WATER SUPPLY AND DEMAND ASSESSMENT IN RELATION TO EXELON POWER 'WEST MEDWAY II' PROJECT

FOR
TOWN OF MILLIS, MA

REVISION 2: MARCH 11, 2016

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WATER SUPPLY AND DEMAND ASSESSMENT
IN RELATION TO
EXELON POWER 'WEST MEDWAY II' PROJECT

REVISION 2

Kleinfelder Project Number: 20162545.001A

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EXECUTIVE SUMMARY

Purpose

Kleinfelder was retained by the Town of Millis (Town) and Exelon West Medway II, LLC (Exelon) to complete an assessment of the feasibility of the Town providing potable water supply to the proposed Exelon West Medway II Project by selling water from Millis to the Town of Medway.

Summary of Major Findings

Kleinfelder's assessment with regards to water demand and supply for the proposed West Medway II Project focused on assessing the adequacy of the Town of Millis' water system. All findings are discussed in detail in this evaluation report and are summarized below. See Section 1.1.4 for definitions of the terms used in this summary.

Exelon Water Needs (see Section 2.3.2)

The Exelon water needs used for this analysis differ somewhat from those used in Kleinfelder's analysis for the Town of Medway. The Exelon water needs used for this current analysis are updated volumes based on data presented in the *Draft Environmental Impact Report (*Epsilon, 2015) or provided directly by Exelon's representatives. The estimated average annual water use for the proposed Exelon facility is 95,206 gallons per day (gpd) or 0.095 million gallons per day (MGD) with a three-year rolling average of 68,880 gpd (0.069 MGD) according to the *Draft Environmental Impact Report*. Exelon will supply 51,840 gpd using an on-site well, therefore, the proposed Exelon facility should require an average daily supply of 43,366 gpd (0.043 MGD) from the Town of Millis. Based on information provided by Exelon representatives, Exelon is also requesting a 10% safety factor (T. Sanford, 2015). Therefore for the purposes of this evaluation, the average daily demand of the proposed Exelon facility is 47,703 gpd **(0.048 MGD**). According to Exelon representatives, the highest daily maximum facility water use is 190,000 gpd (**0.190 MGD**), which was utilized for Kleinfelder's assessment of maximum demand as a worst case scenario (for example if the well was out of service). However, in general, it is anticipated that the on-site well at the proposed facility will supply 51,840 gpd to the proposed facility, and the proposed Exelon facility will require a maximum daily demand of 138,160 gpd (0.138 MGD) from the Town of Millis.

Available Supply from the Town of Millis (see Section 2.2)

The Town of Millis draws drinking water from six local groundwater supply wells. The Town has discretion to pump these wells in any combination to meet system demands, provided the following three requirements from the Town's current (2010) Water Management Act (WMA) permit are met:

1. The maximum average daily withdrawal volume from all six wells combined is less than or equal to 0.80 MGD over the course of a calendar year;
2. No groundwater sources are pumped above their safe yields shown in Table ES-1 at any time.
3. The Town of Millis must cease use and operation of Wells 5 and 6 when stream flow in the Charles River falls to 0.21 cubic feet per section per square mile (13.80 cubic feet per second) as measured at the USGS gauge #01103280, except when selling water to the upstream municipalities located in the Charles River Basin.

The WMA permit annual average withdrawal limit of 0.80 MGD is for "Period 1", the initial 5-year term of the Permit.[1]

The sum of the individual wells' safe yield provides the maximum total daily withdrawal available of 4.33 MGD to the Town should it need to meet atypical peak or emergency demands (i.e. firefighting) on a short term basis. It is also important to note that anytime the Town pumps above the permitted average daily withdrawal limit, enough corresponding days where pumping is below the average will be necessary to ensure that the annual average of 0.80 MGD is met.

The Town's available water supply is summarized in Table ES-01 using the terms Normal Daily Output (NDO) and Maximum Daily Output (MDO). It is important to note that these terms are a conservative estimate of the current capacity of the wells to perform, not the current demand of the water system.

NDO estimates what the wells could reliably produce to meet average daily demand during a time of elevated (but not maximum) demand. This metric has been used to quantify the pumping rate that the wells and the aquifer can safely sustain during an extended period of higher demand in the future. As pumping test performance records were not available, NDO values were derived from recent daily pumping records provided by the Town of Millis. The values were derived from the average of actual daily pumping rates in 2014 and 2015 for the summer period (July – September) at each well. Well 4 was out of service during most of the summer of 2015 and was restored to service in September 2015. The Draft Report had used a higher value of 0.884 MGD based on summer 2015 pumping data, with the exception of Well 4 (used 2014 data).

Table ES-01: Available Water Supply

Source Name	WMA Permit Maximum Daily Withdrawal (MGD)	Available Supply (MGD)	
		Maximum Daily Output[2]	Normal Daily Output[3]
Well 1	0.72	0.677	0.173
Well 2	0.50	0.383	0.098
Well 3	0.75	0.936	0.259
Well 4	0.86	0.842	0.115
Well 5	1.50[1]	2.123[4]	0.134[4]
Well 6			
Total	**4.33**	**4.961**	**0.779**

Notes:
WMA: Water Management Act
MGD: million gallons per day

(1) Wells 5 and 6 have a maximum wellfield capacity of 1.50 MGD and the operation of the wells is restricted by Permit conditions linked to streamflow in the Charles River.
(2) Maximum Daily Output values were provided by the Town of Millis (J. McKay, December 2, 2015; J. McKay, December 3, 2015). It is noted that these are the maximum well yields and that the Town's SCADA system limits the wells so that the Permit Daily Maximums are not exceeded.
(3) Normal Daily Output was calculated from summer 2014 & 2015 daily pumping records provided by the Town of Millis (J. McKay, November 18, 2015). Well 4 was out of service during most of the summer of 2015.

[1] The WMA permit annual average withdrawal limit for "Period 2" is 0.99 MGD. The WMA permit further states that access to water withdrawals for Period 2 and beyond is contingent upon MassDEP completing a 5-Year Review or a permit amendment. MassDEP has stated its intent to complete the 5-year review in 2018.

The term maximum daily output (MDO) has been used in this report to describe an estimate of the wells' ability to meet future maximum demands. Maximum Daily Output (MDO) values are ideally derived from flow tests to rate the well's current maximum 24-hour capacity. However, most wells did not have recent well inspection and flow test reports available. Accordingly, MDO values for the wells (provided by the Town of Millis Public Works) were derived from recent (2015) data on daily total withdrawal and total run time at each well. These values are assumed to be the maximum daily supply for the Town of Millis for the purposes of Kleinfelder's assessment. Kleinfelder recommends that these values be confirmed by flow testing via a licensed well contractor. The Town is limited via SCADA controls to pumping the permit maximum of 4.33 MGD.

The Town of Millis operates four Water Treatment Facilities (WTF) with a total capacity of 4.10 MGD as summarized in Table ES-02.

Table ES-02: Water Treatment Facility Capacity[1]

Source Name	WTF	WMA Permit Maximum Daily Withdrawal (MGD)	WTF Capacity (MGD)
Well 1	George D'Angelis WTF	0.72	1
Well 2		0.50	
Well 3	Well 3 WTF	0.75	0.74
Well 4	South End Pond WTF	0.86	0.86
Well 5	Norfolk Road WTF	1.50[2]	1.5
Well 6			
	Total	**4.33**	**4.10**

Notes:
WMA: Water Management Act
WTF: Water Treatment Facility
MGD: million gallons per day

(1) Information obtained from Town of Millis, *Water System Master Plan* (W&C, 2010), unless otherwise noted.
(2) Wells 5 and 6 have a combined Maximum Authorized Daily Volume of 1.50 MGD and the operation of the wells is restricted by streamflow in the Charles River.

Demand Projections (see Section 2.3)

Near Term Demand Projections- Average Day: The Town of Millis' average daily demand (ADD) has trended downward from 2003 to 2008 and remained fairly flat during the past six years. Based on the daily pumping records for 2015, the ADD for 2015 is 0.665 MGD. To estimate the Town's near term future (2018) ADD, the demands for development projects provided by Millis were added, assuming that all would be online by 2018 prior to Exelon being online. The requested supply for Exelon (0.048 MGD) has the potential to raise the Millis 2018 ADD to 0.738 MGD. Millis' 2018 projected demand (with and without Exelon) is shown in Table ES-03.

Table ES-03: Estimated Current & Near Term Future Millis ADD	
Source	**ADD (MGD)**
Millis 2015 ADD	0.665[1]
Millis Development Projects online by 2018	0.025[2]
Total Projected Millis 2018 ADD	**0.690**
Exelon ADD by 2018	0.048
Total 2018 ADD with Exelon	**0.738**

Notes:
ADD: Average Daily Demand
MGD: million gallons per day

(1) 2015 ADD based on daily pumping records (J. McKay, November 18, 2015 and February 4, 2016)
(2) Demands associated with development projects were provided by the Town of Millis (C. Aspinwall, February 4, 2016).

Near Term Demand Projections- Max Day: Estimated Millis maximum daily demand (MDD) for 2018 (including pending and proposed residential developments, but excluding Exelon) is 1.277 MGD. The addition of Exelon's max day demand (0.190) would raise the MDD up to 1.415 MGD (with Exelon on-site well online) or up to a worst case maximum of 1.467 MGD (Exelon well off-line). With Wells 5 and 6 offline, the available maximum daily output from the Town of Millis system is reduced from 4.958 MGD to 2.838 MGD. Therefore, with its largest sources (Wells 5 and 6) offline the Town of Millis can still meet its current MDD with Exelon's additional MDD.

Longer Term Supply ADD Projections: Kleinfelder used population projection information from a variety of industry standard sources to develop a water needs forecast for Millis in accordance with the Massachusetts Water Resources Commission (WRC) 2009 Water Needs Forecast current methodology. All of the population projections predict a significant decline in Millis population due to various factors including an aging population and migration trend data. The available forecast data indicate an average of an 8% decline in Millis population between 2020 and 2035 (the latest year for which predictions available).

Using the most conservative population projection data set, the range of projected future demand is shown below in Table ES-04. This table presents both WRC Scenario 1 (most optimistic) and WRC Scenario 4 (most conservative):

Table ES-04: Summary of ADD (2020-2035) under 2009 WRC Scenarios 1 & 4				
Description	**Year**	**ADD (mgd)**	**Exelon ADD (mgd)**	**Total ADD (mgd)**
Scenario 1: Future residential water use rate at current value (57 GPCD) and future unaccounted for water at current value (7%)	2020	0.647	0.048	**0.695**
	2025	0.719	0.048	**0.767**
	2030	0.747	0.048	**0.795**
	2035	0.727	0.048	**0.775**
Scenario 4: Future residential water use at 65 GPCD and future unaccounted for water at 10%	2020	0.725	0.048	**0.773**
	2025	0.795	0.048	**0.843**
	2030	0.820	0.048	**0.868**
	2035	0.797	0.048	**0.845**

Scenario 4 results in a maximum ADD (including Exelon) of 0.868 for 2030, decreasing to 0.845 by 2035. The conservative estimate from Scenario 4 was used to evaluate supply adequacy.

Supply Adequacy (see Section 2.4)

As seen on Figure 4, Section 2.4, total ADD is projected to exceed the conservatively estimated supply (NDO of 0.779 MGD, based on 2014-2015 summer pumping data) sometime after 2020 due to the planned development projects coming online. This analysis incorporates several layers of contingency including: 1) the most conservative population estimates, 2) the most conservative demand projection calculation scenario, and 3) a conservative estimate of supply (NDO). The projected maximum ADD of 0.87 MGD in 2030 is lower than summer 2015 demand (0.884 MGD) and is close to higher historic year round demands (0.84 MGD in 2003) experienced by Millis in the past due to high levels of unaccounted for water (water loss) via leaks and main breaks. In the years since 2003, Millis' diligent efforts at leak detection and main repair have paid off, resulting in lower ADD in the range of 0.56 to 0.66 MGD from 2006 to present.

Based on currently available data and given continuation of best practices for maintenance of water infrastructure, Millis' supply is anticipated to meet future average daily demand. Confidence in the conclusions of adequacy would be increased by performance of well performance testing to verify the NDO yield values. Recommendations to maintain supply adequacy are provided in Section 3.

Assuming maximum daily output (MDO) rates for 24 hours per day, using all six of their wells running, Millis' supply availability (4.958 MGD) is adequate to meet the projected 2018 MDD (including development and Exelon) MDD of 1.467 as well as the projected future MDD (2030) of 1.708 MGD. Confidence in the conclusions of adequacy would be increased by well performance testing. Recommendations to maintain supply adequacy are provided in Section 3.

Assessment of Permitted Supply (see Section 2.5; Section 3.1)

Millis' WMA Permit authorizes sufficient water withdrawal to meet the estimated 2015 ADD and the projected 2018 ADD (including pending and proposed new residential development and Exelon). The WMA permit annual average withdrawal limit for "Period 2" (the current period) is 0.99 MGD. However, the WMA permit states that access to water withdrawals for Period 2 and beyond is contingent upon MassDEP completing a 5-Year Review or a permit amendment. It is anticipated that MassDEP will complete the 5-year review in 2018. When the review is completed, at a minimum, the limit is expected to increase to 0.84 to accommodate the new definition of baseline under revised Water Management Act regulations, which adds a 5% increase to the prior limit of 0.80 for Millis. Based on projected demands from 2025 onward that equal or exceed 0.84, Millis may need to request an increase in the Permit.

Evaluation of Storage Adequacy (see Section 2.6)

Based on the Millis *Water System Master Plan* (W&C, 2010), the Town of Millis has two active storage tanks. The Farm Street Tank has a capacity of 0.99 MG and the Walnut Hill Tank has a capacity of 0.55 MG. Based on available supply, the Town of Millis' system should be, and is, capable of meeting MDD each year without relying on system storage. With the Town's largest source offline (Wells 5 and 6) and Well 4 additionally offline (since elevated levels of manganese in Well 4 reportedly limit its use), the Town's MDO (for Wells 1, 2, and 3) would be 1.996 MGD. This available supply would be adequate to meet a future maximum Town MDD of 1.518 MGD

(based on 2030 ADD) combined with a max day demand of 0.190 MGD of the proposed Exelon facility, without relying on storage.

The Town's storage tanks, in conjunction with well pumps, are able to maintain pressures in the distribution system and adequate tank levels during peak hourly demand. The max additional flow required from Exelon (0.190 MGD) is incremental in comparison to the amount of available withdrawal from the Town's existing well pumps and therefore the tanks and pumps operating together are adequate for meeting the Town's peak current and projected demands.

Water Distribution Assessment (see Section 2.7)

Kleinfelder utilized the Town's existing water distribution system hydraulic model to evaluate the impacts to fire flow availability throughout the Town under the scenario of water being provided to the proposed Exelon project, via the Town of Medway's water distribution system. In addition, Kleinfelder utilized the model to identify the preferred interconnection location with Medway's system.

Available Fire Flow Analysis: Kleinfelder modeled the Present Day demand, 2018 demand (both with and without Exelon), and 2035 demand (both with and without Exelon) to determine whether available fire flow (AFF) may be impacted by the additional Exelon demand. Overall, AFF was found to remain relatively constant from the Present Day simulation to the 2018 simulation without Exelon, and actually improved to some degree due to the water main upgrade anticipated on Orchard Street. The addition of Exelon in 2018 also had very minor impacts, with a single node dropping from an AFF greater than 1,000 gpm to below this threshold. The model simulations for 2035 actually predict improvements relative to 2018, as population is projected to decrease over this period. As such, Kleinfelder's preliminary determination is that the requested Exelon demand will have little impact to the water distribution system's hydraulics and that no new fire flow deficiencies will be created.

The water system hydraulic model, as provided to Kleinfelder, did not include information for Needed Fire Flow (NFF). NFF indicates how much flow is required to a specific site (node) and is calculated in accordance with Insurance Services Office, Inc. (ISO) guidelines, which considers factors including but not limited to site use, building size, and occupancy limits. When modeled AFF is found to be less than NFF, it indicates that insufficient fire flow is available at that location. As NFF data was unavailable, and the determination of NFF was beyond the scope of this evaluation, Kleinfelder did not determine if there are any locations for which AFF is less than NFF.

Interconnection with Medway: The potential interconnection location at Main Street in Millis is served by an 8" water main that dead ends at a valve just prior to the town line with Medway. This area of Main Street in Millis has historically been identified as having deficient AFF and these low flows were confirmed via on-site fire flow testing and further modeling analysis completed by Kleinfelder as part of this evaluation. On the Medway side of the town line, Main Street is served by dual 6" and 12" diameter water mains. The potential interconnection location at Village Street in Millis is served by a 12" water main from the east and a 10" water main from the north. This redundancy and increased water main diameter results in an increased AFF at the interconnection, which was confirmed via fire flow testing and further modeling analysis completed by Kleinfelder. In Medway, Main Street is served by a 6" water main at this potential interconnection location. Modeling analysis of the 6" water main in Medway indicates that flow correlating to the peak Exelon demand of 250 gpm can be introduced to this main without adversely impacting the Medway distribution system.

Kleinfelder has preliminarily identified Village Street as the more favorable interconnection location, as it appears the Millis distribution system is able to provide a more reliable volume of water to this location under all system demand conditions. The Millis water model did not identify deficient fire flows in the vicinity of the Village Street interconnection under any of the peak hour demand scenarios evaluated. In summary, an interconnection between the two systems at Village Street appears to be feasible, provided that certain improvements are made, as discussed below.

Booster Station: In order for Millis to provide water to the Medway distribution system, a booster pumping station will be required. This was determined by analyzing the existing water storage facilities in each town. As both the Millis and Medway distribution systems operate in a single pressure zone and maintain two storage tanks, the hydraulic grade line (HGL) of each system is equal to the water elevation in the water tanks, with the maximum HGLs being equal to the overflow elevations of the tanks in each town. In Millis, the overflow elevation of the two tanks is ~294 feet, with the base elevations of the two tanks being 206 feet and 236 feet respectively. In Medway, the overflow elevation of the two tanks is ~366 feet, and the base elevation of the two tanks is 286 feet. As such, barring the unlikely scenario that both tanks in Medway are nearly empty (no storage), the HGL in Medway will almost always be greater than that in Millis, meaning that water will naturally flow from the Medway system to Millis without the presence of a booster pumping station.

Water Compatibility Evaluation: Kleinfelder noted that the chemical dosing and the operational pH range varied between the Millis and Medway water distribution systems. The Millis system maintains a lower target pH and chlorine dosing than Medway. The Medway system also treats its water with a fluoride and a polyphosphate chemical for sequestration and corrosion protection while Millis does not. Based on these differences, the introduction of water from Millis into Medway will effectively dilute the water in Medway when the booster station is operational. In order for Medway to retain its system's current finished water properties, adjustments to the treatment parameters may be needed. This will most likely be accomplished by the incorporation of chemical feed systems within the booster station. While the connection is considered feasible, additional evaluation is needed during the next project phase to determine the extent of the additional chemical dosing requirements and the cost to implement necessary controls.

Implementation Considerations (Section 3)

In order for Millis to provide potable water to Medway, permanent infrastructure improvements will be required at the Village Street interconnection. In particular, a booster pumping station and appurtenances would be required for water from Millis to overcome the higher hydraulic grade line of the Medway system. The chemical dosing and operational pH range varies between the Millis and Medway water distribution systems. Further evaluation into the water properties of the resultant "blended" water is recommended (Section 4).

The only apparent regulatory requirement would be the need for a system modification permit from MassDEP for adding the booster station. When receiving water from Millis, Medway would still be required to meet all of its current requirements as a Public Water System (PWS) including maintenance of the distribution system and water quality monitoring and reporting. An Inter-Municipal Agreement (IMA) should be used to define and detail the distribution of responsibilities between Medway and Millis for operations, maintenance and billing.

Conclusions & Recommendations (Section 4)

The Town of Millis' supply appears to be adequate to meet the projected near term (2018 and 2020) ADD which includes foreseeable developments and supply to Exelon. Despite projected decreases in population, however, projected ADD may exceed supply availability after 2020 due to permitted and planned future development. In order to safely and reliably meet projected ADD, the following steps are recommended for Millis:

- Continue to manage demand to maintain residential use and unaccounted for water at or below current standards.
- Institute and fund a comprehensive program of annual well inspection, testing, maintenance (cleaning) and recordkeeping.
- Closely track water quality at Well #4 and consider implementing iron and manganese controls (e.g. sequestering) or other treatment as needed to maintain reliable use of the source.

Kleinfelder recommends the following steps to implement an interconnection between Millis and Medway:

- Complete further analysis of the water quality blend that will occur with the mixing of the Millis water into the Medway system so as to determine additional treatment requirements (if any).
- Design and construction of a booster station for the interconnection between the two Towns as described in Section 3.
- Establishment of an Inter-Municipal Agreement between Millis and Medway, to include identification of flow and flow rates to be delivered to Medway, water quality targets to be maintained by each town, additional treatment requirements, determination of responsible party for operation and maintenance of the required booster pumping station, etc.
- Complete planned water main replacement in Orchard Street in Millis, from Walnut Street to Grove Street with a larger diameter water main. The model used for this analysis assumes the implementation of this replacement project in the scenario simulations for future demand. However, the Present Day model simulation utilized the physical conditions of the system as they currently exist and did not reflect the completion on the Orchard Street water main replacement project.

While not critical to the interconnection, the following additional improvements are highly recommended:

- Replacement of existing 6" diameter water main on Village Street in Medway with a larger diameter water main (8" minimum) from the proposed booster pumping station to Island Road.
- Further investigation of locations with deficient or suspected deficient AFF values in Millis to determine the need for system improvements.
- Prioritization of 6" diameter water main replacement projects to larger diameter mains (8" minimum) in both Millis and Medway as part of future water main replacement programs, to align with current MassDEP guidance for new water mains.

1. INTRODUCTION

Kleinfelder was retained by the Town of Millis (Town) and Exelon West Medway II, LLC (Exelon) to complete an assessment of the feasibility of the Town providing potable water supply to the proposed Exelon West Medway II Project.

The West Medway II Project is a proposed expansion of the West Medway Station, owned by Exelon Corporation. The expansion will include the construction of a new energy peaking facility, south of the existing facility, to be operated during times of peak energy demand. Exelon requests water from the Town of Millis for the proposed facility, mainly for process needs. The Draft Environmental Impact Report (Epsilon, 2015) proposes water be purchased from the Town of Millis and transported through an existing emergency connection between the Town of Millis and the Town of Medway to the current Exelon facility along Summer Street. Municipal water is proposed to be used for potable water (plumbing), service water, and fire suppression at the proposed facility. Also, the proposed facility will have a 500,000 gallon raw water storage tank and a 450,000 gallon finished water storage tank to store water required for processing needs and a dedicated volume for fire suppression.

It should be noted that Kleinfelder's findings in this report are solely based on its review of available information as provided by the Town, Exelon and its representatives, and from other sources of information as described herein. For this assessment, Kleinfelder utilized the average daily demand for the proposed Exelon facility as presented in Table 7-1 in the *Draft Environmental Impact Report (*Epsilon, 2015) and the peak day demand as presented by Tammy Sanford of Exelon during an October 26, 2015 meeting (T. Sanford, 2015).

1.1 Background

1.1.1 Town of Millis Background

The Town of Millis is approximately 12.2 square miles in size and is located in Norfolk County; bordered by Sherborn, Holliston, Medway, Norfolk, and Medfield (see Figure A1 in Appendix A). The Charles River forms the majority of the Town's southern border and all of the Town's eastern border. All of Millis lies within the Charles River major basin. Millis has a population of approximately 7,891 (2010 US Census), which is currently expected to remain flat or decrease (MAPC, 2014).

1.1.2 Town of Millis Water System

The Town of Millis provides drinking water to residents and businesses via six local groundwater supply wells installed in sand and gravel aquifer deposits (Table 1-1). The distribution system consists primarily of a single pressure zone, with the exception of a small boosted pressure system on Walnut Street. The distribution system is served by 42 miles of 2-inch to 12-inch diameter water mains and two (2) active water storage standpipes with a combined usable capacity of 1.54 million gallons.

Table 1-1: Existing Wells, Town of Millis, Massachusetts[1]						
Well #	**Location**	**Year Constructed**	**Screen Diameter (inches)**	**Depth (feet)**	**Pump (Hp)**	**Water Management Act Permit Maximum Daily Rate (MGD)**
1	7 Water St.	1952	24	60	15	0.72
2	7 Water St.	1961	24	50	10	0.50
3	Birch St.	1972	24	60	40	0.75
4	Orchard St.	1983	24	53	50	0.86
5	Norfolk Rd.	1999	24	57	40	1.50[2]
6	Norfolk Rd.	1999	24	62	60	
					Total	**4.33**

Notes:
Hp: horsepower
MGD: million gallons per day
(1) Unless otherwise noted, information was obtained from the Town of Millis Water System Master Plan (W&C, 2010). Design capacity information was not available.
(2) The WMA permit provides a combined Maximum Daily Rate for Wells 5 and 6; therefore, the values for Maximum Daily Output and Normal Daily Output for Wells 5 and 6 are combined for consistency.

Millis has a current WMA Permit annual maximum raw water withdrawal limit (registration + permit volume) of 0.80 million gallons per day (MGD) on an average daily basis, which is discussed in further detail in Section 2. The Town has system interconnections with three communities available for use during emergencies; the Towns of Medway, Medfield, and Franklin. For more detailed information regarding the Millis water system, refer to the Town of Millis, *Water System Master Plan* (W&C, 2010).

1.1.3 Regional Water Basin Description

Figure A-1, in Appendix A, illustrates the major water basins in the vicinity of the Town of Millis. The Town of Millis' source groundwater wells are located in two separate subbasins within the Charles River Basin (Bogastow Brook sub-basin and Charles Chicken Brook to Stop River sub-basin). The subbasins have been categorized under the Water Management Act Regulations (310 CMR 36.00) as Groundwater Withdrawal Categories 4 and 5, respectively, which requires that the Town minimize existing impacts to the greatest extent feasible, making conservation and water loss reduction in this area important priorities. The Town of Millis sources and associated subbasins are summarized in Table 1-2.

Table 1-2: Millis Supply Well & Subbasin Summary		
Well #	**Location**	**Charles River Subbasin Name & Subbasin ID #**
1	7 Water St.	Bogastow Brook, #21123
2	7 Water St.	Bogastow Brook, #21123
3	Birch St.	Chicken Brook to Stop River, #21133
4	Orchard St.	Bogastow Brook, #21123
5	Norfolk Rd.	Chicken Brook to Stop River, #21133
6	Norfolk Rd.	Chicken Brook to Stop River, #21133

1.1.4 Definitions

Kleinfelder utilizes several different key terms in this assessment which are defined in this section.

1.1.4.1 Water Management Act (WMA) Permit

The WMA became effective in March 1986. The WMA regulates the quantity of water withdrawn from both groundwater and surface water sources. Any proposed withdrawal in excess of an annual average of 100,000 gallons per day (gpd), or 9 million gallons in any three month period must apply for a permit.

The Town of Millis owns and operates its water supply and distribution system under the requirements of WMA Permit #9P4-2-20-187.03. The WMA permit was issued to The Town of Millis on March 1, 2010. The WMA permit establishes allowable withdrawal limits over a 20-year period, divided into four 5-year Periods. The specific limits made by this permit are discussed in this assessment.

1.1.4.2 Sustainable Water Management Initiative (SWMI)

The SWMI is a policy framework developed by the Massachusetts Executive Office of Energy and Environmental Affairs, which informs and guides the development of future WMA permits. SWMI is intended to balance the need to provide water to Massachusetts communities, while also recognizing the need for ecological health and promoting economic development. The framework for the SWMI was published in November 2012. MassDEP has begun to incorporate the SWMI principles into its WMA permitting process by conducting several rounds of pilot projects with communities in the Commonwealth.

1.1.4.3 Safe Yield

The term safe yield is often used to describe the total volume of water that may be withdrawn from a source without causing failure. Safe yield is also used to describe the maximum authorized daily withdrawal that is available from an individual groundwater supply. This limit is defined in the Town of Millis' WMA permit. For the purposes of Kleinfelder's evaluation, safe yield is the latter definition and specifically applies to maximum daily withdrawals (raw water pumped from the wells). This is a theoretical safe yield based on aquifer and well characteristics. Actual well yield depends on operational considerations and current well conditions and are described by normal and maximum daily output (see below).

1.1.4.4 Average Daily Demand (ADD)

The term average day demand is used throughout this evaluation and is abbreviated by ADD. The ADD is the total water supplied to a service area in the period of one year and divided by 365 days. The total water provided includes any water used for maintenance, hydrant flushing and any unaccounted for water that may not be used directly by the end user. Kleinfelder utilized the Town's daily pumping records provided by James McKay, the Town of Millis Public Works/Highway Department Deputy Director/Chief of Operations for the year 2015 to calculate the 2015 ADD (J. McKay, November 18, 2015 and J. McKay, February 4, 2016). Historic ADD was obtained from Millis' Annual Statistical Reports.

1.1.4.5 Maximum Daily Demand (MDD)

The term maximum day demand is used throughout this evaluation and is abbreviated by MDD. The MDD is the maximum water demand over a 24-hour period in the course of one year.

When evaluating the adequacy of supply sources to meet water demand it is critical to account for MDD. The Town of Millis' system should be capable of meeting the MDD each year without relying on system storage. Storage should be reserved to meet demands during periods of peak consumption and should provide the volume of water required for fire protection.

1.1.4.6 Normal Daily Output (NDO)

The term normal daily output (NDO) has been used in this report to describe an estimate of the system's ability (in this case the ability of the wells) to meet future elevated demand. This can be estimated from well pumping test performance records or well pumping records during periods of elevated demand. For this analysis, records of recent summer pumping were used as a conservative estimate of NDO, as discussed in Section 2.2.2.

1.1.4.7 Maximum Daily Output (MDO)

The term maximum daily output (MDO) has been used in this report to describe an estimate of the wells' ability to meet future maximum demands. For this analysis, records were used of the reported maximum operational capacity for a well pumping at 24 hours per day, as discussed in Section 2.2.2

1.1.4.8 Peaking Factor

The peaking factor is unit-less and calculated as a ratio of MDD to ADD and represents the relationship between MDD and ADD for the given community for water supply.

1.1.4.9 Peak Hour Demand

All community water systems experience a peak hour demand due to events like water main breaks, and fires. Peak hourly flows are supplied from storage constructed at appropriate locations within the distribution system and not from the design capacity of the sources of supply.

1.2 Information Sources Reviewed

Kleinfelder's scope of review was limited to documents provided by the Town of Millis and Exelon and its representatives. Specifically, those documents that relate to water supply and demand were reviewed for this study, as summarized below.

1. American Water Works Association, *Distribution System Requirements for Fire Protection*, Fourth Edition, 2008.
2. C. Aspinwall, 2015 (email communication, *Projects*, November 5).
3. C. Aspinwall, 2016 (email communication, *comments on report*, February 4).
4. E. Las, 2015 (email communication, Maximum Facility Demand, November 23).
5. Epsilon Associates, Inc. (Epsilon), 2016, *Final Environmental Impact Report: West Medway II*, February 1.
6. J. McKay, (November 18, 2015). Town of Millis Daily Pumping Records for 2011, 2012, 2013, 2014, and 2015.
7. J. McKay, 2015 (email communication, Maximum Daily Output for Wells Multi 1, 3, and 4, December 2).
8. J. McKay, 2015 (email communication, Maximum Daily Output for Wells 1, 2, 5, and 6, December 3).

9. D. Gilmore, 2016 (email communication, Town of Millis Daily Pumping Records for 2015, January 28).
10. Kleinfelder, 2015, *Water Supply & Demand Assessment in Relation to Exelon Power 'West Medway II' Project*, Town of Medway, MA, October 5.
11. Massachusetts Department of Environmental Protection (MassDEP), 2010, *Final 20 Year Permit Renewal*, Millis, Massachusetts, February 26.
12. *MassDEP, 2014, Guidelines for Public Water Systems,* Chapters 1-12, April.
13. MassDEP, 2004 - 2015, *Public Water System Annual Statistical Report Reporting Years 2003 through 2014*, Millis Water/Sewer Department, Millis, Massachusetts.
14. Metropolitan Area Planning Council (MAPC), 2014, *Population and Housing Demand Projections for Metro Boston, Regional Projections and Municipal Forecasts, Executive Summary*, January.
15. T. Reardon, 2015 (email communication, Inquiry – Town of Millis Population Projections, December 4).
16. H. Renski, 2010, *Economic, Demographic and Housing Trends in 495/MetroWest Region.*
17. T. Sanford, (October 26, 2015). Comments made during meeting on the West Medway II Project. Millis, Massachusetts.
18. S. Strate, 2015 (email communication, Inquiry – Town of Millis Population Projections, December 4).
19. M. Stone, 2015 (email communication, Millis – Medway- Exelon questions, December 7).
20. UMass Donahue Institute, 2013, *Long-term Population Projections for Massachusetts Regions and Municipalities*, November.
21. Woodard & Curran (W&C), 2010, *Water System Master Plan*, June.

