SECTION 9
RECOMMENDED PLAN AND IMPLEMENTATION

9.1 RECOMMENDED PROJECTS

This section contains the recommended plan including both the water supply and the wastewater management components of project. The recommended plan is the result of the alternative analyses as discussed in Sections 5 and 8 of this report.

9.1.1 Water Supply Projects

This analysis conducted under this project began by establishing future demands and water system needs. Historical water use trends were looked at against projected development and residential growth. From there a projected average day demand (ADD) of 1.6 MGD and a maximum day demand (MDD) of 2.58 MGD were established.

In order to meet future water demands, different alternatives were considered including water conservation, maintaining the system as is (no build), and new supply sources in and out of Town.

Water Conservation efforts are mandatory per IBTA, MWRA OP.10 and other agreements. This alternative was chosen for more consideration, to be implemented in conjunction with the other alternatives.

The No Build alternative consisted of optimizing local sources and maintaining the Andover interconnection. This alternative was not considered further as it provided no benefit to the Ipswich River needs and required capital investment without return. New in Town water supply sources are not available and were not evaluated further as they would increase stress on the Ipswich River and in town surface water sources have limited size, capacity and water quality issues.

Drawing supply from neighboring town's sources was also considered. Neighboring communities included those located within a 2.5 mile radius of North Reading. A review of their capacities showed that there were no viable sources that could meet North Reading's long term water supply needs. Two neighboring communities, Reading and Wilmington currently have MWRA connections and it was considered to connect to the MWRA through their existing connection. This represents the only viable option that meets the goals and objectives of water supply in the community. A connection to the MWRA through Reading was chosen for final consideration. This interconnection could be carried out in one of two ways, directly connecting to the MWRA main in Reading or wheeling water from the MWRA through Reading. Both options would require construction and coordination with Reading, but the latter was chosen as a more cost effective option.

9.1.1.1 Connection to MWRA through Reading

The recommended plan for an alternative water supply source for North Reading is connecting to the MWRA. The Town's current groundwater wells will be abandoned, and the interconnection with Andover converted to an emergency connection.

The Town will not connect directly to the MWRA piping system, rather it will "wheel water" through Reading's existing distribution system, which currently purchases water from the MWRA.

Improvements will need to be made to the Reading water system in order to accommodate North Reading's flows, preventing negative impacts to the MWRA from the connection. Portions of the existing water mains will need to be cleaned, lined, or replaced with larger pipes. Increased inlet and outlet piping from the Auburn street tank is also suggested.

9.1.1.2 Water Conservation

Continuing the current water conservation program and implementing new efforts in North Reading was chosen as an alternative to supplement a connection with MWRA. As discussed in detail in Section 5, North Reading continues to work towards a per capita water use of less than 65 gpcd and an UAW percentage of 10% or less. As demonstrated in Section 5, North Reading has implemented a significant number of water conservation strategies and continues to make conservation a priority. Many of these were recently implemented in anticipation of developing a new water supply source and it will take a few years to completely realize the benefits of these changes. The Town anticipates continuing to advance water conservation efforts to meet regulatory requirements.

9.1.2 Wastewater Management Projects

The Wastewater Needs Analysis identified areas where existing conditions may cause a risk to public health, environmental resources, or financial burden. In order to evaluate wastewater needs, risk factors were established and a risk score was calculated for each property in town. This risk score serves to compare lots relative to the likelihood of current or future pollution to the environment as well as difficulties in siting an on-site wastewater disposal system due to a variety of factors, such as soil conditions, depth to groundwater, small or restricted lots, proximity to environmental resources, etc.

The lots were assigned a risk score. The Town was then broken into 16 Need Study Areas based on similarities in geography, risk profile, and land use and a statistical analysis using GIS information was completed to determine which study areas have the highest risks. The four study areas with the highest average risk points per lot were then analyzed for potential wastewater alternatives and projected wastewater flows from those areas was calculated to be about 0.503 MGD.

9.1.2.1 Alternatives Considered

Many different wastewater options were considered as specified by the ENF including a No Build option, in-town options such as centralized, satellite and decentralized options, and out of town options such as neighboring communities and regional treatment facilities.

The No Build (as is) alternative was determined to not adequately address the needs establish for this Project. The needs analysis identified improving water quality as a need for the Martins Pond and Ipswich river basin areas. Keeping the existing residential septic systems which have been tied to water quality impairments, will continue to contribute to pollution and commercial/industrial users will also continue to impact water quality. Furthermore, privately managed systems operate less reliably and effectively than municipally operated systems, therefore the current groundwater discharge permits should also be considered for upgrading. Many of the existing residential septic systems are aging and failing, and will need to be upgraded in the future. For these reasons, it was determined that maintaining wastewater management systems as-is is not a sustainable option for the Town.

In-town municipal management systems were also considered. A wastewater flow of 0.503 MGD was used to determine approximate groundwater discharge system size and land requirements. Required system sizes were compared to the lot size of underdeveloped parcels. Each parcel in Town was given a groundwater discharge score based on its likelihood to be able to sustain a groundwater discharge system on site.

An in-town centralized system would consist of a WWTF facility for the entire needs area. A NPDES permit cannot be obtained for the Town; therefore a GWDP is required for the disposal of the wastewater. The alternatives analysis cross-referenced with the sites identified in the draft CWMP and reviewed all public and private lots large enough to site a 0.503 MGD WWTF. It was concluded that there are no feasible sites within North Reading to site a centralized WWTF.

Additional in Town analysis considered in-town satellite systems that would consist of multiple smaller GWDP systems. Potential discharge sites were reviewed in proximity to the Needs Area. The minimum lot size for decentralized system would be five acres based on a 50,000 gpd discharge. All public and privates lots feasible for this size were reviewed. It was determined that having multiple decentralized systems was not feasible. WWTFs smaller than 50,000 gpd result in increased costs per gallon and require considerable energy consumption resulting in GHG. The current Department of Public Works (DPW) was determined to be the only viable and economical site for a WWTF. The site's proximity to the Needs Area and prior explorations conducted on the site make it a viable candidate. However, upon further analysis, the site had several environmental and economic factors that prevented the facility from being a preferred alternative.

Out of town wastewater management options with the Massachusetts Water Resources Authority (MWRA) and the Greater Lawrence Sanitary District (GLSD) were also screened. The MWRA collection system does not have capacity for North Reading flow and conditions for connection are challenging as compared to a connection to GLSD. GLSD has capacity to serve North Reading and Andover is amenable to an IMA to convey wastewater through its system.

9.1.2.2 Recommended Plan

The recommended wastewater plan is a blended approach with in town and out of town management options. The Project will include a connection to GLSD to discharge 0.503 MGD. A municipal collection system will require approximately 25 miles of sewer, six pump stations, and a limited number of residences served by low pressure sewer which will ultimately discharge to Andover for conveyance to GLSD.

It is also recommended that the High School WWTF be optimized and select users in the center of town be captured by the system. Optimization of the existing High School WWTF at High School will require phased permitting and construction of small collection system to connect nearby customers.

Finally, the existing septic systems for properties not included in the Needs Area will remain and be upgraded by home owners as needed. Continued enforcement of Public Health regulations and education regarding failing systems and alternative technologies is recommended. Property owners should be educated and encouraged to utilize I/A technologies where the conditions warrant it.

9.1.3 Water Conservation Projects

This section outlines some of the water conservation projects that are ongoing or planned by North Reading. The goal of these projects is to continue to promote water conservation through the reductions in unaccounted for water and water use per capita.

9.1.3.1 Comprehensive Planning & Drought Management Planning

North Reading is continuously evaluating water management and addressing needs through local regulations. North Readings updated its Water Use Restrictions rules & regulations (R&R) in October 2010, April 2012 and March 2014. North Reading also updated its Drought Management Plan (DMP) in November 2013. North Reading will continue to update it water use restrictions and drought management plan on a regular basis.

9.1.3.2 Water Audit

Water system audits can help water conservation through the identification of the causes for unaccounted for water (UAW). The Town plans to appropriate approximately $50,000 in funds for this project at Town meeting for fiscal year 2017.

9.1.3.3 Leak Detection

As a key component of UAW, identifying and repairing leaks can reduce UAW and improve water conservation in a community. North Reading completed a leak detection survey on the entire water distribution system on 12/3/14. The survey identified 25 leaking services & 11 leaking hydrants. The repairs were completed in 2015. It is recommended that North Reading continue leak detection efforts and to conduct a system wide survey every two years.

9.1.3.4 Metering

Master & sub-master meter calibration is an important process to reduce unaccounted for water and ensure accurate production and use calculations. Calibration of 11 meters across 6 sites was completed in February 2016. It is recommended that North Reading conduct master meter calibrations on an annual basis.

Accurate residential meters are also important. North Reading has approved $1,700,000 in funding for an Advanced Metering Infrastructure (AMI) system. Upon approval at Town meeting the installation of these meters would occur over the next two years.

9.1.3.5 Rates

North Reading continuously evaluates water use and operating budgets to determine appropriate water rates. The projects included in the recommended plan will result in significant changes to North Reading's capital and O&M costs. It is recommended that North Reading conduct a rate study to develop a rate plan that will establish water rates based on capital improvements, O&M costs, and costs to purchase water. The rate study should also consider water conservation in establishing the rates and tier structure. The rates already exceed several median standards in the State.

9.1.3.6 Residential

The Town of North Reading has set goals to improve residential water use through several proposed programs. It is recommended that the Town continue to evaluate a program to facilitate installation of water efficient plumbing fixtures. These fixtures have been required by the State Plumbing Code since 1992; however, many older homes still have not upgraded their facilities to the new standards. It is recommended that North Reading consider a program which could provide rebates for low flow fixtures.

The new metering proposed will provide the Town with more data to evaluate specific home owners use and allow them to specifically target users that in the higher water usage brackets. This will allow the Town to proactively notify users of excessive use and have homeowners more responsive and responsible for their use.

The Town is near the thresholds required under the guidelines and it is anticipated that water usage will quickly become in specific compliance with the standards. The opportunity to provide even better statistics for water use, the town should consider residential water use audits including online programs and home visits.

Finally, North Reading is considering incentives for the installation of moisture based & rain shutoffs for irrigation systems.

9.1.3.7 Public Sector

North Reading completed an audit of Public Building Water Use in December of 2014. The audit identified short and long term retrofit projects. The improvements will be completed in phases, and North Reading plans to appropriate $26,000 at the fiscal year 2017 town meeting.

9.1.3.8 Industrial, Commercial, and Institutional & Agricultural

Although non-residential users represent a relatively low percent of North Reading, the Town is considering a few programs to reduce the water use by these customers. North Reading is planning to conduct water audits for the non-residential users, starting with those users with the highest water use. Data from the study should allow the Town to develop a Water Savings Strategy including an implementation plan.

9.1.3.9 Lawn & Landscape

North Reading mitigates the impacts of lawn and landscaping irrigation through their seasonal demand management plan. North Reading has adopted Water Use Restriction Bylaw (191-6) and associated Rules & Regulations (see 1.b.) In Fall 2014, North Reading approved DPW enforcements of the water use restriction policies.

North Reading is considering incentives for the installation of moisture based & rain shutoffs for irrigation systems.

9.1.3.10 Public Education & Outreach

North Reading is working towards improved water conservation through public outreach and communication. North Reading has several pages of their Town website dedicated to water conservation education.

North Reading plans to improve outreach through the development of a Water Conservation Public Education Plan (WCPEP). The WCPEP will promote water conservation by educating the public on the environmental benefits of water use reduction as well as the long term cost saving to users – both at home and town wide.

Once the plan is complete, the Town will implement the plan using the following platforms:

- Bill Inserts
- Print media
- Patch
- Social Media
- Town Website- Water Department and Town homepage
- Elementary School programs
- Public speaking- Chamber of Commerce, Rotary, church groups, etc

9.2 IMPLEMENTATION

This section will address the implementation plan for the recommended plan. Specifically, this section will discuss the Project phasing and time. The section will also address costs and funding.

9.2.1 Project Schedule

A Project of this size can not feasible be designed and constructed as a single project. Factors such as regulatory requirements, funding, and community impacts require project be broken into well thought out phases.

For this Project, the water project will precede the wastewater work. This is done for several reasons. Much of the water infrastructure needed is already in place making the project more straight-forward to permit, design and construct. Additionally, the Town's existing facilities are reaching the end of their useful like and the Andover water supply agreement are anticipated to sunset within 4 years.

The proposed schedule is as follows:

Water projects:

- Permitting Phase:
    - IBTA- Following FEIR Certificate
    - IMA with Reading
    - Agreement with MWRA
- Design – Est. June 2016 to June 2017
- Construction – Est. June 2017 to June 2019
- Target Date for MWRA Connection - July 2019
- Decommission water treatment plants/wells – 2020-2021

Wastewater projects:

- Preliminary: 2018-2020
    - IMA with Andover
    - Agreement with GLSD
- Phase 1 Andover Sewer Improvements
    - Design– 2021 - 2022
    - Construction – 2023 - 2025
- Phase 2 Rt. 28 and Concord Street Sewer, Main PS and FM
    - Design – 2025 - 2026
    - Construction – 2027 - 2029
- Phase 3 Rt.62 Area Sewer
    - Design – 2028 - 2029
    - Construction – 2030 - 2031
- Phase 4 Martins Pond Area Sewer
    - Design – 2031 - 2032
    - Construction – 2033 - 2034

- Phase 5 Park St Area Sewer
    - § Design – 2031 - 2032
    - § Construction – 2033 - 2034

9.2.2 Project Costs

The cost components for the water related portion of the Project consist of: upgrades to the North Reading distribution system, upgrades to the Reading system, a buy-in to MWRA, and annual costs to Reading and MWRA.

The MWRA buy in is listed a capital cost; however, the buy-in fee is paid interest fee over 25 years. The Reading and MWRA annual costs are rate based fees billed based on the amount of water withdrawn from MWRA and wheeled through Reading. Table 9-1 is a summary of costs for the water components of the recommended plan. The Annual Cost presented represents the change from the current costs within the water department. The elimination of the wells will reduce costs associated with the operation of the wells; however this is offset by an increase in costs to purchase more water from the MWRA.

It is the Town's intention to fund the individual projects themselves through the appropriate enterprise funds, although the Town may seek a grant to help pay the MWRA buy-in fee. The costs to the Town will be represented in the water billing rates and tax rates.

The Town has already appropriated funds for the design of a portion of the North Reading and Reading system improvements and plans to appropriate additional funds for the next phase at Town Meeting in June 2016.

Table 9-1
Summary of Water Capital Costs

Item	Capital Cost	Annual cost	20-Year Cost
North Reading Distribution System	$9,500,000	($400,000)	$1,500,000
Reading Improvements	Included above	1	1
MWRA Connection	$7,700,000	$400,000*	$13,700,000
Total	**$17,130,000**	**TBD**	**TBD**

* Additional Cost above that paid to Andover for water supply
1 Under negotiation

The cost components for the wastewater related portion of the Project consist of: construction and maintenance of the North Reading collection system, upgrades to the Andover system, a buy-in to GLSD, and annual costs for conveyance through Andover and treatment at GLSD. Table 9-2 is a summary of costs for the wastewater components of the recommended plan.

Currently the town intends to fund the wastewater portion of the Project themselves. Due to the size of the project, a blend of annual fees, sewer betterments, and tax rate funding will be developed before final implementation proceeds. As the Project proceeds to the preliminary design phase, the cost estimate for each phase of work will be updated and the sewer rates, betterments, and tax rates will be determined.

Table 9-2
Summary of Wastewater Capital Costs

Item	Capital Cost	Annual cost	20-Year Cost
North Reading Collection System	56,000,000	$550,000	$67,000,000
Andover Connection	$9,200,000	$70,000	$10,600,000
GLSD Connection	$1,500,000	$270,000	$6,900,000
High School Treatment Facility Optimization	$2,000,000	$230,000	$4,600,000
Total	**$68,700,000**	**$1,120,000**	**$89,100,000**

9.3 IMPACTS ANALYSIS

The goal of the impacts/integration analysis is to assess the impacts and highlight the benefits of the chosen water and wastewater plans together to ensure town goals are met, environmental protection is achieved, and solutions are cost effective.

The recommended plan will be scrutinized on its impacts to water quality, public health, the water balance, stormwater, land/open space, resource areas, historic/archeological resources.

The projects included within the recommended plan will be finalized during design. The exact size and location of various infrastructure elements may change. The impact analysis serves to identify impacts that will require specific mitigation. Since the recommended plan includes connection to regional facilities, construction and permanent impacts will be limited to pumps stations and pipe work. Since the infrastructure will be largely constructed within the Town's right of way, most impacts are likely to be temporary or minor in nature.

The Project includes improvements in three communities: North Reading, Reading and Andover; therefore impacts within all three communities will be considered. Figures 9-1, 9-2, and 9-3 show the locations improvements overlaid with GIS layers representing various impact factors for North Reading, Reading, and Andover, respectively. It should be noted that at the given scale and for clarity, the symbols used are many times larger than the item they represent. For example a sewer that is only 12" in diameter appears to be 50' wide. This is relevant because in some cases a pump station may appear to overlap with a resource boundary; however, as proposed there are no pump station(s) installed within a resource area.

Source citations...
Legend
Vernal Pools
Water Body
NHESP Priority Habitats of Rare Species
NHESP Estimated Habitats of Rare Wildlife
Open Space
MHC Historic Inventory Points
MHC Historic Inventory Areas
NWI Rivers and Streams
NWI Wetland Areas
ANDOVER
WILMINGTON
NORTH READING
READING
Decomission pump station and WTP
Decomission water pump station
Decomission water pump station and WTP
Proposed sewer collection system (TYP)
Proposed wastewater pump station (TYP)
PS
WTP
N
0 100 200 400 600 800 1,000 1,200 1,400 Feet
North Reading Impacts
PROJ NO: 12820
DATE: 3/1/2016
FIGURE: 9-1
WRIGHT-PIERCE
Engineering a Better Environment


Source citations...
Legend
Vernal Pools
Proposed Improvement
Reading Water Main
Water Body
NHESP Priority Habitats of Rare Species
NHESP Estimated Habitats of Rare Wildlife
Open Space
MHC Historic Inventory Points
MHC Historic Inventory Areas
NWI Wetland Areas
NORTH READING
WILMINGTON
Replace 8-inch on Franklin Street from 24-inch cross country to Main St
Reactivate 24- inch cross country main
READING
LYNNFIELD
Replace 12-inch tank inlet/outlet with 20-inch
Replace 12-inch from Auburn St to Main St with 16-inch
Replace 8-inch on Linden with 12-inch
Replace 10-inch on Woburn St with 12-inch
WAKEFIELD
WOBURN
STONEHAM
N
Feet
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS
Reading Impacts
PROJ NO: 12820
DATE: 3/1/2016
FIGURE: 9-2
WRIGHT-PIERCE
Engineering a Better Environment


Legend
Vernal Pools
Water Body
NWI Wetland Areas
NHESP Priority Habitats of Rare Species
NHESP Estimated Habitats of Rare Wildlife
Open Space
MHC Historic Inventory Points
MHC Historic Inventory Areas
NWI Rivers and Streams
METHUEN
METHUEN
LAWRENCE
DRACUT
NORTH ANDOVER
ANDOVER
LOWELL
TEWKSBURY
WILMINGTON
NORTH READING
BILLERICA
N
Feet
ANDOVER INFRASTRUCTURE WITH REDUNDANT MAINS. ISOLATED IMPROVEMENTS ONLY
ANDOVER INFRASTRUCTURE THAT MAY REQUIRE LINING OR MINOR IMPROVEMENTS
ANDOVER INFRASTRUCTURE LIKELY TO REQUIRE UPGRADES
PROPOSED FORCEMAIN FROM NORTH READING MAIN PUMP STATION
Andover Impacts
PROJ NO: 12820
DATE: 3/1/2016
FIGURE: 9-3
WRIGHT-PIERCE
Engineering a Better Environment

9.3.1 Water Quality

Creation of sewer and discounting use of septic systems in environmentally sensitive areas will protect water bodies including Martins Pond and the Ipswich River. The wastewater is being transported out of the sensitive areas where it will received advanced treatment prior to discharge to the Merrimack River. Groundwater and surface water sources in the area will benefit from reduced pollutant discharges.

