Pond of Congamond Lakes	May meet some or all requirements; need feasibility study
CFR/ minimization/ mitigation	Purchase water from SWSC	No current limit; more expensive than surface water releases
Minimization (mitigation[7])	Continuance of water conservation program over entire, 20-year permit	0.052 - 0.210
Minimization/ mitigation	Infiltration-based stormwater practices	Requires additional data
Mitigation	Increased infiltration/inflow detection and repair, credit estimated as up to 50% of estimated I/I	0 MGD for subbasin 19078 Up to 0.216 MGD for subbasins 19078, 19076, 19074, 19090 and downstream
Mitigation	Private well bylaw update	up to 0.100
Mitigation	Stormwater bylaw	up to 0.100
Mitigation	Acquire and protect land in Zone I/II (under consideration)	up to 0.100
Total reduction/credit beyond surface releases and SWSC water		**~1.04 – 1.26[8]**

In summary, WSDPW should pursue the following actions:

- Implement nonessential outdoor water use restrictions including private well bylaw;
- Initiate an annual rebate program with customer education;
- Increase UAW efforts or implement MassDEP's functional equivalence plan;
- Conduct a rate study to determine water rates that will recover the full cost of water provision including the above measures;
- Coordinate with SDPW to conduct a feasibility study for surface water releases from Congamond Lakes in collaboration with SDPW;
- Initiate tracking of projects that qualify for minimization and/or mitigation credits including working across departments to identify such projects (e.g., stormwater, I/I and land acquisition) and acquire the data necessary to calculate the credit;

7 We estimated that water conservation options will be exhausted in meeting 65 RGPCD and minimization requirements; therefore, we do not anticipate additional availability meeting mitigation requirements.

8 The minimum and maximum values listed in the table reflect 5- and 20-year savings estimates. The individual minimum and maximum values do not necessarily sum to the total minimum and total maximum values because some savings estimates are dependent on each other. For example, the savings from meeting 65 RGPCD is smaller for the 20-year estimate because greater long-term savings are expected from outdoor use restrictions resulting in lower water savings requirements for meeting the 65 RGPCD.

- Apply for an implementation grant to fund the rebate program, feasibility study, and UAW efforts under next year's WMA Program (request for proposals is expected in August or September 2016).

Additional actions will depend on consultations with DFW and MassDEP. These actions will include submitting minimization and mitigation plans based on the consultations and options outlined in this report.

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Acknowledgements

The project team would like to thank the municipal staff from public works, engineering, conservation and planning and other departments who made this effort possible. They invested considerable effort to support the study and kindly shared knowledge of their systems, their data and the studies about the communities they serve. The core project team included Randy Brown and Dick Grannells from the Southwick Department of Public Works, Jeffrey Auer from West Springfield Department of Public Works, Viktoria Zoltay and Annie Brown from Abt Associates, and Patty Gambarini and Jaimye Bartak from the Pioneer Valley Planning Commission.

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List of Acronyms

ANGD	August Net Groundwater Depletion
BC	Biological Category
BMP	Best Management Practice

CFR	Coldwater Fish Resource
DFW	Massachusetts Department of Fish and Wildlife
GWC	Groundwater Category
HRU	Hydrologic Response Unit
HSPF	Hydrologic Simulation Program-Fortran
I/I	Infiltration/Inflow
MassDEP	Massachusetts Department of Environmental Protection
MG	Million Gallons
MGD	Million Gallons per Day
MWI	Massachusetts Water Indicators
NSE	Nash-Sutcliffe Efficiency
PVPC	Pioneer Valley Planning Commission
RGPCD	Residential Gallons per Capita per Day
SDPW	Southwick Department of Public Works
SWSC	Springfield Water and Sewer Commission
SYE	Massachusetts Sustainable Yield Estimator
UAW	Unaccounted-for-Water
USGS	United State Geological Survey
WMA	Water Management Act
WMOST	Watershed Management Optimization Support Tool
WSDPW	West Springfield Department of Public Works Water Division
WWPCP	Westfield Water Pollution Control Plant

1 Background

The Southwick Department of Public Works (SDPW), West Springfield Department of Public Works (WSDPW), Abt Associates and Pioneer Valley Planning Commission (PVPC) (the Project Team) are pleased to submit this final report in satisfaction of the Water Management Act (WMA) Grant. The project's objectives were to assess the implications of the revised WMA regulations (the Regulations) on the planning, operations and management of the water resources of the Town of Southwick, Massachusetts (Southwick) and the Town of West Springfield, Massachusetts (West Springfield), and to identify cost-effective ways to meet human and environmental water needs. This final report summarizes the findings of our assessment. In addition, we implemented a water use survey in the towns and developed a water conservation program with educational materials based on the survey results. Finally, we presented project results for each town. For Southwick, we presented in a recorded, public meeting. For West Springfield, the presentation was recorded and later televised. Water conservation program materials and the public meeting presentation slides are provided as attachments to this report and are available on Abt Associates and PVPC websites.[9] Data presented in this report are from SDPW or WSDPW unless otherwise noted.

1.1 Water Management Act

In 1986, the Commonwealth of Massachusetts (the Commonwealth) promulgated regulations under the WMA (the Regulations) to regulate withdrawals greater than 100,000 gallons per day. In 2014, the Commonwealth revised the Regulations to advance sustainable water management objectives by setting more explicit provisions to balance environmental protection and water needs of communities.[10] The revisions include changes to the Massachusetts Department of Environmental Protection (MassDEP) process for reviewing and granting water withdrawal permits and actions required to reduce the environmental impact of withdrawals. These changes will affect planning decisions by cities and towns on the most cost-effective ways to meet current and future water needs. The four primary categories of requirements are briefly summarized below.

5. <u>Standard permit conditions</u>: All permittees must meet standard permit conditions. There are three primary standard conditions: 1) two performance standards consisting of the maximum average residential per capita water use and maximum percent of unaccounted-for-water (UAW), 2) water conservation best management practices (BMPs) that include leak detection and repair, metering, and others, and 3) limits on non-essential, outdoor water use.

6. <u>Coldwater Fish Resources</u> (CFRs): The Regulations include specific protections for CFRs. These are the smaller tributary streams that contain the conditions for and/or have existing populations of coldwater fish, such as brook trout. These streams play a key role in supporting the ecological health and hydrological function of watersheds. Permittees with withdrawals in subbasins with CFRs must consult the Commonwealth and evaluate reducing impacts through pumping optimization and other means.

7. <u>Minimization of existing impacts</u>: MassDEP has identified subbasins that are August net groundwater depleted (ANGD) – where the net of groundwater withdrawals and groundwater returns are 25 percent or more of the subbasin unimpacted flow in the month of August. Permittees with sources in ANGD

9 See www.abtassociates.com/wma and www.pvpc.org

10 Water Management Act (MGL 21 G) Regulation (310 CMR 36.00), http://www.mass.gov/eea/agencies/massdep/water/regulations/310-cmr-36-00-the-water-management-act-regulations.html#2

subbasins have to minimize “existing impacts to the greatest extent feasible.” Minimization actions may include optimizing the operation of existing water supplies, using alternative sources including interconnections, additional conservation measures beyond the standard permit conditions, and water releases and returns.

8. Mitigation of withdrawals above “baseline”: In 2014, MassDEP allocated “baseline withdrawals” to each permittee based on one of three methods outlined in the revised WMA. Permittees requesting withdrawals above baseline in their permit renewal request will have to mitigate the additional withdrawals “commensurate with impact” and prior to those withdrawals. The WMA guidance specifies planning priorities (MassDEP, 2014). First, all feasible options for demand management must be implemented. If mitigation is still required, then direct mitigation should be prioritized over indirect actions. Direct mitigation is defined as actions whose impact can be volumetrically quantified while indirect actions are given credit on a points-based system. Finally, permittees may be asked to demonstrate that no feasible alternative sources exist if the additionally requested volume causes a change in the source subbasin’s Biological Category (BC) or Groundwater Impact Category (GWC).[11]

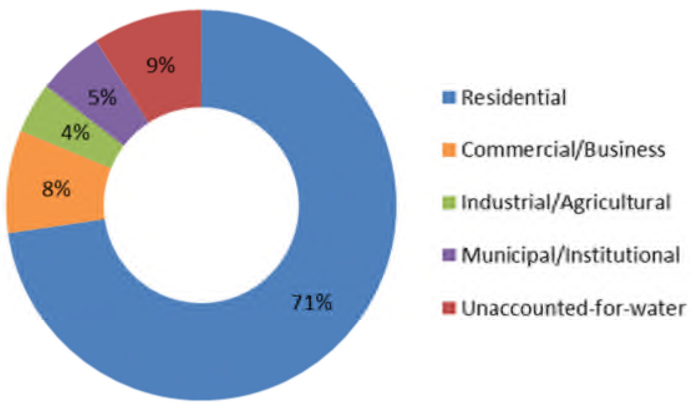
1.2 Town of Southwick and Its Water Supply

Southwick is mainly located in the Westfield Basin with minor areas in two other major basins (3.6% in the Connecticut Basin and 13% in the Farmington Basin). Land use in the town of Southwick is primarily residential with a population density of 300 people per square mile. Southwick had a population of 9,502 in 2010 with SDPW supplying the drinking water needs of 72% of the town population (U.S. Census 2010).

1.2.1 Southwick Demand

Based on the 2011-2015 period, residential users are SDPW’s largest customer group, accounting for 71% of the total water demand (Exhibit 3). The remaining demands, in decreasing order, are UAW, commercial, industrial and municipal.

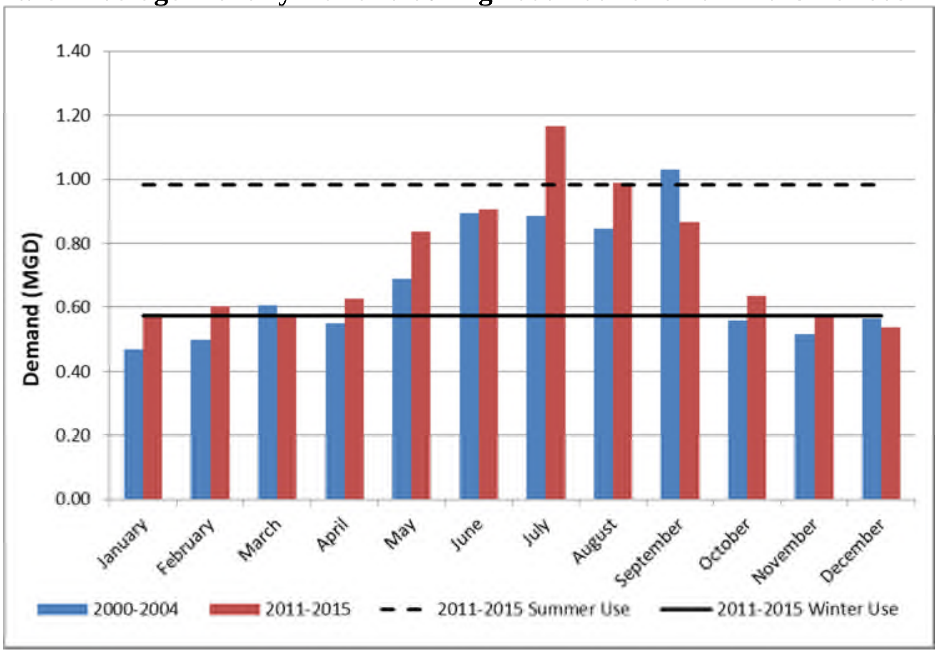
Exhibit 3: SDPW Customer Profile based on Average Water Sales in 2011 through 2015



[11] BCs are a function of impervious cover, cumulative groundwater withdrawal as a portion of the unimpacted August median flow, stream channel slope, and percent wetland within the stream buffer area. GWCs are based on the ratio of the 2000-2004 groundwater withdrawal volume to the unimpacted August median flow. The scale is from 1 (least impacted) to 5 (most impacted).

Exhibit 4 shows Southwick demand for the historical/baseline (2000-2004) and the more recent (2011-2015) periods. SDPW's demand has declined slighty from the baseline demnd of 0.67 MGD to the more recent 0.65 MGD. On average, SDPW customers use 44% more water in the summer (June-August) than in the winter (December-January). This increase is 0.44 MGD, on average, during the summer months.

Exhibit 4: Southwick Average Monthly Demand during 2000-2004 and 2011-2015 Periods



1.2.2 Southwick Water Supplies

Southwick has two main sources of water supply – two wells in the subbasin 19078 (Great Brook subbasin) in the Westfield Basin and purchasing water from Springfield Water and Sewer Commission (SWSC). Subbasin 19078 is 8 mi^2, and 99% of the subbasin is located in Southwick (Exhibit 5). SDPW and WSDPW are the only authorized entities withdrawing from subbasin 19078 (see Section 1.3 for a description of WSDPW).

Exhibit 5: Towns of Southwick and West Springfield and their Water Supply Source Subbasins

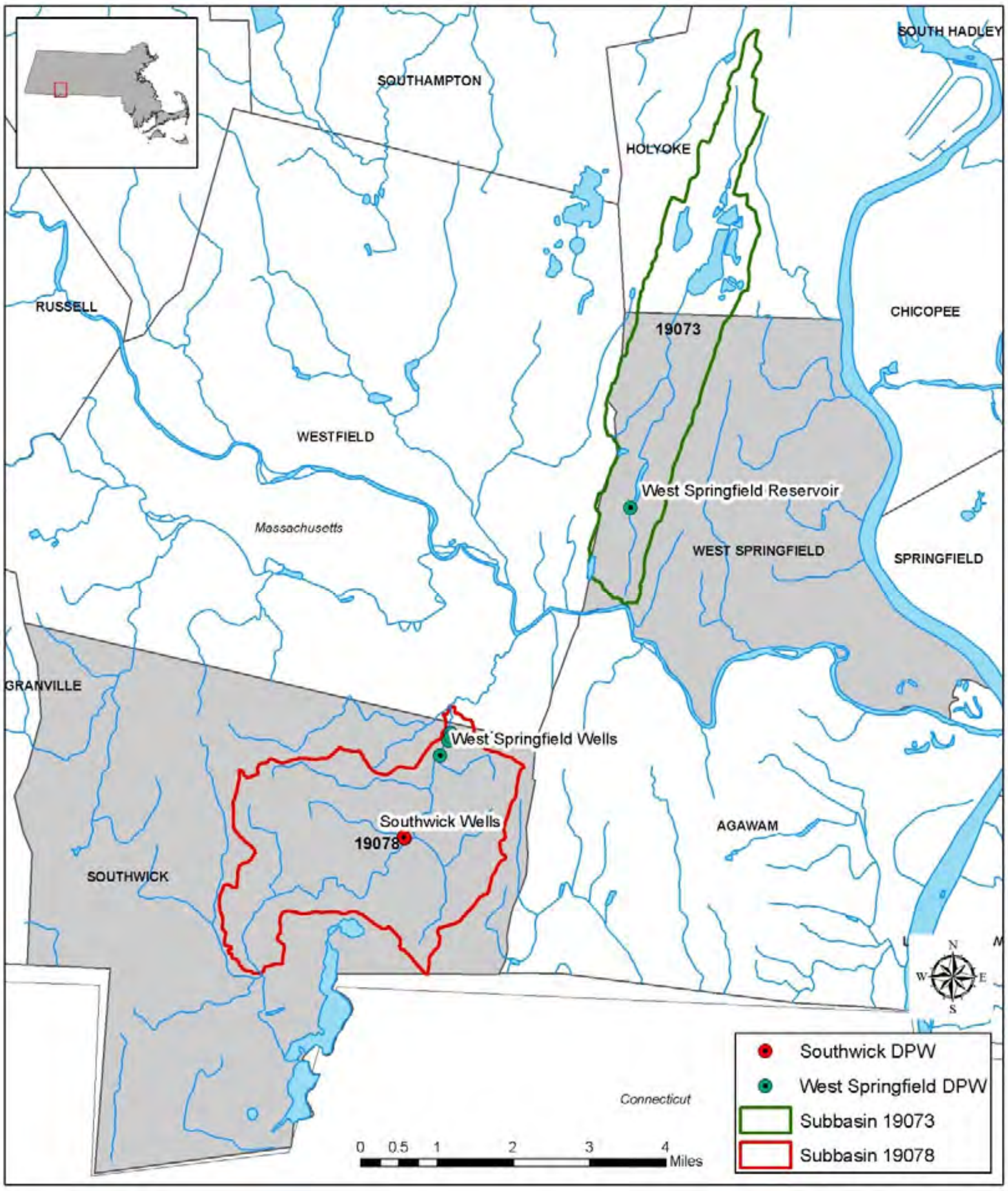


Exhibit 6 shows the proportion of demand met by the wells in subbasin 19078 and by purchased water from SWSC. On average, subbasin 19078 supplies 76% of SDPW's demand with purchased water accounting for the remainder. SDPW's current agreement with SWSC does not specify a limit on the purchase water volume.

Exhibit 6: SDPW Average Daily Withdrawals and Purchased Water by Month during 2011-2015				
	Average Volume (MGD)		Percentage of Demand	
Month	Pumped from Subbasin	Purchased from SWSC	Pumped from Subbasin	Purchased from SWSC
January	0.420	0.155	73%	27%
February	0.440	0.163	73%	27%
March	0.406	0.166	71%	29%
April	0.441	0.184	71%	29%
May	0.610	0.226	73%	27%
June	0.710	0.196	78%	22%
July	0.935	0.231	80%	20%
August	0.797	0.191	81%	19%
September	0.707	0.161	81%	19%
October	0.523	0.113	82%	18%
November	0.421	0.158	73%	27%
December	0.414	0.124	77%	23%

Exhibit 7 presents a summary of SDPW's wells and their characteristics. The authorized pumping rate for each well is 1.02 MGD but the system-wide authorized volume is 0.73 MGD. Of this system-wide volume, 0.28 MGD is permitted and 0.45 MGD is registered volume. Both wells are in close proximity to Great Brook.

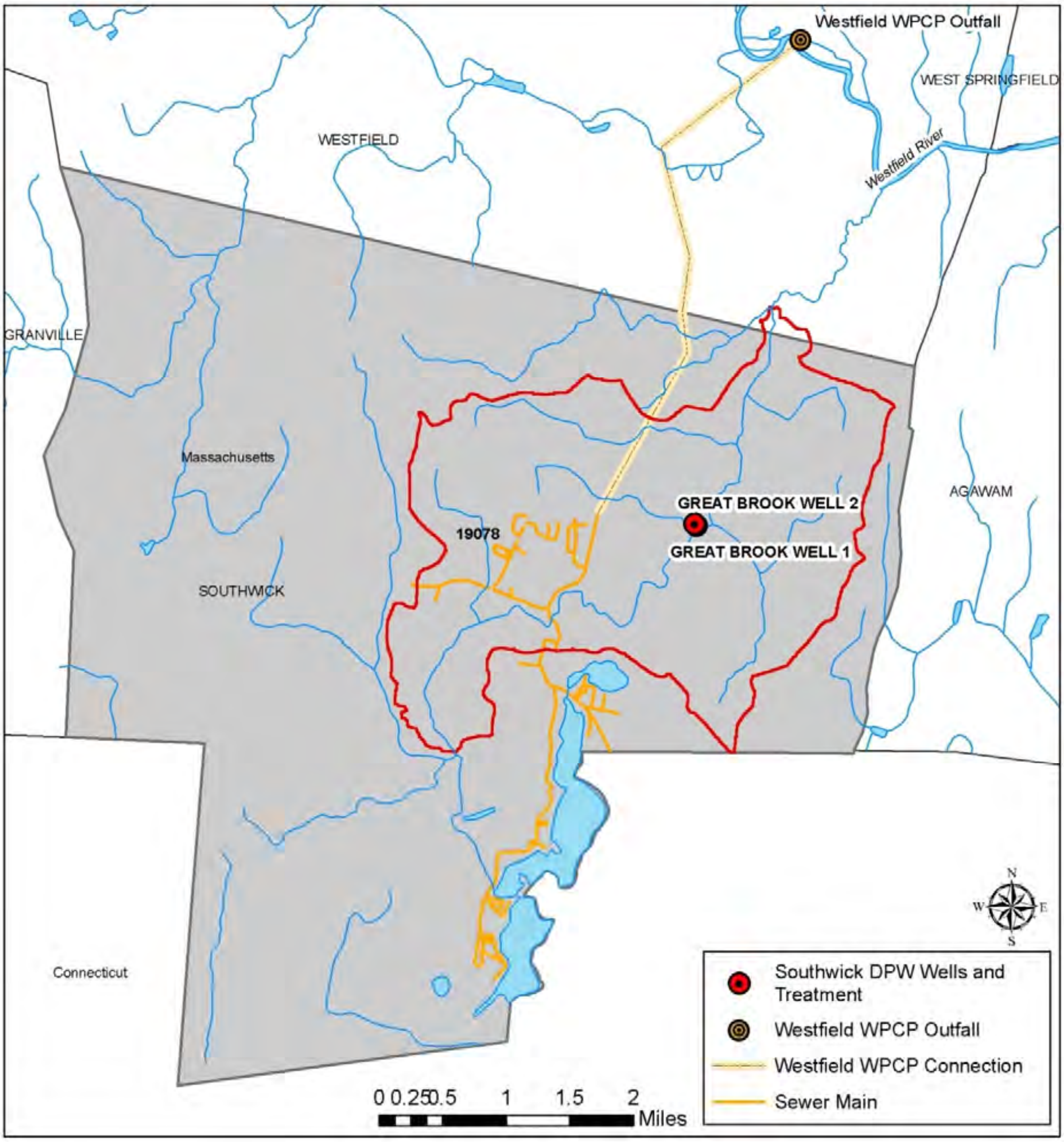
Exhibit 7: SDPW Wells					
Subbasin	Source Name	Permitted / Registered	Distance to Stream (ft)	Authorized Pumping (MGD)	2015 Average Pumping (MGD)
19078	Great Brook Well #1	Both	250	1.02	0.09
	Great Brook Well #2	Both	330	1.02	0.51
Total				**0.73**	**0.60**

1.2.3 Southwick's Water and Wastewater Infrastructure

The water pumped from SDPW's groundwater wells is high quality and, for much its history, did not require treatment before distribution. After multiple occurrences of bacteria from 2005-2009, MassDEP now requires SDPW to treat its water. SDPW has historically relied on Springfield water to meet chlorination requirements. In October 2015, SDPW connected a chlorination system to the wellfield to reduce reliance on purchased water. The current pumping capacity of the chlorination system is 0.8 MGD. SDPW maintains 51 miles of mains for the water distributions system.