2. WATER SYSTEM ADEQUACY

2.1 Approach

The ability of a water system to meet the water demand in the system must be evaluated from: (A) the adequacy of its supplies; (B) the adequacy of its treatment; (C) the adequacy of its storage; and (D) the adequacy of its distribution system to deliver the supply.

A. Water supply adequacy is evaluated based on how the supply is permitted and how the water system operates. In most cases, one of these two factors (permit limits or operational limits) is what determines the actual available supply.

    1. Compare the actual operational capacity of the sources with water demand (current and future) in the system.
    2. Compare the permitted withdrawal amount for the sources with water demand in the system.

B. Treatment adequacy is evaluated by comparing the available treated supply to current and future demands.

C. Storage adequacy is evaluated by comparing storage capacity to current and future demands.

D. Water distribution system adequacy is evaluated by determining the impacts of the proposed Exelon development to the Town of Millis' distribution system and its ability to supply adequate fire flow during peak hour demand in the system while maintaining adequate service pressure to customers.

2.2 Available Supply from the Town of Millis

As discussed in Section 1.1.2, the Town of Millis draws drinking water from six local groundwater supply wells. The groundwater withdrawals are permitted through the established WMA safe yield for each individual groundwater source. An evaluation of Millis' available permitted groundwater withdrawal is discussed in Section 2.5.

2.2.1 Safe Yield

The groundwater sources utilized by the Town of Millis include six local supply wells (Wells #1 through #6). The Town has discretion to pump these wells in any combination to meet their system demands, provided the following three requirements from the Town's WMA permit are met:

1. The maximum average daily withdrawal volume from all six wells combined is less than or equal to 0.80 MGD over the course of a calendar year;
2. No groundwater sources are pumped above their safe yields shown in Table 2-1 at any time.
3. The Town of Millis must cease use and operation of Wells 5 and 6 when stream flow in the Charles River falls to 0.21 cubic feet per section per square mile (13.80 cubic

feet per second) as measured at the USGS gauge #01103280, except when selling water to the Town of Franklin.

As was previously defined, "safe yield" is the maximum daily withdrawal that can be made at an individual groundwater source as set by the WMA permit so as to ensure that neither the well nor the aquifer contributing to it, are ever overstressed. As such, the sum of each well's safe yield provides the maximum total daily withdrawal available to the Town should it need to meet atypical peak or emergency demands (i.e. firefighting) on a short term basis. The safe yield for each groundwater source as well as the total maximum daily withdrawal are presented in Table 2-1. Note that the safe yield considers the effects of pumping during drought conditions and is therefore lower than the design capacity of the sources. It is also important to note that anytime the Town pumps above the permitted average daily withdrawal limit, enough corresponding days where pumping is below the average will be necessary to ensure that the annual average of 0.80 MGD is met.

Table 2-1: Safe Yield – Groundwater Sources

Source	WMA Permit Approved Max Daily Withdrawal (MGD)
Well 1	0.72
Well 2	0.50
Well 3	0.75
Well 4	0.86
Well 5	1.50[1]
Well 6	
Total	**4.33**

Notes:
WMA: Water Management Act
MGD: million gallons per day

(1) Wells 5 and 6 have a maximum wellfield capacity of 1.50 MGD and the operation of the wells is restricted by streamflow in the Charles River.

Actual well yields depend on operational considerations and current well conditions and are described by normal and maximum daily output (see below).

2.2.2 Supply Availability

In order to determine the Millis wells supply availability and their potential to meet an increased demand, the Normal Daily Output (NDO) and Maximum Daily Output (MDO) were estimated and are summarized in Table 2-2. It is important to note that these terms are a conservative estimate of the current capacity of the wells to perform.

NDO is term that estimates what the wells could reliably produce during a time of elevated (but not maximum) demand. This metric has been used to quantify the pumping rate that the wells and the aquifer can safely sustain during an extended period of higher demand in the future. As pumping test performance records were not available, NDO values were derived from recent daily pumping records provided by the Town of Millis, which capture the current well capacities and conditions (J. McKay, November 18, 2015). The values were derived from the average of actual

daily pumping rates in 2014 and 2015 for the summer period (July – September) at each well. Well 4 was out of service during most of the summer of 2015 and was restored to service in September 2015. The Draft Report had used a higher value of 0.884 MGD based on summer 2015 pumping data, with the exception of Well 4 (2014 data).

The summers of 2014 and 2015 represent periods of dry to normal conditions compared to average summer conditions (MassDCR climate index). The NDO of 0.779 MGD is likely a conservative estimate and could underestimate available supply. For example, the system was able to provide an average of 0.84 MGD over the course of 2003, when several large water main leaks led to an increase in demand. Also, in recent years when one or more wells have been offline for service for an extended period of time, Millis has had no problem keeping up with demand.

The term maximum daily output (MDO) has been used in this report to describe an estimate of the wells' ability to meet future maximum demands. For this analysis, records were used of the reported maximum operational capacity for a well pumping at 24 hours per day.. Ideally, these values are obtained by a licensed well contractor conducting flow testing of the well at various rates up to a maximum rate. MDO values for the wells were provided by the Town of Millis (J. McKay, December 2, 2015; J. McKay, December 3, 2015). These values were derived from recent daily total withdrawal and total run time at each well. MDO values for each well were derived from total withdrawal and total run time data collected on the following dates: September 5, 2015 for Well 6, October 10, 2015 for Well 5, October 11, 2015 for Wells 3 and 4, and October 14, 2015 for Wells 1 and 2. These values are assumed to be the maximum daily supply for the Town of Millis for the purposes of Kleinfelder's assessment.

Table 2-2: Available Water Supply

Source Name	WMA Permit Maximum Daily Withdrawal (MGD)	Available Supply (MGD)	
		Maximum Daily Output[2]	Normal Daily Output[3]
Well 1	0.72	0.677	0.173
Well 2	0.50	0.383	0.098
Well 3	0.75	0.936	0.259
Well 4	0.86	0.842	0.115
Well 5	1.50[1]	2.123[4]	0.134[4]
Well 6			
Total	**4.33**	**4.961**	**0.779**

Notes:
WMA: Water Management Act
MGD: million gallons per day

(1) Wells 5 and 6 have a maximum wellfield capacity of 1.50 MGD and the operation of the wells is restricted by streamflow in the Charles River.
(2) Maximum Daily Output values were provided by the Town of Millis (J. McKay, December 2, 2015; J. McKay, December 3, 2015). It is noted that these are the maximum well yields and that the Town's SCADA system limits the wells so that the Permit Daily Maximums are not exceeded.
(3) Normal Daily Output was calculated from summer 2014 & 2015 daily pumping records provided by the Town of Millis (J. McKay, November 18, 2015).Well 4 was out of service during most of the summer of 2015.
(4) The WMA permit provides a combined Maximum Daily Rate for Wells 5 and 6; therefore, the values for Maximum Daily Output and Normal Daily Output for Wells 5 and 6 are combined for consistency.

The actual available supply is limited by permit limits and operational infrastructure factors which prevent the Town of Millis from maximizing withdrawals, not the individual safe yield for each well as established by the WMA permit or available supply. Limitations on supply due to water treatment considerations are discussed below in 2.2.3. Limitations of the WMA permit on average daily withdrawal is discussed below in Section 2.5.

2.2.3 Supply Treatment Limitations

Based on information presented in the Town of Millis, *Water System Master Plan* (W&C, 2010), the Town of Millis operates four Water Treatment Facilities (WTF) with a total capacity of 4.10 MGD as summarized in Table 2-3.

Water pumped from Wells #1 and #2 is treated at the George D'Angelis WTF, which utilizes air stripping for volatile organic compounds and chemical injection for disinfection using sodium hypochlorite and fluoridation using sodium fluoride. Water pumped from Well #3 is treated at the Well 3 WTF and water pumped from Well #4 is treated at the South End Pond WTF. Both the Well 3 WTF and South End Pond WTF use chemical injection for pH control using sodium hydroxide and fluoridation using sodium fluoride. The Well 3 WTF has disinfection using sodium hypochlorite and the South End Pond WTF has emergency provisions for disinfection using sodium hypochlorite. Water from Wells #5 and 6 is treated at the Norfolk Road WTF, which uses chemical injection for pH control using sodium hydroxide, fluoridation using sodium fluoride, and disinfection using sodium hypochlorite.

Table 2-3: Water Treatment Facility Capacity[1]

Source Name	WTF	WMA Permit Maximum Daily Withdrawal (MGD)	WTF Capacity (MGD)
Well 1	George D'Angelis WTF	0.72	1
Well 2		0.50	
Well 3	Well 3 WTF	0.75	0.74
Well 4	South End Pond WTF	0.86	0.86
Well 5	Norfolk Road WTF	1.50[2]	1.5
Well 6			
	Total	**4.33**	**4.10**

Notes:
WMA: Water Management Act
WTF: Water Treatment Facility
MGD: million gallons per day

(1) Information obtained from Town of Millis, *Water System Master Plan* (W&C, 2010), unless otherwise noted.
(2) Wells 5 and 6 have a maximum wellfield capacity of 1.50 MGD and the operation of the wells is restricted by streamflow in the Charles River.

Based on the Town of Millis Water System Master Plan (W&C, 2010) and information provided by the Town of Millis, manganese levels at Well #4 are close to the MassDEP Secondary Maximum Contaminant Level of 0.05 mg/l. Therefore, the Town limits the operation of Well #4 to avoid any potential issues or customer complaints. Treatment may need to be required if the concentrations of manganese at Well #4 became a water quality issue.

2.3 Demand Projections

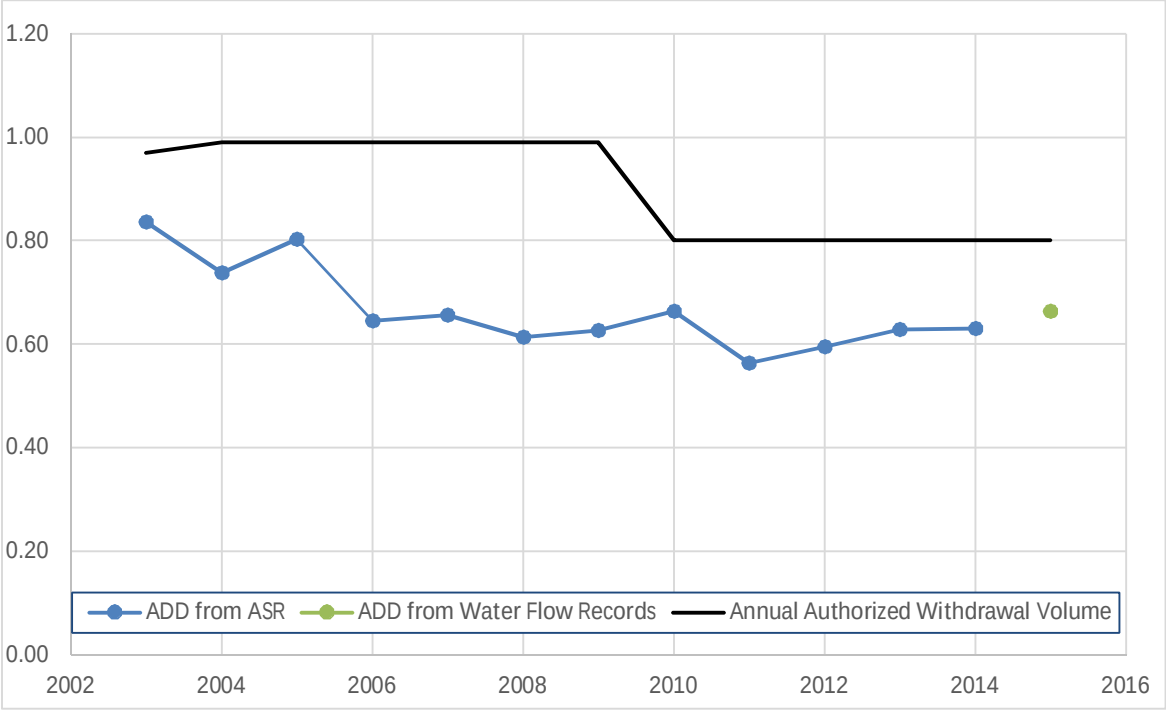
2.3.1 Town of Millis Water Demand

Water demands presented in this section specifically deal with historical and projected water demand for existing and future Town of Millis users, not including the proposed Exelon facility. The projected water demand for the proposed Exelon facility is discussed in Section 2.3.2.

2.3.1.1 Millis Historic and Current Average Daily Demand

A compilation of ADD based on a review of *Public Water System Annual Statistical Reports* for the Town of Millis since 2003 is shown below in Figure 1, along with the Town's WMA Permit limits. Based on Figure 1, ADD has trended downward from 2003 to 2008 and remained fairly flat during the past six years. Millis has reported residential gallons per capita use rates at below the state standard of 65 for the past five years. Millis has also reported unaccounted for water percentages below the 10% standard for the past 4 years.

Figure 1: Historic Demands and Authorized Withdrawal Volumes (MGD), Town of Millis



In order to determine the current ADD and MDD values for 2015, Kleinfelder utilized the Town's daily pumping records for the year 2015 (J. McKay, November 18, 2015 and J. McKay, February 4, 2016). Based on this information, the ADD value for 2015 is 0.665 MGD.

2.3.1.2 Millis' Near Term Future (2018) Average Daily Demand (ADD)

To estimate future ADD, it was necessary to identify system demands for the period when Exelon actually begins using water at the requested flows. Based on information provided by Exelon, Kleinfelder has assumed that the Exelon demands will be in effect during 2018. Therefore, in

order to project a near term future (2018) ADD value for Millis that accounts for possible development in the Town, Kleinfelder added the demand for several proposed development projects to the 2015 ADD. As summarized in Table 2-4, these demands included mainly residential developments which have been permitted or for which a water reserve has been established by the Town of Millis.

Table 2-4: Town of Millis Future Development Water Demands and Water Reserves[1]

Future Developments or Reserves	Permitted Title V Volume or Reserved Future Demand[2] (gpd)	Future Demand For Evaluation[3] (gpd)
(Online 2016-2018)		
Hickory Hill (Acorn & Farm)[4]	30,000	15,000
McDonough (Spring Street)	660	330
Roche (Spring Street)	2,640	1,320
South End Farm (25 of 38 units)[4]	7,526	3,763
Rockville Meadows	600	300
JOPA	5,000	2,500
Dmytrck	2,640	1,320
Kensington Pl. (1 of 12 units)[4]	333	167
Sub-Total (2016-2018)	**49,399**	**24,700**
(Online 2019-2030)		
South End Farm (13 of 38 units)[4]	3,914	1,957
Downtown Reserve	40,000	40,000
Glenn Ellen	65,108	65,108
Glenn Ellen Amenities	37,000	37,000
Kensington Pl. (11 of 12 units)[4]	3,667	1,833
Hickory Hill (Harkey Land)[4]	10,000	5,000
2019-2030 Sub-Total	**159,689**	**150,898**
Total	**209,088**	**175,598**

Notes:
gdp: gallons per day

(1) Demands associated with development projects were provided by the Town of Millis (C. Aspinwall, 2015; C. Aspinwall, 2016).
(2) Based on information from the Town of Millis, the permitted or reserved future demand values were based on Title V, with the exception of Downtown Reserve. The future reserve for Downtown Reserve is an estimate based on a full buildout of retail and housing (C. Aspinwall, 2015).
(3) Given the average residential per capita use, , half of the permitted or reserved Title V volumes were utilized with the exception of Downtown Reserve, Glen Ellen, and Glenn Ellen. Based on information from the Town of Millis, the permitted or reserved future demand for Glen Ellen amenities and Glen Ellen reflect a discounted value using Title V for senior housing (C. Aspinwall, 2015).
(4) Hickory Hill, South End Farm, and Kensington Pl. are development projects which are expected to span several years (ie: construction of some units between 2016 and 2030). Therefore, the permitted or reserved future demand for these developments is proportionate to the total number of units which will be constructed between 2016 and 2018 and 2018-2030, respectively.

Table 2-5 below summarizes the current and near term future demand for Millis, including these development projects. The projected near term ADD value for 2018 for the Town of Millis, including pending and proposed developments is 0.69 MGD.

Table 2-5: Estimated Current & Near Term Future Millis ADD Exclusive of Exelon West Medway II	
Source	**ADD (MGD)**
Millis 2015 ADD	0.665[1]
Development Projects Online by 2018	0.025[2]
Total Projected Millis 2018 ADD	**0.690**

Notes:
ADD: Average Daily Demand
MGD: million gallons per day
(1) 2015 ADD based on daily pumping records (J. McKay, November 18, 2015 and February 4, 2016)
(2) Demands associated with development projects were provided by the Town of Millis (C. Aspinwall, February 4, 2016).

2.3.1.3 Town of Millis Current and Future Maximum Daily Demand (MDD)

As shown in Table 2-6, the MDD in the Town of Millis system averaged 1.28 MGD from 2008 through 2014 based on a review of the *Annual Statistical Reports* for the Town of Millis. As discussed below in Section 2.3.1.4, the projected Town of Millis future ADD (including planned development) is estimated to be 0.797 MGD by 2035. As discussed in Section 2.3.1.2, Kleinfelder estimated Millis' near term ADD to be 0.69 MGD in 2018. A peaking factor of 1.85, which is the average peaking factor reported in the *Public Water System Annual Statistical Reports* between 2008 and 2014, was used to calculate a current MDD of 1.23 MGD. The peaking factor (1.85) was also applied to the ADD for 2035 to calculate a projected MDD of 1.474 MGD. Table 2-6 summarizes the historic and projected water use by the Town of Millis, as well as the source of the information.

Table 2-6: Historic and Projected Town of Millis Water Demand, Exclusive of Exelon				
Year	**ADD (MGD)**	**MDD (MGD)**	**Peaking Factor (MDD/ADD)**	**Data Source**
2008	0.61	1.16	1.89	Public Water System Annual Statistical Reports
2009	0.63	1.42	2.26	
2010	0.66	1.38	2.08	
2011	0.56	2.00	3.56	
2012	0.59	1.02	1.71	
2013	0.63	0.99	1.58	
2014	0.63	1.01	1.60	
Average 2008 – 2014	0.62	1.28	1.85[1]	
2015	0.665	1.23	1.85	ADD calendar year 2015 (J. McKay, November 18, 2015 & February 4, 2016)
2018	0.690	1.277	1.85	Kleinfelder projection see Scenario 4 as outlined in Section 2.3.1.4. Includes future development projects identified in Table 2-4 and excludes Exelon demand.
2030	0.820	1.521	1.85	
2035	0.797	1.474	1.85	

Notes:
MGD: million gallons per day
ADD: Average Daily Demand
MDD: Maximum Daily Demand
(1) The peaking factor from 2011 was not included in the calculation of the average peaking factor between 2008 and 2014 since it reflected a very large water main break and was not representative

2.3.1.4 Millis Longer Term Water Needs Projections

Kleinfelder used population projection information from a variety of industry standard sources to develop a water needs forecast for Millis in accordance with the Massachusetts Water Resources Commission (WRC) 2009 Water Needs Forecast current methodology. All of the population projections predict a significant decline in Millis population due to various factors including an aging population and migration trend data. The available forecast data project an average of an 8% decline in Millis population between 2020 and 2035 (the latest year predictions available). The full analysis is presented below in this Section.

Future water demands were calculated using the Massachusetts Water Resources Commission Policy for Developing Water Needs Forecasts for Public Water Suppliers and Communities and Methodology for Implementation, 2009. WRC uses forecasts of water needs to justify changes in permitted withdrawals under the Water Management Act (WMA) to "ensure an adequate volume and quality of water for all citizens of the Commonwealth, both present and future." The forecast methodology takes into consideration historic and existing water-use patterns, population projections, employment projections, and is consistent with water-use efficiency and conservation standards outlined in the Massachusetts Water Policy (EOEA 2004) and the Water Conservation Standards (EOEA and WRC 2006).

<u>Current Use</u>

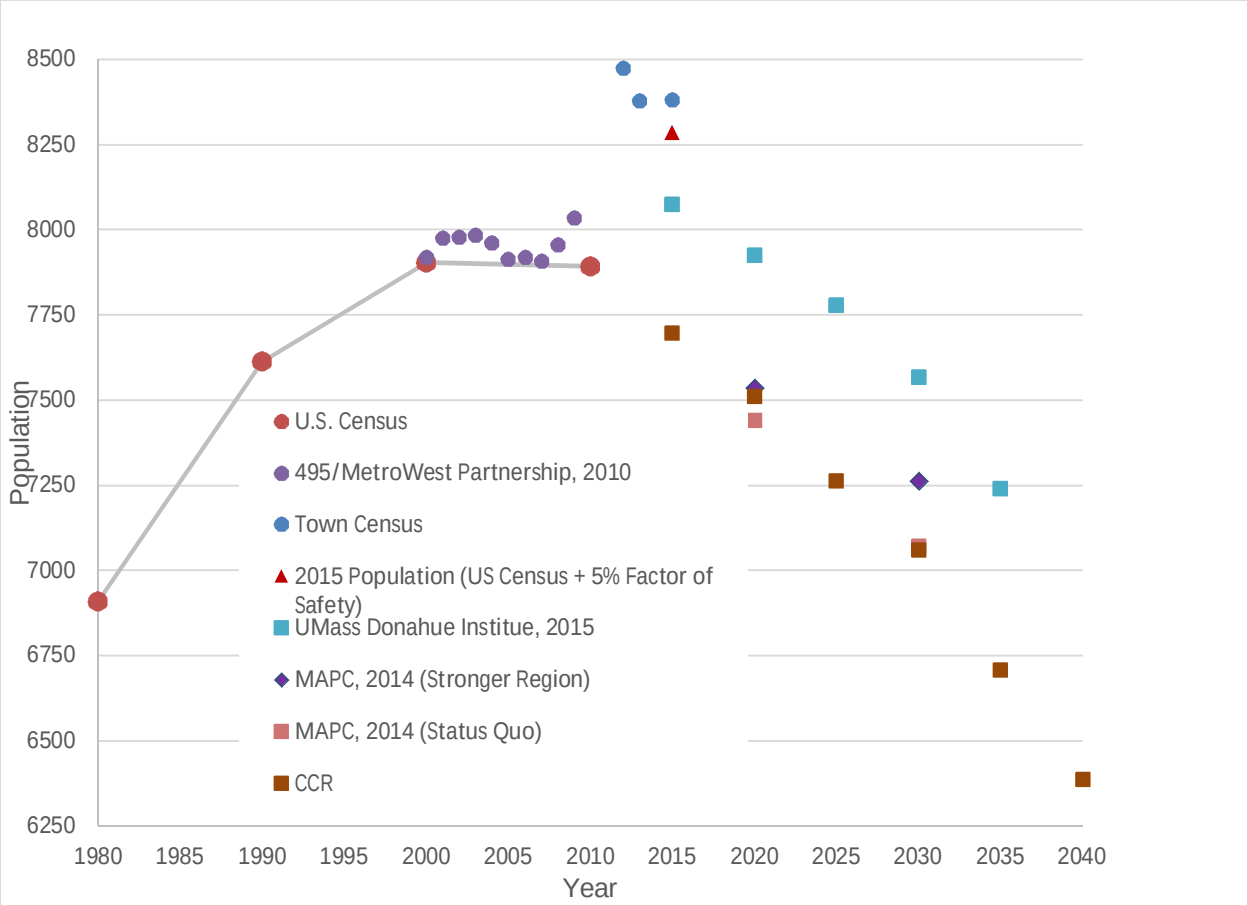
The current water use is a sum of estimated residential or household use, non-residential use (ie: commercial or industrial use), and losses due to treatment plant processing or unaccounted for water (ie: water main breaks, leaks, unmetered water). Current water usage data was obtained from the Annual Statistical Reports (ASR) provided to MassDEP by Millis.

<u>Population Data and Trends</u>

Projections of water use are determined based on projected changes in population, development, and water-use efficiency. Kleinfelder completed a review of available population data and projection models, and estimated projected population based on the data available (Figure 2). Data sources include two projections from a widely-cited regional planning agency, Metropolitan Area Planning Council (MAPC); and two projections from UMass Donahue Institute's Population Estimation Program, labeled in Figure 2 as UMass Donahue Institute, 2015 and CCR (cohort-change ratio).

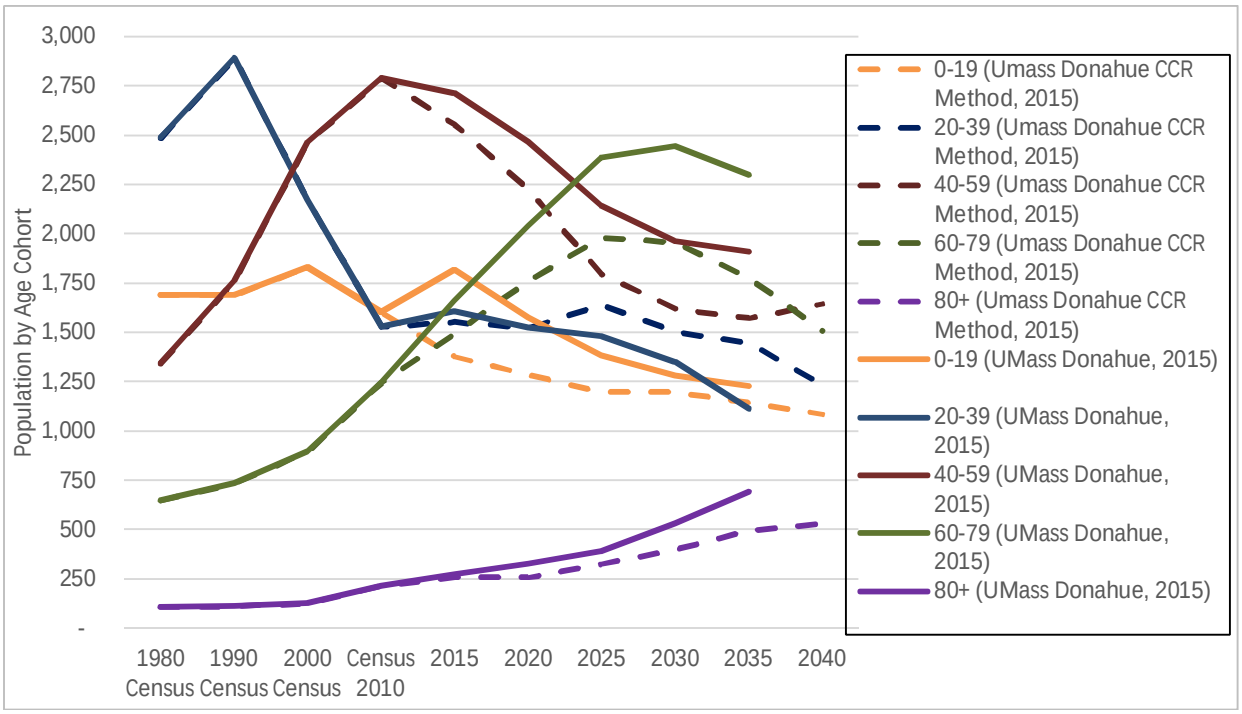
MAPC uses broad trends in Massachusetts and the local region to estimate population under two scenarios, Status Quo and Stronger Region. The Status Quo projection accounts for recent regional trends in birth rate, mortality rate, and housing occupancy to estimate future population from 2010-2040. The Stronger Region scenario assumes from 2010-2040, a population growth rate of 12.6% (compared to 6.6%), a 24% increase in the demand for housing (compared to 17%), and a 6.9% increase in the size of the labor force (compared to 0.4%). It should be noted that although the metro-west region is projected to grow under this model, municipal trends will be affected by local patterns and policies, including restrictive zoning, an aging population, and decreased preference among millennials for suburban living, all of which may translate to declines in population over time in both MAPC scenarios. This is certainly the case for Millis, which has an aging population and a trend towards smaller households.

Figure 2: Town of Millis – Population Data and Projections (1980-2040)



The UMass Donahue Institute Main Projection Series (labeled on Figure 2 as UMass Donahue, 2015) uses a similar framework as MAPC, analyzing recent regional trends to estimate future populations in the main projection series. Municipal-level trends are analyzed using Cohort-Change Ratios (CCR), an iterative method, which estimates rates of change in population for age-sex groups over five-year intervals based on historic data. Rapid population growth trends in Millis pre-2000 leveled off from 2000-2010, and current projections also take into account state-wide and regional trends of decreased in-migration. As shown in the CCR population by age projections (Figure 3), the only age groups increasing in the town from 2015 forward are those over age 60. The Town of Millis' aging population contributes to a decline in the projected fertility rate and an increase in the mortality rate over the projected timeframe. Migration trends, fertility rate, and mortality rate all contribute to a significant projected decline in Millis' population from 2015-2035.

Figure 3: Town of Millis – Population by Age



Projected Water Use

This evaluation takes into consideration the average daily demand for the projects that are currently permitted by the Town of Millis, and assumes that all future projects listed in Table 2-4 will be online during the ranges listed in Table 2-4. The additional ADD from new development from 2016-2018 and 2019-2030, is 0.025 MGD and 0.151 MGD, respectively. For the forecast period (2015-2035), Kleinfelder compiled available data and used the most conservative (highest) estimate for population between 2020 and 2035 (UMass Donahue Institute, 2015).

Water-use efficiency is modeled in four scenarios, per WRC methods, to project how changes in unaccounted for water (UAW) and residential water use in gallons per capita per day (GPCD) impact ADD over time. As shown in Table 2-7, the first scenario assumes residential water use and UAW are constant over time at base year levels, at 58 GPCD and 7.21% respectively. These values were calculated using the WRC methodology, using ASR reported data from 2012-2014. With these assumptions, the future total ADD is projected at 0.647 MGD (2020), 0.719 MGD (2025), 0.747 MGD (2030), and 0.727 MGD (2035).

The second scenario assumes UAW is 10% and residential water use is constant over time at 2014 levels. This scenario is used by WRC for public water suppliers which exceed the 10% UAW limit. The Town of Millis has been proactive in leak detection and repairs, and has maintained UAW rates under the 10% limit in recent years. Based on this historic data, provided that the Town of Millis continues to take steps to reduce UAW, it is possible that these assumptions would overestimate demand.

The third scenario assumes UAW constant at 2014 levels and residential water use at the 65 GPCD water conservation standard. This scenario assumes that public water suppliers which have not met the 65 GPCD residential water use limit will decrease their residential water use to

the standard, and in particular is for communities in a basin with higher levels of stress. Based on this historic data and provided that the Town of Millis continues to take steps to increase residential water use efficiency and implement water conservation policies, this scenario would overestimate demand.

The fourth scenario is the most conservative of the four and assumes UAW is 10% and residential water use is 65 GPCD. This scenario is for suppliers which exceed both UAW and residential water use limits. Based on ASR data from 2012-2014, Millis does not fall into this category for the justifications described above, however, this scenario provides a conservative estimate of demand and it sets upper limits based on water use standards.

Table 2-7: Summary of ADD (2020-2035) under 2009 WRC Scenarios 1 & 4

Description	Year	ADD (mgd)	Exelon ADD (mgd)	Total ADD (mgd)
Scenario 1: Future residential water use rate at current value (57 GPCD) and future unaccounted for water at current value (7%)	2020	0.647	0.048	**0.695**
	2025	0.719	0.048	**0.767**
	2030	0.747	0.048	**0.795**
	2035	0.727	0.048	**0.775**
Scenario 4: Future residential water use at 65 GPCD and future unaccounted for water at 10%	2020	0.725	0.048	**0.773**
	2025	0.795	0.048	**0.843**
	2030	0.820	0.048	**0.868**
	2035	0.797	0.048	**0.845**

The most conservative Scenario 4 estimate is used to evaluate supply adequacy (Section 2.4 below). Under Scenario 4, assuming water sales to Medway for the Exelon project (an additional 0.048 MGD), Total ADD will increase from 2015 until 2030, with a peak at 0.868 MGD. Total ADD will decrease to 0.845 MGD by 2035.