9.3.2 Public Health

Public health in North Reading will benefit greatly from the improved water quality in Town. The surface waters in town will experience decreased pollution making them safer for recreation.

In addition, the drinking water produced by the MWRA is of a higher and more consistent quality than that produced by local sources. Therefore, the public's drinking water will be improved.

9.3.3 Water Balance and Ipswich River Impacts

As discussed in the Needs Analysis for both Water and Wastewater, extreme high flows and extreme low flows plague the Ipswich River, leading to impaired water quality and a strain on aquatic life. Wastewater and stormwater recharge is important in balancing the water budget.

Switching to the MWRA for a water source would reduce demand in the Ipswich River basin. On the other hand, sending a portion of wastewater out of basin would reduce the amount of water returned to the basin. This balance is described in much more detail in the IBTA section which follows later in this section. The overall water balance anticipated by the Project showing relationship between water and wastewater inputs and outputs in shown in Table 9-3.

TABLE 9-3
IPSWICH RIVER WATER BALANCE

	Existing Conditions	Recommended Plan (Future Conditions)
Sources - Approvals		
Local Source Registration (annual AVG)	0.96 MGD	0.00 MGD
Andover IBTA (Max Day)	1.50 MGD	Emergency Only
MWRA IBTA (Max Day)	0.00 MGD	2.58 MGD
Sources –Withdrawals		
Local Source Registration (annual AVG)	0.52 MGD	0.00 MGD
Andover IBTA (annual AVG)	0.89 MGD	Emergency Only
MWRA: ADD	0.00 MGD	1.60[1] MGD
MDD (IBTA)	0.00 MGD	2.58 MGD
Ipswich River Basin		
Total Withdrawal from Basin	- 0.52 MGD	- 0.00 MGD
Wastewater Generated	+ 1.41 MGD[2]	+ 1.60 MGD[2]
Wastewater Conveyed out of Basin	- 0.00 MGD	- 0.503 MGD[3]
Net Water Change to the Basin	+ 0.89 MGD	+ 1.10 MGD

1. Assumes current well users are added to system, 65 gpcd, 10%UAW, maintain current trends in CEMU and Non-residential use. DEIR includes detailed analysis.
2. Assumes 100% of water use become wastewater discharge.
3. Assumes 0.503 MGD of wastewater is sent to GLSD under recommended plan.

Based upon a USGS fact Sheet *Effects of Water Withdrawals on Streamflow in the Ipswich River Basin, Massachusetts for the Ipswich River* the modeled 7Q10 at the South Middleton gauging station downstream of North Reading is 0.54 cubic feet per second. The additional flow suggested in the water balance represents an additional 0.32 cubic feet per second on an average basis or a 60% increase in the 7Q10 base flow.

9.3.4 Stormwater Impacts

Since the recommended plan includes connection to regional facilities, construction will be largely limited to pumps stations and pipe work. Since the infrastructure will be primarily constructed within the paved right of way, the increase of impervious area will be limited to the roofs of and access drives for the water and wastewater pumping stations. Only two of the pumping stations are anticipated to require formal buildings and access driveways, the primary wastewater and water booster pumping station. The total anticipated area is expected to be less than 4,000 square feet. This additional increase in impervious area will be mitigated by on-site management of stormwater resulting in no permanent changes in stormwater flows from the Project.

As a result of the negligible increase to impervious area, significant stormwater impacts are not anticipated for these projects. There is the potential for temporary construction impacts such as runoff. To mitigate these short term impacts, the design will be coordinated with the local authorities, and Best Management Practices (BMPs) will be used during construction to reduce erosion and manage runoff.

Town wide, North Reading is addressing stormwater concerns. In September 2013, North Reading completed Phase 1 of a Drainage Infrastructure Mapping Project with the assistance of New England Civil Engineering Corp. (NECE). This report identified the number and location of all drainage infrastructures. The report also identified areas of illicit sewer and septic connections to the drainage system.

The town's need for work in the stormwater area has been recognized, including budget for drain cleaning, inspection, and drain map data enhancement. Initial funding for the FY 16 was approved. The stormwater management projects being conducted will improve stormwater performance in town. An excerpt of the Town's Drainage Infrastructure Mapping Project Report is included in Appendix J.

9.3.5 Land Impacts

Open space is a valuable resource and planning efforts have been made to preserve land to remain open space. This Project does not propose to install any infrastructure on land designated as open space. Impacts should be minimal as work will occur primarily within the existing roadway rights-of-way.

Open space lands adjacent to the proposed North Reading collection system area are shown in Figure 9-1. Many open space areas are in Reading along the southern side of the Ipswich River. The only permanent above grade structure will be the wastewater pump stations all of which are proposed to be installed outside of lands designated as open space. The decommissioning of the existing water infrastructure in North Reading will decrease use within open space lands which will be a benefit to those areas. The water pump station will also be located within North Reading; the final location has not been determined at this time. The location of areas of open space will be considered when selecting a site.

Projects within Andover will occur predominantly within the paved right-of-way. One area identified in the impacts analysis was an existing cross country main located in open space adjacent to Pomps Pond recreation Area. This area is designated as potential minor improvements or lining. Since the Project would be limited to the repair or improvement of existing utilities, not permanent impact is anticipated. Temporary construction impacts will be mitigated through BMPs such as erosion controls.

There are no projects within Reading that are adjacent to open space.

9.3.6 Wetland and Surface Water Impacts

It is not anticipated under the recommended plan that the Project will have permanent impact to wetlands or surface water.

As shown in Figure 9-1 the proposed North Reading collection system will be installed adjacent to several waters and wetlands, however, the only permanent structure proposed are pump station which are proposed outside of these resource areas. The water pump station will also be located within North Reading; however, the final location has not been determined at this time. The location of resource areas will be considered when selecting a site.

It is likely that some construction activities will take place within wetland, surface water, or riverfront buffers. The work will also require several crossings of resource areas. In all of these instances, the work is anticipated to be limited to the existing right-of-way and permitting with the local Conservation Commission will be coordinated during design of each specific phase of work. All conditions of the Order of Conditions issued by the commission will be combined with erosion and runoff control devices to mitigate the construction impacts. Where appropriate, direction drilling will be used in lieu of open cut installation. In this case the access pits can be placed outside the resource areas to further minimize impacts.

Special care will be given to the Martins Pond area. The proposed collection system will be installed adjacent to the pond and a wetlands system. Once again mitigation efforts will be coordinated with the local Conservation Commission and care will be taken to prevent runoff into the resource areas.

The projects within Andover will occur predominantly within the paved right-of-way. The flow path through Andover runs parallel to the Shawsheen River. Efforts will be made to use pipe lining technology where possible to reduce impact to the resource areas. Where open cut construction is required, permitting with the local Conservation Commission will be coordinated during design. All conditions of the Order of Conditions issued by the commission will be combined with erosion and runoff control devices to mitigate the construction impacts.

There are no projects within Reading that are adjacent to wetlands or surface area.

The projects outlined in the recommend plan also provide benefits to the local resource areas. The needs area within North Reading contains many resource areas. Lots in close proximity to wetlands and impaired waters pose a contamination threat to these resource areas due to known cases of failing septic systems. Thus, replacing septic systems with sewers in these areas would help to improve and protect wetlands and surface waters.

Decommissioning of North Reading's water treatment plants and wells may also reduce stress and on nearby wetlands and the Ipswich River watershed.

9.3.7 Habitats of Rare Species

As discussed in Section 2, there are some area of NHESP Priority Habitats of Rare Species and NHESP Estimated Habitats of Rare Wildlife in Town; however, proposed sewer collection system does not intersect with these habitats. This is also true of the sewer improvements in Andover and the water improvement in Reading. Limiting construction to previously disturbed areas such as paved roadways, will help to prevent negative impacts to rare species.

9.3.8 Historic Places and Archaeological Resources

Figures 9-1, 9-2 and 9-3 show the known areas of historic importance. The proposed sewer collection system will be installed in a portion of Concord Street indicated as West Village which is significant for its agricultural history. There are also many Massachusetts Historic Commission (MHC) Historic Inventory Points which are located along the sewer system. The majority of these points are cemeteries, houses, barns or other structures which are located off of the right-of-way. Impacts are anticipated to be related to construction that will occur within the existing right-of-way.

The Martins Brook Bridge located on Route 28 and spans Martin’s Brook. It is recommended that directional drilling or pipe jacking be used at this location to avoid impacts to the historic structure and river.

Local Historic Commissions and MHC coordination and consultation during design of each phase of work and will be necessary to negate impacts to these historic places. It is anticipated impacts will be minimal as construction will occur in existing roadway areas.

Prior studies completed by the Town provided that MHC indicated that the DPW site is “archaeologically sensitive and likely to contain archaeological sites associated with the Native American occupation of the North Reading area”. This site is no longer recommended for a WWTF.

Andover has several historic districts and MHC Historic Inventory Points along the flow path, the most concentration along the Shawsheen River and along North Main Street. Until final design of the Andover upgrades are completed, the following represents potential areas of interaction with MHC resources. A majority of sites identified were structures adjacent ot he roadway right-of-way. Andover also has history mills, dams and bridges along the river. The bridges represent the potential sites to be impacted by the Project. The Steven Street Bridge over the Shawsheen is located in an area where minor improvements may be needed. In the event the sewer at this location requires improvement, priority will be given to trenchless technologies.

There are also a few bridges in the north of town, such as the Haverhill Street Bridge, Balmoral Street Bridge, Essex Street Bridge and North Main Street Bridge, which may be impacted. These sites are located within the area that has redundant mains; therefore, the likelihood of improvements is minimal. In all cases the design will be coordinated with the local historic commission and MHC.

There are also a few sites of historic concern in Reading. The Lob Pound Mill site is located on the Ipswich River adjacent to the border with North Reading. This site was originally considered as a site for a water pump station; however, it is no longer a candidate. The final location of the water booster pump station has not been determined, but all candidate sites being considered at this time are within North Reading. There are also a few historic sites adjacent to proposed improvements in Reading. The majority of these points are houses, barns or other structures which are located off of the right-of-way. It is anticipated impacts will be minimal as construction will occur in existing roadway areas.

9.3.9 Hazardous Materials

Section 2 outlined areas in North Reading where hazardous materials were of concern. These areas were reviewed and compared to the locations of proposed improvements to determine potential hazardous and potential for moving contaminated soils during construction. There are a number of Underground Storage Tanks near the proposed sewer network and a limited number of Activity Use Limitations sites. These areas are mostly off of the right-of-way, but where excavation is proposed in the vicinity of potential contaminated areas, a Licensed Site Professional (LSP) will be consulted during design. The design will include provisions for a comprehensive soils management plan to ensure soils are tested, handled, and disposed of in accordance with all applicable regulations.

Work in the vicinity of older existing utilities can also encounter asbestos concrete (AC) pipe. The design of any underground utility work near known AC pipe will include provisions for an asbestos management and abatement plan to ensure all asbestos materials are handled, stored and disposed of in accordance with all applicable regulations.

9.3.10 Residential and Commercial Impacts

Since the majority of construction will take place on existing commercial and residential roadways, care must be taken during construction. Design will include a traffic management plan on State roads, and contractors will prepare plans prior to construction on local roads. The traffic management plans will facilitate adequate traffic controls, detours and police details during construction. Project timing will be determined on a project by project basis to coordinate with residents and businesses to minimize construction impacts, such as utility interruption, traffic impacts, and noise impacts. These impacts should all be temporary in nature.

There will be positive impacts to local residents and businesses as a result of projects. By providing sewer to residents and businesses in the needs areas, users with site restrictions can replace failed or limited sewer system with a public sewer connection. This will allow for improved quality and reliability of service, as well as the potential for future improvements and development to properties. All residents and businesses will benefit from the improve water quality in the regions ground water and surface waters.

9.3.11 Greenhouse Gas Impacts

The greenhouse gas (GHG) study conducted for this Project had two parts. The first part compared the GHG produced under each major alternative for the environmental impact analysis. This allowed GHG emissions to be a part of the decision making process for selecting the final recommended plan. The second part was to compare the recommended alternatives to the baseline. The goal of this part is to identify ways to make the recommended plan more efficient and thereby, mitigating some of the GHG impacts of the Project.

9.3.11.1 Wastewater Analysis

This section presents an analysis of Greenhouse Gas (GHG) emissions associated with the Recommended Wastewater plan. The Executive Office of Energy and Environmental Affairs (EEA) developed and issued the GHG Policy and Protocol. Projects involving indirect emissions associated with significant consumption of water undergoing review by MEPA are required to quantify the projects' GHG emissions. Measures to avoid, minimize or mitigate such emissions should be identified as well. At this time the GHG Policy and Protocol's focus is on carbon dioxide (CO_2).

Projects that will consume greater than 300,000 gallons per day (gpd) of water or generate greater than 300,000 gpd of wastewater will typically be considered to fall within this category.

There are several steps to calculating GHG emissions:

- Identify appropriate conditions for each aspect of the Project
- Calculate GHG emissions associated with baseline and preferred alternative separately
- Estimate GHG reductions associated with alternatives and GHG reductions associated with mitigation efforts not adopted, as a percent of total
- Clearly state which GHG mitigation measures will be adopted, and provide reasoning

The ENF form for this Project states that alternative analysis must be performed for two scenarios; the baseline case (no-build) and the preferred case (GLSD connection). There are many factors and emission sources to consider for both cases. It should be noted that these estimates are not exact as GHG analysis is done before the final design is completed and several assumptions are included in the analysis. Furthermore, GHG emissions associated with construction and improvements of new water and sewer infrastructure are not considered.

Methodology

Wastewater systems in North Reading and recommended wastewater systems contribute to Greenhouse Gases in different ways. Septic systems produce methane, a very harmful greenhouse gas. But septic systems also require pumping, and CO2 is produced from the vehicles that haul the septic waste to the final treatment plant, from the biological processes used to treat the waste, and electricity used to treat septic waste. North Reading also has a number of on-site private treatment facilities. These facilities contribute to CO2 emissions as they need electricity for power, and use biological process to treat the waste. Finally, a connection to the GLSD is part of the recommended plan. GLSD requires electricity to run its plant and CO2 is produced during the biological treatment processes.

In order to calculate Greenhouse Gas emissions, a number of resources were used to determine CO_2 and CO_2 equivalents emissions rate from various emission sources. These resources are summarized in Table 9-4.

TABLE 9-4
SUMMARY OF GHG RESOURCES USED

Emission Type	CO_2 Emission Rate	Data Source
Electricity	996 lb/mWh	Massachusetts average, ISO New England Electric Generator Air Emissions Report, 2013
Septic System Methane Emissions	Equation 10.6	Local Government Operations Protocol, May 2010
CO2 Emissions from Biological Process	Equation 3-2	GHG Emissions Estimation Methodology for Selected Biogenic Source Categories, RIT International December 2010
Vehicle Fleet	8.887×10^{-3} metric tons/gallon gasoline	EPA, Greenhouse Gas Equivalencies Calculator, 2015
	4.75 metric tons CO_2E /vehicle/year	

In addition, the MEPA office provides, with the assistance of MassDEP, average energy use data for water and wastewater treatment facilities. These averages were used to estimate GHGs associated with electricity usage for the baseline and preferred case alternative. MEPA states that for projects located within Massachusetts Water Resources Authority (MWRA) communities, approximately 1.3 kWh of electricity are used for every 1,000 gallons of wastewater treated. For projects located outside MWRA communities, this number increases to 1.7 kWh of electricity used for every 1,000 gallons treated.

CO_2 is also produced as a product of the biological treatment process. This applies to the treatment of septic waste, private treatment facilities, and wastewater sent to GLSD. To calculate CO_2 from this source the *GHG Emissions Estimation Methodology for Selected Biogenic Source Categories* was used. Sludge generated from septic systems is sent to the Great Lawrence Sanitary District for final treatment. GLSD uses aeration treatment and anaerobic digestion for sludge treatment process. It is assumed that GLSD is a well-managed activated sludge system. The High School and Middle School Facility is a package MBR plant. It is assumed that methane produced by the treatment process is captured and there are no emissions associated with the anaerobic sludge digestion. For each case in this analysis for which this applies, an inlet BOD_5 was assumed.

Data was collected to assist in GHG calculations. Records include the following:

1. Board of Health records documenting the number of septic systems in Town
2. A listing of Groundwater Discharge Permits

Parcels on Riverpark Drive discharge to the Massachusetts Water Resources Authority through a private connection. This connection requires a pump station and 3,000 feet of force main. This connection enters the MWRA system through the Town of Reading's sewer system. This analysis does not look at GHG emissions from the current MWRA connection on Riverpark drive as it is assumed this connection will not be impacted.

Baseline (No Build)

Private Treatment Facilities

There are a number of small treatment facilities in the Town of North Reading that hold their own groundwater discharge permits. It is expected that all, but the High School treatment facility, would be abandoned as part of the preferred alternative. The electricity required to run these facilities produces CO2. To estimate GHG emissions associated with these sources, it was assumed 1.7 kWh were used for every 1000 gallons treated.