Southwick initiated sewering in early 2000's and only small portion of Southwick is sewered (Exhibit 8). Southwick used SDR 35 polyvinyl chloride piping and performs an I/I analysis every year showing minimal I/I. The 13 miles of sewer mains provide connections to 23% of the people in Southwick. Of the 848 sewer accounts, only approximately 1.2% of the sewer accounts are not on public water. A 21-inch sanitary gravity line connects the sewer system in Southwick to the Westfield Water Pollution Control Plant (WWPCP). The City of Westfield and the Town of Southwick are co-permittees of the NPDES permitted wastewater discharge to the Westfield River in subbasin 19076. Southwick has a flow limit of 0.5 MGD wastewater to the WWPCP.

Exhibit 8: SDPW Water and Wastewater Infrastructure



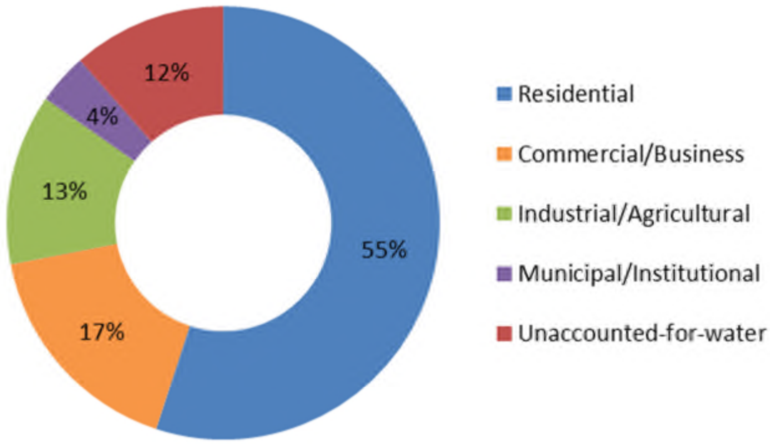
1.3 Town of West Springfield and Its Water Supply

West Springfield is located about two miles northeast of Southwick with 60% of the town in the Westfield Basin and the remainder in the Connecticut Basin. WSDPW has 5 authorized sources: Bear Hole Reservoir in subbasin 19073 and four wells in subbasin 19078 (Exhibit 5). West Springfield had a population of 28,391 in 2010 with WSDPW supplying the drinking water needs of 99% of the town population (U.S. Census 2010).

1.3.1 West Springfield Demand

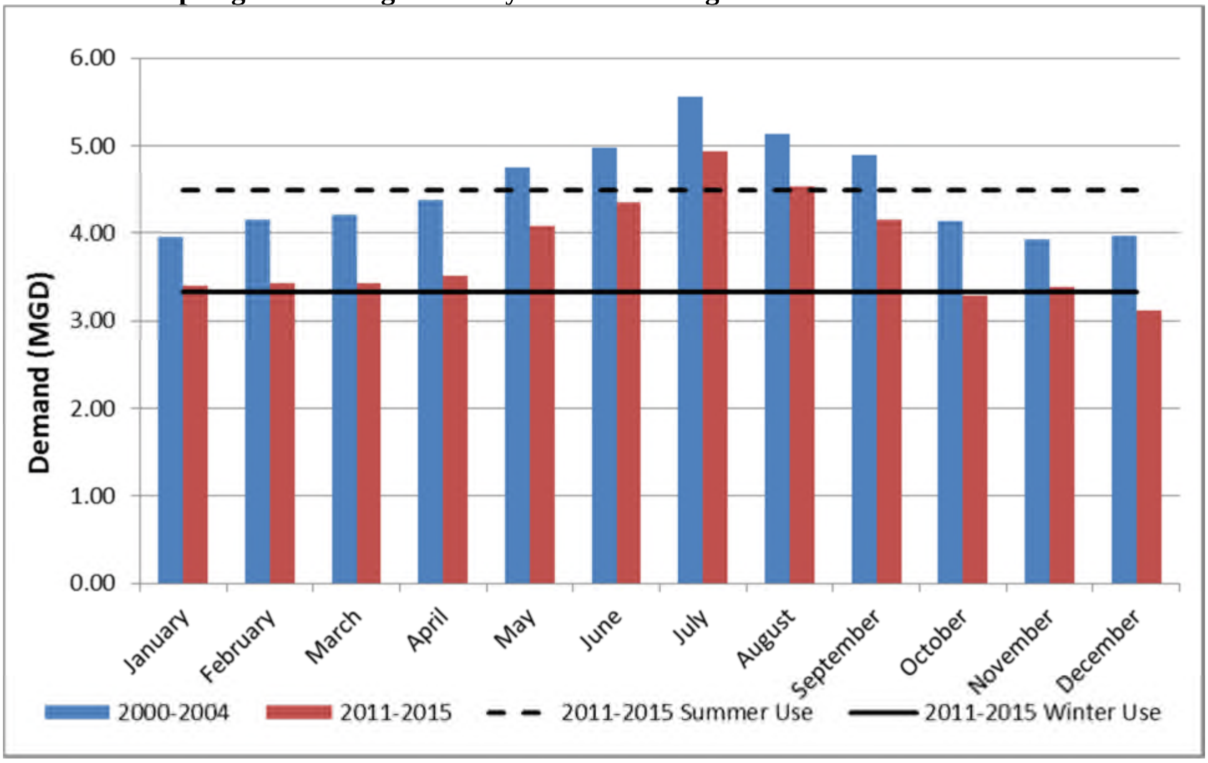
The majority of West Springfield demand is residential users (55%, Exhibit 9). Commercial and industrial users account for 30% of the demand. UAW and municipal users make up the remaining demand for West Springfield water.

Exhibit 9: WSDPW Customer Profile based on Average Water Sales in 2011 through 2015



Demand in West Springfield has declined by 13% from the baseline period at 4.5 MGD to the more recent period of 2011-2015 at 3.9 MGD (Exhibit 10). In general, this is attributed to a decline in the commercial and indsutrial sectors. WSDPW customers use 30% more water in the summer, which amounts to 1.26 MGD of outdoor water use during those summer months..

Exhibit 10: West Springfield Average Monthly Demand during 2000-2004 and 2011-2015 Periods



1.3.1 West Springfield Supplies

WSDPW owns four groundwater wells in subbasin 19078 and Bear Hole Reservoir (the reservoir) in subbasin 19073 (Exhibit 5). WSDPW discontinued the use of the reservoir in 19073 because the slow-sand filtration system would have required significant upgrades to continue to meet drinking water standards. In addition, the reservoir had a maximum safe yield of 1.25 MGD, only 32% of the town's total demand. Instead WSDPW invested in the 19078 wellfield which yielded high quality water.

On average, groundwater from subbasin 19078 is 97% of West Springfield's water supply as show in Exhibit 11. Purchased water from Springfield was significantly reduced in 2015 when WSDPW connected a 24" water transmission main from the groundwater wells to West Springfield to replace a 16" water main because the smaller main could not handle the summer demand.

Exhibit 11: WSDPW Average Daily Withdrawals and Purchases by Month during 2011-2015

Month	Average Volume (MGD)		Percentage of Demand	
	Pumped from Subbasin	Purchased from SWSC	Pumped from Subbasin	Purchased from SWSC
January	3.229	0.186	95%	5%
February	3.518	0.000	100%	0%
March	3.415	0.000	100%	0%
April	3.506	0.000	100%	0%
May	4.181	0.032	99%	1%
June	4.261	0.090	98%	2%

Exhibit 11: WSDPW Average Daily Withdrawals and Purchases by Month during 2011-2015				
	Average Volume (MGD)		Percentage of Demand	
Month	Pumped from Subbasin	Purchased from SWSC	Pumped from Subbasin	Purchased from SWSC
July	4.775	0.443	92%	8%
August	4.364	0.231	95%	5%
September	4.142	0.059	99%	1%
October	3.276	0.026	99%	1%
November	3.240	0.166	95%	5%
December	2.899	0.125	96%	4%

Exhibit 12 summarizes the characteristics of WSDPW's well in subbasin 19078. All four wells are in close proximity to Great Brook. The sum of individual authorized volumes for each well is greater than the total authorized volume for the system, which is 6.45 MGD.

Exhibit 12: WSDPW Wells					
Subbasin	Source Name	Permitted / Registered	Distance to Stream (ft)	Authorized Pumping (MGD)	2015 Average Pumping (MGD)
19078	GP Well #1	Permitted	10	1.91	1.43
	GP Well #2	Permitted	190	0.98	0.22
	GP Well #3	Permitted	215	1.21	0.66
	GP Well #4	Permitted	160	2.91	1.39
Total				**7.01**	**3.69**

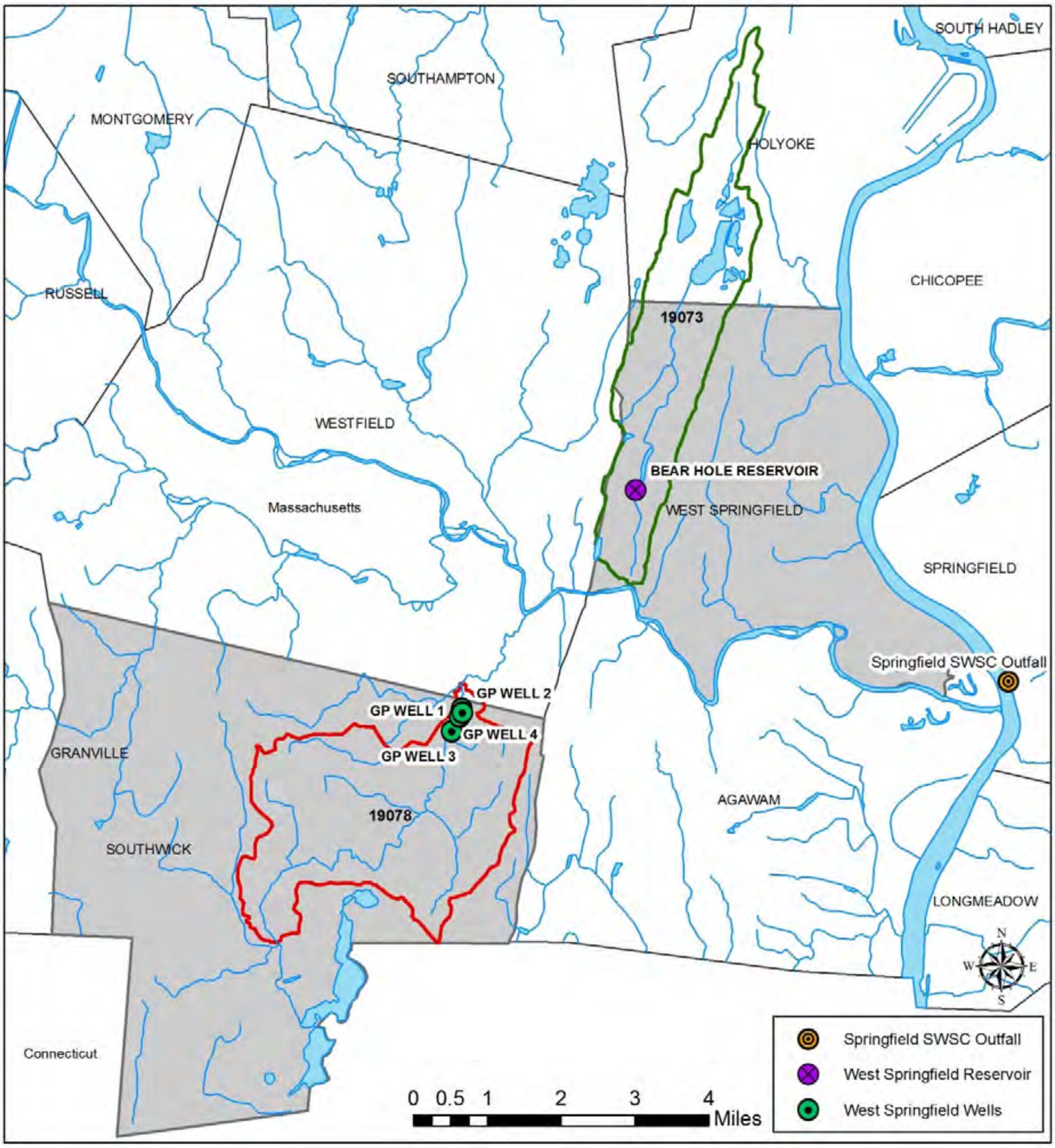
1.3.2 West Springfield Water and Wastewater Infrastructure

A summary of water treatment facilities are shown in Exhibit 13. As discussed in the previous section, Bear Hole Reservoir and its slow-sand filtration plant are not operational but since they still exist we list them in Exhibit 13 for completeness. In 1986, West Springfield detected ethylene dibromide and dichlorophenol in its wells from historical, tobacco pesticide use. Since then, WSDPW has installed granular activated carbon filtration to treat water pumped from its wells.

Exhibit 13: WSDPW Water Treatment Locations					
Town	Facility Name	Subbasin	Treatment Type	Source Treated	Capacity (MGD)
West Springfield	Bear Hole Water Treatment Plant	19073	Slow sand filter	Bear Hole Reservoir	Not operational
	Southwick Wells GAC Water Treatment Facility	19078	Granular Activated Carbon	GP Well #1	5.5
				GP Well #2	
				GP Well # 3	
				GP Well # 4	

The vast majority of the population of West Springfield is sewered (~97-99%) with a connection to the SWSC Treatment Plant. The discharge location of the plant is the Connecticut River. WSDPW estimates that only approximately 1.56% of public water customers' wastewater discharges in the Westfield Basin. West Springfield's sewer system was originally constructed in 1876. The last major upgrade to the system was 1974 as a result of the Clean Water Act, but some original sewer mains remain. Infiltration and inflow (I/I) is estimated to be at least 25%. Exhibit 14 shows WSDPW's wellfield and treatment facility, Bear Hole Reservoir, and the discharge location of the SWSC treatment plant.

Exhibit 14: WSDPW Water and Wastewater Infrastructure



2 Meeting Applicable Water Management Act Requirements

In July 2015, MassDEP held an outreach meeting to initiate the permit renewal process for the Westfield Basin. Both towns submitted their permit renewal application by August 31, 2015. As summarized in Section 1.1, the revised Regulations require permittees to meet standard permit conditions, minimize existing impacts in depleted basins and CFRs, and mitigate withdrawals above baseline allocation. In this section, we review baseline and current conditions and then identify and evaluate the actions needed to meet each of the requirements and associated costs.

2.1 Baseline Conditions Used for Determining Regulatory Requirements

Exhibit 15 provides an overview of each source subbasin for the regulatory baseline period of 2000-2004 as compiled by MassDEP.[12] Although Bear Hole Reservoir in subbasin 19073 is not a currently viable source (as discussed in Section 1.3.1), we show the data for that subbasin for completeness.

Exhibit 15: WMA Baseline August Conditions, 2000-2004

Subbasin	Subbasin Name	Registered / Permitted Sources	ANGD[13] (%)	CFR	GWC	BC
19073	Westfield River-Little River	Registered	-2.3	Yes	1	4
19078	Great Brook	Both	114	Yes	5	5
Subbasin	**Subbasin Name**	**August Unaffected Streamflow (MGD)**	**August Groundwater Withdrawals[14] (MGD)**	**August Groundwater Recharge[15] (MGD)**	**To Change GWC (MGD)**	**To Change BC (MGD)**
19073	Westfield River-Little River	1.117	0.015	0.041	0.019	NA
19078	Great Brook	3.962	4.843	0.327	NA	NA

2.2 Current Conditions (2011-2015)

Significant changes in withdrawals and returns have occurred between the baseline period and 2011-2015. Demand for water in Southwick and West Springfield has decreased. Southwick septic returns to subbasin 19078 due to sewering have decreased as described in Appendix **Error! Reference source not found.**. Exhibit 16 shows

[12] Data sources include United States Geological Survey (USGS) dataset from the Massachusetts Water Indicators (MWI) report data and Sustainable Yield Estimator (SYE) as compiled in the WMA tool. The majority of the data focus on conditions in August during the baseline period of 2000-2004.

[13] ANGD is calculated as August groundwater withdrawals minus August groundwater returns divided by the median August unaffected streamflow. Unaffected streamflow is estimated using SYE over the period of 1960-2004.

[14] August groundwater withdrawals are 2000-2004 SDPW and WSDPW withdrawals plus private groundwater withdrawals in the subbasin estimated from U.S. Census data.

[15] August groundwater returns are groundwater discharge from septic systems in the subbasin estimated from U.S. Census data.

the updated August conditions for 2011-2015. In addition, we identified differences between measured and SYE modeled streamflow. We show an adjusted August median unaffected streamflow in Exhibit 16 with details proceed in Appendix **Error! Reference source not found.**. Although these data refinements may be submitted to MassDEP per WMA Permit Guidance Document Section 10 (MassDEP, 2014), they do not change the groundwater category or August net groundwater depletion status for the subbasin and, therefore, do not change any applicable requirements. However, we carry forward the values in Exhibit 16 and the data associated with them for all subsequent calculations and analyses presented in this report.

Exhibit 16: Current August Conditions, 2011-2015

Subbasin	Registered / Permitted	ANGD (%)	CFR	August Unaffected Streamflow[16] (MGD)	August Groundwater Withdrawals[17] (MGD)	August Groundwater Returns[18] (MGD)
19078	Both	102	Yes	4.924	5.161	0.139

Note: Shading indicates changes from Exhibit 15.

