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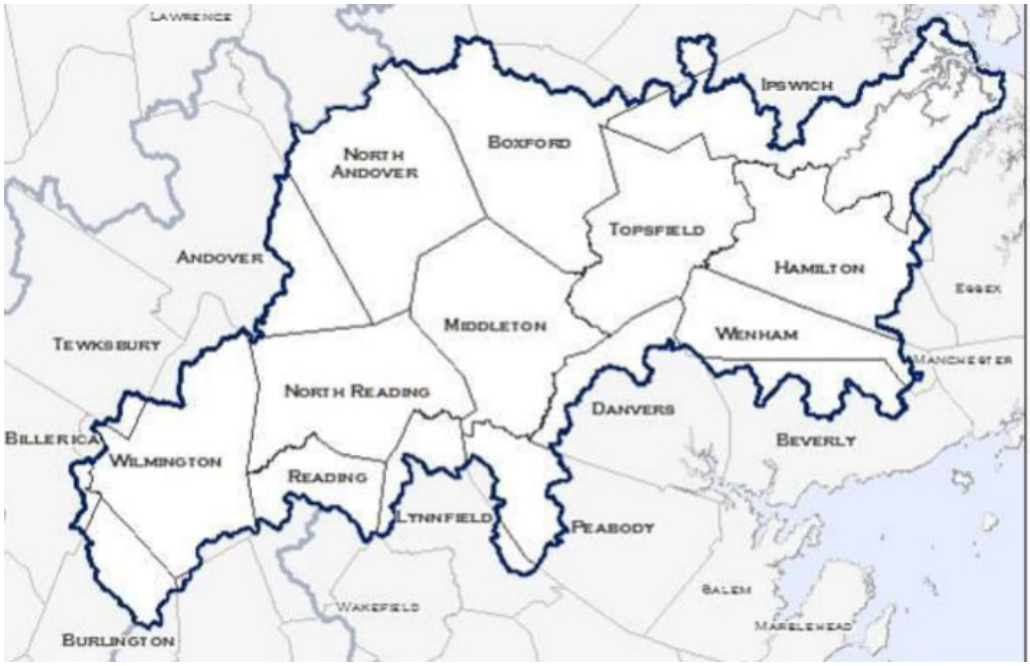

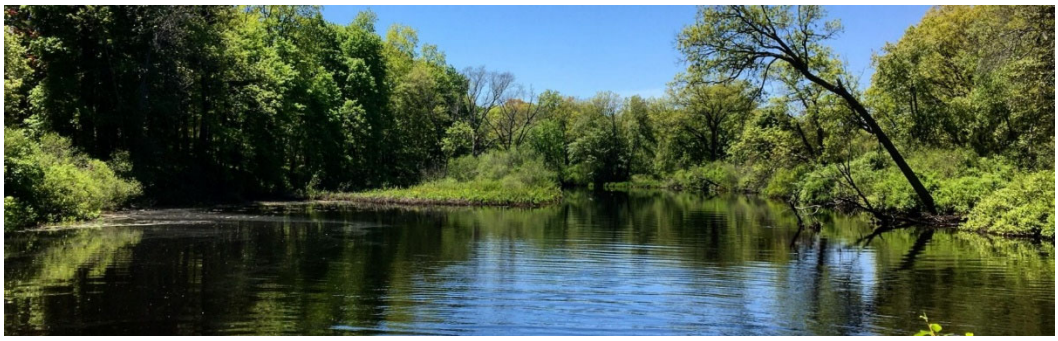

BWR 2022-01 Water Management Act (WMA) Grant - Regional Evaluation to Improve Water Supply Resiliency within the Lower Ipswich River Watershed

Task 6 – Final Report (Abridged Version)

Town of Hamilton, Massachusetts

June 30, 2022

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EXECUTIVE SUMMARY

The overall purpose for the subject WMA Grant is to conduct a regional evaluation of alternative sources to improve water supply resiliency within the lower Ipswich River Watershed for the Town of Hamilton and its neighboring communities of Topsfield, Manchester, Ipswich, Essex and Wenham. The WMA grant is divided into six (6) discrete tasks, each with its own required deliverable. Hamilton's existing water system borders all five (5) partnering communities and currently has interconnections with three of them including Ipswich, Essex and Wenham. This geographic condition places Hamilton in the best position to effectively convey and/or transfer alternate sources of supply between the partnering communities as well as sharing surplus supply available with the partnering communities to supplement and/or fulfill the water needs of the region.

For Task 1, we arranged for and conducted meetings with representatives from the Town of Hamilton, the partnering water system communities, Salem-Beverly Water Supply Board (SBWSB), MassDEP and other stake holders as necessary to discuss the project goals and scope, and review deliverables.

For Task 2, we coordinated and collected data from the partnering water system communities, Salem-Beverly Water Supply Board (SBWSB), and other resources as needed to perform the evaluations under Tasks 3, 4 and 5 for improving the supply resiliency of Hamilton and the partnering water systems.

For Task 3, we evaluated the feasibility of obtaining alternative water supply from the Salem-Beverly Water Supply Board (SBWSB) to supplement the water needs of Hamilton and the partnering communities on a regional/seasonal basis to reduce withdrawals from the Ipswich River Basin. We identified potential impacts to water quality, infrastructure, system hydraulics and operations, WMA withdrawals/regulations and permitting from augmenting Hamilton's existing well sources with SBWSB supply on a short-term basis, and fully supplying Hamilton on a permanent basis. We also identified similar impacts to sharing and/or transferring Hamilton and SBWSB's blended supply with the partnering water systems. Conceptual infrastructure upgrades with cost estimates were developed for **three (3) future pipeline routes** for connecting Hamilton's water system with the City of Beverly's water system for obtaining SBWSB supply. Hydraulic analyses were performed to determine the supply rates that could be effectively delivered into Hamilton from each future pipeline connection with the City of Beverly for obtaining additional supply to augment Hamilton's system only, or for fully supplying Hamilton's system. **Option A was recommended as the preferred pipeline route with Option B as the alternate.**

Similar hydraulic analyses were conducted to determine the supply rates that Hamilton could effectively deliver though the existing interconnections with the partnering water systems of Essex, Wenham and Ipswich. Upgrades to these existing interconnections such as the need for a pressure reducing valve or booster pump station were also identified. The Town of Manchester is not currently connected with Hamilton's water system and would require a new pipeline and interconnection to share and/or transfer supply. The feasibility of this new pipeline along with the needed infrastructure to connect Hamilton to Manchester for improving the supply resiliency of each system was evaluated under Task 4 of the WMA grant scope.

The Town of Topsfield is also not currently connected with Hamilton's water system and would require a new pipeline and interconnection to share and/or transfer supply as well. The evaluation of a new interconnection between Hamilton and Topsfield along with determining the ability of Hamilton and Topsfield to share supply was completed under Task 5 of the WMA grant scope. The results of the

evaluation for obtaining SBWSB supply to improve the water supply resiliency of Hamilton and the partnering water systems was issued in the **Task 3 Technical Memorandum.**

For Task 4, we evaluated the feasibility of installing a new interconnection between Hamilton and Manchester to allow the ability to share water supply between the two systems, along with the other partnering water systems on a partially regional basis. Conceptual infrastructure upgrades with cost estimates were developed for a **future pipeline route along Chebacco Road** which was determined to be the only viable option to connect Hamilton's water system with Manchester's water system. Hydraulic analyses were performed to determine the supply rates that could be effectively delivered into Hamilton from this future pipeline connection with Manchester for obtaining additional supply to augment Hamilton's system only, or for fully supplying Hamilton's system. We identified potential impacts to water quality, infrastructure, system hydraulics and operations, WMA withdrawals/regulations and permitting from having Manchester augmenting Hamilton on a short-term basis, and fully supplying Hamilton on a permanent basis. We completed an assessment of Manchester's WMA authorized withdrawals versus pump capacity and future water needs to estimate the available supply surplus for augmenting Hamilton and the partnering water systems.

We identified potential impacts to water quality, infrastructure, system hydraulics and operations, and permitting from sharing and/or transferring Hamilton and Manchester's blended supply with the partnering water systems. Similar hydraulic analyses were also conducted to determine the supply rates that Hamilton could effectively deliver though the existing interconnections with the partnering water systems of Essex, Wenham and Ipswich. Upgrades to these existing interconnections such as the need for a pressure reducing valve or booster pump station were identified along with developing conceptual cost estimates.

As previously noted above, the Town of Topsfield is not currently connected with Hamilton's water system and would require a new pipeline and interconnection to share and/or transfer supply with Hamilton and the partnering water systems. The evaluation of a new interconnection between Hamilton and Topsfield along with determining the ability of Hamilton and Topsfield to share supply was completed under Task 5 of the WMA grant scope. The results of the evaluation for a new pipeline interconnection with Manchester to improve the water supply resiliency of Hamilton and the partnering water systems on a partially regional basis was issued in the **Task 4 Technical Memorandum.**

For Task 5, we evaluated the water systems of Ipswich, Essex, Wenham and Topsfield to determine the ability of sharing available supply between Hamilton and these systems to mitigate future short-term supply shortages on a Mutual Aid basis. Upon reviewing the existing system infrastructure of each individual water system, we assessed the adequacy of their water supply to meet future water needs while having surplus supply available under their current WMA authorized withdrawals to share amongst the partnering water systems. We then evaluated the possibility of sharing any identified surplus supply between the partnering communities under current WMA allocations and Interbasin Transfer Act (IBTA) regulations taking into consideration DCR Water Needs Forecast for the region.

We identified potential impacts to water quality, infrastructure, system hydraulics and operations, and permitting from sharing and/or transferring surplus supply between Hamilton and the partnering water systems. Hydraulic analyses were conducted to determine the supply rates that Hamilton could effectively deliver though the existing interconnections with the partnering water systems of Essex, Wenham and Ipswich. Upgrades to these existing interconnections such as the need for a pressure reducing valve or

booster pump station were identified along with developing conceptual cost estimates. In addition, we evaluated a new pipeline and interconnection to connect the water systems of Hamilton and Topsfield along with determining the ability of Hamilton and Topsfield to share supply. We developed conceptual infrastructure upgrades with cost estimates for a **future pipeline along Asbury Street** which was determined to be the only viable option to connect Hamilton's water system with Topsfield's water system. Hydraulic analyses were performed to determine the supply rates that could be effectively delivered between Hamilton and Topsfield from this future pipeline connection.

We completed an assessment of the WMA authorized withdrawals versus pump capacity and future water needs for each partnering water system to estimate the available supply surplus that could possibly be shared between systems as needed. The results of the evaluation to determine the ability of Hamilton and the partnering water systems to mitigate future short-term supply shortages between systems on a Mutual Aid basis was issued in the **Task 5 Technical Memorandum.**

For Task 6, we prepared a summary of the work completed for Tasks 3, 4 and 5 including evaluations, analyses and results along with recommendations for Hamilton and the partnering communities to improve their water supply resiliency. The recommendations presented herein take into consideration the goal of Senator Tarr's North Shore Water Resiliency Task Force study which will be identifying a long-term regional solution to alleviate water resiliency issues and challenges faced by water systems located within the Ipswich River Watershed. Per the requirements of the WMA grant study, and to provide one comprehensive document that includes all narratives and supporting figures prepared for this project, **we have included the Task 3 through 5 Technical Memorandums in their entirety as attachments to this report.**

Given the order in which the Technical Memorandums were prepared, our approach to some of the evaluations and concepts presented initially in these documents changed during the completion of this study as a result of obtaining additional information or from applying a different perspective. As such, some of the narrative within these stand-alone documents has been revised and/or expanded on within the respective sections of this report.

1. Introduction

The overall purpose for the subject WMA Grant is to conduct a regional evaluation of alternative sources to improve water supply resiliency within the lower Ipswich River Watershed for the Town of Hamilton and its neighboring communities of Topsfield, Manchester, Ipswich, Essex and Wenham. This **Task 6 Final Report** presents a summary of methods and analyses employed to evaluate alternative supply sources and possible WMA withdrawals available to Hamilton and the partnering water systems along with recommendations for future infrastructure upgrades and additional analysis.

1.1 WMA Grant Study Overview

Hamilton's existing water system borders all five (5) partnering communities and currently has interconnections with three of them including Ipswich, Essex and Wenham. This geographic condition places Hamilton in the best position to effectively share alternate water supplies and/or available surplus water between the partnering communities to mitigate short-term and long-term water supply shortages. The WMA grant is divided into six (6) discrete tasks, each with its own required deliverable, as summarized below:

- **Task 1: Team Meetings and Project Management**
  - Conduct meetings and phone calls with representatives from the partnering water systems and other stakeholders including members of Senator Tarr's Task Force as applicable to kick-off project tasks, review draft deliverables, project status, schedule and issues related to the project.
- **Task 2: Data Collection**
  - Meet with and collate relevant data from the participating communities for determining existing system conditions, compatibility of water quality, hydraulic constraints, and costs of establishing regional water supply and management strategies.
- **Task 3: Assessment of Future Water Supply Connection with Salem-Beverly Water Supply Board (SBWSB)**
  - Evaluate the feasibility of obtaining alternative water supply from the SBWSB through a future pipeline connection to supplement the water needs of Hamilton and the participating communities on a regional/seasonal basis to reduce withdrawals from the Ipswich River Basin.
- **Task 4: Assessment of New Interconnection w/ Manchester (Partial Regionalization)**
  - Evaluate the feasibility of installing a new interconnection between Hamilton and Manchester to allow the ability to share water supply between the two systems, along with the other participating communities on a partially regional basis.
- **Task 5: Feasibility of Sharing Current/Future Water Supplies on a Mutual Aid Basis**
  - Evaluate the feasibility of sharing current and future water supplies between the partnering communities of Ipswich, Essex, Wenham and Topsfield on a Mutual Aid Basis.
- **Task 6: Final Report**
  - Prepare and submit a draft and final project report to MassDEP summarizing entire project, including methods, results, and conclusions.

2. Task 3 Summary and Conclusions

2.1 Introduction

For Task 3, we evaluated the feasibility of obtaining alternative water supply from the Salem-Beverly Water Supply Board (SBWSB) to supplement the water needs of Hamilton and the partnering communities on a regional/seasonal basis to reduce withdrawals from the Ipswich River Basin. As Hamilton has no direct connection with the SBWSB, a new pipeline will be required for the SBWSB to supply Hamilton's water system. Physically, the closest source of SBWSB supply to Hamilton is the City of Beverly's water system, which borders the southern side of Wenham with Hamilton bordering the northern side. Given the proximity of Hamilton to Beverly and Wenham, and the fact that a portion of Beverly's water system already extends into Wenham to supply Gordon College, connecting to Beverly for obtaining future SBWSB supply would be the most feasible approach to consider. Refer to attached **Figure 1 – Updated City of Beverly Water System Plan dated June 2022 included in Appendix D** as prepared from the Town's GIS data provided for the study.

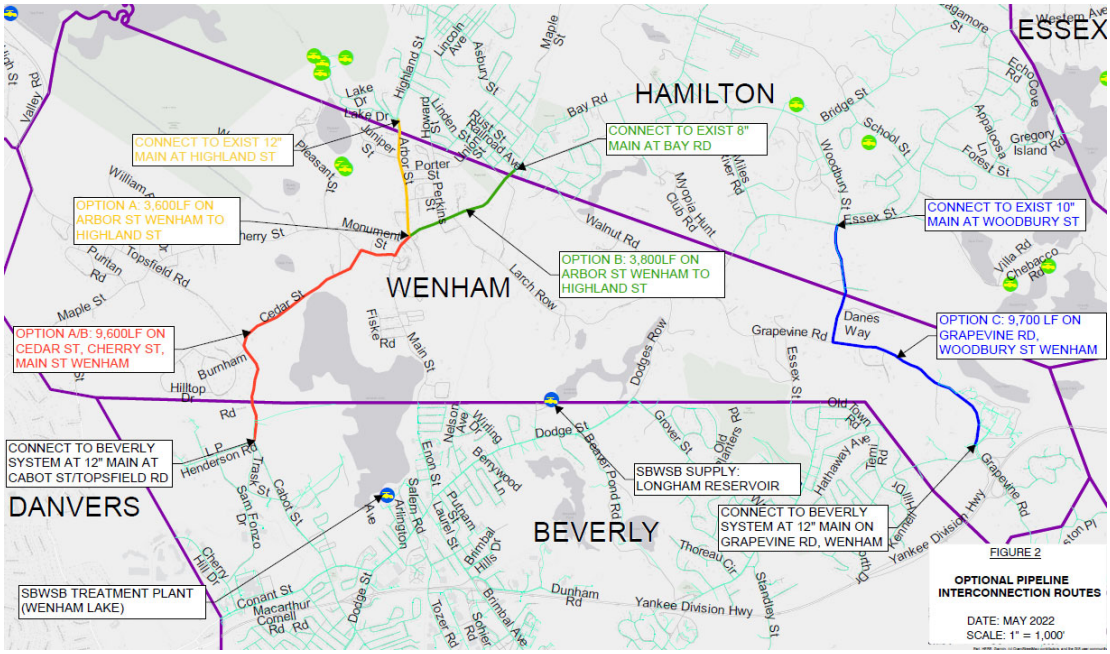
The Task 3 Technical Memorandum included in its entirety as **Appendix A** documents the evaluation and findings for this new water supply connection with the SBWSB including: review of SBWSB's supply system; review of Beverly's water system; analysis of the optional pipeline routes identified along with needed infrastructure upgrades and associated costs; review of water supply permitting considerations; review of water quality impacts from blending SBWSB finished water with Hamilton finished water and the partnering water systems' finished water; and needed infrastructure upgrades to supply the partnering water systems. Please refer to the **Task 3 Technical Memorandum** for full narratives of the specific topics evaluated as required per the WMA grant scope along with supporting tables and figures. The following provides an overview of the results related to the optional pipeline connection route assessment, water supply and permitting impacts, water quality review, and needed infrastructure upgrades for supplying Hamilton and the partnering water systems.

2.2 Pipeline Route Assessment for Future SBWSB Supply Connection

Based on existing system infrastructure, we identified three (3) options for a possible future interconnection with Beverly to supply Hamilton and the partnering communities on a seasonal and/or regional basis. These three options are as follows:

- Option A – Extending a new 12-inch water main from Cabot Street in Beverly up to Topsfield Road, Cedar Street, Cherry Street, Main Street and Arbor Street in Wenham to Highland Street in Hamilton ***(approx. 12,900 feet)***
- Option B – Extending a new 12-inch water main from Cabot Street in Beverly up to Topsfield Road, Cedar Street, Cherry Street and Main Street in Wenham to Bay Road in Hamilton ***(approx. 13,500 feet)***
- Option C - Extending a new 12-inch water main from Grapevine Road in Wenham up to Rubbly Road (Rte. 22) in Wenham to Woodbury Street in Hamilton ***(approx. 7,600 feet)***

Refer to **Figure No. 2 included in Appendix A of the Task 3 Technical Memorandum**. We have included a partial view of Figure 2 for reference on the following page. Each connection option will require a revenue meter chamber for measuring and totalizing flow along with a backflow prevention device for cross-connection control. As Beverly operates at a higher gradient than Hamilton (239 feet vs 210 feet), each option will require a pressure reducing valve (PRV) to control the supply gradient entering Hamilton's system when augmenting Hamilton's existing supplies.