TABLE 9-5
CO_2 EMISSIONS FROM PRIVATE TREATMENT FACILITIES DUE TO ELECTRICITY

Facility	Waste Water Treated* (gal)	lbs CO_2 per day	Permit Limit (gal)	lbs CO_2 per day permit limit
Meadowview Care & Rehab Center	9657	16.35	17000	28.78
Edgewood Luxury Apartments	44012	74.52	63240	107.08
Greenbriar Condominiums	19520	33.05	40000	67.73
Park Colony Condominiums	25600	43.35	26000	44.02
U.S. Postal Service	9748	16.51	16000	27.09
Total	**90548**	**183.77**	**162240**	**274.70**

*****Maximum daily flow reported between October 1st 2014 and September 30th, 2015

To calculate CO_2 emissions from biological treatment processes at the private treatment facilities, it was assumed that inlet BOD_5 is 300 mg/L and reduced by 30% through primary treatment, thus to 210 mg/L. It is assumed that these are well-managed activated sludge systems. This results in 86.96 lbs of CO_2 per day produced for the treatment facilities. Full calculations are shown at the end of this section (calculation #1).

Private Treatment Facilities- High School and Middle School

To estimate electricity used to power the High School and Middle School MBR facility, energy use data was collected from a similar MBR plant lcoated in Cohasset, MA. This MBR plant is a 38,000 gpd plant and uses approximately 136,710 kWh per year. The High School Treatment Plant treats approximately 12,300 gpd. If energy use is of a similar scale to the Cohasset MBR plant, then the High School facility uses approximately 44,244.60 kWh per year, thus 122 lbs CO2 per day.

To calculate CO_2 emissions from biological treatment processes at the facilities, it was assumed that inlet BOD_5 is 300 mg/L and reduced by 30% through primary treatment, thus to 210 mg/L. This results in approximately 9.86 lbs of CO_2 per day. Full calculations are shown at the end of this section (calculation #2).

Residential Septic Systems

Much of North Reading's residential wastewater is managed through onsite septic systems. For the purpose of this evaluation, Greenhouse Gas emissions from septic systems include fugitive methane emissions in terms of CO_2 equivalent, emissions produced by vehicles in transporting the waste to treatment plants, and eventually treating the waste sent to treatment plants. There are 4,343 developed lots in North Reading. Assuming all of these lots have septic systems (except the six known private WWTFs), 4,337 septic systems will be used as estimation for calculations.

Fugitive Methane (CH_4) from Septic Systems
The Local Government Operations Protocol for the quantification and reporting of greenhouse gas emissions inventories (May 2010) presents an equation for the estimated of CH_4 emissions in terms of metric tons CO_2e. This equation assumes a BOD_5 load of 0.090 kg BOD_5 per person per day. This is based on the EPA's Inventory of US GHG Emissions and Sinks.

As discussed in Section 4, the 2013 population of North Reading was 14,896 persons. Not everyone in Town uses septic systems. Therefore, the people on private treatment facilities must be ruled out. As discussed above, private treatment facilities treat about 80,000 gpd of wastewater (number does not include the Post Office facility). Assuming, wastewater is produced at a rate of 100 gal per person per day, there would be 808 people not on septic systems. Thus there are an estimated 14,088 people on septic systems. Using this population assumption and the equation presented by the Local Government Operations protocol, an estimated 17,610 lbs of CO_2e are produced per day by the Town's septic systems fugitive methane emissions. (See end of section calculation #3).

Pump Out Transportation Emissions
Based on North Reading's Board of Health Pump out records, a number of assumptions were used to calculate emissions associated with transportation of waste pumped out of septic systems. These assumptions include:

- North Reading has approximately 4337 septic systems, each with an average size of about 1000 gallons
- Each septic system is pumped out once every two years
- Septic hauling trucks are typically 2000 gallons, thus can accommodate about two septic systems worth of waste
- Septic hauling trucks drive about 50 miles to dispose septic waste to treatment facilities and get an average of 4 miles per gallon
    - Septic truck sizes and MPGs were estimated based on truck listings on nationaltruckcenter.com

Based on these assumptions, it can be estimated that about 1084 trips are made per year by septic haulers in North Reading, totaling 54,200 miles. Assuming 4 MPG and an emission rate as stated in Table 9-4 this can amount to approximately 727.33 lbs CO_2 produced per day for septic waste hauling.

Septic Waste Treatment
Waste pumped from septic systems in North Reading is sent to GLSD for treatment. Carbon dioxide emissions associated with treatment are based on electricity usage and CO_2 burned during treatment. To estimate GHG emissions associated with electricity, it was assumed 1.7 kWh were used for every 1000 gallons treated, based on MEPA averages. Though the waste sent to GLSD is likely more concentrated than typical waste treated at the plant, it is assumed that the pretreatment performed by septic systems offsets any additional CO_2 produced through treatment. This results in 10.06 lbs of CO_2 per day.

To calculate CO_2 emissions from biological treatment processes, it was assumed that the septic waste is ten times more concentration than other waste sent to GLSD. This results in 47.59 lbs of CO_2 per day. Full calculations are shown at the end of this section (calculation #4).

TABLE 9-6
SEPTIC SYSTEM GHG EMISSIONS

Source	**lbs. CO_2 per day**
Fugitive Methane (CO2e)	17610.11
Pump Out Transportation Emissions	727.34
Septic Waste Treatment Electricity	10.06
Biological treatment	47.59
Total	**18,395.28**

Preferred Alternative

Private Treatment Facilities

As part of the recommended plan, all the private treatment facilities, except the high school, will be abandoned. The waste water from these facilities will be conveyed to a centralized pump station, and selected areas that currently use septic systems will be converted to sewer. 500,000 gpd will be sent to GLSD.

High School Treatment Plant

The wastewater treatment facility at the High school/middle school will take on an additional 5,000 gpd of wastewater, captured from select users in the center of town, resulting in approximately 17300 gpd treated at the High School Treatment facilities. There will be approximately 14 lots worth of wastewater added.

CO_2 emissions are based on electricity used in treatment and CO_2 produced from biological processes.

As discussed for the Baseline case, to estimate electricity used to power the High School and Middle School MBR facility, energy use data was collected from a similar MBR plant in Cohasset, MA. This MBR plant is a 38,000 gpd plant and uses approximately 136,710 kWh per year. The High School Treatment Plant will treat approximately 17,300 gpd. If energy use is of a similar scale to the Cohasset MBR plant, then the High School facility uses approximately 62,230 kWh per year, thus 171 lbs CO2 per day.

To calculate CO_2 emissions from biological treatment processes at the facilities, it was assumed that inlet BOD_5 is 300 mg/L and reduced by 30% through primary treatment, thus to 210 mg/L. This results in approximately 13.86 lbs of CO_2 per day.

Connection to GLSD

A connection to the Greater Lawrence Sanitary District is also a part of the recommended plan. It is estimated that 500,000 gpd will be sent to the GLSD. Carbon dioxide emissions associated with treatment are based on electricity usage and CO_2 burned. To estimate GHG emissions associated with electricity, it was assumed 1.7 kWh were used for every 1000 gallons treated, based on MEPA averages. This results in 846.60 lbs of CO_2 per day.

To calculate CO_2 emissions from biological treatment processes, it was assumed that inlet BOD_5 is 300 mg/L and reduced by 30% through primary treatment. Full calculations are shown at the end of this section (see calculation #5). This results in 400.62 lbs of CO_2 per day.

Remaining Septic Systems

Approximately 70 percent of the septic systems will remain after completion of the Project. Therefore we can assume GHG emissions associated with septic systems will be reduced by 30 percent. As calculated above, approximately 18,395 lbs of CO_2 are produced per day as a result of septic systems in the Town. This includes CO_2 as a result of electricity used for treating septic waste at GLSD, CO_2 produced during biological treatment processes, fugitive methane release in CO_2e, and fuel emissions during pump outs. This will be reduced to 12,876.7 lbs.

Pump Stations

This Recommended Plan will require the addition of pump stations to support new waste water flow. As discussed in Section 8, six pump stations will be needed.

Assume

- 6 Pump stations will be needed
- The main pump station will be the largest, with a flow of approximately 0.5 MGD
- Pumps run 24 hours a day
- Pump efficiency is 60%
- Motor efficiency is 90%
- Building electricity (for lighting, controls etc...) is 1 kW per hour

- TDH is a sum of static head and assumed friction losses

TABLE 9-7
PUMP STATION CALCULATIONS

Pump Station	Flow (gpd)	TDH (ft)	kWh/day	lb CO_2/day
Main	500,000	170.00	518.52	516.45
Park St	12,700	41.00	27.03	26.92
Concord	9,000	41.00	26.15	26.04
Cold Spring Rd	9,000	40	26.09	25.99
Southwick Rd	4,000	49	25.14	25.04
Abbott	5,000	40	25.16	25.06
			Total	645.5

DPW Wastewater Treatment Facility

Another wastewater disposal option was considered in the final analysis but not included in the Recommended Plan.

A new 125,000 gpd WWTF facility was proposed for the DPW site. Emissions associated with treatment are based on electricity usage and CO_2 burned.

Similar to the CO2 analysis for the High School treatment facility, energy use data was collected from a similar MBR plant in Cohasset, MA to estimate emissions associated with the DPW facility. This Cohasset MBR plant is a 38,000 gpd plant and uses approximately 136,710 kWh per year. The DPW treatment plant was designed to treat approximately 100,000 gpd. If energy use is of a similar scale to the Cohasset MBR plant, then the High School facility uses approximately 449,704.95 kWh per year, thus 1,237.0 lbs CO2 per day.

To calculate CO_2 emissions from biological treatment processes at the facilities, it was assumed that inlet BOD_5 is 300 mg/L and is not reduced through primary treatment. It also assumed that the DPW facility would be a well-managed activate sludge system, and all methane is captured. This results in approximately 114.46 lbs of CO_2 per day.

CO_2 sequestered by trees

This scenario would also involve cutting down trees on a nine acre lot. The Town's Open Space Plan indicates that the Town contains very few tracts of forest land. The EPA estimates that on average, **1.22 metric tons of CO_2 are sequestered annually by one acre of average U.S. forest.** **"**Please note that this is an estimate for "average" U.S. forests in 2010; i.e., for U.S. forests as a whole in 2010. Significant geographical variations underlie the national estimates, and the values calculated here might not be representative of individual regions or states."

Therefore in this case, 10.98 metric tons (24,207 pounds) of CO_2 are sequestered annually by the 9 acres proposed for a wastewater treatment facility. This amounts to approximately 66 pounds per day.

Thus the DPW treatment facility would create approximately 1351.46 lbs of CO_2 per day from its treatment process. In addition, 66 pounds per day would not be sequestered by forests anymore, so this can be seen as additional CO_2 creation, resulting in approximately 1417.46 pounds per day of CO_2. As shown, the DPW facility will result in higher GHG emissions overall than sending the same wastewater to GLSD.

Vehicle Fleet

It was assumed that about two vehicles from the DPW fleet would be needed to maintain the new sewer system in Town. Data used in evaluating vehicle fleet emissions from the water Recommended Plan was used to calculate emissions from the proposed wastewater vehicles. Average emissions from all water vehicles is about 35.2 pounds of CO2 per vehicle per day, thus two wastewater vehicles would produce approximately 70.5 pounds of CO2 per day.

Wastewater Greenhouse Gas Emissions Summary

TABLE 9-8
NO BUILD EMISSIONS SUMMARY

Emission Source	Emission Type (lbs/day)				Total (lbs/day)
	Treatment Electricity	From Biological Treatment Processes	Hauling Fuel	Methane in CO_2e	
Septic Systems	10.06	47.59	727.33	17,610.12	18,395.28
High School Treatment Facility	121.70	9.85	-	-	131.56
Private Treatment Facilities	183.77	86.96	-	-	270.74
				Total	18,797.58

TABLE 9-9
RECOMMENDED PLAN SUMMARY WITH DPW FACILITY

Emission Source	Emission Type (lbs/day)					Total (lbs/day)
	Treatment Electricity	Operating Electricity	From Biological Treatment Processes	Fuel	Methane in CO_2e	
Septic Systems	7.04	-	33.32	509.25	12327.08	12,876.70
High School Treatment Facility	171.17	-	13.86	-	-	185.04
Pump Stations	-	645.5	-	-	-	645.5
DPW	981		114.46			1417.46
GLSD	761.94	-	360.56	-	-	1122.5
Vehicle Fleet				70.5		70.5
					Total	16,317.70

TABLE 9-10
RECOMMENDED PLAN SUMMARY WITHOUT DPW FACILITY

Emission Source	Emission Type (lbs/day)					Total (lbs/day)
	Treatment Electricity	Operating Electricity	From Biological Treatment Processes	Fuel	Methane in CO_2e	
Septic Systems	7.04	-	33.32	509.25	12327.08	12,876.70
High School Treatment Facility	171.17	-	13.86	-	-	185.04
Pump Stations	-	645.5	-	-	-	645.5
GLSD	846.6	-	400.62	-	-	1247.22
Vehicle Fleet				70.5		70.5
					Total	15,025.01

The Recommended Plan shows a decrease in emissions of approximately 20%.

Sample Calculations

CO_2 Emissions from Biological Treatment Process

Equation Used:

$$CO_2 = 10^{-6} \times Q_{WW} \times OD \times Eff_{OD} \times CF_{CO2} \times [(1 - MCF_{WW} \times BG_{CH4})(1 - \lambda)]$$

Parameter	Definition	Unit
CO_2	CO_2 emission rate	Mg CO_2/hr
Q_{WW}	Wastewater influent flow rate	m^3/hr
OD	Oxygen demand of influent wastewater to the biological treatment unit determined as either BOD5 or COD	g/m^3
Eff_{OD}	Oxygen demand removal efficiency of the biological treatment unit	
CF_{CO2}	Conversion factor for maximum CO2 generation per unit of oxygen demand	1.375 g CO2/ g oxygen demand
MCF_{WW}	methane correction factor for wastewater treatment unit, indicating the fraction of the influent oxygen demand that is converted anaerobically in the wastewater treatment unit	
BG_{CH4}	Fraction of carbon as CH4 in generated biogas	0.65 (default value)
λ	Biomass Yield	g C converted to biomass/g C consumed in the wastewater treatment process

1) Private Treatment Systems:

$\boldsymbol{Q_{WW}}$	108,537 gpd (17.12 m^3/hr)
$\boldsymbol{MCF_{WW}}$	0
λ	0.65 assuming a well-managed aerated treatment process
OD	210 mg/L (BOD begins as 300 mg/L and is reduced by 30%)

Eff_{OD} 95%

$CO_2 = 10^{-6} \times 17.12\ m^3/hr \times 210\ g/m^3 \times 0.95 \times 1.375\ g\ CO2/g\ OD \times [(1 - 0 \times 0.65)(1 – 0.65)]$

CO_2 = 0.0016 Mg CO_2/hr = **<u>86.96 lbs</u>** CO2/day

2) High School Treatment Systems:

Q_{WW}	12,300 gpd (1.94 m^3/hr)
MCF_{WW}	0
λ	0.65 assuming a well-managed aerated treatment process
OD	210 mg/L (BOD begins as 300 mg/L and is reduced by 30%)
Eff_{OD}	95%

$CO_2 = 10^{-6} \times 1.94\ m^3/hr \times 210\ g/m^3 \times 0.95 \times 1.375\ g\ CO2/g\ OD \times [(1 - 0 \times 0.65)(1 – 0.65)]$

CO_2 = 0.00019 Mg CO_2/hr = **<u>9.86 lbs</u>** CO2/day

3) Fugitive CH_4 Emissions from Septic Tanks (CO_2 equivalent)

$$CH_4\ emissions\ (metric\ tons\ CO_2e) = P \times BOD_5\ load \times Bo \times MCF_{septic} \times 365.25 \times 10^{-3} \times GWP$$

Parameter	Definition	Unit	Value
P	Population served by septic systems	person	14,088
BOD_5 Load	amount of BOD_5 produced per person per day	kg BOD5/person/day	0.09
Bo	max CH_4-producing capacity for domestic wastewater	kg CH4/kg BOD5 removed	0.6
MC_F septic	CH_4 correction factor for septic systems		0.5
GWP	Global Warming Potential		21

Source: EPA *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006*, Chapter 8, 8-9 (2008).

CO_2e per day = 14088 x 0.09 x 0.6 x 0.5 x 10^{-3} x 21= 6.8 Metric tons CO_2e per day = **<u>17610</u>** lbs

4) Septic System Waste Sent to GLSD:

Q_{WW}	5939.73 gpd (0.94 m^3/hr)
MCF_{WW}	0
λ	0.65 assuming a well-managed aerated treatment process
OD	210 mg/L (BOD begins as 300 mg/L and is reduced by 30%)
Eff_{OD}	95%
Strength	10 times stronger than normal waste sent to GLSD

$$CO_2 = 10^{-6} \times 14.3\ m^3/hr \times 210\ g/m^3 \times 0.95 \times 1.375\ g\ CO_2/g\ OD \times (1 - 0.65) \times 10$$

CO_2 = 8.9946E-04 Mg CO_2/hr = **<u>47.59 lbs</u>** CO_2/day

5) Wastewater Treated at GLSD:

Q_{WW}	450,000 gpd (71 m^3/hr)
MCF_{WW}	0
λ	0.65 assuming a well-managed aerated treatment process
OD	210 mg/L (BOD begins as 300 mg/L and is reduced by 30%)
Eff_{OD}	95%

$$CO_2 = 10^{-6} \times 71\ m^3/hr \times 210\ g/m^3 \times 0.95 \times 1.375\ g\ CO_2/g\ OD \times [(1 - 0 \times 0.65)(1 - 0.65)]$$

CO_2 = 0.0068 Mg CO_2/hr = **<u>360.55 lbs</u>** CO_2/day

9.3.11.2 Water Analysis

This section presents an analysis of Greenhouse Gas (GHG) emissions associated with the preferred alternative, a connection to the MWRA water system through Reading. The Executive Office of Energy and Environmental Affairs (EEA) developed and issued the GHG Policy and Protocol. Projects involving indirect emissions associated with significant consumption of water undergoing review by MEPA are required to quantify the projects' GHG emissions. Measures to avoid, minimize or mitigate such emissions should be identified as well. At this time the GHG Policy and Protocol's focus is on carbon dioxide (CO_2).

Projects that will consume greater than 300,000 gallons per day (gpd) of water or generate greater than 300,000 gpd of wastewater will typically be considered to fall within this category.

There are several steps to calculating GHG emissions:

- Identify appropriate conditions for each aspect of the project
- Calculate GHG emissions associated with baseline and preferred alternative separately

- Estimate GHG reductions associated with alternatives and GHG reductions associated with mitigation efforts not adopted, as a percent of total
- Clearly state which GHG mitigation measures will be adopted, and provide reasoning

The ENF form for this Project states that alternative analysis must be performed for two scenarios; the baseline case (no-build) and the preferred case (MWRA connection). There are many factors and emission sources to consider for both cases. It should be noted that these estimates are not exact as GHG analysis is done before the final design is completed and many assumptions are made. Furthermore, GHG emissions associated with construction and improvements of new water mains are not considered.

Methodology

In order to calculate Greenhouse Gas emissions, a number of resources, summarized in Table 9-11, were used to determine CO_2 and CO_2 equivalent emissions rate from various sources.