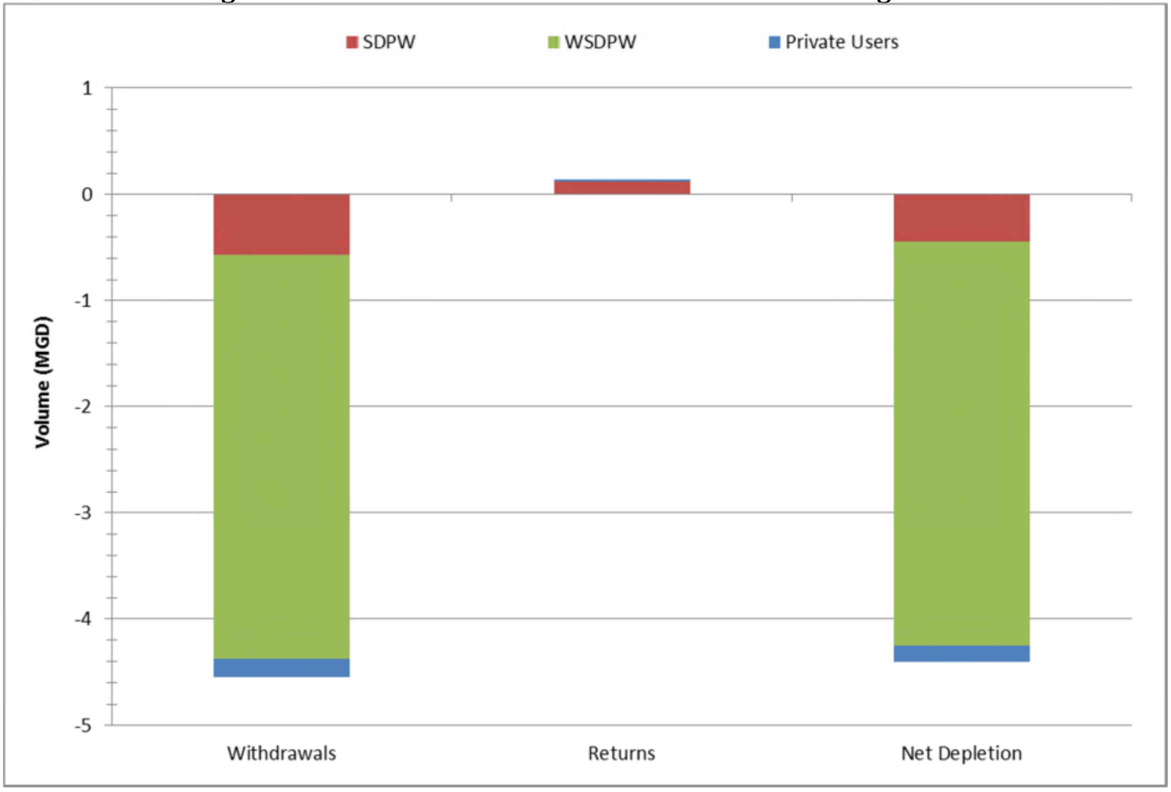
Withdrawal and return flows in the source subbasin are shown in Exhibit 17. The chart shows the relative contribution of each town and private users to the total subbasin withdrawals, returns, and net depletion on an average annual basis. Subbasin returns are 3% of the subbasin withdrawals, leading to the net groundwater depletion status.

16 August unaffected streamflow is calculated as show in Appendix A.

17 August groundwater withdrawals are 2011-2015 SDPW and WSDPW withdrawals plus private groundwater withdrawals in subbasin 19078.

18 August groundwater returns are calculated as the residential usage for septic users in subbasin 19078 assuming 65 residential gallons per capita per day (RGPCD) and 15% lost to consumptive use.

Exhibit 17: Average Withdrawals and Returns in Subbasin 19078 during 2011-2015



2.3 Standard Permit Conditions

Standard permit conditions must be met by all withdrawal permittees under the Regulations. We summarize the three categories of conditions below. Section 5 of the WMA Guidance provides full details (MassDEP 2014).

- Performance standards: Permittees must meet the following two standards within five years or they must implement MassDEP's functional equivalence plan.
    - Maximum of 65 residential gallons per capita per day water use (RGPCD)
    - Maximum of 10% UAW
- Water conservation requirements: All permit applicants must include a water conservation program with their application. At a minimum, permittees must complete the Water Conservation Questionnaire for Public Water Supplier and implement seven categories of measures outlined in Table 5a-1 of the WMA Guidance.
- Limits on nonessential outdoor water use: Permittees must prepare for logistics of new requirements which for subbasin 19078 is limiting nonessential outdoor water use to one day per week between 5 pm and 9 am during the season. The season may be defined as May through September or based on MassDEP-defined flow triggers at a designated stream gage.

In the sub-sections below, we review the current status of each town with respect to each condition and the estimated effect of full compliance on demand. Expenditures associated with meeting standard permit conditions are not considered in the cost feasibility assessment outline in the Guidance (MassDEP 2014).

2.3.1 Standard Permit Conditions for Southwick

Exhibit 18 summarizes SDPW's status with respect to each condition and the effect of full compliance on demand.

Exhibit 18: Southwick's Compliance with Standard Permit Conditions

Condition[19]	Status[20]	Estimated Average Annual Demand Reduction (MGD)
Limits on nonessential outdoor water use		
Outdoor water use restrictions	Implement restricted hours and reduce to 1 day per week all season	0.038 (0.025-0.065) [21] [Average seasonal: 0.44]
Performance standards		
65 residential gallons per capita per day (RGPCD)	74 RGPCD	0.026 (0.011-0.036)[22,23]
10 percent unaccounted-for-water (UAW)	8.7 percent UAW	Fully compliant, no demand reduction
Water conservation requirements		
Water Conservation Questionnaire for Public Water Supplier	Submitted with permit renewal application	Fully compliant, no demand reduction
System water audits and leak detection	Leak detection every 3 years	
Metering	Town-wide meter replacement project to be completed by 2017	
Pricing	Rates evaluated annually to ensure water department budget is recovered	
Residential and public sector conservation	Municipal buildings retrofitted in 2014	
Industrial and commercial water conservation	Reviewed largest users and currently considering an outreach program to inform largest users on water conservation practices	
Lawn and landscape	See "Limits on nonessential outdoor water use below"	
Education and outreach	Water Conservation Plan was developed in 2005,	

[19] Conditions as described in *Water Management Act Permit Guidance Document* (MassDEP 2014).

[20] SDPW status based on SDPW's 2013-2015 Annual Statistical Report to MassDEP and SDPW personal communication.

[21] Range in estimates varies based on the assumed efficiency of outdoor water use measures due to compliance with restrictions. The first value represents an estimate of 20% reduction in outdoor water use, and the range of values represents an estimate of 13 and 34% reduction in outdoor water use based on restrictions. See text for details.

[22] Range in estimates varies based on the assumed efficiency of outdoor water use measures due to compliance with restrictions. The first value represents an estimate of 20% reduction in outdoor water use, and the range of values represents an estimate of 13 and 34% reduction in outdoor water use based on restrictions. See text for details.

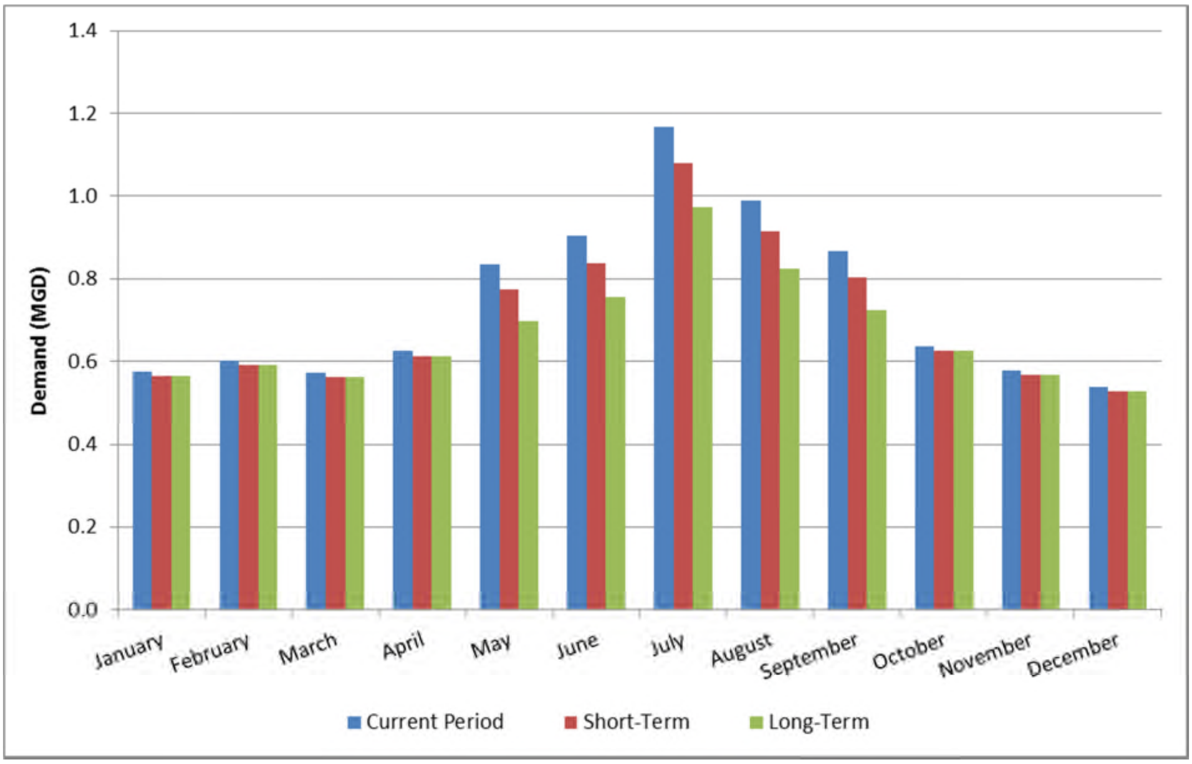
[23] Reduction estimates for meeting the 65 RGPCD performance standard is based on residential usage after reduction in water use from standard outdoor water use restrictions is taken into account.

Exhibit 18: Southwick's Compliance with Standard Permit Conditions		
Condition[19]	Status[20]	Estimated Average Annual Demand Reduction (MGD)
	new program and materials developed under this grant (Section 3)	

To estimate the demand reductions due to outdoor water use restrictions, we adjusted demand to reflect a 20% reduction in outdoor water use in the summer months (May through September) with a potential range of 13% and 34% reduction. These reductions are based on the experience of other towns that implemented outdoor water use restrictions (Town of Franklin et al. 2015). Short-term reductions of 13% were seen within the first five years and long-term reductions of 34% after ten year or more. The increase in reduction was attributed to a higher compliance rate over time.

Exhibit 19 shows the estimated decline in average annual and summer demand if all standard permit conditions are met. The exhibit shows three demand profiles: (1) current (2011-2015); (2) 2011-2015 demand with 65 RGPCD and short-term reductions in outdoor water use; and (3) 2011-2015 demand with 65 RGPCD and long-term reductions in outdoor water use. Note that these estimates do not account for demand increase from population growth and only reflect the adjustments discussed above.

Exhibit 19: SDPW Current Demand (2011-2015) and Modeled Demand for Meeting Standard Permit Conditions



2.3.2 Standard Permit Conditions for West Springfield

Exhibit 20 summarizes WSDPW's status with respect to each condition and estimated demand reductions from full compliance with the conditions.

Exhibit 20: West Springfield's Compliance with Standard Permit Conditions

Condition[24]	Status[25]	Estimated Average Annual Demand Reduction (MGD)
Limits on nonessential outdoor water use		
Outdoor water use restrictions	Under new permit: implement restricted hours and reduce to 1 day per week all season	0.123 (0.080-0.210) [26] [Average seasonal: 1.26]
Performance standards		
65 residential gallons per capita per day (RGPCD)	73 RGPCD	0.172 (0.125-0.196)[27,28]
10 percent UAW	13 percent UAW	0.194
Water conservation requirements		
Water Conservation Questionnaire for Public Water Supplier	Submitted with permit renewal application	Fully compliant, no demand reductions
System water audits and leak detection	Leak detection survey last completed in 2012	
Metering	Full metering of town and ongoing meter inspection program for 15 years	
Pricing	No decreasing block rates	
Residential and public sector conservation	Municipal retrofits are in progress with some buildings up to date	
Industrial and commercial water conservation	Aware of top users and their usage	
Lawn and landscape	See "Limits on nonessential outdoor water use below"	
Education and outreach	Water Conservation Plan was developed in 2005, new program and materials developed under this grant (Section 3)	

Exhibit 21 shows the estimated decline in demand if all standard permit conditions are met. The exhibit shows three demand profiles: (1) current (2011-2015); (2) 2011-2015 with 65 RGPCD, 10% UAW and short-term

24 Conditions as described in *Water Management Act Permit Guidance Document* (MassDEP 2014).

25 WSDPW status based on WSDPW's 2013-2015 Annual Statistical Report to MassDEP and WSDPW personal communication.

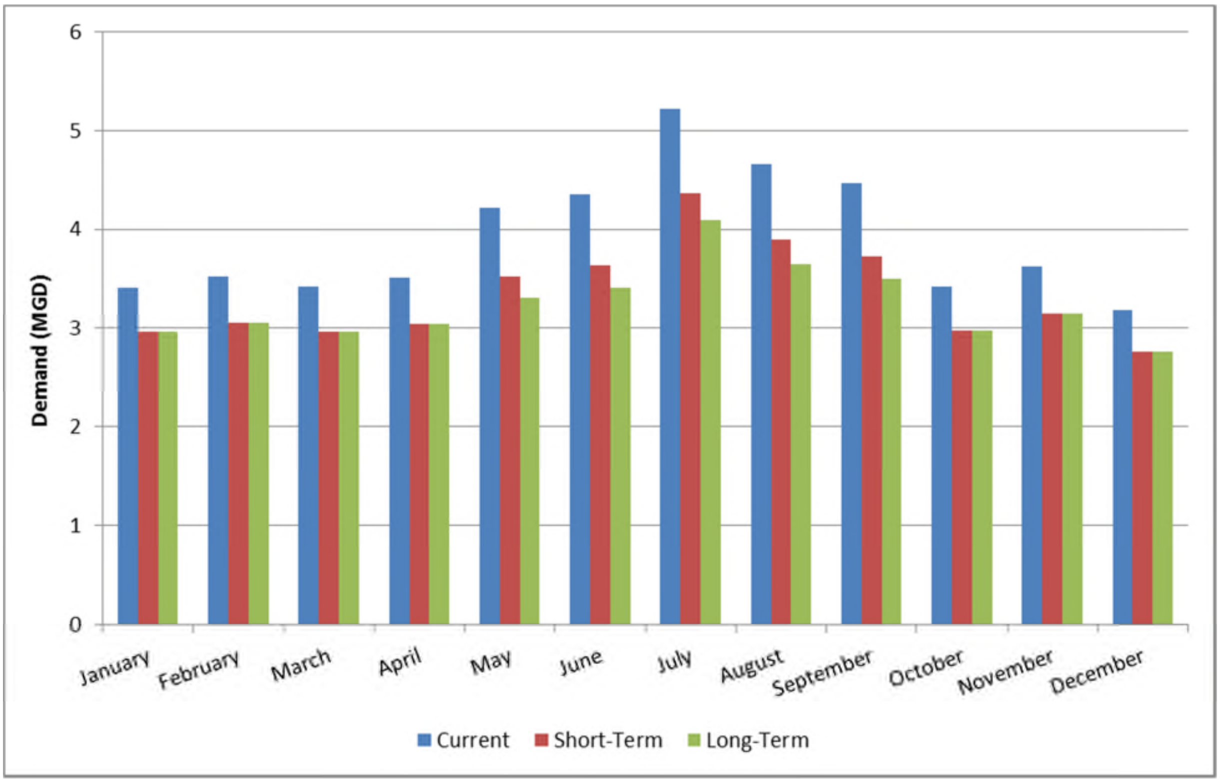
26 Range in estimates varies based on the assumed efficiency of outdoor water use measures and compliance with restrictions. The first value represents an estimate of 20% reduction in outdoor water use based on the restrictions, and the range of values represents an estimate of 13 and 34% reduction in outdoor water use based on restrictions.

27 Range in estimates varies based on the assumed efficiency of outdoor water use measures and compliance with restrictions. The first value represents an estimate of 20% reduction in outdoor water use based on the restrictions, and the range of values represents an estimate of 13 and 34% reduction in outdoor water use based on restrictions.

28 Reduction estimates for meeting the 65 RGPCD performance standard is based on residential usage after reduction in water use from standard outdoor water use restrictions is taken into account.

reductions in outdoor water use; and (3) 2011-2015 demand with 65 RGPCD, 10% UAW and long-term reductions in outdoor water use. Note that these estimates do not include account for demand increase from population and only reflect the adjustments discussed above.

Exhibit 21: WSDPW Current Demand (2011-2015) and Modeled Demand for Meeting Standard Permit Conditions



2.4 Coldwater Fish Resources (CFRs) and Minimization

As described in Section 1.1, CFR and minimization requirements both concern the minimization of existing impacts on streamflow. MassDEP has determined that the Great Brook in subbasin 19078 is a CFR (Exhibit 22). In addition, as discussed in Section 2.1, subbasin 19078 is greater than 25% ANGD and, therefore, minimization requirements also apply.

CFR requires consultation with Massachusetts Department of Fish and Wildlife (DFW) and desktop optimization of existing, alternative sources. Desktop optimization is also required under minimization. In addition, minimization also requires consideration of water releases, water returns and additional conservation measures. Permittees must develop a minimization plan and should consider costs, level of improvement expected to result from actions, available technology and the applicant's authority to implement the actions. Permittees may propose alternative measures to minimize the impact of its withdrawals – in addition to, or in place of the above requirements – and MassDEP will consider those measures on a case-by-case basis.

To determine which of the above potential actions would cost-effectivley reduce streamflow impacts, we used EPA's Watershed Management Optimization Support Tool (WMOST) to model subbasin 19078, specify streamflow targets and assess the cost-effectiveness of actions to meet those targets. Appendix Chapter

1Appendix B provides details on the setup of the WMOST model including input data and calibration. In the following sections, we review the required considerations for CFR and minimization requirements and discuss their representation in the WMOST model. Then, we present the methods and results from the WMOST modeling. In the following sections we consider and discuss total actions required to improve streamflow, that is, actions are not specified per town. We do not have guidance from MassDEP on the extent of streamflow improvements required under CFR and minimizaiton nor on the sharing of responsibility by mutliple permitees.

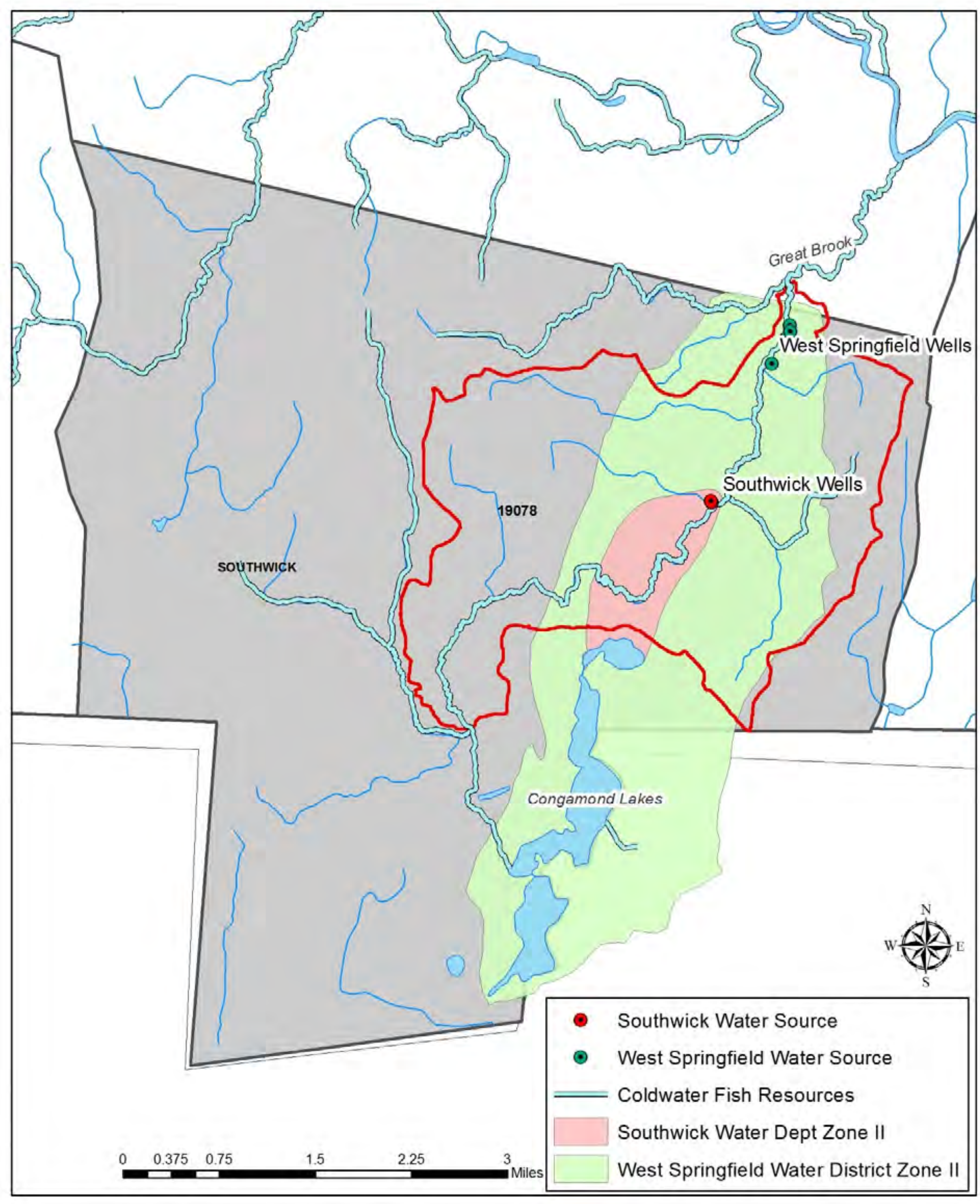
It is important to note that we ran the model for 2000-2004 weather conditions which includes a 1 in 20 dry-year. Therefore, actions selected by the model will the streamflow targets in any year that has as much or more precipitaiton than the 2000-2004 period.