The Town of Millis requested a 50-year projection for this assessment. The planning period for feasibility studies is typically 20 years, which is represented in our evaluation provided. Extending the planning period beyond 20 years poses several challenges, particularly due to the uncertainty associated with the percent and duration of projected annual population decline in the Town of Millis. Parameters associated with population projection are complex and rely upon both demographics and economic development activity, among others. Although a complete build-out scenario can be determined on the basis of existing zoning, the period over which build-out would be achieved could not. Kleinfelder did not feel that we could provide meaningful projections as far out as the 50 years requested by the Town because the uncertainty on infrastructure demands would be so large.

2.3.2 Exelon Facility

2.3.2.1 Average Daily Demand (ADD) and Maximum Daily Demand (MDD)

The Exelon water needs used for this analysis differ somewhat from those used in Kleinfelder's analysis for the Town of Medway. The Exelon water needs used for this current analysis are updated volumes based on data presented in the *Draft Environmental Impact Report (*Epsilon, 2015) or provided directly by Exelon's representatives which was available after the Medway analysis was conducted. The estimated average water use for the proposed Exelon facility is

95,206 gallons per day (gpd) or 0.095 million gallons per day (MGD) with a three-year rolling average of 68,880 gpd (0.069 MGD) according to the *Draft Environmental Impact Report (*Epsilon, 2015). Exelon will supply 51,840 gpd using an on-site well, therefore, the proposed Exelon facility should require an average daily supply of up to 43,366 gpd (0.043 MGD) from the Town of Millis. Based on information provided by Exelon representatives, Exelon is also requesting a 10% safety factor (T. Sanford, 2015). Therefore for the purposes of this evaluation, the average daily demand of the proposed Exelon facility is 47,703 gpd (0.048 MGD).

According to Exelon representatives, the highest daily maximum facility water use is 190,000 gpd (0.190 MGD), which was utilized for Kleinfelder's assessment of maximum demand as a worst case scenario (for example if the Exelon well was out of service). However, in general it is anticipated that the on-site well at the proposed facility will typically supply 51,840 gpd to the proposed facility, and the proposed Exelon facility will require a maximum daily demand of 138,160 gpd (0.138 MGD) from the Town of Millis.

Including an on-site well at the Exelon facility, the total 2018 MDD for the Town of Millis would be approximately 1.415 MGD. Without the supply from the on-site well, the MDD of the proposed facility (0.190 MGD) would result in a total 2018 MDD of approximately 1.467 MGD

Table 2-8: Summary of Projected Town of Millis and Exelon Demands

User	Projected 2018 Demand[1] (MGD)		Projected 2030 Demand[2] (MGD)	
	ADD	MDD	ADD	MDD
Town of Millis System	0.689	1.277	0.820	1.518
Proposed Exelon Facility[3]	0.048	0.190	0.048	0.190
Total	**0.736**	**1.467**	**0.868**	**1.708**

Notes:
MGD: million gallons per day
ADD: Average Daily Demand
MDD: Maximum Daily Demand

(1) The Town of Millis System ADD and MDD are the projected 2018 values, which represent the addition of known development projects (excluding Exelon demand) as discussed in Sections 2.3.1.2 and 2.3.1.3.
(2) The Town of Millis System ADD and MDD values for 2030 are based on Kleinfelder's projections as discussed in Section 2.1.3.4. 2030 values were used rather than 2035 as they are more conservative.
(3) The Exelon facility ADD values assume the on-site well would provide the estimated volume of water (51,840 gpd) to the Exelon facility as identified in the *Draft Environmental Impact Report (*Epsilon, 2015). The Exelon facility MDD values does not include the estimated volume of water (51,840 gpd) supplied from the on-site well to the Exelon facility.

2.4 Evaluation of Supply Adequacy

The current available supply from the Town of Millis was discussed in Section 2.2. Estimates of existing and future demand for the Town of Millis and the proposed Exelon facility were discussed in Section 2.3. This section presents the comparison between available supplies in relation to projected demands (including the Exelon facility). WMA Permit limits are discussed in more detail in Section 2.5.

2.4.1 Supply Adequacy to Meet Average Day Demand (ADD)

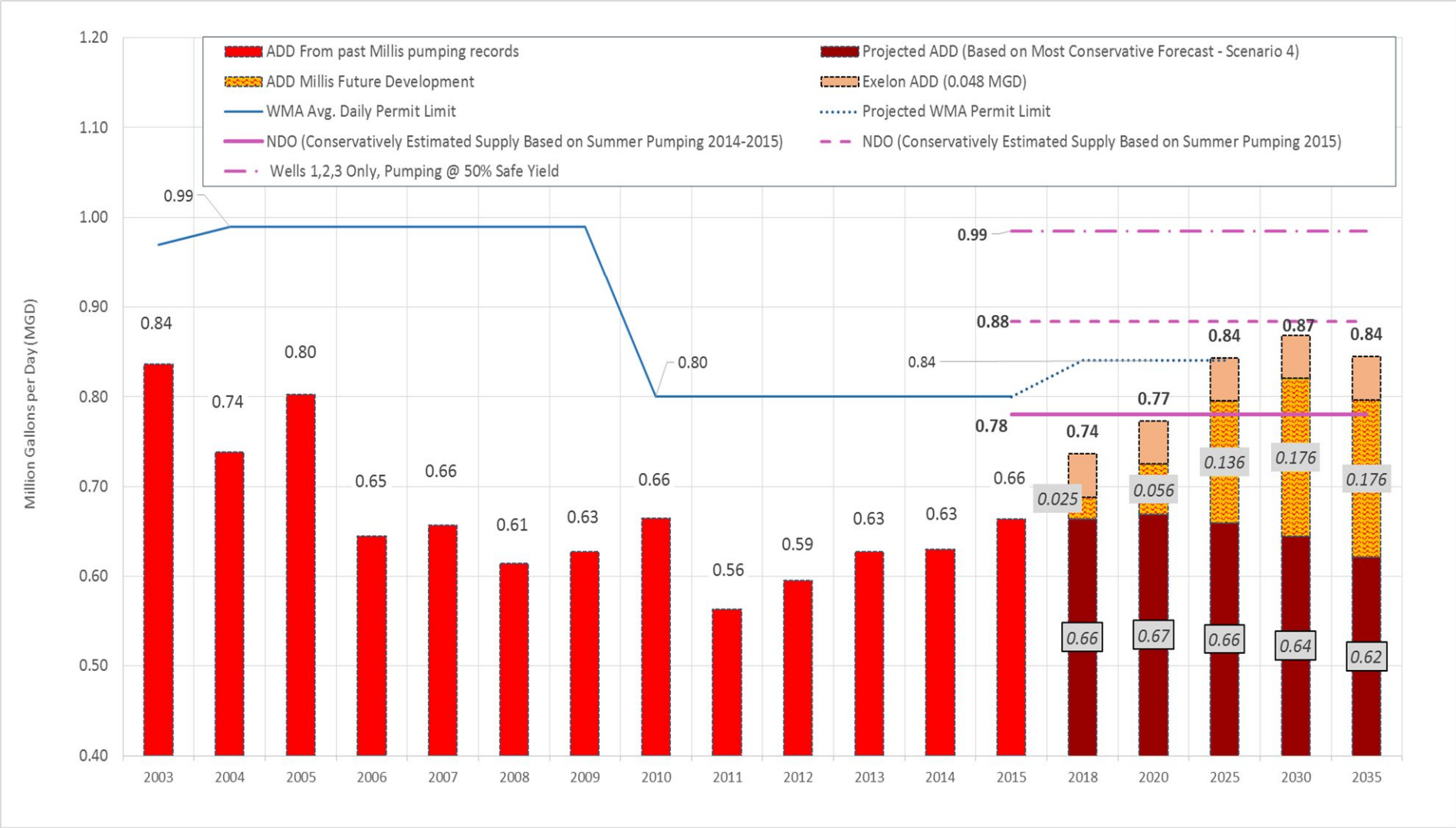
Figure 4 graphically summarizes Millis' supply in comparison with projected future average day demand. Permit limits are also presented for reference and are discussed further in Section 2.5. The combination of historic and projected future ADD presented reveals certain trends in water use that can inform decisions around supply adequacy and sale of water. Millis has experienced some years of historic demand that are similar in magnitude to the projected future (2025 and beyond) ADD. In 2003 and 2005, Millis used 0.84 and 0.80 MGD, respectively. These episodes of high demand were driven by high levels of unaccounted for water (water loss) via leaks and main breaks (Millis ASRs). In the years since then, Millis' diligent efforts at leak detection and main repair have paid off, resulting in ADD in the range of 0.56 to 0.66 MGD that can be seen from 2006 to present. While population has remained flat during the past 15 years (Figure 2), ADD has fluctuated, demonstrating the importance of leak detection and main repair to control reduce water loss and manage ADD.

The effect of Millis' aging population and future population decline is seen on the bottom bars for projected ADD in Figure 4, which decrease from 2020 to 2035. This portion of the projected ADD is based on the most conservative water needs forecast scenario which uses residential water use rates that are 15% higher than current levels and unaccounted for water about 40% higher than current levels. In addition, although the baseline population of Millis will decline, there are a number of planned developments expected to be built over the course of the next 15 years that are projected to increase Millis' overall average day demand to a high of 0.82 MGD by 2030 (excluding Exelon) or 0.87 including Exelon. Although this seems contradictory, it correlates with existing regional and local trends of fewer persons per household.

A projected maximum of 0.87 MGD in 2030 is close to the 2003 historic demand (0.84) experienced by Millis. As seen on Figure 4, total ADD is projected to exceed the conservatively estimated supply (NDO, based on recent summer pumping data) sometime after 2020. Millis' supply availability (0.779 MGD) will meet the projected 2018 and 2020 ADD of 0.737 and 0.773, respectively (including pending and proposed new residential development and Exelon). However, future ADD after 2020 exceeds NDO due to the development projects coming online.

This analysis incorporates several layers of contingency including: 1) the most conservative population estimates, 2) the most conservative demand projection calculation scenario, and 3) a conservative estimate of supply (NDO). For comparison to the 0.78 MGD 2014-2015 and 0.88 MGD 2015 NDO estimates, another measure of supply has been shown representing the supply provided (0.99 MGD) by the three smallest wells (Wells 1, 2, and 3) pumping at 50% of their safe yield (with Wells 4, 5, and 6 offline). Based on currently available data and given the continuation of best practices for maintenance of water infrastructure, Millis' supply is anticipated to meet future daily demand. Confidence in the conclusions of adequacy would be increased by performance of well performance testing to verify the NDO yield values. Recommendations to maintain supply adequacy are provided in Section 3.

Figure 4: Historic and Projected ADD Compared with Estimated Supply and Permit Limit



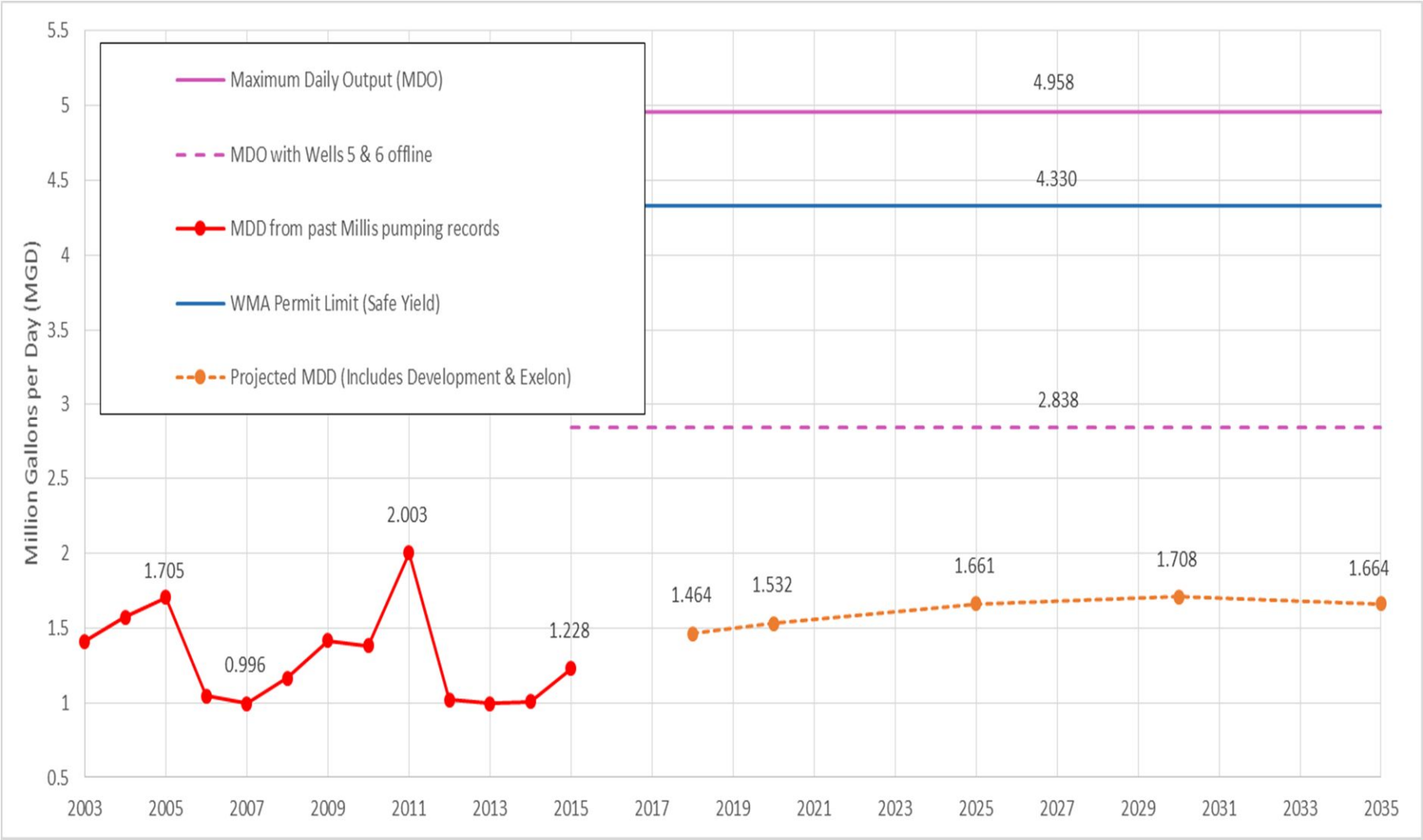
2.4.2 Supply Adequacy to Meet Maximum Day Demand (MDD)

Figure 5 below illustrates Millis' supply in comparison to past and projected future MDD. Assuming maximum daily output (MDO) rates for 24 hours per day, using all six of their wells running, Millis' supply availability (4.958 MGD) is more than adequate to meet the projected 2018 MDD (including development and Exelon) MDD of 1.464 as well as the projected future MDD (2030) of 1.708 MGD. Confidence in the conclusions of adequacy would be increased by performance of well inspection and flow testing to verify the MDO values. Recommendations to maintain supply adequacy are provided in Section 3.

When performing this type of water supply analysis it is typical to evaluate adequacy with the case of the single, largest source offline, so as to provide a factor of safety. The MassDEP "Guidelines and Policies for Public Water Systems" and the American Water Works Association (AWWA) "Distribution System Requirements for Fire Protection Manual" describe that "[with] any pump out of service, the remaining pump or pumps shall be capable of providing the maximum daily pumping demand of the system".

In the case for the Town of Millis, the largest source is the combination of Wells 5 and 6, because they collectively have the highest permitted withdrawal volume (1.50 MGD) and highest reported MDO (2.123 MGD). With Wells 5 and 6 offline, the available maximum daily output from the Town of Millis system is reduced from 4.958 MGD to 2.838 MGD. Therefore, with the Wells 5 and 6 offline the Town of Millis can still meet its current and future MDD.

Figure 5: Historic and Projected MDD Compared with Supply and Permit Limits (MGD)



2.5 Comparison of Demand to Permitted Withdrawal Limits

The Town of Millis' WMA permit dated March 2, 2010, covers a 20-year term. The permit term is divided into four 5-year periods and permits average daily withdrawal rates on an annual basis during each period (MassDEP, 2010). The permitted average daily withdrawals are summarized in Table 2-9. The WMA permit annual average withdrawal limit of 0.80 MGD is for "Period 1", the initial 5-year term of the Permit. The WMA permit annual average withdrawal limit for "Period 2" is 0.99 MGD. The WMA permit states that access to water withdrawals for Period 2 and beyond is contingent upon MassDEP completing a 5-Year Review or a permit amendment. It is anticipated that MassDEP will complete the 5-year review in 2018. When the review is completed, at a minimum, the limit is expected to increase to 0.84 to accommodate the new definition of baseline under revised Water Management Act regulations, which adds a 5% increase to the prior limit of 0.80 for Millis.

Table 2-9: Summary of Current WMA Permitted Daily Withdrawal Limits

Period	Date Range	Daily Withdrawal (MGD)	Annual Withdrawal (MGY)
1	3/1/10 – 2/28/14	0.80	292.00
2[1]	3/1/14 – 2/29/19	0.99	361.35
3[1]	3/1/19 – 2/28/24	0.99	361.35
4[1]	3/1/24 – 2/28/29	0.99	361.35

Notes:
MGD: million gallons per day
MGY: million gallons per year

(1) Permitted volumes are contingent upon MassDEP completing a 5-year review or permit amendment.

As seen in Table 2-10, the projected ADD is below the WMA Permitted Withdrawal Limit in 2018 and 2020, with the inclusion of proposed developments and Exelon. However, the future ADD (2025-2035) is projected to exceed the current WMA Permitted Withdrawal Limit of 0.80 MGD. Values for 2030 ADD and MDD were used as they represent peak ADD. Therefore, it is possible that Millis may need to request an increase in its current WMA Permit limit to accommodate projected demand.

Table 2-10: Comparison of Demand and Permitted Withdrawal Limits				
User	Projected (2018) Demand (MGD)[1,3]		Future (2030) Demand (MGD)[2]	
	ADD	MDD	ADD	MDD
Town of Millis System	0.689	1.277	0.820	1.518
Proposed Exelon Facility	0.048	0.190	0.048	0.190
Total	**0.736**	**1.467**	**0.868**	**1.708**
Current Permitted Withdrawal Limit[4]	0.80	4.33	0.80	4.33
Volume Above Current Permitted Withdrawal	-	-	**0.068**	-

Notes:
MGD: million gallons per day
ADD: Average Daily Demand
MDD: Maximum Daily Demand

(1) The Town of Millis System ADD and MDD are the projected 2018 values, which represent the addition of known development projects (excluding Exelon demand) as discussed in Sections 2.3.1.2 and 2.3.1.3.
(2) The Town of Millis System ADD and MDD values for 2030 are based on Kleinfelder's projections as discussed in Section 2.1.3.4. 2030 values were used rather than 2035 as they are more conservative.
(3) The Exelon facility ADD values assume the on-site well would provide the estimated volume of water (51,840 gpd) to the Exelon facility as identified in the *Draft Environmental Impact Report (*Epsilon, 2015). The Exelon facility MDD values does not include the estimated volume of water (51,840 gpd) supplied from the on-site well to the Exelon facility.
(4) The current WMA Permit Withdrawal Limit was assumed for comparison purposes only. The current WMA Permit extends through 2/28/2029 and the Town's average daily permit withdrawal limit has not increased to 0.99 MGD (Period Two volume) because it was prepared under an interim methodology and will need to undergo MassDEP review and or permit amendment first, which is anticipated for 2017. Therefore, the WMA Permit Withdrawal Limit for 2035 may be different from the current WMA Permit Limit.

The implications of Millis' Water Management Act Permit limits in the context of the 5-year review and the new Water Management Act regulation requirements for minimization and mitigation are discussed in further detail in a separate document supplemental to this report.

2.6 Storage Adequacy Evaluation

Based on the Millis *Water System Master Plan* (W&C, 2010), the Town of Millis has two active storage tanks. The Farm Street Tank has a capacity of 0.99 MG and the Walnut Hill Tank has a capacity of 0.55 MG. Based on available supply, the Town of Millis' system should be, and is, capable of meeting MDD each year without relying on system storage. Storage should be reserved to meet demands during periods of peak consumption and should provide the volume of water required for fire protection. With the Town's largest source offline (Wells 5 and 6) and Well 4 additionally offline (since elevated levels of manganese in Well 4 reportedly limit its use), the Town's MDO (for Wells 1, 2, and 3) would be 1.996 MGD. This available supply would be adequate to meet a future maximum Town MDD of 1.518 MGD (based on 2030 ADD) combined with a max day demand of 0.190 MGD of the proposed Exelon facility, without relying on storage.

Based on the Town of Millis, *Water System Master Plan* (W&C, 2010) the Town's water storage was determined to be adequate for emergency and fire protection use, but not for peak hour pressure equalization, at appropriate elevations, in the two tanks under current and projected water demands. However, Woodard & Curran (W&C, 2010) determined that the Town's storage tanks, in conjunction with well pumps, would be able to maintain pressures in the distribution

system and adequate tank levels during peak hourly demand. The max additional flow required from Exelon (0.190 MGD) is incremental in comparison to the amount of available withdrawal from the Town's existing well pumps and therefore the tanks and pumps operating together are adequate for meeting the Town's peak current and projected demands. The effect of Exelon peak hourly demand on available fire flow is discussed in Section 2.7.

Therefore, although current and future demand estimates included in this assessment differ slightly from the values included in the Water System Master Plan, Kleinfelder concludes that water storage in conjunction with the operation of well pumps is still adequate within this minor variation in estimates. However, it should be evaluated again in the Town's next Water System Master Plan update and the Town should consider additional storage options if possible.

2.7 Water Distribution System Adequacy

Kleinfelder utilized the Town of Millis' existing water distribution system hydraulic model to evaluate the impacts to fire flow availability at peak hour demand throughout the Town should Millis provide water to the proposed Exelon peaking station project, at Exelon's peak hourly demand of 250 gallons per minute, via an interconnection with the Town of Medway's water distribution system. In addition, Kleinfelder utilized available distribution system data and the Town of Millis' hydraulic model to identify the preferred interconnection location to Medway's system.

Kleinfelder's analysis was completed using WaterGemsV8i hydraulic modeling software by Bentley. The Town's water distribution system model was developed by Woodard and Curran and was provided to Kleinfelder for the purpose of analyzing the system hydraulics with and without the proposed demand from the Exelon development. Per the scope of Kleinfelder's analysis, it was assumed that the model accurately reflects the Town's existing distribution system.

2.7.1 Available Fire Flow Modeling Analysis

The intent of the hydraulic analysis completed by Kleinfelder was to determine if providing water to the Medway distribution system following the construction of the Exelon project will significantly reduce Available Fire Flow (AFF) in any areas of the Town. AFF provides a representation of how much sustainable flow is available at a specific location in a distribution system and is considered representative of the overall system "strength" at that location. To evaluate Exelon's impact, Kleinfelder conducted simulations for five modeling scenarios:

1. *Present Day*: This scenario simulated AFF under current demand conditions to determine if any problem areas already exist.
2. *2018 Future Day*: This scenario simulated AFF under future projected demand conditions for the year 2018 to determine if any new problem areas occur without the introduction of the Exelon demand. This scenario introduced additional water demands that were provided by the Town for development projects that are under construction or permitted, and likely to be completed by the time the Exelon project is operational (circa 2018). Per discussions with the Town, the 2018 *Future Day* simulation also reflects the replacement of the existing 8" water main on Street (from Walnut Street to Grove Street) with a 12" water main to accommodate the proposed Glen Ellen development. As base demand in the Town has remained relatively flat in recent years, the 2018 projections maintained the same ADD as used for the *Present Day* simulation.

3. *2018 Future Day with Exelon*: This scenario simulated the impact of Exelon on AFF, assuming the 2018 Future Day demand conditions with the Exelon demand included.
4. *2035 Future Day*: This scenario simulated AFF under future projected demand conditions for the year 2035, to determine if any new problem areas occur without the introduction of the Exelon demand. This scenario introduced one additional development project provided by the Town; the "Downtown Reserve". While development is anticipated in the Downtown Reserve area, no permitted project is yet in place and as such it was not included in the 2018 simulations. The base demand was also increased using a multiplier based on future 2035 population projections. It should be noted that the 2035 model simulations assumed that the Town will maintain the system in its current condition (pipes, pumps, tanks, etc.). As such, the pipe (C-factor) conditions and all pump and tank controls from the Base and 2018 projections were retained for the 2035 modeling.
5. *2035 Future Day with Exelon*: This scenario simulated the impact of Exelon on AFF assuming the 2035 Future Day demand conditions with the Exelon demand included.

2.7.1.1 Millis Distribution System Model Conditions

The existing model as created by Woodard and Curran distributed average daily water demands throughout the water system. In order to analyze the impact of the Exelon project on AFF under the most conservative conditions, Kleinfelder updated the model to reflect peak hour demands under both present day and future day model scenarios. This was accomplished by multiplying ADD under both present and future conditions by a peaking factor that Kleinfelder established in accordance with TR-16 guidance recommendations (TR-16, 2011). The guidance is commonly used for relating average wastewater flow to peak wastewater flow based on service population, but can be reasonably applied to drinking water systems to approximate peak flow. Furthermore, for the two model scenarios that evaluated the presence of Exelon, it was assumed that Exelon was also operating at its peak demand. Based on the information provided by Exelon and its representatives, Kleinfelder understood that the facility's peak demand will be 250 gpm and it will occur when Exelon is filling its on-site water storage tanks.

In addition to the previously described changes to water demand, Kleinfelder adjusted the model scenarios to account for the operational limitations of the Town's distribution system. In particular, it was noted that Wells #5 and #6 have seasonal operating restrictions tied to the water level in the Charles River. As such, there are times in the year when these wells are prohibited from operating. Therefore, all model simulations assumed these wells were offline because they cannot be relied upon for supply throughout the year. Lastly, Insurance Services Office, Inc. (ISO) and AWWA guidelines dictate that water distribution system modeling simulations shall assume that the single largest water source is offline so as to provide a conservative estimate of a system's redundancy and ability to deliver adequate flow under peak demand conditions. As such, Well #4 was considered to be offline in all model simulations, based on it having the highest remaining permitted withdrawal limit. With these restrictions in place, the model simulations represent the water distribution system with only Wells #1, 2 and 3, and both storage tanks operational.

2.7.1.2 Modeling Scenario Results

The water system hydraulic model, as provided to Kleinfelder, did not include information for Needed Fire Flow (NFF). NFF indicates how much flow is required at a specific site (node) and is calculated in accordance with ISO guidelines, which consider factors including but not limited to site use, building size, and occupancy limits. When simulated AFF is found to be less than NFF, it indicates that insufficient fire flow is available at that location. As NFF data was unavailable, and determination of NFF was beyond the scope of this evaluation, Kleinfelder was not able to determine all locations in the water system model where fire flow is insufficient.

However, ISO guidelines provide a minimum threshold at which AFF is considered deficient for all types of development. This threshold is 500 gpm and any model locations with simulated AFF below this amount were noted as deficient. Additionally, AFF values of less than 1,000 gpm may be deficient for denser residential development and some levels of commercial development. Consequently, Kleinfelder was able to identify model locations that did not meet this threshold as locations of possible fire flow deficiency. However, further analysis would be required to definitively identify the adequacy of all locations within the Town's model that exhibited AFF greater than 500 gpm under any of the demand scenarios previously noted. For this modeling analysis, Kleinfelder's review was therefore limited to identifying whether or not a location was adversely impacted (i.e. AFF reduced) by the introduction of new system demands, including Exelon. A description of the results of this analysis follows.

Utilizing the distribution system conditions noted in the preceding sections, each of the five modeling scenarios were simulated and the resultant AFF values were tabulated for each of the model's 1,111 nodes (locations within the water distribution system representing junctions along a system's water mains). Analysis of the *Present Day* simulation indicated that the lowest AFF values were generally found in the northwest corner of the Town in the vicinity of the Walnut Hill Storage Tank and Orchard Street, with a modeled AFF of 500 gpm or less at a total of 14 nodes in the area. These low AFF values are primarily due to the high relative elevations of the nodes. Lower AFF values were also noted in a number of locations where water mains dead end without any looping, including but not limited to Main Street near the Millis-Medway town line, Main Street near the Millis-Medfield town line, Dover Street, Ridge Street near Curve Street, and Dean Street near the Millis-Norfolk town line. Altogether 50 nodes (~4.5% of all nodes) were identified as having an AFF of 500 gpm or less under the *Present Day* simulation. Figures that identify the nodes, under various conditions, with modeled AFF of 500 gpm or less were provided to Millis under separate cover.

AFF was found to remain relatively unchanged from the *Present Day* simulation to the *2018 Future Day* simulation, despite the addition of the Exelon development water demand. In some instances, the AFF estimates actually improved due to the water main upgrade anticipated on Orchard Street. While AFF improved along this stretch of Orchard Street, lower values continued to be simulated at the other remaining locations that were observed during the *Present Day* simulation as follows:

- Overall, AFF tended to drop slightly excluding the improvements along Orchard Street, with an average decrease of 3% noted across all other nodes and a maximum decrease of 9%.
- Altogether 39 nodes (~3.5% of all nodes) were identified as having an AFF of 500 gpm or less under the *2018 Future Day* simulation, which is 11 fewer deficient nodes than in the *Present Day* simulation.

The addition of Exelon for the *2018 Future Day with Exelon* simulation resulted in minor additional reductions to AFF and lower AFF values continued to be simulated in the same locations that were observed during the *Present Day* simulation as follows:

- Overall, AFF decreased approximately 5% on average across all nodes (excluding the increases related to the water main improvements on Orchard Street) and a maximum decrease of 16% at one node when compared to the *Present Day* simulation.

- As with the base *2018 Future Day* simulation, 39 nodes were identified as having an AFF of 500 gpm or less under the *2018 Future Day with Exelon* simulation, while one additional node dropped from an AFF greater than 1,000 gpm to below this threshold.

Both the *2035 Future Day* and the *2035 Future Day with Exelon* model simulations actually predicted system improvements in regard to AFF when compared to the respective 2018 Future Day simulations, as Kleinfelder projected that overall base water demand will decrease based on a correlating decrease in population projections over this period. When compared against the *Present Day* simulation, the 2035 model simulations indicated the following:

- AFF tended to decrease at a reduced rate than what was predicted for the 2018 model simulations, with an average reduction of 2% (excluding Orchard Street).
- A maximum AFF decrease of 8% for the *2035 Future Day* simulation at one node.
- An average AFF reduction of 4% (excluding Orchard Street) and a maximum decrease of 13% for the *2035 Future Day with Exelon* simulation.
- As with the 2018 model simulations, 39 nodes were identified as having and AFF of 500 gpm or less under both 2035 simulations, and lower AFF values continued to be observed at the same locations that were observed in the Present Day simulation.

The model simulations discussed in the preceding paragraphs indicate that water demands related to future development projects in the Town, as well as the demand from Exelon will cause AFF to decrease within the Town's distribution system. However, the overall decrease in AFF is projected to be relatively small, with the largest average decrease projected at 5% via the *2018 Future Day with Exelon* simulation. Further, the addition of the future development project demands and the Exelon demand did not result in any new locations having a calculated AFF of 500 gpm or less. Given that these limited impacts were observed during peak hour demand simulations, it is Kleinfelder's opinion that the addition of the Exelon demand does not adversely impact the Town's water distribution system.

2.7.1.3 Available Fire Flow Modeling Analysis – One Tank Operational

The Farm Street water storage tank (0.99 MG capacity) was out of service at the time of this report and being rehabilitated by the Town. As such, the Town's distribution system is currently operating with only the Walnut Hill Tank (0.55 MG capacity) and Wells #1, 2, and 3 online. While this does not represent typical operations for the Town, Kleinfelder completed model simulations to identify the impact to AFF of having the Farm Street Tank offline for the same five scenarios described in the preceding section.

The model results indicate that having the Farm Street Tank offline greatly impacts overall AFF in the distribution system. Comparing the simulations under *Present Day* conditions, AFF was projected to be approximately 33% less on average system wide with only one tank operational, with a maximum reduction of 78% projected for one node. Introducing the projected development projects under the *2018 Future Day* conditions further reduces AFF, with an average 45% reduction projected system wide and a maximum reduction of 85% for one node when compared to *Present Day* conditions. The introduction of the Exelon demand under the *2018 Future Day with Exelon* scenario reduces AFF yet again, with an average 56% reduction projected system wide and a maximum reduction of 90% for one node when compared to *Present Day* conditions. As was the case in the analysis of the Town's system with two tanks online, AFF improved slightly for the *2035 Future Day* scenario when compared to the respective *2018 Future Day* scenario.