TABLE 9-11
SUMMARY OF RESOURCES USED

Emission Type	CO_2 Emission Rate	Data Source
Electricity	996 lb/mWh	Massachusetts average, ISO New England Electric Generator Air Emissions Report, 2013
Chlorine Treatment	4380 kWh/tonne	Energy Use and Energy Intensity of the U.S. Chemical Industry, April 2000
Natural Gas	117 lb/mmBTU	EPA, Greenhouse Gas Equivalencies Calculator, 2015
Vehicle Fleet	8.887×10^{-3} metric tons/gallon gasoline	
	4.75 metric tons CO_2E /vehicle/year	

In addition, the MEPA office provides, with the assistance of MassDEP, average energy use data for water and wastewater treatment facilities. These averages were used to estimate GHGs associated with the baseline and preferred case alternative. MEPA states that for projects located within Massachusetts Water Resources Authority (MWRA) communities, approximately 0.2 kWh of electricity are used for every 1,000 gallons treated. For projects located outside MWRA communities, this number increase to 1.1 kWh of electricity used for every 1,000 gallons treated.

Data was also collected from the Town to assist in GHG calculations. Records include:

1. Electrical bills for each treatment plant and/or pump station
    a. Route 125 Well
    b. Central street well and treatment plant
    c. Railroad bed and well pump
    d. Lakeside Boulevard and well pumps
2. Vehicle fleet information from 2013 and 2014
3. Natural Gas bills for Lakeside between June 2012 and June 2014

The following sections describe the steps taken and assumptions made in calculating CO_2 emissions associated with the baseline case and the preferred case alternative. Calculated emissions will be presented as an average of CO_2 pounds (lbs) per day.

Baseline (No Build Alternative)

The Baseline Case involves calculating GHG emissions from the Town's current water treatment operations. The Town currently operates two water treatment plants and well houses that also perform water treatment. Electricity used to power and natural gas used to heat these facilities will be used to determine CO_2 emissions. Mobile emissions from the Town's vehicle fleet that manages treatment facilities will also be taken into account. Energy use inherent in the production of treatment chemicals, such as chlorine will be looked at. Treatment emissions associated with water purchased from Andover will be included. Wastewater generated through treatment processes will not be considered as it is typically through on-site lagoons and is not biological in nature.

Electricity

Table 9-12 shows the amount of water treated and purchased by North Reading as presented in the Water Supply Section. These numbers will be used in estimated CO_2 emissions from treatment electricity.

TABLE 9-12
WATER TREATED AND PURCHASED BY NORTH READING

Source	Current Usage (MGD)
Lakeside	0.3
Railroad Bed	0.3
Central Street	0.07-0.08
Andover Interconnection	0.89*
Total	**1.57**

*Average water purchased between 2008 and 2013

Two different approaches for calculating baseline greenhouse gas emissions associated with electricity usage where used. The first approach used MEPA's average electrical energy usage with treatment facilities, which estimates that 1.1 kWh are needed to treat every 1000 gallons of water. The current treated flows, as presented in the Water Needs Analysis section, and summarized in Table 9-12 were used in this estimate. It was assumed that 996 lbs of CO_2 were generated per mWh used. Table 9-13 summarizes emissions based on MEPA averages.

TABLE 9-13
APPROACH 1: EMISSIONS BASED ON MEPA AVERAGES

Water Source	Water Treated (MGD)	mWh	lbs CO_2/day
North Reading	0.68	0.748	745
Andover	0.89	0.979	975
Total	1.57	1.727	**1720.092**

The second approach, summarized in Table 9-14, used electrical bills for the Town's treatment and pumping facilities. Monthly electrical bills from between July 2011 and June 2014 were collected for the Central street well and treatment facility, Railroad well treatment plant, Lakeside wells and treatment plant, and Route 125 well. Utility bills show the kWh used between periods. Assuming an average of 30 days per month, average daily kWh usage and CO_2 emissions were calculated for all four treatment facilities and wells. This does not include water purchased from Andover. Since electric bills from Andover were not available, MEPA kWh averages for water treatment from the first approach were used.

TABLE 9-14
APPROACH 2: EMISSIONS BASED ON NORTH READINGS ELECTRICAL BILLS

Treatment Facility	Average mWh/day	Average lbs/CO_2 day
Central Street	0.3	300
Railroad Bed	0.51	509
Lakeside	0.4	399
Route 125	0.3	300
Total	**1.56**	**1508**

To calculate the total lbs of CO_2 produced per day for the second approach, CO_2 emissions associated with water purchased from Andover were calculated separately using MEPAs averages. If North Reading purchases an average of 0.89 MGD from Andover, this would amount to an average of 975 lbs of CO_2 per day, bringing the total CO_2 emissions for this method to 2483.63 lbs per day.

The second method thus is a more conservative, higher estimate of CO_2 emissions from North Reading's treatment process and will be used moving forward. As shown, North Reading's treatment facilities use an average of 1.56 mWh per day. Since on average the plants have a treatment capacity of 0.68 MGD, this would mean that the Town averages about 2.29 kWh per 1000 gallons treated, nearly double the MEPA average.

Natural Gas

Natural Gas bills were also obtained for the town's treatment facilities. Hess and Direct Energy bills reported volume used in MMBTU between July 2012 and June 2014. Assuming 117 lbs of CO_2 are produced per mmBTU, an average CO_2 emission was calculated to be approximately 104 lbs per day. National Grid delivery charges were also looked at for comparison purposes which reported meter readings in therms.

Vehicle Fleet

North Reading also provided an inventory of all town owned vehicles. Seven water department vehicles and one mechanic vehicle are used for baseline calculations. Using vehicle type, make, and model miles per gallon estimates were found using fueleconomy.gov. North Reading also provided information on vehicle mileage per year. From there, average miles driven per vehicle per day were multiplied by the estimated fuel economy to determine gallons of gasoline used per day. For this calculation, it was assumed that 19.6 lbs (0.008887 metric tons) of CO_2 were produced per gallon of gasoline. Vehicle fleet emissions are summarized Table 9-15.

TABLE 9-15
VEHICLE FLEET CO_2 EMISSIONS

Vehicle Type	AVG miles per day	AVG MPG	Gallons of gas per day	CO_2 per day (lbs)
SUV	26.32	23.00	1.14	22.42
Truck-Pickup	9.57	15.00	0.64	12.50
Truck-Pickup*	33.27	13.00	2.56	50.14
Truck-Pickup	21.84	15.00	1.46	28.53
Truck-Utility	27.15	13.00	2.09	40.91
Truck-Utility	45.11	13.00	3.47	67.99
Truck-Utility	18.44	13.00	1.42	27.78
Truck-Dump	21.18	13.00	1.63	31.92
			Total	**282.20**

*Mechanic vehicle, all others are used by water department

To double check these assumptions, the EPA also estimates that 4.75 metric tons of CO_2e/vehicle/year. For eight vehicles this would amount to 229.52 lbs of CO_2 per day, which is less than what was estimated in the first method. Therefore 282 lbs of CO_2 per day will be used moving forward for the baseline estimate.

Recommended Plan (MWRA Alternative)

The Recommended Plan involves calculating GHG emissions associated with a direct connection to MWRA at the Town border with Reading and/or Wilmington. A number of assumptions are made with the preferred case alternative. First, the Town would abandon and decommission its treatment plants and wells, while keeping their interconnection with Andover only for emergencies. Therefore, GHG emissions associated with Andover will not be accounted for in the MWRA alternative. The Town's storage tanks will be unchanged. The Town's water vehicle fleet will be assumed to be reduced by two vehicles. Lastly, a booster pump station will be added to increase the pressure of the water to meet the North Reading system requirements for water from MWRA.

Electricity

To determine CO_2 emissions for the preferred case alternative MEPA averages for MWRA communities were used which estimates 0.2 kWh per 1000 gallons of water treated. Since the baseline emissions were calculated assuming current flows, the same flows were used to estimate GHG emissions for the preferred alternative. Using a total of 1.6 MGD, this would result in an average of 312.74 lbs of CO_2 per day produced.

Booster Pump Station

A booster pump station will be necessary to pump flow into North Reading from the Reading system. Electrical demand and associated CO_2 emissions are import to consider. The following assumptions were made in calculations:

- Pumps run 24 hours a day
- Flow is 1.6 MGD (2.48 cubic feet per second)
- Static Head is 5 ft, plus 15 ft of pressure

TABLE 9-16
BOOSTER PUMP STATION CALCULATIONS

Pump Efficiency %	Motor Efficiency	kW for pumping	kW for building control	kWh/day	lb CO2/day
80.00%	95.00%	5.51	1.00	156.28	155.66

Vehicle Fleet

For the purposes of this estimation, it was assumed that the town would keep all but two, or 80 percent, of its water department vehicles. In 2014, the Town averaged 282 lbs of CO_2 per day for its vehicle fleet. Reducing the vehicle fleet by 20 percent, or two vehicles, would results in an average of approximately 214 lbs of CO_2 per day.

Summary

Table 9-17 is a summary of GHG emissions associated with both the baseline case and preferred case alternative. Overall the preferred case alternative results in approximately 76 percent reduction in CO_2 production per day.

TABLE 9-17
SUMMARY

Emission Source	Emission Type (lbs/day)							Total
	Treatment Plant Electricity			Natural Gas	Vehicle Fleet Fuel	Chemical Production	Pump Stations	
	North Reading	Andover	MWRA					
Baseline	**1508**	**975**	**-**	**104**	**282**	**73**	**-**	**2942**
MWRA	**-**	**-**	**313**	**-**	**226**	**-**	**156**	**694**
							Emissions Reduction	**76%**

Mitigation

As shown, GHG emissions are significantly reduced by the Recommended Plan. Further measures may be taken to ensure GHG emissions are as low as possible. The design of a booster pump station and equipment selection will be made with premium efficiency in mind.

9.3.11.3 GHG Reduction for Recommended Plan

This Project benefits from the recommended plan causing an overall benefit by reducing GHG production compared to existing conditions in town. There are several design considerations that can further mitigate GHG emissions.

Since electricity is a large component of GHG creation, energy efficiency must be a priority. The primary electricity consumption for this Project is at the pump stations. Treatment for the wastewater is being conducted by large regional facility that is inherently more efficient than smaller local facilities.

High efficiency pumps, blowers, motors and drives have become standard practice in the industry and will be used for both the water and wastewater projects. In addition, variable-speed drives and motors using programmed logic controls will be used to further improve efficiency. The variable drives when paired with smart process control can effectively increase and decrease the energy used in a process as demands increase or decrease. This offers significant energy saving compared to tradition single speed drives and motors that run only at full speed when on. Additionally the incorporation of epoxy lined pump systems, which reduce friction losses, will be used on the Project.

Another goal of the water and wastewater projects is to improve efficiency of HVAC and lighting. Modern lighting and efficient HVAC systems reduce energy use by up to 40%.

Finally, sources of renewable energy will be considered during design. As an off-set to the energy, solar panels will be included in the final construction of the pumping stations. These solar panels will be used to provide power to constant energy systems, such as controls and HVAC systems. Given a total area of 200 square feet available for the water booster and main wastewater pumping station, it is anticipated that approximately 20 KWHs per day can be produced to offset the new energy demands from the Project.

Overall it is estimated that the incorporation of these improvements over the baseline scenario will provide an overall reduction in in greenhouse gas emission of 0.3% for the Project.

9.4 PERMITTING AND AGREEMENTS

9.4.1 Water Related Permits

The following list includes the anticipated permits and approvals required for the water phases included within the recommended plan:

- Massachusetts Environmental Policy Act
- Water Resources Commission – Inter-Basin Transfer
- Local approval (planning, zoning, BOH, conservation commission, historic commission)
- MWRA/OP.10
  - § Advisory Board
  - § Board of Directors
- MassDEP approval
  - § Modification to distribution system
  - § Decommissioning/abandonment of current infrastructure

9.4.2 Wastewater Related Permits

The following list includes the anticipated permits and approvals required for the wastewater ohases included within the recommended plan:

- Massachusetts Environmental Policy Act
- MassDEP approvals
- Local approval (planning, zoning, BOH, conservation commission, historic commission)
- Stormwater management – Construction mitigation

9.4.3 Interbasin Transfer Act

Summary

Under current conditions, the North Reading water supply consists of withdrawals from local sources with a registered well withdrawal from the Ipswich River basin of up to 0.96 MGD and the purchase of water via interconnection with the Town of Andover from the Merrimack River basin of up to 1.5 MGD under an existing Inter-Basin Transfer Act (IBTA) permit.

Under the recommended plan up to 2.58 MGD on a maximum day basis of water will be purchased from the Massachusetts Water Resources Authority (MWRA), and up to 0.503 MGD on an average day basis of wastewater will be discharged to the Greater Lawrence Sanitary District (GLSD).

As stated in the Environmental Notification Form (ENF), a connection to the MWRA water supply would require a new IBTA since the MWRA's sources are located in the Chicopee and Nashua River basins and the water would be used in the Ipswich River Basin.

A secondary transfer would also occur since a portion of the imported water will be discharged to the Merrimack River basin where the GLSD treatment facility is located.

Per the recommended plan, the existing interconnection with Andover would be maintained for emergencies only.

The recommended plan also requires the formal decommissioning of North Reading's local sources and forfeiture of the existing withdrawal registration; therefore, North Reading would not withdraw any water from the Ipswich River basin.

Once a connection to MWRA is established, and the connection is deemed stable, the local sources would be abandoned and decommissioned under a BRP WS 36 permit, and in accordance with Massachusetts Department of Environmental Protection (MassDEP) guidelines including: removal of obstructions, plugging of the existing wells, and surface restoration. The existing water treatment facilities will also be decommissioned. The connection to Andover under an existing IBTA will serve as the emergency source satisfying the MassDEP and MWRA requirements for maintaining emergency sources.

As shown in the Table 9-18 below, both under existing conditions and the recommended plan, more water is imported to the Ipswich River basin than is exported out of basin.

TABLE 9-18
WATER BALANCE IN RELATION TO IPSWICH RIVER BASIN

	Existing Conditions	**Recommended Plan (Future Conditions)**
Sources - Approvals		
Local Source Registration (annual AVG)	0.96 MGD	0.00 MGD
Andover IBTA (Max Day)	1.50 MGD	Emergency Only
MWRA IBTA (Max Day)	0.00 MGD	2.58 MGD
Sources –Withdrawals		
Local Source Registration (annual AVG)	0.52 MGD	0.00 MGD
Andover IBTA (annual AVG)	0.89 MGD	Emergency Only
MWRA: ADD	0.00 MGD	1.60[1] MGD
MDD (IBTA)	0.00 MGD	2.58 MGD
Ipswich River Basin		
Total Withdrawal from Basin	- 0.52 MGD	- 0.00 MGD
Wastewater Generated	+ 1.41 MGD[2]	+ 1.60 MGD[2]
Wastewater Conveyed out of Basin	- 0.00 MGD	- 0.503 MGD[3]
Net Water Change to the Basin	+ 0.89 MGD	+ 1.10 MGD

4. Assumes current well users are added to system, 65 gpcd, 10%UAW, maintain current trends in CEMU and Non-residential use. DEIR includes detailed analysis.
5. Assumes 100% of water use becomes wastewater discharge.
6. Assumes 0.503 MGD of wastewater is sent to GLSD under recommended plan.

9.4.3.1 Donor Basin

The donor basin analysis section was prepared in partnership with MWRA. Many figures and paragraphs of analysis and description were provided by MWRA during the preparation of this DEIR.

Existing Transfer System

The principal structural components of the MWRA system consist of Quabbin and Wachusett Reservoirs, the Ware River intake, the deep rock tunnels which deliver water by gravity eastwards and about 285 miles of pipe that distribute water to MWRA communities. A General Plan of the MWRA Water System, showing the reservoirs, principal conveyance facilities, and the MWRA service area is shown in Figure 9-4. A more detailed figure of the MWRA watersheds is provided in Figure 9-5.

Water can flow into each reservoir from inflows or transfers. Flow out of the reservoirs is made up of withdrawals for water supply, required releases, managed voluntary releases, and overflows when the reservoir is full. Releases are both controlled (i.e. result of human decision) and uncontrolled (i.e. when the reservoir fills and overflows). Figure 9-4 provides a schematic of reservoir inflows and outflows.