2.4.1 Desktop Optimization

Optimization is focused on operational optimization; that is, shifting withdrawals among existing sources to reduce imapcts on streamflow in CFR and ANGD subbasins. All Southwick and West Springfield wells are located in subbasin 19078; therefore, shifting pumping among those wells will not reduce impacts on streamflow in the subbasin. West Springfield has Bear Hole Reservoir but that subbasin is also a CFR and the source in not currently viable (see Section 1.3.1). Both towns' only currently-viable, alternative source is purchasing water from SWSC. Consultation with DFW is required to determine protective streamflow targets and whether the use of SWSC water will be required to meet those targets or the minimization requirement.

The purchase of water from SWSC was represented in the WMOST model as "interbasin transfer of water" purchased at current rates. Since each town's purchasing rate is different, the value in WMOST is the flow-weighted average rate (i.e., rate of each town weighted by the recent purchase volume of each town).

Exhibit 22: Zone II Delineation for Southwick and West Springfield Wells and Coldwater Fish Resources in Subbasin 19078



2.4.2 Water Releases

Congamond Lakes are the only upstream surface water body that may serve as a source of water releases to offset withdrawal impacts. Congamond Lakes are composed of three ponds – North, Middle and South – connected by culverts (Exhibit 22, Exhibit 24). We had access to two reports on Congamond Lakes – a Draft Environmental Impact Report on Flood Control Works for Congamond Lakes from 1980 by Cortell and Associates for the Commonwealth of Massachusetts and a Diagnostic/Feasibility Study for Congamond Lakes by Baystate Environmental Consultants in 1983 focusing on water quality restoration. We summarized relevant data from these reports.

The total volume of Congamond Lakes has been estimated at 2,773 million gallons with a mean depth of 41 feet (Baystate Environmental Consultants 1983). Groundwater discharge is the largest source of inflow followed by an unnamed stream, overland runoff and precipitation. Exhibit 23 shows the estimated hydrologic budget. The retention time for the three ponds was estimated at 1.1 years. Groundwater basin boundaries differ from surface watershed boundaries. Congamond Lakes have been subject to significant hydrological alternations since the 1700's. They are both fed by groundwater discharge and provide significant recharge to the Great Brook Aquifer (Baystate Environmental Consultants 1983).

Exhibit 23: Estimated Average Annual Hydrologic Budget for Congamond Lakes based on Baystate Environmental Consultants 1983

Inputs	Million Gallons per Year
Direct precipitation	555
Surface water runoff including Great Brook backflow	1,215
Groundwater	819
Total inputs	**2,589**
Outputs	**Million Gallons per Year**
Great Brook	1,110
Evaporation from lake surface	343
Groundwater underflow to North and South	1,136
Total outputs	**2,589**

Great Brook originates from the southern end of the Middle Pond and is an outlet for the Congamond Lakes. During extreme storm events, Great Brook can become an inflow (Baystate Environmental Consultants 1983). These conditions are due to the flat topography of the land surrounding Congamond Lakes. Historically, during flood conditions, stoplogs had been placed at the Great Brook outlet to prevent backflow to the Middle Pond and reduce flooding. Stoplogs were subsequently removed to allow outflow. These conditions have also been observed for Canal and Palmer Brooks in the South Pond.

The 1980 report on flood controls for Congamond Lakes discussed multiple options to reduce backflow and flooding. The report notes that the capacity of Great Brook as the only outlet diminished over the years due to natural succession, sedimentation and debris within the stream channel. In addition, insufficient culvert capacity downstream to handle stormwater causes backflow annually (Cortell and Associates 1980). In the subsequent years and presumably based on options presented in the report, the U.S. Army Corps of Engineers planned to dredge Great Brook from the lake to approximately 500 feet past Industrial Road. However, dredging was only completed on a short section of Great Brook between the confluence of Great Brook, Johnson Brook and Pearl Brook to Industrial Road shown with a red circle in Exhibit 24. This section was dredged wide creating a pool of stagnant water and flows out of Congamond Lakes via Great Brook have not been restored (Grannells personal communication 2016).

Exhibit 24: Dredging Location from Great Brook's Confluence with Pearl Brook and Johnson Brook to Industrial Road

Currently, a dual box culvert is located under Berkshire Avenue and there are wood stop logs in place in that structure. Southwick has applied for a grant authorized under Section 319 of the federal Clean Water Act (319 grant) to replace the wood stop logs with stainless steel dual acting weir gates, stormwater improvements and an alum treatment. The lake, canal and brook levels are constantly monitored and adjustments are made to maintain the lake level at 224.5 +/- 0.2 feet mean sea level. The target elevations are intended to prevent the flooding of septic systems on the Connecticut shoreline of the ponds and other assets which have been observed at 225 feet. Typically, only one or two adjustments are required per year depending on storm activity. In general, adjustments are consistent with the historical practice of putting stop logs in place to prevent backflow from Great Brook and later removed (Grannells personal communication 2016).

Given the volume of Congamond Lakes, they could serve as a valuable source of surface water releases. The current, maximum target elevation is 224.7 feet and Great Brook outlet is at 224.3 feet leaving 0.4 feet for the storage of spring runoff for late-summer releases (Cortell and Associates 1980). We represented this option in the WMOST model by allowing for surface water releases from the surface water storage/reservoir component. The required reservoir volume for meeting the streamflow targets can be compared with height and volume available for storage and release in Congamond Lakes (i.e., 0.4 feet).

2.4.3 Water Returns

Under Section 6 of the WMA Guidance, minimization may include returns of water including “stormwater recharge, I/I improvements, and wastewater discharges that result in improvements to the quantity and timing of streamflow” (MassDEP 2014). We included the following considerations in the WMOST model:

- Stormwater retrofitting is explicitly included in WMOST as a management option. We considered three design depths – 0.6, 1 and 2 inches – and two BMP types – infiltration trench and bioretention basin.
- The reduction of I/I is also explicitly considered in WMOST. However, only reduction in Southwick’s I/I would result in improvements in subbasin 19078 streamflow but Southwick’s I/I is minimal (Section 1.2.3). West Springfield has significant I/I at approximately 25% and its repair could yield improvements in subbasins 19078, 19076, 19074, 19090 and downstream. However, it is not included in the model of subbasin 19078 because West Springfield’s land area is not upstream of subbasin 19078. Instead it is listed under mitigation options for West Springfield.
- Wastewater - Septic: Southwick water customers on septic systems in subbasin 19078 will return, on average, 0.147 MGD. This value is based on 2011-2015 demand adjusted for outdoor water conservation and meeting 65 RGPCD. These returns are automatically considered in WMOST. However, these flows are not expected to change and, therefore, are not expected to improve upon current conditions.
- Wastewater - Sewer: Southwick’s customers are 23% sewered and export their wastewater to Westfield WCPC discharging elsewhere is the Westfield Basin and not contributing to streamflow in subbasin 19078. West Springfield’s customers are almost entirely sewered and export their wastewater to SWSC discharging in the Connecticut Basins. These wastewater flows are not expected to change and, therefore, not expected to improve upon current conditions. Further, both of these sewered wastewater flows are represented as exported wastewater since they do not discharge upstream nor within subbasin 19078.

2.4.4 Additional Conservation Measures

We designed a rebate program as shown in Appendix Chapter 1Appendix C . The demand reductions available from such a program would yield demand reductions beyond those needed for meeting the 65 RGPCD standard condition. Therefore, we specified the availability of the remaining demand reductions from a rebate program and the associated cost for the towns in the WMOST model. The remaining reductions are 0.028 MGD and 0.025 MGD for Southwick and West Springfield, respectively, for a total of 0.053 MGD. The annual cost for each town is summed for a total annual cost of $45,810.

In addition, WMOST models the effect of price increase on customers' demand. We specified price elasticities by customer type and allowed a maximum price increase that is the equivalent of the WMA Guidance cost feasibility threshold 3, that is, a 2% annual increase. We show all three thresholds calculated for each town in Appendix Chapter 1Appendix C .

2.4.5 Additional Measures to Minimize Impact of Withdrawals

Additional measures that we considered in the WMOST modeling include aquifer storage and recharge and direct water reuse through the additional treatment of wastewater and construction of a nonpotable distribution system.

2.4.6 Streamflow Targets

We were not able to get guidance from DFW about specific streamflow targets or seasons for the CFR requirement. We also did not have guidance on the extent of actions reqruiements for minimizing existing impacts on streamflow (i.e., WMA Guidance states "to the greatest exten feasible"). Therefore, to determine actions that would minimize existing impacts and may be considered protective of CFRs, we calcualted three different "stringency" streamflow targets for the summer, low-flow bioperiod – July, August, September (Exhibit 25):

- Remove subbasin 19078 from the "net depletion" categorization, that is, the subbasin would be less than 25% net depleted;
- Change subbasin 19078 from a GWC 5 to a GWC 3; and
- Change subbasin 19078 from a GWC 5 to GWC 2.

The calculations for these targets are shown in Appendix Chapter 1Appendix B . The net depletion and GWC3 targets were close in value; therefore, we did not run both set of targets. We ran net depletion and GWC2; these targets are summarized in Exhibit 25 below.

Exhibit 25: Streamflow Targets for WMOST Model Runs

Target Level	Target Definition	July Streamflow Target (cfs)	August Streamflow Target (cfs)	September Streamflow Target (cfs)
ANGD	75% of unaffected August streamflow plus returns	11.0	9.81	7.8
GWC 2	10% of unaffected August streamflow	13.3	11.6	9.5

2.4.7 WMOST Modeling Results

We ran the model with all actions described above as available for meeting streamflow targets. The following actions were selected as cost-effective:

- Surface water releases from Congamond Lakes into Great Brook at various levels of maximum required, stored volume,
- Both demand management options – price increase and water conservation program – to the full extent available,
- Repair of remaining leaks in the distribution system (i.e., lower than the 10% performance standard), and

- Elimination of purchasing SWSC water.

With surface water releases, streamflow targets can be met and the use of SWSC water can be eliminated which is more expensive than locally pumped water. Exhibit 26 shows the actions and associated costs for each of the two streamflow targets. As shown, expenditure on different actions does not change between streamflow targets. However, the volume of lake water to be managed does change as shown in Exhibit 27.

Exhibit 26: Management Actions and Associated Annual Costs[29] to Meet Streamflow Targets

Actions	ANGD	GWC2
Surface Water Releases	$5,000	$5,000
Consumer Rate Change	$3,000	$3,000
Direct Demand Reduction/Rebates	$6,000	$6,000
Groundwater Pumping and Treatment	$942,000	$942,000
Potable Distribution System Repair	$63,000	$63,000
Purchase of SWSC Water	$0	$0
Total Annual Cost	**$1,019,000**	**$1,019,000**

Surface water releases were able to meet downstream flow targets within the volume and height of the Congamond Lakes that are available as shown in (i.e., above the weir and below flood height, which is 0.4 feet, see Section 2.4.2). We were not able to assign a cost to implementing automated streamflow controls at Congamond Lakes directly in WMOST. The cost would be a one-time investment of approximately $75,000[30] but WMOST requires cost data to be specified on the basis a million gallons (i.e., $/MG). The one-time $75,000 annualized over the 20-yr permit period is $3,750 per year at 5% interest rate. We may assume that some management and upkeep is necessary to keep the automated system operations; therefore, we rounded the cost to $5,000 per year. This value is less than or comparable to all other actions selected by the model.

Exhibit 27: Volume and Height of Water to Manage in Congamond Lakes for Surface Water Releases

Target Level	Maximum Volume to Store for Releases (MG)	Maximum Change in Elevation[31] (ft)	Pumped Groundwater (MGD)
ANGD	59	0.39	3.23
GWC2	64	0.42	3.23

We show the resulting modeled streamflow when meeting GWC2 flow targets below in Exhibit 28. The pattern of water storage and subsequent releases are coincident with the low-flow bioperiods. The graph shows that

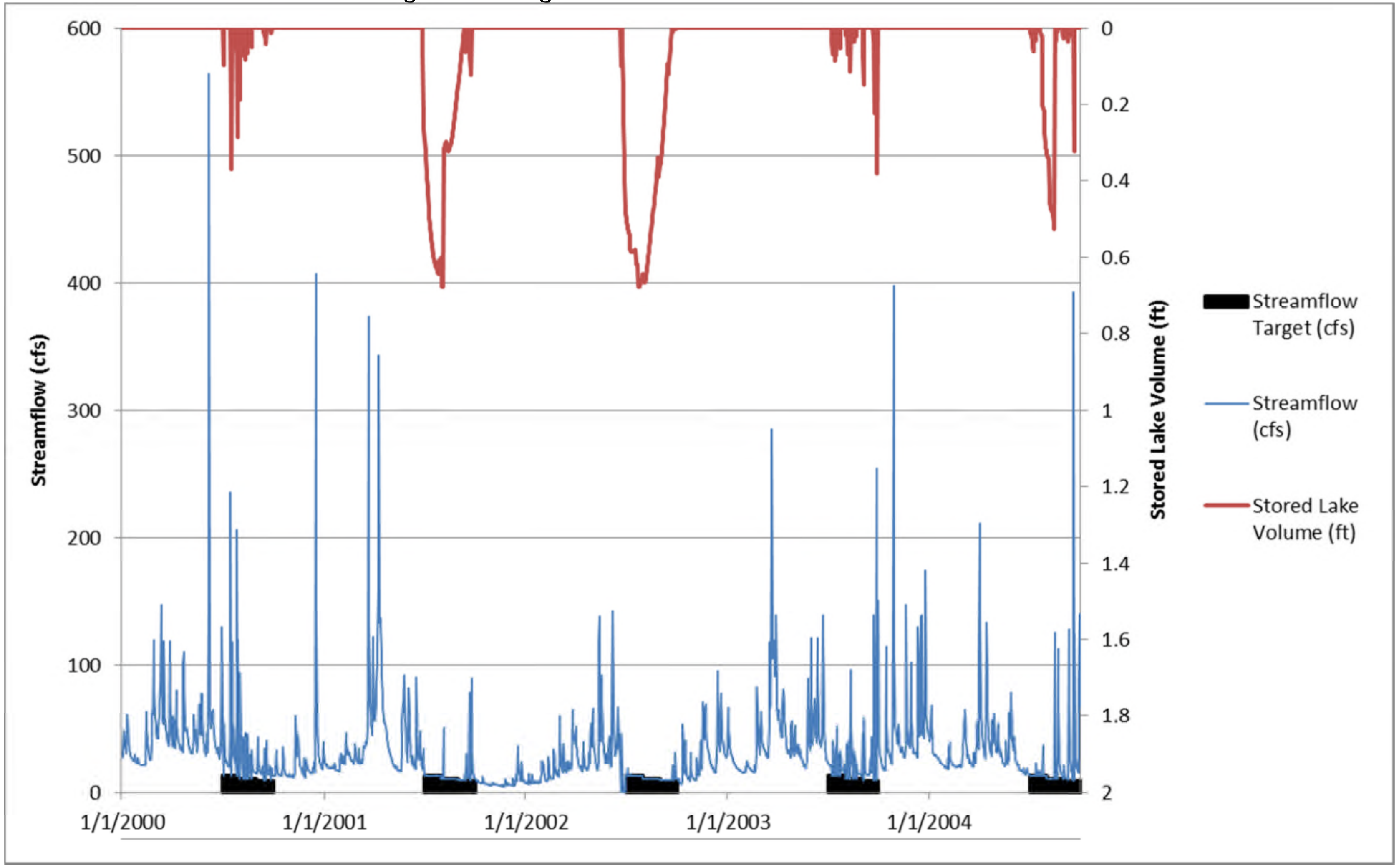
29 All costs are rounded to the nearest thousand dollars to reflect and emphasize that the modeling and its results are screening-level or planning-level accuracy.

30 Estimate is based on Town of Halifax WMA grant budget for 2016 to conduct a feasibility assessment of automating the outlet structure at Monponsett Pond and implementation.

31 We estimated that 0.4 feet of height is available in Congamond Lakes for storing water without flooding properties, see Section 2.4.2.

streamflow is always above the specified target. However, there is one instance in 2002 before the start of the July target that streamflow is severely depleted and close to zero. Ultimately, minimum outflow from the Congamond Lakes should be specified for all months to ensure some minimum flow year-round.

Exhibit 28: Streamflow and Lake Storage for Meeting GWC2 for 2000-2004 Weather Conditions



Given that lake releases for low-flow minimization are not currently practiced and obstacles may surface during the feasibility evaluation, we also ran the model without the availability of lake releases. Exhibit 29 presents the results of those model runs. We see similar actions implemented such as the two demand management options and repair of distribution system. However, without surface releases, the model selected the purchase of SWSC water to meet flow targets. This means that stormwater, aquifer storage and recovery, and nonpotable water reuse were not cost-effective actions relative to the purchasing of SWSC water. The need to use SWSC water results in a 9% and 27% increase in costs for the ANGD and GWC3 streamflow targets, respectively.

Exhibit 29: Management Actions and Associated Costs[32] to Meet Streamflow Targets without Surface Water Releases

Actions	ANGD	GWC3
Consumer Rate Change	$3,000	$3,000
Direct Demand Reduction/Rebates	$6,000	$6,000
Groundwater Pumping and Treatment	$942,000	$942,000
Potable Distribution System Repair	$63,000	$63,000
Purchase of SWSC Water	$94,000	$276,000
Total Annual Cost	**$1,108,000**	**$1,290,000**

A final minimization plan cannot be constructed until after consultation with MassDEP during which the extent of requirements will be determined and acceptability of using Congamond Lakes for surface releases can be discussed. Until such discussions, the feasibility of Congamond Lakes for releases should be evaluated.

2.5 Mitigating Withdrawals Above Baseline

The Regulations specify that permittees must mitigate withdrawals above baseline commensurate with impact (see Section 1.1). In the sections below, we discuss mitigation actions for each town. As discussed in Section 1.1, “demand management to the greatest extent feasible” is required before additional withdrawals and associated mitigation actions are permitted. Based on actions needed for meeting standard permit conditions, CFR and minimization, we assume that demand management actions will have been exhausted. As such this section focuses on actions that are available to each town should demand still exceed baseline.

Two general sets of actions are available: 1) direct actions for which a volumetric equivalent can be calculated and 2) indirect actions for which credit points are awarded. Indirect actions are limited to 1 MGD total per permittee and 10 points are equivalent to 0.10 MGD. Indirect credits are specified as “up to” a specific value. Therefore, we specify credit for these actions as “up to” a specific value. MassDEP is due to provide guidance on required documentation for credits and methodology for credit calculations (e.g., average annual recharge from stormwater project). In the interim and for this project, we specify our methods and assumptions in calculating credits. Unlike CFR and minimization requirements which are subbasin specific, mitigation requirements are based on permittee-specific baseline values and projected demand; therefore, we discuss the towns separately.

[32] All costs are rounded to the nearest thousand dollars to reflect and emphasize that the modeling and its results are screening-level or planning-level accuracy.

2.5.1 Potential Mitigation Actions for Southwick

MassDEP allocated 0.69 MGD to SDPW as baseline withdrawal.[33] From 2011 to 2015, SDPW's average withdrawal levels were near this baseline, ranging from 0.46 to 0.65 MGD. Several measures are available, and some required, that may keep demand below 0.69 MGD in the near future including standard conditions, CFR and minimization requirements (Sections 2.3 and 2.4, respectively). However, demand beyond 0.69 MGD would require mitigation actions before additional withdrawals are made. Under the current permit renewal, up to 0.73 MGD may be re-permitted requiring up to 0.04 MGD mitigation. Withdrawals beyond 0.73 MGD would require a new permit and the mitigation of all volumes under that permit.