Partial View of Figure 2-Optional Pipeline Interconnection Routes

We conducted hydraulic analyses of each pipeline option using the Town of Hamilton's existing computerized water system model to identify system impacts and the available supply that can be effectively delivered into Hamilton for the following operational scenarios:

- **Scenario #1:** Current System Conditions with Plant Finish Water Pumps On-line and Additional Supply from New Interconnection with New PRV and New Meter/Backflow Preventer Device
- **Scenario #2:** Plant Finish Water Pumps Off-line with Full Supply from New Interconnection without PRV and with New Meter/Backflow Preventer Device

For Scenario #1, we determined the optimal settings for the new PRV interconnection to supplement Hamilton's existing water system for each pipeline option. **For Scenario #2**, we determined the maximum flow that could be delivered through each new interconnection via gravity for fully supplying Hamilton. A summary of the results for the analyses completed is included in **Table 2.1** on the following page which was included in Section 3 of the attached Task 3 Technical Memorandum. Based on the results presented, **under Scenario #1**, both Options A and B would effectively augment Hamilton's existing water system with minimal impact to their current operations. As shown on **Table 2.1,** flow rates up to 300 gallons per minute (gpm) could be supplied with the new PRVs for Option A and B set to a downstream gradient of approximately 215 feet and 210 feet, respectively. Option C would only provide flow rates up to 200 gpm through the new PRV.

For Scenario #2, all three pipeline options could deliver flows up to approximately 600 gpm via gravity for fully supplying Hamilton. As Hamilton's finish water pumps operate at a flow rate of about 680 gpm to meet current system demands and maintain storage volumes, a new 1.5 million gallons per day (MGD) booster pump station would be needed for each option to replace the Town's current supply production and provide some surplus for the partnering water systems.

As noted in the Task 3 Technical Memorandum, although the Option C pipeline would deliver similar flow rates to the Option A and B pipelines for fully supplying Hamilton, it resulted in reducing available fire

flows within Hamilton's existing water system. This is due primarily to the proximity of the Option C interconnection to Hamilton's existing Browns Hill Reservoir, which would have the new supply entering Hamilton's water system on the same side as the existing storage volumes. Ideally, it is more effective to have the supply and storage volumes on opposite side of the system to provide a more balanced approach for fire protection.

Table 2.1 Pipeline Interconnection Options Analyses Summary

Condition	Supply Rate	Comment
Option A, Scenario #1 – Additional SBWSB Supply, Current Existing Conditions w/ New PRV		
PRV set @ 220'	150 to 425 gpm	Ex. pumps & tank will be isolated from system
PRV set @ 215'	250 to 300 gpm	Ex. pumps & tank will operate, turnover reduced by about day
PRV set @ 210'	75 to 175 gpm	Ex. system not impacted, but minimal available supply
Option B, Scenario #1 – Additional SBWSB Supply, Current Existing Conditions w/ New PRV		
PRV set @ 215'	150 to 575 gpm	Ex. pumps & tank will be isolated from system
PRV set @ 210'	75 to 325 gpm	Ex. pumps & tank will operate, turnover reduced by about day
PRV set @ 208'	50 to 190 gpm	Ex. system not impacted, but minimal available supply
Option C, Scenario #1 – Additional SBWSB Supply, Current Existing Conditions w/ New PRV		
PRV set @ 225'	150 to 250 gpm	Ex. pumps & tank will operate, turnover reduced less than a day
PRV set @ 220'	155 to 210 gpm	Ex. pumps & tank will operate, turnover reduced by about day
PRV set @ 215'	50 to 160 gpm	Ex. system not impacted, but minimal available supply
Option A, Scenario #2 – Full SBWSB Supply, Finish Water Pumps Off-line, No PRV		
Maximum Supply	Up to 425 gpm	New 12" main up to existing interconnection at Town line
Maximum Supply	Up to 585 gpm	Extending New 12" main into Hamilton by 415 feet
Option B, Scenario #2 – Full SBWSB Supply, Finish Water Pumps Off-line, No PRV		
Maximum Supply	Up to 585 gpm	New 12" main up to existing interconnection at Town line
Maximum Supply	Up to 625 gpm	Extending New 12" main into Hamilton by 1,300 feet
Option C, Scenario #2 – Full SBWSB Supply, Finish Water Pumps Off-line, No PRV		
Maximum Supply	Up to 275 gpm	New 12" main up to existing interconnection at Town line
Maximum Supply	Up to 625 gpm	Extending New 12" main into Hamilton by 2,000 feet

Table 2.2 on the following page summarizes the total estimated costs for the three pipeline options as presented in the Task 3 Technical Memorandum to connect with Beverly and the SBWSB to supply Hamilton and the partnering communities under the two noted operational scenarios. The estimated total costs do not include land acquisition, right-of-way procurement and legal fees. Costs include 30% for engineering/permitting and a 25% contingency for planning purposes. All costs are presented in 2022 dollars and are based on the **May 2022 Boston ENR construction cost index of 17506.61.**

2.2.1 Conclusion

Based on the evaluation completed for each pipeline interconnection option, and considering the current and future supply needs of Hamilton and the partnering communities, **Option A is recommended as the preferred approach with Option B as an alternate** for obtaining SBWSB supply. Both of these options can effectively supplement Hamilton's existing water system as needed with minimal impact to system operations. Subsequently, these options would be best for fully supplying Hamilton and the partnering water sytsems on a more regional basis. For Option C, additional improvements to Hamilton's system such as a new storage tank along with larger water mains to support the new tank would be needed to maintain adequate fire protection for fully supplying Hamilton and the partnering communities.

Table 2.2 Cost Summary - Pipeline Interconnection Options

Item			Total Cost[1]
Option A – 12,900' of New 12" main w/ New Revenue Meter/Backflow Preventer			
Scenario #1: Additional SBWSB Supply, Current Existing Conditions w/ New PRV			$7,004,250
Scenario #2: Full SBWSB Supply, Finish Water Pumps Off-line, New 1.5 MGD Booster Pump Station			$7,637,500
Option B – 13,500' of New 12" main w/ New Revenue Meter/Backflow Preventer			
Scenario #1: Additional SBWSB Supply, Current Existing Conditions w/ New PRV			$7,296,250
Scenario #2: Full SBWSB Supply, Finish Water Pumps Off-line, New 1.5 MGD Booster Pump Station			$7,869,000
Option C – 9,600' of New 12" main w/ New Revenue Meter/Backflow Preventer[2]			
Scenario #1: Additional SBWSB Supply, Current Existing Conditions w/ New PRV			$5,395,000
Scenario #2: Full SBWSB Supply, Finish Water Pumps Off-line, New 1.5 MGD Booster Pump Station			$6,028,750

1. Costs do not include land acquisition, right-of-way procurement and legal fees.
2. Costs for Option C include the additional 2,000 feet of new 12" main as recommended in the Task 3 technical Memorandum.

It is also recommended that the preferred **Option A or alternate Option B be implemented in two phases** to account for the planned upgrades at the SBWSB's existing plant noted in the Task 3 Technical Memorandum. The initial phase would include the construction of the new 12-inch main, revenue meter/backflow preventer vault and PRV needed to connect Hamilton with the City of Beverly and the SBWSB. These initial upgrades will provide a supply rate of 275 gpm to 300 gpm to supplement Hamilton's existing well supplies when needed along with the other partnering communities. When the SBWSB's planned upgrades to increase the production capacity at their plant are completed as discussed further below, Hamilton can then consider completing the construction of the new booster pump station for being fully supplied from the SBWSB if desired and agreed to by the SBWSB. At a minimum, the station should be designed with a rated capacity of 1 MGD, or 700 gpm, to meet Hamilton's supply needs. For the purposes of this study, since we do not know at this time what the intent or additional supply needs of the partnering communities are, we have assumed a new 1.5 MGD booster pump station will be installedo.

2.3 SBWSB Water Supply/Permitting Impacts

As presented in **Section 4 of the Task 3 Technical Memorandum**, the SBWSB's existing Charter allows them to sell water to the Towns of Wenham and Hamilton along with Salem and Beverly. As such, new legislation would be needed to update the Charter to allow the SBWSB to supply the additional communities of Ipswich, Essex, Manchester and Topsfield. The passing of this new legislation is not viewed as a significant hurdle and should be attainable if needed.

With respect to available supply, the current total average day demand (ADD) for the cities of Salem and Beverly is 8.9 MGD with a WNF 2029 projected total ADD of 9.5 MGD. Based on SBWSB's existing registered withdrawal of 10.17 MGD, there is a current surplus of 1.27 MGD available to augment Hamilton and the other partnering water systems which will reduced to 0.67 MGD in the future. The SBWSB also has an additional permitted withdrawal of 2.27 MGD which if activated, would provide adequate surplus to fully supply Hamilton and other partnering water systems in the future.

From Table 4.1 in Section 4 of the Task 5 Technical Memorandum, we presented current and future average day demands (ADDs) for Salem-Beverly, Hamilton, Topsfield, Wenham, Essex, Ipswich and Manchester based on historical water usage, official DCR Water Needs Forecast and local studies. From this table, the total current ADD for the partnering communities listed above including Salem-Beverly is approximately **11.76 MGD,** with a 10-year projected ADD of **13.36 MGD.** Hamilton's current and projected ADDs are 0.55 MGD and 0.75 MGD, respectively.

With a projected ADD of 9.5 MGD for Salem-Beverly, the SBWSB could almost fully supply Hamilton and meet the future water needs of Salem-Beverly under their current registered withdrawal of 10.17 MGD **(9.5 MGD + 0.75 MGD = 10.25 MGD).** With activating their additional permitted withdrawal of 2.27 MGD, the SBWSB could supply Hamilton on a permanent basis along with a surplus of approximately 2.19 MGD to supply the other partnering systems **(12.44 MGD – 10.25 MGD = 2.19 MGD).** This surplus volume would be adequate to fully supply the combined future water needs of Wenham, Essex, Manchester and Topsfield with some surplus remaining to augment Ipswich as needed based on the DCR Water Need Forecast.

As noted in the Task 3 Technical Memorandum, MassDEP has never activated the permitted volume and that the SBWSB would need to demonstrate via an updated WNF that it needs the additional water. As such, the proposed needs of Hamilton and other partnering water systems would need to be included in an updated WNF for SBWSB to be able to activate its permit. Another consideration is that were the permit to be activated, a series of conditions such as mandatory water conservation requirements not currently required on the SBWSB registration would be imposed by MassDEP. Therefore, SBWSB would need to evaluate if these conditions are acceptable. It is assumed that if SBWSB wants to activate its permitted volume for the purpose of supplying the partnering water systems on a regional approach thereby reducing groundwater withdrawals within the Ipswich River Basin, MassDEP would be willing to ease some of those requirements.

With respect to production capacity, although the SBWSB's existing plant was originally designed to treat 24 MGD, changes to turbidity requirements limit the plant's peak capacity to only 16 MGD to achieve compliance. With peak daily flow rates of up to 16 MGD currently occurring within the systems of Salem and Beverly during high demand periods, the plant is required to operate at its maximum rate. During these periods of high demand, SBWSB would not have any surplus for supplying Hamilton and the partnering water systems due to the plant's limited production. As such, the SBWSB is not currently able to physically supply Hamilton and the other partnering water systems on a permanent and/or regional basis even with activating its permitted volume.

However, the SBWSB is planning to complete significant upgrades to its plant as part of their current Capital Sustainability Plan (CSP) for the next 10 years to increase production capacity. The CSP includes nine (9) phases of upgrades to the plant and related water supply system that have been estimated to cost upwards of $50 million to complete. Considering future increases in demands within Salem and

Beverly, SBWSB stated that they would need to complete the first five phases of their CSP which would return the plant back to its original 24 MGD capacity. This restored capacity should likely be enough to allow SBWSB to meet the future water needs of Salem-Beverly while fully supplying Hamilton along with Wenham, Essex, Manchester and Topsfield on a regional basis.

For Tasks 4 and 5, we collected and presented data related to future maximum day demands (MDDs) for Hamilton and the partnering water systems. Based on this data, the total future maximum day demand (MDD) for the water systems of Hamilton, Wenham, Essex, Manchester and Topsfield is approximately **4.78 MGD**. For Salem-Beverly, we do not have any data on future MDDs however, applying the current MDD/ADD ratio of 1.8 (16 MGD/8.9 MGD) to the projected ADD of 9.5 MGD results in an estimated future MDD of **17.1 MGD**. As such, the total future MDD that would need to be met by the SBWSB to supply Salem-Beverly, Hamilton, Wenham, Essex, Manchester and Topsfield on a regional basis would be approximately **21.88 MGD** which is below the increased capacity of 24 MGD anticipated for the plant.

Based on SBWSB's existing registered and permitted withdrawal volumes, and planned upgrades to its existing plant, the SBWSB will eventually have the supply and production capacity available to fully meet the water needs of Hamilton, Wenham, Essex, Manchester and Topsfield along with Salem-Beverly on a regional basis. Currently, SBWSB has the supply and production capacity available to meet the water needs of Salem-Beverly with some surplus to augment Hamilton's supply and possibly other partnering communities during normal demand periods. If Ipswich elects to be considered as part of this future regional approach, then discussions with MassDEP will be needed to allow the SBWSB to increase their permitted withdrawals which would likely require the partnering communities to forego utilization of their local WMA allocations. With most partnering communities in this WMA grant study relying on groundwater withdrawals from the Ipswich River Basin, transferring existing groundwater allocations to seasonal pump-storage water within the SBWSB reservoir system should be viewed as beneficial to improving the ecology of the Ipswich River.

2.4 Water Quality Review

Per Task 2 of the WMA grant study, we coordinated and requested various water quality and system infrastructure data from Hamilton, the SBWSB and partnering communities including Ipswich, Essex, Wenham and Topsfield as required to complete this task. **Table 2.3** below presents a summary of the finish water quality data collected from each of the communities and the SBWSB as it relates to this assessment.

Table 2.3 Finish Water Quality Summary

Parameter	SBWSB	Hamilton	Manchester	Essex	Ipswich	Topsfield	Wenham
pH	7.0 - 7.3	7.2 - 7.4	7.1 - 7.8	7.3 - 7.5	6.5 - 8.0	7.5	Unknown(2)
Chlorine (ppm)	0.57	0.50 - 0.75	0.80 - 1.40	0.53 - 0.59	0.25 - 0.89	0.22 - 0.34	0.3 - 0.88
Phosphate (ppm)	0.45 – 0.90	0.4 – 0.5	0.3 - 1.6	N/A(1)	0.5 - 0.80	Unknown(2)	Unknown(2)
TTHMs (ppb)	25 – 87	47 – 83	36 – 52	37 – 40	20 - 68	18 – 38	15.7
HAAs (ppb)	17 – 54	0 - 46	11 – 19	6 - 9	4.9 -35	ND - 4.5	4.4
PFAS6 (ppt)	2.4 - 4.9	4.9 – 13.0	7.3 - 18.9	<1.9	ND - 23.3	10-23	Unknown(2)

1. Essex does not add phosphate to their finished water.
2. Data was unable to be obtained from the partnering community.

Hamilton's primary source of supply is the **Idlewood wellfield** which consists of five (5) individual wells. These wells are pumped up to the Idlewood Water Treatment Plant (WTP) for treatment prior to being introduced into the distribution system which consists of pre-oxidation with sodium hypochlorite for iron and manganese removal through pressure filters containing a proprietary high rate catalyzed media. Post-filtration treatment includes sodium hypochlorite for disinfection, sodium fluoride for fluoridation, and a poly/orthophosphate blend for corrosion control. The Town's secondary source of supply is the **School Street well** which is chemically treated only before being delivered into the distribution system with sodium hypochlorite for disinfection, sodium fluoride for fluoridation, potassium hydroxide for pH adjustment, and a poly/orthophosphate blend for corrosion control.

SBWSB utilizes conventional treatment at their plant to treat their **3 surface water supplies** which includes flocculation, sedimentation, filtration via sand/anthracite media and post-treatment including disinfection with sodium hypochlorite, hydrofluorosilicic acid for fluoridation, quick lime for pH adjustment and an ortho/polyphosphate blend for corrosion control.

In comparing the finished water quality being produced by Hamilton and the SBWSB, they are compatible with respect to pH, free chlorine and total phosphate levels. Both use chlorine for disinfection so there is no concern of blending chlorinated water with chloraminated water. Additionally, since both use phosphate products for corrosion control and maintain similar pH levels within their system, there should be minimal impacts to Hamilton's system with respect to lead and copper. Levels of TTHMs, HAA5s and PFAS are also similar within the water systems of Hamilton and the SBWSB, with all being below their respective established MCLs. Recent sampling of Hamilton's School Street in 2021 showed a total sum of 13 ppt for the 6 regulated PFAS compounds which is still below the MCL of 20 ppt but over the 10 ppt threshold which requires monthly sampling of the source. Hamilton has limited the use of this well and is currently evaluating options for providing future on-site treatment for PFAS removal.

Based on the finished water quality maintained by the two water systems, Hamilton should be able to utilize a future interconnection with the SBWSB without any major water quality issues or impacts with meeting current drinking water standards. Given Hamilton's current upgrade of adding a new GAC treatment system at its plant and SBWSB's planned upgrades at their plant, the finish water quality of both systems should improve.

2.4.1 Supplying Partnering Water Systems

The **Town of Ipswich's** two surface water supplies are chemically treated and filtered at Ipswich's Water Treatment Plant (WTP) which includes rapid mixing, flocculation, sedimentation and filtration. The post-treatment of the filtered water includes disinfection with sodium hypochlorite, fluoridation with hydrofluorosilicic acid, pH adjustment with sodium hydroxide and an ortho/polyphosphate blend for corrosion control. Treatment at **Ipswich's five (5) wells** includes disinfection with sodium hypochlorite, fluoridation with hydrofluorosilicic acid and a poly/orthophosphate blend for corrosion control. corrosion control.

The **Town of Essex** has only wells for supplying their system which are chemically treated and filtered through its water treatment plant that includes disinfection with chlorine gas, and pH adjustment with potassium hydroxide. The **Town of Topsfield** has only wells for supplying their system which are chemically treated and filtered through its water treatment plant that includes disinfection with sodium hypochlorite, fluoridation with sodium fluoride, pH adjustment with potassium hydroxide and an ortho/polyphosphate blend for corrosion control/sequestering. The **Town of Wenham** has only wells for

supplying their system which are chemically treated only including disinfection with calcium hypochlorite, fluoridation with sodium fluoride and corrosion control with zinc orthophosphate.