The reduction to AFF noted in the simulations completed with the Farm Street Tank offline predict that a significant number of locations will have AFF values of less than 1,000 gpm. Under *Present Day* conditions, with both tanks online, 183 nodes (17% of all nodes) were projected to have AFF values of 1,000 gpm or less. With only one tank online, this number increases to 210 (19% of all nodes), jumps to 752 (68% of all nodes) under *2018 Future Day* conditions, and increases further to 827 (75% of all nodes) under *2018 Future Day with Exelon* conditions. Further, under the *2018 Future Day with Exelon* conditions, with one tank online, 56 total nodes are projected to have AFF values of 500 gpm or less, which is 17 more than the 39 nodes identified under the same conditions with both tanks online.

Based on these results, Kleinfelder recommends that the Town minimize the duration of time that either of the two water storage tanks remains out of service to the extent possible, to ensure that the distribution system can provide an adequate supply of fire flow should it be needed. The Town may also want to consider having additional emergency measures in place, such as the ability to readily connect to or open interconnections with adjoining towns, or to be prepared to increase well run times for the duration a tank is offline.

2.7.2 Interconnection Location

Based on the physical orientation of the Millis and Medway water distribution systems, two locations were identified as possible system interconnections: Village Street and Main Street. The analysis of these two locations included a review of the physical properties of the distribution systems in each town and the modeling results under present day conditions for the Town of Millis.

The potential interconnection at Main Street in Millis is served by an 8” water main that dead ends at a valve just prior to the town line with Medway. This area of Main Street has historically been identified as having deficient AFF. These lower AFF values were also identified by the modeling analysis discussed previously and via fire flow testing completed by Kleinfelder as part of this evaluation. As the distribution system is currently configured, a booster station at the potential interconnection at Main Street would theoretically reduce AFF along Main Street since the impacted main is a “dead end”. In order to improve AFF on Main Street, water main diameters would need to be increased, or looping would be needed. On the Medway side of the town line, Main Street is served by dual 6” and 12” diameter water mains.

The potential interconnection at Village Street in Millis is served by a 12” water main from the east and a 10” water main from the north. This redundancy and increased water main diameter results in an increased AFF at the interconnection, which was confirmed via fire flow testing and further modeling analysis completed by Kleinfelder. In Medway, Main Street is served by 6” and 8” water mains. A 12” water main is present approximately 2,500 LF from the town line.

Kleinfelder has identified Village Street as the more favorable interconnection location, as it appears the Millis distribution system is able to provide a more reliable volume of water to this location under all system demand conditions. The Millis water model did not identify deficient fire flows in the vicinity of the Village Street interconnection under any of the five peak hour demand scenarios evaluated [*Present Day*, *2018 Future Day* (with and without Exelon), *2035 Future Day* (with and without Exelon)].

On the Medway side of the town line at Village Street, the system is served by a 6” water main from the town line, west to Island Road. Analysis of the Medway distribution system hydraulic model indicated that water velocities within the 6” water main will be within the acceptable limits

of 2 to 7 feet/second with the addition of the 250 gpm demand (Exelon peak flow). The model also identified a high head loss over one segment of the 6" water main that carries the full flow received from Millis. However, this segment of 6" water main is short and the total head loss that occurs in the area as a whole is low. As such it does not negatively impact fire flow in the area of the water system served by this 6" water main and is therefore of minimal concern due to the overall system strength. Based on this analysis, Kleinfelder does not foresee the need to upsize the 6" water main along Village Street in order for Millis to provide the water to fulfill the Exelon demand. However, as MassDEP guidance requires that all new water mains intended to provide fire flow have a minimum diameter of 8", it is recommended that this existing 6" water main be included for consideration in any future water main replacement planning by the Town of Medway.

2.7.3 Booster Station

In order for Millis to provide water to the Medway distribution system, a booster pumping station will be required. This was determined by analyzing the existing water storage facilities in each town. As both the Millis and Medway distribution systems operate in a single pressure zone and maintain two storage tanks, the hydraulic grade line (HGL) of each system is equal to the respective water elevations in each Town's tanks, with the maximum HGL being equal to the tank overflow elevations. In Millis, the overflow elevation of the two tanks is approximately 294 feet, with the base elevations of the two tanks being 206 feet and 236 feet respectively. In Medway, the overflow elevation of the two tanks is approximately 366 feet, and the base elevation of the two tanks is 286 feet. As such, the HGL in Medway is greater than that in Millis, meaning that water will flow by gravity from the Medway system to Millis without the presence of a booster pumping station.

A booster pump station will also provide control of the flow rate and volume of water transferred from the Millis system to the Medway system. The pump station can be designed to provide the necessary rate and volume over a desired duration with metering and options for remote control if needed. Design of the booster station and determination of the desired flow rate and control mechanism by which water will be transferred was not investigated further as part of this analysis and should be negotiated during the drafting of an Inter-municipal Agreement between Millis and Medway.

2.7.4 Water Compatibility Evaluation

Kleinfelder noted that the chemical dosing and the operational pH range varied between the Millis and Medway water distribution systems. The Millis system maintains a lower target pH (7.00 to 7.20) and sodium hypochlorite disinfection dosing concentration (0.30 to 0.65 mg/L) than Medway (pH target of 7.50 and sodium hypochlorite dosing of 0.80 to 1.0 mg/L respectively). The Medway system also treats its water with, with a polyphosphate additive for sequestration of iron and manganese and corrosion protection while Millis does not. Based on these differences, the introduction of water from Millis into Medway will effectively dilute the water properties in Medway when the booster station is operational. In order for Medway to retain its system's current finished water properties, adjustments to the treatment parameters will be needed. This will most likely be accomplished by the incorporation of chemical feed systems within the booster station. While the connection is considered feasible, additional evaluation is needed during the next project phase to determine the extent of the additional chemical dosing requirements and the cost to implement necessary controls.

3. IMPLEMENTATION CONSIDERATIONS

3.1 Interconnection with Medway

Millis has two interconnections with Medway which are currently utilized as emergency interconnections only. There is no record of either interconnection being recently utilized, although Millis does have established Standard Operating Procedures for activating the connection, as provided in its 2010 Water Master Plan. In order for Millis to provide potable water to Medway, permanent infrastructure improvements would be required at the Village Street interconnection, as was discussed in Section 2.7. In particular, a booster pumping station would be required for water from Millis to overcome the higher HGL of the Medway system. In addition to the booster station itself, short lengths of water main will need to be installed, as well as related appurtenances, including but not limited to isolation valves, check valves, and flow meters. Some of the variables that Kleinfelder foresees will need to be negotiated further by Millis and Medway in the form of an Inter-Municipal agreement include: the location of the station, the responsible party for operation and maintenance of the station, and the total flow and typical flow rate of water to be pumped from Millis to Medway on a daily basis.

The booster pumping station would have to be sized to be capable of delivering the peak Exelon demand. Assuming the station will be an underground, precast unit consisting of two pumps (one "running", one "standby"), controls, a backup power generator, flow metering, and chemical monitoring, Kleinfelder estimates that the cost for construction may range from $200,000 to $350,000, excluding engineering services, but including a 30% contingency for supplemental water main piping, valves, and other appurtenances. This estimate assumes that there is town land (if needed) available for the booster station to be installed upon or near the interconnection location. Cost may increase depending on the results of negotiations between Millis and Medway.

In addition to the physical and operational considerations required for implementation noted in the preceding paragraph, the two towns will also need to come to an agreement as to the water quality parameters of the water to be pumped from Millis to Medway. As was discussed in Section 2.7, the chemical dosing and operational pH range varied between the Millis and Medway water distribution systems. In order for Medway to retain its system's current finished water properties, adjustments to the treatment parameters may be needed. Further investigation into the water properties of the resultant "blended" water that will be present in the Medway distribution system may be necessary. Negotiations for the Inter-Municipal Agreement should identify the desired system water properties for each town, and if necessary, what additional treatment processes may be required, where such systems would be implemented, and who will maintain, operate and pay for such systems.

3.2 Regulatory Requirements for Implementation

Kleinfelder has consulted with MassDEP to determine any new regulatory obligations that may result from an interconnection between Millis and Medway for selling water to Exelon. If Medway's water supply is supplemented with finished water from Millis, Medway would still be required to meet all of its current requirements as a Public Water System (PWS) including maintenance of the distribution system, and water quality monitoring and reporting. An Inter-Municipal Agreement (IMA) should be used to define and detail the distribution of responsibilities between Medway and Millis for operations, in particular for infrastructure changes including the addition of a booster

pumping station. An additional pump station would modify the distribution system and would therefore require a system modification permit from MassDEP. Preliminary review suggests that it does not appear that either Town would need an increased level of operator licensure. This should be confirmed as the process proceeds and the treatment processes and responsibilities are better established.

Similar intermunicipal purchasing arrangements are in place within MassDEP's Central Region. Norfolk purchases water from Wrentham, Charlton purchases water from Southbridge, Westminster purchases water from Fitchburg, Holden and Paxton purchases water from Worcester, and Southborough and Northborough purchase all of their water from the Massachusetts Water Resources Authority (MWRA). At this point, MassDEP has not identified any significant regulatory obstacles to this purchasing arrangement (personal communication, Marielle Stone, MassDEP).

Requirements relating to the Water Management Act Permit are discussed in a supplemental document appended to this report.

3.3 Maintenance of Supply Adequacy

As was discussed in Section 2.4, the Town of Millis' supply appears to be adequate to meet the projected near term (2018 and 2020) average daily demand. However, based on the conservative estimate from Scenario 4 (Section 2.3.1.4), the Town's ADD after 2020 may exceed some estimates of supply adequacy. Confidence in supply adequacy could be increased by conducting well performance testing during 2016.

In order to maintain supply adequacy at current levels, the Town will need to:

- Continue to manage demand to maintain residential use and unaccounted for water at or below current standards.
    - Ideally, continue to maintain the current levels of residential use and unaccounted for water, which are below the required standards of 65 rgpcd and 10%.
- Institute and fund a regular program of well inspection, well performance testing, maintenance, and recordkeeping. This recommendation has also been previously noted by others (Master Plan, 2010).
- Closely track water quality at Well #4 (including conducting monthly monitoring of iron and manganese levels) and consider implementing iron and manganese controls (e.g. sequestering) or treatment as needed to maintain use of the source. This recommendation has also been previously noted by others (Master Plan, 2010). A relatively low cost treatability study ($15,000 to $30,000) would provide an alternatives analysis, recommendations for appropriate treatment technology and estimated cost for capital budgeting, which would be a significant expense.

3.3.1 Well Maintenance Program

Complete records of routine well inspection, flow testing, maintenance and cleaning were not readily available in the Town of Millis' records. Similar to recommendations in the 2010 Water Master Plan, it is critical to implement a regular and robust program so that problems can be identified early and addressed before more serious problems develop, leading to extended well down-time. The following actions are recommended:

- Annual Inspection & Flow Testing:

    - Retain a licensed well contractor to conduct well inspection and flow testing as well as motor inspection/testing. Costs are typically less than $700 per well.
    - Track key performance indicators such as specific capacity, pumping level, and energy use results in a running spreadsheet to identify year to year trends in well efficiency indicating possible screen clogging or pump wear.
- Regular Cleaning & Rehabilitation:
    - Recommended good operating practice is to conduct well rehabilitation (pull, inspect and repair pump, conduct TV inspection of screens, clean, and flow test well) about once every 5 years unless water quality and specific capacity results indicate more frequent cleaning required. Operating an inefficient well or pump will increase power costs and regular maintenance will provide significant electrical cost savings. An annual operating budget item of approximately $30,000 to clean / rehab one well per year is recommended, if not already in place. It will be particularly important to frequently clean Well #4 due to elevated manganese concentrations.

3.4 Water Delivery through Alternative Methods

As discussed in Section 8.2.3 of the Exelon Environmental Impact Report (Epsilon Associates, 2016), the Project has initiated discussions with two firms for the purpose of providing supplemental water supplies, up to the peak day demand, via truck rather than through the preferred water main interconnection. The use of trucking water from a separate vendor is proposed by Exelon as a contingency in the event of its onsite well becoming unavailable. Exelon has expressed that the preferred mode of water supply to Exelon is via the Medway water distribution system. However Exelon and Millis have discussed the potential alternative of Exelon trucking water from Millis's Wells 1 and 2 facility, as a backup to the preferred interconnection if an agreement regarding the Medway interconnection could not be reached. Potential issues that would need to be reviewed in the next project phase for fully vetting this alternative include concerns about additional truck traffic in Millis as well as in Medway, and Millis operational staffing requirements.

3.5 Other Recommended Improvements

Based on analyses to date, Kleinfelder does not foresee the need for additional infrastructure improvements beyond those related to the interconnection improvements presented in Section 3.1 in order for Millis to deliver the requested Exelon demand to Medway. However, a number of issues were noted in both Millis and Medway for which infrastructure improvements are recommended in order to enhance distribution system operation:

- Orchard Street from Walnut Street to Grove Street in Millis was identified as having deficient fire flows under *Present Day* conditions. Per discussions with the Town, it is Kleinfelder's understanding that the Glen Ellen Country Club is to be replaced by a housing development and this water main is to be replaced. Modeling analysis indicates that replacement of this water main with a larger diameter main (12") significantly increased AFF. Kleinfelder recommends that this water main be replaced even if development of the area were to stall or not occur.
- Deficient or potentially deficient AFF values were identified in a number of additional "dead-end" locations within the Millis water distribution system, including Main Street at both the Medway and Medfield town lines, Dover Street, Ridge Street near Curve Street, and Dean Street near the Millis-Norfolk town line. The Town should consider alternatives,

to improve AFF to these locations in their master planning efforts. Alternatives may include installation of new water main to provide looping, upsizing existing 6" water mains, and rehabilitating aging mains.

- The proposed booster pumping station will connect to an existing 6" water main in Medway. While the model simulations indicate that this water main can handle the additional flow provided by Millis, higher pressure losses were projected for this location than for other spots within the Medway distribution system. In addition, MassDEP guidance requires new water main intended to deliver fire flow to have a minimum diameter of 8". Based on these factors, it is recommended that the Town of Medway consider replacing the existing main with a larger diameter main in any future water main replacement planning.

4. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

This section presents a summary of conclusions and recommendations, which are presented as underlined.

4.1 Supply and Demand:

As discussed in Section 2.4, Millis' supply availability will meet the projected 2018 and 2020 ADD including pending and proposed new residential development and Exelon. However, future ADD after 2020 may exceed supply based on the conservatively estimated NDO (0.779 MGD based on 2014-15 summer pumping) due to the development projects coming online.

In order to safely and reliably meet projected future ADD, the following steps are recommended for Millis:

- Conduct well performance testing to verify supply availability.
- Continue to manage demand to maintain residential use and unaccounted for water at or below current standards.
- Institute and fund a comprehensive program of annual well inspection and testing, maintenance (cleaning) and recordkeeping. This recommendation has also been previously noted by others (Master Plan, 2010).
- Closely track water quality at Well #4 and consider implementing iron and manganese controls (e.g. sequestering) or other treatment as needed to maintain reliable use of the source. This recommendation has also been previously noted by others (Master Plan, 2010).

The Town's current Permit limit of 0.80 MGD for annual average day demand will be sufficient to meet projected ADD for 2018, with the inclusion of proposed developments and Exelon. However, the Town's current Permit limit of 0.80 MGD for annual average demand will not be sufficient to meet the projected 2025 demand based on the conservative estimate from Scenario 4, as discussed in Section 2.3.1.4. Therefore, Millis may need to access the 0.99 MGD volume slated for the permit 'Period 2' as part of the 5-year permit review process with MassDEP.

With respect to maximum daily demand, the Town's supply appears to be adequate, based on recent reported maximum well pumping rates reported by the Town. Recent flow test records were not typically available, therefore, confirmation of the reported MDO values through flow testing by a well contractor would increase confidence in this conclusion.

4.2 Infrastructure

As was presented in Section 2.7, the analysis of Millis' Water Distribution System resulted in the following findings:

- The model identified locations within the distributions system that have deficient AFF (less than 500 gpm) under existing conditions. Additional locations were identified as possible locations of fire flow deficiencies (AFF less than 1,000 gpm).

- The model indicates that the addition of the Exelon demand results in minor reductions to AFF system wide under both *Future Day* conditions (2018 and 2035), with average decreases of 5% and 4% and maximum decreases at a single node of 16% and 13% respectively compared against *Present Day* conditions. The Exelon demand does not reduce any additional locations below an AFF of 500 gpm under either scenario. As such, it was determined that the Exelon demand does not adversely impact overall distribution system conditions and operations.
- The model indicates that AFF system wide is impacted significantly when the Farm Street tank is removed from operation. Conditions were particularly impacted under the 2018 *Future Day with Exelon* scenario, with AFF dropping on average by 56% when compared against *Present Day* conditions.
- The Village Street interconnection was identified as the most favorable location due to the relative strength of the Millis distribution system when compared to the location on Main Street.
- An interconnection at Village Street is feasible. A booster pumping station will be required to deliver the needed Exelon demand from the Millis distribution system to the Medway distribution station.
- The finished water targets in Millis and Medway differ in regard to system pH, chlorination dosing, and corrosion control methodologies. Additional treatment processes or adjustments to existing processes may be required by either town if these targets are to be maintained.

Based on these conclusions, as well as additional information that was gathered in regard to the distributions systems in Millis and Medway, Kleinfelder recommends the following steps to implement an interconnection between Millis and Medway:

- <u>Complete further analysis of the water quality blend that will occur with the mixing of the Millis water into the Medway system so as to determine additional treatment requirements (if any). Analysis may include, but not be limited to a review of water quality data from each town (or sampling and laboratory analysis if data is not readily available), computer modeling of the blended water, jar testing, and determination of supplemental treatment methods if needed.</u>
- <u>Design and construction of a booster station for the interconnection between the two Towns as described in Section 3.</u>
- <u>Establishment of an Inter-Municipal Agreement between Millis and Medway, to include identification of flow and flow rates to be delivered to Medway, water quality targets to be maintained by each town, additional treatment requirements, determination of responsible party for operation and maintenance of the required booster pumping station, etc.</u>
- <u>The model used for this analysis assumes the implementation of the replacement of water main replacement in Orchard Street in Millis, from Walnut Street to Grove Street with a larger diameter water main, as indicated by the Town.</u>

While not critical to the interconnection, the following additional improvements are highly recommended:

- Replacement of existing 6” diameter water main on Village Street in Medway with a larger diameter water main (8” minimum) from the proposed booster pumping station to Island Road to align with current MassDEP guidance for new water mains.
- Further investigation of locations with deficient or suspected deficient AFF values in Millis to determine the need for system improvements. Projects to improve system pressures and fire flows were recommended in a number of the locations identified in this report in

the 2010 Water Master Plan completed by Woodard and Curran as well, including Dover Road and the neighborhood around the Walnut Hill Tank.

- Prioritization of 6" diameter water main replacement projects to larger diameter mains (8" minimum) in both Millis and Medway as part of future water main replacement programs, to align with current MassDEP guidance for new water mains. Such work was also recommended for the Millis system in the 2010 Water Master Plan by Woodard and Curran and for the Medway system in the 2010 Water Master Plan completed by Weston and Sampson.

APPENDIX A

Figure A-1: Town of Millis Water Supply System

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Figure A-1
Locus Map
Town of Millis, Massachusetts
Exelon Power Water Assessment

Legend

- Town Boundary
- SWMI Basins
- Wetlands
- Major Streams

Pump

- Public Well- Millis

N
W E
S

0 1,250 2,500 5,000 Feet

Revision Date: 12/8/2015

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WOODARD & CURRAN

MINIMIZATION & MITIGATION IMPLEMENTATION ANALYSIS

TOWN OF MILLIS, MASSACHUSETTS

Supplemental Document to:

Water Supply and Demand Assessment
In Relation to Exelon Power "West Medway II" Project, Revision 2: March 11, 2016

MARCH 2016

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A Report Prepared for:

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MINIMIZATION & MITIGATION IMPLEMENTATION ANALYSIS

TOWN OF MILLIS, MASSACHUSETTS

Supplemental Document to:
Water Supply and Demand Assessment
In Relation to Exelon Power "West Medway II" Project Revision 2: March 11, 2016

Kleinfelder Project Number: 20162545.001A

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EXECUTIVE SUMMARY

Background and Purpose

This document has been prepared as a supplement to the *Draft Water Supply & Demand Assessment in Relation to Exelon Power 'West Medway II' Project, Prepared for the Town of Millis* (Kleinfelder, 2016). Kleinfelder conducted an analysis of minimization, mitigation and offset options that may be required of Millis in relation to its public water supply withdrawals in the Charles River basin under the revised Water Management Act (WMA) Regulations. MassDEP will apply the new requirements in accordance with the November 2014 Water Management Act Permit Guidance Document when a water supplier's WMA permit is up for renewal, or when a water supplier requests an increase in withdrawal above an established baseline withdrawal volume.

Millis' groundwater supply wells are located within Charles River subbasins that have been determined to have August net groundwater depletion levels of 25% or greater, which is an indication of negative environmental impacts on streamflow and aquatic habitat according to US Geological Survey studies. Therefore, upon Permit renewal, even if Millis does not request a volume above baseline, under the new WMA regulations Millis will be required to submit a Minimization Plan for reducing environmental impacts of these withdrawals to the greatest extent feasible.

Millis' existing 2010 WMA Permit already includes the setting of a baseline amount. In the Millis 2010 Permit, baseline is defined as the larger of volume withdrawn during 2005, the average between 2003 and 2005, or the registered volume (whichever is highest). Millis' baseline was set at its reported 2005 withdrawal volume, or 0.80 million gallons per day (MGD). The new WMA regulations have revised the definition of baseline to include a 5% 'buffer'. Under the new regulations, Millis' baseline would be set at 0.80 MGD plus 5%, or 0.84 MGD. As described in Millis' existing WMA Permit, Special Condition 10, the first time Millis' water withdrawals exceed baseline for a calendar year, Millis must perform an Offset Feasibility Study which includes a written analysis of the cost effectiveness of following various water management Best Management Practices.

This implementation analysis is intended to address the potential requirements of both the current Permit and the new regulations. It provides a qualitative ranking of options and a planning level cost for the top three minimization options and the top three mitigation options. The analysis is intended to help the Town prioritize implementation of projects that provide the most environmental benefit for the best value if future demands require Millis to withdraw greater than its baseline amount.

WMA Permit Requirements and Millis Projected Demands (Section 2)

Millis' existing WMA Permit approves a total withdrawal volume of 0.80 MGD (292 MGY) for Period 1 (3/1/2010 – 2/28/2014). The WMA permit approves a total withdrawal volume of 0.99 MGD for Period 2 through 4 (2/28/2014 – 2/28/2029). Millis' WMA maximum withdrawal limit, for

the final 5 year period (3/1/2024 through 2/28/2029), remains at 0.99 MGD. The Town's permitted withdrawal volume has not increased to 0.99 MGD (Period 2) because it was prepared under an interim methodology and will need to undergo MassDEP review and a permit amendment first, which is anticipated to occur in 2017. There are a number of development projects that may bring additional demand to the Millis water system. As discussed in the *Water Supply and Demand Assessment In Relation to Exelon Power 'West Medway II' Project* (Kleinfelder, 2016), the potential average day demand of proposed developments and water reserves (which includes the proposed Exelon facility) by 2018 is estimated to be 0.025 MGD based on information provided by the Town and Exelon. Additional development will cause this value to increase to 0.224 MGD by 2030.

Minimization and Mitigation Feasibility Study (Section 3)

Kleinfelder utilized background information existing in previously completed studies or otherwise provided by Town staff or other sources to conduct a planning-level analysis. The methodology used was based on the MassDEP Water Management Act Permit Guidance Document dated November 7, 2014. The feasibility evaluation and qualitative ranking of options considered the following factors: Millis' authority to implement the action, feasibility considerations and constraints, estimated volume of offset or water savings, synergy with other regulatory programs, if applicable, and cost to implement. The approach taken in this study was to examine all possible options for potential future credits and possible overlap with other regulatory programs, such as the NPDES MS4 stormwater and TMDL requirements. This analysis could help Millis to plan for future demands that might not be currently known or estimated.

Minimization Options (Section 3.1)

Upon Permit renewal, Millis will be required to submit a Minimization Plan for reducing environmental impacts of its groundwater withdrawals to the greatest extent feasible. Twenty (20) different minimization options from the WMA Guidance Document were evaluated and rated, as summarized in Table 10 of Section 3. The top three minimization options were identified as: Optimization of Existing Resources, Enhanced Non-essential Outdoor Water Restrictions, and Modifying the Survey Method for Leak Detection. Each is described briefly below, and in more detail in Section 3.1.

<u>Optimization of Existing Sources:</u> The minimization approach evaluated would increase summer withdrawals from Wells 1 and 2 while reducing them from Wells 3, 5, and 6, which are in a subbasin with higher groundwater depletion levels. This approach is consistent with the approach recommended by the WMA Guidance Document for desktop optimization analyses.

<u>Enhanced Non-essential Outdoor Water Restrictions:</u> This option would implement new restriction requirements using a calendar based water ban limiting outdoor non-essential watering to 2 days a week (with no watering between 9:00 AM and 5:00 PM).

<u>Modifying the Survey Method for Leak Detection:</u> This option would consist of using existing annual leak detection efforts in a targeted way by prioritizing the system into zones by water main age, material, and break history and focusing efforts in higher priority areas first.

Mitigation Options (Section 3.2)

If Millis exceeds its baseline withdrawal or requests an increase in its baseline, it will be required to develop a plan to mitigate or offset the withdrawal above baseline. The Town of Millis could request an adjustment to the mitigation volume for water efficiency through achieving a higher residential use efficiency and a lower unaccounted for water than stipulated by the WMA Performance Standards. In addition, the Town of Millis could request a potential adjustment for current and future wastewater returns through septic systems. Through these adjustments it is estimated the Town of Millis has the potential to offset a volume of water which is greater than the projected future demand above baseline.

However, if the Town is not able to offset the requested volume above baseline via adjustments, the Town would need to implement mitigation measures. For that reason, Kleinfelder assessed the feasibility of three (3) Direct Mitigation and fourteen (14) Indirect Mitigation options. The top three mitigation options were identified as: Stormwater Recharge Projects, Infiltration/Inflow Removal and the replacement of the Village Street Culvert. Each is described briefly below and in more detail in Section 3.2.

Stormwater Recharge Projects: This Direct Mitigation option would consist of constructing a stormwater infiltration structure on a municipally owned property. A desktop screening analysis using GIS was performed to identify potential areas for both enhancing stormwater recharge and reducing total phosphorus export to waterways. The analysis utilized a scoring and ranking process that quantitatively evaluated sites where Green Infrastructure (GI) could be used to increase stormwater recharge, based on the following criteria: soils, slope, elevation, impervious area, land use type, and impaired water proximity. Parcels within Millis were ranked and Town-owned parcels were evaluated to determine potential suitable locations. This option would have a dual benefit of meeting obligations under both the WMA Permit and the NPDES MS4 stormwater Permit.

Inflow / Infiltration Removal: The Town has completed a number of efforts toward removing and reducing inflow and infiltration of groundwater to its sewer system. Volumes of removal could potentially be recognized as direct mitigation. This option consists of an existing program that the Town is implementing that could be credited towards WMA obligations.

Village Street Culvert Replacement: Culvert replacements, when designed to facilitate wildlife passage or aquatic habitat benefit, are considered Indirect Mitigation efforts. The Town already has plans to replace the Village Street Culvert due to needed repairs. A design that will improve habitat continuity, restore natural hydraulics, or provide a natural streambed in accordance with the Massachusetts Stream Crossing Standards handbook could be eligible for indirect mitigation credits.

1. Introduction & Overview

This document has been prepared as a supplement to the *Water Supply & Demand Assessment in Relation to Exelon Power 'West Medway II' Project, Prepared for the Town of Millis* (Kleinfelder, 2016), Kleinfelder conducted an analysis of minimization, mitigation and offset options that may be required of Millis in relation to its public water supply withdrawals in the Charles River basin under the revised Water Management Act (WMA) Regulations. MassDEP will apply the new requirements in accordance with the November 2014 Water Management Act Permit Guidance Document when a water supplier's WMA permit is up for renewal, or when a water supplier requests an increase in withdrawal above an established baseline withdrawal volume. The Town's existing WMA Permit, Special Condition 10, requires the Town to perform an Offset Feasibility Study if its water withdrawals for a calendar year exceed its Permit established baseline withdrawal of 0.80 MGD. Upon Permit renewal, even if Millis does not request a volume above baseline, under the new WMA regulations Millis will be required to submit a Minimization Plan for reducing environmental impacts of these withdrawals to the greatest extent feasible.

This implementation analysis is intended to meet the offsetting analysis requirements of both the current Permit and the new regulations. It provides a qualitative ranking of options and a planning level cost for the top three minimization options and the top three mitigation options. The analysis is intended to help the Town prioritize implementation of projects that provide the most environmental benefit for the best value if future demands require Millis to withdraw greater than its baseline volume. It should be noted that Kleinfelder's analysis and findings in this report are largely based on a review of available information provided by the Town, Exelon and its representatives, and from other sources as described herein.

1.1 SWMI Framework and WMA Regulations

The SWMI Permitting Framework was developed by the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) and its agencies with the objective of helping balance ecological and human water needs through the Water Management Act. The SWMI development process began in 2010 and involved an Advisory Committee, Technical Subcommittee and stakeholders, all of whom were engaged in the development of the Framework. The SWMI Framework document was issued Final, following a public comment period, in November 2012. The Massachusetts Department of Environmental Protection (MassDEP) conducted a Pilot Program with several public water supplier communities to test the Framework under different real world scenarios. MassDEP applied the SWMI Framework to WMA permitting and new WMA Regulations (310 CMR 36.00) were promulgated in the fall of 2014 (see http://www.mass.gov/eea/agencies/massdep/water/watersheds/water-management-act-program.html#4).

1.1.1 Basin Characterization and Categorization

All of the river subbasins in the Commonwealth have been categorized on the basis of the findings of a United States Geological Survey (USGS) study that evaluated streamflow alteration, habitat fragmentation, impervious cover, and water quality in Massachusetts (Weiskel et. al, 2010, SIR2009-5272). The USGS study determined the safe yield for each major river basin, which is the maximum amount of water that may be withdrawn during drought conditions while maintaining

sufficient water in streams for environmental protection. The USGS study also established the following parameters for each subbasin:

Biological Category (BC): Five biological categories were established on the basis of relationships between fish abundance and flow, percent impervious cover, and natural basin characteristics. BC-1 would represent the highest quality aquatic habitats, relatively un-impacted by human alteration while BC-5 is the most impacted habitat.

Groundwater Withdrawal Category (GWC): Five categories were established representing the percent alteration of August natural median streamflow due to upstream groundwater withdrawals. GWC-1 is the least impacted (less than 3% of August median flow alteration) while the highest, GWC-5, represents a subbasin with 55% or more alteration of August median flow.

1.1.2 Application of WMA Permit Guidance and Tier Reviews

MassDEP will apply requirements under the November 2014 Water Management Act Permit Guidance Document when a water supplier's WMA permit is up for renewal, or when a water supplier requests an increase in withdrawal above an established baseline withdrawal. Baseline has been defined by MassDEP as the volume of water withdrawn during calendar year 2005 plus 5% or the average volume withdrawn from 2003 through 2005 plus 5%, whichever is higher provided that the baseline is not less than the registered volume or greater than the authorized volume for 2005. Millis' baseline was established during its 2010 Permit renewal and does not include the 5% addition to the 2005 withdrawal. Millis' baseline is discussed further in Section 2.

When volume is requested above baseline, MassDEP will check the request against the existing total basin withdrawals and the overall basin safe yield. Then, the WMA permit will be subject to the following Tier levels and corresponding requirements:

Table 1: Water Management Act Permit Tiers

Tier	Trigger	Requirements
Tier 1	No additional withdrawal request above Baseline- all GWCs	Minimize impacts by achieving the following demand management steps, which apply to all Permits: • 65 RGPCD • 10% unaccounted for water • Institute limitations on nonessential outdoor water use. • Water conservation program for water audits and leak detection, meter repair/replace, water revenue evaluation, public education and outreach
	Additional requirements for groundwater sources in subbasins with an August net groundwater depletion of 25% or more (GWC 4 & 5)	Develop and Implement a plan to minimize impacts in 25% or greater August Net Groundwater Depleted subbasins (GWC 4&5
Tier 2	Withdrawal request above baseline; which results in no change in subbasin groundwater withdrawal category or biological category	In addition to the Tier 1 requirements, develop a mitigation plan and mitigate impacts commensurate with impact of withdrawal

Tier	Trigger	Requirements
Tier 3	Withdrawal request above baseline that changes the subbasin groundwater withdrawal category or biological category	In addition to Tier 1 & 2 requirements, demonstrate no feasible alternative source that is less environmentally harmful

Note: Further additional requirements apply for sources in subbasins with Coldwater Fish Resources.