FIGURE 9-4
GENERAL PLAN MWRA WATER SYSTEM

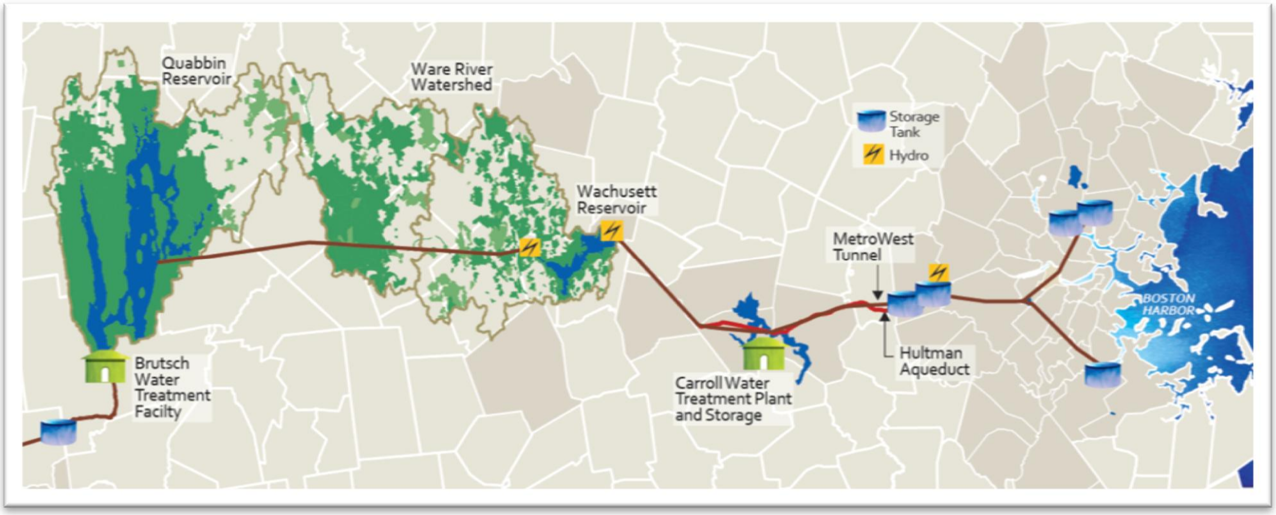
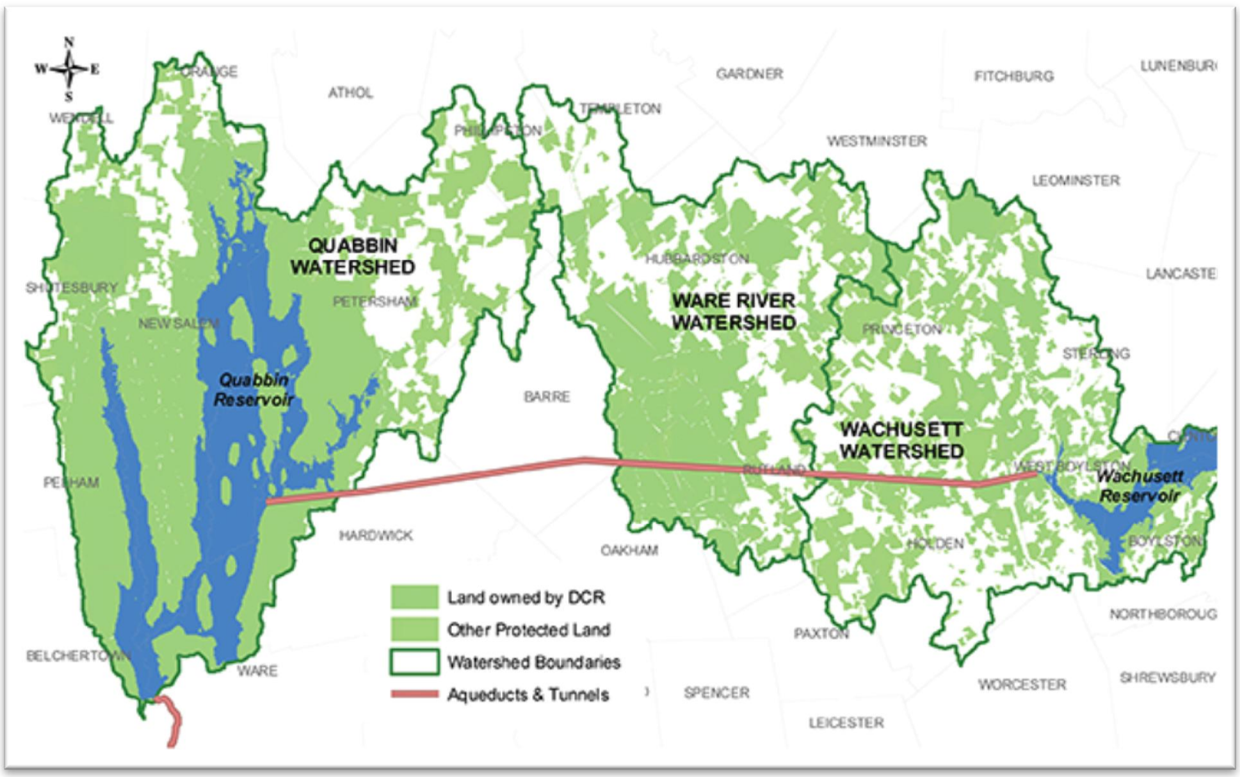


FIGURE 9-5
MWRA WATERSHEDS



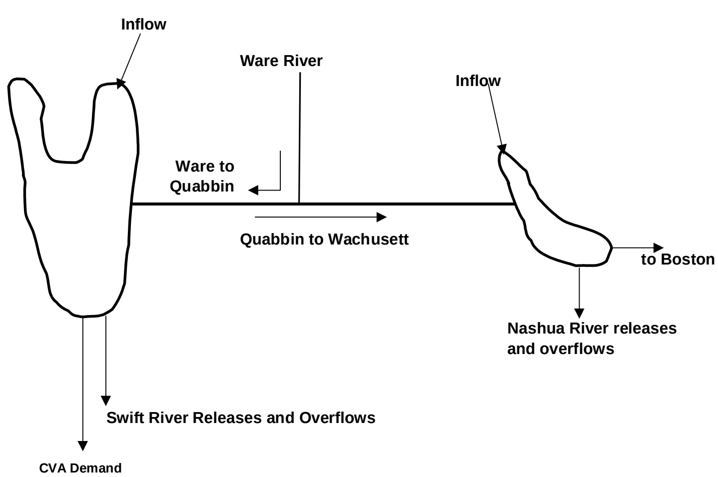
Out-of-Basin Conveyance Capacity

The Quabbin Tunnel is 24 miles long, extending from Shaft 12 at the Quabbin Reservoir intake in the Chicopee River Basin, to the Wachusett Reservoir in the Nashua River Basin. Quabbin flow transferred via the Quabbin Aqueduct enters the upper end of Wachusett Reservoir and constitutes more than half of the average annual inflow to Wachusett Reservoir. The Quabbin Tunnel can also transfer water from the Ware River watershed to Quabbin Reservoir, via the Ware River Intake at Shaft 8 in Barre.

The other principal conveyance structure that is actively used to transport MWRA water out of the donor basins is the Cosgrove Aqueduct, which conveys water from Wachusett Reservoir in the Nashua River Basin, to the John J. Carroll Water Treatment Plant (JJCWTP) in Marlborough in the SUASCO River Basin. The Wachusett Aqueduct serves as back-up to the Cosgrove Aqueduct and similarly conveys flow from Wachusett Reservoir to the JJCWTP. After treatment, water is sent eastward through either the new MetroWest Water Supply Tunnel or Hultman Aqueduct.

In total, the MWRA transmission system consists of over 100 miles of active tunnels and aqueducts as well as over 40 miles of stand-by/emergency aqueducts that transport water by gravity to points of distribution within the MWRA service area.

FIGURE 9-6
INFLOWS AND OUTFLOWS



Storage Capacity, Withdrawal Constraints and Discharges, and Other Limiting Factors

The MWRA reservoir system is operated with the primary objective of ensuring a high quality adequate water supply for the MWRA service area. Secondary operational objectives for the reservoir system include maintaining an adequate flood protection buffer particularly during the spring melt and hurricane seasons and maintaining required minimum releases to the Swift and Nashua Rivers.

Quabbin Reservoir

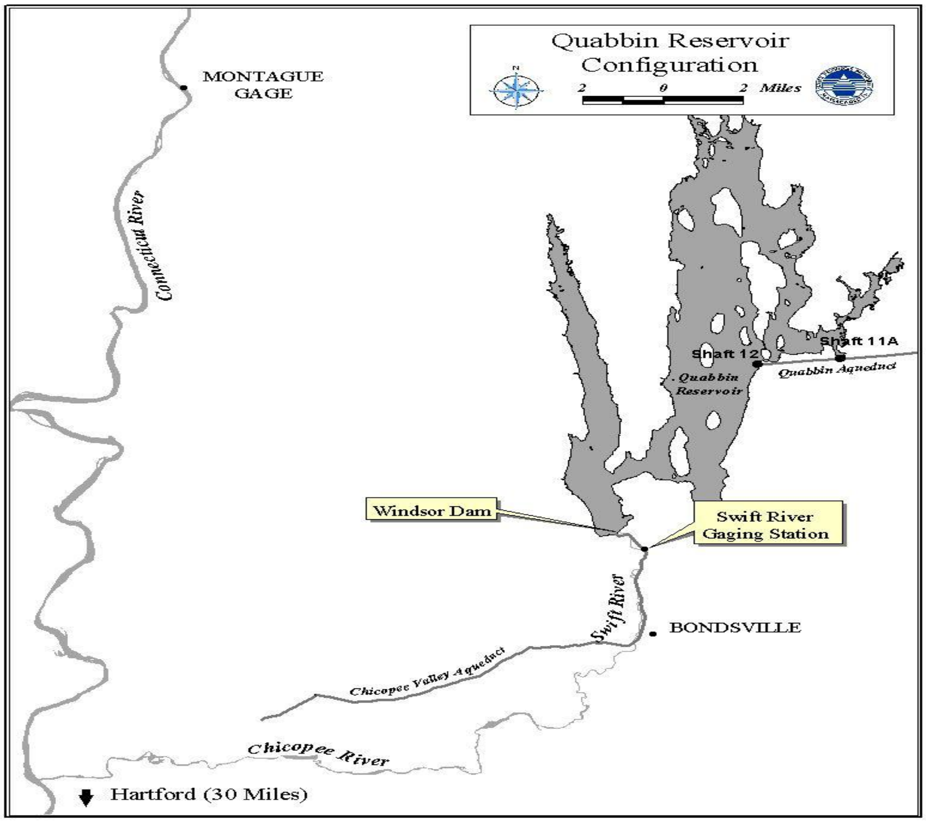
Quabbin Reservoir has a maximum storage capacity of 412 billion gallons, equivalent to about five to six years' worth of supply. It is fed by a well-protected watershed of 186 square miles, of which approximately 90% is forest or wetlands. The Quabbin Reservoir contributes about 53% of the total system safe yield of 300 mgd,

Water is discharged from the Quabbin Reservoir primarily from the Quabbin Aqueduct where it ultimately discharges into the Wachusett Reservoir. Quabbin flow transferred to Wachusett enters the upper end of the Reservoir and constitutes more than half of the average annual inflow to Wachusett Reservoir. Releases from Quabbin also occur through the Chicopee Valley Aqueduct to supply water to three communities west of Quabbin. Additional outflow from Quabbin includes discharges to the Swift River at the Winsor Dam.

Minimum Release Requirements

Chapter 321 of the 1927 Acts of Massachusetts and the 1929 War Department Requirement dictate minimum discharges to the Swift River.

FIGURE 9-7
QUABBIN RESERVOIR CONFIGURATION



Chapter 321 of the 1927 Acts of Massachusetts.

Sufficient water must be discharged from the Quabbin Reservoir to provide at least 20 mgd in the Swift River at the Village of Bondsville located five miles downstream of Winsor Dam. At least 18 MGD is released from the Winsor Dam each calendar day, which more than satisfies the 20 mgd requirement, since the intervening watershed between Winsor Dam and Bondsville is estimated on average, to contribute 4 mgd; in the summer months, the intervening watershed contributes less.

***1929 War Department Requirement*.**

A War Department permit issued in 1929, now overseen by the Corps of Engineers, requires additional releases. During the period from June 1 to November 30, streamflows on the Connecticut River at Montague govern the required releases from the Swift. When the daily average flows in the Connecticut River are less than the 4900 cfs at Montague, the release from the reservoir must be 45 MGD. When flows at Montague fall below 4650 cfs, the release from the reservoir must be 70 MGD. For flows at Montague above 4900 cfs, the minimum flow of 20 MGD governs.

Wachusett Reservoir

Wachusett Reservoir has a maximum capacity of 65 billion gallons and is fed by a more developed watershed that is 107 square miles. The Wachusett Reservoir contributes about 34% of the MWRA's system safe yield of 300 mgd. Wachusett Reservoir must be managed for continuous water availability, optimal water quality and flood control as described below.

Wachusett Reservoir's elevation is maintained within a narrow operating band. The range of elevations was established because it provides adequate supply to meet customer demands, minimizes shoreline erosion, provides adequate free board to minimize the possibility of downstream flooding, and improves water quality by submerging gull roosting areas near the intake. This operating range is maintained by local Wachusett watershed yield as well as transfers, as needed, of water from Quabbin Reservoir to Wachusett Reservoir via the Quabbin Aqueduct.

Optimizing Water Quality

Wachusett water quality is dependent on elevation control for keeping shallows submerged as part of bird harassment, for controlling sediment or aquatic vegetation issues in areas near the intake, and for minimizing sunlight penetration for algae control. In general, higher reservoir levels benefit water quality. Once the reservoir has 'iced in' and bird populations disperse, lower water elevations can be tolerated.

Wachusett inflow is 'younger' and of poorer quality and is improved through dilution by inflows from Quabbin which have been naturally treated by the long detention of the reservoir. Transfers from Quabbin to Wachusett are beneficial any time of the year since they lower, by dilution, the concentration of reactive organic matter considered a precursor to disinfection byproducts.

During summer stratification, Quabbin transfer water can establish an 'interflow' layer in which higher quality Quabbin water moves in a narrow band through the reservoir to the Cosgrove intake. Reservoir stratification is normally established by mid-June. Through reservoir modeling and testing MWRA has observed the benefit of transferring water between reservoirs particularly between May and October. During this time of the year the reservoir's thermocline has developed which allows water transferred from Quabbin to move as an interflow from the aqueduct's point of discharge to the Cosgrove Intake, providing a more rapid and stronger effect. Having the higher quality water at the intake is particularly important during this period due to the relationship between warmer temperatures and disinfection processes. When Wachusett watershed yields are sufficient to maintain reservoir elevations within the normal operating range, and transfers of additional water for water quality purposes are made, additional releases from valves at the Wachusett Dam may be required to maintain adequate freeboard to minimize flooding potential.

In anticipation of starting the transfer, especially during periods of high spring run-off and lower spring system demand, the Wachusett Reservoir elevation is brought back down to this operating range by releasing flow to the Nashua River above the minimal required release. This release also restores some flood storage to accommodate future spring run-off events. It may be necessary, in wet years to continue this release to prevent the elevation from increasing back up above 391.5 BCB.

Quabbin to Wachusett transfers may also be made between September/October to "Ice In" (typically January or February). In order to keep shallow areas in Wachusett reservoir submerged, thereby assisting in bird harassment, Quabbin transfers are started when the Wachusett elevation drops to 390.0 BCB and shut down when the elevation rises to 391.5 BCB. The rate of transfer can be controlled in the range of 100-300 MGD in order to supplement tributary production and keep pace with demand in order to keep a more steady elevation.

Minimum Release requirements

The MWRA discharges water to the Nashua River consistent with *Chapter 488 of the Acts of 1895*. This Act states that not less than 12 million gallons per week must be discharged into the South Branch of the Nashua River. This release is made via a continuous release into the basin at the base of the dam.

Flood control

The Wachusett Reservoir watershed, after significant rain events, can produce a level of inflow such that the available storage in the reservoir is exceeded, causing spillage. As an example, a rain event on April 14, 2007 resulted in the level of the reservoir rising 2.2 feet (about 3 billion gallons) in a 40 hour period. This resulted in a rate of spillage on the order of 800 million gallons per day. March 2010 saw even greater spillage (2 billion gallons a day) Such spillage impacts available water supply yield, creates the risk of aggravating downstream flooding, and can be a concern to the safety of the dam structure in an extreme flood event. Lower reservoir levels benefit flood control by providing a cushion to absorb severe storms.

Ware River

The MWRA can transfer water from the Ware River watershed via the Quabbin Aqueduct to contribute 13 % of total safe yield. By law, Ware River transfers are limited to a period when river flows exceed 85 mgd and are subject to the following conditions: no diversion of Ware River flows are allowed from June 15 to October 15. Diversions from June 1 to June 15 and from October 15 to November 30 must have prior permission from the DEP Division of Water Supply.

Ware River water is not usually diverted when the Quabbin water level is within the "Normal" level, as defined in the MWRA/MDC Drought Management plan. That said, MWRA does retain its rights to divert the Ware River at any time allowed within its regulatory requirements and at times there may be departure from the above noted typical operating procedures.

The Army Corps of Engineers or local fire departments may request (and have requested in the past) that Ware River water be taken for flood protection of the lower Ware River area. These requests can come in at any time of year, and MWRA will usually comply if storage at Quabbin is available.

Detailed Description of Proposed Interbasin Transfer

Table 9-19 provides overview information and information on capacity of the MWRA aqueducts and tunnels that transport flow from the Chicopee and Nashua River donor basins to downstream points of distribution.

TABLE 9-19
MWRA INTERBASIN TRANSFER SYSTEM

Aqueduct/Tunnel	Transfer	Year Built	Capacity (mgd)	Length (miles)	Status
Quabbin Aqueduct	Quabbin Res. & Ware River (Chicopee River Basin) to Wachusett Res. (Nashua River Basin)	1939	610*	24.6	Active
Chicopee Valley Aqueduct	Downstream Chicopee River Basin communities; Connecticut River Basin	1949	20	14.8	Active
Cosgrove Aqueduct (under normal operating conditions)	Wachusett Res. (Nashua River Basin) to John J. Carroll Treatment Plant (SUASCO River Basin)	1967	450	8	Active
Wachusett Aqueduct (back-up to Cosgrove for redundancy)	Wachusett Res. (Nashua River Basin) to JJCTP (SUASCO River Basin)	1897	240-250	12	Stand-by
MetroWest Water Supply Tunnel (MWWST) (Provides redundancy to Hultman)	JJCWTP and points downstream in MWRA service area.	2003	342	17.6	Active
Hultman Aqueduct(provides redundancy to MWWST)		1939	291	17	Active
City Tunnel		1950	300	5.4	Active
CityTunnel Ext.,		1963	200	7.0	Active
Dorchester Tunnel		1976	200	6.4	Active

* While Quabbin tunnel has a flow capacity of 610 mgd under certain conditions, flow is restricted at its outlet (the Qakdale turbine and bypass valve) to 300 mgd.

North Reading would receive MWRA water via Reading: Reading is served by MWRA's Northern Intermediate High Distribution system, which is receives treated water from the

MWRA's John J. Carroll Water Treatment Plant (JJCWTP), via the MetroWest Tunnel, City Tunnel and City Tunnel Extension, noted above. The maximum capacity of the JJCWP is 405 mgd. Currently, the water demand of communities served by the JJCWP is 185 mgd (MWRA's Chicopee Valley Aqueduct communities and other system demand/water loss accounts for approximately 15 mgd). North Reading's proposed average and maximum day transfers are 1.6 mgd on an annual average basis and 2.58 on a maximum day.

The capacity of the transfer system is based on detailed design analysis as well as empirical operating history. There are no changes in MWRA's existing structures and/or changes in MWRA's operating rules, or changes in transfer constraints that are necessary for MWRA to supply North Reading and the other communities that have discussed joining the MWRA water system. (In addition to North Reading, Ashland, and Southfield [Weymouth Naval Air Station Redevelopment] are pursuing admission to the MWRA Water System. Other communities may be interested in the near future as well. Their cumulative demands are projected to be 10 mgd).

More locally, Reading will need to make changes to its distribution system in order to wheel water to North Reading, and these include reactivating certain pipelines as well as construction new sections of larger diameter distribution system piping, increasing inlet/outlet of tanks, and new meter and meter chamber. MWRA is also in the process of designing and constructing its Northern Intermediate High Redundancy Project, which will provide a redundant pipeline to supply the service area (a new loop, so there is not a single pipeline serving the area).

Exact Location and River Basin of the Source (s) of the Proposed Transfer

The sources of water are the Quabbin Reservoir in the Chicopee River Basin and the Wachusett Reservoir in the Nashua River Basin. As discussed earlier, water is conveyed eastward to the Boston Metropolitan Area through a series of tunnels and aqueducts.

Operating Schedule of the Proposed Interbasin Transfer

North Reading proposes to withdraw 1.6 on an annualized basis and up to 2.58 mgd on a maximum daily basis. Given that MWRA's reservoirs are multi-year storage reservoirs with 477 billion gallons of storage, the variation in North Reading's demand from MWRA over a 24 hour period, or day to day or between winter and summer months is of no significance to reservoir operations.