In comparing the finished water quality of the partnering communities with the Town of Hamilton's current water quality and future water quality if blended with SBWSB supply, they are similar with respect to pH and free chlorine with exception of Ipswich which maintains a larger range of pH than the other systems. However, they do use an ortho/polyphosphate blend similar to Hamilton and the SBWSB for corrosion control so it is not anticipated that this larger pH range will be an issue. As shown in **Table 2-3** above, the Town of Essex does not use any phosphate addition for corrosion control which could be an issue with respect to lead and copper if supply from Hamilton and the SBWSB is delivered into their system. All the partnering communities rely on free chlorine for disinfection so **there is no concern of blending chlorinated water with chloraminated water between systems.**

Two possible water quality issues were identified in the Task 3 Technical Memorandum about blending the water supplies between the partnering water systems including Essex's lack of using phosphate for corrosion control and the presence of PFAS within several individual supplies as shown in **Table 2-3.** The water systems of Manchester, Topsfield and Ipswich have had reported PFAS levels just at or above the 20 ppt MCL, however recent samplings have seen PFAS levels come down. These occasionally elevated levels could be problematic if introduced into another system with lower PFAS levels. This matter would likely have to be reviewed with MassDEP to determine what special requirements will need to be implemented before approving such a transfer. There are operational measures and treatment strategies that the systems can employ to mitigate their PFAS issues such as modifying the usage of the impacted supply similar to Hamilton or providing treatment for its removal. It is our understanding that Topsfield has already taken steps to address their PFAS levels and is in the process of adding granular activated carbon (GAC) at their treatment plant.

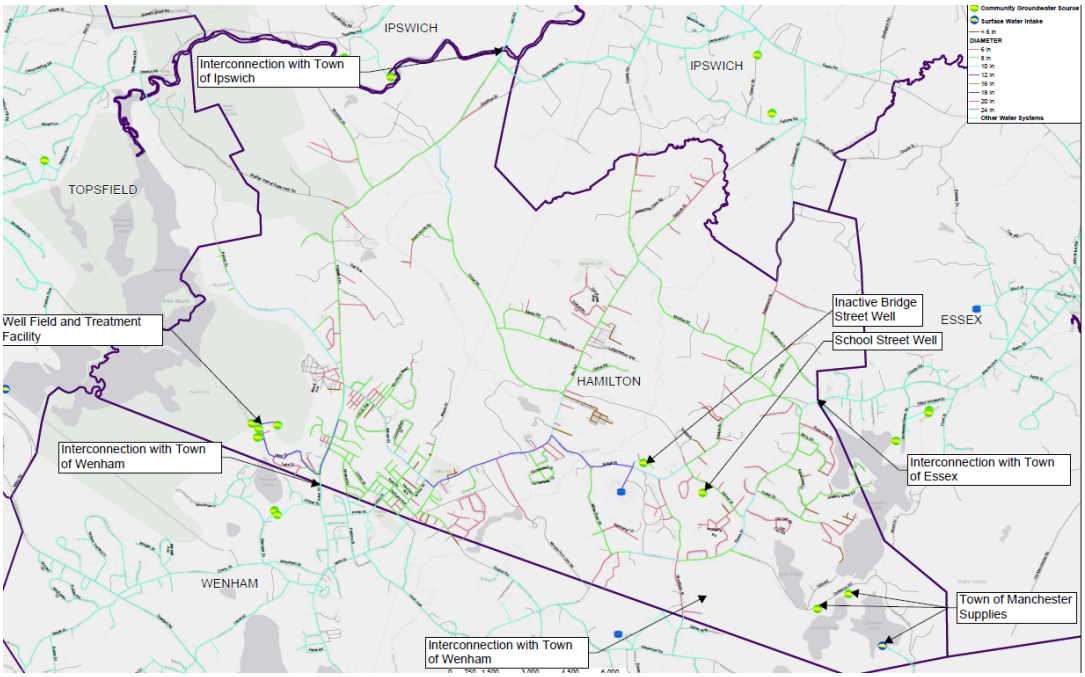
For Essex, the introduction of phosphate-treated water into their system could potentially disrupt the current chemistry that is providing the protective coating on the interior lead and copper surfaces. It will also increase the chlorine demand within the distribution system which will require adjusting the current chlorine dosages to avoid having coliform issues. Using the blended supply of Hamilton and the SBWSB on a short-term basis to alleviate a temporary loss of supply should not pose a significant issue. However, if Essex intends to obtain supply on a more regional/permanent basis, then they would likely need to adjust their current treatment practice for corrosion control to include phosphate.

2.5 Infrastructure Needs to Supply Partnering Communities

As previously noted herein, Hamilton has existing interconnections with the Towns of Ipswich, Essex and Wenham, ranging in size from 2-inches to 8-inches **(Refer to Figure No. 3 in Appendix A of the Task 3 Technical Memorandum).** We have included a view of Hamilton's water system showing the locations of the existing interconnections for reference on the following page. Hamilton currently has no interconnections in place with Topsfield or Manchester and as such, new interconnections and related pipelines will need to be constructed to connect these two systems with Hamilton. **These required pipeline improvements were evaluated under Tasks 4 and 5 of this WMA grant study and are reviewed in Sections 3 and 4 of this report.**

For Wenham, there are two existing interconnections including an 8-inch on Highland Street and a 6-inch on Woodbury Street. Based on Hamilton's existing system, the 8-inch interconnection on Highland Street would be more favorable for transferring future supply between Hamilton and Wenham. For Essex, there

is an existing 4-inch and 2-inch interconnection at the end of Essex Street (Rte. 22) which is fed by Hamilton's 10-inch main. To effectively transfer future supply between the two systems, **it was recommended to replace this interconnection with a new single 8-inch connection.** For Ipswich, there is an existing 6-inch interconnection at the end of Waldingfield Road which is fed by Hamilton's 8-inch main. This interconnection should be adequate for transferring future supply between Hamilton and Ipswich.



View of Hamilton Water System w/ Existing Interconnections

Using Hamilton's computerized model, we conducted hydraulic analyses to estimate future supply rates that Hamilton's existing water system could deliver at each existing interconnection to augment the supplies of Wenham, Ipswich and Essex with a reduction in system pressure of no more than 3 psi. From the results of the analyses, a supply rate of up to 200 gpm can be provided at Wenham's interconnection, a supply rate of up to 300 gpm can be provided at Essex's interconnection, and a supply rate of up to 150 gpm can be provided at Ipswich's interconnection. **Table 2.4** on the following page shows the current operating gradient of Hamilton and the partnering water systems as determined from the Task 2 collected data and from correspondence with the partnering communities.

From **Table 2.4**, given that the existing system gradients for Wenham and Ipswich are about equal to Hamilton's gradient, supply between the systems can be delivered via gravity without the need for a PRV or a booster pump station. Depending on the demand and pressure fluctuations that occur within each of the systems over the course of a day, there will be times when the available gravity supply from Hamilton will be reduced. With Essex having a system gradient about 8 feet higher than Hamilton, a **booster pump station** will be needed at the interconnection to effectively supply Essex daily over an extended period. However, there could be times over a course of a day when the gradients between the two systems allow gravity flow.

Table 2.4 Existing System Gradients

Community Water System	Hydraulic Gradient (feet)
Hamilton	210
Manchester	273
Ipswich	210(1)
Topsfield	260
Essex	217.7
Wenham	211

1. Main pressure zone gradient as maintained by Tower Hill Tank.

These existing interconnections will also need to be provided with new revenue meters for measuring and totalizing flow being supplied to the partnering water systems. If these interconnections are to be used on a temporary or short-term basis and would be normally closed otherwise, then it not expected that backflow prevention devices for cross-connection control will be needed. If, in the future, these existing interconnections are used on a more permanent basis and/or are left normally open, then the installation of a backflow prevention device may be necessary depending on applicable water system requirements and regulations. **The estimated costs for upgrading the existing interconnections as needed for sharing supply between Hamilton, Wenham, Ipswich and Essex are included in Section 4 of this report summarizing the Task 5 Technical Memorandum.**

The above analyses were completed to determine the available supply rates that Hamilton could possibly deliver to augment the supplies of Wenham, Ipswich and Essex based on existing infrastructure. We do not have working models of the other partnering water systems so we could not determine the available supply rates that could possibly be delivered into Hamilton from these systems. It is our understanding both Wenham and Ipswich do not have computerized models of their water system. However, based on the operating gradients maintained by the partnering systems as shown in **Table 2.4**, and the existing infrastructure of their systems as described in the **Task 5 Technical Memorandum**, it is reasonable to surmise that these systems should be able to deliver similar supply rates into Hamilton.

If the approach of having the SBWSB supplying the future water needs of Hamilton and the partnering water systems on a permanent/regional basis is considered, additional analyses will have to be completed to determine what other possible infrastructure upgrades may be needed for delivering the expected higher supply rates.

3. Task 4 Summary and Conclusions

3.1 Introduction

For Task 4, we evaluated the feasibility of installing a new interconnection between Hamilton and Manchester to allow the ability to share water supply between the two systems, along with the other partnering water systems on a partially regional basis. As Hamilton has no direct connection with Manchester, a new pipeline will be required for the two systems to share water supply. Refer to attached **Figure 2 – Updated Town of Manchester Water System Plan dated June 2022 included in Appendix D** as prepared from the Town's GIS data provided for the study.

The Task 4 Technical Memorandum included in its entirety as **Appendix B** documents the evaluation and findings for this new pipeline interconnection with Manchester including: review of Manchester's water supply system; analysis of the new pipeline route along with needed infrastructure upgrades and associated costs; review of water supply availability and permitting considerations; review of water quality impacts from blending Manchester finished water with Hamilton finished water and the partnering water systems' finished water; and needed infrastructure upgrades to supply the partnering water systems. Please refer to the **Task 4 Technical Memorandum** for full narratives of the specific topics evaluated as required per the WMA grant scope along with supporting tables and figures. The following provides an overview of the results related to the new pipeline interconnection assessment, water supply and permitting impacts, water quality review, and needed infrastructure upgrades for sharing supply between Hamilton, Manchester and the partnering water systems.

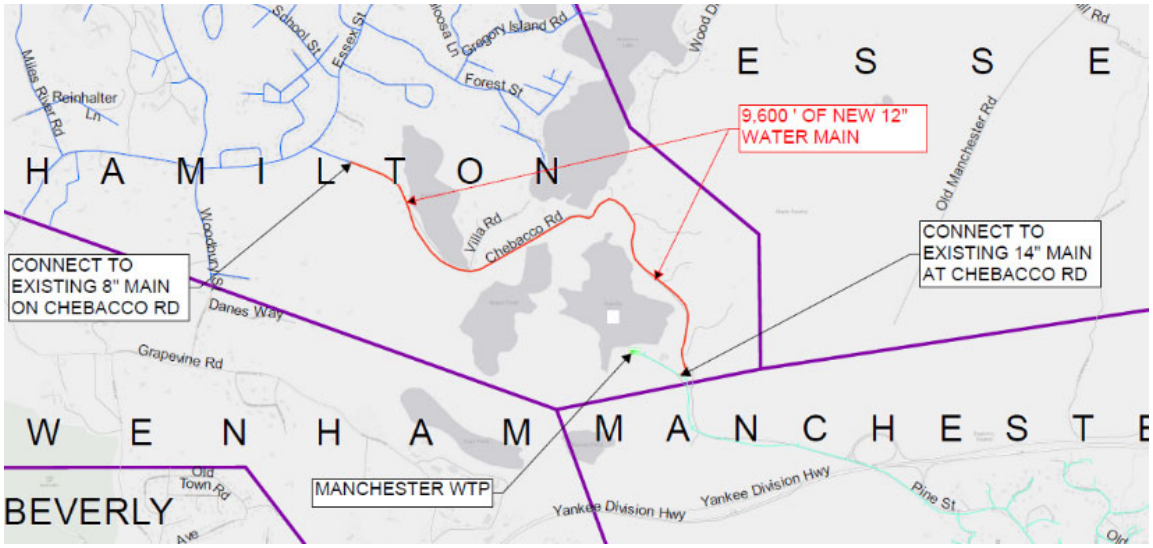
3.2 Pipeline Interconnection with Manchester

Based on existing infrastructure and previous discussions, the most preferable alignment for installing a new pipeline for connecting Hamilton to Manchester was determined to be along Chebacco Road which is located within Hamilton, MA. Refer to **Figure No. 1 included in Appendix A of the Task 4 Technical Memorandum**. We have included a partial view of Figure 1 for reference on the following page. A new 12-inch pipeline will initially connect to Hamilton's existing 8-inch main in Chebacco Road and extend westerly along Chebacco Road for approximately 9,600 feet terminating at Manchester's 14-inch transmission main leaving their WTF.

The new interconnection with Hamilton's existing 8-inch main will require a revenue meter chamber for measuring and totalizing flow along with a backflow prevention device for cross-connection control. As Manchester operates at a higher gradient than Hamilton **(273 feet vs 210 feet),** a pressure reducing valve (PRV) will be required to control the supply gradient entering Hamilton's system. Conversely, a new booster pump station will be needed to deliver supply into Manchester.

We conducted hydraulic analyses using the Town of Hamilton's existing computerized water system model to identify system impacts and the available supply that can be effectively delivered into Hamilton through the new pipeline and interconnection under the following operational scenarios:

- **Scenario #1:** Current System Conditions with Additional Supply from Manchester into Hamilton through New Interconnection with New PRV and New Meter/Backflow Preventer Device
- **Scenario #2:** Hamilton's Supplies Off-line with Full Supply from Manchester through New Interconnection with New PRV and New Meter/Backflow Preventer



Partial View of Figure 1- Pipeline Interconnection w/in Chebacco Rd.

For Scenario #1, we determined the optimal settings for the new PRV interconnection to supplement Hamilton's existing water system. **For Scenario #2**, we determined the maximum supply rate that could be hydraulically delivered through the new PRV interconnection to fully supply Hamilton. A summary of the results for the analyses completed is included in **Table 3.1** below which was included in Section 3 of the attached Task 4 Technical Memorandum.

Table 3.1 Chebacco Road Pipeline Interconnection Option Analyses Summary

Condition	Supply Rate	Comment
Scenario #1 – Additional Manchester Supply, Current Existing Conditions w/ New PRV		
PRV set @ 220'	150 to 525 gpm	Ex. pumps & tank will be isolated from system
PRV set @ 215'	150 to 385 gpm	Ex. pumps will not operate, tank turnover reduced to < half foot a day
PRV set @ 212'	100 to 325 gpm	Ex. pumps & tank operate, turnover reduced to ¾ foot a day
PRV set @ 210'	0 to 220 gpm	Ex. pumps & tank will operate, turnover reduced to 1-1/4 foot a day
PRV set @ 208'	0 to 100 gpm	Ex. system not impacted, but minimal available supply
Scenario #2 – Full Supply from Manchester, Finish Water Pumps & Reservoir Off-line, New PRV		
PRV set @ 230'	Up to 700 gpm(1)	Pressure increase by 9 psi, need to construct new tank in Hamilton
PRV set @ 235'	Up to 810 gpm(1)	Pressure increase by 11 psi, need to construct new tank in Hamilton

1. Manchester's current WMA Permit allows for a maximum authorized withdrawal of 0.72 MGD.

Based on results presented above for **Scenario #1**, the most favorable option is to set the new PRV to a downstream gradient somewhere between 210 feet and 212 feet which will supply flow rates up to 300 gpm to augment Hamilton's existing supplies with minimal impact to Hamilton's current operation. The final setting can be adjusted as needed based on actual system conditions when the new interconnection is installed and how much additional supply is needed. For **Scenario #2**, a maximum supply rate of about 800 gpm is predicted to be available for fully supplying Hamilton's system. This is based on the new PRV set at a downstream gradient of 235 feet which is the highest gradient that could be introduced into

Hamilton's system without causing significant pressure issues as their current system gradient is only 210 feet. **However, at this higher system gradient, Hamilton's existing Brown Hill Reservoir with a maximum water level elevation of 210 feet will no longer function as it will be hydraulically isolated from the system.**

For Scenario #2 to be feasible, Hamilton will need to construct a new taller storage tank at the appropriate height to replace the loss of the Browns Hill Reservoir for providing system equalization and fire protection. Also, based on Hamilton's current and future water needs, Manchester would need to have a supply surplus of about 1 MGD above their current supply needs along with the ability to withdraw this surplus from their existing sources to fully supply Hamilton, and provide some surplus for the partnering water systems. As noted in the **Task 4 Technical Memorandum**, Manchester's current WMA registration allows for a maximum authorized withdrawal of 0.72 MGD. This need for increased withdrawals to supply Hamilton and the partnering water system is discussed further in the following section.

Table 3.2 below summarizes the total estimated costs for the new pipeline within Chebacco Road as presented in the Task 4 Technical Memorandum to connect with Manchester to supply Hamilton and the partnering communities under the two noted operational scenarios. The estimated total costs do not include land acquisition, right-of-way procurement and legal fees. Costs include 30% for engineering/permitting and a 25% contingency for planning purposes. All costs are presented in 2022 dollars and are **based on the May 2022 Boston ENR construction cost index of 17506.61.**

Table 3.2 Cost Summary - Chebacco Road Pipeline Interconnection

Item			Total Cost[1]
Scenario #1: Additional Manchester Supply w/ New PRV, FW Pumps & Browns Hill Tank On-Line			
9,600' of new 12" Main w/ New PRV, Revenue Meter & Backflow Preventer			$5,565,625
Scenario #2: Full Manchester Supply w/ New PRV, FW Pumps & Browns Hill Tank Off-line			
9,600' of new 12" Main w/ New PRV, Revenue Meter & Backflow Preventer			$5,565,625
New 0.80 MG Storage Tank, Demolition of Ex. 0.80 MG Tank & Appurtenances			$4,021,875
Total - Scenario #2			**$9,587,500**

1. Costs do not include land acquisition, right-of-way procurement and legal fees.

3.2.1 Conclusion

Based on the assesment completed above, the option of constructing a new pipeline along Chebacco Road to connect Manchester with Hamilton would be effective for augmenting Hamilton's existing well supplies. There would be some system impacts with respect to a reduced turnover rate within the Browns Hill Reservoir, but on an temporary basis, this should not pose any significant operational or water quality issues. For fully supplying Hamilton on a more permanent basis, there would be signifiant impacts to Hamilton's system including the hydraulic loss of the Browns Hill Reservoir due to the increased gradient of the system. **Additional system improvements such as a new storage tank to replace the existing Browns Hill Reservoir along with larger water mains to support the new tank would be needed.**

Also, as noted above, Manchester would need to have a surplus of 1.0 MGD available within their existing supply capacity and allowable WMA withdrawal to be able to fully supply Hamilton along with supplementing the other partnering water systems while meeting their own water needs. An evaluation of Manchester's current supply capacity versus future water needs is presented in the following section.

3.3 Manchester Water Supply Availability/Permitting Impacts

3.3.1 Adequacy to Supply Hamilton and Partnering Water Systems

Manchester's current WMA registration allows for a total combined authorized daily withdrawal of 0.72 MGD from its three water supplies including the Gravelly Pond Reservoir, the Lincoln Street well and the Round Pond GP Well #1 which is pumped into the Gravelly Pond Reservoir to maintain storage volumes. A summary of Manchester's existing water supplies including approved daily withdrawals and maximum pump capacities is included in **Table 3.3** below which was included in Section 4 of the attached Task 4 Technical Memorandum.