Mitigation required under Tiers 2 and 3 can be categorized into three different areas, in decreasing order of preference: demand management, direct mitigation, and indirect mitigation (per the Water Management Act Permit Guidance Document).

Demand Management: These efforts are generally the most cost-effective and environmentally beneficial steps that a water supplier can take and include things like outdoor watering restrictions, public education, retrofitting of plumbing fixtures, etc. Although communities often expect that demand reduction measures will significantly impact water revenue, anecdotal evidence from other regional water suppliers provided to Kleinfelder indicates a lack of direct significant correlation.

Direct Mitigation: These options represent ways for a credibly estimated volumetric offset to be accounted for. Examples include septic systems or wastewater returns located within the basin, surface water releases, and stormwater recharge.

Indirect Mitigation: These options include actions to improve aquatic habitat through things like dam removal, stream channel restoration or promotion of improved capture, treatment, and infiltration of stormwater through regulatory/administrative controls such as bylaws.

1.2 Town of Millis Background

The Town of Millis is approximately 12.2 square miles in size and is located in Norfolk County; bordered by Sherborn, Holliston, Medway, Norfolk, and Medfield (see Figure 1). The Charles River forms the majority of the Town's southern and eastern borders. All of Millis lies within the Charles River major basin.

1.2.1 Topography, Geology, and Surface Water

Millis' landscape is characterized by generally low and rolling topography with elevations ranging from 243 feet to 113 feet, where the Charles River flows into Sherborn in the northeastern corner of Millis. Agricultural, forested, and wetland areas dominate the landscape of Millis, accounting for approximately 70% of the town's total area. The Great Black Swamp covers a majority of the northwest portion of Millis. Maple Swamp and wetlands along the Charles River and South End Pond cover the majority of the eastern portion of Millis. Much of the wetland area in eastern Millis forms part of the Charles River Valley Natural Storage Area, which is owned and managed by the Army Corps of Engineers for purposes of flood risk management. The Charles River creates the southern and eastern border of Millis and several ponds are located within Millis, including the South End Pond, Bogastow Pond, Richardson's Pond, Walker Pond, and McCarthy Pond. In addition, Bogastow Brook flows through the northern section of Millis and enters wetlands associated with the Charles River near South End Pond. (PCI, 2001)

Figure 1
Locus Map Town of Millis, Massachusetts
1 Inch = 4320 Feet

www.cai-tech.com

Data shown on this map is provided for planning and informational purposes only. The municipality and CAI Technologies are not responsible for any use for other purposes or misuse or misrepresentation of this map.

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Figure 2

Town of Millis, Massachusetts
Exelon Power Water Assessment

Legend

- Town Boundary
- SWMI Basins
- Wetlands
- Major Streams

Pump

- Public Well- Millis

N
W E
S

0 1,250 2,500 5,000 Feet

Revision Date: 12/8/2015

KLEINFELDER
Bright People. Right Solutions.

WOODARD & CURRAN

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The landscape has been shaped by the advance and retreat of glaciers during the Pleistocene. The underlying bedrock consists of granite, diorite and granodiorite and the overlying sediments consist of stratified sand and gravel that have been reworked by glacial meltwater streams. In general, soils in Millis are well or moderately drained sands and gravel. The stream valley deposits consist of sands and gravels, with varying amounts of peat and organic swamp deposits.

1.2.2 Land Use and Demographics

Millis' original roots are as an agricultural community in the 17th and 18th centuries, developing into an industrial and manufacturing community fueled by mills, factories, brickyards, and foundries through the mid-twentieth century. With the closing of the mills and factories, Millis has over time maintained some of its rural character and transitioned to a 'bedroom' community where many residents commute for work to other cities and towns. Newer commercial development is focused along Route 109 in commercial plazas. (PCI, 2001). As discussed in Section 2.3.1.4 of the *Water Supply and Demand Assessment In Relation to Exelon Power 'West Medway II' Project* prepared for the Town of Millis (Kleinfelder, 2016) population projections predict a significant decline in Millis' population due to various factors including an aging population and migration trend data.

1.2.3 Water Resources Infrastructure

Wastewater: Over two-thirds of the Town residents are served by the Town sewer system. The system flows to the Charles River Pollution Control District (CRPCD) Waste Water Treatment Plant. The plant discharges treated water to the Charles River at a location near the intersection of Franklin, Medway and Millis, just downstream of Populatic Pond and located at the southwest corner of Millis. The remainder of Town is served by private on-site septic systems.

The Town of Millis is continuously evaluating its sewer system looking for deficiencies and opportunities to address infiltration and inflow (I/I), as a condition of its membership in the CRPCD. Based on information presented in the Phase III – Sewer System Investigations & Repair Summary Status Report (GCG, 2015), the Town of Millis has performed several I/I evaluations and repairs on its overall sewer system between 2008 and 2014 . The Status Report (GCG, 2015) states that through these investigations and repairs, 126,950 gpd of peak I/I have been removed to date and 51,700 gpd of peak I/I are remaining. In addition, the Status Report states that 23,760 gpd of clear flow investigations remain. As funding sources become available, the Town will continue its efforts towards quantifying and removing I/I from its sewer system.

Drinking Water: Millis' drinking water is supplied by six publicly owned and operated wells installed in sand and gravel aquifer deposits. The system consists primarily of a single pressure zone, with the exception of a small boosted pressure system on Walnut Street. The distribution system is served by 42 miles of 2-inch to 12-inch diameter water mains and two (2) active water storage standpipes with a combined usable capacity of 1.44 million gallons. The water system and recommended improvements has been described in detail by the 2010 Water Master Plan (W&C, 2010). According to the Millis Board of Health, there are 222 private wells in the Town.

The Town of Millis operates four Water Treatment Facilities (WTF). Water pumped from Wells 1 and 2 is treated at the George D'Angelis WTF, which utilizes air stripping for volatile organic compounds and chemical injection for disinfection using sodium hypochlorite and fluoridation

using sodium fluoride. Water pumped from Well #3 is treated at the Well 3 Treatment Facility and water pumped from Well 4 is treated at the South End Pond WTF. Both the Well 3 WTF and South End Pond WTF use chemical injection for pH control using sodium hydroxide and fluoridation using sodium fluoride. The Well 3 WTF has disinfection using sodium hypochlorite and the South End Pond WTF has emergency provisions for disinfection using sodium hypochlorite. Wells 5 and 6 are treated at the Norfolk Road WTF, which uses chemical injection for pH control using sodium hydroxide, fluoridation using sodium fluoride, and disinfection using sodium hypochlorite.

The six supply wells are summarized in Table 2:

Table 2: Existing Wells, Town of Millis, Massachusetts

Well #	Location	Normal Daily Output (1) (gpm/ MGD)	Year Installed(2)	Screen Dia.(2) (in)	Depth(2) (ft)	DEP (3) Maximum Daily Rate (MGD)	DEP (3) Maximum Daily Rate (gpm)	Hp	Maximum Daily Output5 (gpm/ MGD)
1	7 Water St.	130 / 0.187	1952	24	60	0.72	500	15	470 / 0.677
2	7 Water St.	74 / 0.107	1961	24	50	0.50	347	10	266 / 0.383
3	Birch St.	210 / 0.302	1972	24	60	0.75	521	40	650 / 0.936
4	Orchard St.	101 / 0.146	1983	24	53	0.86	597	50	585 / 0.842
5	Norfolk Rd.	99 / 0.142	1999	24	57	1.50[4]	1042	40	1,474 / 2.120
6	Norfolk Rd.		1999	24	62			60	
Total Capacity		**614 / 0.884**	**-**	**-**	**-**	**4.33**	**3,007**	**-**	**3,445 / 4.96**
Max Day Demand		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1,154 / 1.66**

Notes:

(1) Normal Daily Output values were calculated from summer 2015 daily pumping records provided by the Town of Millis (J. McKay, November 18, 2015). Summer 2014 was used for Well 4.
(2) Water System Master Plan, Woodard & Curran, June 2010
(3) Water Management Act Withdrawal Permit, Final, March 1, 2010. Permit also specifies an annual withdrawal of 292.00 MGY or a daily average of 0.80 MGD from permitted and registered sources.
(4) Wells 5 and 6 have a maximum wellfield capacity of 1.5 MGD and the operation of the wells is restricted by stream flow in the Charles River.
(5) Maximum Daily Output values were provided by the Town of Millis (J. McKay, December 2, 2015; J. McKay, December 3, 2015)

Millis has a current Water Management Permit maximum withdrawal (registration + permit volume) of 0.80 MGD, which is discussed in further detail in Section 2. In recent years Millis has pumped below this maximum withdrawal volume. Historic water use is discussed in Section 2.

Based on Kleinfelder's *Water Supply & Demand Assessment in Relation to Exelon Power 'West Medway II' Project Prepared for the Town of Millis* (Kleinfelder, 2016), the Town of Millis has adequate supply to meet both near–term (2018) and future (2035) average daily demand and maximum daily demand. Kleinfelder included the additional demand of known development projects, as provided by the Town of Millis and Exelon, in the calculation of the values. However,

the future (2035) average daily demand exceeds the current WMA permit limit, and the supply adequacy is marginal. Therefore, the Town of Millis is anticipated to need to request an increase in its current WMA permit limit if all known development projects were constructed. The reader is referred to the Kleinfelder 2015 report for further detail regarding the Town's available supply and projected demands.

Stormwater: Millis lies in the Charles River Basin and is subject to the total maximum daily load (TMDL) requirements described in the NPDES Phase II Small MS4 General Permit (MS4). According to the 2014 Draft MA MS4 Permit, Appendix F, the Town is required to decrease phosphorus loading from its stormwater runoff by 27%. This requirement is projected to present a significant capital cost for Millis and the other Upper Charles communities to implement. (HWG & AMEC, 2011). Millis will also be subject to the pathogen reduction requirements described in the 2014 Draft NDPES MS4 Permit to meet the bacteria and pathogen TMDLs for both the Charles River and Bogastow Brook.

2. Water Management Act Regulations and Millis

2.1 Millis' Supply Wells and Existing Water Management Act Permit

The Town has six local groundwater sources permitted under the Water Management Act; the sources and associated subbasins are summarized below in Table 3. Millis' WMA Permit approves a total withdrawal volume (permit + registered volume) of 0.80 MGD (292 MGY) for Period 1 (3/1/2010 – 2/28/2014). The WMA permit approves a total withdrawal volume of 0.99 MGD for Period 2 through 4 (2/28/2014 – 2/28/2029). Millis' WMA maximum withdrawal limit, for the final 5 year period (3/1/2024 through 2/28/2029), remains at 0.99 MGD. The Town's permitted withdrawal volume has not increased to 0.99 MGD (Period 2) because it was prepared under an interim methodology and will need to undergo MassDEP review and a permit amendment first, which is anticipated in 2017.

Table 3: Millis Supply Well & Subbasin Summary

Well #	Location	Subbasin & Subbasin ID #
# 1	7 Water St.	Bogastow Brook, #21123
# 2	7 Water St.	Bogastow Brook, #21123
# 3	Birch St.	Chicken Brook to Stop River, #21133
# 4	Orchard St.	Bogastow Brook, #21123
#5	Norfolk Rd.	Chicken Brook to Stop River, #21133
#6	Norfolk Rd.	Chicken Brook to Stop River, #21133

Millis' existing WMA Permit already includes the setting of a 'Baseline'. In the Millis 2010 Permit, baseline is defined as the larger of volume withdrawn during 2005, the average between 2003 and 2005, or the registered volume (whichever is highest). Millis' baseline was set at its reported 2005 withdrawal volume, or 0.80 MGD (292.56 MGY). The new WMA regulations have since revised the definition of baseline to include a 5% 'buffer'. Under the new regulations, Millis' baseline would be set at 0.80 MGD plus 5%, or 0.84 MGD. As described in the WMA Permit, Special Condition 10, the first time Millis' water withdrawals exceed baseline for a calendar year, Millis must perform an Offset Feasibility Study which includes a written analysis of the cost effectiveness of following various water management Best Management Practices (BMPs). The evaluation in Section 3 is intended to meet this requirement should it be required.

2.2 Summary of Existing Water Use Practices & Trends

In Millis' 2010 Water Master Plan (W&C, 2010), about $7.57 million dollars in system improvements were recommended for the 20 year planning period. In recent years, Millis has undertaken many improvements, including the following:

- Farm Street Tank was cleaned and inspected in 2014 and painted in 2015
- Master meter calibrated twice a year.
- Pumps at Well 3 and Well 4 were replaced within the last five years.
- Well 1 was cleaned within the last five years.
- Leak detection surveys are conducted approximately every year and leaks are repaired upon discovery.
- In 2011 a leak was identified in a 6" water main under the Charles and the water main was replaced.
- The Town reviewed all large water meter accounts in 2011 and determined that three laundromats and two car wash businesses had not been incorporated into the Town's billing system after their construction.

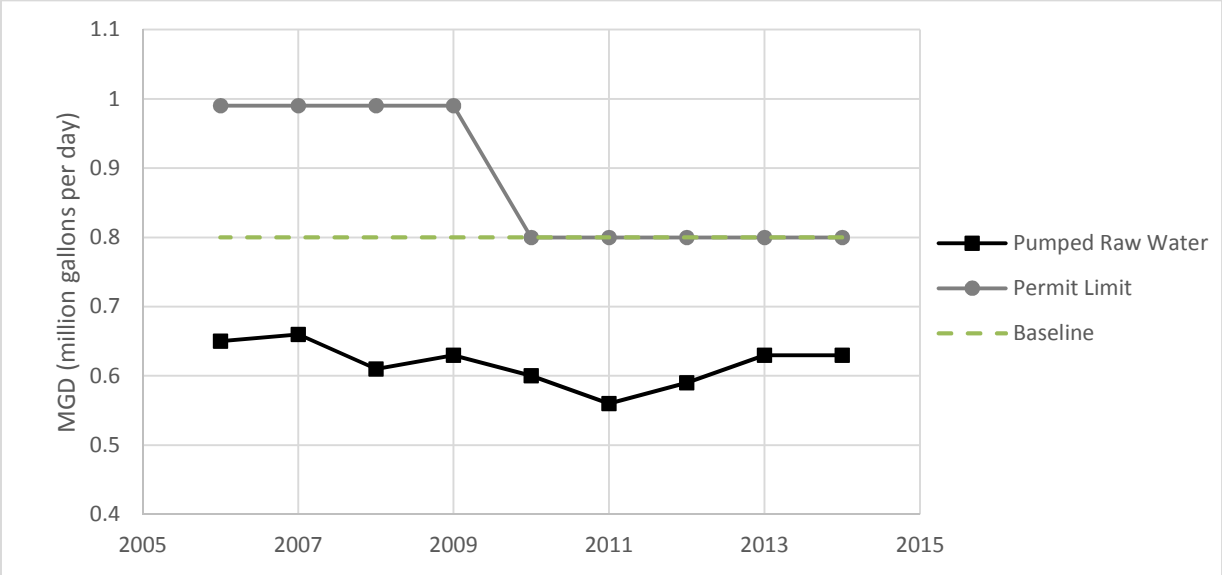
Water use statistics for recent years are summarized below in Table 4 and Figures 3 and 4. As shown in Figure 3 and Table 4, Millis' reported raw water withdrawal has remained relatively stable between 2006 and 2014, with slight fluctuations, between 0.59 MGD and 0.66 MGD. Millis' WMA Permit maximum withdrawal was reduced in 2010, and Millis has consistently been below its maximum limit of 0.80 MGD since 2010. In addition, Millis has historically been below baseline of 0.80 MGD.

Table 4: Millis Water Use Trends

	Raw Water Reported on Annual Statistical Report (MGD) [1]								
Well	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**
Well #1	0.125	0.139	0.146	0.156	0.107	0.112	0.151	0.185	0.132
Well #2	0.074	0.077	0.081	0.084	0.184	0.088	0.102	0.119	0.080
Well #3	0.180	0.173	0.036	0.063	0.152	0.134	0.177	0.210	0.139
Well #4	0.132	0.147	0.149	0.114	0.166	0.009	0.012	0.012	0.081
Well #5	0.152	0.177	0.195	0.176	0.291	0.193	0.197	0.232	0.132
Well #6	0.222	0.218	0.244	0.364	0.206	0.230	0.314	0.000	0.234
TOTAL (MGY)	**229.92**	**229.15**	**216.9**	**205.4**	**217.31**	**228.97**	**223.97**	**239.4**	**235.5**
TOTAL (MGD)	**0.63**	**0.63**	**0.59**	**0.56**	**0.60**	**0.63**	**0.61**	**0.66**	**0.65**
Max. Withdrawal Limit (MGD)	0.8	0.8	0.80	0.80	0.80	0.99	0.99	0.99	0.99
Over Limit (MGD)	Did Not Exceed Withdrawal Limit Between 2006 and 2014								
Over 0.80 Baseline (MGD)	Did Not Exceed Baseline Between 2006 and 2014								
UAW (%)	7.7	9.6	4.6	5.5	15.5	15.5	11.9	17	11.5
RGPCD (gpd)	57	56	56	52	55	53	54.6	58.12	58.5
MDD (MGD)	1.02	1.01	1.02	2.00	1.38	1.43	1.17	1.02	1.05

[1] Information obtained from ASRs between 2006 and 2014

Figure 3: Water Withdrawal in Millis, 2006 - 2014

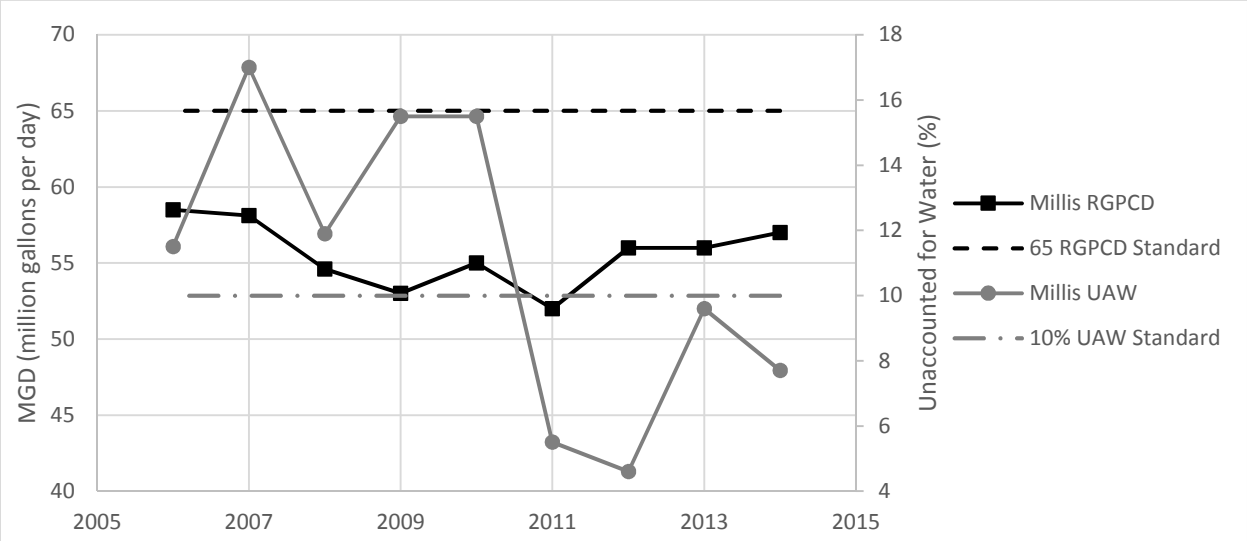


Millis' maximum authorized withdrawal was established in 2009 by the Department of Conservation and Recreation (DCR) through DCR's Water Needs Forecast methodology. The methodology used Town estimates of future water demands in 2009, the 2008 estimated population (8,208), and the estimated percent served by the water system (which was reported as nearly 100% by Millis) to project service and employment populations through 2029. Millis'

maximum withdrawal limit could change following an updated water needs forecast completed by DCR.

As seen below in Figure 4, Millis' reported residential water use has generally remained relatively stable since 2006, with slight fluctuations between 52.0 and 58.5 Residential Gallons Per Capita Per Day Water Use (RGPCD), and has been well below the state standard of 65 RGPCD.

Figure 4: Residential Water Use and Unaccounted-For Water



Conversely, Millis' unaccounted-for water (UAW) exceeded the 10% WMA Permit standard between 2006 and 2010. In 2011, the Town of Millis took several steps to reduce UAW including the repair of a leak in a 6" water main (Pleasant Street bridge water main) under the Charles River and an assessment of the Town's large meter accounts which revealed five businesses not incorporated into the billing system, which was corrected. Since 2010, the UAW has fluctuated below 10% (Figure 4). UAW is a challenging issue for many communities. Measures which may be helpful in maintaining low UAW or reducing UAW are discussed in more detail in Section 3.1.4.1.

As a community, Millis desires to grow its tax base by attracting responsible new development. There are a number of projects that may bring additional demand to the water system (C. Aspinwall, 2015). As discussed in the *Water Supply and Demand Assessment In Relation to Exelon Power 'West Medway II' Project* prepared for the Town of Millis (Kleinfelder, 2016), the potential demand of proposed developments and water reserves by 2018 and the proposed Exelon facility is estimated to be 0.025 MGD and 0.048 MGD, based on information provided by the Town and Exelon, for an additional ADD of 0.073 in 2018. Additional development will cause this sum to increase to 0.244 MGD by 2030. Therefore, for the purposes of this report and analysis, proposed and potential commercial/residential developments could represent up to 0.224 MGD of additional demand.

Millis has improved its operations with efforts such as meter testing, leak detection, and outdoor water restrictions. Millis' existing and potential additional demand management efforts are described in detail in Section 3.

2.3 Millis Sources and New Water Management Act Requirements

This section summarizes Millis' water supply in relation to the requirements of the current Water Management regulations that were promulgated in November 2014, and in relation to a potential increase in demand due to planned development and a potential sale of water from Millis to the Town of Medway.

As presented above in Table 3, Millis' six supply wells lie in subbasins 21123 and 21133 of the Charles River Basin. Millis' Wells #1 and #2 (located at 7 Water Street) and Well #4 (located on Orchard Street) are located in subbasin 21123. Well #3 (located on Birch Street) and Wells #5 and 6 (located on Norfolk Road) are located in subbasin 21133. The subbasin classifications are summarized below:

Table 5: Subbasin Characteristics [1]

Charles Subbasin & Subbasin ID #	Groundwater Withdrawal Category	Subbasin Biological Category	Millis Sources	August Net Groundwater Depletion	Aug GW withdrawal / unaffected streamflow (%)	Available Withdrawal without changing GWC (MGD)
Bogastow Brook, #21123	4	5	Wells #1, 2, and 4	29.5%	49.9	0.202
Chicken Brook to Stop River, #21133	5	5	Wells # 3, 5, and 6	46.1%	60.3	0

[1] SWMI Interactive Map and WMA Permitting Tool http://www.mass.gov/eea/agencies/massdep/water/watersheds/sustainable-water-management-initiative-swmi.html

The anticipated requirements of the new WMA Permit process are discussed below. It is indicated in each section, where the requirements are expected to apply to Millis. Kleinfelder has corresponded with MassDEP regarding these requirements. It should be noted, however, that the details of specific requirements will need to be identified via more in depth consultation with MassDEP.

The Town's sources are located in subbasins that have been categorized as GWC 4 and 5, as shown on Figure 2. Because its sources are located in GWC 4 and 5 subbasins, when the Town's permit is renewed, the Town will be subject to the Tier 1 requirements of minimizing existing impacts to the greatest extent feasible, taking cost into account. **This requirement, as summarized in Table 1, applies regardless of the Town's withdrawal in relation to baseline.** Minimization options are evaluated below in Section 3.1.

As seen in Figure 3, reported water withdrawals over the last 9 years have remained relatively stable and historically below baseline. Although current demand may not warrant request for

withdrawal above baseline during the upcoming 5-year permit review, potential future development demands (Section 2.2) could push Millis' demand above 0.8 MGD. The town of Millis estimates an additional demand for future development and water reserves of 0.176 MGD coming online between 2016 and 2035, with 0.136 MGD online by 2025. An additional 0.048 MGD for the proposed Exelon facility would increase the 2025 ADD to 0.843 and the 2030 ADD to 0.868 MGD, or 0.043 MGD and 0.068 MGD above the baseline, respectively. Withdrawals above baseline would require Millis to meet Tier 2 requirements (Table 1) to mitigate the volume to the maximum extent feasible. A mitigation analysis is presented in Section 3.2.

There are no cold water fisheries identified within the Town of Millis. The nearest cold water fishery resource is Shepard Brook, which is a tributary to the Charles River located in Franklin. Millis will not have to meet additional restrictions relating to cold water fisheries.

3. Millis Minimization and Mitigation Implementation Feasibility Study

A feasibility analysis of the options for minimization and mitigation under the new Water Management Act regulations was conducted for Millis. The analysis used the approach and methodology described in the MassDEP Water Management Act Guidance Document dated November 7, 2014. This study is also intended to meet the requirements outlined in Millis' existing Water Management Act Permit, Special Condition 10 for water withdrawals exceeding baseline. Kleinfelder utilized background information existing in previously completed studies or otherwise provided by Town staff, and assumptions where necessary to conduct a planning-level analysis. The feasibility evaluation and qualitative ranking of options considered the following factors: Millis' authority to implement the action, feasibility considerations and constraints, estimated volume of offset or water savings, synergy with other regulatory programs, if applicable, and cost to implement. The approach taken in this study was to examine all possible options for potential future credits and possible synergy with other regulatory programs, such as the NPDES MS4 and TMDL requirements. This analysis could help Millis to plan for future demands that might not be currently estimated.

As described in Section 1.1.2, Millis will be subject to Tier 1 minimization requirements due to the location of wells within a subbasin with an August net groundwater depletion of 25% or more. Upon renewal of the Town's WMA permit, the Town will be required to develop and implement a plan to minimize impacts as part of the requirements under the WMA permit regulations. The Minimization Plan must be submitted for review and approval by the MassDEP. Therefore, Kleinfelder assessed the feasibility of various minimization options, as discussed in Section 3.1 below.

In addition, Millis could be subject to Tier 2 requirements if Millis requests a withdrawal above its baseline (currently 0.80 MGD). For that reason, following the assessment of minimization options, Kleinfelder assessed the feasibility of various mitigation options, as discussed in Section 3.2 below. When reviewing adjustment and credits, as indicated in the WMA Permit Guidance Document, MassDEP is likely to prioritize mitigation in the following order: demand management, direct mitigation, and indirect mitigation.

3.1 Minimization of Existing Impacts

WMA Permit Guidance minimization options were evaluated for Millis in terms of feasibility of implementation and a planning level cost was developed for the three identified as the most feasible options. The options were qualitatively ranked and are summarized in Section 3.1.5. Each option is discussed in detail below in Section 3.1.1-3.1.6. Minimization options that represent demand management strategies are included in Section 3.2.

3.1.1 Optimization of Existing Resources

All six of Millis' current wells exist in subbasins with a GWC of 4 or 5 (Table 5), which means Millis must submit a plan to minimize existing flow impacts to the greatest extent feasible upon renewal of its WMA Permit. The subbasin 21123 has the potential to be forced into a higher GWC by additional withdrawals. However, this subbasin has approximately 0.202 MGD additional withdrawal capacity without changing from GWC 4 to GWC 5, according to the SWMI Water Management Act Permitting Tool on the MassDEP website. The subbasin 21133 is a GWC 5 with a higher August net groundwater depletion than subbasin 21123 (46.1% versus 29.5%). Additionally, the operation of Wells 5 and 6 in subbasin 21123 is already restricted in summer months by the flow of the Charles River as specified in the Millis WMA Permit. Based on these factors, a minimization approach was evaluated that increased summer withdrawals from subbasin 21123 while reducing them from 21133. This approach is consistent with the approach recommended by the WMA Guidance Document for desktop optimization analyses.

Conceptually, this approach would involve Millis increasing its pumping from Wells 1, 2, and 4 during the typically high demand and lower streamflow summer season since subbasin 21123 has additional capacity and a lower ratio of groundwater withdrawals to August median flow than subbasin 21133. A proposed pumping capacity was established for each well to more fully develop this alternative, as summarized in Table 6. Design capacity for the wells and water treatment facilities, permit limit, and historical and recent pumping records were used to establish the proposed, reasonably achievable pumping rates utilized for this analysis. A detailed discussion of the establishment of normal daily output and maximum daily outputs for the Millis wells was previously presented in the Water Supply and Demand Assessment Report (Kleinfelder, 2016).

At the current normal daily output, manganese levels at Well #4 are near the MassDEP Secondary Maximum Contaminant Levels of 0.05 mg/L, therefore a proposed increase in pumping rate at Well #4 is ruled-out. A proposed 68% increased output in Wells # 1 and 2 would maximize withdrawals from subbasin 21123 without altering its GWC, and result in a proposed normal daily output of 0.314 MGD and 0.180 MGD, respectively. The George D'Angelis WTF, which treats the water from Wells # 1 and 2, has a design capacity of 1.00 MGD sufficient to treat both wells pumping at those rates. With increased output from Wells # 1 and 2, there is opportunity to minimize withdrawals from subbasin 21133 by decreasing withdrawals. This optimization pumping scheme evaluated a 45% reduction in pumping rates from Wells 3, 5, and 6, which results in a proposed normal daily output of 0.166 MGD from Well 3 and 0.08 MGD from Wells 5 and 6 combined. There would be no net change in output under this proposed pumping scheme.

Table 6: Proposed Well Pumping Rates

Current			Proposed				Restrictions		
Well	Normal Daily Output		Change in Output		Normal Daily Output		Design Pump Capacity	WMA Max Daily Rate	Basis of Assumption
#	gpm	MGD	%	MGD	gpm	MGD	gpm[1]	gpm	
1	129.9	0.187	68%	0.127	218	0.314	463	500	Ensure additional withdrawals from subbasin 21123 do not exceed 0.202 MGD
2	74.3	0.107	68%	0.073	125	0.180	266	347	
3	209.7	0.302	-45%	-0.136	115	0.166	521	521	GWL 5
4	101.4	0.146	0%	0.000	101	0.146	585	597	Manganese levels near MassDEP Secondary Contaminant Level of 0.05 mg/L
5	98.6	0.142	-45%	-0.064	54	0.08	1042	1042[2]	GWL 5; Operation of wells restricted by streamflow
6									
Sum		0.884		0.000		0.884			

[1] ASR Reported Data
[2] Wells 5 and 6 have a maximum wellfield capacity of 1.50 MGD (1042gpm) and the operation of the wells is restricted by streamflow in the Charles River.

From July through September, Wells # 1 and 2 could theoretically provide a combined 45.44 MG at pumping rates of 218 gpm and 125 gpm, respectively, continuously for 24-hours a day. However, this mode of pumping is undesirable from a well recharge basis and unrealistic from an operational basis, assuming no maintenance shutdowns at all. A more realistic condition assumes an average operating day of 18 hours for each well from July through September. This operational approach would allow the wells to recharge and would also allow for occasional maintenance shutdowns.

At the subbasin level, Millis withdrew 36.29 MG from basin 21123 between July and September 2014 and 31.86 MG from subbasin 21133 during the same time period. While any reduction in withdrawals will be dependent on the magnitude and duration of maximum demand periods as well as operational considerations, we consider it reasonable to assume that the withdrawals from subbasin 21133 could be reduced by approximately 45% by prioritizing 21123 withdrawals during the summer and operating the wells an average of approximately 18 hours a day. That would correspond to a maximum average daily reduction in withdrawals from 21133 of approximately 0.2 MGD from July through September should the proposed pumping rates be implemented.

The proposed operational approach would optimize the withdrawals from the 21123 subbasin to minimize impacts to streamflow in subbasin 21133 during the summer period. This alternative is

considered a viable option to reduce the impact on the GWC5 21133 subbasin during the summer period. However, the cost differential anticipated due to the increased cost of operating Wells 1 and 2 at a higher pumping rate should be considered. Renovations to an air stripper associated with the treatment of water from Wells 1 and 2 and treatment system upgrades are currently scheduled for late-2016 or 2017. The Town of Millis has full authority to adjust well operations as proposed and has expressed a willingness to minimize impacts through this optimization strategy. Both subbasins are part of the larger Charles River basin, so there will be no net change on the macro basin level. . However, prior to implementation, costs associated with the renovations and treatment processes of this option should be evaluated to ensure no negative impact on the wells and on the water system's flexibility, and to evaluate any infrastructure rehabilitation or repairs that may be needed. Millis reports that an optimization study to be prepared by others will be conducted to further explore this option.