Potential mitigation actions identified and quantified during this project are summarized in **Error! Reference source not found.** below.

Exhibit 30: Potential Mitigation Actions and Associated Credits for Southwick

Action	Status	Credit (MGD)
Direct		
Surface water releases	SDPW can implement a surface water release schedule to improve streamflow in Great Brook during low-flow periods. Consultation with DFW is required to determine targets and releases and, therefore, associated managed volume.	Up to 64 MG of managed storage meets up to GWC2 streamflow targets[34]
Purchase water from SWSC	Available without a limit under current contract	Available as needed but more expensive than surface releases
Infiltration-based stormwater practices	Reduction reflects stormwater projects installed to date.[35] SDPW must maintain these projects to maintain infiltration performance. Additional qualifying projects are expected under new MS4 requirements.	At least 0.15 (additional expected under MS4 program)
Wastewater adjustment via groundwater returns	Credit for public water withdrawn above baseline and returned to the basin via septic systems (i.e., future customers on public water and septic systems), ~50% of future withdrawals if similar percent of customers on septic	0.02[36]
Indirect		
Culvert replacement	Southwick has performed and plans to perform additional culvert replacement projects that meet stream crossing standards.	up to 0.15
Stormwater bylaw	Southwick's stormwater bylaw will be updated to meet the MS4 requirements.	up to 0.10
Private well bylaw	Southwick may update the town's private well bylaw to promote	up to 0.10

33 This volume is the town's water use in 2005 plus five percent. Maximum permitted volume with permit renewal is 0.73 MGD, the current permit maximum. Additional volume would require a new permit application. Withdrawals above baseline, whether under permit renewal or new permit, require mitigation.

34 See Section 2.4.2 for details.

35 SDPW can be awarded direct mitigation credit on a volumetric basis for increases in average annual recharge volumes resulting from any stormwater projects approved by MassDEP. SDPW has 41 stormwater infiltration projects that increase recharge to the Westfield Basin and 2 additional projects in the Farmington Basin. SDPW receives 100% and 50% volumetric credit for stormwater recharge to the Westfield and Farmington Basin, respectively. We used the Stormwater Credit Calculator developed under a previous WMA Program grant for the Town of Wrentham and available at http://www.abtassociates.com/wma.

36 MassDEP gives mitigation credit for groundwater returns for the water withdrawn *above* the baseline volume that will be returned to groundwater through septic systems or permitted groundwater discharges (MassDEP 2014). Therefore, this calculation and resulting value are different from the septic recharge calculation in Section 2.1.

Exhibit 30: Potential Mitigation Actions and Associated Credits for Southwick		
Action	**Status**	**Credit (MGD)**
update	equitable and effective outdoor conservation.	
Acquire and protect land in Zone I/II	Southwick may purchase conservation land in the Zone I/II area (Exhibit 22) to promote recharge in the Zone I/II area.	up to 0.10
Total Mitigation Credits in addition to surface releases and purchasing SWSC water		**up to 0.62 MGD**

2.5.2 Potential Mitigation Actions for West Springfield

MassDEP allocated 4.45 MGD to WSDPW as baseline withdrawal.[37] From 2011 to 2015, WSDPW's average withdrawals were near this baseline, ranging from 3.54 to 3.88 MGD. Several measures are available, and some required, that may keep demand below 4.45 MGD in the near future including the standard conditions and minimization requirements (Sections 2.3 and 2.4, respectively). Additional demand beyond 4.45 MGD would require mitigation actions before additional withdrawals can be made. Actions identified and quantified during this project are summarized in Exhibit 31 below

Exhibit 31: Potential Mitigation Actions and Associated Credits for West Springfield		
Action	**Status**	**Credit (MGD)**
Direct		
Surface water releases	WSDPW can coordinate with SDPW to implement a surface water release schedule to improve streamflow in Great Brook during low-flow periods. Consultation with DFW is required to determine targets and releases and, therefore, associated managed volume.	Up to 64 MG of managed storage meets up to GWC2 streamflow targets[38]
Purchase water from SWSC	Available without a limit under current contract	Available as needed but more expensive than surface releases
Infiltration-based stormwater practices	WSDPW has stormwater projects but we did not have sufficient data to calculate a recharge credit. Additional qualifying projects are expected under new MS4 requirements. Data necessary for recharge calculation would need to be collected.	Need additional data
Repair of I/I	Significant opportunities existing for volumetric credit for removal of I/I via sewer improvement projects. The WMA Guidance states that I/I projects are assumed to reduce 50% of I/I.	0 MGD for subbasin 19078 Up to 0.216 MGD for subbasins 19078, 19076, 19074, 19090 and downstream
Indirect		
Stormwater bylaw	West Springfield's stormwater bylaw will be updated to meet the MS4 Requirements.	up to 0.10
Private well bylaw update	West Springfield may update the town's private well bylaw to promote effective and equitable outdoor conservation.	up to 0.10

37 This volume is the town's water use in 2005 plus five percent. Maximum permitted volume with permit renewal is 6.45 MGD, the current permit maximum. Additional volume would require a new permit application. Withdrawals above baseline, whether under permit renewal or new permit, require mitigation.

38 See Section 2.4.2 for details.

Exhibit 31: Potential Mitigation Actions and Associated Credits for West Springfield		
Action	**Status**	**Credit (MGD)**
Acquire and protect land in Zone I/II	West Springfield may purchase conservation land in the Zone I/II area (Exhibit 22) to promote recharge in the Zone I/II area.	up to 0.10
Total Mitigation Credits in addition to surface releases and purchasing SWSC water		**up to 0.59 MGD + additional pending data**

3 Water Use Survey

3.1 Water Use Survey

3.1.1 Background

An electronic survey tool (Survey Monkey) was used to provide insight into how Southwick and West Springfield residential water customers perceive conservation, and respond to conservation strategies[39]. Questions focused on current behaviors/practices, perceptions of water conservation, willingness to change practices, and receptiveness to conservation incentives, programs, and restrictions. As no demographic data was collected in the survey, it is not possible to determine if the survey elicited responses from a representative sample of customers. Respondents were self-selected and therefore may represent a sample of customers that responded based on their interest in water conservation or water use issues at large.

The response size represented a relatively small sample of the representative populations in Southwick and West Springfield. In Southwick there were 314 respondents, which represents 11.5% of the public water supply accounts (though not all respondents were on public water supply). In West Springfield, there were 454 responses, which represents 5.1% of all accounts. Though these are relatively small sample sizes, common responses to many of the questions in the survey did indicate patterns of water conservation practices and perceptions that could be targeted in a water conservation program.

The survey was advertised in local newspapers, on town websites and social media pages, and on the Pioneer Valley Planning Commission's website, and through media releases that resulted in a story about this study in the Westfield News. Postcards were sent to all water account users in each town during the second week of the survey, and the survey was open for responses for three weeks (April 11-May 1, 2016).

3.1.2 Survey Design

Because of the large spikes in water use attributed to summer lawn watering, the survey was designed to gain distinct information about both outdoor and indoor practices and perceptions. Once finished with outdoor water use questions, respondents could choose to continue on to indoor water use questions with the incentive that they would be double-entered into a raffle for a $100 Amazon gift certificate. Respondents that responded to outdoor water use questions could also choose to enter a single entry to the raffle. The response rate for outdoor vs. indoor sections was 314 to 184 in Southwick and 454 to 275 in West Springfield.

The survey also aimed to distinguish between public water users and those on private wells by asking an initial question about their water source. This question is more relevant to Southwick –260 Southwick respondents out of 314 indicated they use public water – than West Springfield, where almost the entire town is served by public water.

(Note: The survey results discussed below reflect the answers of those respondents that indicated they were on the public water system, and excludes those on private water supplies.)

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[39] Note that while survey solicitations also went to commercial customers in West Springfield, the response was so small (with 9 businesses responding) that analysis of results was not worthwhile.

3.1.3 Outdoor Water Use Survey Results

Questions related to outdoor water use indicate that many respondents water their lawns outside of times or methods that are optimal for either water conservation or lawn health. For example, most respondents note that they are watering outside of "prime" watering hours of 5-9 a.m., when there is the least amount of evaporation and risk of causing fungal diseases (50% in West Springfield, 46% in Southwick). In addition, 66% and 66% in West Springfield and Southwick, respectively, report using a hose with sprinkler or timer-automated irrigation to water their lawns. Both methods are not utilizing technology that detects moisture in the ground. However, most respondents using town water indicate that they try to conserve outdoor water (92% in West Springfield, and 97% in Southwick). Most respondents on public water in both towns also state that they "rarely" or "never" water their lawns (56% in West Springfield, 58% in Southwick).

In addition to outdoor lawn watering, 63% in West Springfield and 69% in Southwick report washing their car outdoors. Outdoor car washing can use significantly more water than using commercial car washes.

Considering these response results with the documented spikes in water use during the summer suggests that while water users are motivated to conserve water, and want to "do the right thing," there may be a lack of information about what irrigation practices contribute to water conservation, or a lack of understanding of just how much water is consumed by watering lawns in sub-optimal ways. This notion is supported when isolating the answers of respondents that water their lawns more than twice a week – of these, 90% and 95% in West Springfield and Southwick, respectively, indicate that they "try to conserve outdoor water use." One other possibility for the discrepancy between perceived outdoor water use and the observed spike in summer water use is that the respondents of this survey may be inclined towards water conservation in the first place.

Another interesting note specific to Southwick is that there is a perception that utilizing private wells for irrigation is a method of water conservation, despite the fact that private wells utilize the same groundwater as the public water system. Though only a small number (4%) of respondents indicate they use private wells to conserve public water, free-form comments in the survey as well as anecdotal knowledge in Southwick suggest a far more prevalent use of private wells and perception that wells are a method of conservation. The results suggest an opportunity to educate all Southwick residents about the natural origins of their water.

In terms of what would "definitely" or "probably" prompt respondents to implement outdoor water saving practices, the most significant responses are town-wide conditions or opportunities that would also have an individual impact, such as:

- Drought/emergency: 89% West Springfield, 81% Southwick
- Water use restrictions: 77% West Springfield, 72% Southwick
- Rebates/incentives: 76% West Springfield, 73% Southwick

These responses were chosen in greater extent than other options describing more isolated or individually tailored conditions and opportunities, such as a higher water bill, learning about nearby economic or environmental impacts of excessive water consumption, or learning about a neighbor's water conservation practices. The results suggest that respondents are most prompted to save water when responsibility or opportunity for conservation is broadly distributed, rather than in reaction to individual events or circumstances.

When asked about what conservation measures they most support, respondents rate town-wide lawn-watering restrictions highest in Southwick (73% strongly or moderately support) and more information about effective techniques and practices highest in West Springfield (79%). West Springfield respondents identify strong or moderate support (77%) for limiting lawn watering as well, the second-highest rated option. Respondents are also greatly interested in rebates and incentives to purchase water-efficient irrigation devices or tools (69% in West Springfield, 70% in Southwick) and rebates and incentives to purchase less water-intensive grass and native plant species (67% in West Springfield, 68% in Southwick). The most unpopular conservation strategy is raising rates on those who exceed a certain threshold (36% strongly or moderately oppose in Southwick, 34% in West Springfield). Monthly billing and information on how water conservation efforts are contributing to goals/thresholds received only moderate support.

These results again suggest that respondents wish to "do the right thing," but within the confines of a common standard that does not unduly impact individual users that may have different needs (such as larger families). One encouraging note is that 69% of respondents in Southwick and 78% of respondents in West Springfield strongly or moderately oppose the statement, "I do not support water conservation; town should find more water for my needs."

In summary, the greatest barriers to water conservation practices appear to be the perception of cost and uncertainty about the best approaches to conserve water (i.e. what gets the "most bang for the buck"), as well as a lack of understanding of the problem and what water conservation means in practice. Respondents are most interested in water conservation strategies that provide a common standard to follow and support the required outdoor watering restrictions required by the new permit. Incentives, rebates, and information about effective outdoor water conservation were also in high support by the respondents.

3.1.4 Indoor Water Use Survey Results

As mentioned above, respondents were incentivized to answer the questions about indoor water use through an increased chance to win a raffle for an Amazon gift certificate. For West Springfield, 60% of outdoor respondents proceeded to the indoor questions; the proportion was 58% in Southwick. Indoor questions were structured similar to the outdoor use questions to facilitate comparison of attitudes.

The survey results reveal that most indoor use respondents live in homes built before 1994, when national water efficiency standards were put into effect (86% in West Springfield, 68% in Southwick). Exhibit 32 shows the number of respondents that indicated they have no regular/non-low-flow fixtures from respondents that are on public water and living in pre-1994 homes.

Exhibit 32: Survey Respondents that Live in Pre-1994 Homes and Have All Low-Flow Fixtures

Town	Number of Respondents that Live in Homes Built before 1994	No 6- or 3.5-Gallon Toilets	No Regular Faucets	No Regular Showerheads
Southwick	124	59 (48%)	9 (9%)	35 (35%)
West Springfield	247	124 (50%)	20 (10%)	57 (37%)

The results suggest that there is a more ready adoption of low-flow toilets (approximately half of respondents have done so in each town) but less so for regular faucets and showerheads. They also suggest that there is significant opportunity to save more water through fixture upgrades. The opportunity is also roughly illustrated when such adoption rates as found in the survey are considered in light of American Community Survey 2014 estimates of housing age by the U.S. Census, which indicate that approximately 31% of units (1,182 out of 3,861) in Southwick and 8% of units (962 out of 12,073) in West Springfield were built after 1990.

Among other water-using appliances, 77% and 78% of West Springfield and Southwick respondents, respectively, have dishwashers. There is a slightly higher adoption of front-loading washing machines in Southwick (39%) than in West Springfield (31%), but most respondents (approximately 60%) still have top-loading washers, which use significantly more water than front-loading washers. The largest difference between the two towns in terms of appliances is between garbage disposals, where 80% in West Springfield and 26% in Southwick reported having them. This is likely due to wastewater disposal guidance from Springfield Water and Sewer Commission urging the use of garbage disposals in homes. Although disposals are certainly not the largest users of water in a house, reducing the use of disposals through organics/food composting offers additional water saving potential.

Similar to the outdoor portion of the survey, respondents were given a yes-no question on whether they engage in indoor water conservation. In West Springfield 90% indicated they did, and 96% in Southwick said likewise. These are similar levels to outdoor responses, but represent a smaller sample size. The responses might possibly be composed of respondents more interested in water conservation, as the top reason listed for conserving indoor water in both communities was concern for the environment (58% in West Springfield, 53% in Southwick), followed by "to save money" (33% in West Springfield, 42% in Southwick).

Of those saying they do not try to conserve water (33 in West Springfield and 14 in Southwick), the top reasons in West Springfield were "I haven't thought about it" and "not sure what would be effective," and in Southwick they were "not sure what would be effective" and "water conservation is not a priority for us." As with the outdoor responses, it appears that uncertainty about what the most optimal conservation methods are and a lack of awareness/understanding of the importance of water conservation contribute to no action. Less (15% in West Springfield, 7% in Southwick) identified a concern with the cost of efficiency upgrades as a reason not to conserve. (It must be emphasized, however, that these are small sample sizes.)

In terms of what practices respondents engaged in to conserve indoor water, most identified running appliances like dishwashers and washing machines only when full, fixing leaks immediately, or leaving the tap off while brushing teeth or washing dishes, while the least-identified practice was taking shorter showers (see question #24 in the survey responses in the appendix). This suggests that for the most part, behavioral changes are more readily adopted for indoor water conservation, and could be made more effective through the implementation of water-efficient fixtures. Correspondingly, rebates or incentives were identified by 57.89% and 54.79% in West Springfield and Southwick, respectively, as a likely motivation to upgraded older fixtures. Clearer guidance on what fixtures are best was also a significant motivator (34% in West Springfield, 31% Southwick), though less so behind incidental circumstances such as when an older fixture breaks or home renovations.

In comparison with outdoor use, respondents in both towns would "definitely" or "probably" be prompted by mostly the same top-ranked scenarios to implement indoor water-saving measures: 1) significant drought, 2) water use restrictions, and 3) rebates offered by the water department or bills rising significantly (Exhibit 33). Water bills rising significantly is identified as less of a motivator to save water outdoors than it is indoors. Community impacts, such as detrimental environmental impacts and negative economic development consequences, were larger motivators to conserve water outdoors than indoors (see questions 16 and 31 in the survey responses in the appendix). These results suggest that outreach messages for indoor and outdoor water use should be tailored to the benefits of water use restrictions and rebates/incentives to upgrade fixtures.

Exhibit 33: Indoor versus Outdoor Conservation Motivators

Motivator	Southwick Indoor Responses	Southwick Outdoor Responses	West Springfield Indoor Responses	West Springfield Outdoor Responses
Total number of Respondents on Public Water	174	181	277	302
Drought / emergency	87%	81%	85%	89%
Water bills rise significantly	70%	54%	76%	65%
Town-wide water restrictions	80%	72%	82%	77%
Rebates for efficiency upgrades	76%	73%	75%	76%

3.2 Water Conservation Program

Water conservation recommendations for Southwick and West Springfield apply to all water users, but are focused largely on the residential population. This is by far the largest user group and the sector presenting the greatest potential for savings. As noted above, the residential population in Southwick accounts for 73% of use and in West Springfield accounts for 50% of use. In addition, the residential sector as a group tends to use water in the same ways, making it easier and more cost effective to promote behavior change.[40]

The water conservation program described herein builds on several of the insights gained from the residential water use practices survey as described in the previous section. Key insights informing the water conservation program are:

- Majority of accounts indicate support for town-wide water use restrictions
- Majority of accounts are using older fixtures and appliances
- Important opportunities with many accounts to improve water use, particularly with regard to lawn care and car washing, and garbage disposal (in West Springfield particularly)

[40] In contrast, the industrial and commercial sector (the next biggest user group in each community at 12% in Southwick and 26% in West Springfield) tends to use water in many different ways. Promoting practices in this sector requires a more individualized strategic approach with outreach to specific subgroups (e.g., restaurants, supermarkets, manufacturing facilities).

3.2.1 Updating Water Use Regulations and Implementing Restrictions on Non Essential Outdoor Watering

Both communities have water use regulations in place. Southwick last revised its regulation in 2015 and West Springfield in 2001. West Springfield has in hand recommendations now to update its regulations based on MassDEP's 2009 model. Regulations in both communities also need updates such that requirements apply to all users and not strictly those purchasing public water. This is critically important in a water supply area--such as Southwick--where all uses essentially impact the same groundwater sources. This change is also important to ensuring fairness and equity throughout each Town as restrictions are implemented. (See appendixes for recommended changes in water use regulations and irrigation system policies.)

Non-essential outdoor watering restrictions are to be instituted indefinitely in both communities given location in a subbasin where the August Net Groundwater Depletion exceeds 25% and where use exceeds 65 Residential Gallons Per Capita Per Day. Both communities have in hand proposed language for the Public Notice declaring a State of Water Supply Conservation based on the calendar option of 1 day of watering per week for non-essential outdoor uses. (See appendixes for language of these notices.)

For Southwick, projected demand reduction for implementation of outdoor water use restrictions is 0.025 to 0.065 MGD. For West Springfield, projected demand reduction is 0.080 to 0.210 MGD.

3.2.2 Incentivizing Installation of High Efficiency Fixtures and Appliances

Responses to the residential survey indicate tremendous opportunity to promote changes within households to high efficiency fixtures (specifically toilets, showerheads, and faucets) and appliances (specifically clothes washers). A majority of accounts, as indicated by survey responses in Exhibit 34, are using older, inefficient fixtures and appliances that could be upgraded to collectively realize important water use reductions in Southwick and West Springfield.

Exhibit 34: Residential Survey Responses Indicating Use of Older Fixtures and Appliances

Fixtures/Appliances	Southwick	West Springfield
Traditional toilet to 3.5 gals. per flush	60.5%	66.0%
Regular showerheads	40.8%	47%
Regular faucets	56.3%	60.5%
Top loading clothes washer	60.8%	66.4%

A series of fact sheets have been prepared to show the collective waste in using these fixtures and appliances and the savings in both water and costs that could be realized. (See appendixes for these fact sheets.) These will be used in conjunction with a rebate program that will be rolled out in each of the communities. Each town is in the process of determining the details of the rebate program based on information provided through this project. See Section 5c, Water Efficiency Rebate Program, which follows.