Table 3.3 Town of Manchester - Existing Water Supplies

Supply	Maximum Pump Capacity (MGD)	Maximum Pump Capacity (gpm)	Approved Daily Withdrawal (MGD)	WMA Approved Annual Withdrawal (MGD)
Gravelly Pond	4.30(2)	3,000	0.12	0.72(1)
Round Pond GP Well#1	N/A(3)	N/A(3)	0.43	
Lincoln Street Well	0.67	475	0.38	
Total	4.97	3,475	0.93	0.72

1. The WMA approved annual withdrawal from Manchester's combined supplies is 0.72 MGD.
2. This is the maximum pump capacity at the Gravelly Pond WTF which treats both Gravelly Pond and the Round Pond GP Well#1 supplies.
3. The Round Pond GP Well#1 has a rated well pump capacity of 300 gpm which is pumped into Gravelly Pond.

As shown in **Table 3.3**, Manchester has a maximum pump capacity of **4.97 MGD** with its existing supplies and infrastructure fully operational. From Hamilton's 2020 Water System Plan, Hamilton's projected average day demand (ADD) for 2035 is 0.671 MGD with a projected maximum day demand (MDD) of 1.01 MGD. From Manchester's **2018 Capital Efficiency Plan Report**, Manchester's projected ADD for 2035 is 0.620 MGD with a projected MDD of 2.03 MGD. From these projections, the total combined MDD for Hamilton and Manchester in 2035 would be approximately **3.04 MGD (1.01 MGD + 2.03 MGD),** which is below Manchester's current production capacity of 4.97 MGD. As such, Manchester has the infrastructure and pumping capacity to deliver enough supply to meet their future water needs, and the future water needs of Hamilton while having some surplus to share with the other partnering water systems. As noted in the Task 4 Technical Memorandum, Manchester's projected water needs included a 25% unaccounted-for water (UAW) which should be reduced in the coming years, thus resulting in a larger future surplus available to share.

With respect to available supply, as noted above, Manchester's projected ADD for 2035 is 0.620 MGD which is close to their recent ADD of 0.628 MGD as reported in their 2020 Annual Statistical Report (ASR). Based on Manchester's existing WMA registered withdrawal of 0.72 MGD as shown in **Table 3.3** above, there will be a future surplus volume of only 0.092 MGD available which is not enough volume to reliably augment Hamilton's supply as intended with the new future interconnection. However, as discussed in the Task 4 Technical Memorandum, this surplus could theoretically be increased up to 0.180

MGD if Manchester's current UAW percentage of 25% is reduced to 12% in the future which could possibly augment Hamilton enough to alleviate their current supply issue.

Based on the expected surplus volumes, there are several supply scenarios that could be considered for augmenting Hamilton's supplies through the new future interconnection while staying under their current registration. Some of which could allow Hamilton to reduce the use of its poorest raw water quality well, Idlewood Well #2, resulting in better finish water quality at its treatment plant as well as reducing withdrawals from the Ipswich River Basin. However, under these scenarios, there would not be any available surplus to supply the other partnering water systems.

For Manchester to fully supply Hamilton's future water needs of 0.671 MGD on a permanent basis along with their future water needs of 0.62 MGD as noted above, they would need to obtain MassDEP approval to increase their current WMA registered withdrawal of 0.72 MGD within the North Coastal Basin to **1.29 MGD (0.671 MGD + 0.620 MGD).** To achieve the goal of improving the supply resiliency of Hamilton and the other partnering water systems on a partial regional basis, then an additional increase to Manchester's current registered withdrawal volumes beyond the 1.29 MGD would be needed. The needed permitted volume would be dependent on how the partnering water systems intend to integrate this available supply into their system.

3.3.2 Water Supply Permitting Considerations

As presented in the Task 4 Technical Memorandum, Manchester can apply for a withdrawal permit from the DEP Water Management Program to increase its allowable withdrawal. However, Manchester's sources are within the North Coastal Watershed, which has a level 5 biological category and a level 4 Groundwater withdrawal category. This designation means the sub-basin is already depleted and suffering from significant environmental harm from water withdrawals. To obtain a new permit in this sub-basin, Manchester would first need to demonstrate it has a solid plan and program in place to get its UAW and gallons per capita day (gpcd) to below the State standards of 10% UAW and 65 gpcd. Second, Manchester would be required to *minimize* its existing withdrawals through a minimization program and *mitigate* the impacts of the new withdrawals on the sub-basin. While these steps are technically feasible, it is unclear if Manchester has enough options available to successfully meet the minimization and mitigation requirements. The permitting process would also require an extensive alternatives analysis to demonstrate that Hamilton has no other feasible and less-damaging water source alternative.

With Hamilton's existing water supplies within the Ipswich River Watershed, and Manchester's existing supplies within the North Coastal Watershed, an Inter-basin Transfer Act (IBT) permit will be needed to transfer water between the two systems and other affected partnering water systems. Depending on the volumes involved **(over 1 million gallons per day),** an IBT permit also requires that an Environmental Impact Statement assessment take place, which involves another layer of review. Several State agencies collectively participate in the IBT review and the permit is issued by the State Department of Conservation & Recreation under its role as support to the Massachusetts Water Resources Commission, which makes such regulatory decisions. The conditions of an IBT permit are contingent on overall environmental benefit, meaning a transfer from one basin can only be approved if it will have a neutral or net environmental benefit to the Commonwealth. Moreover, an IBT permit would require that both the donor and receiving permittees first comply with the principles of efficient water use as defined by the State Water Conservation Standards.

In the case of Manchester and Hamilton, the transfer of water between the two communities could theoretically be approved if both communities demonstrate efficient water use and a Comprehensive Water Resources Management Plan (CCMP) proves there is a neutral or net environmental benefit. The CCMP would analyze and demonstrate how the Towns would meet the Water Conservation Standards and reduced discretionary water use to the extent possible. For example, UAW would need to be 10% or below, and per capita water use below 65 gallons per day as previously noted for increasing registered withdrawals.

As the Town of Essex's sources within the North Coastal Basin are directly downstream of Manchester's water sources, the permitting process involved for both increasing existing WMA withdrawals and obtaining an IBT permit would require an analysis to determine the impact on Essex's sources. The Town of Essex, the local State legislative delegation and several stakeholders are currently involved in an extensive environmental assessment of the lower Essex River and Chebacco Lake Watersheds where the Manchester and Essex water sources are located. The study thus far has identified water withdrawals as a concern and potential source of water quality and flow impairments in the watershed. There is also a significant statewide effort amongst river advocates to prevent additional withdrawals in level 4 and 5 sub basins which may impact any decisions should Manchester request to increase its allocation. Any effort to increase Manchester's withdrawals would likely generate considerable involvement in downstream and other stakeholders, creating additional hurdles in the permitting process. To summarize, it is technically feasible for Manchester to increase its withdrawals, but the Towns would need to prove that overall environmental conditions will be improved through this effort.

3.3.3 Conclusions

Based on Manchester's existing registered withdrawals and future water needs, they should have the supply and production capacity available to augment the supply needs of Hamilton with a volume adequate to allow Hamilton to reduce the use of its Idlewood Well#2 source. This will result in an overall improvement of Hamilton's finish water quality, as well as reduce their withdrawals from the Ipswich River Basin and decrease the stress placed on their other's existing wells. However, under this supply scenario, there will be no surplus supply available to augment the other partnering water systems.

For Manchester to fully supply Hamilton and possibly other partnering water systems on a permanent or partial regional basis, they will need MassDEP approval to significantly increase their current registered withdrawals along with approval to transfer over 1 MGD of supply from one sub-basin to another. As noted above, although not impossible, the chances that Manchester can meet the withdrawal minimization and mitigation requirements for this approval is highly uncertain. In addition, given that Hamilton has another feasible and less-damaging source alternative with connecting to the SBWSB as discussed in Section 2, the likelihood of Manchester obtaining the noted permits to supply Hamilton and the partnering water systems on a regional basis would be even less. **As such, Hamilton should consider the new pipeline interconnection with Manchester as a short-term solution only to supplement their current supply needs.**

3.4 Water Quality Review

Per Task 2 of the WMA grant study, we coordinated and requested various water quality and system infrastructure data from Hamilton, Manchester and the partnering water systems of Ipswich, Essex, Wenham and Topsfield as required to complete this task. A summary of the finish water quality data collected from each of the water systems is presented in **Table 2.3** included in Section 2.4 of this report.

As previously noted in Section 2.4, **Hamilton's** five (5) Idlewood wells are post-treated at the Town's WTP after filtration for iron and manganese with sodium hypochlorite for disinfection, sodium fluoride for fluoridation, and a poly/orthophosphate blend for corrosion control. The Town's School Street well is chemically treated only before being delivered into the distribution system with sodium hypochlorite for disinfection, sodium fluoride for fluoridation, potassium hydroxide for pH adjustment, and a poly/orthophosphate blend for corrosion control.

From the Task 4 Technical Memorandum, **Manchester** utilizes the Trident/Microfloc package water treatment system at the Gravelly Pond WTF which includes oxidation, coagulation with aluminum sulfate, pH adjustment with sodium hydroxide, clarification, filtration, fluoridation with sodium fluoride, disinfection with sodium hypochlorite and corrosion control with zinc orthophosphate. This plant also treats raw water from the Round Pond GP Well#1 as this source is pumped directly into the Gravelly Pond reservoir. Treatment of Manchester's second source of supply, the Lincoln Street Well, is provided at the Lincoln Street Corrosion Control Facility which includes sodium hypochlorite for disinfection, sodium hydroxide for pH adjustment, a 70/30 percent non-sodium, non-zinc poly orthophosphate blend for corrosion control and prevention of colored water, and sodium fluoride for fluoridation.

As shown in **Table 2.3**, the finished water pH being maintained within Manchester's distribution system is in the range of 7.1 to 7.8 with a free chlorine residual in the range of 0.8 mg/l to 1.40 mg/l. The total phosphate residual maintained is in the range of 0.30 mg/l to 1.6 mg/l. In comparing the finished water quality being produced by Hamilton and Manchester, they are compatible with respect to pH, free chlorine and total phosphate levels. Both use chlorine for disinfection so there is no concern of blending chlorinated water with chloraminated water. Additionally, since both use phosphate products for corrosion control and maintain similar pH levels within their system, there should be minimal impacts to Hamilton's system with respect to lead and copper.

Levels of TTHMs and HAA5s within Manchester's system are less as compared to Hamilton's system, with both being below their respective established MCLs. However, Hamilton is currently constructing a new GAC treatment system that will reduce the levels of both TOCs and TTHMs at the plant which will improve finish water quality. PFAS levels at Manchester's Lincoln Street have had reported levels just at or above the 20 ppt MCL, however recent samplings have seen PFAS levels come down. These occasionally elevated levels could be problematic as they are higher than levels reported at Hamilton's Idlewood and School Street wells. However, sampling of Hamilton's School Street in 2021 showed a total sum of 13 ppt for the 6 regulated PFAS compounds which is still below the MCL of 20 ppt but is over the 10 ppt threshold which requires monthly sampling of the source. Hamilton has limited the use of this well and is currently evaluating options for providing future on-site treatment for PFAS removal.

There are operational measures and treatment strategies that Manchester can employ to mitigate their PFAS issues such as modifying the usage of the impacted supply similar to Hamilton or providing on-site treatment for its removal. **As such, Hamilton should be able to utilize a future interconnection with Manchester without any major water quality issues or impacts with meeting current drinking water standards, except for the noted PFAS.**

3.4.1 Supplying Partnering Water Systems

In Section 2.4, we presented and evaluated the finish water quality of the partnering water systems including Ipswich, Essex, Wenham and Topsfield, and possible water quality impacts with respect to Hamilton sharing its current and/or blended SBWSB supply with the partnering water systems. From

Table 2.3, given that Manchester's post-treatment practices and finish water quality closely match SBWSB, the blended supply of Hamilton and Manchester will have similar water quality impacts and issues related to supplying the partnering water systems as previously discussed in Section 2.4. With the partnering water systems of Ipswich, Wenham, Essex and Topsfield relying on free chlorine for disinfection as Hamilton and Manchester do, **there is no concern of blending chlorinated water with chloraminated water between systems.** The only two possible water quality issues identified in Section 2.4 which also apply here include Essex's lack of using phosphate for corrosion control and the presence of elevated PFAS levels within individual supplies for Manchester, Topsfield and Ipswich. As these same issues were already evaluated and discussed in Section 2.4, we did not feel it was necessary to repeat the same narrative. Please refer to Section 2.4 for the detailed discussion on these issues.

3.5 Infrastructure Needs to Supply Partnering Communities

As previously discussed in Section 2.5 of this report, Hamilton has existing interconnections with the Towns of Ipswich, Essex and Wenham, ranging in size from 2-inches to 8-inches **(Refer to Figure No. 2 in Appendix A of the Task 4 Technical Memorandum).** A view of Hamilton's water system showing the locations of the existing interconnections is included for reference in Section 2.5. Hamilton currently has no interconnection in place with Topsfield and as such, a new interconnection and related pipeline will need to be constructed to connect Topsfield with Hamilton. **This required pipeline improvement was evaluated under Task 5 of the WMA grant and is discussed in Section 4 of this report.**

The evaluation of these existing interconnections with Ipswich, Essex and Wenham related to the ability of Hamilton to hydraulically transfer supply into these systems based on current system gradients and infrastructure was previously presented in Section 2.5 of this report. The noted results from that evaluation are applicable here as well given that these same interconnections will be used to share the blended supply of Hamilton and Manchester with the partnering water systems under the same hydraulic conditions. Please refer to Section 2.5 for the detailed evaluation of these existing interconnections along with needed upgrades and considerations.

To summarize, it was recommended to replace Essex's existing 4-inch and 2-inch interconnection at the end of Essex Street (Rte. 22) **with a new single 8-inch connection.** For Ipswich, the existing 6-inch interconnection at the end of Waldingfield Road was noted to be adequate for transferring supply as was the existing 8-inch interconnection on Highland Street with Wenham. Additionally, it was estimated from hydraulic analyses that Hamilton's existing water system can deliver a supply rate of up to 200 gpm at Wenham's interconnection, up to 300 gpm at Essex's interconnection, and up to 150 gpm at Ipswich's interconnection.

As we do not have working models of the other partnering water systems, we could only determine what Hamilton could possibly deliver to augment the supplies of Wenham, Ipswich and Essex based on existing infrastructure. However, based on the operating gradients maintained by the partnering systems as shown in **Table 2.4**, and the existing infrastructure of their systems as described in the **Task 5 Technical Memorandum**, it is reasonable to surmise that these systems should be able to deliver similar supply rates into Hamilton.

Based on the existing system gradients of Hamilton and the partnering water systems as shown in **Table 2.4** in Section 2.5, Hamilton should be able to supply the systems of Wenham and Ipswich via gravity without the need for a PRV or a booster pump station. To effectively supply Essex, **a booster pump station** will be needed to overcome Essex's higher system gradient of 218 feet as compared to

Hamilton's gradient of 210 feet. The existing interconnections with Ipswich, Wenham and Essex will also need to be provided with new revenue meters for measuring the flows being supplied to the partnering water systems. The need for installing a backflow prevention device will be dependent on how the partnering water systems envision operating their interconnections, whether on a temporary/short-term basis or on a more permanent basis. **The estimated costs for upgrading the existing interconnections as needed for sharing supply between Hamilton, Wenham, Ipswich and Essex are included in Section 4 of this report summarizing the Task 5 Technical Memorandum.**

4. Task 5 Summary and Conclusions

4.1 Introduction

For Task 5, we evaluated the water systems of Ipswich, Essex, Wenham and Topsfield to determine the ability of sharing available supply between Hamilton and these systems to mitigate future short-term supply shortages on a Mutual Aid basis. As Hamilton has no direct connection with Topsfield, a new pipeline and interconnection will be required for the two systems to share water supply.

The Task 5 Technical Memorandum included in its entirety as **Appendix C** documents the evaluation of the partnering water systems along with the new pipeline for connecting Topsfield including: review of the existing water system infrastructure; review of water supply availability to meet future water needs within current WMA authorized withdrawals; identifying possible surplus supply to share amongst the partnering water systems; permitting considerations with sharing supply between different basins; review of water quality impacts from sharing and/or transferring finished water supply between Hamilton and the partnering water systems; needed infrastructure upgrades and associated costs to share supply between the partnering water systems; and analysis of the new pipeline route to connect Topsfield to Hamilton along with needed infrastructure and associated costs.

Please refer to the **Task 5 Technical Memorandum** for full narratives of the specific topics evaluated as required per the WMA grant scope along with supporting tables and figures. The following provides an overview of the results related to the assessment of existing water supply capacities and WMA registrations, review of system water needs, estimated supply surplus, water supply and permitting impacts, water quality review, and needed infrastructure upgrades for sharing supply between Hamilton and the partnering water systems.

4.2 Review of Existing Water System Supplies

4.2.1 Town of Ipswich

The Town of Ipswich's water system includes two (2) surface water supplies, five (5) groundwater supplies, one (1) conventional treatment facility, three (3) storage tanks and approximately 100 miles of water main. The distribution system includes three pressure zones or gradients as maintained by the Town Hill Tank (210 feet MSL), the Plover Hill Tank (216 feet MSL) and the Pinefield tank (269.5 feet MSL). The distribution system also includes approximately 4,764 service connections, and serves residential, commercial, business and institutional users. From the 2020 Annual Statistical Report (ASR), the average daily water consumption for the system was reported to be approximately **1.008 million gallons per day (MGD).** The town has existing emergency interconnections with the neighboring communities of Hamilton and Rowley. The major components of Ipswich's current water system are shown on the attached **Figure 1 in Appendix A of the Task 5 Technical Memorandum.**

Ipswich's water supply includes several sources located within the Parker River Basin and Ipswich River Basin. The sources within the Parker River basin include two surface water sources, the Dow Brook and Bull Brook Reservoirs, the Mile Lane well and the Browns well. The two reservoirs are operated in series with the Bull Brook flowing via gravity into the Dow Brook where the combined sources are then treated and filtered at the Town's water treatment plant which has a reported production capacity of **2.5 MGD**. The Mill Lane and Browns wells are chemically treated only and have a combined reported maximum pump capacity of **0.42 MGD**. The Town's current WMA registration allows for a maximum authorized

withdrawal of **0.98 MGD**, or 358 million gallons (MG) in a year, from all its combined sources located within the Parker River Basin.

The sources within the Ipswich River basin include the Fellows Road well, the Essex Road well and the Winthrop GD Well 2. The Town's current WMA Permit allows for a maximum authorized withdrawal of **0.20 MGD**, or 73 MG in a year, from all its combined sources located within the Ipswich River Basin. These three wells are chemically treated only and have a reported maximum pumping capacity of **0.75 MGD.** A summary of the Town's existing supplies and average annual withdrawals as taken from Table 2.1 included in Section 2.1 of the attached Task 5 Technical Memorandum is provided in **Table 4.1** on the following page. As noted in the Task 5 Technical Memorandum, Ipswich has taken Browns GP well off-line due to elevated levels of PFAS, and that new piping has already been installed up to the Town's WTP for purpose of blending the well water with the two surface water reservoirs for treatment.