3.1.2 Releases from Surface Water Impoundments

The Town of Millis has three dams that impound surface water. The dams are located at Bogastow Pond, Richardson Pond, and Walkers Pond. South End Pond feeds Bogastow Brook, which leads into the Charles River. The Town is in on-going communication with the owner of the privately held property on which the Bogastow Pond dam is located, with the goal of possibly removing this dam, pending available funding. The dam is currently damaged and allowing significant flow, so could potentially be a candidate for evaluating removal. However, potential unintended consequences should be evaluated carefully. Millis' Well#4 is located on the shore of Bogastow Pond near its inlet. It is likely that the pond's storage provides recharge contributing to Well 4 and may help to buffer the impacts of Well 4 withdrawals on Bogastow Brook. According to Town officials, the other two locations (Richardson and Walker) would probably be poor candidates for dam removal projects.

The minimization alternative examined here calls for the Town of Millis to remove dams, as feasible, to supplement streamflow in the Charles River. Dam removal, while generally welcomed by regulatory agencies and beneficial to streamflow, can be quite costly. The feasibility of dam removal must be evaluated by studying the downstream hydraulic impacts and many other considerations, including sediment characterization and disposal. Feasibility studies and permitting costs are often comparable to the dam demolition costs. The only feasible option is the removal of the Bogastow Pond Dam, which is currently privately owned, so this option is rated as Poor. However, this option could be reconsidered in the future as a minimization option if the Town were to take ownership of the Bogastow Pond Dam.

3.1.3 Enhanced Nonessential Outdoor Water Restrictions

The Town of Millis currently implements calendar-based outdoor water use restrictions that prohibit nonessential outdoor water use between 9am and 5pm during the period between May 1st and September 30th. Under new permit regulations, since the net groundwater depletion in both subbasins in Millis is greater than 25% and household water use is less than 65 RGPCD, Millis will be required to implement additional nonessential outdoor water ban restrictions as follows:

Calendar Option:

- All season (May 1st through September 30th): outdoor water use is allowed a maximum of 2 days per week outside the hours of 9am and 5pm.
- When 7-day low-flow trigger occurs: outdoor water use is allowed a maximum of 1 day per week outside the hours of 9am and 5pm.

Or Streamflow Option:

- When flow is below the Aquatic Base Flow (ABF): outdoor water use is allowed a maximum of 2 days per week outside the hours of 9am and 5pm.
- When 7-day low-flow trigger occurs: outdoor water use is allowed a maximum of 1 day per week outside the hours of 9am and 5pm.

The two options presented above are compared in this minimization alternative.

In accordance with the Town's current WMA Permit, streamflow triggers would take effect if streamflow in the Charles River, as measured at the USGS Survey Gauge 01103280, for three consecutive days falls below the applicable ABF. During the period between May 1 and June 30, the June ABF of 59 cfs applies, and between July 1 and September 30, the August ABF of 20 cfs applies. The streamflow based restriction would remain in-place until streamflow at the gauge meets or exceeds the ABF trigger for seven consecutive days or until a Drought Advisory or higher is declared by the Massachusetts Drought Management Task Force. Both the Calendar and Streamflow Option include the same 7-day low-flow trigger. Therefore, to evaluate the Calendar Option minimization alternative, an analysis was completed to determine how many days the streamflow option would typically restrict use.

Using USGS published streamflow data from 2008 through 2014 at gauge 01103280, Kleinfelder completed an analysis of the potential water savings of a streamflow-based restriction by simulating the implementation of the Streamflow Option based on historic data. Average daily flow statistics from May 1st through September 30th over this 8-year period were examined, and based on historic averages, flow trends were established for dry years (25th percentile of daily streamflow), average years (50th percentile of daily streamflow), and wet years (75th percentile of daily streamflow). Figure 5 compares these flow trends to the appropriate ABF Streamflow Trigger.

For the 75th percentile trend, during the periods between May 1 to June 30 and July 1 to September 30, streamflow remained above the thresholds of 59 cfs and 20 cfs, respectively, which would permit outdoor watering throughout the entire 153 day summer period. At the 50th percentile, streamflow fluctuated on either side of the thresholds throughout the summer, with an estimated 65 days of permitted outdoor watering. For the 25th percentile, streamflow generally remained below each of the thresholds throughout the summer, with the exception of early-mid May when streamflow was at or above ABF. This resulted in approximately 61 permitted days of water. These estimates exclude periods when a 7-day low-flow trigger occurs, which would limit watering to 1-day per week rather than 2-days per week. Should a 7-day low-flow trigger occur during this period, which is likely in drier years, approximately the same number unrestricted days would decrease under either option.

Figure 5: Charles River Summer Streamflow (2008-2014) USGS Gauge 01103280

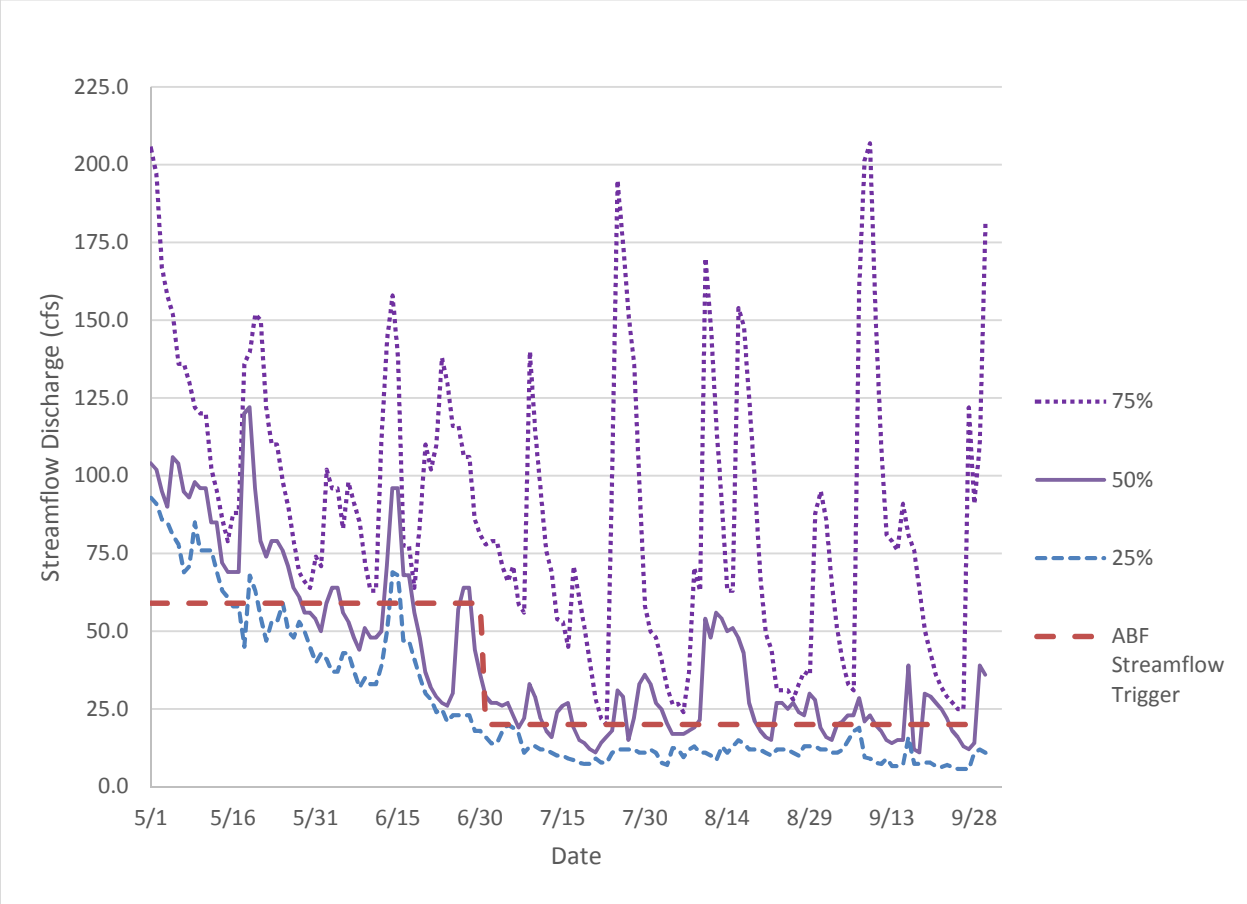


Table 7: Calendar Option Minimization

Percentile	# Unrestricted Days between May 1-Sept 30 using Streamflow Option[1]	# Unrestricted Days between May 1-Sept 30 using Calendar Option[1]
25%	61	44
50%	65	
75%	153	

[1] Should a 7-day low-flow trigger occur during this period, approximately the same number of unrestricted days would decrease under either option.

Based on Table 7, under a streamflow-based water ban option, residents would be allowed to water a total of 21 more days (at the 50th percentile) than if a calendar-based water ban was implemented. Using the calculation for unrestricted weekly water use, as outlined in SWMI Pilot Phase 1 Report, which assumes an average watering flowrate of 5 gpm and an average watering run time of 45 min/day, the approximate water used for outdoor watering at one residence over 21 days is 4,725 gallons. Based on an MAPC estimate from 2014, there are 3,030 households in Millis. Under the assumption that every household conducted outdoor watering during the additional 21 days, a total of 14.3 MG would be utilized for outdoor watering. Therefore, in Millis'

case, based on the evaluation of implementing the Streamflow Option at the 25th, 50th and 75th percentiles showing a lower number of unrestricted days in the Calendar Option, the Calendar Option would be an effective and feasible low cost minimization measure with a high benefit of reducing withdrawals. The potential minimization of withdrawals by utilizing the Calendar Option is evaluated as Good overall. Accordingly, we consider a calendar-based approach to achieve the greatest reduction in withdrawals of the outdoor water use restrictions.

3.1.3.1 Additional Restrictions to Outdoor Watering

The current seasonal water ban limits outdoor watering to the hours outside of 9am and 5pm; however, under the new WMA permit, regardless of the Minimization Option selected, when a 7-day low-flow is triggered, the Town would be required to enforce a restriction that limits outdoor watering to 1-day per week outside of the 9am-5pm hours. The Board of Selectmen has the authority to further restrict water usage by its customers. For example, during the high demand summer months, the Commissioners can elect to limit outdoor watering to 1-day or 0-days per week. Using the SWMI Pilot Phase 1 Table 4-7, the 1 day/week option represents a water savings of 15,300 gallons/household/year, representing a savings of 0.12 MGD compared to no restriction. A 0-day per week restriction would save an estimated 0.158 MGD compared to no restriction. These options are rated as Poor because although they provide significant savings with little to no monetary cost to the Town, the Town's future outdoor watering restrictions under the new regulations will already be significantly stricter than currently and additional restrictions are likely to be subject to strong public opposition. This option should be considered only if the Town begins to exceed their permitted withdrawal amount during the summer months.

3.1.4 NEWWA BMP Toolbox Options

The New England Water Works Association (NEWWA) Toolbox of Best Management Practices (BMPs) is developed by NEWWA for water suppliers to use as a 'menu' of various BMPs that can be considered for managing a water system. The WMA Permit Guidance document indicates that NEWWA Toolbox Options should be considered for minimization of existing impacts. Evaluation of several minimization Toolbox options is discussed below and summarized on Table 10. In addition, many of the NEWWA Toolbox BMPs are demand management options, which are discussed under Section 3.2, Demand Management.

3.1.4.1 Better Accounting for All Water Use

To reduce the amount of unaccounted water, the NEWWA recommends that Public Water Suppliers identify and quantify each component of real and apparent losses and takes action minimize the impacts when benefits to the water system, society, or environment outweigh the costs. In addition to water audits, the tools discussed in accounting for water losses include: identifying meter inaccuracies and repairing, replacing, or calibrating meters, as necessary; identifying unmetered and unauthorized uses through water audits and leak detection surveys; and considering best practices for data management to mitigate errors associated with data input and billing.

3.1.4.1.1 Meter Inaccuracies

NEWWA recommends that meters should be regularly calibrated to ensure the accuracy of measured quantity of water passing through the system. Accurately calibrated meters improve the ability for a water supplier to account for water losses and identify solutions. The Town of Millis uses a systematic approach to calibrating source water and finished water meters on an annual basis, with master meters calibrated twice per year. As necessary, the Town responds to requests for individual service meter inspection within the billing cycle, and aims to address potential issues expeditiously. As meters age, there is a greater potential for water to be under-registered. Testing meters of a given type (age, model, and size) provides a supplier with a better estimate of quantities of water missed between calibrations due to the tendency for meters to under-register or fail with increasing age. While meter inaccuracies do not directly reduce withdrawals, accounting for the variation in the meter age, model, and size through testing will allow Millis to accurately estimate the quantity of water missed between calibrations and identify meters that require calibration, repair, or replacement. Considering the systematic approach Millis currently uses to ensure accuracy of meters, the limited impact this BMP will have on minimization, and the costs associated with increased testing, this BMP option is evaluated as Poor.

3.1.4.1.2 Unmetered Uses and Unauthorized Uses

To ensure proper accounting for water, all uses should be metered or properly documented, even if a water bill is not issued. Under Town General Bylaws, all connections to the municipal water system require permits and the act of water meter tampering is restricted. The Town annually hires Liston Utility Service to perform a comprehensive survey of all 42 miles of the distribution system. The last survey was conducted in January 2015. In addition, the Town conducts water audits every three years. The Town of Millis is currently following the BMPs to meter all municipal facilities, meter water used by contractors, document water use for activities such as hydrant flushing using flow gauges, and restrict unauthorized use under bylaws, and should continue its current practices. In recent years the Town has identified and remedied several commercial unmetered users. Therefore, the Town could consider increasing the frequency of its water audits in order to identify water losses and adjustments required for metering system. Increasing the frequency of water audits would require additional testing of the water system and additional Town staff time, with likely minimal benefit. Therefore, this option is rated Poor.

3.1.4.1.3 Data Management

Data management errors, either from incorrect data entry when recording meter readings, incorrect software conversion factors, or improper billing, can impact water accounting. As discussed in previous sections, the Town of Millis conducts water audits on a recurring basis. The Town should sustain current practices to ensure billing accuracy. Large meter accounts are reviewed as part of the water audits and through the most recent water audit, five commercial facilities (two car washes and three laundromats) were identified as non-charged accounts. Therefore, the Town could consider reviewing large meter accounts more frequently to ensure that all commercial and business establishments are being billed and accounted for properly. Increasing the frequency of the review of large meter would require a minimal cost associated with additional Town staff time. This option is rated Fair.

3.1.4.2 Reducing Water Withdrawals

Reducing water withdrawals through increased efficiency and reduced demand has the potential to positively impact on streamflow. NEWWA outlines several methods to decrease the amount of water withdrawal including leak detection and repair, water distribution improvement projects, modifications to rates and billing structures, demand management programs for both indoor and outdoor water use, land use, and enforcement of regulations related to water use through plumbing code. These are each discussed below.

3.1.4.2.1 Leak Detection and Repair

The Town of Millis has demonstrated a proactive approach to leak detection and repair. To the best of its ability, the Town repairs any leaks associated with meters and any water main leaks that surface or are discovered in the public right-of-way. Funding is available for the repair of leaks through the Water Department. To detect and locate subsurface or hidden leaks and therefore reduce UAW, the Town annually hires Liston Utility Service to perform a comprehensive survey of all 42 miles of the distribution system, utilizing an acoustic (noise correlation) method, to detect leaks. This method is an externally based system that detects escaping liquids and correlates sounds with a location of a potential leak. This is a widely-used, cost-effective, and versatile option as it provides the opportunity to customize the survey design. It is possible to survey large areas or target specific higher-risk locations in the distribution network to detect leaks. The Town follows-up by investigating and responding to detected leaks.

Prior to 2010, Millis' UAW was above 10% but more aggressive efforts have paid off, including the detection and repair of some large leaks. In recent history, surveys identified few leaks (usually no more than 1-3). The most recent survey, in November 2015, detected a service leak of approximately 12 gpm on Himelflarb Street, which was subsequently repaired by the property owner. This resulted in direct and immediate reductions in water loss.

Table 8: 2015 Leak Detection Survey Results

Type	Location	Estimated Leakage (GPM)	Estimated Leakage (GPY)
Service	14 Himelflarb Street	12	6,307,000

The Town intends to continue with current practices and annual surveys, which is more frequent than the 3-year frequency established by the WMA permit, but is consistent with BMPs recommended by NEWWA to minimize impacts of withdrawals. In addition, alternating survey methods or using system isolation may be a beneficial lower cost alternative during annual surveys. Areas of town could be prioritized based on water main age, material, and break history to target smaller but higher risk areas for more comprehensive methods of leak detection. This technique can result in the discovery of a greater number of leaks or larger leaks during each survey. The costs may be dependent on the type of survey method but would likely be a minimal cost differential from the current system-wide surveys. For these reasons, this minimization option is rated as Good. Other more costly options for leak detection include internally based systems such as Balancing Systems (line, volume, mass), Real Time Transient Modeling (RTTM), Pressure and Flow monitoring, and Statistical analysis and externally based systems including fiber optic sensing cables, vapor sensing cables, and liquid sensing cables. These are not recommended at this time.

3.1.4.2.2 Distribution System Improvements

Improvements to the distribution system, including valve replacement and water main replacement of older mains prone to leakage, can minimize water loss. The Town of Millis has a systematic approach to improving the distribution system in implementing the recommendations described in the most recent System Master Plan (Woodard & Curran, 2010). As described in Section 2.2, the Town has taken a proactive approach to implementing the recommended improvements, and in 2015 began or completed projects in each of the three categories described above. As feasible, the Town should prioritize and complete recommended improvements from W&C 2010 Water System Master Plan which minimize impacts to streamflow or decrease withdrawals. Although improvements are dependent on many factors (including funding and public support), prioritizing improvements would yield a moderate environmental benefit with a low administrative cost to determine the improvements which should be prioritized. Prioritization could be refined by using a low cost risk-based approach to minimize probability and consequence of failure. Therefore, this option is rated Fair to Good.

3.1.4.2.3 Rate & Billing Structures

The Town currently bills water accounts on a quarterly basis. Each user is billed a base rate and a value based on usage rates. Base rates vary depending on the size of the metered pipe, with larger pipes, usually located at commercial properties, charged a higher base rate than smaller pipes, usually at residential properties. However, as shown in Table 9, below, usage rates are based on volume of water used, with the first 25,000 gallons of water per billing cycle charged at $2.77 per 1,000 gallons. Quantities of water greater than 25,000 gallons are billed at higher rates. Water bills include a quantitative description of the amount of water used (in gallons) as well as the accounts' past usage, which is consistent with NEWWA recommendations for descriptive billing.

Table 9: Water Usage Rate Structure

Number of Gallons	Tiered Rate ($ per 1,000 gallons)
0-25,000	2.77
25,001-50,000	4.40
>50,000	7.05

NEWWA describes additional options for water rates and billing structures which encourage conservation including: descriptive billing, full cost recovery, increased billing frequency, seasonal surcharges, blocked rate structures for varying types of accounts, and increased rates for irrigation meters. Each of the rate and billing adjustments aim to adjust the consumer valuation of water to account for the real cost of providing water. For example, NEWWA explains that imbedding the costs of infrastructure improvements in a general tax or deferring funding requests until a Town Meeting or until an external funding source is established could lead to lower rates on quarterly bills as opposed to including indirect costs for providing water services in billed rates. The price disparity could account for the need to, at times, postpone essential maintenance and improvements until funding sources are established. In addition, a low water bill may cause consumers to undervalue the cost of water, and potentially use more than is necessary.

Based on NEWWA recommendations, the Town could consider increasing the frequency of billing to monthly and evaluating and potentially adjusting its rate structure on a regular basis to encourage water conservation. The Town indicates that staff manually read large meters, which could be a factor to consider. Other meters are radio-read. The Town indicates that a monthly bill would be cost prohibitive at this time but would consider it in the future. An evaluation of the water savings cannot be determined without further study. Therefore, at this time, monthly billing is rated Poor, but could be reconsidered by the Town in the future. However, implementation of water conserving rate structures is moderate to low cost with potentially good benefit and so would be rated Fair.

3.1.4.2.4 Residential Indoor Demand Management

In previous years, the Town of Millis has participated in or coordinated programs to provide households with residential water saving devices. A recent partnership with a local contractor provided low-flow toilets to residents on a first-come-first-served basis. The Town has expressed willingness to continue coordinating or supporting giveaways to reduce residential indoor demand, provided that external funding is available and the community has interest. Millis currently meets WMA Permit standards of 65 RGPD, so a program to reduce residential use is not mandated. However, it may be worthwhile to consider funding opportunities to provide aerators, low flow showerheads, dye tables, and toilet displacement bags to reduce water use. Water savings for these devices are significant, with estimates for low flow showerheads at 2,900 gallons/family/year and aerators at 700 gallons/family/year. The costs associated with such a program would vary depending on the size of the program and without a currently identified source of funding, this option is rated Fair to Poor.

3.1.4.2.5 Outdoor Demand Management

The Town of Millis has a Water Use Restriction Bylaw, which provides the Board of Selectmen with the authority to declare a State of Water Conservation. In addition, the Town has taken measures to reduce outdoor demand. For instance, irrigation controls and rain and moisture sensors are integrated into the sprinkler systems located on Town-operated playing fields. In previous years, the Town of Millis participated in regional initiatives to provide households with rain barrels. The Town has expressed willingness to continue coordinating or supporting outdoor water saving device giveaways to reduce outdoor demand, provided that external funding is available and there is interest within the community. For such giveaways, there may be opportunities to collaborate with local organizations to increase awareness throughout the community and decrease administrative burden on Town staff. Once a specific program is proposed or developed, the water savings and costs, which are anticipated to be low to moderate depending on the type of program and amount of participation, can be determined. Therefore this option is rated Fair.

3.1.4.2.6 Irrigation Alternatives

NEWWA BMPs include implementation of stormwater or greywater capture and reuse, conversion of wet ponds for irrigation, and reclaimed water stored in ponds. No existing bylaw or practices exist to ensure that planned irrigation systems or systems currently in place reflect the best available technology and no programs are in place to provide incentives to improve efficiency of

irrigation systems. However, the Town Hall Rain Garden Project, which includes a cistern to collect and store stormwater for irrigation, was completed in 2008 through a state-funded grant. Results from this demonstration project were broadcast on local television throughout November 2008. The Town could implement a similar rain garden project at other municipal buildings, at a relatively low cost by utilizing volunteers or grant funding. Since the water savings offset by the utilization of collected stormwater for irrigation is likely to be low, this option is rated Fair.

3.1.4.2.7 Non-residential Indoor Demand Management

The Town's current WMA permit states all municipally owned public buildings must be retrofitted with water-savings devices by January 1, 2014. The Town has taken steps to retrofit municipal buildings, as funding is available. To date, the Library, Police Station, Town Hall, and DPW have all been retrofitted with some or all of the required water-saving devices. Other municipal buildings, including Millis Public Schools, pose a significant financial obstacle for retrofitting projects due to their size, and therefore improvements are necessary. Once an inventory of required upgrades is developed, the water savings and cost can be determined. The Town Water Department should inform the School Department of the obligation and ask that funding be included in the school budget. Since retrofitting is required as a stipulation of Millis' WMA Permit, this option is rated Good.

3.1.4.2.8 Land Use Pattern Changes

This option looks at modifying development bylaws to promote and/or require conservation development, smart growth, and low impact development strategies. Such requirements can lead over time to increased infiltration of stormwater, promoting aquifer recharge, and reduced demand for outdoor water use. While effective, changes are incremental over time as they apply only to new or redevelopment projects.

The Town already has Planning rules and regulations that require all projects meet the Massachusetts Stormwater Standards. In addition, the current Town bylaws establishes smart growth criteria for mixed-use developments in Village Business District Zoning and list low impact development practices as an option for obtaining a permit to increase residential density within a development. At a low administrative cost, the Town could review the current regulations in place and potentially revise them to include more strict guidelines for low impact development and smart growth. The implementations of revised or new regulations would require a vote of approval by the public, however. As described in the 2009 MS4 General Permit Annual Report, the Town developed and presented at a Town meeting a stormwater bylaw to promote low impact development techniques and received significant opposition to the bylaw. As such, this option is rated Fair.

3.1.4.2.9 Rigorous Enforcement/Additional Plumbing Code Changes

The Town of Millis employs a Plumbing Inspector who is responsible for ensuring properties are in compliance with building codes established at the state level. Savings would be on a property by property basis and are estimated to be low for the administration effort required and this option is rated as Poor.

3.1.4.2.10. Private Well Bylaw

Private Wells are regulated under a Water Supply Regulation bylaw, adopted March 20, 1991. This establishes the requirements for and enforcement of a number of specifications including well location, design, operation to protect both public health (water quality) and impacts to streamflow (quantity). The Town has expressed interest in developing partnerships with private well users to optimize the timing of and the quantity of withdrawals. When the Town of Millis issues a water ban notice, the notice stipulates that all residences and businesses must adhere to the ban. However, the Town's bylaws stated that a State of Water Supply Conservation only applies to users of the town's public water system. The Town could consider revising the language of the bylaw to include private well users. This low cost option could produce moderate benefits (the ban would extend to the 222 private well users) due to minimized subbasin impacts and increased water savings. The revised water use ban would need to be approved at Town meeting and could face some public opposition. Therefore this option is rated Fair.

3.1.4.2.11 Mandatory Restrictions

Refer to discussion above in Section 3.1.3.

3.1.5 Summary of Feasibility, Benefit, Cost and Overall Rating: Minimization Options

Table 10 summarizes the minimization options evaluated for Millis in terms of feasibility of implementation, benefit (environmental and/or water savings) of implementation, cost to implement, and overall rating. A planning level cost was conducted for the following three minimization options: Optimization of Existing Resources, Enhanced Non-essential Outdoor Water Restrictions, and Modifying the Survey Method for Leak Detection and Repair, as these were determined to be the top three minimization options for implementation.

Table 10: Summary and Rating of Minimization Options

Item	Current Practice	Minimization Option	**Feasibility** Good (G) Fair (F) Poor (P)	**Benefit** High (H) Moderate (M) Low (L)	**Cost** High (H) Moderate (M) Low (L)	**Overall Rating** Good (G) Fair (F) Poor (P)
***Optimize Existing Resources**	N/A	Increase withdrawals from subbasin #21123 (Wells #1 and 2) and decrease withdrawals from subbasin #21133 (Wells #3, 5, and 6) during summer season (July - Sept.)	G	H	M	G
Releases from Surface Water Impoundments	N/A	Dam Removal Projects at Bogastow Pond, Richardson Pond, and/or Walkers Pond	P	L	M/H	P
***Enhanced Nonessential Outdoor Water Restrictions**	Calendar-based water ban; 7 day no 9am-5pm watering	Implement calendar-based water ban; 2day no 9am-5pm watering instead of streamflow triggered water ban	F	H	L	G
		1 day/week ban; 0 day/ week ban	P	H	L	P

Item	Current Practice	Minimization Option	Feasibility Good (G) Fair (F) Poor (P)	Benefit High (H) Moderate (M) Low (L)	Cost High (H) Moderate (M) Low (L)	Overall Rating Good (G) Fair (F) Poor (P)
NEWWA BMP Toolbox Options						
Meter Inaccuracies	Source and finished water meters calibrated annually. Master meters calibrated twice per year	Test meters of a given type (age, model, and size)	F	L	L	P
		Continue current practices	G	L	L	F
		Increase water audit frequency	F	L	M	P
		More frequent review of large meter account	F	L	L	F
		Continue current practice	G	M	L	F
***Leak Detection and Repair**	Repair leaks on an as-needed basis. Annual leak detection surveys of entire distribution system (42 miles)	*Modify survey method – prioritize certain areas	G	M/H	L	G
Distribution System Improvements	Implement improvements recommended in the 2010 System Master Plan	Prioritized improvements which minimize impacts to streamflow or decrease withdrawals	F	M	L	F/G
Rate & Billing Structures	Quarterly descriptive billing. Implement improvements recommended in the 2010 System Master Plan Billing structure includes two components: base rate (based on metered pipe size) and usage rate (based on volume of water used). Quarterly descriptive billing	Monthly Billing	F	L	L	P
Rate & Billing Structures Residential Indoor Demand Management	No current programs in place. Billing structure includes two components: base rate (based on	Water Conservation Rate Structure - evaluate and potentially adjust rate structure on a regular basis to	F	M	M/L	F

Item	Current Practice	Minimization Option	Feasibility Good (G) Fair (F) Poor (P)	Benefit High (H) Moderate (M) Low (L)	Cost High (H) Moderate (M) Low (L)	Overall Rating Good (G) Fair (F) Poor (P)
	metered pipe size) and usage rate (based on volume of water used).	encourage water conservation				
	Water Use Restriction Bylaw. Irrigation controls on Town-operated playing fields. No current programs in place.	Implement a program to reduce residential use	G	M	M/H	F/P
Outdoor Demand Management	Cistern at Town Hall. No current projects Water Use Restriction Bylaw. Irrigation controls on Town-operated playing fields.	Collaborate with local organizations to coordinate or support outdoor water saving device giveaways to reduce outdoor demand	F	L	M/L	F
Irrigation Alternatives	The Town has taken steps to retrofit municipal buildings, as funding is available. Cistern at Town Hall. No current projects	Implement Rain Garden Project at other municipal buildings	F	L	L	F
Non-residential Indoor Demand Management	Town regulations include MA Stormwater Standards, smart growth criteria, and low impact development practices. The Town has taken steps to retrofit municipal buildings, as funding is available	Inventory required upgrades and retrofit municipal buildings as identified in WMA permit	G	M	M/H	G
Land Use Pattern Changes	Plumbing Inspector is responsible for ensuring properties comply with building codes. No regulatory changes are currently planned Town regulations include MA Stormwater Standards, smart growth criteria, and low impact development practices.	Revise regulations to include more strict low impact development and smart growth criteria	F	M	L	F
Rigorous Enforcement/ Additional Plumbing Code Changes	No existing Private Well Bylaw Plumbing Inspector is responsible for ensuring properties comply with building codes. No regulatory changes are currently planned	Rigorous Enforcement or Additional Plumbing Code Regulations	P	L	L	P
Private Well Bylaw	No existing Private Well Bylaw	Extend seasonal limits on nonessential outdoor water use to private well users	G	M	L	F

Notes:
Feasibility and Overall Rating were analyzed as Good, Fair, or Poor (G, F, P)
Benefit and Cost were analyzed as High, Moderate, and Low (H, M, L)

Cost of Optimization of Existing Resources:
As discussed in Section 3.1.1, increasing withdrawals from Wells 1 and 2 during the high demand and lower streamflow summer season, while reducing withdrawals from Wells 3, 5, and 6 will minimize streamflow impacts to subbasin 21133. There are moderate marginal costs associated with increased pumping rates due to the cost to operate and maintain an air stripping system. Based on a review of available literature, unit costs for air stripping treatment ranges from $0.36 to $0.70 per 1,000 gallons of treated water, depending on pumping rate, technology used, initial concentration of contaminants, and final concentration of contaminants in water (Keller et al., 2006 & Stocking et al., 2006). These estimates accounted for the entire life of the treatment system, including startup costs, rather than marginal increases in flow rate, so the marginal unit cost for additional treatment in the Millis system would likely be below this range or on the lower end of this range. Assuming an additional 0.202 MGD withdrawn from wells 1 & 2 between July 1 and September 30 (92 days) and a marginal cost of $0.36 per 1,000 gallons, there would be an estimated marginal cost of $6,690 per year. There may be additional system upgrades required to implement this option which should be fully evaluated before proceeding. Millis reports that an optimization study to be prepared by others will be conducted to further explore this option.

Cost of Enhanced Non-Essential Outdoor Water Restrictions:
As discussed in Section 3.1.3, if the Town were to implement a calendar-based water ban instead of a streamflow-based water ban, the Town would reduce the number of days the Town could water outdoors by 21 days (during an average year). If it is assumed that an average household conducts outdoor watering for 45 min/day at an average flow rate of 5 gpm, then the 3030 households in Millis would save an approximate 14.3 MG during those 21 days. If the Town chose to implement the streamflow-based water ban, the Town would have to monitor the USGS local stream gauge 01103280 daily, to determine when the ban should be implemented and when the ban could be lifted. The Town would then need to notify residents each time a change to the water ban was enacted. Therefore, the streamflow-based water ban is likely to require additional Town staff time than would a calendar-based water ban. Potential resistance from the public and/or business community should be considered prior to implementation and the Town may want to consider conducting some proactive educational outreach activities to explain the environmental benefit of the additional restrictions. Since the Town is required to notify residents of the water ban under the WMA Permit, no matter which option is chosen, no additional cost is expected if the Town were to implement a calendar-based water ban.