North Reading, Ashland, and Southfield (the Weymouth Naval Air Station Redevelopment) are pursuing admission to MWRA, and other communities may be interested in joining the MWRA. Therefore, MWRA assumes the cumulative demand of new communities may be approximately 10 mgd. 10 mgd represents the average day withdrawal on an annualized basis: demands during the summer months would be higher. The actual monthly demands (2013, 2014, average) of recent past applicants to the MWRA have been extrapolated for 10 mgd. Table 9-20 presents the actual monthly demands of recent entrants to the MWRA system, while Table 9-21 presents the monthly projected demands of North Reading, and extrapolated demands based on cumulative new withdrawals of 10 mgd potential new communities (including North Reading, Ashland, and Southfield). Ultimately, given that MWRA's reservoirs are multi-year storage reservoirs with

477 billion gallons of storage and MWRA has a series of distribution reservoirs to provide flow equalization, the variation in Ashland's demand, or the demand of other new communities, over a 24 hour period, or day to day or between winter and summer months is of no significance to reservoir operations and interbasin transfer.

TABLE 9-20
DEMANDS OF PRIOR APPLICANTS TO MWRA(MGD)

	Stoughton	DWWD	Reading	Wilmington	Total
Annualized	.82	.14	1.6	.29	2.86
January	.691	.07	1.482	.064	2.244
February	.697	.003	1.485	.047	2.232
March	.789	.003	1.478	.007	2.277
April	.828	.0016	1.452	.0625	1.516
May	.79	.0657	1.781	.347	2.636
June	.893	.139	1.875	.602	3.509
July	.839	.339	1.9	.734	3.812
August	.866	.45	1.89	.65	3.856
September	.938	.5986	1.746	.426	3.70
October	.939	.047	1.47	.52	2.96
November	.912	.014	1.38	.471	2.727
December	.761	.0058	1.416	.057	2.2398

TABLE 9-21
DEMANDS OF NEW COMMUNITIES (MGD)

	Demands by Month -Prior Applicants to MWRA System (mgd)	Projected Demands by Month- North Reading (mgd)	Projected Demands By Month– New Communities (mgd)
Annualized	2.86	1.60	10
January	2.244	1.28	8
February	2.232	1.21	8
March	2.277	1.25	8.1
April	1.516	1.34	5.4
May	2.636	1.78	9.4
June	3.509	1.89	12.5
July	3.812	2.17	13.6
August	3.856	2.06	13.8
September	3.70	1.84	13.2
October	2.96	1.68	10.5
November	2.727	1.35	9.7
December	2.2398	1.32	8

Safe Yield

MWRA's documentation of the adequacy of the Safe Yield of the MWRA Water System takes into consideration both existing and projected demand of the existing MWRA Water service area and also considers cumulative demand of not only North Reading, but other potential communities that may join MWRA. The text below therefore first addresses projected demand, then evaluates the cumulative withdrawals on the MWRA/DCR system and the impact on service to existing MWRA served communities. Demand is modeled against six system performance measures.

Existing Service Area Demand

1985-2014

The MWRA Water Service area is currently comprised of fifty-one communities.

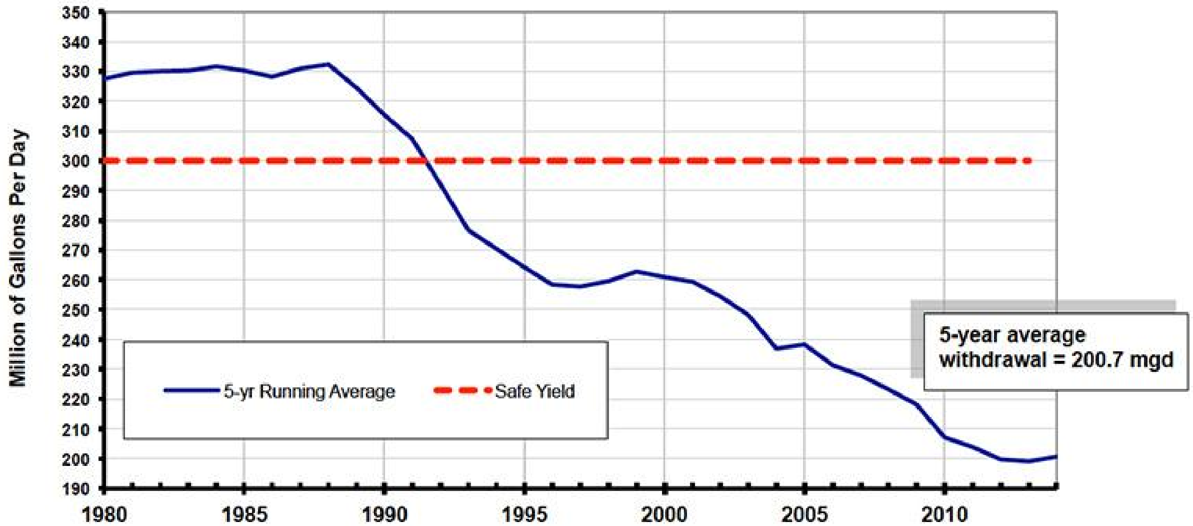
- 32 of these communities are fully supplied users which take all of their water from MWRA

- 15 are partially supplied communities which normally use MWRA as well as locally owned and operated water sources to meet water demand

- 3 are emergency only communities that take MWRA water only in emergency.
- And one community that withdraws raw water from the Wachusett Reservoir.

MWRA system demand now averages approximately 200 mgd (5-year average 2010-2015). As Figure 9-8 illustrates, service area demand has dropped significantly since the MWRA's formation, even as the geographic bounds of the MWRA service area have grown and the population of the MWRA water service area has increased. MWRA's aggressive water conservation efforts, including local leak detection and repair programs, yielded significant gains early on, with a 20 percent drop in five years. The new plumbing code, improved appliance efficiency, the shift in the commercial base from water-intensive manufacturing to less intensive users, good system management, and improved metering and price-response all likely contributed to lower demand.

FIGURE 9-8
Withdrawals and Yield



Projected 2035 Demand

Population projections prepared by the Metropolitan Area Planning Council, and the UMass Donahue Institute for the Office of the Secretary of the Commonwealth of Massachusetts were used as the starting point for projecting future water demand.

In January 2014, the MAPC adopted population projections for 2030 for 101 communities. The population projections include 46 communities of the 50 communities that are part of the MWRA water service area. Projections incorporate data from MAPC's development data base for residential and commercial developments recently completed, constructed, or planned. Communities collaborated and reviewed the projections, which underwent public review prior to finalization. MAPC projected population growth for two different scenarios:

Status quo: Based on a continuation of existing rates of births, deaths, migration and housing occupancy.

Stronger Region: Assumes changing trends that result in higher population growth, greater housing demand, and a substantially larger workforce.

Population growth between 2010 and 2030 for water communities typically served by MWRA (which does not include emergency only communities of Worcester, Leominster, and Cambridge) is projected by MAPC to increase by 142,772 people under the States Quo growth projection, and 263,068 under the Stronger Region projection. Assuming a residential consumption rate of 55 gallons per capita per day, RGPCD (The RGPCD of MWRA's existing Service Area has averaged 53 RGPCD over the past five years, so 55 RGPCD adds some conservatism) the total increase in residential water demand throughout the MWRA service system for the two scenarios would be 7.85 mgd (Status-quo) and 14.5 mgd (Stronger Region) if it is assumed that new population growth in MWRA's communities, both partially and fully served, would be met by MWRA, not local sources. Since past experience has shown water demand has not increased commensurate with population growth due to continued improvements in water use efficiency and awareness, the projection of 7.85-14.5 mgd in residential demand is considered conservative. It is also particularly conservative given that Boston's population growth, as projected by MAPC, comprises approximately more than one third of the total service area growth, and Boston's residential per capita consumption has averaged 41 RGPCD over the past five years. Further, while Boston's population grew from 589,141 people in 2000 to 644,710 people in 2013, and the employment sector added jobs, Boston's water demand dropped from over 80 mgd in 2000 to 63 mgd in 2014.

MWRA also consulted the *Long-term Population Projections for Massachusetts Regions and Municipalities, pr*epared by Donahue Institute for the Office of the Secretary of the Commonwealth of Massachusetts, March 2015. These projections estimate that the MWRA Service area will increase by 337,906 persons between 2015 and 2035. Assuming a residential consumption rate of 55 GDPCD, the total increase in residential water demand based on Donahue Institute projections is 18.6 mgd, if it is assumed that all new population growth in MWRA partially and fully served communities would be met by MWRA, not local sources. Since the projection assumes an RGPCD of 55, rather than the actual 2014 RGPDC of 53 for the MWRA service area and in light of past trends regarding water use and population and employment growth, the projection is believed conservative.

For non-residential demand, MWRA used employment projections developed by Mass Department of Transportation. MassDOT develops forecast for a variety of applications and works closely with state and regional agencies to develop the forecasts. Based on MDOT adopted employment forecasts through 2035, the MWRA water service area is projected to add 119,984 new jobs between 2010 and 2035, or 8.7%. Based on prior analysis, estimates of water use per employee is 33 gallons per new employee. (This is considered conservative as well, since large sectors of employment growth in the Metropolitan Area are professional, scientific, technical, health and education and basis professional that typically have lower than 33 gallons per capita per day). Assuming 33 gallons per day per employee and 119,984 new jobs, results in an increase of 4 mgd in non-residential demand.

Total water demand attributed to employment and population growth in the existing MWRA service area ranges based on more conservative estimates (MAPC Stronger Region and Donahue Institute plus DOT Employment projections) ranges from 18.5 mgd- 22.6mgd. The future water demand of the MWRA's existing service area under the two higher growth scenarios is as follows:

TABLE 9-22
MWRA EXISTING SERVICE AREA: POTENTIAL WATER DEMAND UNDER HIGHER GROWTH SCENARIOS

Baseline (2010-2014)	200 mgd	200 mgd
	MAPC Stronger Region Population Projections and DOT Employment Projections	Donahue Institute and DOT Employment Projections
Increase in Water Demand 2035	18.5 mgd	22.6 mgd
Total	218.5 mgd	222.6 mgd

There is the potential for changes in the use of local sources through either restrictions on use of local sources (e.g., communities in the Ipswich River Basin or communities in highly altered rivers with Water management Act permits), decrease or loss of local source, or potential development of new local sources (e.g. Framingham). For the purpose of this analysis, it is reasonable to assume that that there will be no substantial change in local sources, as the various increases and decreases balance out.

Demand of Ashland plus demand from other potential new Communities

North Reading's future demand on MWRA on an annualized basis is 1.6 mgd. Ashland has identified MWRA as a supplemental water supply and Southfield has identified MWRA as a preferred water supply option. Other communities have also expressed interest in joining MWRA, so this analysis assumes North Reading's demand of 1.6 mgd, as well potential demands of Ashland and Southfield, and a margin of safety for other communities that may approach MWRA in the near future, for a total of 10 mgd.

Cumulative Demands of Existing Service Area and New Communities

Assuming the cumulative withdrawals of both the existing service area projected out to 2035 and the 10 mgd withdrawal by North Reading, Ashland, Southfield and other communities that may approach MWRA in the near future, the proposed rate of interbasin transfer is 232.6 mgd. This is well less than the historical rate of withdrawal/ interbasin transfer (see Figure 9-7).

Other Demands

Pursuant to an MOA with Department of Fish and Game and the Division of Fisheries and Wildlife, MWRA constructing the Chicopee Valley Aqueduct-Fish Hatchery Pipeline and Hydropower Project which includes a water pipeline that will tap raw water off of the MWRA's Chicopee Valley Aqueduct (CVA) and convey six million gallons a day to the Massachusetts Division of Fisheries and Wildlife's (DFW) McLaughlin Fish Hatchery, except during periods of drought. The proposed pipeline to the Hatchery would solve the Hatchery's need for consistently cold, reliable and high quality water and would replace the water that the Hatchery now withdraws from Swift River. The 6 mgd of water piped to the Hatchery would be used in the Hatchery's fish rearing facilities, which include a series of linear raceways. Ultimately, the water supplied and used in the Hatchery's operations would be discharged after treatment to the Swift River (the Hatchery borders the Swift River) to supplement existing flows in the Swift River.

Demand and Effects on Safe Yield and Long-term Reservoir Performance Measures and Operations of the MWRA Water Works System

As noted above, the demand for the existing service area projected out to 2035 with a high level of conservatism built in, plus demand of new communities' totals 232.6 mgd. In addition, MWRA will be supplying 6 mgd to the McLaughlin Fish Hatchery, except during periods of drought. Therefore, on the tables and figures below that address reservoir performance measures at various levels of demand, approximately 240 mgd may be considered the withdrawal that is most applicable for evaluation (Existing MWRA Water System communities' existing and projected demands plus 10 mgd for new communities plus 6 mgd to the McLaughlin Fish Hatchery). MWRA also evaluated the impacts on the reservoir system on withdrawals ranging from 200 mgd to 300 mgd: demand could also be considerably lower than 240 mgd, given declining water use trends, or higher due to uncertainty regarding the effects of climate change, or reduction in use of local sources.

Reservoir Performance Measures

MWRA evaluated the long-term impacts on the reservoir system using system performance measures that were developed in the "Trigger Planning Study". The Trigger Planning Study was done in 1994 by MWRA staff in collaboration with the Water Supply Citizens Advisory Committee (WSCAC), Massachusetts Audubon Society and the Army Corps of Engineers. The reservoir performance measures used not only assess the ability of the system to satisfy projected demands, but also measure the corresponding impacts on the condition and ecology of Quabbin Reservoir and on the consumers served by the system. The performance measures were evaluated using approximately 50 years of data (October 1948 through September 2000) which includes the extreme drought of the mid-1960s.

These measures identified in the Trigger Planning Study are listed below:

- Safe Yield
- Supply Shortfall
- Severity
- Maximum Pool Descent
- Resiliency
- Drought Actions

MWRA used a STELLA model (Stella Research Software Package Version 5.0) to evaluate the impact of varying demands on the Trigger Planning Performance Measures identified above. The results presented here assume use of MWRA's current operating procedures for the Ware River. All analysis also assumes full compliance with all required releases to the Swift and Nashua Rivers, and a continuation of current system operating practices. Performance measures were evaluated using the historical record 1948-2000, which includes the 1960s drought of record.

The model incorporates "pop-up" demand from MWRA partially supplied communities.[1] During the 1960s drought of record, demand from the partially supplied communities increased. The model assumes that during the Drought Warning stage (see ensuing pages for further description of MWRA's drought stages), incremental demand from partially supplied communities increases 6.5 mgd, and during Drought Emergency Stages 1 and 2, incremental demand increases by 12 mgd and 25 mgd, respectively.

Safe Yield

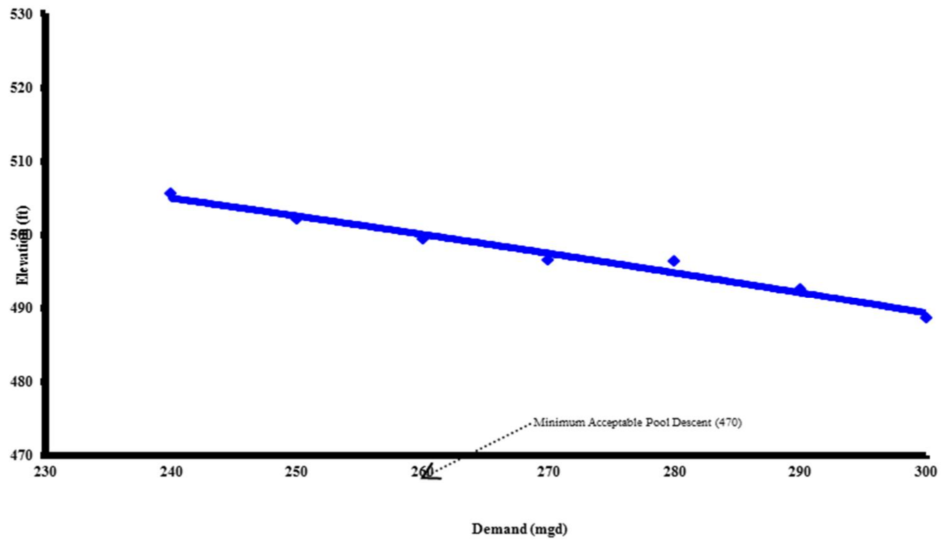
Safe Yield has been defined as the quantity of water that can be supplied on a continuous basis during a critical drought. The Safe Yield of the Wachusett-Ware-Quabbin system is 300 mgd. The demand of the existing MWRA service area continues to decline, thereby allowing MWRA to serve additional communities without affecting MWRA's ability to stay well within safe yield of the watershed system and its Water Management Act (WMA) registrations of 312 mgd.

Maximum Pool Descent

Maximum Pool Descent is defined as the maximum deviation of the pool at Quabbin Reservoir below a specific target pool level at a specific water demand. It is indicated as the elevation of the pool at the maximum deviation. The trigger planning study recommended limiting this descent to 470 feet since at that elevation the reservoir ceases to function as a single unit. Figure 9-9 illustrates Quabbin reservoir's maximum pool descent under varying demands and indicates that the additional communities' demand has a negligible impact. At demands below 250 mgd, Quabbin's maximum descent would still be above 500 feet, well above the level at which performance could be affected, and within its normal operating range.

[1] There are 14 communities that are part of the MWRA water service area that typically use a combination of local sources and MWRA water to meet their current demands. In a recent year, approximately 12 mgd of demand in partially supplied communities was met by MWRA and approximately 36 mgd was met by local sources.

FIGURE 9-9
QUABBIN'S MAX POOL DESCENT
(OCTOBER 1948 – SEPTEMBER 2000)
INCLUDES DROUGHT OF RECORD



Further, at varying demands from 240 mgd to 280 mgd, Quabbin Reservoir would stay above elevation 490, for all scenarios modeled. During a drought as severe as the 1960s and a demand of 300 mgd, Quabbin would drop to about 486.

Drought Actions

Drought Actions are defined as the number of months that Quabbin Reservoir levels remain in each of the stages of the MWRA Drought Management Plan. The Plan has actions associated with various categories related to percent full status of Quabbin Reservoir. The various stages consist of below normal, drought warning, as well as Stage 1 through Stage 3 drought emergencies. In addition Table 9-23 summarizes MWRA's Drought Management Plan, including Drought Stages and Target Use Reductions.

Table 9-24 illustrates the number of months in below normal, drought warning and Drought Emergency Stages 1, 2, and 3 associated with varying levels of demand using the historic record of 1948-2000, including the drought of record. This table shows that at a demand of 240 mgd (encompassing the projected demand of the existing service area in 2035 under the most conservative scenario plus the additional demand of Ashland and other potential new communities (10 mgd total) plus the Fish Hatchery, there would be one month spent in drought stage 1. This is also indicated in Table 9-24. The analysis includes hydrological data for the drought of the sixties. This single drought is responsible for all the drought actions during the 50 year- period. In reality, though, since MWRA water supply to the Hatchery would cease or be decreased during periods of drought, demand, for the purposes of estimating impacts on drought actions, the drought actions for a demand of 230 mgd are more representative of expected impacts.