4.2.2 Town of Essex

The Town of Essex's water system currently includes three (3) groundwater supplies, one (1) conventional treatment facility, one (1) storage tank and approximately 19 miles of water main. The distribution system includes approximately 1,135 service connections, and serves residential, commercial, business, industrial, agricultural and institutional users. The distribution system also includes one pressure zone which operates at a hydraulic gradient of 217.7 feet as maintained by the Town's only water storage tank, the Craft Hill tank. From the 2020 Annual Statistical Report (ASR), the average daily water consumption for the system was reported to be approximately **0.201 MGD.** The Town has existing emergency interconnections with the neighboring communities of Hamilton and Gloucester. The major components of Essex's current water system are shown on the attached **Figure 2 in Appendix A of the Task 5 Technical Memorandum.**

Essex's water supply includes three (3) wells, the Harry Homan's Drive Well #1, the Harry Homan's Drive Well #2, and Centennial Grove Well #3, all located within the North Coastal Basin. The Town's current WMA registration allows for a maximum authorized withdrawal of **0.22 MGD**, or 80.3 MG in a year, from all three sources combined. The Town's maximum pumping capacity for its three sources combined is reported to be **1.21 MGD.** All three wells are chemically treated and filtered at Essex's Water Treatment Plant (WTP) which has reported production capacity of **1.0 MGD.** A summary of the Town's existing supplies and average annual withdrawals as taken from Table 2.3 included in Section 2.2 of the attached Task 5 Technical Memorandum is provided in **Table 4.1** on the following page.

4.2.3 Town of Wenham

The Town of Wenham's water system currently includes two (2) groundwater supplies, one (1) pump station, two (2) storage tanks and approximately 30 miles of water main. The distribution system includes approximately 1,220 service connections, and serves residential, commercial, business, industrial, agricultural and institutional users. The distribution system also includes one pressure zone which operates at a hydraulic gradient of 211 feet as maintained by the Town's Lords Hill Reservoir. The Town's second tank, the Iron Rail Pump storage facility, is pumped storage for fire protection only. From the 2021 Annual Statistical Report (ASR), the average daily water consumption for the system was reported to be approximately **0.259 MGD.** The Town has existing emergency interconnections with the neighboring communities of Hamilton and Beverly. The major components of Wenham's current water system are shown on the attached **Figure 3 in Appendix A of the Task 5 Technical Memorandum.**

Table 4.1 Summary of Existing Supplies for Partnering Water Systems

Supply	River Basin	Maximum Pump Capacity (MGD)	Approved Daily Withdrawal (MGD)	WMA Approved Annual Withdrawal (MGD)	2020 Annual Average Withdrawal (MGD)[3]
Town of Ipswich:					
Dow Brook Reservoir	Parker	2.50	0.80[2]	0.98	0.642[1]
Bull Brook Reservoir	Parker				
Mile Lane GP Well	Parker	0.22	0.15		0.037
Browns GP Well[5]	Parker	0.20[4]	0.49		0.064
Subtotal		2.92	1.44	0.98	0.743
Fellows Road Well	Ipswich	0.31	0.31	0.20	0.102
Essex Road GP Well	Ipswich	0.21	0.21		0.089
Winthrop GD Well 2	Ipswich	0.23	0.23		0.075
Subtotal		0.75	0.75	0.20	0.266
Total – Town of Ipswich		3.67	2.19	1.18	1.009
Town of Essex:					
Harry Homan's Drive Well#1	North Coastal	0.36	0.22[6]	0.22	0.201
Harry Homan's Drive Well#2	North Coastal	0.49	0.48[6]		N/A
Centennial Grove Well#3	North Coastal	0.36	0.43[6]		N/A
Total – Town of Essex		1.21[8]	1.13	0.22	0.201[7]
Town of Wenham:					
GP Well 1	Ipswich	0.39	0.40[9]	0.29	
GP Well 2	Ipswich	1.07	1.08[9]		
Total -Town of Wenham		1.48	1.48	0.29	0.26[9]
Town of Topsfield:					
North Street Wellfield	Ipswich	1.14[9]	1.30[9]	0.43	0.314
Perkins Row Wellfield	Ipswich	0.43[9]	0.48[9]		0.079
Total - Town of Topsfield		1.57[10]	1.78	0.43	0.393[9]

1. Includes withdrawals from both Dow Brook and Bull Brook Reservoirs. Bull Brook transferred via gravity into Dow Brook for treatment.
2. Includes both the Dow Brook and Bull Brook Reservoirs as they are operated in series.
3. Estimated from Ipswich's 2020 Annual Statistical report (ASR).
4. This use of this source is limited due to water quality issues with manganese.
5. The Browns GP well is currently off-line due to elevated PFAS levels.
6. As reported in the Town's 2020 ASR.
7. This represents the supply being pumped into the water treatment plant from all 3 supplies.
8. The Town's water treatment plant that treats all 3 wells has a rated capacity of 1.0 MGD
9. As reported in the Town's 2021 ASR.
10. The Town's water treatment plant that treats both wells has a rated capacity of 1.4 MGD.

Wenham's water supply includes two (2) wells, GP Well 1 and GP Well 2, both located within the Ipswich River Basin. The Town's current WMA registration allows for a maximum authorized withdrawal of **0.29 MGD**, or 105.85 MG in a year, from both sources combined. These two wells are chemically treated only at the Town's Pleasant Street pump station only and have a reported maximum pumping capacity of **1.48 MGD.** A summary of the Town's existing supplies and average annual withdrawals as taken from Table

2.4 included in Section 2.3 of the attached Task 5 Technical Memorandum is provided in **Table 4.1** above.

4.2.4 Town of Topsfield

The Town of Topsfield's water system currently includes two (2) groundwater supplies, two (2) pump stations, one (1) greensand filtration plant, two (2) storage tanks and approximately 50 miles of water main. The system includes approximately 1,850 service connections, and serves residential, commercial, business, industrial, agricultural and institutional users. The distribution system also includes one pressure zone which operates at a hydraulic gradient of 260 feet as maintained by the Town's two water storage tanks including the Boston Street tank and the Garden Street tank. From the 2021 Annual Statistical Report (ASR), the average daily water consumption for the system was reported to be approximately **0.393 MGD.** The Town has existing emergency interconnections with the neighboring community of Danvers. The major components of Wenham's current water system are shown on the attached **Figure 4 in Appendix A of the Task 5 Technical Memorandum.**

Topsfield's water supply includes two (2) well sources, the North Street wellfield and the Perkins Row wellfield, both located within the Ipswich River Basin. The Town's current WMA registration allows for a maximum authorized withdrawal of **0.43 MGD**, or 156.95 MG in a year, from both sources combined. The Town gave up its WMA permitted withdrawal of 0.17 MGD a few years ago. The Town's maximum pumping capacity for its two sources combined is reported to be **1.57 MGD.** All three wells are chemically treated and filtered at Topsfield's Boston Street Water Treatment Plant (WTP) which has reported production capacity of **1.4 MGD.** A summary of the Town's existing supplies and average annual withdrawals as taken from Table 2.6 included in Section 2.4 of the attached Task 5 Technical Memorandum is provided in **Table 4.1** above.

4.2.5 Town of Hamilton

The Town of Hamilton's water system currently includes five (5) groundwater supplies, one (1) storage tank, one (1) water treatment plant and approximately 54 miles of distribution piping. The distribution system includes approximately 2,563 service connections, and serves residential, commercial, industrial, and institutional users. The distribution system also includes one pressure zone which operates at a hydraulic gradient of 210 feet as maintained by the Town's only water storage tank, the Browns Hill Reservoir. From the 2020 Annual Statistical Report (ASR), the average daily water consumption for the system was reported to be approximately **0.561 MGD**. The Town has emergency interconnections with the neighboring communities of Essex, Wenham and Ipswich. The major components of Hamilton's current water system are shown on the attached **Figure 5 in Appendix A of the Task 5 Technical Memorandum.**

Hamilton's water supply includes five (5) groundwater supplies including Idlewood #1, Idlewood #1 Satellite, Idlewood #2, Plateau and Caisson Satellite wells, all located within the Idlewood Wellfield, and the School Street Well. All well supplies are within the Ipswich River Basin and are registered except for the School Street well and Idlewood#1 well which are permitted. The Town's current WMA Permit allows for a maximum registered withdrawal of **0.92 MGD**, or 335.80 MG in a year, with a maximum permitted withdrawal of **0.11 MGD**, or 40.15 MG in a year, for a total authorized withdrawal of **1.03 MGD**, or 376 MG in a year, from all six sources within the Ipswich River Basin. Additionally, no more than 0.88 MGD can be withdrawn from the Idlewood Wellfield, and no more than 0.19 MGD can be withdrawn from School Street.

The Town's maximum pumping capacity for its five (5) Idlewood wells combined is reported to be **1.30 MGD.** All five wells are chemically treated and filtered at Town's Water Treatment Plant (WTP) which has reported maximum production capacity of **0.93 MGD.** The Town's School Street is chemically treated only and has a reported maximum pumping capacity of **0.16 MGD.** A summary of the Town's existing supplies and average annual withdrawals is provided in **Table 4.2** below which was included in Section 2.5 of the attached Task 5 Technical Memorandum. As noted in the Task 5 Technical Memorandum, Hamilton took Idlewood #2 well off-line in 2021 to mitigate water quality issues related to the formation of TTHMs at the plant and impacts to filter performance due to elevated levels of manganese. Also, Hamilton has taken the School Street well off-line due to elevated levels of PFAS.

Table 4.2 Town of Hamilton - Existing Water System Supplies

Supply	River Basin	Maximum Pump Capacity (MGD)	Approved Daily Withdrawal (MGD)	WMA Approved Annual Withdrawal (MGD)	2021 Annual Average Withdrawal (MGD)
Idlewood Wellfield(1)					
Caisson Satellite	Ipswich	0.21	0.22		0.096
Idlewood #1	Ipswich	0.31(3)	0.71(2)		0.323(2)
Idlewood Satellite #1	Ipswich	0.14		0.88	
Idlewood #2(4)	Ipswich	0.32(3)	0.57		0
Plateau	Ipswich	0.32(3)	0.51		0.126
Subtotal		1.30(6)	2.01	0.88	0.545
School Street(2)	Ipswich	0.16	0.19	0.19	0.020
Total – All Supplies		1.46	2.20	1.07(5)	0.565

1. The WMA permitted withdrawal for all combined wells within the Idlewood wellfield is 0.88 MGD.
2. Includes both Idlewood #1 and Idlewood Satellite #1 wells.
3. The maximum pump capacity of these sources is below the approved daily withdrawal due to water Quality issues with iron and manganese.
4. The Idlewood #2 well is currently off-line due to high TOCs and manganese.
5. The Town's WMA allows a total authorized withdrawal of 1.03 MGD from all five sources.
6. The Town's water treatment plant that treats the Idlewood wellfield has a maximum operating capacity of 0.93 MGD.
7. The School Street is currently off-line due to elevated PFAS levels.

4.3 Review of Future Water Supply Needs

4.3.1 Town of Ipswich

From the Town's **Final Water Demand and Supply Evaluation Report dated February 2019,** future average day demands for Ipswich were estimated to determine the future adequacy of the Town's supplies based on historical water usage, population projections and potential development. From this assessment, the Town's average day demand for 2040 was estimated to be **1.39 MGD** which is a 27% increase from its 2020 average day demand of **1.009 MGD** and exceeds its current total WMA registered withdrawal of 1.18 MGD as shown in **Table 4.1**. Additionally, as noted in the Task 5 Technical Memorandum, the safe yield of the Town's combined reservoirs of 0.80 MGD was re-evaluated in the February 2019 Report using supply data from the 2016 drought which resulted in a new established firm yield of **0.41 MGD**. This determination results in Ipswich having less supply available from these sources during a drought condition likely impacting the Town's ability to meet future water needs.

Based on the Town's current WMA registered withdrawal of 1.18 MGD from all its combined sources, Ipswich has a current surplus of **+0.171 MGD** available to share between the partnering communities on a short-term basis (1.180 MGD – 1.009 MGD). This equates to a total yearly volume of 62.4 MG. However, in 2040, the Town will have a supply deficit of -**0.210 MGD** based on its current WMA registered withdrawal (1.180 MGD – 1.390 MGD). Based on this future condition, it was recommended in the February 2019 report that the Town increase its water supply by 0.43 MGD along with requesting an increase in its current WMA withdrawal limits to meet future water demands.

As noted in the Task 5 Technical Memorandum, Ipswich is currently evaluating the development of the two new well sources within the Parker River Basin including one at the Town's existing Lynch site, and one to replace the existing Browns well. These new wells were noted in the February 2019 Report to have potential yields of up to 0.73 MGD and 0.58 MGD, respectively, which would address future supply deficits contingent on MassDEP approving an increase in the Town's current WMA withdrawal of 0.98 MGD for its Parker River basin sources.

In addition to average day demands, we also evaluated the impact to Ipswich's existing supply capacity in meeting future maximum day demands. From Ipswich's 2020 ASR, the maximum day demand within their system was reported to be **1.84 MGD** which equates to about 182% of the average day demand for the same year. From the Town's **Final Water Demand and Supply Evaluation Report dated February 2019,** the future maximum day demand for 2040 was estimated to be **4.17 MGD** which is about 300% of the future average day demand for the same year.

Based on the reported maximum supply capacity of **3.67 MGD** available from its combined Parker River and Ipswich River Basin sources as shown in **Table 4.1,** Ipswich will need to increase its existing supply capacity by at least **0.5 MGD (4.17 MGD – 3.67 MGD)** to meet its future maximum day demands. As MassDEP typically requires water systems to be capable of meeting their maximum day demand with their largest source or pump out of service, Ipswich may need more of an increase in capacity to meet this requirement. The future ratio of maximum day to average day demand used to estimate the Town's future maximum day demand seems high given the ratio noted for 2020, and the future water conservation measures that would likely be implemented. **Ipswich should consider re-evaluating this projection before moving ahead with significant investments to its existing infrastructure.**

Given that Ipswich's current maximum day demand noted above exceeds their current WMA daily registered withdrawal by 0.66 MGD, they would have to pump their sources at rates higher than the WMA daily withdrawal rate to meet this demand. These higher pump rates would likely be needed throughout the summer months when system demands tend to be consistently above the average day demands. As such, during these above average system demand periods, there would be minimal to no supply surplus available to share with the partnering water systems.

4.3.2 Town of Essex

From the Town's **Water System Plan dated September 2019,** future average day demands for Essex were estimated to determine the future adequacy of the Town's supplies based on historical water usage, population projections and potential development. From this assessment, the Town's average day demand for 2035 was estimated to be **0.260 MGD** which is a 30% increase from its 2020 average day demand of **0.201 MGD** and exceeds its current total WMA registered withdrawal of 0.22 MGD as shown in **Table 4.1**. However, Essex can withdraw an additional 0.10 MGD on top of its registered 0.22 MGD on

an average daily basis without triggering additional permitting so they will still be able to operate under their current registration and meet their future water needs.

Based on the Town's current WMA registered withdrawal of 0.22 MGD from its combined sources, Essex has a current surplus of **+0.019 MGD** available to share between the partnering communities on a short-term basis (0.220 MGD – 0.201 MGD). This equates to a total yearly volume of 6.94 MG. However, in 2035, the Town will have a supply deficit of **-0.040 MGD** based on its current WMA registered withdrawal (0.220 MGD – 0.260 MGD). Taking into consideration the additional 0.10 MGD withdrawal available to Essex, there would be a current surplus of about **+0.12 MGD** available to share between the partnering communities on a short-term basis, which equates to a total yearly volume of 43.8 MG (0.320 MGD – 0.201 MGD). In 2035, this available surplus would be reduced to **0.06 MGD** (0.320 MGD – 0.260 MGD), which equates to a total yearly volume of 21.9 MG.

In addition to average day demands, we also evaluated the impact to Essex's existing supply capacity in meeting future maximum day demands. From Essex's 2020 ASR, the maximum day demand within their system was reported to be **0.435 MGD** which equates to about 216% of the average day demand for the same year. From the Town's **Water System Master Plan dated September 2019,** the future maximum day demand for 2035 was estimated to be **0.421 MGD** which is about 162% of the future average day demand for the same year.

Based on the reported maximum supply capacity of **1.0 MGD** available from its treatment plant which treats all its three (3) well sources within the North Coastal Basin as shown in **Table 4.1,** Essex has ample supply capacity to meet its future maximum day demands having a surplus of **0.58 MGD (1.0 MGD - 0.421)** with all sources in operation. Additionally, given the pump capacities of their individual wells as shown in **Table 4.1,** they should be able to meet future maximum day demands with their largest well out of service as required per MassDEP. As with Ipswich, given that Essex's current maximum day demand noted above exceeds their current WMA daily registered withdrawal by 0.215 MGD, they would have to pump their sources at rates higher than the WMA daily withdrawal rate to meet this demand. These higher pump rates would expect to be needed throughout the summer months when system demands tend to be consistently above the average day demands as noted for Ipswich.

As such, during these above average system demand periods, there would be minimal to no supply surplus available to share with the partnering water systems. As shown above, Essex has on average minimal surplus available to share unless they utilize their additional 0.10 MGD withdrawal available under their current WMA registration.

4.3.3 Town of Wenham

From the data collection conducted under Task 2, Wenham has not completed a recent Water System Master Plan and therefore has no future population projections and/or future water need forecasts available. Per discussions with Town staff, it is believed that future average day demands over the next 15 years should remain relatively constant with minimal increase in usage. Recent DCR Water Needs Forecast predicts a 9-percent increase to its average day water usage in 10 years. For the purposes of this assessment, we have assumed that the Town's average day demand for 2035 will increase to **0.280 MGD** which is a 9% increase from its 2021 average day demand of **0.260 MGD**. Based on this assumption, the Town will be operating just below its current WMA registered withdrawal of 0.29 MGD as shown in **Table 4.1** to meet their future water needs.

It should be noted that in the Task 5 Technical Memorandum, we had initially applied a 2% increase to Wenham's current average day demand to estimate their future water needs for 2035. However, upon further review of recent DCR projections and the estimated water needs by the other partnering water systems, we realized that the initial 2% increase was low and that applying a 9% increase was more representative of the region.

Based on the Town's current WMA registered withdrawal of 0.29 MGD from its combined sources, Wenham has a current surplus of **+0.030 MGD** available to share between the partnering communities on a short-term basis (0.290 MGD – 0.260 MGD). This equates to a total yearly volume of 10.95 MG. In 2035, this surplus will be reduced to **+0.010 MGD** (0.290 MGD – 0.280 MGD), which equates to a total yearly volume of 3.65 MG.