For a five-year rebate program, estimated water savings are approximately 0.014 MGD for Southwick and 0.052 for West Springfield. This would annually cost about $11,000 for Southwick and $35,000 for West Springfield. Section 5c has more detail on how these figures were calculated.

3.2.3 Promoting Better Practices through Education and Outreach

An active education and outreach program is a critical component of the water conservation program in both Southwick and West Springfield. There are ample opportunities to provide information and help promote improved practice, including insertion of materials in water bills, posts on the Water Division web page, and displays in public locations and at town events.

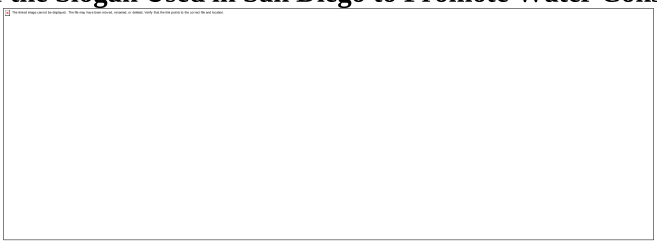
Telling the story of where drinking water comes from and the state of drinking water supply (including how clean and safe it is, but also the need for conservation) can be powerful in helping people move to better water use practices.

Wherever possible, it is recommended that messages help to promote water conservation practices as a positive and where possible as the norm. Normative messaging builds on the desire for people generally to want to fit in with their community and their neighborhood. Recent social science research indicates that people often decide what attitudes and actions are appropriate from those around them. In many instances, this takes additional research to understand the behavior norm in a given area. Normative messaging has been described as the "peer pressure" approach to behavior change.

One idea promoted in the fact sheets builds on the finding from the residential survey that people generally want to conserve water. Whether using water indoors or outdoors, more than 90% of respondents in each community indicate that they conserve water. This gives a sense that people want to "do the right thing." As such the fact sheets emphasize how much water is wasted collectively and then recommends a way to "switch" and "save on water and costs."

It may also be useful to develop a slogan that normalizes water conservation efforts and puts them in a positive light. A current best example of this is from San Diego, California, shown in Exhibit 35.

Exhibit 35: Example of the Slogan Used in San Diego to Promote Water Conservation



Perhaps this could be adapted to Southwick and West Springfield to read:

> “West Springfield/Southwick residents care about drinking water...
>
> striving to conserve in every way.”

4 Summary of Potential Actions for Meeting WMA Requirements

Based on the information and analyses in the previous sections, we summarize actions available for each town for meeting WMA requirements. As discussed throughout the report, uncertainties exist in interpreting the Regulations, WMA Guidance and calculation of demand reductions and credits. Therefore, the towns will only be able to determine the final set of actions that are sufficient to meet all requirements during consultations with MassDEP and DFW.

4.1 Potential Actions and Next Steps for Southwick

Exhibit 36 summarizes all actions evaluated in this project for SDPW. In preparation for the requirements and discussion with MassDEP and DFW, we recommend the following next steps.

- Implement the following water conservation measures and track associated demand reductions to ensure meeting 65 RGPCD:
    - Outdoor water use restrictions,
    - Annual rebate program for water-efficient, indoor fixtures and appliances,
    - Educational outreach to support the above actions using materials developed under this project and consulting or becoming a member of EPA's Water Sense program, and
    - Require all new connections to use Water Sense certified products to maintain water efficiency achieved with the rebate program;
    - Implement private well bylaw for points-based credit and to support effective and equitable outdoor water use restrictions.
- Initiate, in collaboration with WSDPW, a feasibility study for Cogamond Lakes to serve as source of surface water releases including confirmation of available storage volume without adverse impacts and any necessary dredging or other actions;
- Initiate formal tracking of projects that meet minimization or mitigation requirements including working across departments for notification of such project and acquisition of necessary data.
    - Infiltration-based stormwater practices including the following data: impervious acres managed, design depth and infiltration rate;
    - Culvert replacement projects that meet stream crossing standards;
    - Purchase and protection of land in Zone I /Zone II and other projects listed in the WMA Guidance
- Apply for an implementation grant to fund the rebate program and feasibility study under next year's WMA Program for which request for proposals is expected in August or September of 2016.

Additional actions will depend on consultations with DFW and MassDEP. Mainly, submitting minimization and mitigation plans based on the consultations and options outlined in this report.

Exhibit 36: Potential Actions and Associated Reduction and Credits for Southwick

Requirement	Action	Demand Reduction/ Credit (MGD)
Standard permit conditions (Nonessential water use)	Outdoor water use restrictions	0.025 - 0.065
Standard permit conditions (65 RGPCD)	Water conservation program (rebate, education)	0.011 - 0.036
CFR/ minimization/ mitigation	Surface water releases from Middle Pond of Congamond Lakes	May meet some or all requirements; need feasibility study
CFR/ minimization/ mitigation	Purchase water from SWSC	No current limit; more expensive than surface water releases
Minimization (mitigation[41])	Continuance of water conservation program over entire, 20-year permit	0.014 - 0.056
Minimization/ mitigation	Infiltration-based stormwater practices	0.151 (additional expected under MS4 program)
Mitigation	Wastewater returns via septic	0.020[42] (50% of future withdrawals if customers are same percent septic)
Mitigation	Culvert replacement	up to 0.150
Mitigation	Stormwater bylaw	up to 0.100
Mitigation	Private well bylaw update	up to 0.100
Mitigation	Acquire and protect land in Zone I/II (under consideration)	up to 0.100
Total reduction/credit beyond surface releases and SWSC water		**~0.70-0.75[43]**

4.2 Potential Actions and Next Steps for West Springfield

Exhibit 37 summarizes all actions evaluated in this project for WSDPW. In preparation for the requirements and discussion with MassDEP and DFW, we recommend the following next steps.

- Implement the following water conservation measures and track associated demand reductions to ensure meeting 65 RGPCD:
    - Outdoor water use restrictions,

[41] We estimated that water conservation options will be exhausted in meeting 65 RGPCD and minimization requirements; therefore, we do not anticipate additional availability meeting mitigation requirements.

[42] Value based on assumption of mitigating 0.04 MGD and current septic percentage of SDPW customers.

[43] The minimum and maximum values listed in the table reflect 5- and 20-year savings estimates. The individual minimum and maximum values do not necessarily sum to the total minimum and total maximum values because some savings estimates are dependent on each other. For example, the savings from meeting 65 RGPCD is smaller for the 20-year estimate because greater long-term savings are expected from outdoor use restrictions resulting in lower water savings requirements for meeting the 65 RGPCD.

    - Annual rebate program for water-efficient, indoor fixtures and appliances,
    - Educational outreach to support the above actions using materials developed under this project and consulting or becoming a member of EPA's Water Sense program,
    - Require all new connections to use Water Sense certified products to maintain water efficiency achieved with the rebate program, and
    - Implement private well bylaw for points-based credit and to support effective and equitable outdoor water use restrictions;
- Implement an aggressive UAW reduction program to meet or exceed the 10% UAW standard;
- Conduct a rate study to determine appropriate water rates to recover all costs associated with water supply provision including unbilled municipal use and environmental protection measures anticipated to meet the above measures,
- Coordinate with SDPW to initiate a feasibility study for Cogamond Lakes to serve as source of surface water releases including confirmation of available storage volume without adverse impacts and any necessary dredging or other actions;
- Initiate tracking projects that meet minimization or mitigation requirements and working across departments for notification of such projects and acquiring necessary data to calculate the credits:
    - Infiltration/inflow projects,
    - Infiltration-based stormwater practices including the following data: impervious acres managed, design depth and infiltration rate,
    - Purchase and protection of land in Zone I /Zone II and other projects listed in the WMA Guidance.

Additional actions will depend on consultations with DFW and MassDEP. Mainly, submitting minimization and mitigation plans based on the consultations and options outlined in this report.

Exhibit 37: Potential Actions and Associated Reduction and Credits for West Springfield		
Requirement	**Action**	**Demand Reduction/ Credit (MGD)**
Standard permit conditions- Nonessential water use	Outdoor water use restrictions	0.080 - 0.210
Standard permit conditions - 65 RGPCD	Water conservation program (rebate, education)	0.125 - 0.196
Standard permit conditions - 10% UAW	Increase UAW investments or implement Functional Equivalence Plan	0.194
CFR/ minimization/ mitigation	Surface water releases from Middle Pond of Congamond Lakes	May meet some or all requirements; need feasibility study
CFR/ minimization/ mitigation	Purchase water from SWSC	No current limit; more expensive than surface water releases
Minimization (mitigation[44])	Continuance of water conservation program over entire, 20-year permit	0.052 - 0.210
Minimization/ mitigation	Infiltration-based stormwater practices	Requires additional data
Mitigation	Increased infiltration/inflow detection and repair, credit estimated as up to 50% of estimated I/I	0 MGD for subbasin 19078 Up to 0.216 MGD for subbasins 19078, 19076, 19074, 19090 and downstream
Mitigation	Private well bylaw update	up to 0.100
Mitigation	Stormwater bylaw	up to 0.100
Mitigation	Acquire and protect land in Zone I/II (under consideration)	up to 0.100
Total reduction/credit beyond surface releases and SWSC water		**~1.04 – 1.26[45]**

44 We estimated that water conservation options will be exhausted in meeting 65 RGPCD and minimization requirements; therefore, we do not anticipate additional availability meeting mitigation requirements.

45 The minimum and maximum values listed in the table reflect 5- and 20-year savings estimates. The individual minimum and maximum values do not necessarily sum to the total minimum and total maximum values because some savings estimates are dependent on each other. For example, the savings from meeting 65 RGPCD is smaller for the 20-year estimate because greater long-term savings are expected from outdoor use restrictions resulting in lower water savings requirements for meeting the 65 RGPCD.

5 References

Baystate Environmental Consultants. 1983. Diagnostic/Feasibility Study for Congamond Lakes. Town of Southwick, Massachusetts.

Cortell and Associates. 1980. Draft Environmental Impact Report Flood Control Works Congamond Lakes. Southwick, Massachusetts. Massachusetts Department of Environmental Quality Engineering Division of Waterways.

Grannells, R. 2016. Personal email communication between Richard Grannells from Southwick Department of Public Works and Viktoria Zoltay from Abt Associates on June 29, 2016.

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Town of Franklin, Massachusetts. 2014. Regional Evaluation of Water Management Alternatives to Reduce Streamflow Impacts in the Upper Charles River Watershed. 2014 Sustainable Water Management Initiative Grant, Massachusetts Department of Environmental Protection, BRP 2013-06.

United State Geological Survey (USGS). 2016. National Water Information System. "Great Brook near Westfield,MA"/ Site number "01183450". http://waterdata.usgs.gov/nwis, 6/23/16

Data and reports used in the analyses are documented in Appendix Chapter 1Appendix B .

All data and information, unless otherwise noted, are directly from SDPW or WSDPW.

Appendix A Data Review and Refinement

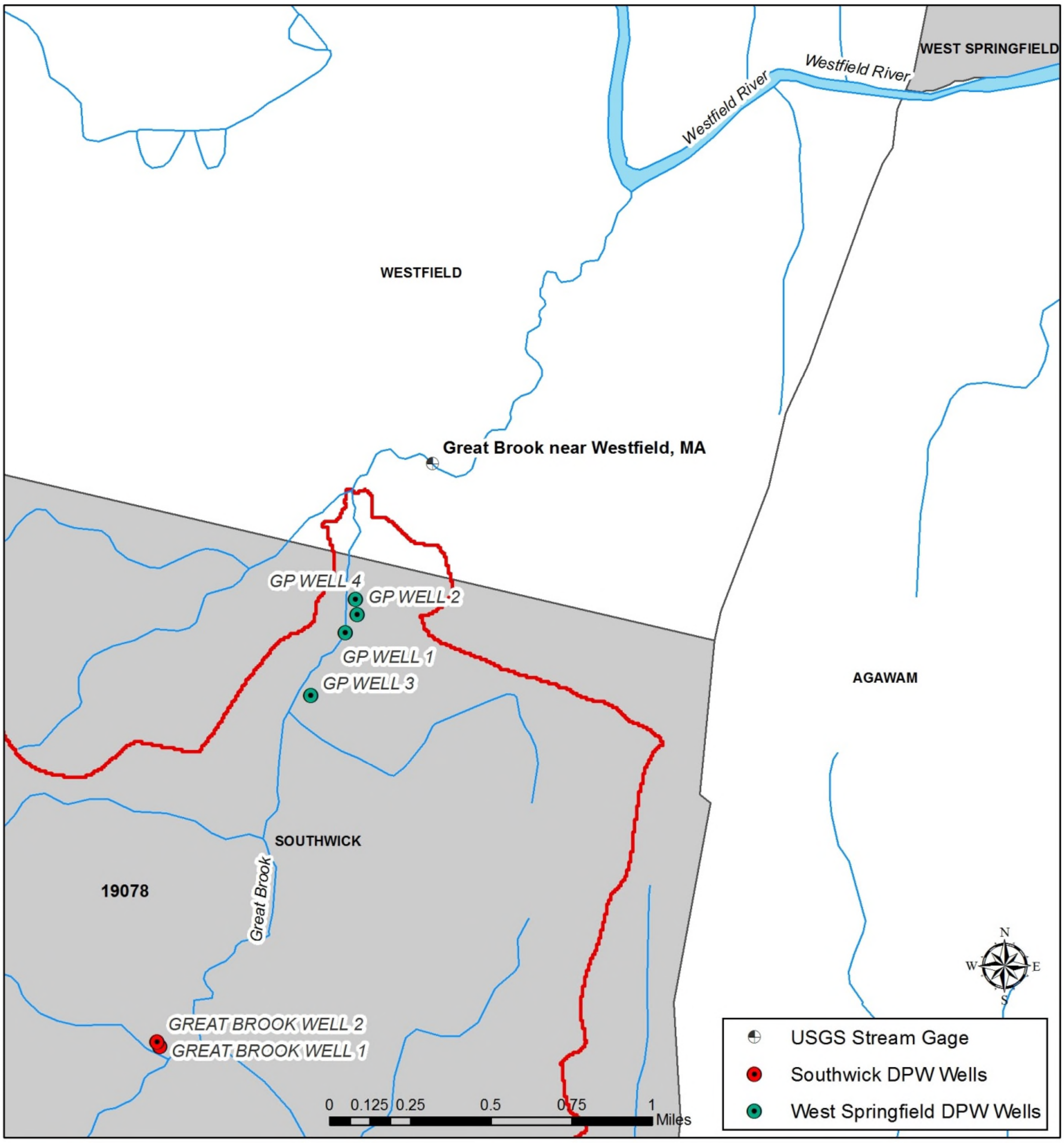
We started the project by compiling and reviewing all available data about Southwick and West Springfield water system and related materials and subbasin 19078. We compared this data with MassDEP baseline data (2000-2004) which is the basis for some regulatory requirements. Below we summarize differences between measured data and SYE modeled data and between the 2000-2004 and more recent data. None of the differences change the GWC or ANGD status and does not change any applicable requirements.

Streamflow Data

Some WMA requirements are determined based on the median unimpacted August streamflow for 1960-2004. Many subbasins in Massachusetts are ungaged so MassDEP used estimated flows from the SYE. SYE estimates daily, unimpacted flow based on measured flow at a stream gage and a regression between a stream gage's watershed characteristics and the ungagged basin's characteristics. After estimating an unimpacted flow time series, SYE subtracts and adds the withdrawals and discharges of water reported in the MWI data to determine the impacted flows. These impacted flows are the basis of some WMA requirements.

To assess the reasonableness of the SYE estimates for subbasin 19078, we compared the SYE estimated streamflows with the USGS stream gage located at the outlet of subbasin 19078 (Exhibit 38). This stream gage has measured data for the time period of 11/10/1972-9/30/1982.

Exhibit 38: Location of the USGS Stream Gage 01183450 on Great Brook near Westfield, MA



Measured streamflow at the gage most closely corresponds with SYE unimpacted streamflows since the pumping impacts during this time period were significantly less than current withdrawals (e.g., population increase, West Springfield still used Bear Hole Reservoir). Exhibit 39 and Exhibit 40 show the comparison of the stream gage data with SYE impacted and unimpacted flows, respectively, for the available period of record.

Exhibit 39: Time Series of Measured and SYE Estimated Impacted Streamflow

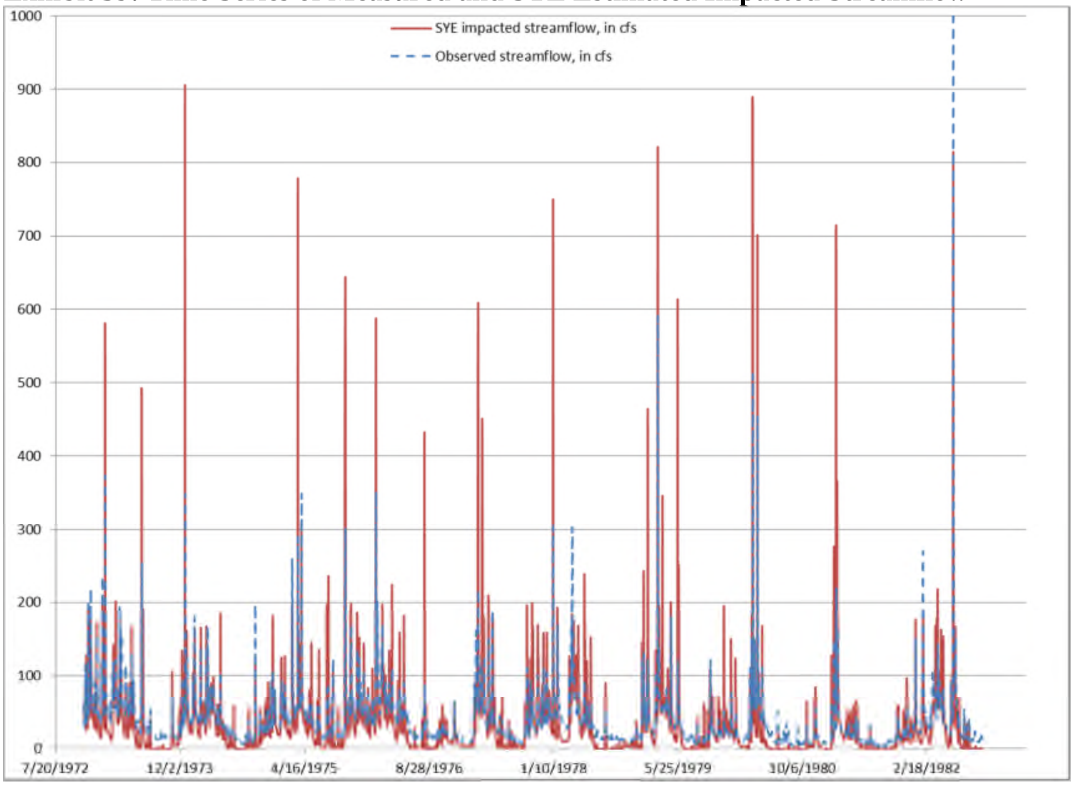
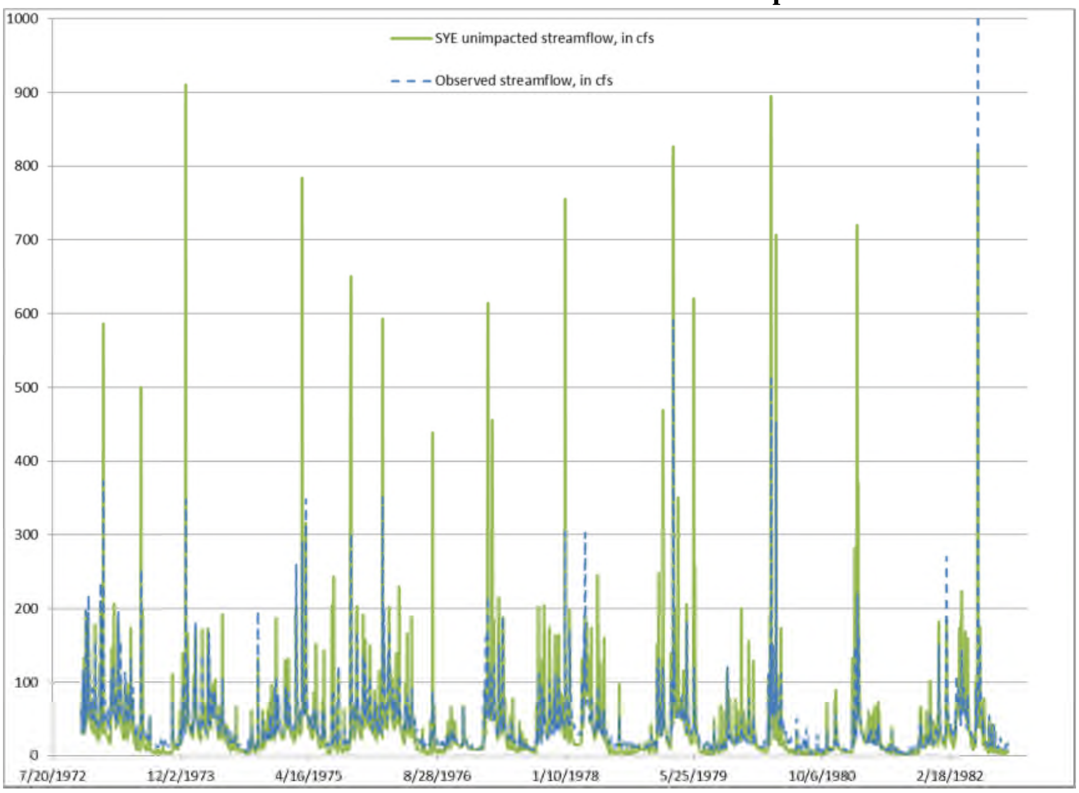


Exhibit 40: Time Series of Measured and SYE Estimated Unimpacted Streamflow



As expected, the comparison shows that unimpacted SYE flows match better with the streamflow gage. However, it also shows that SYE flows are significantly flashier than measured flow; that is, SYE overestimates peak flows and underestimates low-flows. This difference significantly affects summer, low flows which are a main concern of the Regulations.