TABLE 9-23
MWRA DROUGHT MANAGEMENT STAGES

Stage	Trigger Range (Quabbin % Full)	Target Water Use Reduction
Normal Operation	80-100	0
Below Normal	65-90	Previous year's use (Voluntary)
Drought Warning	50-75	5% (Voluntary)
Drought Emergency		(Mandatory Restrictions)
Stage 1	38-60	10%
Stage 2	25-38	15%
Stage 3	Below 25%	30%

TABLE 9-24
NUMBER OF MONTHS IN EACH STAGE OF MWRA'S DROUGHT MANAGEMENT PLAN
(INCLUDING DROUGHT OF RECORD)

Demand (mgd)	Below Normal	Drought Warning	Drought Emergency Stage 1	Drought Emergency Stage 2	Drought Emergency Stage 3
190	21	0	0	0	0
200	31	1	0	0	0
210	44	2	0	0	0
220	42	8	0	0	0
230	51	14	0	0	0
240	50	28	1	0	0
250	60	39	4	0	0
260	55	61	5	0	0
270	41	63	8	0	0
280	43	62	24	0	0
290	67	34	56	0	0
300	98	25	69	4	0

Quabbin Reservoir Levels

Figures 9-10 and 9-11 show the demand and reservoir pattern level for the period 1950 through 2010. Figure 9-11 shows that the lowest reservoir volumes occurred in the late 1960's, near the end of the most severe drought period resulting in low watershed yields over an extended period of time. As the figure also shows, during the 1950-1960 and 2000-2010 periods, two decades where demands generally varied between 200 and 250 mgd, the reservoir was typically more than 80% full, and only briefly skirted the below normal level.

Figure 9-10
MWRA ANNUAL AVERAGE SYSTEM DEMAND

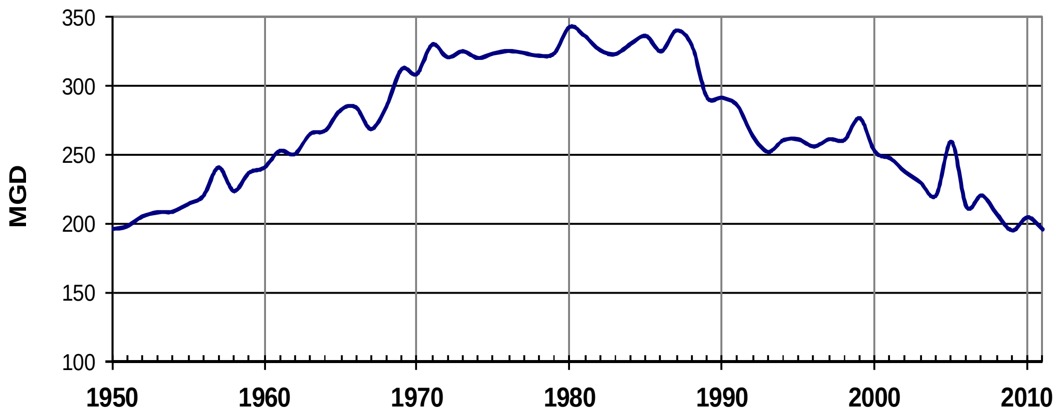


FIGURE 9-11
RESERVOIR PATTERN LEVEL

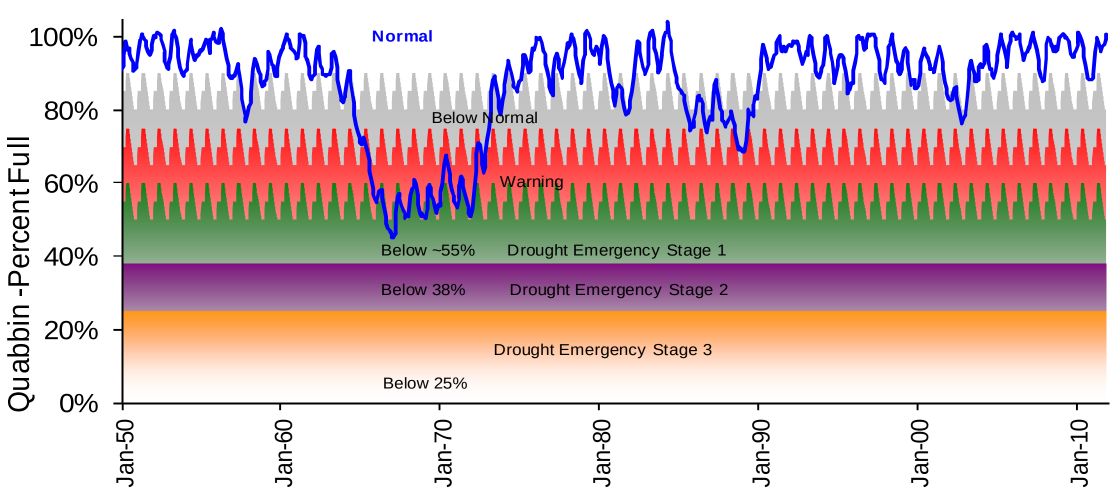


Table of Uncontrolled Releases from Quabbin Reservoir from 1990 to the Present

The directions say to provide the table, "…including what releases would have been with the theoretical demand of the community, had the community been a MWRA customer. Show any changes in the frequency and duration of uncontrolled releases that will occur with the addition of the community's proposed withdrawal." This overlaps with the scatter figures that appear later in the document, but for now, I was thinking that if you show the releases by month for each year, and we also note the water demand for those years, it doesn't have to be theoretical.

Varying water demand at the levels associated with the new communities' demand has no impact on MWRA's ability to maintain required minimum stream flows. Whether MWRA system demand is 200 mgd (the baseline demand), 233 mgd (baseline water demand plus water demand attributable to employment and population in the existing service area plus 10 mgd to North Reading, Ashland, and Southfield plus other potential new communities), or 300 mgd (the level of demand in the 1980s), minimum in-stream flows and discharges required by the 1927 Acts of Massachusetts and 1895 Acts of Massachusetts and 1929 War Department permit are met. Instead, MWRA's controlled discharges are primarily dictated by statutorily required minimum releases, other operational practices that have been put in place to optimize water supply and water quality, and other environmental initiatives of MWRA.

Swift River

As addressed in the preceding pages, MWRA is required under both Chapter 321 of the 1927 Acts of Massachusetts and the 1929 War Department Requirement to release water to the Swift River. These permitted releases are not impacted by the addition of new communities at the level of demand contemplated. Empirical data shows that MWRA has been compliant with its minimum discharge requirements even when demand was considerably higher than the cumulative demands of the existing service area projected out to 2035 and the addition of 10 mgd from Ashland, Southfield, North Reading and other potential new communities.

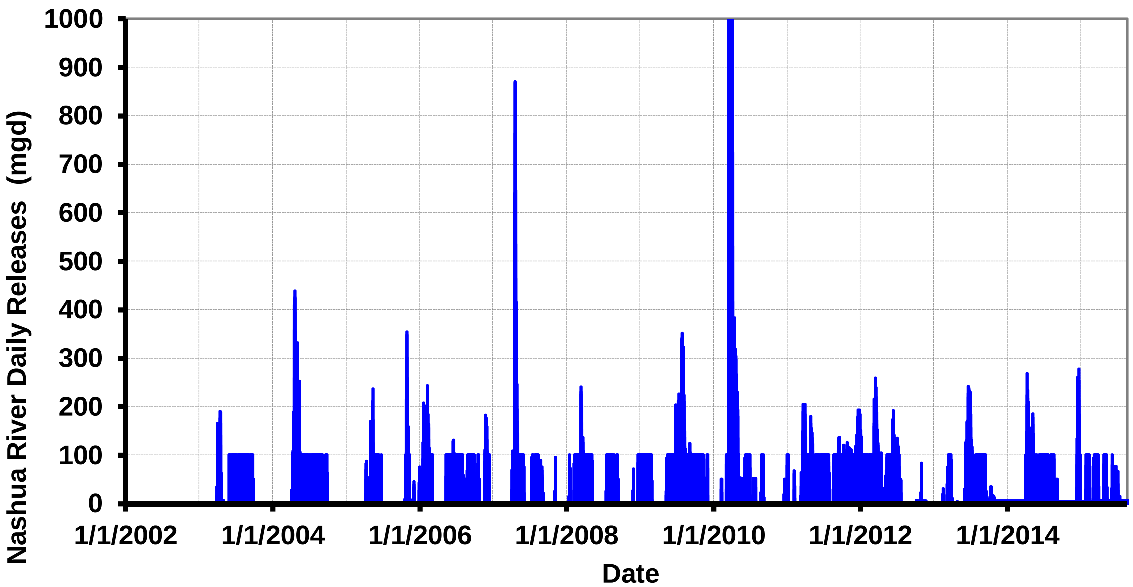
In addition, at the same time that it is supplying water to new communities, MWRA will be supplementing flows to the Swift River via the CVA-Fish Hatchery Pipeline and Hydropower project. The 6 mgd of water piped to the Hatchery would be used in the Hatchery's fish rearing facilities, which include a series of linear raceways. At the hatchery, water must be continuously sent through the raceways to maintain water quality characteristics, including dissolved oxygen and proper temperature. Ultimately, the water supplied and used in the Hatchery's operations would be discharged after treatment to the Swift River (the Hatchery borders the Swift River) to supplement existing flows in the Swift River. This increase in flows to the Swift River would be on top of the minimum discharges MWRA makes every day to achieve at least 20 mgd on the Swift River at Bondsville. This increase by approximately one-third results in an additional discharge of approximately 2 billion gallons per year.

Nashua River

MWRA currently discharges water to the Nashua River consistent with *Chapter 488 of the Acts of 1895* that requires that not less than 12 million gallons per week must be discharged into the South Branch of the Nashua River. Controlled releases to the Nashua River are currently made via a continuous release into the basin at the base of the dam. In late 2003, the MWRA replaced valves at the base of the dam providing staff with better operational control, and resulting in higher discharges to the Nashua River.

Transfers of water from Quabbin to Wachusett to meet water quality objectives may result in higher releases at Wachusett Dam in the summer. Since 2004, following the valve replacement, planned releases to the Nashua River have exceeded the minimum flow requirements (see Figure 9-11). Higher discharges in the summer as have occurred in recent years are the reverse of a natural hydrograph but are required based on MWRA's current understanding of reservoir water quality and MWRA's mission to provide reliable, high quality water.

FIGURE 9-12
NASHUA RIVER DAILY RELEASES



The additional demand of North Reading, Ashland, Southfield, and other potential new communities resulting in a combined demand of 10 mgd on the MWRA system will not in itself cause any change in how the Wachusett Reservoir is operated, nor in releases to the Nashua River.

Analysis and Evaluation of Impact of Proposed Interbasin Transfer on Water Dependent Uses

Effect on the hydraulic characteristics in the stream below the point of withdrawal, including but not limited to flood flows, the aquatic base flow, the 7Q10 flow if used in pollution abatement program, stage, velocity, sediment regimen, and flow values set for donor basin by the WRC in DEM river basin reports.

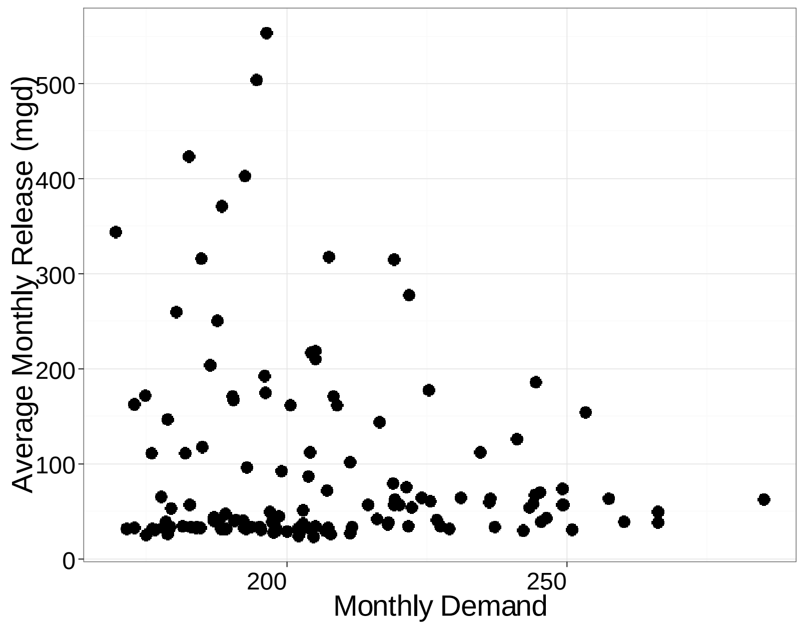
To understand how the stream below the point of withdrawal may or may not be affected, it is first helpful to present some background regarding current discharges from Quabbin Reservoir to the Swift River. Discharges from the Quabbin Reservoir to the Swift River at Winsor Dam occur at a powerhouse through a turbine bypass (the turbine is inoperable). Controlled discharges through the powerhouse are limited to approximately 100 mgd. Typically flows discharged at the powerhouse are limited to flow releases to satisfy the Acts of Massachusetts and the War Department permit, as discussed above. Flows may also occur over the spillway that functions as an overflow outlet when the reservoir is at full capacity.

The reservoir has been historically controlled to maximize safe yield and to assure water quality, at the same time as satisfying the regulatory requirements noted above. When full, the Reservoir has a capacity of 412 billion gallons. In terms of reservoir levels, normal operation of Quabbin Reservoir is considered to be 80-100% full, varying seasonally. If the reservoir is close to full and a storm event occurs, excess water may be spilled over the spillway down the Swift River. There have also been extended multi-year periods when no spillway discharges have occurred.

MWRA's controlled releases are significantly greater than the estimated natural 7Q10 flow as a result of the 20 mgd requirement at Bondsville. Rather than low August flows, the War Department permit frequently requires higher releases in the summer months in response to the Montague gage on the Connecticut River, for when flows drop below trigger levels on the Connecticut, MWRA must release either 45 or 70 mgd.

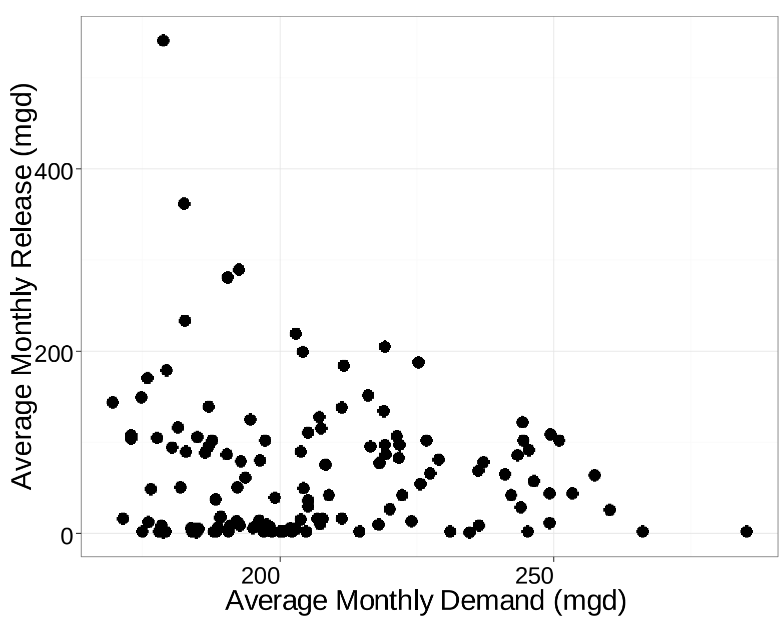
Variability in Swift River flows is attributed to operational practices in a given year, the varying War Department permit releases, the use of the spillway as the reservoir nears full, as well as climatic conditions, and this variability will remain, with or without the supply of 10 mgd to new communities. This is illustrated in Figure 9-13, which shows demands over the years, plotted against discharges to the Swift River by month (discharges/flows as measured by USGS West Ware Gage one mile downstream of the Quabbin Reservoir). Discharges include releases to satisfy mandated releases (up to 70 mgd) and spills (generally, discharges in excess of 70 mgd). As the figure shows, at demands varying between 200-240 mgd, there is no statistically significant relationship between discharges to the Swift River and demand.

FIGURE 9-13
QUABBIN RESERVOIR



Regarding the Nashua River, Figure 9-14 shows monthly demands for the period 01/01/2004 to 12/31/2014 plotted against monthly discharges to the River. As the figure shows, there is no statistically significant relationship between discharges to the Nashua River and MWRA water system demand for demands varying between 200-240 mgd.

FIGURE 9-14
WACHUSETT RESERVOIR/NASHUA RIVER DISCHARGES



As previously concluded by WRC on past requests by other communities on Interbasin Transfer, impacts to the Aquatic Base Flow, 95% flow duration, flood flows and flow velocity will be minimal with the addition of new communities.

Effect on Anadromous Fisheries, Specifically Alewives, Searun Brook, Brown Trout, Smelt, and American Shad

If new communities are provided MWRA water, it will have no effect on anadromous fisheries, searun brook and brown trout, smelt and American shad. There are numerous downstream barriers to fish passage on the Swift and Chicopee Rivers, and the Swift River is not a component of the Connecticut River Anadromous Fish Restoration Program.

Effect on Resident Fisheries

The effect of flow on fisheries habitat was examined by Normandeau in 1977 through the development of a relationship between instream flow and an index of habitat availability called Weighted Usable Area (WUA). WUA versus flow relationships were generated for target organisms (the brown trout, brook trout, and rainbow trout) and target life stages and were developed over a range of spatial scales, from individual transect within individual mesohabitat units, mesohabitat types within study segments, to a generalized relationship for the whole river.

The conclusions of Normandeau's study were that the existing minimum flow standards were adequate to protect the Swift River trout fishery (as noted above, providing 12 mgd to new communities would not affect the minimum flows that MWRA must discharge to the Swift River). Normandeau's study also concluded that flows lower than 75-90 cfs (approximate ABF standards depending on how drainage area is defined) may provide somewhat better conditions for adult and juvenile brook trout, based on the observation that substantial, large, deep pools exist throughout the Swift River which would serve as habitat refuge for adult trout. The efficacy of pools as low flow refuges is enhanced by an abundance of overhanging and downed trees that contribute substantial amount of woody debris. WUA for juvenile brook trout appears to decline with increasing discharge. The Normandeau study also stated that facing higher discharges, juvenile brook trout could be expected to concentrate in low velocity areas along stream margins, which in the Swift River typically possess abundant quantities of overhanging and instream cover.