In addition to average day demands, we also evaluated the impact to Wenham's existing supply capacity in meeting future maximum day demands. From Wenham's 2021 ASR, the maximum day demand within their system was reported to be **0.466 MGD** which equates to about 179% of the average day demand for the same year. For Wenham, since they do not have future water demand projections available, we have estimated their future maximum day demand by applying the current maximum day/average day demand ratio calculated above of 179%. This approach results in a future maximum day demand of **0.500 MGD.**

Based on the reported maximum supply capacity of **1.48 MGD** available from the its two well sources within the Ipswich River Basin as shown in **Table 4.1,** Wenham has ample supply capacity to meet its future maximum day demands having a surplus of **0.98 MGD (1.48 MGD - 0.500)** with both sources in operation. However, given the pump capacities of their individual wells as shown in **Table 4.1,** they would not be able to meet future maximum day demands with their largest well out of service as required per MassDEP.

As with Ipswich and Essex, given that Wenham's current maximum day demand noted above exceeds their current WMA daily registered withdrawal by 0.180 MGD, they would have to pump their sources at rates higher than the WMA daily withdrawal rate to meet this demand. These higher pump rates would expect to be needed throughout the summer months when system demands tend to be consistently above the average day demands as noted for Ipswich and Essex. As such, during these above average system demand periods, there would be minimal to no supply surplus available to share with the partnering water systems.

4.3.4 Town of Topsfield

From the data collection conducted under Task 2, Topsfield has not completed a recent Water System Master Plan and therefore has no future population projections and/or future water need forecasts available. Recent DCR projections used by the Town for renewing a previous water permit shows a slight increase in population which was the basis for the requested 0.03 MGD of additional permitted withdrawal. This DCR forecast predicts a 10-percent increase to its average day water usage in 10 years. For the purposes of this assessment, we have assumed that the Town's average day demand for 2035 will be increase to **0.430 MGD** which is a 10% increase in demand from its 2021 average day demand of **0.393 MGD**. Based on this assumption, the Town will be operating at its current WMA registered withdrawal of 0.430 MGD as shown in **Table 4.1** to meet their future water needs.

It should be noted that in the Task 5 Technical Memorandum, we had initially applied a 3% increase to Topsfield's current average day demand to estimate their future water needs for 2035.

However, upon further review of recent DCR projections and the estimated water needs by the other partnering water systems, we realized that the initial 3% increase was low and that applying a 10% increase was more representative of the region.

Based on the Town's current WMA registered withdrawal of 0.430 MGD from its combined sources, Topsfield has a current surplus of **+0.037 MGD** available to share between the partnering communities on a short-term basis (0.430 MGD – 0.393 MGD). This equates to a total yearly volume of 13.50 MG. In 2035, this surplus will be reduced to zero (0.430 MGD – 0.430 MGD). As noted in the Task 5 Technical Memorandum, Topsfield operated their system in 2021 with a reported unaccounted-for water usage of 22% or approximately 31.6 MG for the year. This equates to a daily withdrawal rate of 0.087 MGD.

If the Town can eventually reduce their unaccounted-for water by half to a more reasonable 11%, this would conversely increase the current supply surplus by about 0.043 MGD (0.087 MGD x 0.5) to approximately **0.080 MGD**, which equates to a total yearly volume of 29.20 MG. In 2035, the Town could potentially have a supply surplus of **0.043 MGD,** which would allow Topsfield to continue operating under their current WMA registration with some additional surplus for sharing water with the partnering communities.

In addition to average day demands, we also evaluated the impact to Topsfield's existing supply capacity in meeting future maximum day demands. From Topsfield's 2021 ASR, the maximum day demand within their system was reported to be **0.823 MGD** which equates to about 209% of the average day demand for the same year. For Wenham, since they do not have future water demand projections available, we have estimated their future maximum day demand by applying the current maximum day/average day demand ratio calculated above of 209%. This approach results in a future maximum day demand of **0.900 MGD.**

Based on the reported maximum supply capacity of **1.40 MGD** available from its treatment plant which treats its two (2) well sources within the Ipswich River Basin as shown in **Table 4.1,** Topsfield has ample supply capacity to meet its future maximum day demands having a surplus of **0.50 MGD (1.40 MGD - 0.90)** with both sources in operation. However, given the pump capacities of their individual wells as shown in **Table 4.1,** they would not be able to meet future maximum day demands with their largest well out of service as required per MassDEP.

As with Ipswich, Essex and Wenham, given that Topsfield's current maximum day demand noted above exceeds their current WMA daily registered withdrawal by 0.470 MGD, they would have to pump their sources at rates higher than the WMA daily withdrawal rate to meet this demand. These higher pump rates would expect to be needed throughout the summer months when system demands tend to be consistently above the average day demands as noted for Ipswich, Essex and Wenham. As such, during these above average system demand periods, there would be minimal to no supply surplus available to share with the partnering water systems.

4.3.5 Town of Hamilton

From the Town's **Water System Master dated February 2020,** future average day demands for Hamilton were estimated to determine the future adequacy of the Town's supplies based on historical water usage, population projections and potential development. From this assessment, the Town's average day demand for 2035 was estimated to be **0.671 MGD** which is about an 18% increase from its 2021 average day demand of **0.565 MGD** but still below its current WMA authorized withdrawal of 1.03 MGD as shown

in **Table 4.2**. As such, the Town will still be able to meet their future water needs with their current WMA authorized withdrawal.

Based on the Town's current WMA authorized withdrawal of 1.03 MGD from its combined registered and permitted sources, Hamilton would have a surplus of **+0.470 MGD** available to share between the partnering communities on a short-term basis (1.03 MGD – 0.565 MGD). However, as noted in the Task 5 Technical Memorandum, the Town has taken the School Street well off-line indefinitely due to elevated PFAS levels. As such, this only leaves the Idlewood wellfield available for the Town's use which has a WMA authorized withdrawal of 0.88 MGD as shown in **Table 4.2**. Based on this supply condition, Hamilton has a current surplus of **+0.315 MGD** available to share between the partnering communities on a short-term basis (0.880 MGD – 0.565 MGD). This equates to a total yearly volume of 114.98 MG. In 2035, this available surplus would be reduced to **+0.209 MGD** (0.880 MGD – 0.671 MGD), which equates to a total yearly volume of 76.29 MG.

In addition to average day demands, we also evaluated the impact to Hamilton's existing supply capacity in meeting future maximum day demands. From Hamilton's 2021 ASR, the maximum day demand within their system was reported to be **0.770 MGD** which equates to about 1.36% of the average day demand for the same year. From the Town's **Water System Master Plan dated February 2020,** the future maximum day demand for 2035 was estimated to be **1.006 MGD** which is 150% of the future average day demand for the same year.

Based on the current maximum production capacity of **0.93 MGD** at its treatment plant which treats all its five (5) Idlewood well sources as shown in **Table 4.2,** Hamilton will need to increase its existing supply capacity by at least **0.08 MGD (1.006 MGD – 0.937 MGD)** to meet its future maximum day demands. As MassDEP typically requires water systems to be capable of meeting their maximum day demand with their largest source or pump out of service, Hamilton may need more of an increase in capacity to meet this requirement. As noted in the Task 5 Technical Memorandum, the Town has taken its Idlewood #2 well which is its larger producer off-line for over a year due to elevated TOCs and manganese. This is significantly impacting the operation of the wellfield as other wells must be pumped more than they should to make up for the loss of the Idlewood #2 well in meeting system demands.

As noted in the Task 5 Technical Memorandum, this limited supply availability is further impacted by Hamilton having to routinely take one of the Idlewood wells off-line for redevelopment and maintenance due to excessive iron and manganese within the raw water. For example, taking one of the Idlewood wells off-line for maintenance with the Idlewood #2 well already off-line can potentially reduce Hamilton's available supply capacity to **0.67 MGD** which is less than the Town's higher summer demands which can approach 1.0 MGD at times. This places a great strain on the remaining wells and requires the plant to operate close to 24 hours a day during these higher demand periods to maintain adequate levels within their storage tank. The Town is currently completing the construction of a new GAC treatment facility to remove TOCs and TTHMs from the filtered water which will hopefully allow the Town to utilize Idlewood #2 well more often to help meet system demands. However, its use will always be limited due to its raw water quality which impacts the plant's filter performance and as such, would likely never be able to contribute enough to alleviate future supply deficits.

Unlike the other partnering water systems. Hamilton's current maximum day demand of 0.770 MGD is below its current WMA daily authorized withdrawal of 0.88 MGD for its Idlewood wellfield, which leaves some surplus to share. However, as noted above, given the current operation and water quality of the

Idlewood wells, this surplus is mostly unattainable, particularly during the summer months when Hamilton is struggling to meet system demands given their supply limitations.

4.3.6 Conclusion

For the assessment above, we first evaluated current and future average day demands of each partnering water system to identify supply surplus available under current WMA authorized withdrawals for sharing and which systems may be facing future supply deficits. We then evaluated the ability of each partnering water system's existing supply capacity to meet current and future maximum day demands and what impacts these higher demands will have on available surplus. **Table 4.3** below summarizes the results of the evaluations conducted under average day and maximum day demands for each partnering community water system.

Table 4.3 Available Surplus – Average Day & Maximum Day Demands

Year	Maximum Supply Capacity (MGD)	WMA Authorized Withdrawal (MGD)	Average Day Demand (MGD)	Surplus/ Deficit (MGD)	Maximum Day Demand (MGD)	Surplus/ Deficit (MGD)
Ipswich:						
2020	3.67	1.18	1.009	+0.171	1.837	-0.657
2040	3.67	1.18	1.390	-0.210	4.170	-2.99
Essex:						
2020	1.00	0.220	0.201	+0.019	0.435	-0.215
2035	1.00	0.220	0.260	-0.040	0.421	-0.201
Wenham:						
2021	1.48	0.290	0.260	+0.030	0.466	-0.176
2035	1.48	0.290	0.280	+0.010	0.500	-0.220
Topsfield:						
2021	1.40	0.430	0.393	+0.037	0.823	-0.393
2035	1.40	0.430	0.430	0.00	0.900	-0.470
Hamilton:						
2021	0.93	0.880	0.565	+0.315	0.770	+0.110
2035	0.93	0.880	0.671	+0.209	1.006	-0.126

As shown in **Table 4.3**, there is some surplus supply available within current WMA authorized withdrawals to share between the partnering water systems for mutual aid purposes based on current average day demands. However, based on future average day demands, all partnering water systems except Hamilton will have little to no surplus available to share for mutual aid purposes under current WMA authorized withdrawals. As shown in **Table 4.3**, both Ipswich and Essex are predicted to have supply deficits with Wenham and Topsfield predicted to be operating just at their WMA authorized withdrawals. Essex is permitted under their current WMA registration to withdraw an additional 0.10 MGD to meet their future water needs so they will be able to still operate under their current WMA authorized withdrawals.

Although Hamilton has surplus supply available within their current WMA authorized withdrawals, due to the poor water quality of its wells, Hamilton is limited to how much supply they can withdraw and treat which significantly diminishes the useable surplus available, particularly during high demand periods.

With respect to meeting future maximum day demands, from **Table 4.3**, Essex, Wenham and Topsfield will have ample supply capacity available as their maximum supply capacities exceed their future maximum water supply needs. However, based on the pump capacities for each individual source as shown in **Table 4.1**, both Wenham and Topsfield will not be able to meet these future demands fully with their largest well out of service.

With Ipswich's maximum supply capacity being less than their predicted future maximum day demand, they will need to improve their supply capacity either by increasing source pump rates, upgrading the production capacity of its treatment plant or developing a new source. As previously noted herein, the Town is evaluating the feasibility of installing a new well at its existing Lynch well site and a new replacement well for its Browns well which could potentially yield an additional combined capacity of 1.31 MGD. The future completion of these new wells, which are located within the Parker River basin, should alleviate the future supply and capacity deficits noted herein and improve Ipswich's ability to share supply with the partnering communities. **This is contingent on the Town being granted an increase in its current WMA authorized withdrawal for the Parker River Basin by MassDEP**

Like Ipswich, Hamilton's future maximum day demand exceeds their maximum supply capacity which as noted herein, is already reduced due to the water quality of their wells. The overall quality and performance of the Town's Idlewood wells have been gradually declining over the years with current production at about 60% of their approved capacity as shown in **Table 4.2**. This decline in water quality limits the production rate that the wellfield can yield, and the plant can treat providing little to no redundancy for the Town to rely on. The current condition of these wells makes it difficult to meet higher demand periods and as shown in **Table 4.3**, will not be adequate to future maximum day demands. This loss of production within their primary source of supply is the basis for Hamilton completing this study to identify alternative sources for improving its water supply resiliency to meet future water needs in the event future losses in production of these wells occur.

Although there is no apparent future surplus available to share during higher summer demand periods when most likely needed, some systems may have the capacity to pump their sources at higher rates to meet their water needs and still provide some surplus supply. As shown in **Table 4.3,** except for Ipswich, the maximum supply capacities for Essex, Wenham and Topsfield exceed their future maximum day demand so they may have the ability to meet their high demand periods and possibly share some supply on a mutual aid basis. **This would be contingent on the systems being able to over pump their wells during these high demand periods without having excessive drawdown issues due to long recovery periods as a result of low flow conditions within the subject river basins.**

Additionally, during the lower demand periods of the year when the partnering water systems typically pump their sources at or below the WMA daily authorized withdrawals, there would be surplus supply to share on an emergency or mutual aid basis. For most systems, this would be between the months of October and April.

4.3.7 Permitting Considerations for Sharing Surplus Supply

The water sources for the communities that are subject to this study are within 3 major river basins including the Ipswich, Parker and North Coastal. As noted in **Section 4.2**, Hamilton, Wenham and Topsfield are in the Ipswich Basin, Manchester and Essex are in the North Coastal basin and Ipswich has sources in both the Parker and Ipswich River Basins. As such, withdrawals made from the Ipswich Basin to share supply between Ipswich, Topsfield, Hamilton and Wenham would only be governed by the WMA

requirements. However, withdrawals made from the North Coastal and Parker River Basins by Manchester, Essex and Ipswich to share supply with the Ipswich River Basin systems or vice versa would also need an **Interbasin Transfer Act (IBTA) permit.**

Based on conversations with WMA and IBTA staff conducted as part of this study, sharing water amongst the communities on an emergency or short-term basis should not be problematic so long as proper notifications and regulatory processes were followed. Regarding longer term or more permanent sharing of water scenarios, including on a regular mutual aid basis, more regulatory issues would come into play. **Because the updated Safe Yield (SY) for the Ipswich River is roughly equal to existing allocations, it would be nearly impossible to either increase withdrawals to serve communities within the basin or transfer water outside the basin to serve Manchester and Essex.**

Although it is theoretically possible to increase withdrawals in the North Coastal or Parker River watersheds because the SY for those river basins has not yet been exceeded, doing so would still be onerous as the sub-basins where Essex, Manchester and Ipswich withdraw are classified as **Level 4 or 5 Biological Category (BC) and Groundwater Category (GWC)** as explained in detail in the Task 4 Technical Memorandum with regard to Manchester supplying Hamilton. Regarding the WMA, sharing water amongst communities within the same river basin is allowable so long as the overall allocations for that basin is not exceeded. There are two scenarios where this could work. Under **Scenario One**, so long as an individual community does not exceed their authorized withdrawal volume, they would be free to share water to another community within a basin. Under **Scenario Two**, a community could exceed its withdrawals to share with another in-basin community so long as the receiving community reduced its withdrawal by a like amount.

Although some surplus supply for sharing amongst the partnering water systems was previously identified, there are additional regulatory considerations to consider as part of the new WMA and IBTA regulations in the Ipswich, Parker and North Coastal Basins. First, it is ***highly unlikely*** that increased water allocations would be allowed in the Ipswich, North Coastal or Parker River sub-basins where current withdrawals are being made to meet the needs of other communities because they are all currently located in a level 4 or 5 sub-basin. As such, any realistic water sharing scenarios would be limited to existing allocations. Second, although Hamilton appears to have a significant amount of surplus water within its permitted allocation, the State bases their allocations on ***actual*** need as determined by local use statistics and the official DCR Water Needs Forecast.

As such, it is possible that their allocation would be deemed unavailable by DEP to be shared with other towns. Additionally, based on the physical limitations of Hamilton's water supply documented earlier in Section 4.3, it is unlikely that surplus could ever be made available to other partnering water systems. Finally, the region has witnessed two severe droughts and one of the wettest summers on record just in the last 6 years making annual water use statistics difficult to use as a basis for confidently estimating the sustainability of the local water surpluses identified earlier in this memorandum in light of climate change.

To help provide for a broader range of scenarios given the extreme variability in weather and water use statistics in recent years, we compiled water use data for the last 6 full years (which encompassed two droughts, one wet year and three normal years) to provide a more representative picture. Also, we developed additional water savings estimates that could be implemented to examine if this were a means to provide additional water supply resiliency. **Table 4.4** below which was included in Section 4 of the

attached Task 5 Technical Memorandum presents existing and projected water use that was developed to assess the feasibility of various water sharing scenarios amongst the communities in this study.

Table 4.4. Water Supply Needs by Community Under Various Scenarios

City or Town	Avg. Use: Current MGD(1)	Summer Use: High Month(2)	DEP Allocation MGD(3)	10-Year Need Projection(4)	Potential Water Savings(5)	Net Available Supply(6)	Net Available Supply(7)
Salem/Beverly	8.50	10.39	12.44	9.85	1.7 (20%)	2.59	4.29
Hamilton	0.55	0.65	1.02	0.75	0.8 (15%)	0	0.8
Ipswich	1.03	1.28	1.18	1.09	0.15 (15%)	0	0.15
Topsfield*	0.40	0.53	0.43	0.44	0.06 (15%)	0	0.05
Wenham	0.34	0.44	0.29	0.37	0.07 (20%)	0	-0.01
Essex	0.23	0.31	0.22	0.24	0.05 (20%)	0	-0
Manchester**	0.71	1.22	0.72	0.62	0.21 (30%)	0.10	0.31
Totals:	11.76	14.82	16.3	n/a	3.04	2.69	5.61

Notes:
1. Average daily use, 2016-2021
2. Average summer high use MGD, 2016-2021
3. Combination of registered and permitted volume
4. From official DCR Water Need Forecast (except Manchester and Essex: figures from local studies)
5. If enhanced water conservation program based on meeting Massachusetts Water Conservation Standards and Recommendations based on percentage of current use and individual town water conservation measures, UAW and summer use statistics. See publication: Recipe for Water Resiliency published by the Parker-Ipswich-Essex Rivers Resiliency Partnership, June 2022.
6. Amount of DEP allocation available to be shared with other communities based on current average use net of 10 year needs 5% protection buffer and that existing GW withdrawals in the Ipswich basin could not be shared due to regulation.
7. Amount of DEP allocation available to be shared with other communities based on average use net of implementation of enhanced water conservation program net of 10-year forecast needs and 5% protection buffer and that exiting GW withdrawals could not be shared due to regulation but water conservation savings could be.

* Based on finished water as raw water statistics unavailable for some years.
** Does not include 2017 data

Although there appears to be some surplus water available within existing WMA allocations to share on a mutual aid basis as identified in Section 4.3, sharing it to provide significant water supply resiliency benefits on a consistent basis and justify the capital costs over the long term would be challenging. This said, if communities were to implement an enhanced water conservation program, there should be enough water available to meet the needs of local communities for the short to medium term providing resiliency to both meet local growth needs and provide flexibility to address PFAS contamination. If the infrastructure investments analyzed herein to share water amongst the communities on a mutual aid basis were implemented, it would also allow for the importation and sharing of surplus water from future sources such as the SBWSB, thereby addressing the water supply resiliency needs of these communities for the long term.