In addition to visual comparisons, we determined the agreement between streamflows by calculating the Nash-Sutcliffe Efficiency (NSE) coefficient over all days in the available period and for August flows. NSE is a commonly-used metric for assessing the predictive value of hydrologic models such as the SYE. NSE values can range from 1.0 (perfect fit) to negative infinity. A NSE value below zero indicates that the mean of the observed time series would have been a better predictor than the model. Exhibit 41 confirms that unimpacted streamflow matches measured streamflow better. For unimpacted flow, the NSE is slightly greater than zero over the period of record. However, the NSE is significantly negative for August flows indicating a lack of agreement.

Exhibit 41. Comparison of SYE Estimated Streamflow with Measured Streamflow

Time Period	NSE Values	
	Unimpacted Streamflow	Impacted Streamflow
1972-1982, all days	0.165	0.158
1972-1982, August	-1.723	-2.138

Ideally, we would use measured flows for calculating flow targets and calibrating modeling efforts, but there are no gage data available after 1982. Therefore, we calculated the average difference in August flows between unimpacted SYE flows and measured flows for 1972-1982 and applied the same difference to the 2000-2004 SYE unimpacted flows for the baseline period. On average, the measured flow is 3.43 MGD, or 158%, greater than the SYE unimpacted flow in 1972-1982.

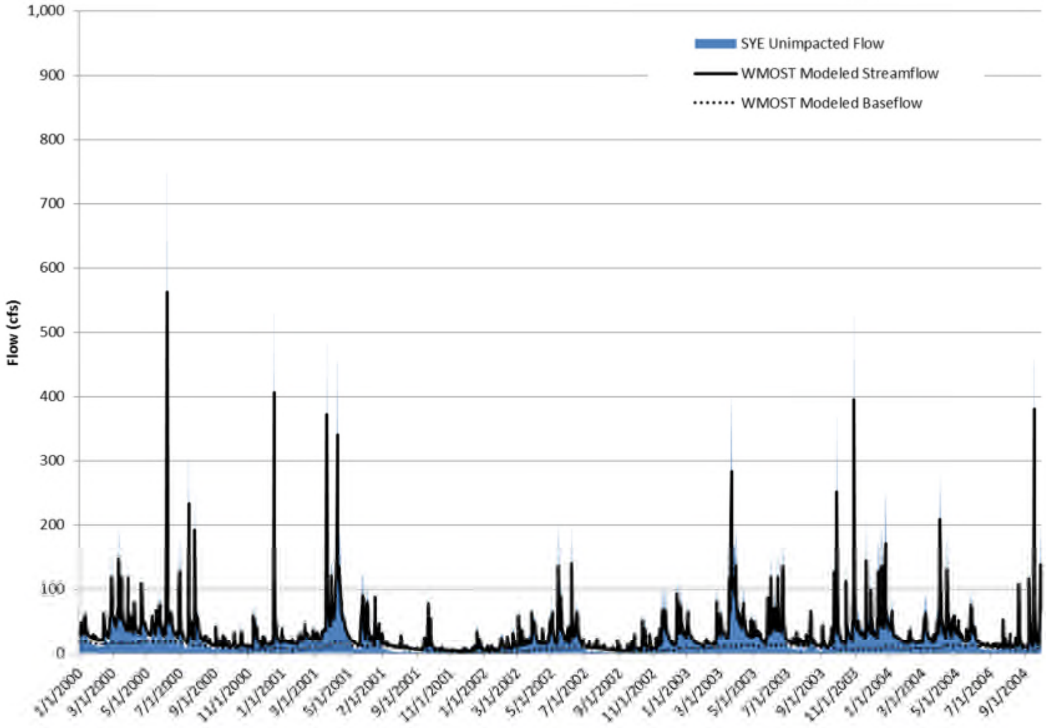
Assuming the ratio between measured and estimated flows in 1972-1982 is constant over time, it is reasonable to apply the same 158% correction to the SYE calculated August median unimpacted streamflow for 1960-2004. Exhibit 42 shows the original value for August median unimpacted streamflow, which is the same as the WMA Tool value, and the adjusted SYE August median proposed to be used in calculations for meeting the requirements. As shown in Section 2.1, this adjustment does not change the GWC or ANGD status and does not change any applicable requirements.

Exhibit 42. SYE Estimated Unimpacted Streamflow and Adjusted Unimpacted Streamflow

Statistic	SYE Unimpacted Streamflow (MGD)	Adjusted SYE Unimpacted Streamflow (MGD)
August Median	3.962	4.924

Exhibit 40 (above) and Exhibit 43 (below) show very similar trends in terms of deviations from SYE unimpacted flows. Note that the graphs are set on the same scale for easier comparison. The final NSE values for WMOST streamflows relative to SYE unimpacted flows for all days in the 2000-2004 period is 0.90 and for August days is 0.74. The August percent difference is 141% greater than SYE unimpacted flow compared to the 158% for measured flow.

Exhibit 43: Modeled Streamflow Time Series Comparison - SYE Unimpacted and WMOST



Septic Recharge

In comparing data between baseline and more recent periods, we identified a significant difference in septic recharge volumes for subbasin 19078. Southwick added a sewer connection to the WWPCP in 2001. Since then, Southwick has added 848 sewer connections. Many of these connections are located in subbasin 19078, reducing the number of septic users in the basin and the recharge volume.

We estimated the septic recharge in 2011-2015 using the Southwick water and sewer mains map and census block groups to determine the population in the subbasin that is on public water and septic and private water and septic. We assumed these users have a daily use of 65 gallons per person, of which 15 percent is consumed (i.e., does not recharge via septic systems). Exhibit 44 shows the estimated values for public and private water septic returns to the subbasin. Since subbasin 19078 is almost entirely within Southwick, the data reflects Southwick water users.

Exhibit 44: Average Septic Returns for 2011-2015

Source of Water for Returns	Population	Water Use (MGD)	Loss to Consumptive Use	Septic Returns (MGD)
Public Water Septic Users	2,258	0.147	15%	0.125
Private Water Septic Users	257	0.017	15%	0.014
Total Septic	2,004	0.163	15%	0.139

The septic returns for subbasin 19078 should be reduced from 0.327 to 0.111 MGD to account for the decrease in septic systems in the subbasin from the baseline period. As shown in Section 2.1 below, this adjustment does not change the groundwater category or August net groundwater depletion status of the subbasin. Therefore, it does not change any applicable requirements.

Appendix B WMOST Modeling and Input Data

We used WMOST in this planning study to screen among water management options to meet WSDPW customer demand while complying with requirements of the Regulations. WMOST is a public-domain software application designed to aid decision making in integrated water resources management. WMOST identifies the least-cost combination of management practices to meet the user specified management goals. The tool considers a range of management practices related to water supply, wastewater, nonpotable water reuse, aquifer storage and recharge, stormwater, low-impact development (LID) and land conservation, accounting for both the cost and performance of each practice.

In general, WMOST requires four categories of input data: watershed system, human water system, management costs, and effects of management practices on the watershed and/or human system. The general approach for the modeling study involved populating WMOST with data characterizing each of the systems. This process allows the user to better understand the dynamics and capabilities of the water system they are working with, and its constraints.

For more details, please refer to the full documentation available from the following EPA website: https://www.epa.gov/exposure-assessment-models/wmost-20-download-page

Calibration of WMOST Model

The purpose of the calibration scenario is to verify the model's ability to simulate known conditions. Generally, this is done by comparing measured streamflow with modeled streamflow. We selected the period of 2000 through 2004 for calibration because it served as the basis for MassDEP's determination of the "baseline withdrawals" for the Regulations and as such there is sufficient data on all regulated withdrawals and discharges in the subbasin and associated streamflows from SYE.

We calibrated the groundwater recession coefficient to achieve the appropriate general response over the entire modeling period and the approximate percent deviation of August flows (see Appendix A for details). Exhibit 45 summarizes key specifications for the calibration scenario.

Exhibit 45: Summary of Calibration Scenario Specifications

Data/Assumption	Values
SDPW and WSDPW demand	2000-2004 (based on SYE/WMA pumping data)
Customer price for water	Based on 2014-2016 data of SDPW or WSDPW revenue from records or fiscal year budget
Non-SDPW or -WSDPW withdrawals and discharges	2000-2004 SYE/WMA Tool water use and discharge flows
Management actions	None available
Management costs	2014-2016 O&M costs (based on expenses for electricity, natural gas, and chemicals; does not include bond payments or asset depreciation)
Streamflow target	None

Exhibit 46. WMOST Model Input Data for Subbasin 19078 Modeling

Input Data	Units	Data Sources: Subbasin-specific	Data Sources: Southwick	Data Sources: West Springfield	Notes
LAND USE (LU)					
Number of land uses/HRUs	Numerical value	13			Based on delineation in Sudbury-Assabet HSPF watershed simulation model
Stormwater Management Sets	Numerical value	9			Infiltration basin, bioretention area, and detention basins at 3 depths: 0.6", 1.0", 2.0". USGS Sudbury-Assabet HSPF Model Output modified using SUSTAIN
Existing land use for each HRU	Acres	Varies by HRU and subbasin, see model interface			Intersection of MassGIS 1999 Land use and Surficial Geology layers, crosswalked to HSPF HRU categories. For land conservation maximum areas, all land that has been conserved are removed.
Minimum area for each HRU	Acres	0			Intersection of MassGIS 1999 Land use and Surficial Geology layers, crosswalked to HSPF HRU categories. For land conservation maximum areas, all land that has been conserved are removed.
Maximum area for each HRU	Acres	Existing HRU areas with all existing conservation areas removed			Intersection of MassGIS 1999 Land use and Surficial Geology layers, crosswalked to HSPF HRU categories. For land conservation maximum areas, all land that has been conserved are removed.
Capital cost to conserve land use/HRU	$/acre	19,240			Purchase cost for vacant land in Southwick
O&M cost to conserve land use/HRU	$/acre/ year	19200%			1% of capital cost
Stormwater Management					
Capital installation cost	$	Varies based on stormwater BMP and size			Based on data in TetraTech (2010) Stormwater BMP Performance Analysis
O&M cost	$	5% of capital costs			Default value
RUNOFF AND RECHARGE (Ru/Re)					

Exhibit 46. WMOST Model Input Data for Subbasin 19078 Modeling

Input Data	Units	Data Sources			Notes
		Subbasin-specific	Southwick	West Springfield	
Recharge rates for each original or "baseline" land use	in/day	See model interface for time series or summary table of average annual values in report Appendix Appendix B			Based on delineation in Sudbury-Assabet HSPF watershed simulation model
Runoff rates for each original or "baseline" land use	in/day				
Recharge rates for each "managed" land use	in/day				HSPF watershed simulation outputs modified with SUSTAIN
Runoff rates for each "managed" land use	in/day				
WATER DEMAND (Demand)					
Number of water user types (including UAW)	Numerical value		5	5	Residential, commercial, industrial, municipal, UAW (based on ASR data)
Demand for each user for each day	MGD		See model interface for timeseries	See model interface for timeseries	-Monthly water pumping time series (2000-2004), scaled up to current (2011-2015)
					-Percent of water use by type based on ASR data and <10% UAW to meet standard permit conditions
Percent consumptive use for each water user for each month	%		Oct-Mar 4%; April 6%; May-Sept 20-29% (see model interface for specific monthly values)		Based on data in Amy Vickers (2002) Handbook of Water Use and Conservation
Nonpotable water					
Maximum percent demand that can be met by nonpotable water for each user	%		Ranges from 4 to 90%, see model interface		Based on data in Amy Vickers (2002) Handbook of Water Use and Conservation
Percent consumptive use for nonpotable water for each user for each month	%		Ranges from 1 to 24%, see model interface		Based on data in Amy Vickers (2002) Handbook of Water Use and Conservation
Demand Management					
Price elasticity for each user	Fraction		Ranges from -0.2 to -0.2, see model interface		Based on data in Amy Vickers (2002) Handbook of Water Use and Conservation
Capital cost to implement price increase	$		10,000	10,000	Based on previous Littleton study estimate for initial education and outreach to public and decision makers

Exhibit 46. WMOST Model Input Data for Subbasin 19078 Modeling

Input Data	Units	Data Sources			Notes
		Subbasin-specific	Southwick	West Springfield	
O&M cost to administer price increase (e.g., resurvey for appropriate price etc.)	$/year		1,000	1,000	10% of initial cost for continued outreach for continued acceptance
Maximum price change over planning horizon	%		49		Maximum percent change in price over 20 year planning horizon based on WMA Guidance (2014) maximum annual price change of 2%
Initial cost of providing rebates	$		5,457	86,518	Cost estimate for total value of town offered rebates for updated water fixtures based on estimated savings in planning horizon
O&M cost of providing rebates	$/year		0	0	All rebate program costs considered initial
Maximum demand reduction	MGD		0.028	0.025	
SEPTIC (Sep)					
Percent septic use for public water user draining inside the study area	%	3.3			Septic populations determined by population outside of the SDPW sewer main reaches and on SDPW water
Percent septic use for public water user draining outside the study area	%	2.9			
SURFACE WATER (SW)					
Reservoir Storage					
Initial reservoir volume	MG	0			Reservoir volume is 2,773 MG, according to data gathered from reservoir reports. Reservoir volume is considered zero initially, but the model used surface water releases to meet streamflow targets when needed
Minimum reservoir volume	MG	0			
Current maximum reservoir volume	MG	0			
Capital construction cost	$/MG	0			Estimated costs to represent the costs of managing surface water releases at the reservoir
O&M costs	$/MG	5,000			
Streamflow					
Inflow from external surface water	cfs	See model interface for time series			Timeseries outputs from Massachusetts Sustainable Yield Estimator (SYE). Subbasin 19078 has two headwater subbasins, 19009 and 19010. Streamflow from subbasin 19009 and 19010 is inflow to subbasin 19078.
Minimum in-stream flow standards	cfs	See Section X in report			Values set based on 2011-2015 flows plus needed improvements to reach various minimization targets
Maximum in-stream flow standard	cfs	None			No maximum in-stream flow considered

Exhibit 46. WMOST Model Input Data for Subbasin 19078 Modeling

Input Data	Units	Data Sources: Subbasin-specific	Data Sources: Southwick	Data Sources: West Springfield	Notes
Private withdrawals of surface water	MGD	None			Timeseries outputs from Massachusetts SYE. No private withdrawals exist in the subbasin.
Private discharge of surface water	MGD	None			Timeseries outputs from Massachusetts Sustainable Yield Estimator (SYE). No private discharges exist in Westborough.
GROUNDWATER (GW)					
Groundwater recession coefficient	1/day	0.007			HSPF Sudbury-Assabet model: [1 - (area-weighted average of AGWRC across HRUs)] based on distribution of HRUs in each subbasin. The calculated groundwater recession coefficient was altered during calibration, and the calibrated coefficients are shown.
Initial groundwater volume	MG	1,623			Back calculated based on SYE streamflow for month 1 of time series and groundwater recession coefficient
Minimum volume	MG	0			Default setting
Maximum volume	MG	5,650,000			Default values used so that recharge level are not limited
Flow from external groundwater	cfs	None			None considered.
Private withdrawals of groundwater	MGD	0.132			Estimate of private well withdrawals from MassDEP WMA Tool.
Private discharge of groundwater	MGD	None			Timeseries outputs from Massachusetts Sustainable Yield Estimator (SYE). No private discharges exist in the subbasin.
INTERBASIN TRANSFER (IBT)					
Purchase price for IBT potable water	$/MG		1,420	1,014	Price paid to Springfield Water and Sewer Commission (SWSC) by SDPW and WSDPW
Purchase price for IBT wastewater	$/MG		3,500	992	Price paid to Westfield Water Pollution Control Plant (Westfield WPCP) by SDPW and price paid to SWSC by WSDPW
Initial cost for new/additional IBT potable water	$/MG		None		No new interbasin transfer scenarios considered
Initial cost for new/additional IBT wastewater	$/MG		None		
Maximum additional capacity for water and wastewater	MGD		0		
Daily limits for water	MGD		6.24		Water limit set based on Springfield's authorization limit and Springfield's annual use from 2010-2012. The difference between the authorized limit and their annual use is considered to be available for purchase by SDPW or

Exhibit 46. WMOST Model Input Data for Subbasin 19078 Modeling					
		Data Sources			
Input Data	Units	Subbasin-specific	Southwick	West Springfield	Notes
					WSDPW
Daily limits for wastewater	MGD		0.5	9	Wastewater limit set based on SDPW's limit in contract with Westfield WCPC and WSDPW's limit in contract with SWSC
INFRASTRUCTURE					
Planning horizon	years		20		Default setting
Interest rate	%		3		
Water Treatment Plant (WTP)					
Customer's price for potable water	$/HCF		1.01	1.89	Average price to users for water after prices are flow-weighted by town
Customer fixed monthly account fee	$/month		1.89	2.02	Average monthly charge to users after fees are flow-weighted by town
Gw pumping – Capital construction cost	$/MGD		5,787,037		Based on previous Littleton study (Abt Associates et al, 2014)
Gw pumping – O&M costs	$/MG		70.8	380.3	Flow-weighted SDPW and WSDPW O&M costs for pumping water in 2015
Gw pumping – Current max capacity	MGD		2	7	Maximum existing pumping capacity of wells
Gw pumping lifetime – remaining on existing construction	years		25		Values set higher than planning horizon to exclude replacement costs from analysis
Gw Pumping lifetime – new construction	years		25		
Sw pumping – Capital construction cost	$/MGD		0		No existing surface pumping or potential for surface water (no reservoir)
Sw pumping – O&M costs	$/MG		0		
Sw pumping – Current max capacity	MGD		0		
Sw pumping lifetime – remaining on existing construction	years		0		
Sw Pumping lifetime – new construction	years		25		Values set higher than planning horizon to exclude replacement costs from analysis
Wtp – Capital construction cost	$/MGD		6,229,186		Based on previous Littleton study (Abt Associates et al, 2014)
Wtp – O&M costs	$/MG		0.73	344.6	Flow-weighted SDPW and WSDPW O&M costs for treating water in 2015

Exhibit 46. WMOST Model Input Data for Subbasin 19078 Modeling

Input Data	Units	Data Sources			Notes
		Subbasin-specific	Southwick	West Springfield	
Wtp lifetime – remaining on existing construction	years		25		Values set higher than planning horizon to exclude replacement costs from analysis
Wtp lifetime – new construction	years		25		
Wtp – Current max capacity	MGD		0.8	6.5	Maximum treatment capacity of wells
Capital cost of survey & repair	$		0		Reduction UAW considered an annual cost
O&M costs for continued leak repair	$/year		3,333	60,000	SDPW spends $10,000 on leak repair every three years, and WSDPW spends $60,000 on leak repair each year
Maximum percent of leaks that can be fixed	%		99		Default setting
Wastewater treatment plant (WWTP)					
Customer's price for wastewater	$/HCF		0		All wastewater is exported to Westfield WPCP or SWSC so wastewater treatment was not included
Customer fixed monthly account fee	$/month		0		
Capital construction cost	$/MGD		0		
Charged based on water or wastewater?	water or waste-water		water		
O&M costs	$/MG		0		
Lifetime remaining on existing construction	years		0		
Lifetime of new construction	years		35		
Current maximum capacity	MGD		0		
Initial groundwater infiltration into WW collection system	%		0		Wastewater infiltration from SDPW and WSDPW was not considered.
Initial cost of repairs	$		0		
O&M costs of repairs	$/year		0		
Maximum percent of leakage that can be fixed	%		0		
Water reuse facility (WRF)					

Exhibit 46. WMOST Model Input Data for Subbasin 19078 Modeling

Input Data	Units	Data Sources			Notes
		Subbasin-specific	Southwick	West Springfield	
Capital construction cost	$/MGD		18,644,791		Values from Littleton study (Abt Associates et al, 2014)
O&M costs	$/MG		1,305,135		
Lifetime remaining on existing construction	years		0		No initial capacity. Lifetime value set higher than planning horizon to exclude replacement costs from analysis
Lifetime of new construction	years		35		
Current maximum capacity	MGD		0		No existing capacity
Nonpotable water distribution system (NPDist)					
Consumer cost for nonpotable water	$/HCF		3.02		Values from Danvers-Middleton case study (EPA 2013)
Capital construction cost for nonpotable distribution system	$/MGD		12,529,440		
O&M cost for nonpotable distribution system	$/MG		1,716		
Aquifer Storage and Recovery (ASR)					
Capital construction cost	$/MGD		10,807,824		Values from Danvers-Middleton case study (EPA 2013)
O&M costs	$/MG		3,769		
Lifetime remaining on existing construction	years		0		No initial capacity. Lifetime value set higher than planning horizon to exclude replacement costs from analysis
Lifetime of new construction	years		35		
Current maximum capacity	MGD		0		No existing capacity
MEASURED FLOW					
Measured flow	cfs	See model interface for timeseries			Massachusetts SYE flows adjusted for withdrawals and discharges with MWI data

Input Data References

Abt Associates, Town of Littleton, Horsley Witten Group, and Charles River Association. 2014. Maximizing Sustainable Water Management by Minimizing the Cost of Meeting Human and Ecological Water Needs.