As noted above, providing water to North Reading and other new communities would not affect the minimum flows that MWRA must discharge to the Swift River. Existing instream flows will be maintained, and in fact increased with MWRA’s supply of 6 mgd of raw water to the McLaughlin Fish Hatchery. Irrespective of whether new communities are added to the MWRA system, MWRA has, however, undertaken actions and/or adopted goals to improve flow and habitat in the Swift River downstream of Quabbin Reservoir. These include but are not limited to:

1) Implementation, in the early 1990s, of continuous 24-hour discharges from Quabbin Reservoir into the Swift River all year around, in response to fishery concerns. In

prior decades, MWRA met its year-round 20 mgd minimum release requirement through releases 5-7 hours a day.

2) Revision of MWRA operations to more slowly ramp up the higher volume discharges made in the summer months, in response to a request of the Division of Fisheries and Wildlife.

3) Established coordination with the hatchery on water quality issues.

4) Developed operating procedures to reduce the impacts of warm water spills, by increasing the cold water release through the powerhouse diluting and cooling the spills, and adding stop logs to reduce the quantity of the warm water releases when flood control considerations would allow.

5) Collaboration between MWRA and Department of Fish and Game and Division of Fisheries and Wildlife construction of a pipeline to the McLaughlin Fish Hatchery to convey 6 mgd to the Hatchery to provide a consistent and reliable supply of cold water to the Hatchery. This will enhance fishery operations and in effect, result in an increased flow to the Swift River, as the Hatchery will replace its existing river withdrawals with MWRA water. MWRA will provide this water to the Hatchery free of charge.

Effect on Wetlands and Dependent Flora and Fauna

The current variation of flows would not be altered as a result of supplying Ashland and other new communities a total of 10 mgd. Considering that the quantity of MWRA water that would be distributed to new communities if they were to join the MWRA system is small in comparison to the capacity of the reservoir, and the fact that typical/minimum discharges through the powerhouse are governed by regulatory requirements, no perceptible effect on the reservoirs, river hydrology, and any adjacent wetlands and dependent flora and fauna is anticipated

Effects on Water Quality, Recreational Uses and Aesthetic Values, Values of Critical Environmental Concern, Areas Protected Under Article 97, and Designated Scenic Rivers

The Quabbin and Wachusett reservoirs offer unique combinations of natural, cultural and engineering history that attract hundreds of thousands of visitors each year for hiking, birding, fishing, picnicking and sightseeing. Public education programs at both reservoirs provide a variety of information about the reservoirs and watersheds, with a particular focus on water quality and conservation.

The reservoirs offer outstanding fishing. The reservoirs provide quality fishing opportunities both from shore (both reservoirs) or from boats (Quabbin only), and a wide variety of both cold and warm water fish species. In addition to the fishing opportunities in the reservoirs themselves, great fishing is also available in the ponds, rivers and streams both above the reservoirs and below the dams, and the Swift River below Winsor Dam supports a unique year-round "tail water" fishery, and is considered one of the premiere fly fishing locations in the state.

Several tributaries to the reservoirs provide wild trout and/or salmon fishing in natural or even wilderness settings.

The current values would not be altered as a result of supplying 10 mgd of water to North Reading as well as Ashland, Southfield, and other potential new communities, and no effects on water quality and recreational uses and aesthetic values are anticipated. MWRA's reservoir system will continue to be operated to maximize water quality, and will continue to be governed by an operating policy developed and supported by detailed modeling.

Supply of water to North Reading as well as Ashland, Southfield, and other potential communities totaling 10 mgd will not perceptibly affect reservoir elevation, or spillway discharges. However, admission of North Reading (as well as other new communities) would occur at the same time that MWRA will be conveying 6 mgd from the CVA to the Hatchery, so discharges downstream of the Quabbin reservoir would increase.

Effect on Existing and Planned Future Uses Dependent on Reservoir Levels

Admission of North Reading and any other new communities will have no effect on existing and planned uses dependent on reservoir levels and would have an imperceptible effect on existing and planned uses dependent on reservoir levels.

Effect on Hydropower Production

There are no hydropower projects on the Swift River downstream of Winsor Dam. On the Chicopee River, downstream of the Swift River, there is the Red Bridge Dam, the Ludlow Dam, Indian Orchard Dam, Chicopee Falls Dam and Dwight Dam. These Chicopee River hydropower projects are affected by flows from a much greater drainage area than just the Swift above Winsor Dam. From the Winsor Dam to the Swift River's confluence with the Ware River, the Swift River is 9.8 miles long and drains an additional 30 square miles. Downstream of the Ware and Swift Rivers' confluence, the Ware River becomes confluent with the Quabog River. In turn, the main stem of the Chicopee is formed by the union of the Ware River and the Quabog River. The Chicopee River has a total drainage area of 727 square miles. A 6 mgd increase in the Swift River below the Hatchery would translate to approximately 9 cfs increase in flow. This is small in comparison to the design flow for the downstream hydropower projects on the Chicopee (Past investigations by MWRA indicated that the design flows of the Chicopee River hydroelectric facilities ranged from approximately 250 cfs to approximately 900 cfs). These projects would be unaffected by the proposed withdrawal from North Reading and other new communities, but may marginally benefit by the additional water conveyed to the Hatchery by MWRA and discharged downstream, and the decrease in the Hatchery’s river withdrawals.

Effect on Present and Foreseeable Water Withdrawals within the Donor Basin

At the same time that MWRA is supplying North Reading and other new communities, it will be supplying water to the Hatchery, and in effect, increasing its minimum discharge to the Swift River. The McLaughlin Fish Hatchery withdraws approximately 6,000 gpm from the Swift River; the hatchery obtains another 1,500 gpm from wells. The current river withdrawal will be replaced by approximately 6 mgd which will be supplied by MWRA via a water pipeline to serve the Hatchery. After being fed to trout rearing pools, the effluent is treated and discharged back into the river. The hatchery is not a consumptive use: after treatment, virtually all water used at the hatchery is discharged back into the Swift River, so minimum flows in the Swift River below the hatchery would be at least 26 mgd (and even greater given flows from the contributing drainage area below Quabbin), every day except during periods of drought. Releases pursuant to the 1929 War Department permit will continue to be made.

No other present and foreseeable water dependent uses within the donor basin are anticipated as a result of provision of water to North Reading and other new communities based on the reasons and documentation cited above

Past and Authorized Transfers and Withdrawals

Chapter 488 of the Acts of 1895 established the original metropolitan water district. Successive acts of the legislature authorized further expansion. These statutes which preceded the Interbasin Transfer Act allow MWRA, as the successor to MDC, to exercise the rights to use the waters of the Swift, Ware, and Nashua rivers for water supply and to extend the water supply to additional cities and towns. Chapter 375 of the Acts of 1926 authorized the Metropolitan Water Supply Commission (a predecessor to the MWRA) "to divert into the Wachusett reservoir . . . the flood waters . . . of the Ware River . . . for the purpose of extending and increasing the water supply of the metropolitan water system, and of such cities and towns not members of the metropolitan water district as may hereafter require water from said system . . .". Chapter 321 of the Acts of 1927 also authorized the same commission to construct such tunnel, aqueduct and diversion dam structures as would create a storage reservoir in the Swift River valley (now the Quabbin Reservoir) "for the purpose of adding to, extending and further developing the additional sources of water supply of the metropolitan water system". The legislation provided further general authority to the commission to build such other future structures to become part of the metropolitan water system that in the commission's opinion "may be necessary for the additions, extensions and developments authorized by this act."

In 1984, when the Interbasin Transfer Act was enacted, the MDC water service area consisted of 44 communities, 42 of which were located outside the Chicopee and Nashua River Donor Basins. In 1984, the MDC water service area demand was approximately 330 mgd: these transfers were authorized pursuant to the Interbasin Transfer Act regulations, which defined the "Present Rate of Interbasin Transfer" to be the: "the hydraulic capacity of an interbasin transfer system which was authorized, constructed, and usable for water supply purposes without installation of additional facilities or change in any authority operating rule prior to the effective date of the Act."

In 1984 the MWRA was created. MWRA's Enabling Act, Section 8(d) and Operating Policy #10, Admission of New Communities to the Waterworks System allows new communities or other local bodies to join the system assuming that they first satisfy all prerequisites to admission, including receipt of applicable regulatory approvals. The Water Resources Commission determined that ITA approvals were required for Bedford, Stoughton, Wilmington, and Reading and accordingly, ITA approvals were sought and received (see Table 9-25). The

WRC considered the Dedham/Westwood Water District's admission to the MWRA grandfathered by the MWRA's Enabling Act and did not require ITA approval.

TABLE 9-25
COMMUNITIES ADMITTED TO THE MWRA REQUIRING INTERBASIN ACT APPROVAL

Community	WRC Approval Volume	Year Admitted to MWRA	MWRA Withdrawal at date of new community's admission to MWRA (5-year running average)
Bedford	1.75	1993	276.5 mgd
Stoughton	1.15 mgd	2002	254 mgd
Reading	2.1 mgd	2005	238.4 mgd
Wilmington	1.7 mgd	2009	238.4 mgd

Under the Water Management Act (WMA) MWRA is registered to withdraw a combined total of 312.82 mgd from the Nashua and Chicopee River Basins (186.7 mgd for the Chicopee River Basin and for 126.12 mgd in the Nashua River Basin. Pursuant to the WMA, registered volumes are based on "Existing Withdrawals", which means the average volume of water withdrawn from a particular water source during the five years prior to January 1, 1986. MWRA withdrew an average of 312.82 mgd from the Nashua and Chicopee River Basins during the five years prior to January 1, 1986.

Proposed Transfers

MWRA's proposed supply of water to North Reading as well as to Ashland, Southfield, and other potential new communities for a total of 10 mgd represents about six percent of the 130 mgd decrease in water demand that has occurred in the MWRA service area since the Interbasin Transfer Act was enacted.

The construction of Quabbin and Wachusett Reservoir obviously altered the normal hydrology of the river systems. As a result of minimum mandated releases to the Swift River, a steady flow of cold clear water now occurs during the times of year when most rivers and streams are experiencing higher temperatures and drastically reduced flows: this has greatly enhanced the trout fishery and recreational value of those river.

The analysis in the preceding pages documents that the proposed transfer will not affect system operation and MWRA's ability to reliably high quality water to its existing customers. Analysis indicated minimal drought action impacts at demand levels that assume projected growth and the addition of 10 mgd to new communities.

MWRA water system demand is considerably below Safe Yield and historic levels of demand. Not only is water supply more than adequate, robust infrastructure exists to serve North Reading, as other new communities at the level of demand contemplated.

Mitigation

The addition of North Reading, and other new communities, will not adversely affect in-stream flow, and therefore no proposed flow augmentation provisions, flow protection thresholds, or other measures are proposed to protect in-stream flow, as part of review under the Interbasin Transfer Act.

However, irrespective of the addition of North Reading, or Ashland, or Southfield, or any other new community, MWRA will be indirectly augmenting flow to the Swift River as a result of its collaboration with the MA. Department of Fish and Game and Division of Fisheries and Wildlife.

As noted previously, an additional 6 mgd would be discharged to the Swift River via a water supply pipeline to the McLaughlin Fish Hatchery through a new pipeline constructed by MWRA. The Fish Hatchery borders the Swift River approximately 1.4 miles downstream of the Quabbin Reservoir. MWRA will provide the Hatchery raw water free of charge, and after circulation through the Hatchery's raceways and treatment, water will be discharged to the Swift River. Raw water supplied via the pipeline will replace, and supplement, the Hatchery's current river withdrawals.

EO 385 – Minimizing Unnecessary Loss or Depletion of Environmental Quality and Resources

EO 385, Planning for Growth, requires that the Executive Office of Energy and Environmental Affairs consider the consistency of Agency actions with the provisions of EO 385 in its review of any project requiring the filing of an Environmental Notification Form pursuant to the Massachusetts Environmental Policy Act.

The Declaration of Policy in EO 385 contains the following provisions:

- Section 1. The Commonwealth shall actively promote sustainable economic development in the form of: a) economic activity and growth which is supported by adequate infrastructure and which does not result in, or contribute to, avoidable loss of environmental quality and resources, and b) infrastructure development designed to minimize the adverse environmental impact of economic activity.

- Section 2. The dual objectives of resource protection and sustainable development shall be pursued as much as possible through means other than new rules and regulations, such as proactive planning, interagency coordination, incentives and assistance to interested private parties as well as local and regional governments and organizations, and streamlining of regulatory processes so as to facilitate economic activity consistent with this policy.

Use of MWRA's large, multi-year Wachusett and Quabbin storage reservoirs to reduce or replace withdrawals from local sources in highly flow altered communities such as North Reading fits within both the SWMI framework and EO 385.

9.4.3.2 Receiving Basin

Communities and Water Districts That Will Use the Water to Be Transferred.

North Reading will use the water to be transferred from MWRA. The water will replace local sources and North Reading's purchases from Andover. The user base, including agricultural users, should not be negatively impacted by the transition since the water demand is already served under an existing IBTA. In the future North Reading could be used as an emergency connection for neighboring communities.

Discharge Location

Immediately upon connection to MWRA, all water used by North Reading will be discharged in town to the Ipswich River basin through individual septic systems or private treatment facilities, with the exception of the existing private connection to MWRA in the southwest corner of town.

Upon completion of the wastewater collection system recommended herein, most of the water imported to North Reading will be discharged in town to the Ipswich River basin through individual septic systems or private treatment facilities. A portion of the flow, up to 0.503 MGD, will be discharged to GLSD located in the Merrimack River basin.

As demonstrated in Table 9-2, Inter-Basin Transfer Act, within the summary, the net change of flow into the Ipswich River basin is an increase of 0.21 MGD as a result of the proposed IBTA. This increase may assist in the stabilization of base flows in the Ipswich River basin, but is not significant enough to alter the existing balance within the basin.

The transfer of wastewater to GLSD would occur under a secondary transfer since a portion of the imported water will be discharged to the Merrimack River basin where the GLSD treatment facility is located.

Impacts and Mitigation

Additional information on existing and future water use by the receiving community is discussed in Sections 3 and 5. Discussion of the impacts the recommended projects will have on the receiving basin are discussed in Sections 5, 7 and 9.

9.4.4 Inter Municipal Agreements

To secure the rights to utilize infrastructure owned by others and to dictate the terms of services provided by local communities, Inter Municipal Agreements (IMA) are required. The IMA will serve as an agreement including all required conditions to connection to a neighboring community. The IMA will include provisions for buy-in costs, required improvements and cost sharing, rate based service costs (O&M), and limits to the withdrawal/discharge.

North Reading will negotiate IMA with the following communities:

- GLSD to treat wastewater

- Reading to wheel water from MWRA to North Reading
- Andover to convey wastewater from North Reading to GLSD

9.5 SECONDARY BENEFITS

The projects included within the recommended plan are anticipated to provide the benefits targeted by the needs, alternatives, and impacts analyses, such as: improved water quality, reduced complexity to the water system, improved reliability to water and sewer users, improved water conservation.

The projects will also have additional benefits. Improvement to the public utilities is consistent with North Reading's goals for smart growth and sustaining the Town's industrial and commercial base. For example, providing a municipal sewer solution will increase the sustainability of existing businesses as well as promote new businesses which could not feasibly site onsite systems.

The connection from Reading to North Reading may allow Reading to formally abandon its back-up water supply. Currently Reading expends considerable effort to maintain its wells as a backup source. The connection from Andover to North reading and the inter-connection with Reading will facilitate this action.

9.6 PUBLIC PARTICIPATION

Public participation is an important part of the DEIR process. While not mandatory a series of workshops were conducted to provide information on the status of the Project as well as elicit feedback on the Project. A list of stakeholders was created at the beginning of the Project. These stakeholders along with the public were invited to attend three public workshops.

The following parties were identified as stakeholders:

- Secretary Maeve Vallely Bartlett; Executive Office of Energy and Environmental Affairs
- Department of Environmental Protection ; Commissioner's Office
- MassDEP/Northeast Regional Office; MEPA Coordinator
- Mass DOT - District #4 Office; MEPA Coordinator
- Massachusetts Historical Commission
- Merrimack Valley Planning Commission
- Metropolitan Area Planning Council
- Town of North Reading Board of Selectmen
- Michael Gilleberto; Town Administrator Town of North Reading
- Town of North Reading Community Planning Department
- Town of North Reading Conservation Commission
- Town of North Reading Health Department
- Town of Reading Board of Selectmen
- Robert W. LeLacheur, Jr., Town Manager Town of Reading

- Town of Wilmington Planning Department
- Town of Wilmington Health Department
- Town of Wilmington Conservation Commission
- Town of Wilmington Board of Selectmen
- Town of Reading Planning Department
- Town of Reading Conservation Commission
- Town of Reading Health Department
- Town of Andover Board of Selectmen
- Reginald S. Stapczynski; Town Manager Town of Andover
- Town of Andover Planning Board
- Town of Andover Conservation Commission
- Town of Andover Board of Health
- Natural Heritage and Endangered Species Program; Commonwealth of Massachusetts
- DCR; MEPA Coordinator
- Department of Public Health ; Director of Environmental Health
- Massachusetts Water Resource Authority; MEPA Coordinator
- Energy Facilities Siting Board; MEPA Coordinator
- Division of Energy Resources; MEPA Coordinator
- Ipswich River Watershed Association, Wayne Castonguay, Executive Director
- Martins Pond Association

The three meeting were organized as follows:

- Public Meeting #1: September 18, 2014
    - Project Background
        - Project History
        - Planning Tools
    - Project Objectives and Goals
        - Water
        - Wastewater
    - Project Scope
        - Alternatives
        - Permitting

- Public Meeting #2: June 25, 2015
    - Water Needs Recap
        - Updates and Clarifications from last Meeting
    - Water Alternatives Analysis
        - Alternatives Screening
        - Selected Alternatives
    - Wastewater Needs Analysis
        - Scoring Matrix Methodology
        - Results
    - Wastewater Alternatives Analysis
        - Preliminary Screening
        - Potential Alternatives

- Public Meeting #3: February 4, 2016
  - Water Alternatives Analysis
    - Selected Alternative Summary
  - Wastewater Alternatives Analysis
    - Selected Alternative Summary
  - Recommended Plan
    - Water and Wastewater Plan
    - Cost & Financial Plan
    - Implementation Schedule
    - Permitting
  - Environmental Impacts
    - GHGs, Stormwater
    - Mitigation

Copies of the presentations for each meeting along with the attendance sheet for each meeting are included in Appendix B.

9.7 NON-STRUCTURAL RECOMMENDATIONS

In addition to the projects included in the recommended plan, public outreach and educations are goals for North Reading. Through public outreach, the Town hopes to improve water conservation in town including information fliers in water bills, workshops, and rebates for low flow water fixtures.

North Reading also aims to improve understanding and maintenance of existing septic systems for residents and businesses outside of the needs areas. Through public outreach, the Town will educate septic owners of proper maintenance, solutions to failing systems, and alternative technologies for properties where traditional systems are not the best solution.