Cost of Modifying the Survey Method for Leak Detection and Repair:
As discussed in Section 3.1.4.2.1, the Town of Millis conducts annual leak detection surveys and repairs identified problem areas as needed. However, the Town of Millis' water distribution system totals 42 miles and in recent history, surveys identified few leaks (usually no more than 1-3). Therefore, alternating survey methods or using system isolation may be a beneficial alternative during annual surveys. This technique could be targeted towards areas where leaks commonly occur or where infrastructure issues are known, which may result in the discovery of a greater

number of leaks during each survey. As shown in Table 8, the leak detection survey conducted in 2015 identified a 12 gpm (0.01728 MGD) leak on Himelflarb Street. Based on information provided by the Town, the leak detection survey conducted in 2015 cost $6,090. However, the cost to implement an alternative survey program, which focuses on certain portions of the water system each time, could vary depending of the type of survey conducted and the number of surveys conducted each year. It is assumed that the alternate survey could be conducted under current funding levels but may detect a larger number of leaks by focusing efforts in higher risk areas. The added cost for an evaluation to prioritize the system for targeted leak detection would be on the order of $3,000 to $4,000. As leak detection efforts can vary widely from event to event and the size of leaks found cannot be predicted, the cost per gallon is not a meaningful metric.

3.2 Mitigation Options

As described in Section 2.3, Millis will be subject to Tier 1 minimization requirements due to the location of wells within GWC 4 and 5 subbasins. In addition, Millis would be subject to Tier 2 requirements if Millis requests withdrawal above its baseline and would be required to implement mitigation measures. As discussed in Section 2.3, potential future development demands within the Town could increase Millis' demand above their baseline of 0.8 MGD. When DEP reviews the permit (estimated in 2018), the baseline will increase by 5% from 0.8 MGD to 0.84. The additional projected demand of 0.224 MGD for proposed developments and water reserves (which includes the proposed Exelon facility) to the projected 2030 ADD would require a total 2030 ADD of 0.868 MGD, or 0.028 MGD above the baseline.

Therefore, based on available information, Millis' likely foreseeable 'ask' or volume request above baseline, is not expected to exceed 0.202 MGD, which is the additional capacity of subbasin 21123 without changing the GWC or BC classifications (as discussed in Section 2.4.

Mitigation measures are volumetrically quantified and the total mitigated volume must be equal to the requested increase. Mitigation for withdrawals above baseline can be provided in three categories, in order of decreasing preference as stipulated in the WMA Permit Guidance Document: Additional Demand Management & Wastewater Adjustments, Direct Mitigation, and Indirect Mitigation. Each of these methods and associated options are discussed in Sections 3.2.1 through 3.2.4.

3.2.1 Additional Demand Management

Under WMA Permit regulations, each permittee is required to meet the following performance standards: a RGPCD of 65 gallons or less and a UAW value of 10% of total water withdrawals or lower. Per the WMA Permit Guidance Document the potential to reduce demand by achieving or exceeding these performance standards over the length of the WMA Permit can be evaluated as a method of offsetting a withdrawal volume over baseline.

3.2.1.1 Residential Use Efficiency

The Town of Millis achieved an average of 55 RGPCD over the past 5 years, with the highest RGPCD in the past five years in 2014 (57 RGPCD), which is summarized in Table 4 above.

The Town has met their WMA permit requirement of 65 RGPCD or lower over the past five years. Millis saved approximately 0.067 MGD by achieving 57 RGPCD in 2014 as compared to the

permit limit of 65 RGPCD. However, the Town should strive to maintain a yearly rate of 55 RGPCD or below in the future. Each year the Town would save 0.084 MGD by maintaining a rate of 55 RGPCD when compared to the permit limit of 65 RGPCD. Implementing additional conservation measures can help them meet this goal. Since the Town of Millis' RGPCD was slightly above 55 RGPCD over the last three years and the Town achieved a RGPCD of 55 or below in 2010 and 2011, the option to maintain a RGPCD of 55 is considered Fair.

If the target water efficiency were reduced to 50 RGPCD, the Town would have a total savings of 7 RGPCD (between the target and the 2014 RGPCD). In 2014, according to the Town's Annual Statistical Report there was a residential service population of 8,390. Based on this information, a total volume of 0.059 MGD would be saved beyond the water savings the Town is already achieving by maintaining a RGPCD below 65. This option should be considered only if the Town exceeds their permitted withdrawal amount in the future. In general, the option to increase residential use efficiency below 55 RGPCD is rated as Poor because the residents already implement measures to keep their RGPCD low and additional reductions may not be feasible.

3.2.1.2 Unaccounted for Water

The Town of Millis obtained an average UAW of 8.58% over the past five years, which is summarized in Table 4 above. The Town of Millis currently meets their WMA permit requirement of less than 10% UAW and has for the past four years. Millis saved approximately 0.015 MGD by achieving 7.7% UAW in 2014 as compared to the permit limit of 10% UAW. If the Town were to reduce their UAW by 1% to 6.7%, the additional water savings would be 0.006 MGD, beyond the water savings the Town is already achieving by maintaining a UAW below 10%. Although maintaining a lower UAW could be difficult, modifications as discussed in Section 3.1.4.1 could be considered in ordered to reduce UAW. The cost to implement additional measures to reduce UAW would be moderate; however, reducing Millis' UAW could have a high environmental benefit. Therefore, this option is rated Fair.

3.2.2 Wastewater Returns

Per the WMA Permit Guidance Document if a portion of the water withdrawn is returned to groundwater via septic systems, an 85% credit can be assessed for volume returned to the same major basin. The credit for wastewater returns via septic systems can be subtracted from the total volume that must be mitigated.

Based on available information, some parcels within the Town of Millis are not connected to the municipal sewer system and do have septic systems. Millis has reported that the most significant new planned development with septic is South End Farm, which, when completed, will have 49 units on septic. This is estimated to consist of approximately 5,700 gpd of water use, or 0.0057MGD. This would reflect a mitigation volume of 0.00485 (15% consumptive use).

3.2.3 Estimated Water Savings Through Additional Demand Management & Wastewater Returns

Millis saved approximately 0.067 MGD by achieving 57 RGPCD in 2014 as compared to the permit limit of 65 RGPCD and approximately 0.015 MGD by achieving 7.7% UAW in 2014 as compared to the permit limit of 10% UAW. This is a total estimated water savings of 0.082 MGD in 2014. By maintaining current practices and implementing a minimization plan as described in

Section 3.1, it is anticipated that the Town of Millis will maintain the performance standards achieved in 2014 in the future. As summarized in Table 11, if the Town of Millis were to reduce its RGPCD to 55 and its UAW to 6.7%, then the Town would save an estimated 0.105 MGD each year as compared to the permit limits.

Table 11: Estimated Water Savings of Additional Demand Management & Wastewater Returns

Item	Current Practice	Mitigation Option and Potential Adjustment
Residential Use Efficiency	Meet a RGPCD of less than 65, per WMA permit	WMA Guidance Document recognizes water efficiency through reduction in RGPCD as a potential adjustment. The Town should strive to maintain a yearly rate of 55 RGPCD or below in the future. Each year the Town would save **0.084** MGD by maintaining a rate of 55 RGPCD when compared to the permit limit of 65 RGPCD.
Unaccounted for Water	Meet a UAW of less than 10%, per WMA permit	WMA Guidance Document recognizes water efficiency through reduction in UAW as a potential adjustment. If the Town were to reduce UAW by 1% from 2014 UAW value (6.7%), the additional water savings would be **0.021** MGD, as compared to the permit limit of 10%.
Wastewater Returns	N/A	WMA Guidance Document recognizes septic system returns as a wastewater adjustment. It is estimated that the South End Farm Project could provide credit for **0.00485 MGD**

In addition, as discussed in Section 3.2.2, the Town of Millis may be eligible to obtain an adjustment for the volume of water currently returned to groundwater within the Charles River basin through septic systems. However, Kleinfelder was not able to conduct an analysis for current and future wastewater returns to determine if the Town could potentially receive a credit for wastewater returns based on the information available. This could be determined in the future from sewer GIS and a database of the number of septic systems.

Through additional demand management and wastewater adjustments the Town of Millis has the potential to save an estimated volume of water which is greater than the projected future demand above baseline 0.068 MGD. Kleinfelder also assessed the feasibility of implementing additional mitigation (direct and indirect) measures, should they be needed to meet future additional demand mitigation.

3.2.4 Direct Mitigation

Direct mitigation options are considered volumetric offsets that can be credibly quantified and have direct impact on streamflow by replenishing groundwater recharge, increasing streamflow or releasing surface water. Three primary areas being considered for credit are: surface water releases, stormwater recharge, and infiltration and inflow (I/I) removal. The options are discussed below and summarized on Table 12.

3.2.4.1 Surface Water Releases

Surface water releases were discussed above in Section 3.1.2, and are not considered a viable option for Millis.

3.2.4.2 Stormwater Recharge

There are opportunities to modify existing site specific stormwater management practices by redirecting stormwater from the piped drainage system to localized infiltration to recharge aquifers. The Town of Millis has already required the installation of stormwater recharge systems at 19 locations in the Town, which are listed below:

• Tuckerdale Way • DPW property • Kensington Place • CVS • Heritage Path • Forest Rd. • South End Farm • Millis Public Library • Millis Police Station • South End farms	• Hickory Hill • Spring St. apartments • New CVS • Milliston Place • Gold's Gym • Milliston Common renovations • JOPA/Town project • Rockville Meadows • Town Hall rain garden

It is possible that the Town could receive credit for existing stormwater recharge projects, either on private or public property, although MassDEP has not finalized guidance at this time. Once the guidance is final, the Town should seek credit for projects that have already been built.

However, there are other potential projects available to improve stormwater recharge going forward. On the whole, stormwater recharge mitigation may be achieved by redeveloping or disconnecting impervious surfaces currently draining directly to the Town's stormwater collection system.

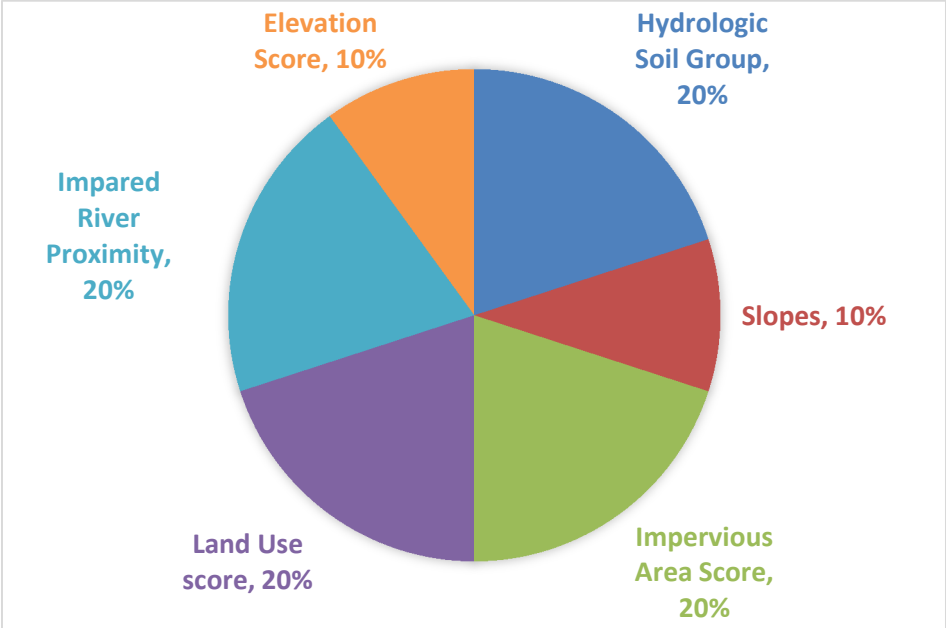
Kleinfelder conducted a GIS-based desktop screening analysis in order to identify potential additional areas for both enhancing storm water recharge and reducing total phosphorus export, on the parcel level, for the Town of Millis. The analysis utilized a scoring and ranking process that quantitatively evaluated sites where Green Infrastructure (GI) to increase stormwater recharge and decrease nutrient runoff is most appropriate, based on multiple criteria. For each parcel in the town, the following metrics were evaluated and used to assign ranking criteria:

- Hydrologic soil group
- Slope
- Elevation
- Impervious area
- Land use type
- Impaired river proximity

To increase recharge in subbasins from which the Town pumps public water, only town-owned parcels within the subbasins 21123 and 21133 were evaluated. Additional parcels excluded from the rankings include those classified to include preexisting wetlands, rare wildlife habitats, AUL/Chapter 21e Sites which have documented contamination of soil and / or groundwater.

Both graphical and tabular data identifying potential sites for stormwater recharge and GI is included below. As discussed further in section 3.2.4.3, *a*s projects are evaluated, a site specific investigation to quantify the stormwater recharge capacity for direct mitigation offset and site specific costs should be given further investigation.

Figure 6: GIS Based Screening Analysis Ranking Criteria for Stormwater Recharge Sites



Hydrologic Soil Group (20%): Using soil data retrieved from the USDA web soil survey, a dominant hydrologic soil type was assigned to each land parcel in the study area. Soils with high infiltration rates and low runoff potential are ranked highly (type A, B) and soils with high runoff potential and low infiltration rates are ranked poorly.

Slope / Elevation (10%): Flat slopes and areas of depression were ranked higher than steep areas for their ability to allow stormwater to collect and infiltrate into the underlying soil rather than flowing downhill. Using this metric, the lowest regions in the town are assigned the highest score, and the highest regions the lowest score. Parcels are also ranked by slope category, with the lowest score being assigned to slopes >17% and the highest to areas with slopes between 0-1%

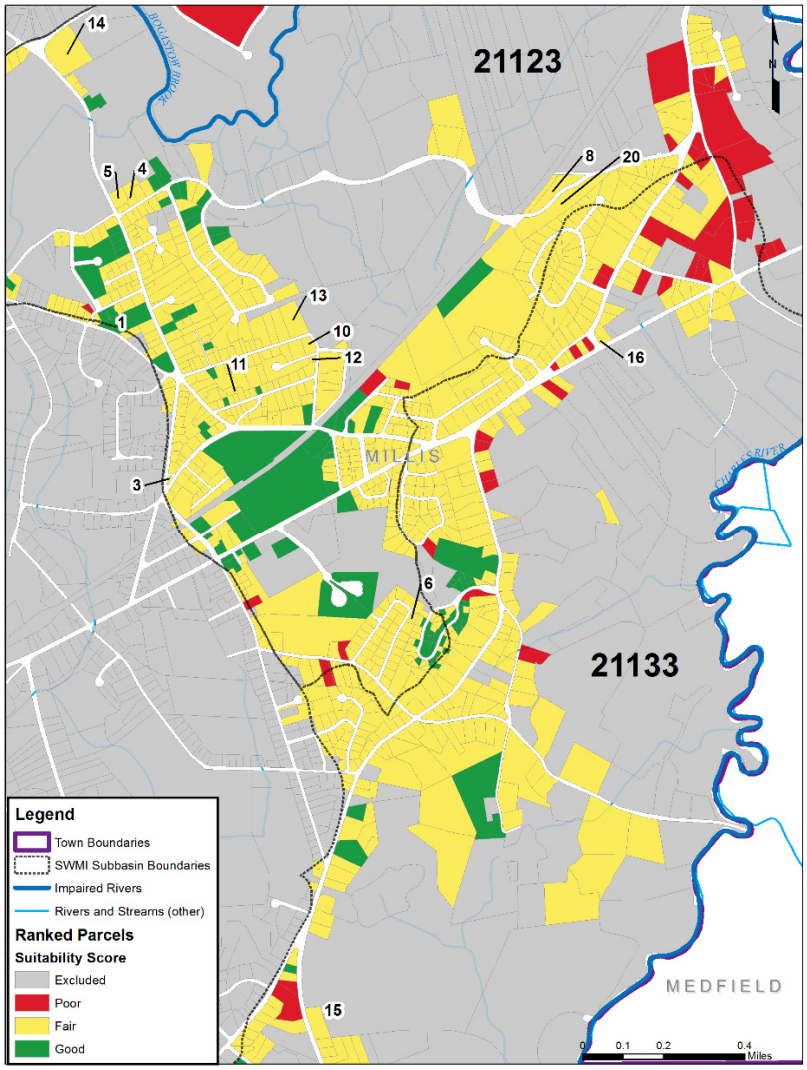
Impervious Area (20%): Parcels with a high percentage of impervious area were targeted using this metric. To calculate the impervious area percentage, the MassGIS Impervious surface raster layer was downloaded and analyzed on a per-parcel level. The impervious area percentage is calculated by dividing the impervious portion of each parcel by the total land area of each parcel.

Land Use Type (20%): Land use data was acquired from MassGIS and reclassified to fall into the 9 land use groups defined by the Massachusetts NPDES MS4 Draft General Permit – Appendix F Attachment 1 guidelines. These land use categories allow the ranking of parcels based on estimated phosphorus load export rates, where water quality is a factor.

Impaired River Proximity (20%): Parcels proximal to the rivers identified by MassDEP as impaired waterbodies with established TMDLs (Bogastow Brook and Charles River) were given preference using this ranking metric. The distance from each parcel to the edge of the closest impaired waterbody was calculated. These distances were scaled to a 0-100 ranking assigned to each parcel, where the closer a parcel is located to an impaired waterbody, the higher it will rank.

Parcel Ranking: Kleinfelder ranked the parcels and then evaluated Town-owned parcels to determine the most feasible and optimal locations for a future stormwater recharge structure. Figure 7 depicts each of the top-rated parcel's quantitative ranking, based on the parameters discussed above, as well as a qualitative suitability score of "excluded," "poor," "fair," or "good."

Figure 7: Stormwater Recharge Parcel Ranking



The highest rated option, the Millis Housing Authority located between Union Street and Exchange Street (labeled as 1, good), has an estimated half-acre of area available for GI improvements due to the large size of the parking lot. Based on the Assessor's database, the Town has the ability to implement GI improvements on this property since it is Town-owned.

However, funding for any project would need to be secured. Additional evaluation would be needed to develop a conceptual design for a proposed green infrastructure BMP.

Appendix A includes a ranking of the top-rated town-owned parcels in the subbasins of interest. as well as the estimated cost for implementing GI based on the size managed area, which is discussed further in Section 3.2.4.3.

As projects are developed, credits may be discussed on a site specific basis with regulatory authorities. Projects aimed towards GI improvements would have a moderate to high environmental benefit, depending on the scale of the project, due to the increase in stormwater recharge and reduction in total phosphorous to nearby surface waters or streams. This option has the benefit of meeting obligations under two regulatory programs, the WMA and the phosphorus TMDL and for these reasons is rated as Good.

3.2.4.3 Infiltration and Inflow Removal

Based on information presented in the Phase III – Sewer System Investigations & Repair Summary Status Report (GCG, 2015), the Town of Millis has performed several infiltration and Inflow (I/I) evaluations and repairs on its overall sewer system between 2008 and 2014 . The Status Report (GCG, 2015) states that through these investigations and repairs, 126,950 gpd of peak I/I have been removed to date and 51,700 gpd of peak I/I are remaining. In addition, the Status Report states that 23,760 gpd of clear flow investigations remain.

Based on WMA Permit Guidance, an assessment could be conducted utilizing the Guidelines for Performing Infiltration/Inflow Analyses and Sewer System Evaluation and the Town may be able to seek credit for proposed or completed Infiltration and Inflow removal. However, given the information provided, the level of potential credit could not be established at this time. Nevertheless this option would likely have a significant environmental benefit and is already required by the Town's obligations as a member of the CRPCD to reduce I/I and so the option is rated as Good.

3.2.4.4 Summary of Feasibility, Benefit, Cost, and Overall Rating: Direct Mitigation Options

Table 12 summarizes the direct mitigation options evaluated for Millis in terms of feasibility of implementation, benefit (environmental and/or water savings) of implementation, cost to implement, and overall rating.

Table 12: Summary and Rating of Direct Mitigation Options

Item	Current Practice	Minimization Option	**Feasibility** Good (G) Fair (F) Poor (P)	**Benefit** High (H) Moderate (M) Low (L)	**Cost** High (H) Moderate (M) Low (L)	**Overall Rating** Good (G) Fair (F) Poor (P)
Surface Water Releases	Refer to Table 10					P
***Stormwater Recharge**	N/A	enhancing storm water recharge at selected parcels	F	M/H	M	G

Item	Current Practice	Minimization Option	Feasibility Good (G) Fair (F) Poor (P)	Benefit High (H) Moderate (M) Low (L)	Cost High (H) Moderate (M) Low (L)	Overall Rating Good (G) Fair (F) Poor (P)
***Infiltration/ Inflow Removal**	Investigations and repairs conducted between 2008 - 2014. Conduct I/I removal as funding becomes available	Perform remaining I/I work identified. WMA Guidance Document recognizes completed I/I removal as a direct mitigation credit. Kleinfelder was not able to establish potential credit for previous I/I removal with the information in hand at the time of this report	G	M	M/H	G

Notes:
Feasibility and Overall Rating were analyzed as Good, Fair, or Poor (G, F, P)
Benefit and Cost were analyzed as High, Moderate, and Low (H, M, L)
*Top Rated Options

Cost of Stormwater Recharge Option:

As discussed in Section 3.2.4.2, the Millis Housing Authority was identified as the highest rated option for implementation of GI improvements, based on a GIS analysis. The site may be well-suited for bioretention technology, implementation of porous pavement, or other stormwater recharge improvements, with an estimated project cost on the order of $156,000. The cost was estimated based on the following analysis.

Planning level unit construction costs have become more readily available as more GI programs are implemented in the United States (USEPA, 2013 & USEPA, 2014). The unit construction cost estimates developed here referenced these resources with specific construction, design, contingencies, locational/temporal adjustments that were used to develop the unit construction costs, and unit life-cycle costs for evaluating the implementation scenario costs.

The estimate was prepared in accordance with the guidelines of the Association for the Advancement of Cost Engineering (AACE) International. According to the definitions of AACE International, the Class 5 Estimate is defined as the following:

> *This estimate is prepared based on limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes include but are not limited to, market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, and long-range capital planning. Examples of estimating methods used would include cost/capacity curves and factors, scale-up factors, and parametric and modeling techniques. Typically, little time is expended in the development of this estimate. The expected accuracy ranges for this class estimate are -20 to -50 percent on the low side and +30 to +100 percent on the high side.*

The unit construction costs from the ongoing GI programs for other communities (Onondaga County, New York and Lancaster, Pennsylvania and Boston) were used for this analysis (USEPA,

2014). Unit construction costs were not adjusted to account for the inherent locational and temporal differences, rather typical construction costs for GI per unit area were used the estimate project costs for the eleven highest-scoring municipal properties, excluding those without significant impervious area, as summarized in Appendix A. A summary of the costs for the top-rated result is included below, in Table 13.

Table 13: Cost Analysis for Top-Rated Stormwater Recharge Parcel

Site Description	Total Parcel Size (Acres)	Estimated Managed Area Sizes (Acres)	[1]Typical Construction Costs ($/acre area managed by GI)	[2]Construction Cost Year 2015	30% Contingency	Design and System Development Charges Cost	[3]Total Project Cost
Calculations		A	B	C = A x B	D = 30% x C	E = 25% (C + D)	F = C + D + E
Millis Housing Authority Parcel 19_021 UNION & EXCHANGE ST	3.07	0.500	$192,000	$96,000	$28,800	$31,200	$156,000

[1]Area managed by BMP multiplied by the BMP cost per unit area inclusive of the capital cost multipliers

[2]NPV of Construction Costs only

[3]Life-Cycle Costs = Present Value Cost of (Construction Costs + O&M Costs + Replacement Costs)

The cost is intended to be used as high level planning opinions and assumes that although it is possible to receive runoff from outside parcel area, the GI in suitable parcel only manages runoff from itself.

Cost of Infiltration/Inflow Removal Option:

Based on information presented in the Phase III – Sewer System Investigations & Repair Summary Status Report (GCG, 2015), GCG Associates, Inc. prepared a cost estimate ($265,350) for the repair of defects identified during prior investigations. GCG Associates, Inc. stated that the estimate was for the remaining open excavation repair work for removal of I/I, which included sewer main and manhole replacement and repairs. The Phase III – Sewer System Investigations & Repair Summary Status Report (GCG, 2015) also identified 51,700 gpd in remaining peak I/I to date. Therefore, based on the values presented in the 2015 Status Report, the cost per MGD would be $5.1M. Although the cost of I/I removal is high, the Town must implement the program as a condition of its CRPCD wastewater permit.

3.2.5 Indirect Mitigation

Indirect Mitigation options are those that are not easily quantifiable, but that provide a benefit to the environment by improving habitat, flow, water quality, stream continuity, or water supply protection. When a public water supplier's withdrawal request is above baseline and the volume requested cannot be offset via additional demand management, wastewater returns, and direct mitigation, the required number of additional indirect credits must be determined. The number of credits required depends on the remaining volume a public water supplier must offset once savings for additional demand management, wastewater returns, and direct mitigation have been subtracted from the requested volume above baseline. The November 2014 Water Management Act Permit Guidance Document provides a table (Table 9f-1) which correlates the volume of water which must be offset with the number of credits a supplier is required to obtain from the implementation of Indirect Mitigation measures. The Water Management Act Permit Guidance Document states that "*the credit values for specific activities are based on best professional*

judgement and are intended to provide a starting point for discussion" between the applicant and the MassDEP.

As previously discussed (Section 3.2), the additional projected demand of 0.184 MGD for proposed developments and water reserves to the current (2015) demand would require 0.072 MGD above the baseline. This volume is likely to be mitigated via additional demand management, wastewater returns, and direct mitigation options described in previous sections. Nevertheless, the feasibility of potential indirect mitigation options were evaluated qualitatively in order to provide a complete summary of options Millis might consider. In addition, there are other regulatory obligations that Millis could meet through certain indirect options. As identified in Table 9f-2 of the WMA Permit Guidance Document, strategies for indirect mitigation discussed below have been organized in the following categories and are summarized in Table 14.

Table 14: Indirect Mitigation Options

Indirect Mitigation Options	
Habitat Improvement & Protection	Remove a dam or other flow barrier
	Install and maintain a fish ladder
	Culvert Replacement to meet stream crossing standards
	Streambank restoration
	Stream channel restoration
	Stream buffer restoration
	Establish/contribute to aquatic habitat restoration fund
	Acquire property in Zone I or II
	Acquire property for other natural resource protection
Stormwater	Stormwater bylaw with recharge requirements
	Stormwater utility meeting environmental requirement
	Implement MS4 requirements
Wastewater	Infiltration/Inflow removal program
Optimization	Surcharge Reach
Demand Controls	Private Well Bylaw

3.2.5.1 Habitat Improvement & Protection

3.2.5.1.1 Dam Removal; Fish Ladder Installation

The removal of dam is considered mitigation worthy of significant credits under the WMA Permit Guidance because it would improve aquatic fish habitat by facilitating fish passage. There are three dams within Millis: Bogastow Brook Dam, Richardson Pond Dam, and Walkers Pond Dam. As discussed in Section 3.1.2, the option of dam removal is rated as Poor. Installing and maintaining a fish ladder at Bogastow Brook could also improve fish passage without having to remove the dam. The full extent of the potential benefit would need to be vetted with the Department of Fish and Game. Economically, however, this option would most likely only make sense if major repair or modification to the dam was planned to address structural hazards or flooding / hydraulic issues. For now, this option is rated as Poor but this option could be re-assessed and considered if the Town were to obtain ownership of the dam.

3.2.5.1.2 Culvert Replacement to meet Stream Crossing Standards

Older culverts are often not designed with wildlife passage in mind and may represent barriers to fish or other wildlife passage. The Massachusetts Stream Crossing Standards were developed to provide guidance on design of new or replacement culverts that promote wildlife passage, improve habitat continuity, restore natural hydraulics, and provide suitable streambed for aquatic organisms. Upgrading a culvert to meet Stream Crossing Standards would be eligible for indirect mitigation credit under the WMA Permit Guidance Document. The Town of Millis conducts culvert replacements on an as-needed basis and based on availability of funding. Recently the Town replaced a culvert on Causeway Street in July 2013 and based on the 2015 NPDES PII Small MS4 General Permit Annual Report, the Town is planning for a culvert replacement on Village Street. According to the WMA Permit Guidance Document (November 2014), culvert replacement to meet stream crossing standards is considered indirect mitigation and worth a total of 20 points (Water Quality Improvement = 5 points, Habitat Improvement = 5 points, and Stream Continuity Improvement =105 points) on the Table 9f-2 - Indirect Mitigation Activities and Potential Credits of the guidance document. Should the Town require further mitigation credits, it could seek credit for this practice with regulators. This option is rated as Good.

3.2.5.1.3 Stream Bank, Channel, or Buffer Restoration

This mitigation option would consist of implementing a stream restoration project. Eroded stream banks can choke streams with sediment, resulting in poor water quality and threatening aquatic species. Stream channels that have had natural hydraulics altered by armoring or straightening provide less diverse microhabitat for aquatic species. Stream buffer / riverfront area that has been cleared, paved, or is built upon delivers pollutants in runoff more directly to the stream. The Town is not aware of any areas in Town where stream bank erosion or channel degradation is a particular problem. If undertaken in conjunction with planned projects for roadway improvement or culvert replacement, this option could be worth exploring further. Although channel/bank improvements would require permits from MassDEP and Army Corps, for a large roadway project the added cost may be modest. However, at this time no significant projects are planned in Millis. For these reasons, stream channel or bank project options are rated as Poor.

The restoration of stream buffer / riverfront area could be a relatively lower cost option possibly worth considering. A project involving plantings of native species and invasive species removal would be achievable using Town staff and existing resources, as well as volunteer residents. This would represent an opportunity for public outreach and involvement to get citizens involved in water resources protection. For example, Millis has several locations which are important recreational wildlife viewing locations for the community, including South End Pond and Richardson's Pond. If a portion of a Pond's shoreline was degraded, selected areas could be restored with native plantings. As a lower cost project with an educational component, this option is rated as Fair.

3.2.5.1.4 Aquatic Restoration Fund

The WMA Permit Guidance includes this option as a possible source of indirect mitigation. Some states (for example, New Hampshire) maintain a compensatory mitigation program where monetary contributions can mitigate projects where offsetting of impacts are infeasible by funding projects in other locations. However, Massachusetts does not currently have a state program like New Hampshire's. Even if a fund were to be established, either at the state or local level, with

economic pressures high, funds short, and Town infrastructure costs increasing, the business community may not support a monetary contribution that does not have a meaningful direct connection to benefits for the Town. Funds and staff effort is likely better directed towards local, hands-on projects such as clean-up days, stream buffer restoration, or other public involvement activities under the NPDES MS4 stormwater program. For these reasons this option is rated as Poor.

3.2.5.1.5 Acquire Property in Zone I / II

Acquiring and protecting land in the Zone II of a water supply helps protect the quality and capacity of the well by limiting impervious surfaces and thereby promoting filtering and recharge of rainwater into the aquifer. Within Millis, there are currently no parcels within the Zone I or II of the Town's wells identified as high priority and targeted for acquisition. The MassDEP maintains a grant program (Drinking Water Land Protection) that provides 80% funds towards the purchase of land for aquifer protection. However, a grant application would not rank highly and the cost for this action is not likely to be publicly supported if no parcels have been already identified for protection and so this option does not rank high for Millis and was rated as Poor.

3.2.5.1.6 Acquire other habitat for natural resource protection

There are currently no parcels identified as high priority and targeted for acquisition. The cost for this action is not likely to be publicly supported if no parcels have been already identified for protection, so this option was rated as Poor.

3.2.5.2 Stormwater

3.2.5.2.1 Stormwater Bylaw with recharge requirements

The Town's current regulations were reviewed for stormwater control requirements that could be considered as mitigation for groundwater withdrawals, particularly recharge requirements. In accordance with their requirements under the National Pollutant Discharge Elimination System (NPDES) Phase II municipal separate storm sewer system (MS4) general permit, the Town has stormwater regulations in place that precludes illicit discharges or illegal dumping into the Town's drainage system. Millis' regulations include the following:

- The Town of Millis' Stormwater Management Regulations state that all developments of 1 acre or greater shall submit a Stormwater Management Plan which meets Massachusetts Stormwater Management Standards.
- The Zoning Bylaw establishes the Watershed Protection and Special Flood Hazard Zoning Districts in part to protect, preserve and maintain the water table and water recharge areas within present and potential water supplies. These areas include all special flood hazard areas designated as Zone A or AE on the Norfolk County Flood Insurance Rate map (FIRM) issued by the Federal Emergency Management Agency, all land that borders any natural water body that lies within a horizontal distance of 25 feet from the mean high water line, all water bodies encircled by the boundary lines of the District, and all land along designated brooks, tributaries and wetlands described as upland swamps or marshes. No building or structure shall be erected, constructed, or altered in these overlay districts without a Special Permit from the Town.