4.4 Water Quality Review

Per Task 2 of the WMA grant study, we coordinated and requested various water quality and system infrastructure data from Hamilton and the partnering water systems of Ipswich, Essex, Wenham and Topsfield as required to complete this task. A summary of the finish water quality data collected from each of the water systems is presented in **Table 2.3** included in Section 2.4 of this report.

In comparing the finished water quality of the partnering water systems with the Town of Hamilton's current and future water quality, they are similar with respect to pH and free chlorine with exception of Ipswich which maintains a larger range of pH than the other systems. However, they do use an ortho/polyphosphate blend like Hamilton for corrosion control so it is not anticipated that this larger pH range will be an issue. As noted in Section 2.4, Essex does not use any phosphate addition for corrosion control which could be an issue with respect to lead and copper if supply from Hamilton and the other partnering water systems is delivered into their system. **All the partnering communities rely on free chlorine for disinfection so there is no concern of blending chlorinated water with chloraminated water between systems.**

From **Table 2.3**, levels of TTHMs and HAA5s within Hamilton's system are higher as compared to Ipswich, Wenham, Essex and Topsfield, but still below their respective established MCLs, so there is a potential for seeing an increase in these constituents within their systems. However, blending of the supplies between the partnering communities should minimize this issue to some extent and prevent any possible MCL exceedance. Additionally, Hamilton is currently constructing a new GAC treatment system that will reduce the levels of both TOCs and TTHMs at the plant which will improve finish water quality. As such, it appears that Hamilton and the partnering communities should be able to share supply utilizing existing and future interconnections without any major water quality issues or impacts with meeting current drinking water standards, except for the two noted below.

The only two possible water quality issues identified in Section 2.4 which also apply here include Essex's lack of using phosphate for corrosion control and the presence of elevated PFAS levels within individual supplies for Topsfield and Ipswich. As these same issues were already evaluated and discussed in Section 2.4, we did not feel it was necessary to repeat the same narrative. Please refer to Section 2.4 for the detailed discussion on these issues.

4.5 Infrastructure Needs to Supply Partnering Communities

As previously discussed in Section 2.5 of this report, Hamilton has existing interconnections with the Towns of Ipswich, Essex and Wenham, ranging in size from 2-inches to 8-inches **(Refer to Figure No. 5 in Appendix A of the Task 5 Technical Memorandum).** A view of Hamilton's water system showing the locations of the existing interconnections is included for reference in Section 2.5. Hamilton currently has no interconnection in place with Topsfield and as such, a new interconnection and related pipeline will need to be constructed to connect Topsfield with Hamilton. **The feasibility of a new interconnection with Topsfield is evaluated in the following section.**

The evaluation of these existing interconnections with Ipswich, Essex and Wenham related to the ability of Hamilton to hydraulically transfer supply into these systems based on current system gradients and infrastructure was previously presented in Section 2.5 of this report. The noted results from that evaluation are applicable here as well given that these same interconnections will be used to share surplus supply between Hamilton and the partnering water systems under the same hydraulic conditions. Please refer to Section 2.5 for the detailed evaluation of these existing interconnections along with needed upgrades and considerations.

To summarize, it was recommended to replace Essex's existing 4-inch and 2-inch interconnection at the end of Essex Street (Rte. 22) **with a new single 8-inch connection.** For Ipswich, the existing 6-inch interconnection at the end of Waldingfield Road was noted to be adequate for transferring supply as was

the existing 8-inch interconnection on Highland Street with Wenham. Additionally, it was estimated from hydraulic analyses that Hamilton's existing water system can deliver a supply rate of up to 200 gpm at Wenham's interconnection, up to 300 gpm at Essex's interconnection, and up to 150 gpm at Ipswich's interconnection. The existing interconnections with Ipswich, Wenham and Essex will also need to be provided with new revenue meters for measuring the flows being supplied to the partnering water systems. The need for installing a backflow prevention device will be dependent on how the partnering water systems envision operating their interconnections, whether on a temporary/short-term basis or on a more permanent basis.

As we do not have working models of the other partnering water systems, we could only determine what Hamilton could possibly deliver to augment the supplies of Wenham, Ipswich and Essex based on existing infrastructure. However, based on the operating gradients maintained by the partnering systems as shown in **Table 2.4**, and the existing infrastructure of their systems as described in the **Task 5 Technical Memorandum**, it is reasonable to surmise that these systems should be able to deliver similar supply rates into Hamilton.

Based on the existing system gradients of Hamilton and the partnering water systems as shown in **Table 2.4** in Section 2.5, Hamilton should be able to supply the systems of Wenham and Ipswich via gravity without the need for a PRV or a booster pump station since their gradients are about equal. Since these interconnections will be used for sharing supply between both respective systems, we would recommend the use of an electromagnetic type flow meter as the revenue meter which can measure the gravity flow in either direction. Otherwise, two separate meters and pipe connections would be needed.

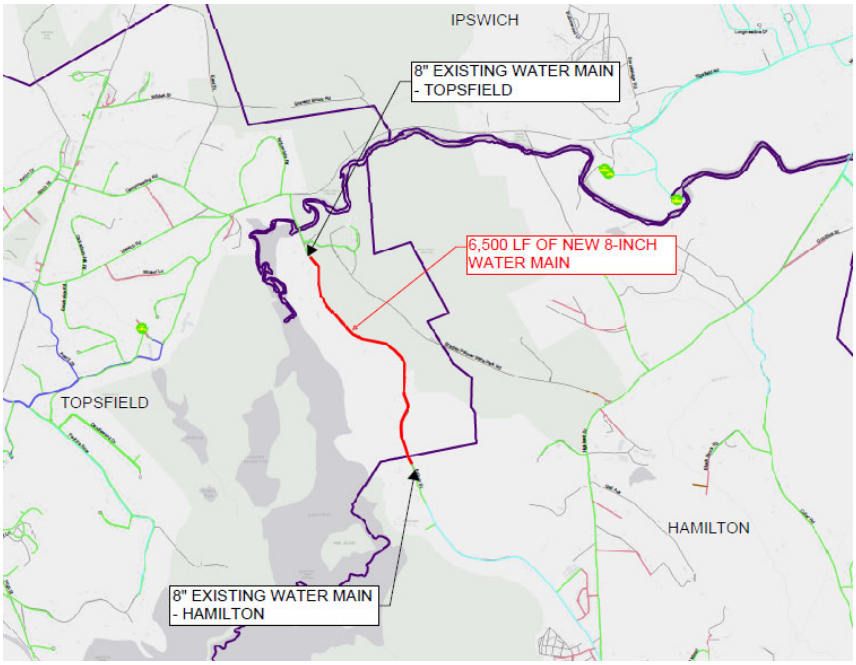
With Essex having a system gradient about 8 feet higher than Hamilton, **a booster pump station** will likely be needed at the interconnection to effectively supply Essex daily over an extended period. Based on the estimated supply rate of about 300 gpm that Hamilton can supply at the interconnection with Essex as noted above, we would recommend that a 350 gpm booster pump station be provided. Conversely, supply from Essex into Hamilton can likely be delivered via gravity since Essex maintains a higher gradient than Hamilton. To allow this gravity flow from Essex into Hamilton, the new interconnection with Essex would need to have a bypass around the booster pump station with a separate revenue meter. **The estimated costs for upgrading the existing interconnections as needed for sharing supply between Hamilton, Wenham, Ipswich and Essex are included in Section 4.5.2 of this report.**

For Topsfield, with an operating gradient of 260 feet, a booster pump station will be needed for Hamilton to supply Topsfield. Conversely, a pressure reducing valve (PRV) will be needed for Topsfield to supply Hamilton. Like Essex, a new interconnection with Topsfield would need to have a bypass around the booster pump station for the PRV along with a separate revenue meter. The following section evaluates the feasibility of installing a new pipeline to connect Hamilton and Topsfield for sharing surplus supply between their systems and the other partnering communities.

4.5.1 Future Pipeline Interconnection with Topsfield

In reviewing Topsfield's existing water distribution system as provided by the Town under Task 2, the best route for installing a new pipeline to connect the systems of Hamilton and Topsfield within an existing public road was identified in the Task Technical Memorandum to be along Asbury Street. The new pipeline would initially connect to Hamilton's existing 8-inch main in Asbury Street and extend westerly approximately 6,500 feet along Asbury Street terminating at Topsfield's existing 8-inch main in Asbury

Street. Refer to **Figure 6 – Hamilton-Topsfield Potential Interconnection included in Appendix A of the Task 5 Technical Memorandum.** We have included a partial view of Figure 1 for reference below.



Partial View of Figure 6- Hamilton/Topsfield Potential Interconnection

The new interconnection with Hamilton's existing 8-inch main will require a revenue meter chamber for measuring and totalizing flow. As this new interconnection will be normally closed and only manually opened when needed under a controlled operation, it is not expected that a backflow prevention device for cross-connection control will be needed. As such, we have not included the installation of this device in our assessment. If, in the future, this new interconnection is used on a more permanent basis and/or are left normally open, then the installation of a backflow prevention device may be necessary depending on applicable water system requirements and regulations.

As Topsfield operates at a higher gradient than Hamilton **(260 feet vs 210 feet),** a new booster pump station will be needed for Hamilton to share supply with Topsfield. Conversely, a new PRV station will be needed for Topsfield to share supply with Hamilton. Utilizing the Town of Hamilton's computerized water model, we conducted a hydraulic analysis to determine the design criteria for the new pipeline, PRV and booster pump station required to share supply between Hamilton and Topsfield.

From Hamilton's water system model, the hydraulic gradient at the proposed interconnection with Hamilton's existing 8-inch main on Asbury Street varies from **205 feet to 218 feet** over a 24-hour period depending on system demand, tank level and whether the Town's finish water pumps are operating. Upon including the new pipeline and new revenue meter into Hamilton's computerized water system model, we conducted extended period simulation (EPS) analyses for various PRV settings under average day demands computer simulations to determine the optimal PRV setting for augmenting Hamilton's existing water system from Topsfield. For the EPS analyses, the Browns Hill Reservoir was initially set at an elevation of 209 feet with the plant's finish water pumps on-line and controlled off reservoir level.

From the results of the analyses, the most favorable option would be to set the new PRV to a downstream gradient somewhere between **208 feet and 212 feet.** This will hydraulically allow a predicted supply rate in the range of 200 gpm to 300 gpm, respectively, into Hamilton through the new interconnection with little impact to the current operation of Hamilton's system. The final setting can be adjusted as needed based on actual system conditions when the new interconnection is installed and how much supply is to be shared. As we don't have a working model of Topsfield's water system, we cannot determine the supply rates that Topsfield could possibly deliver into Hamilton. However, based on their higher operating gradient as shown in **Table 2.4**, and the noted infrastructure of their system in **Section 2**, it is reasonable to surmise that Topsfield should be able to deliver appropriate supply rates into Hamilton.

For the new pipeline, given the fact that Topsfield's gradient is 50 feet higher than Hamilton's gradient, an 8-inch diameter main should be enough to deliver flows up to 300 gpm. At this flow rate, the frictional head loss generated through 6,500 feet of 8-inch main would approximately 15 feet which, based on an operating gradient of 260 feet, would still provide an upstream gradient of about 245 feet at the new PRV. We do not have a model of Topsfield's water system and as such, we cannot determine the pressure fluctuations at the connection with Topsfield's existing 8-inch main. However, based on the higher operating gradient maintained by Topsfield, and the noted the infrastructure of their system in **Section 2 of the Task 5 Technical Memorandum**, we do not anticipate an issue.

For a new booster pump station, based on the predicted supply rates noted above, we would recommend that a **350 gpm booster pump station** be provided. The new booster station should be sized to overcome both the difference in static pressure and frictional losses to supply Topsfield from Hamilton. As noted above, the head loss through 6,500 feet of 8-inch main when supplying flow at a rate of 300 gpm would be approximately 15 feet. The gradient difference between Topsfield and Hamilton is 50 feet **(260 feet – 210 feet**). Allowing for station losses and having some additional head to effectively deliver water into Topsfield's system, the new pump station should be rated for 350 gpm at a total dynamic head (TDH) of about 80 feet.

4.5.2 Estimated System Infrastructure Costs for Sharing Supply

Tables 4.5 and 4.6 on the following pages present the estimated costs for the infrastructure upgrades for Hamilton to supply Ipswich, Essex and Wenham through their existing interconnections and Topsfield through a new interconnection and 8-inch pipeline based on the above assessment. These tables were previously included as Table 6.2 and Table 6.3 in Section 6 of the attached Task 5 Technical Memorandum. The estimated water main costs per foot included in the tables on the following page are weighted costs and include the cost for furnishing and installing the pipe, valves, fittings, bedding, backfill, traffic control, trench and site restoration. Costs were developed in part using recent construction cost data for new water mains, pumping stations, and appurtenances. The estimated costs do not include land acquisition, right-of-way procurement and legal fees. We have included 30% for engineering/ permitting and a 25% contingency for planning purposes. All costs are presented in 2022 dollars and are based on the **May 2022 Boston ENR construction cost index of 17506.61.**

Table 4.5 Infrastructure Upgrades to Existing System Interconnections

Item			Cost[1]
Interconnection with Wenham			
New Revenue Meter Vault and appurtenances[2]			$150,000
New Electrical/Control Systems & SCADA upgrades (for meter)			$30,000
Miscellaneous (testing, commissioning, general conditions, etc.)			$20,000
Subtotal			**$200,000**
Engineering and Permitting (30%)			**$60,000**
Subtotal – Engineering and Construction			**$260,000**
25% Contingency			**$65,000**
Total - Interconnection with Wenham			**$325,000**
Interconnection with Ipswich			
New Revenue Meter Vault and appurtenances[2]			$150,000
New Electrical/Control Systems & SCADA upgrades (for meter)			$30,000
Miscellaneous (testing, commissioning, general conditions, etc.)			$20,000
Subtotal			**$200,000**
Engineering and Permitting (30%)			**$60,000**
Subtotal – Engineering and Construction			**$260,000**
25% Contingency			**$65,000**
Total - Interconnection with Ipswich			**$325,000**
Interconnection with Essex			
New 350 gpm Booster Pump Station w/ Above-Grade Structure (incl. Revenue Meter)			$175,000
Site work & connections for new Booster Pump Station and Bypass			$75,000
New Revenue Meter Vault and appurtenances (for gravity flow)			$150,000
New Electrical/Control Systems & SCADA upgrades (for meter)			$30,000
Miscellaneous (testing, commissioning, general conditions, etc.)			$50,000
Subtotal			**$480,000**
Engineering and Permitting (30%)			**$144,000**
Subtotal – Engineering and Construction			**$624,000**
25% Contingency			**$156,000**
Total - Interconnection with Essex			**$780,000**

1. Costs do not include land acquisition, right-of-way procurement and legal fees.
2. Based on using single electromagnetic flow meter for measuring bidirectional flow.

Table 4.6 New Hamilton-Topsfield Interconnection Costs

Item			Cost[1]
New Topsfield Interconnection w/ New Pipeline, PRV and Booster Pump Station			
6,500' of New 8" Main in Asbury Street from Ex. 8" Main to Ex. 8" Main @ $225/ft			$1,462,500
New Revenue Meter Vault and appurtenances			$150,000
New PRV Vault and appurtenances			$75,000
New electrical/control systems & SCADA upgrades (for meter & PRV)			$40,000
New 350 gpm Booster Pump Station w/ Above-Grade Structure (incl. Revenue Meter)			$175,0000
Site work & connections for new Booster Pump Station and Bypass			$75,000
Site work & connections to ex. 8" main on Asbury Street (Hamilton)			$25,000
Site work & connections to ex. 8" main on Asbury Street (Topsfield)			$25,000
Miscellaneous (testing, commissioning, general conditions, etc.)			$225,000
Subtotal			**$2,252,500**
Engineering and Permitting (30%)			**$675,750**
Subtotal – Engineering and Construction			**$2,928,250**
25% Contingency			**$732,000**
Total - Interconnection with Topsfield			**$3,660,250**

1. Costs do not include land acquisition, right-of-way procurement and legal fees.

5. Future Water Supply Resiliency Summary/Recommendations

5.1 General

In the previous sections and attached Technical Memorandums, we evaluated alternatives for Hamilton to address its water supply limitations due to the deteriorating quality and capacity of its Idlewood wellfield for meeting future water needs. Two alternative sources of supply were identified for being evaluated as part of the WMA grant study including a new interconnection with SBWSB **per Task 3** and a new interconnection with Manchester **per Task 4.** Both alternatives were evaluated based on two supply scenarios including 1) supplementing Hamilton's existing water system on an as-needed basis and 2) fully supplying Hamilton on a permanent basis. For each alternative, we also determined the supply rates that could be delivered to the partnering water systems through existing interconnections with Hamilton and the associated infrastructure upgrades needed to augment their water systems. We identified possible issues with blending and sharing supply from the SBWSB, Manchester and the partnering water systems with respect to water quality and permitting impacts. Costs for system infrastructure required for the SBWSB and the Manchester to supply Hamilton were developed and presented in Sections 2 and 3 of this report.

Per **Task 5** of the WMA study, we also evaluated current and future water needs of the partnering water systems to determine available supply surplus for sharing when needed to mitigate future short-term supply shortages on a Mutual Aid basis. Similar to Tasks 3 and 4, we determined the supply rates that could be delivered through existing interconnections with Hamilton and the associated infrastructure upgrades needed to augment their water systems. This included a new pipeline and interconnection between Hamilton and Topsfield. We also identified possible issues with blending and sharing supply between the partnering water systems with respect to water quality and permitting impacts. Costs for system infrastructure required to share surplus supply between Hamilton and the partnering water systems were developed and presented in Section 4 of this report.

5.1.1 Permitting and Regulatory Considerations Summary

Public water supply is generally considered a utility for regulatory purposes. In Massachusetts, two laws and regulatory regimes govern drinking water: The Water Management Act (WMA) which governs the withdrawal of water from the environment and the Safe Water Drinking Water Act (SDWA) which governs the public health and safety-related aspects of water. This project reviewed the implications of the WMA as it relates to the ability to share and increase water withdrawals and the SDWA as it relates to the water quality implications of sharing different sources of water amongst the studied communities. A third law also comes into play in situations where water withdrawn from one watershed is discharged into another community in a different watershed, the Interbasin Transfer Act (IBTA).

This is the case for this study as the subject partnering communities are in three different river basins: The Ipswich, The Parker and the North Coastal. The regulatory implications of these three laws with respect to sharing supply between the partnering communities were examined in detail in the Task 3, 4 and 5 Technical Memorandums. **Table 4.4** included in Section 4.3.7 of this report and **Figure 5.1** included on the following page presents existing and projected water use, and withdrawal data that was developed and utilized to assess the various water sharing and resiliency scenarios examined under this project.