DeSimone, LA, Walter, DA, Eggleston, JR, and Nimroski, MT, 2002. *Simulation of Ground-Water Flow and Evaluation of Water-Management Alternatives in the Upper Charles River Basin, Eastern Massachusetts*. Water-Resources Investigations Report 2002-4234. U.S. Geological Survey, Westborough, Massachusetts.

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U.S. Geological Survey (USGS). 2010. Effects of Water Use and Land Use on Streamflow and Aquatic Habitat in the Sudbury and Assabet River Basins, Massachusetts, Scientific Investigations Report 2010–5042, (prepared by Phillip J. Zarriello, Gene W. Parker, David S. Armstrong, and Carl S. Carlson)

All data and information, unless otherwise noted, are directly from SDPW or WSDPW.

Streamflow Target Calculation

We developed streamflow targets to drive the WMOST model to apply water management actions to the subbasin system in order to meet the minimum streamflow standards. The tables below specify calculations for each of the months in the low-flow bioperiod.

Exhibit 47: Calculation of Streamflow Targets for July

Values Used for Calculation	Target Category		
	NGD 75% of Unaffected Median Streamflow Plus Returns	GWC3 55% of Unaffected Median Streamflow	GWC2 10% of Unaffected Median Streamflow
Unaffected *Median* Flow (cfs)	21.37	21.37	21.37
Average Withdrawals (cfs)	9.04	9.04	9.04
Average Recharge (cfs)	0.14	0.14	0.14
Maximum withdrawal to meet streamflow condition (cfs)	5.48	5.34	2.14
Unaffected Median minus maximum withdrawal (cfs)	15.89	16.03	19.23
Ratio of minimum to median flow	0.69	0.69	0.69
Minimum in-stream flow target (cfs)	10.97	11.07	13.29

Exhibit 48: Calculation of Streamflow Targets for August

Values Used for Calculation	Target Category		
	NGD 75% of Unaffected Median Streamflow Plus Returns	GWC3 55% of Unaffected Median Streamflow	GWC2 10% of Unaffected Median Streamflow
Unaffected *Median* Flow (cfs)	21.37	21.37	21.37
Average Withdrawals (cfs)	8.19	8.19	8.19
Average Recharge (cfs)	0.14	0.14	0.14
Maximum withdrawal to meet streamflow condition (cfs)	5.00	4.86	1.95
Unaffected Median minus maximum withdrawal (cfs)	16.37	16.50	19.42
Ratio of minimum to median flow	0.60	0.60	0.60
Minimum in-stream flow target (cfs)	9.81	9.90	11.64

Exhibit 49: Calculation of Streamflow Targets for September			
	Target Category		
	NGD	GWC3	GWC2
Values Used for Calculation	**75% of Unaffected Median Streamflow Plus Returns**	**55% of Unaffected Median Streamflow**	**10% of Unaffected Median Streamflow**
Unaffected *Median* Flow (cfs)	19.32	19.32	19.32
Average Withdrawals (cfs)	7.71	7.71	7.71
Average Recharge (cfs)	0.14	0.14	0.14
Maximum withdrawal to meet streamflow condition (cfs)	4.97	4.83	1.93
Unaffected Median minus maximum withdrawal (cfs)	14.35	14.49	17.39
Ratio of minimum to median flow	0.55	0.55	0.55
Minimum in-stream flow target (cfs)	7.84	7.91	9.50

Appendix C Water Conservation Savings from Rebate Program

To develop the water conservation rebate program, we considered: 1) the cost feasibility for each town, as defined by Section 9h of the WMA Guidance; 2) rebate programs offered by other towns in Massachusetts; 3) water use survey results (see Section 3); and 4) the cost-effectiveness of the appliances offered in the rebate program.

Cost Feasibility Assessment Thresholds

Exhibit 50 and Exhibit 51 show the calculations that follow WMA Guidance (MassDEP 2014) on three approaches for determining cost feasibility thresholds.

Exhibit 50: Calculations to Support Cost Feasibility Threshold Calculations

Parameters	Southwick	West Springfield
Median Household Income (MHI, $)	64,313	49,519
Average household size	2.6	2.3
Gallons per household at 65 RGPCD	61,685	54,568
Water rate ($/1000 gal)	4.75	3.01
Monthly fixed water fee ($)	12.38	2.41
Average water bill at 65 RGPCD ($/year)	**442**	**193**

Note: MHI and average household size data are from www.city-data.com

Exhibit 51: Cost Feasibility Thresholds

Thresholds	Southwick	West Springfield
Threshold 1 for 2010 = MHI*0.052	$334	$257
Threshold 2 = 2% annual increase in total water bill	$656	$287
Threshold 3 = 0.0125*MHI	$804	$619

Rebate Program Savings

There are two main parts to the calculations that we performed to outline example rebate programs for the towns. First, we estimated the potential, available budget. Second, we gathered data on the rebate values offered by other Massachusetts towns, avoided costs of operations, lost revenues and water savings. Details for each step are provided below.

We estimated a budget for the rebate program based on two factors. First, one of the three cost thresholds for cost feasibility assessment as described in Section 9h of the WMA Guidance (MassDEP 2014). We show all three thresholds calculated for each town in Appendix Appendix C . “Threshold 2” specifies that WMA project costs may result in an annual rate increase of up to 2%. Since demand management is the first and foremost activity required under the WMA, we assumed that at least half of the additional revenue from such increases would be spent on water conservation. The other half may be needed to offset revenue impacts of water conservation and initiate other recommended activities. The second factor in estimating a rebate program budget is the example of the Town of Sharon which spends 1% of its annual budget on water conservation. Based on the assumption of an annual increase of one percent increases in revenue, the water conservation program budget would be $10,000 per year for Southwick and $34,000 per year for West Springfield.

We note that West Springfield's water rates are low relative to other Massachusetts towns. It is significantly below any of the three thresholds. Southwick's rates result in exceeding one of the three threshold values. As such, it may be appropriate for West Springfield to conduct a water rate study which may result in additional budget than the one estimate in this report.

Exhibit 52: Example Calculation for Estimating a Water Conservation Program Budget

	Southwick		West Springfield	
Year	**Annual Water Revenue ($/year)**	**Revenue from 1% Annual Increase in Water Fees ($)**	**Annual Water Revenue ($/year)**	**Revenue from 1% Annual Increase in Water Fees ($)**
2016 Actual	1,033,325	-	3,368,661	-
2018	1,043,658	10,333	3,402,348	33,687
2019	1,054,095	10,437	3,436,371	34,023
2020	1,064,636	10,541	3,470,735	34,364
2021	1,075,282	10,646	3,505,442	34,707
2021	1,086,035	10,753	3,540,497	35,054
Average Annual		10,542		34,367

Based on the survey (Section 3), we estimated the approximate number of accounts that do not have water-efficient fixtures and appliances. We selected values of the rebates based on an informal survey of seven towns in Massachusetts, the rebates they offer, their median household income compared to Southwick and West Springfield, and the success of those programs (Exhibit 53). We calculated the total expected water savings, rebate costs, avoided costs and lost revenues. For Southwick, the avoided costs are the reduction in the cost of purchasing water from SWSC which is more expensive than locally pumped and treated water. For West Springfield who rarely buys water from SWSC, the avoided cost is the reduction in pumping and treatment costs. Finally, we adjusted the total number of rebates to could be offered over the 20-year permit to match the estimated the annual budget that may be available for the program. We relied heavily on the most cost-effective items from the perspective of the towns as seen by the percent of accounts targeted for replacement for various items.

Exhibit 53: Example Massachusetts Water Conservations Programs

Town	**Population**	**Median Household Income**	**Funding Source**	**Program**
Sharon, MA	6,010	$126,205	Budget line-item ($50,000, or about 1% of annual budget)	State water permit requires the town address water conservation. For ten years, the town has offered rebates for low-flow toilets ($200), and later for washing machines ($200). Recipients are required to have the toilet installed by a plumber. They also offer free aerators and low-flow showerheads. (Eric Cooper, DPW Supt.)

Exhibit 53: Example Massachusetts Water Conservations Programs				
Town	**Population**	**Median Household Income**	**Funding Source**	**Program**
Shrewsbury, MA	35,608	$96,365	Funded through permit fees	$35 rebate towards a toilet; Rebate program has only been in place for 6-8 months. Not much interest, since the rebate amount is fairly small. They have also given away faucets, but again, that program is not too popular, since a plumber needs to replace the faucet, and the payback period is long as a result. water conserving fixtures available through Niagara Conservation. (John DaSilva, Shrewsbury Water Dept)
Acton, MA	21,924	$120,865	Funded through Water Dept revenue ($4000-9000/year)	Program started in 2008, and has been funded through the Water Dept ever since (i.e., no outside funding). Program doesn't set a limit on the number of toilets for which customers can request a rebate. Rebate given as an abatement on water bill (water rates have been rising in recent years) *Criteria*: Toilet must be WaterSense rated ($75 rebate), washers must meet Tier 3 CEE rating ($100 rebate). Appliance must be installed to request rebate. Avg 10-15 washer rebates/year. (Matthew Mostoller, Water Dept Conservation)
Dedham-Westwood, MA	24,729 - 14,618	$85,558 - $128,813	Funding from operating budget (similar to MassSAVE program structure)	Offer free low-flow showerheads and faucet aerators, as well as rain sensor for lawn sprinklers. Also offer rebates for washing machines ($100) and toilets ($75). toilets must use <1.28gpf, and washing machines must have a WF≤4. The program sends consumers an actual check. Cost of appliance is not a major factor - generally the homeowner has already decided to purchase a new appliance. Local retailers are aware of program and also promote rebate program (to an extent). (Eileen Commane, Dedham-Westwood Water District)
Reading, MA	24,747	$103,903	??	Rebates available for ultra-low-flow toilets ($120) and clothes washers ($200).
Concord, MA	17,669	$132,385	??	Offers rebates of $100 towards both high-efficiency toilets and high-efficiency clothes washers. Town is a WaterSense partner. Toilets must be WaterSense certified, and washers must meet CEE-Tier 3 criteria.
Westford, MA	21,951	$125,143	SWMI water conservation grant	Rebates of $100 of Water-Sense toilets and $75 off of washers with a water factor of 4.0 or less. The grant paid for 80% of the rebate, the town added the other 20%. Residents requested about 60 rebates for toilets and 20+/- for washers.

Example water conservation programs for each town for the first, five-year period until the first permit review are shown in Exhibit 54 and Exhibit 56 below (with additional details in Exhibit 55 and Exhibit

57). The items listed in the tables are in order of most to least cost-effective from the perspective of the town. Following discussion with MassDEP about minimization requirements the towns may customize the example programs by changing the number of rebates to target a different annual budget or change the distribution of funds among rebates based on customer interest. In addition, some towns require that the customer surrender their old fixture or appliance to the town to claim the rebate. We also note that the estimates assume that each account or customer replaces their main fixture or appliance. If additional fixtures or appliances are replaced by a customer, such as the guest bathroom toilet, then the rebate program may be more expensive shown.

Each town will need to determine the final details of the program to meet their needs and requirements of MassDEP. For this study, we wanted to derive one set of estimates for the total water savings that could be realistically accomplished through a rebate program and the associated costs. As such we took in to account the potential annual budget, number of accounts without high-efficiency fixtures or appliances and a likely percent of them that could be replaced given the budget and 20-year time frame. The values presented in Exhibit 54 and Exhibit 56 show the annual cost of a five-year program, total rebates assumed to be claimed by customers and the on-going water savings. The values for a 20-year program are shown in Exhibit 58and Exhibit 59.

Given the revenue impact of water conservation programs, the program should be implemented incrementally, on an annual basis, and concurrently with an increase in water rates to fund the program and offset revenue impacts. In addition, if demand increases due to population growth or other development, the program can be calibrated to offset those new demands and delay mitigation requirements.

Exhibit 54: Example Five-Year Water Conservation Program for the Town of Southwick										
Fixture/Appliance	**Residential Accounts**	**Eligible Accounts for New Fixture**	**Accounts to Be Replaced Over 20 Year (%)**	**Rebates Over Five-Year Period**	**Rebate Value Offered ($/unit)**	**Avoided Purchase of SWSC Water ($/yr)**	**Lost Revenue ($/yr)**	**Rebate Cost ($/yr)**	**Net Cost ($/yr)**	**Total Water Savings (MGD)**
Toilet displacement device	2,418	100	100	25	15	101	340	75	313	0.000
Showerhead	2,418	867	100	217	50	2,767	9,255	2,170	8,658	0.005
Toilet (traditional replacement)	2,418	307	100	77	110	1,499	5,015	1,694	5,210	0.003
Faucet aerator	2,418	2418	100	605	8	470	1,573	968	2,071	0.001
Clothes washer	2,418	1406	30	106	130	1,299	4,345	2,756	5,802	0.003
Toilet (low-flow replacement)	2,418	907	30	68	110	588	1,966	1,496	2,874	0.001
Faucet	2,418	1695	30	127	70	545	1,822	1,778	3,055	0.001
						7,269	24,315	**10,937**	27,984	**0.014**

Exhibit 55: Unit Data for Fixtures and Appliances in Southwick's Program			
Fixture/ Appliance	**Water Savings per Unit (MG/yr)**	**Avoided SWSC Water Cost per Unit ($/yr)**	**Water Revenue Lost per Unit ($/yr)**
Toilet displacement device	0.003	4.06	13.58
Showerhead	0.009	12.75	42.65
Toilet (traditional replacement)	0.014	19.47	65.13
Faucet aerator	0.001	0.78	2.60
Clothes washer	0.009	12.25	40.99
Toilet (low-flow replacement)	0.006	8.64	28.91
Faucet	0.003	4.29	14.34

Exhibit 56: Example Five-Year Water Conservation Program for the Town of West Springfield										
Fixture/Appliance	Residential Accounts	Eligible Accounts for New Fixture	Accounts to Be Replaced Over 20 Year (%)	Rebates Over Five-Year Period	Rebate Value Offered ($/unit)	Avoided Purchase of SWSC Water ($/yr)	Lost Revenue ($/yr)	Rebate Cost ($/yr)	Net Cost ($/yr)	Total Water Savings (MGD)
Toilet displacement device	7,995	300	85	64	15	455	1,645	191	1,380	0.001
Showerhead	7,995	3402	85	723	50	16,221	58,572	7,229	49,580	0.018
Toilet (traditional replacement)	7,995	2200	85	468	110	16,018	57,839	10,285	52,106	0.018
Faucet aerator	7,995	7995	85	1699	8	2,324	8,393	2,718	8,787	0.005
Clothes washer	7,995	5233	20	262	130	5,643	20,375	6,803	21,535	0.006
Toilet (low-flow replacement)	7,995	3111	20	156	110	2,366	8,543	3,422	9,599	0.003
Faucet	7,995	6018	20	301	70	2,271	8,199	4,213	10,141	0.002
						45,298	163,566	**34,861**	153,128	**0.052**

Exhibit 57: Unit Data for Fixtures and Appliances in West Springfield's Program			
Fixture/ Appliance	Water Savings per Unit (MG/yr)	Avoided Pump and Treat per Unit ($/yr)	Water Revenue Lost per Unit ($/yr)
Toilet displacement device	0.003	1.58	13.58
Showerhead	0.009	4.95	42.65
Toilet (traditional replacement)	0.014	7.56	65.13
Faucet aerator	0.001	0.30	2.60
Clothes washer	0.009	4.76	40.99
Toilet (low-flow replacement)	0.006	3.35	28.91
Faucet	0.003	1.66	14.34

Exhibit 58: Example 20-Year Water Conservation Program for the Town of Southwick										
Fixture/Appliance	**Residential Accounts**	**Eligible Accounts for New Fixture**	**Accounts to Be Replaced Over 20 Year (%)**	**Rebates Over 20-Year Period**	**Rebate Value Offered ($/unit)**	**Avoided Purchase of SWSC Water ($/yr)**	**Lost Revenue ($/yr)**	**Rebate Cost ($/yr)**	**Net Cost ($/yr)**	**Total Water Savings (MGD)**
Toilet displacement device	2,418	100	100	100	15	406	1,358	75	1,027	0.001
Showerhead	2,418	867	100	868	50	11,067	37,020	2,170	28,123	0.021
Toilet (traditional replacement)	2,418	307	100	308	110	5,997	20,059	1,694	15,757	0.012
Faucet aerator	2,418	2418	100	2420	8	1,881	6,294	968	5,380	0.004
Clothes washer	2,418	1406	30	424	130	5,196	17,381	2,756	14,941	0.010
Toilet (low-flow replacement)	2,418	907	30	272	110	2,351	7,864	1,496	7,009	0.005
Faucet	2,418	1695	30	508	70	2,178	7,286	1,778	6,886	0.004
						29,076	97,262	**10,937**	79,123	**0.056**

Exhibit 59: Example 20-Year Water Conservation Program for the Town of West Springfield										
Fixture/Appliance	**Residential Accounts**	**Eligible Accounts for New Fixture**	**Accounts to Be Replaced Over 20 Year (%)**	**Rebates Over 20-Year Period**	**Rebate Value Offered ($/unit)**	**Avoided Pump and Treat Costs ($/yr)**	**Lost Revenue ($/yr)**	**Rebate Cost ($/yr)**	**Net Cost ($/yr)**	**Total Water Savings (MGD)**
Toilet displacement device	7,995	300	85	256	15	609	2,202	192	1,784	0.002
Showerhead	7,995	3402	85	2892	50	21,632	78,113	7,230	63,711	0.071
Toilet (traditional replacement)	7,995	2200	85	1872	110	21,378	77,201	10,296	66,119	0.072
Faucet aerator	7,995	7995	85	6796	8	3,126	11,213	2,718	10,806	0.019
Clothes washer	7,995	5233	20	1048	130	7,535	27,206	6,812	26,483	0.026
Toilet (low-flow replacement)	7,995	3111	20	624	110	3,164	11,425	3,432	11,694	0.010
Faucet	7,995	6018	20	1204	70	3,034	10,932	4,214	12,112	0.010
						60,479	218,293	**34,894**	192,709	**0.210**