- The Zoning Bylaw establishes four Groundwater Protection Districts, Zone A, Zone II, Zone C, and Zone I. This bylaw is intended to preserve and protect existing and potential sources of drinking water supplies. Zone A includes all aquifers, Zone II includes Zone II areas delineated by MassDEP, Zone C includes watershed areas, and Zone I includes area within 400 feet of a public water supply. The Zoning Bylaw stipulates Special Use Regulations and Prohibited Activities for each Zone. The Special Use Regulations place limitations on the total impervious surface present and on-site sewer capacity as well as stipulating infiltration of stormwater run-off.
- The Zoning Bylaw stipulates that as part of the approval process for new commercial and industrial developments the Planning Board will review a site plan which must include measures to maximize groundwater recharge and protect groundwater quality.

Currently the Town of Millis applies the recharge standards from the MassDEP Stormwater Management Standards to proposed development. According to the WMA Permit Guidance Document (November 2014), stormwater bylaw with recharge requirements is considered indirect mitigation and worth a total of 10 points (Instream Flow Improvement = 5 points and Water Quality Improvement = 5 points) on the Table 9f-2 - Indirect Mitigation Activities and Potential Credits of the guidance document. Should the Town require further mitigation credits, it could seek credit for this practice with regulators. This option is rated as Good.

Additionally, the Public and Environmental Health Review Regulations and Standards establishes a zero net increase in the volume of runoff in proposed development. Beyond these existing practices, the Town could implement more aggressive recharge standard than that required by the MassDEP Stormwater Management Policy, which would allow more water to infiltrate to the groundwater and therefore replenish base flows while accommodating the potential increased runoff generated by the proposed development. However, as described in the 2009 MS4 General Permit Annual Report, the Town developed and presented at a Town meeting a stormwater bylaw to promote low impact development techniques. The Town received significant opposition to the bylaw and the bylaw was placed on hold.

3.2.5.2.2 Stormwater Utility

A stormwater utility would provide a stable source of revenue for stormwater system operation, maintenance, capital improvements that would include increased recharge, and overall compliance with NPDES Phase II requirements. An added benefit of a stormwater utility is that it typically includes a credit program that encourages reduction in stormwater quantity and/or pollutant loads by ratepayers which would incentivize the use of things like rain gardens, permeable pavement and reduction in impervious surface leading to increased recharge. It can also consolidate and coordinate program responsibilities that are currently dispersed under various departments and not fully recognized as services by the public. When done properly, the system is equitable (i.e. based on system demand).

There are considerable challenges to implementing a Stormwater Utility and a thorough process of public education to achieve stakeholder buy-in - early and often- is critical. Due diligence is critical to establishing a system that is defensible and fair. Due diligence must consider multiple 'tracks' including governance, program elements, legal/financial basis, public involvement and

adequacy of data. The process has parallels to business planning. Enabling legislation (MGL Ch 83.S16 and Ch40 S1A) allows the Town to establish a utility. A Town meeting vote would be required to pass an ordinance to put the utility into effect. The potential benefit as a stable revenue source is very high and once implemented, the administrative costs would be fairly low as it could be managed in parallel with the existing water utility. Existing grant programs are available that could fund stormwater utility implementation planning to define revenue potential and build public support. Nevertheless, due to the challenges associated with establishing a stormwater utility, at this time this option is rated Fair.

3.2.5.2.3 Implement MS4 Requirements

Millis is a NPDES Municipal Separate Storm Sewer System (MS4) Phase II regulated community and performs the following actions under its current stormwater management program:

- Public education and outreach which includes publishing news articles, distributing brochures and information at public events, making information available on the Town website, and incorporating water resources topics into the public school's curriculum in an effort to educate residents on the importance of reducing stormwater pollution.

- The Town has continued efforts to remove illicit discharges by testing its sewer system as needed to identify and eliminate improper connections. An outfall location and stormwater drain system map has been completed by the Town. The Town revises the map on an as needed basis as new development is constructed or changes are observed in the field.

- The Town practices pollution prevention and good housekeeping for its municipal operations through various activities. The Department of Public Services (DPS) sweeps 100% of its streets on an annual basis. The Town has a catch basin cleaning program in place and 100% of its catch basins are cleaned on an annual basis. Also, all DPW employees are trained in various topics related to the SPCC plan for the Highway Garage and stormwater.

According to the WMA Permit Guidance Document, work related to implementing the MS4 requirements, which result in increased recharge, is considered indirect mitigation and worth 10 points (Water Quality Improvement = 10points) on Table 9f-2 - Indirect Mitigation Activities and Potential Credits of the guidance document. This option is rated as Good for seeking of mitigation credits because it addresses two regulatory programs and the Town's progress is well underway.

3.2.5.2.4 Infiltration/Inflow Removal Program

As discussed in Section 3.2.4.3, The Town of Millis is continuously evaluating its sewer system looking for deficiencies and opportunities to address I/I. According to the WMA Permit Guidance document, implementing an I/I removal program is worth 5 credits for indirect mitigation, if approved by the MassDEP. However, obtaining credit for I/I as an Indirect Mitigation measure may not be possible if the Town applies for Direct Mitigation credit for I/I Removal (as discussed in Section 3.2.4.3). This option is rated Good because the Town already must implement the program as a condition of its CRPCD wastewater permit.

3.2.5.3 Summary of Feasibility, Benefit, Cost, and Overall Rating: Indirect Mitigation Options

As previously discussed in Section 3.2.5, if Millis were to request a withdrawal above baseline, this volume is likely to be mitigated via additional demand management, wastewater returns, and direct mitigation options described in previous sections. However, if Millis needed to implement Indirect Mitigation measures to offset a remaining volume of water the town could seek credit through various Indirect Mitigation options as shown in Table 14 and discussed in Sections 3.2.5.1 and 3.2.5.2. As shown in Table 15 below, many of the Stormwater Options are rated as Fair to Good, in part because they would address not only WMA Permit requirements but also NPDES MS4 Permit requirements. Continuing to implement the MS4 requirements and to explore a potential Stormwater Utility to fund future stormwater needs are good actions for the Town to take. Most of the Habitat Protection options are rated Poor.

Table 15: Summary and Rating for Indirect Mitigation Options

Item	Current Practice	Planned or Potential Indirect Mitigation Option	Feasibility Good (G) Fair (F) Poor (P)	Benefit High (H) Moderate (M) Low (L)	Cost High (H) Moderate (M) Low (L)	Overall Rating Good (G) Fair (F) Poor (P)	Possible Credit
Remove a dam or other flow barrier	See Table 10					P	25
Install and maintain a fish ladder	None	Install fish ladder at Bogastow Brook	P	M	H	P	10
***Culvert Replacement to meet stream crossing standards**	Town conducts culvert replacements on an as-needed basis and based on availability of funding	Culvert replacement on Village Street	G	H	M	G	20
Streambank or channel restoration	No significant project are currently planned	Town is not aware of any areas in Town where stream bank erosion or channel degradation is a particular problem	P	M		P	15
Stream buffer restoration	No significant project are currently planned	Restoration of stream buffer/riverfront area - plantings of native species and removal of invasive species	F	M	L	F	15
Establish/ contribute to aquatic habitat restoration fund	None	Establish/contribute to an aquatic restoration fund. Funds would help improve aquatic habitat protection	P	L		P	5
Acquire property in Zone I or II	No current plans to acquire property	Acquire property within a Zone I / II	P	H		P	10
Acquire property for other natural resource protection	No current plans to acquire property	Acquire property for natural resource protection	P	H		P	5

Item	Current Practice	Planned or Potential Indirect Mitigation Option	Feasibility Good (G) Fair (F) Poor (P)	Benefit High (H) Moderate (M) Low (L)	Cost High (H) Moderate (M) Low (L)	Overall Rating Good (G) Fair (F) Poor (P)	Possible Credit
Stormwater bylaw with recharge requirements	The Town's Stormwater Management Regulations requires developments of 1 acre or greater to submit a Stormwater Management Plan which meets MA Stormwater Management Standards.	Adopt a town-wide stormwater bylaw	F	M	L	P	10
Stormwater utility meeting environmental requirement	None	Implement a Stormwater Utility	F	H	M	F	10
Implement MS4 requirements	Town is currently in the NPDES Phase II Stormwater Program	Continue to implement MS4 requirements	G	H	M	G	10
Infiltration / Inflow removal program	See Table 12						5
Surcharge Reach	See Table 10						10
Private Well Bylaw	See Table 10						10

Notes:
Feasibility and Overall Rating were analyzed as Good, Fair, or Poor (G, F, P)
Benefit and Cost were analyzed as High, Moderate, and Low (H, M, L)
*Top Rated Options

Kleinfelder identified the top Indirect Mitigation option as the replacement of the Village Street culvert. The Town could seek credit once this activity is completed (potential 20 credits). Based on the 2015 NPDES PII Small MS4 General Permit Annual Report, the culvert replacement is still in the design phase; therefore, the cost will be dependent on the final design. However, based on information from the Town, there are structural issues with the culvert and the Town will also consider stormwater improvement opportunities during the design/replacement. Therefore, there is a high benefit to replacing the Village Street culvert.

4. Summary of Analysis

The Town of Millis has taken many steps to better manage its water and to reduce demand, including leak detection and repair, water auditing, meter calibration, outdoor watering restrictions, and promoting conservation. These efforts are helping to minimize and mitigate impacts on flow-altered subbasins in the Charles River Basin. As described in Section 1.1.2, Millis will be subject to Tier 1 minimization requirements due to the location of wells within a subbasin with an August net groundwater depletion of 25% or more. Upon renewal of the Town's WMA permit, the Town will be required to develop and implement a plan to minimize impacts as part of the requirements

under the WMA permit regulations. **The top three minimization options were identified as Optimization of Existing Resources, Enhanced Non-essential Outdoor Water Restrictions, and Modifying the Survey Method for Leak Detection and Repair.**

In addition, Millis could be subject to Tier 2 requirements if Millis requests a withdrawal above its baseline (currently 0.80 MGD and anticipated to rise to 0.84 upon permit review) to meet projected demands. If the Town of Millis requests a withdrawal above baseline, mitigation measures would need to be implemented in order to offset the requested volume above baseline. The Town of Millis could request an adjustment for water efficiency through achieving a higher RGPCD and UAW than stipulated by the WMA Performance Standards. In addition, the Town of Millis could request a potential adjustment for current and future wastewater returns through septic systems. However, if the Town is not able to offset the requested volume above baseline via adjustments the Town would need to implement mitigation measures. For that reason, Kleinfelder assessed the feasibility of various mitigation options, as discussed in Section 3.2. **The top three mitigation options were identified as: Stormwater Recharge Projects, Infiltration/Inflow Removal and the replacement of the Village Street Culvert.**

5. List of References

Kleinfelder's scope of review was limited to documents provided by the Town of Millis and its representatives, as summarized below.

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APPENDIX A
GIS Analysis Top-Rated Stormwater Recharge Parcels

Figure A-1: Stormwater Recharge Locus Map

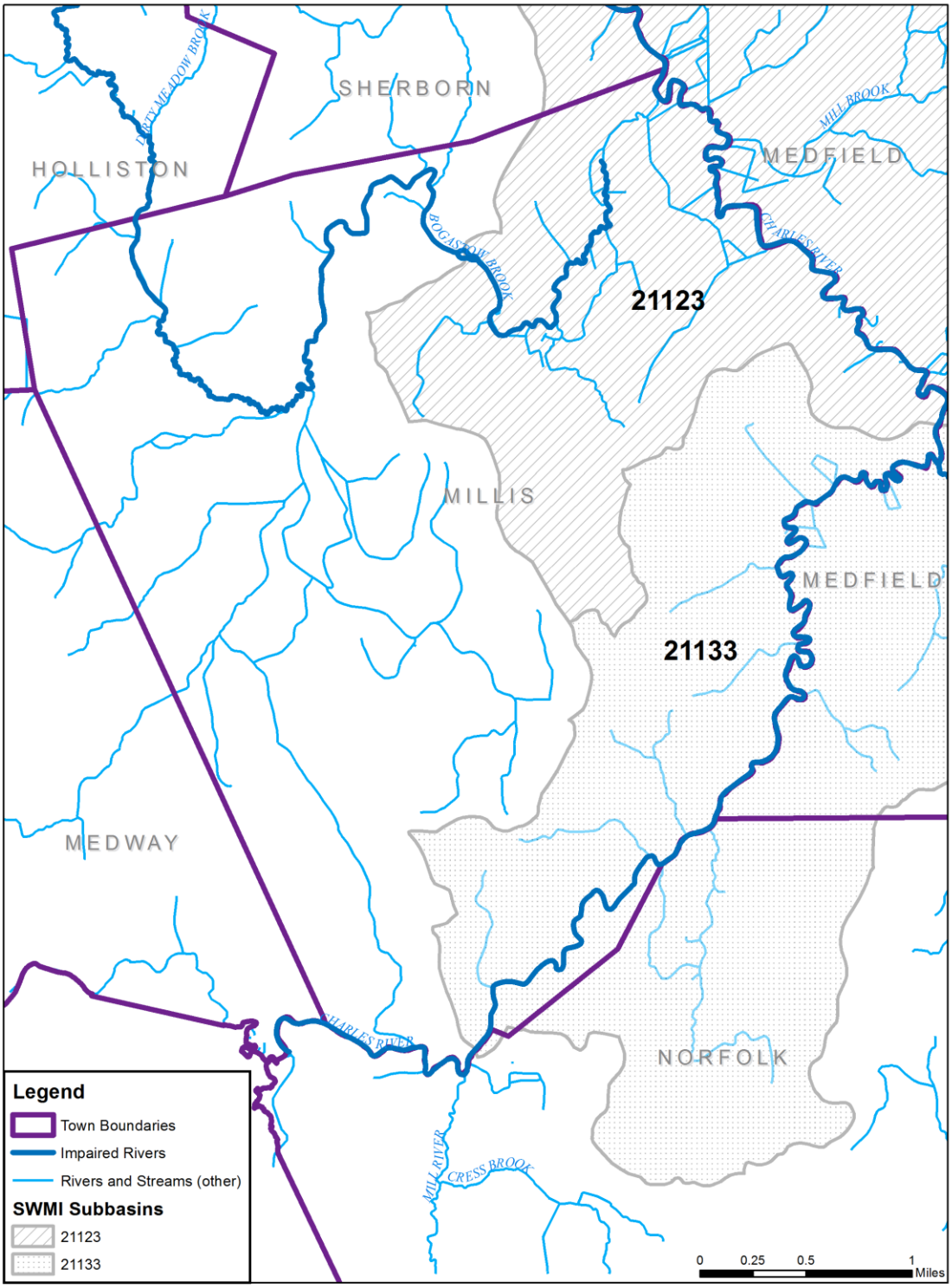

Figure A-2: Stormwater Recharge Centered

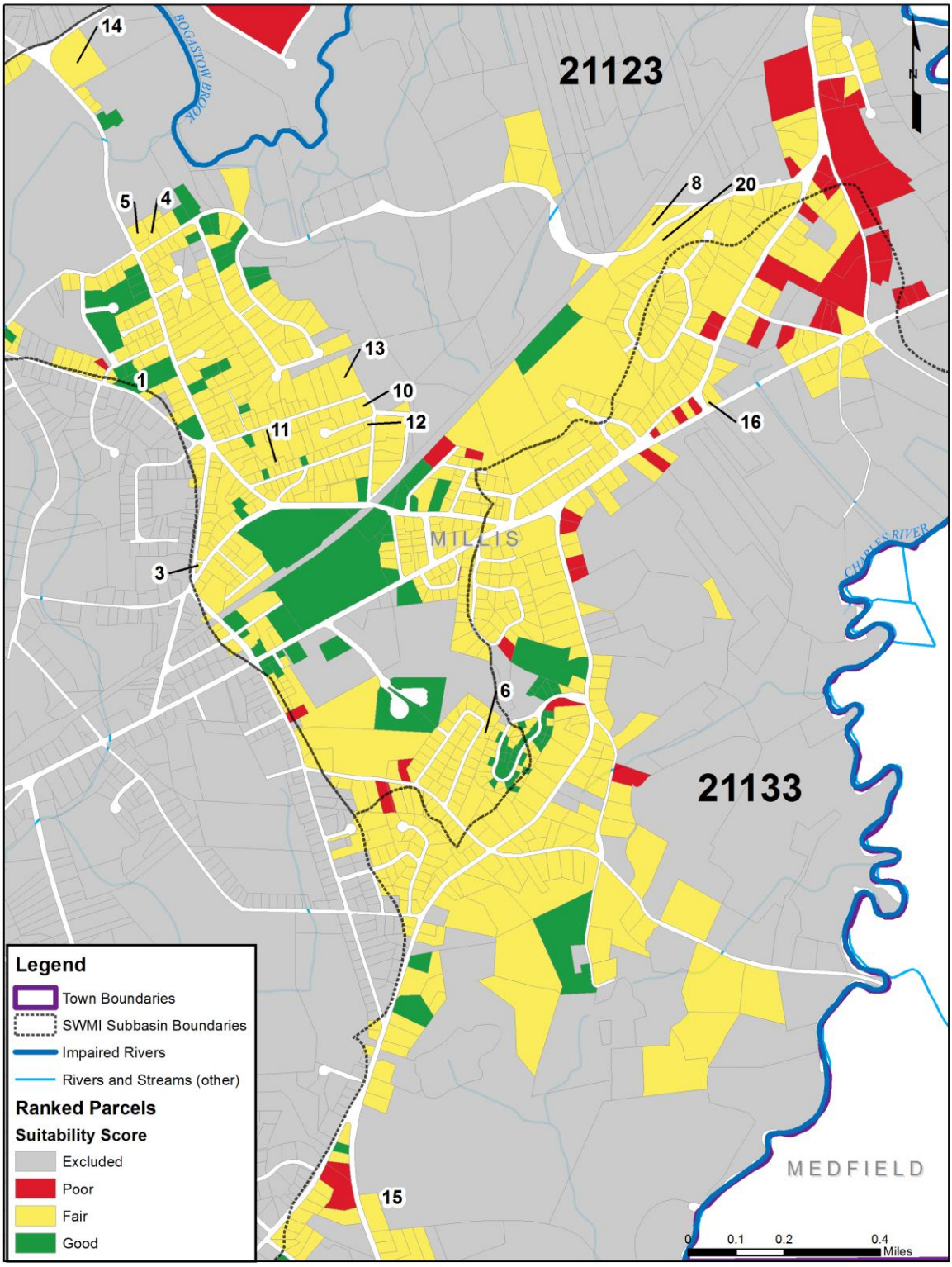

Figure A-3: Stormwater Recharge North

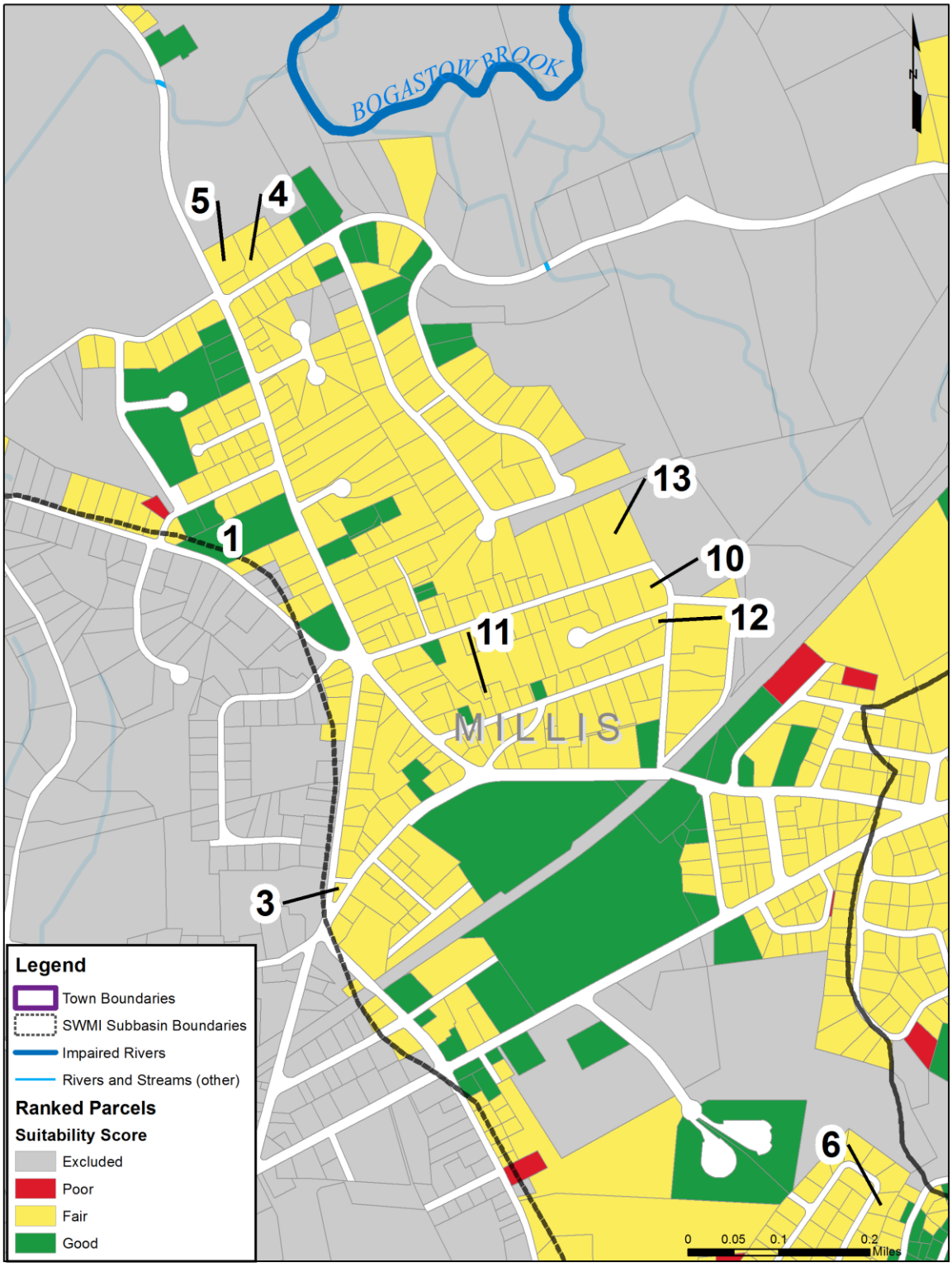

Figure A-4: Stormwater Recharge South

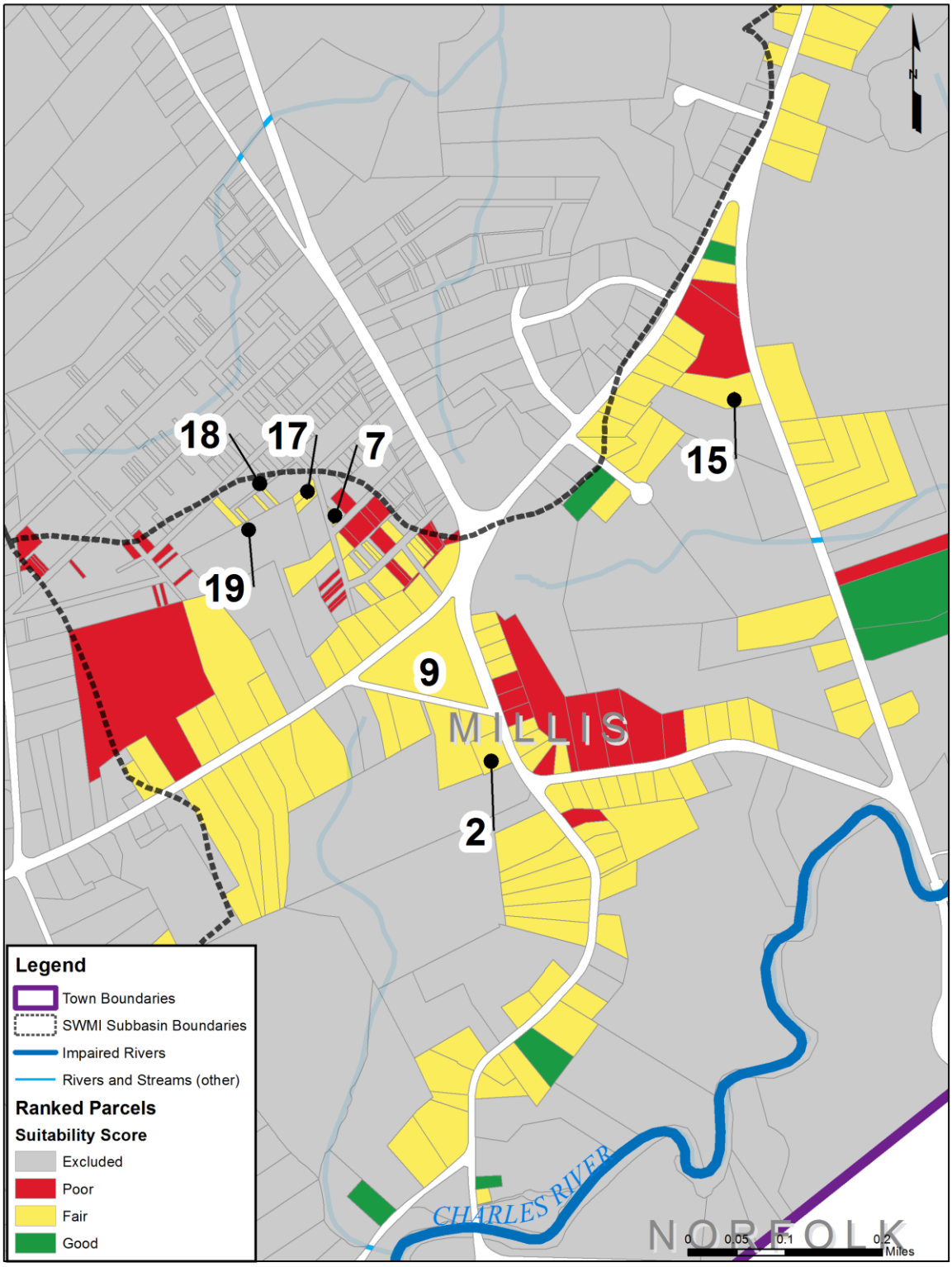

Table A-1: Millis Municipal Parcels GI Suitability Ranking

Rank #	Parcel ID	Site Address	Parcel Area (Acres)	Soil Type	Impervious Area (Acres)	Final Rank (%)
1	**19_021**	**UNION & EXCHANGE ST**	**3.07**	**A**	**1.34**	**72.1**
2	**43_013**	**185 PLEASANT ST**	**0.74**	**A**	**0.04**	**56.9**
3	**24_004**	**MEMORIAL PARK**	**0.12**	**A**	**0.04**	**56.5**
4	16_116	48 ISLAND RD	0.90	B	0.00	56.2
5	16_117	EXCHANGE ST	0.97	B	0.00	55.4
6	29_101	BOW ST	0.35	A	0.00	52.7
7	**40_103**	**MILLIS HGHTS**	**0.06**	**B**	**0.05**	**51.6**
8	**53_042**	**ISLAND RD**	**2.18**	**A**	**0.09**	**51.6**
9	**40_019**	**PLEASANT ST PARK**	**4.46**	**A**	**0.12**	**48.8**
10	19_116	VAN KLEECK RD	0.77	A	0.00	48.8
11	19_137	IRVING ST	0.07	A	0.00	48.1
12	19_155	DANIELS ST	0.14	A	0.00	48.1
13	**19_068**	**VAN KLEECK RD**	**2.51**	**A**	**0.03**	**46.2**
14	**11_042**	**ORCHARD ST**	**5.53**	**B/D**	**0.01**	**44.7**
15	**39_043**	**121 NORFOLK RD**	**1.99**	**A**	**0.13**	**43.7**
16	**26_014**	**DOVER RD**	**0.16**	**B/D**	**0.04**	**42.9**
17	40_096	BROAD ST	0.15	B	0.00	42.8
18	40_089	COURT PL	0.06	B	0.00	42.4
19	40_091	COURT PL	0.05	B	0.00	42.2
20	**53_043**	**ISLAND RD**	**5.61**	**A**	**0.02**	**42.2**
21	40_125	CONGRESS ST	0.12	A	0.00	41.4
22	52_014	WATER ST	0.34	A	0.00	40.8
23	40_090	COURT PL	0.05	B	0.00	40.3
24	40_128	MILLIS HGHTS	0.09	A	0.00	39.9
25	40_118	BROAD ST	0.07	B	0.00	39.8
26	40_120	MILLIS HGHTS	0.05	B	0.00	38.1
27	40_124	CONGRESS ST	0.07	A	0.00	37.8
28	40_127	CONGRESS ST	0.20	A	0.00	37.8
29	40_102	GEORGE AVE	0.23	C	0.00	33.1
30	44_009	PLEASANT ST	2.71	D, C/D	0.00	30.0
31	40_037	MILLIS HGHTS	0.05	D, C/D	0.00	27.8
32	40_036	MILLIS HGHTS	0.05	D, C/D	0.00	25.8
33	40_092	FEDERAL ST	0.06	D, C/D	0.00	25.6
34	40_068	MILLIS HGHTS	0.05	D, C/D	0.00	25.3
35	40_067	FEDERAL ST	0.11	D, C/D	0.00	25.2
36	40_039	COMMONWEALTH BLVD	0.06	D, C/D	0.00	24.4
37	40_093	HENRY ST	0.06	D, C/D	0.00	23.7
38	40_094	HENRY ST	0.06	D, C/D	0.00	21.6
39	40_066	1 MARGO PL	0.11	D, C/D	0.00	19.8

Bold values represent municipally owned parcels with estimated impervious area greater than 0.001 acres

Table A-2: Millis Municipal Parcels GI Cost Estimate

GI Suitability Rank	Parcel ID	Street Name	Total Parcel Size (Acres)	Estimated Managed Area Sizes (Acres)	[1]Typical Construction Costs ($/acre area managed by GI)	[2]Construction Cost	30% Contingency	Design and System Development Charges Costs	[3]Total Project Cost
				A	B	C = A x B	D = 30% x C	E = 25% (C + D)	F = C + D + E
1	19_021	UNION & EXCHANGE ST	3.07	1.34	$192,000	$256,779	$77,034	$83,453	$417,265
2	43_013	185 PLEASANT ST	0.74	0.04		$8,587	$2,576	$2,791	$13,955
3	24_004	MEMORIAL PARK	0.12	0.04		$6,805	$2,042	$2,212	$11,059
4	16_116	48 ISLAND RD	0.90	0.00		Excluded due to Managed Area Size			
5	16_117	EXCHANGE ST	0.97	0.00					
6	29_101	BOW ST	0.35	0.00					
7	40_103	MILLIS HGHTS	0.06	0.05		$8,935	$2,681	$2,904	$14,520
8	53_042	ISLAND RD	2.18	0.09		$16,357	$4,907	$5,316	$26,579
9	40_019	PLEASANT ST PARK	4.46	0.12		$23,094	$6,928	$7,505	$37,527
10	19_116	VAN KLEECK RD	0.77	0.00		Excluded due to Managed Area Size			
11	19_137	IRVING ST	0.07	0.00					
12	19_155	DANIELS ST	0.14	0.00					
13	19_068	VAN KLEECK RD	2.51	0.03		$6,140	$1,842	$1,995	$9,977
14	11_042	ORCHARD ST	5.53	0.01		$2,603	$781	$846	$4,229
15	39_043	121 NORFOLK RD	1.99	0.13		$25,079	$7,524	$8,151	$40,753
16	26_014	DOVER RD	0.16	0.04		$7,655	$2,297	$2,488	$12,439
17	40_096	BROAD ST	0.15	0.00		Excluded due to Managed Area Size			
18	40_089	COURT PL	0.06	0.00					
19	40_091	COURT PL	0.05	0.00					
20	53_043	ISLAND RD	5.61	0.02		$2,916	$875	$948	$4,739
Total				**1.90**		**$364,949**	**$109,485**	**$118,608**	**$593,042**

[1]Area managed by BMP multiplied by the BMP cost per unit area inclusive of the capital cost multipliers

[2]NPV of Construction Costs only

[3]Life-Cycle Costs = Present Value Cost of (Construction Costs + O&M Costs + Replacement Costs)