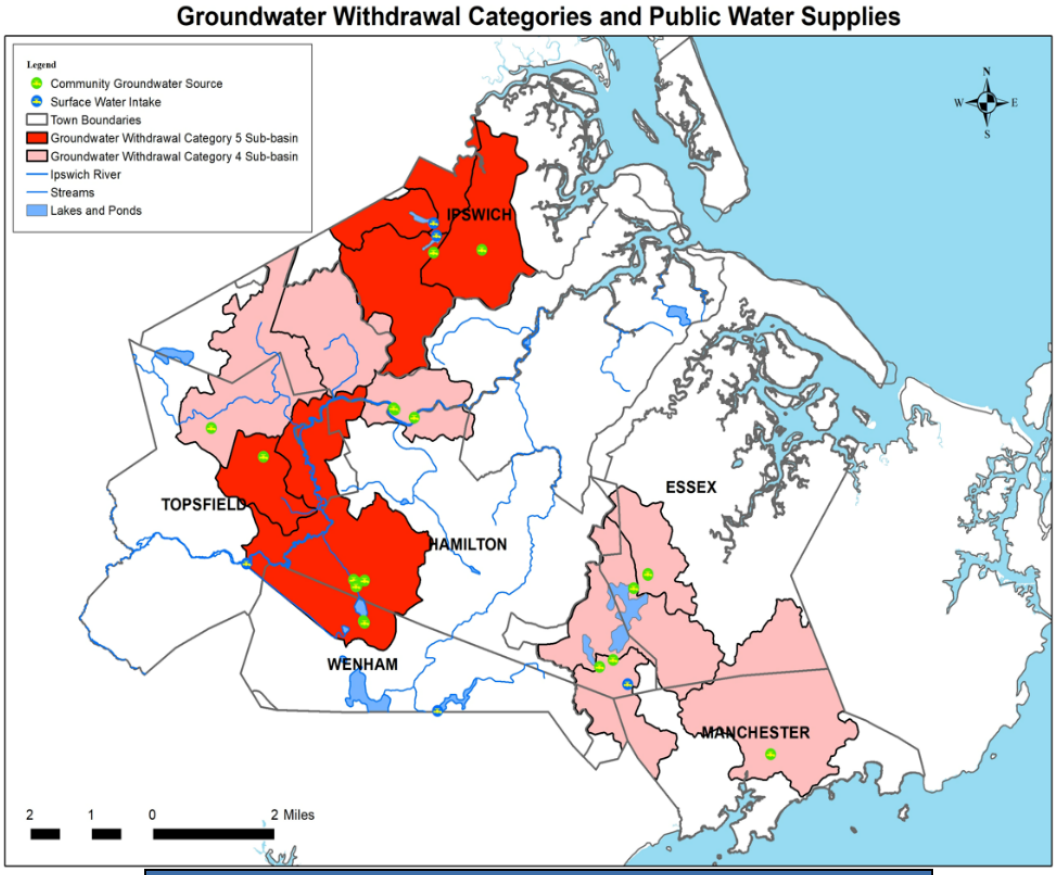


Figure 5.1 Groundwater Withdrawal Categories for Partnering Communities

Based on the data shown in **Table 4.4** and **Figure 5.1**, the following general summary and conclusions can be made regarding regulatory impacts from sharing supply from SBWSB, Manchester, and the partnering communities to meet future water needs.

Summary:

- It is generally feasible to share and move water amongst all the communites in the study provided the identified infrastructure improvements were made, the relatively minor water mixing chemistry issues addressed and legislation passed to amend the charter of the Salem Beverly Water Supply Board (SBWSB) to serve additional communites.
- Although some of the communities have some surplus water available under their existing allocations to share with other communities on a mutual aid basis, it would likely be restricted to the low demand months (due to high summer demand in most communities already pushing their withdrawal and production capacity limits) such that it would make the infrastructure investments necessary to do so difficult to justify economically.
- Because every groundwater-dependent community in the study withdraws from a level 4 or 5 sub-basin, it would be extremely difficult for the communities to increase their local withdrawal allocations in the future.
- Considering current and future water needs, it appears that Essex and Wenham do not have enough water availble under their existing allocations such that alternative sources will be needed by those communities in the near future.

- Although the SBWSB appears to have some surplus water available under its current registration, it would be difficult to share that water on a long term basis considering the future growth needs of Salem and Beverly.
- If the SBWSB were to activate their unused WMA permit allocation of 2.27 MGD, enough water could be made available to supply several or all of the communities with supplemental water and/or serve the entire needs of one to three addional communites completely depending on which ones.
- If the communities implemented an enhanced water conservation program as developed by the Greenscapes Coalition, which all the communities are members of, there appears to be enough water available to meet the water needs of the communities for the forseeable future (assuming water were to be shared with Essex and Wenham).
- Ideally, an alternative water source (currently being studied by the North Shore Water Supply Resileincy Task Force) would be identified to provide long term water resileincy and security for the communities studied which would also aleviate the environmental impact on the three stressed river basins which currently supply the regions water.

Conclusions:

1. It appears to be more feasible for Hamilton to obtain its water from the SBWSB as opposed to Manchester. If the necessary infrastructure improvements were made to connect Hamilton to SBWSB, this would also help meet the additional water supply needs of Essex and Wenham since Hamilton already has interconnections with those communities.
2. If SBWSB were to activate its permit, it could serve Hamilton and provide supplemental water to each of the other communities to provide additional water supply resileicny for the foreseeable future. Implementing enhanced water conservation programs in each of the communities would provide for additional water supply resiliency.
3. Ideally, an alternative source of water would be identified to provide both permanent water supply resilency and increase ecosystem health for the regions water resources.

5.1.2 Water Supply Recommendations

Based on the results of the analyses presented in Sections 2 and 3 of this report, and the regulatory considerations noted above, a new interconnection and pipeline with the SBWSB would be the most feasible approach for meeting the future water supply needs of Hamilton and conversely the partnering water systems. From the three optional pipeline routes evaluated as presented in Section 2, **we recommended Option A which includes installing approximately 12,900' of new 12" water main from the existing 12" main in Cabot Street up to the existing 8" main in Highland Street. The new interconnection will also need to be provided with a new PRV, revenue meter and backflow preventer device to supplement Hamilton's existing water system**.

The SBWSB has the existing supply capacity under their existing registered withdrawals to augment Hamilton's supply and possibly the partnering water systems on a short-term basis. Upon completing the planned upgrades to their existing plant and activating their permitted withdrawal volumes, SBWSB could fully meet the supply needs of Hamilton, Salem-Beverly and most of the partnering water systems on a long-term regional basis. Additionally, as both supplies for Hamilton and the SBWSB are within the Ipswich River Basin, no IBTA permit would be needed. **To fully supply the future water needs of**

Hamilton and other partnering water systems, a new 1.5 MGD booster pump station will be needed at the interconnection with SBWSB as indicated in Section 2.

Although Manchester has the existing supply capacity and registered withdrawals to augment Hamilton's future supply needs, there would be no surplus supply available to augment the other partnering water systems. For Manchester to fully supply Hamilton and possibly other partnering water systems on a permanent or partial regional basis, they will need a significant increase int their current registered withdrawals along with approval to transfer over 1 MGD of supply from one sub-basin to another. As noted in Section 2, this would be challenging and likely not realistic given that Manchester's supplies are located within a level 4 or 5 sub-basin. Additionally, significant upgrades to Hamilton's water system would be needed to accommodate the higher-pressure gradient from being supplied by Manchester including a new taller water storage tank and associated mains.

Given these limitations, and the fact that this future connection would not provide any benefit to the partnering water systems, this approach does not meet the overall goal of improving water supply resiliency on a more regional basis as the future connection with the SBWSB would. Additionally, the recommended SBWSB future connection could be considered the initial step in meeting the goal of Senator Tarr's North Shore Water Resiliency Task Force study to implement a long-term regional solution to alleviate water resiliency issues within the Ipswich River Watershed. As such, we recommend that Hamilton not consider a future pipeline and interconnection with Manchester. **It should be noted that Manchester is already connected to the SBWSB through the City of Beverly, and has the infrastructure in place to be part of a long-term regional approach with SBWSB as the source of supply**

In addition to the new pipeline and interconnection with SBWSB, in Section 4, we also recommended several infrastructure upgrades to Hamilton's existing interconnections with Wenham, Ipswich and Essex for sharing future supply between the partnering water systems on a mutual aid basis. **These included the addition of revenue meters at each interconnection along with the installation of a new booster pump station and pipe upgrades to the interconnection with Essex.**

We also evaluated the feasibility of installing a future pipeline for connecting the systems of Hamilton and Topsfield to provide the ability of the two systems to share surplus supply as needed. From the analyses conducted, it was proposed to **install approximately 6,500 feet of new 8-inch main along Asbury Street, from Hamilton's existing 8-inch main to Topsfield's existing 8-inch main.** Given Topsfield's higher gradient as compared to Hamilton (260 feet versus 210 feet), it was also proposed to install a **new 350 gpm booster pump station** for Hamilton to supply Topsfield and a bypass with a PRV for Topsfield to supply Hamilton.

Based on Topsfield's future water needs as presented in Section 4 of this report, there will be minimal to no surplus supply available within their current WMA registration to share with Hamilton or the other partnering water systems. Given that this future pipeline interconnection with Topsfield will not address Hamilton's future supply issues or be able to aid the other partnering water systems, **we have not recommended it for consideration in this report.** However, as noted in the Task 5 Technical Memorandum, Topsfield has previously evaluated a proposed interconnection with the City of Beverly to obtain alternate supply directly from the SBWSB. This evaluation proposed to install approximately 3.2 miles of pipeline along Route 97 to connect Topsfield's system to Beverly's system at an estimated cost of $11,500,000.

Given the recommendation above to connect Hamilton with the SBWSB, this possible future pipeline and connection with Hamilton along Asbury Street could prove to be a more economical option for Topsfield to consider. Additionally, this future pipeline would certainly be an option that Senator Tarr's North Shore Water Resiliency Task Force can consider as part of their long-term regional study. **As such, we have included it in the following implementation plan for this purpose only.**

5.1.3 Phased Implementation Plan

To assist Hamilton and the partnering water systems in implementing the recommendations to improve overall water supply resiliency, we have prioritized the recommended water supply infrastructure improvements into the following categories based on Hamilton's current and future water needs, and benefit to the partnering water systems.

- **Initial Water Supply Infrastructure Improvements**
- **Short-Term Water Supply Infrastructure Improvements**
- **Long-Term Water Supply Infrastructure Improvements**

The initial water supply infrastructure improvements are based on supplementing Hamilton's existing water system with SBWSB supply to address current and future supply deficiencies with respect to capacity, operations and water quality. These improvements should be implemented preferably over the **next 3 years.** The short-term water supply infrastructure improvements are based on improving the ability to share surplus supply between Hamilton and the partnering water system of Ipswich, Essex, Wenham and Topsfield. These improvements should be implemented preferably over the **next 3 to 5 years.** The long-term water supply infrastructure improvements are based on fully supplying Hamilton's future water needs along with other interested partnering water systems. These improvements should be implemented preferably within the **next 5 to 15 years** in parallel with SBWSB's plant upgrades which will increase its production capacity as needed to fully supply Hamilton.

The recommended water supply infrastructure improvements presented herein are shown on **Figure 3 included in Appendix D.** Based on the categories noted above, we have prioritized the recommended infrastructure improvements presented in this report as follows:

Initial Water Supply Infrastructure Improvements (0-3 Years):

- Design and construction of 12,900' of new 12" DI main with new PRV, revenue meter, backflow preventer and related appurtenances to connect with SBWSB

Short-Term Water Supply Infrastructure Improvements (3-5 Years):

- Design and construction of a new interconnection with Wenham including new revenue meter and related appurtenances
- Design and construction of a new interconnection with Ipswich including new revenue meter and related appurtenances
- Design and construction of a new interconnection with Essex including new 350 gpm booster pump station and bypass, revenue meters (2) and related appurtenances

Long-Term Water Supply Infrastructure Improvements (5-15 Years):

- Design and construction of a new 1.5 MGD booster pump station at the interconnection with SBWSB

- Design and construction of 6,500 feet of new 8-inch DI main on Asbury Street with new PRV, 350 gpm booster pump station and bypass, revenue meters (2) and related appurtenances to connect with Topsfield.

Table 5.1 below presents the estimated costs associated with the recommended water supply infrastructure improvements for the Town of Hamilton to consider based on the categories listed above. Estimated costs are total project costs and include construction, 30% engineering/permititng and 25% contingency for planning purposes as developed from the Task 3, Task 4 and Task 5 Technical Memorandums. The estimated water main costs per foot included in the table are weighted costs and include the cost for furnishing and installing the pipe, valves, fittings, bedding, backfill, traffic control, trench and site restoration. Costs were developed in part using recent construction cost data for new water mains, pumping stations, and appurtenances. The estimated costs do not include land acquisition, right-of-way procurement and legal fees.All costs are presented in 2022 dollars and are based on the **May 2022 Boston ENR construction cost index of 17506.61.** For the short-term and long-term improvements, we applied an inflation adjustment of ten-percent and fifteen-percent, respectively.

Table 5.1 Water Supply Infrastructure Implementation Plan

ITEM			COST[5]
Initial Water Supply Infrastructure Improvements (0 to 3 Years)			
12,900' of new 12" DI main with new PRV, revenue meter, backflow preventer & related appurtenances			**$7,004,250**
Total – Initial Water Supply Infrastructure Improvements			**$7,004,250**
Short-Term Water Supply Infrastructure Improvements (2 to 5 Years)			
New interconnection with Wenham including new revenue meter & related appurtenances			**$325,000**
New interconnection with Ipswich including new revenue meter & related appurtenances			**$325,000**
New interconnection with Essex including new 350 gpm booster station w/ bypass, revenue meters(2) & related appurtenances			**$780,000**
Subtotal – Short -Term Water Supply Infrastructure Improvements			**$1,430,000**
Inflation Adjustment (10%)			$143,000
Total – Short-Term Water Supply Infrastructure Improvements			**$1,573,000**
Long-Term Water Supply Infrastructure Improvements (5 to 15 Years)			
New 1.5 MGD booster station & appurtenances at SBWSB interconnection			**$772,000**
6,500 feet of new 8" DI main with new PRV, 350 gpm booster station & bypass, revenue meters(2) & related appurtenances			**$3,660,250**
Subtotal – Long-Term Water Supply Infrastructure Improvements			**$4,432,250**
Inflation Adjustment (15%)			$664,840
Total – Long-Term Water Supply Infrastructure Improvements			**$4,325,090**

1. Costs do not include land acquisition, right-of-way procurement and legal fees.

APPENDIX A

Task 3 Technical Memorandum w/ Attachments
(Under Separate Cover)

APPENDIX B

Task 4 Technical Memorandum w/ Attachments
(Under Separate Cover)

APPENDIX C

Task 5 Technical Memorandum w/ Attachments
(Under Separate Cover)

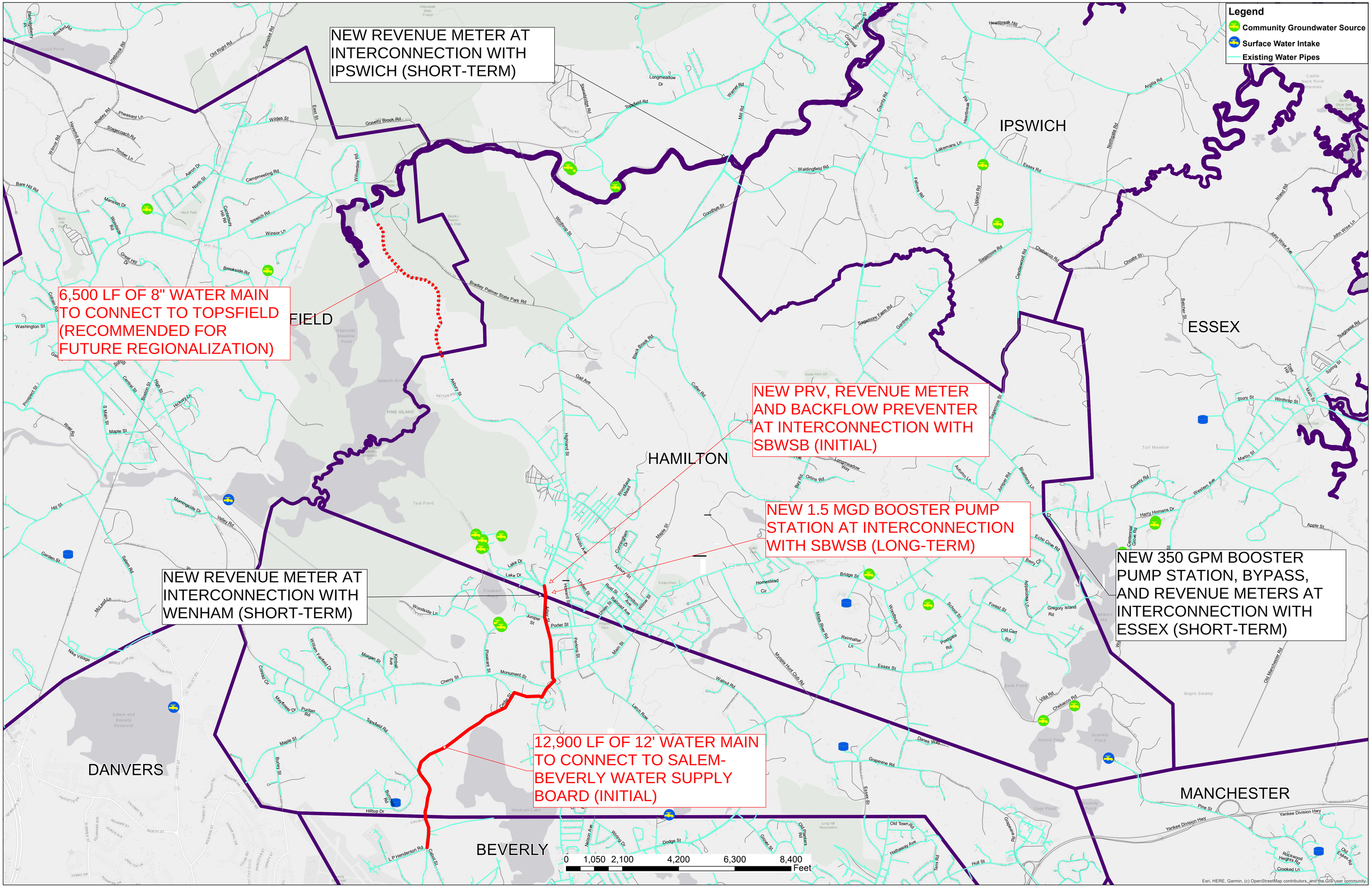
APPENDIX D

Figure 1 – Updated City of Beverly Water System Plan dated June 2022 (excluded)

Figure 2 – Updated Town of Manchester Water System Plan dated June 2022 (excluded)

Figure 3 – Recommended Water Supply Infrastructure Improvements dated June 2022

Figure 3 - Recommended Water Supply Infrastructure Improvements



June 2022

Dewberry